

**CATERPILLAR**  
**3406E, C-10, C-12, C-15, C-16 AND C-18 TRUCK ENGINE**  
**TROUBLESHOOTING**  
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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:** 1900

### System Operation

These engines were designed for electronic control. The injection pump, the fuel lines and the nozzles that are used in mechanical engines have been replaced with an electronic unit injector in each cylinder. A solenoid on each injector controls the amount of fuel that is delivered by the injector. An Engine Control Module (ECM) sends a signal to each injector solenoid in order to provide complete control of the engine.

### Electronic Controls

The engine's electronic system consists of the Engine Control Module (ECM), the engine sensors and the vehicle interface. The ECM is the computer. The personality module is the software for the computer. The personality module contains the operating maps. The operating maps define the following characteristics of the engine:

- Horsepower
- Torque curves
- RPM
- Other characteristics

### Engine Governor

The Electronic Controls on the engine serves as the engine governor.

The Electronic Controls determine the timing and the amount of fuel that is delivered to the cylinders. These decisions are based on the actual conditions and the desired conditions at any given time.

The governor uses the accelerator pedal position sensor to determine the desired engine speed. The governor compares the desired engine speed to the actual engine speed. The actual engine speed is determined through the primary engine speed/timing sensor. If the desired engine speed is greater than the actual engine speed, the governor injects more fuel in order to increase engine speed.

The desired engine speed is typically determined by one of the following conditions:

- The position of the accelerator pedal
- The desired vehicle speed in cruise control
- The desired engine rpm in PTO control

### Timing Considerations

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

- Coolant Temperature Sensor
- Intake Manifold Air Temperature Sensor
- Atmospheric Pressure Sensor
- Boost Pressure Sensor

At start-up, the ECM determines the top center position of the number 1 cylinder from the signal from the secondary engine speed/timing sensor. After start-up, the ECM determines the top center position of the number 1 cylinder from the primary engine speed/timing sensor. The ECM decides when fuel injection should occur relative to the top center position and the ECM provides the signal to the injector at the desired time. The ECM adjusts timing for the best engine performance, the best fuel economy and the best control of white smoke. Actual timing cannot be viewed with the Caterpillar Electronic Technician (Cat ET), and desired timing cannot be viewed with Cat ET.

### Fuel Injection

The ECM controls the amount of fuel that is injected by varying the signals to the injectors. The injectors will pump fuel only if the injector solenoid is energized. The ECM sends a high voltage signal to the solenoid. This high voltage signal energizes the solenoid. By controlling the timing and the duration of the high voltage signal, the ECM can control injection timing and the ECM can control the amount of fuel that is injected.

The personality module inside the ECM sets certain limits on the amount of fuel that can be injected. The FRC Limit (Fuel) is based on the boost pressure. The FRC Limit (Fuel) is used to control the air/fuel ratio for control of emissions. When the ECM senses a higher boost pressure, the ECM increases the FRC Limit (Fuel). A higher boost pressure indicates that there is more air in the cylinder. The ECM allows more fuel into the cylinder when the ECM increases the FRC Limit (Fuel).

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

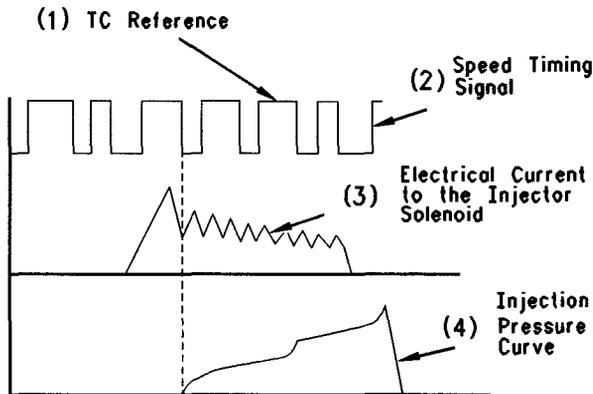


Illustration 1

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- (1) TC reference
- (2) Speed-timing signal
- (3) Electrical current to injector solenoid
- (4) Injection pressure curve

**Note:** The signals and the timing of Illustration 1 are not to scale.

## Cold Mode

The ECM will set cold mode when the coolant temperature is below 18 °C (64 °F).

Cold mode is activated five seconds after the start of the engine. During cold mode, low idle speed will be increased to 800 rpm. After 60 seconds, the engine speed is reduced to 600 rpm. Engine power will be limited until cold mode is deactivated.

Cold mode will be deactivated when the coolant temperature reaches 18 °C (64 °F).

## Customer Parameters And Engine Speed Governing

A unique feature with electronic engines is customer specified parameters. These parameters allow the vehicle owner to fine tune the ECM for engine operation. Fine tuning the ECM for engine operation allows the vehicle owner to accommodate the typical usage of the vehicle and the power train of the vehicle.

Many of the customer parameters provide additional restrictions on the actions that will be performed by the ECM in response to the driver's input. For example, the "PTO Top Engine Limit" is an engine rpm limit. The "PTO Top Engine Limit" is an engine rpm limit that is used by the ECM as a cutoff for the fuel. The ECM will not fuel the injectors above this rpm.

Some parameters are intended to notify the driver of potential engine damage ("Engine Monitoring Parameters"). Some parameters enhance fuel economy ("Vehicle Speed Parameters", "Cruise Control Parameters", "Engine/Gear Parameters" and "Smart Idle Parameters"). Other parameters are used to enhance the engine installation into the vehicle. Other parameters are also used to provide engine operating information to the truck engine owner.

## Engine Monitoring

Caterpillar provides a factory installed engine monitoring system. The Caterpillar engine monitoring system monitors engine oil pressure, coolant temperature, intake manifold air temperature, and coolant level (optional device). Optional devices are OEM installed.

The oil pressure, intake manifold air temperature, and coolant temperature sensors are standard on all engines. The Vehicle OEM installs the coolant level sensor and the associated harness. The coolant level sensor is the only optional component of Caterpillar engine monitoring. Coolant level is selected through a customer programmable parameter.

Caterpillar engine monitoring can be programmed to four different modes. These four modes of programming are the following modes: OFF, WARNING, DERATE, and SHUTDOWN. The coolant temperature sensor, the oil pressure sensor and the coolant level sensor (optional device) will operate in the engine monitoring mode that is selected.

For example, if DERATE mode was selected, the engine will derate engine power and vehicle speed. The engine will derate engine power and vehicle speed if the coolant temperature sensor, the oil pressure sensor or the coolant level sensor detects conditions that exceed acceptable limits.

An excessive intake manifold air temperature will not derate the engine. Also, an excessive intake manifold air temperature will not shut down the engine.

## Caterpillar Engine Monitoring

### OFF

If Caterpillar Engine Monitoring is programmed to OFF, the ECM will not flag low oil pressure, high coolant temperature, and low coolant level. No warnings will occur even though conditions that could cause the ECM to take action (Engine Monitoring) are exceeded.

The ECM still uses these sensors for engine operation. As an example, the Coolant Temperature Sensor is still used for cold mode operation.

**Note:** NOV01 and newer software does not allow the "Engine Monitoring Mode" to be programmed to "Off" except on engine serial numbers (S/N: W1A1-Up; MDP1-Up; MEP1-Up).

### WARNING Operation

If the system is programmed to WARNING, the ECM causes the warning lamp to turn on. This will also cause the Check Engine Lamp to flash because of the active diagnostic code. The flashing check engine lamp indicates that a problem has been detected by the engine monitoring system. No further action by the ECM or action by the engine occurs if the ECM is programmed to WARNING.

If the problem is due to one of the following conditions, the ECM will cause the Warning lamp to turn ON and the ECM will cause the check engine lamp to flash:

- Low Coolant Level
- High Coolant Temperature
- High Intake Manifold Air Temperature
- Low Oil Pressure

### DERATE Operation

If the system is programmed to DERATE, the ECM causes the warning lamp to turn ON. The warning lamp does not flash. Also, the ECM begins flashing the check engine lamp. The flashing check engine lamp indicates that a problem has been detected by the engine monitoring system.

This response is identical to the response when the system is in the WARNING mode.

The DERATE mode alters the engine performance when any of the following conditions exist:

- Oil pressure becomes Very Low Oil Pressure.
- Coolant level becomes Very Low Coolant Level.
- Coolant temperature becomes High Coolant Temperature.
- Coolant temperature becomes Very High Coolant Temperature.

Whenever the warning lamp is flashing, the ECM is limiting or derating the engine.

The ECM limits the maximum vehicle speed and the ECM reduces the available power when any of the following conditions exist:

- High Coolant Temperature
- Very High Coolant Temperature
- Very Low Coolant Level

If the ECM detects Very Low Oil Pressure, the ECM limits the following parameters:

- Maximum vehicle speed
- Available power
- Engine rpm

This derating of engine performance is provided in order to get the driver's attention so the driver can take action in order to avoid engine damage.

### SHUTDOWN Operation

If the system is programmed to SHUTDOWN, the ECM takes all the action that is indicated for the DERATE mode and the ECM will eventually shut down the engine under some conditions.

The SHUTDOWN mode will shut down the engine when any of the following conditions exist:

- Oil pressure becomes Very Low Oil Pressure.

- Coolant level becomes Very Low Coolant Level.
- Coolant temperature becomes Very High Coolant Temperature.

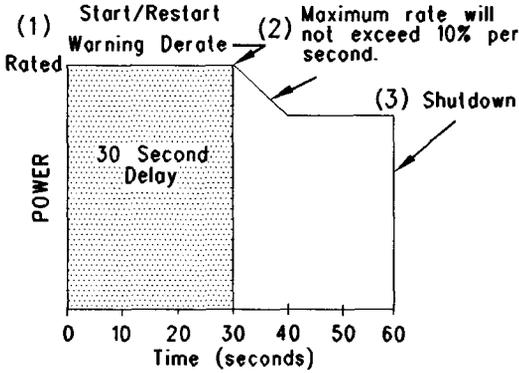


Illustration 2 g00628179

Graph of engine monitoring coolant temperature

- (1) Start or Restart warning derate
- (2) The maximum rate will not exceed 10 percent per second.
- (3) Shutdown

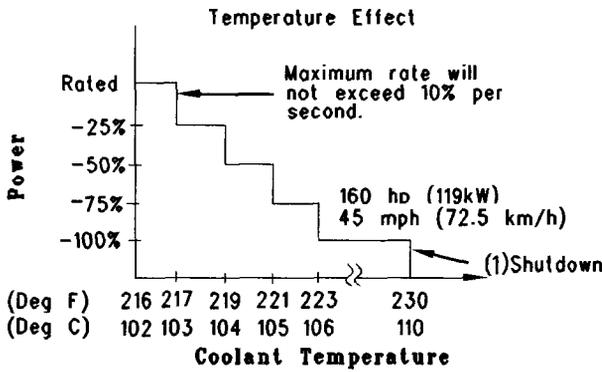


Illustration 3 g00628181

C-10 and C-12 Graph of engine monitoring coolant temperature

- (1) Shutdown

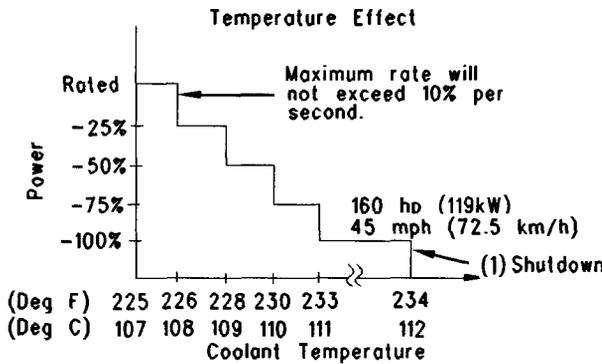


Illustration 4 g00628184

3406E, C-15, C-16 and C-18 Graph of engine monitoring coolant temperature

- (1) Shutdown

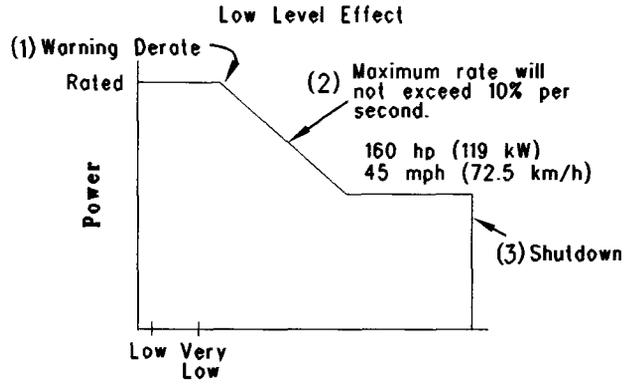


Illustration 5 g00628189

Graph of engine monitoring coolant level

- (1) Warning derate
- (2) The maximum rate will not exceed 10 percent per second.
- (3) Shutdown

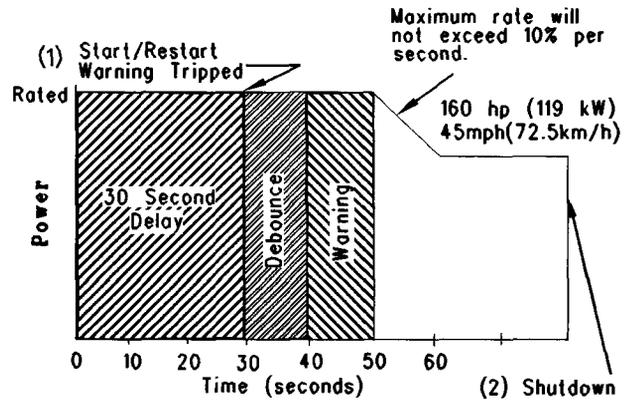


Illustration 6 g00628190

Graph of engine monitoring coolant level time

- (1) Start or Restart warning tripped
- (2) Shutdown

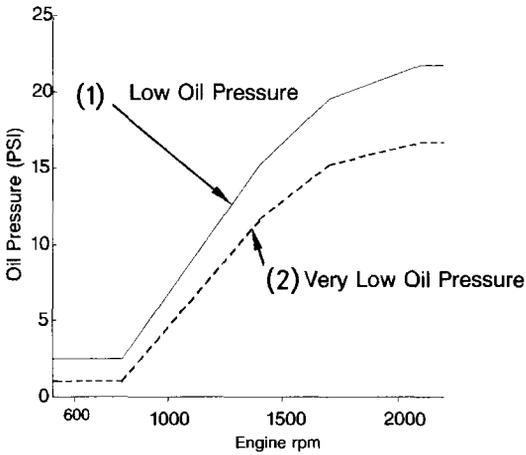


Illustration 7 g00732031  
 C-10 and C-12 Graph of low oil pressure for OCT99 and newer Personality Modules  
 (1) Low Oil Pressure  
 (2) Very Low Oil Pressure

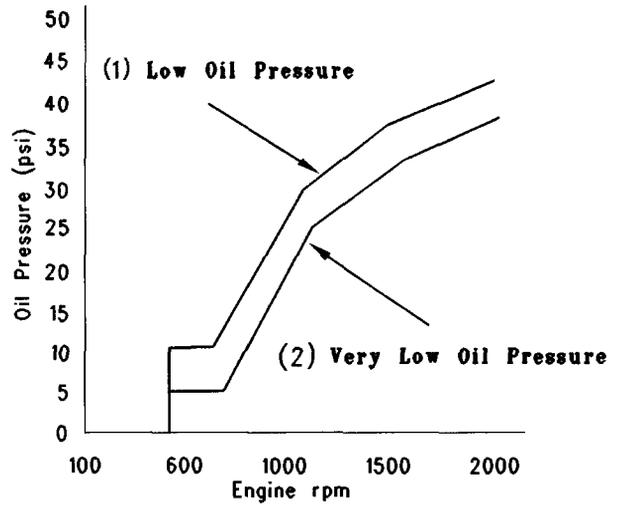


Illustration 9 g00628192  
 3406E, C-15, C-16 and C-18 Graph of low oil pressure  
 (1) Low oil pressure  
 (2) Very low oil pressure

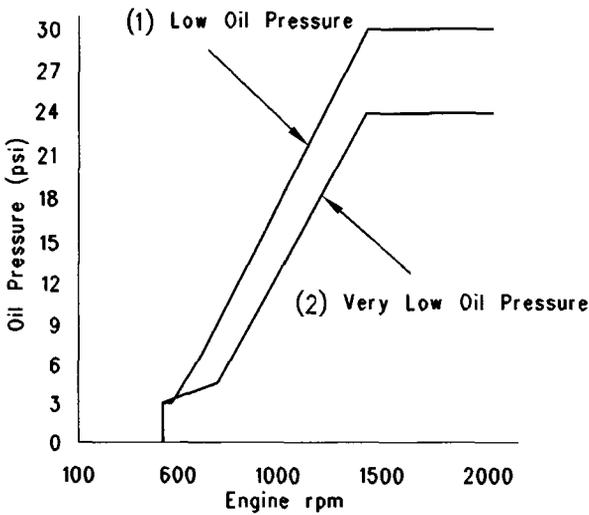


Illustration 8 g00628191  
 C-10 and C-12 Graph of low oil pressure for JUL99 and older Personality Modules  
 (1) Low oil pressure  
 (2) Very low oil pressure

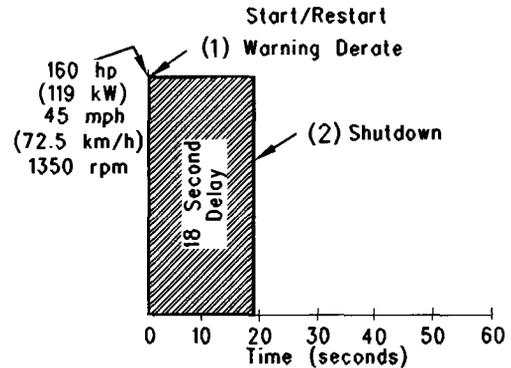


Illustration 10 g00628193  
 Graph of Very low oil pressure start-up or restart  
 (1) Warning derate  
 (2) Shutdown

### Monitoring Fuel Temperature

The fuel temperature sensor monitors the fuel temperature. The fuel rate that is calculated by the ECM is adjusted in order to compensate for changes in fuel temperature. The fuel rate is also adjusted for constant power. The sensor is also used to warn the operator of excessive fuel temperature with a diagnostic event code because excessive fuel temperatures can adversely affect engine performance. Cat ET can be used to temporarily disable the adjustment of fuel temperature. This could be necessary for testing a vehicle on a dynamometer with fuel temperature compensation.

## Other ECM Functions Of Performance

The ECM also provides enhanced control of the engine for vehicle functions such as retarding the engine and controlling the cooling fan. Refer to Troubleshooting, "Sensors and Electrical Connectors" for supplemental information about the systems that can be monitored by the ECM in order to provide enhanced vehicle performance, fuel economy and convenience for the driver.

## Self-Diagnostics

The electronic system has the ability to diagnose problems. When a problem is detected, a diagnostic code is generated and the check engine/diagnostic lamp may be turned ON. In most cases, the code is also stored in permanent memory or logged in the Engine Control Module (ECM).

When diagnostic codes occur, the diagnostic codes are called active diagnostic codes. Active diagnostic codes indicate that a problem of some kind currently exists. Active diagnostic codes should always be serviced before any other work is performed. If a truck is brought in with an active code, find the code in this manual and proceed to diagnose the cause.

Diagnostic codes that are stored in memory are called logged diagnostic codes. Logged diagnostic codes do not necessarily indicate that something needs to be repaired. The problem may have been temporary, or the problem may have been repaired since the problem was logged. Logged diagnostic codes are instead meant to be an indication of probable causes for intermittent problems.

Diagnostic codes that identify operating conditions outside the normal operating range are called events. Event codes are not typically an indication of an electronic system problem.

Some of the diagnostic codes require passwords to be cleared from memory. Diagnostic codes that do not require passwords to be cleared from memory are automatically deleted after 100 hours of engine operation.

## Engine Snapshot Data

Whenever most diagnostic codes occur, the ECM records the time in engine hours of the occurrence. Also, the ECM records the operating parameters of the engine for 9.6 seconds before the diagnostic code and 3.4 seconds after the diagnostic code. The operating parameters of the engine that are recorded are similar to the operating parameters of the engine that are displayed in the status screens on Cat ET. Not all of the status screens on Cat ET or parameters are recorded. The Engine Snapshot can also be triggered from the Cruise Control Set/Resume switch. In order to trigger the Engine Snapshot from the Cruise Control Set/Resume switch, quickly toggle the switch to the Set position. Then, quickly toggle the switch to the Resume position. You can also toggle the Cruise Control Set/Resume switch from the Resume position to the Set position. The Engine Snapshot can also be triggered from Cat ET.

## Effect Of Diagnostic Codes On Engine Performance

The discussion on engine monitoring mentions that the check Engine Lamp flashes when a specific condition exists. When the ECM detects the engine problem, the ECM generates an active diagnostic code. Also, the ECM logs the diagnostic code in order to indicate the time of the problem's occurrence. The ECM also logs the number of occurrences of the problem. There are two types of diagnostic codes. There are fault codes and event codes.

## Diagnostic Fault Codes

Diagnostic fault codes are provided in order to indicate that an electrical problem or an electronic problem has been detected by the ECM. In some cases, the engine performance can be affected when the condition that is causing the code exists. More frequently, the driver cannot detect any difference in the engine performance.

If the check engine lamp is flashing and the driver indicates that a performance problem occurs, the diagnostic code may indicate the cause of the problem. The problem should be corrected.

If the driver does not indicate a problem with the engine performance and a diagnostic code is logged by the ECM, the situation indicates that the ECM detected an abnormal condition, but the abnormal condition did not affect engine performance.

In this situation, the system has no faults except when either of the following conditions exist:

- There are several occurrences of the diagnostic code in a very short period of time.
- The ECM is indicating an active code at the present time.

## Diagnostic Event Codes

Diagnostic event codes are used to indicate that some operational problem has been detected in the engine or in the truck by the ECM. Usually, this does not indicate an electronic malfunction.

The ECM also provides an ECM date/time clock that is used to time stamp the following diagnostic event codes:

- 84-00 Vehicle Overspeed Warning
- 84-14 Quick Stop Occurrence
- 100-11 Very Low Oil Pressure
- 105-11 Very High Intake Manifold Air Temperature
- 110-11 Very High Coolant Temperature
- 111-11 Very Low Coolant Level
- 190-00 Engine Overspeed Warning

Refer to Troubleshooting, "Troubleshooting with a Diagnostic Code" for a listing of all of the diagnostic codes.

## ECM Lifetime Totals

The ECM maintains total data of the engine for the following parameters:

- "Total Time" (Engine Hours)
- "Total Distance"
- "PTO Time" and "PTO Fuel"
- "Idle Time" and "Idle Fuel"
- "Total Fuel"
- "Total Max Fuel"
- "Average Load Factor"(Engine)

The "Total Time" is the engine's operating hours. The engine hours do not include operating time when the ECM is powered ON but the engine is not running.

"Total Distance" Data requires a vehicle speed sensor or an electronic vehicle speed source to be connected to the ECM. The same sensor is used for ECM vehicle speed. Distance can be displayed in miles or kilometers.

"PTO Time" and "PTO Fuel" are logged when the engine rpm is set by the use of the cruise switches and the engine is operating under some load. Also, "PTO Time" and "PTO Fuel" are logged when the PTO On/Off Switch is in the ON position and vehicle speed is within the range of the "PTO Vehicle Speed Limit" Parameter.

"Idle Time" and "Idle Fuel" can include operating time when all of the following conditions are met:

- When engine speed is set by using the cruise switches and the vehicle speed is within the range of the "Idle Vehicle Speed Limit" Parameter.
- The engine is not operating under a load.

Fuel Information can be displayed in US Gallons or liters.

"Total Fuel" is the total amount of fuel that is consumed by the engine during operation.

"Total Max Fuel" is the maximum amount of fuel that could have been consumed by the engine during operation.

"Average Load Factor" provides relative engine operating information. "Average Load Factor" compares actual engine operation information to the maximum engine operation that is available. "Average Load Factor" is determined by using "Total Max Fuel", "Idle Fuel", and "Total Fuel". All of these parameters are available on Cat ET. These parameters are available within the menu for "Current Totals".

## Trip Data That Is Stored In The ECM

The Trip data allows the tracking of engine operation by the vehicle owner over intervals that are defined by the vehicle owner. Two types of Trip Data are stored in the ECM, Driver Trip Data and Fleet Trip Data. All of the Trip Data is stored in memory and the Trip Data is maintained through the Unswitched Battery Lines when the ignition switch is OFF. An internal battery will maintain this information while the Unswitched Battery Lines are disconnected.

### Driver Trip Data

Driver Trip Data is known as the Driver Trip Segment. The Driver Trip Segment includes data for the following parameters:

- Total Time

- Driving Time
- Distance
- Fuel
- Overall Fuel Economy
- Driving Fuel Economy
- Idle Time
- Idle Fuel
- Percent Idle Time
- PTO Time
- PTO Fuel
- Percent PTO Time
- Average Load Factor
- Average Vehicle Speed
- Average Driving Speed
- Maximum Vehicle Speed
- Maximum Engine Speed
- Start Time
- End Time
- Start Odometer
- End Odometer

A Driver Trip Segment can be reset by using Cat ET or a Caterpillar Driver Information Display (CAT ID).

When the data is reset, the ECM stores the Current Totals at the time of the reset. This data is used as the starting point for the Driver Trip Data. Cat ET or the CAT ID accesses this starting point and the Current Totals from the ECM in order to calculate the data for the Driver Trip Segment. Resetting the Driver Trip Segment does not require passwords.

## Fleet Trip Data

Fleet Trip Data includes a Fleet Trip Segment, Histograms, and Custom Data. The Fleet Trip Segment records the same parameters as the Driver Trip Segment except that the Fleet Trip Segment can be reset independently of the Driver Trip Segment.

Three histograms are available. One histogram records engine hours versus the engine speed. The second histogram records engine hours versus vehicle speed. The third histogram records engine hours versus engine speed and vehicle speed.

Cat ET calculates the percentage of time that is spent in each of the engine rpm or vehicle speed ranges. Custom Data is available. Custom Data allows the recording of engine parameters that are specified by the vehicle owner. The ECM records the Custom Data.

A reset of the Fleet Trip Data which includes the Fleet Trip Segment, the Histograms, and the Custom Data can be done in several ways. The following tools can be used to reset the Fleet Trip Data:

- Cat ET which may require Customer Passwords
- Caterpillar Fleet Information Software (FIS)
- CAT ID which requires Customer Parameters Programming to provide access

When the data is reset, the ECM records the Current Totals at the time of the reset. These Totals are used as the starting point for the Fleet Trip. The following tools access the recorded starting point:

- Cat ET
- Caterpillar Fleet Information Software (FIS)
- CAT ID

The tool then subtracts the recorded starting point from the Current Totals in the ECM in order to calculate the Fleet Trip Data. Resetting the Fleet Trip Data requires Customer passwords if the passwords are programmed.

## Fleet Trip Custom Data

Fleet Trip Custom Data is part of the Fleet Trip Segment. Fleet Trip Custom Data allows the owner of the vehicle to set five customized methods of recording data for the vehicle. Refer to Illustration 11 for the basic program.

---

SUM\_\_\_<sup>1</sup> WHEN \_\_\_<sup>2</sup> IS BETWEEN\_\_\_<sup>3</sup>  
AND\_\_\_<sup>4</sup> AND WHEN \_\_\_<sup>5</sup>  
IS BETWEEN\_\_\_<sup>6</sup> AND\_\_\_<sup>7</sup>

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Illustration 11  
Basic Program

g00628194

The following list defines the options for Variable 1 of the basic program:

- "Engine Hours"
- "Distance Traveled"
- "Fuel Burned"
- "Occurrences"

Refer to the following list for information regarding the options that are available for Variable 2 and Variable 5.

Variables 3, 4, 6, and 7 define the minimum range and the maximum range of variables 2 and 5.

- Engine RPM
- Vehicle Speed
- Fuel Rate
- Load Factor
- Coolant Temperature
- Oil Pressure
- Fuel Temperature
- Inlet Manifold Air Temperature
- Cruise
- PTO
- Engine Retarder
- Throttle Position
- Brake

Refer to the example of a Custom Data program, as shown below.

**"Fuel Burned when Fuel Temperature is between 7° and 67° C (45° and 120° F) and Vehicle Speed is between 87 and 137 km/h (55 and 85 mph)"**

The Custom Data programs are protected by Customer Passwords. The programs are stored in permanent memory. The programs are not reset when the Fleet Trip Segment is reset, but the data that is recorded for the Trip is reset.

## Fuel Correction Factor

A Fuel Correction Factor is available for fine tuning the calculations for fuel consumption. The Fuel Correction Factor is protected by Customer Passwords. The Fuel Correction Factor enhances the accuracy of the calculation for fuel consumption. Altering the Fuel Correction Factor does not affect data that is already stored in the ECM. Altering the Fuel Correction Factor only affects data that is stored in the ECM after the Fuel Correction Factor is entered.

**Note:** The Fuel Correction Factor should be adjusted by the use of a long interval, data from the fuel tank and recorded data in the ECM.

## Quick Stop Rate

A Customer Parameter is available in order to record the Quick Stop occurrences. The Parameter determines the rate of change in vehicle speed that is used by the ECM in order to record a Quick Stop Event Code and a Quick Stop Snapshot. Refer to Troubleshooting, "ECM Snapshot".

## Maintenance Indicator Data

The ECM records the Current Totals when a reset occurs for the following three levels of maintenance:

- PM1
- PM2
- Cooling System Clean/Flush

The ECM uses the previous point of maintenance in order to calculate the timing of the next scheduled maintenance work.

The maintenance Indicator mode is programmable to hours or distance. The PM1 maintenance is programmable to the Off, Automatic Distance, Automatic Hours, Manual Distance, or Manual Hours setting.

If the PM1 is programmed to the automatic mode, the ECM calculates the next point of maintenance by considering the history of the vehicle's operation from the previous maintenance interval. If the vehicle has a history of poor fuel economy the maintenance indicator parameter will occur sooner than a vehicle with better fuel economy.

The ECM also uses the Engine Oil Capacity. A larger engine oil capacity provides a longer maintenance interval. The Engine Oil Capacity is programmed into the ECM in liters or quarts. If the PM1 is programmed to the Manual mode, the owner can program the ECM in the owner's specific maintenance interval. The maintenance interval can be programmed to the owner's specific interval that is based on mileage or time. The interval for the PM2 and the interval for the Cooling System Clean/Flush are established by the factory.

## CAT ID

The Caterpillar Driver Information Display (CAT ID) is available to provide engine operating information to the driver. The Driver Trip Segment, the Fleet Trip Segment, and the Maintenance Indicator data can be viewed. However, the Fleet Trip Histograms and the Custom Data cannot be viewed from the display.

The CAT ID provides the ability to enter an ID code for a driver in order to divide the Fleet Trip Segment for two drivers. If the driver enters the information regarding the state of travel, the Fleet Trip Segment can be tagged by the state of travel.

The CAT ID can be used in order to tag portions of the Fleet Trip Segment into two ID codes. The CAT ID can also be used in order to tag portions of the Fleet Trip Segment into the state of travel. The ID code and the information regarding the state of travel cannot be viewed from the display. Only the Caterpillar Fleet Information Software (FIS) can view this information. The ability to reset any of these parameters is dependent on Customer Parameters in the ECM.

The CAT ID will also display engine operating parameters such as engine rpm, coolant temperature, boost pressure and many other parameters.

The CAT ID will also display engine diagnostic codes. The CAT ID will also display a brief text description of the diagnostic codes.

An available feature of the CAT ID is the Theft Deterrent. The Theft Deterrent allows the driver to input a password prior to shutdown. The Theft Deterrent will prevent the engine from restarting until the password is successfully entered. The CAT ID must have the version of software that is capable of supporting this feature.

An "Auto-Enable" option is available as a Theft Deterrent on Personality Modules which are dated OCT99 and newer. If this option is selected, the Theft Deterrent Feature will automatically be activated when the engine is shut down. The driver must input the correct password in order to start the engine.

"Secure Idle" is another Theft Deterrent Feature. This allows the driver to bring the engine to an idle condition. The driver then enters the password. The engine will remain at low idle until the password is re-entered. If the engine is shutdown, a password will be required to go above low idle after start-up.

## Fleet Information Software (FIS)

The Caterpillar Fleet Information Software (FIS) is another method that can be used to review the trip information. The entire Fleet Trip Segment, which includes the following elements of data can be accessed with the Caterpillar FIS:

- Histograms
- Custom Data
- Information that is tagged by the ID code
- Information that is tagged by the state of travel

Maintenance Indicator information can also be accessed by the use of the Caterpillar FIS.

When the Caterpillar FIS downloads the information, the Caterpillar FIS also resets the ECM in order to prepare the ECM for the next trip. The information can be downloaded to a computer with the Caterpillar FIS program, or the information can be downloaded to an Argo Mobile Data Tool (MDT). The Argo Mobile Data Tool (MDT) is then connected to a computer in order to download the information.

## Driver Reward Feature

The Driver Reward Feature automatically adjusts the VSL as a reward to the driver for operating a truck in a manner that meets the truck engine owner's specifications. Several parameters are monitored in order to evaluate a driver's operating technique. Weighting factors are applied to the parameters that reflect the operating techniques that are desired and the operating techniques that are expected. If the operating techniques meet the owner's specifications or the operating techniques exceed the owner's specifications, the VSL is automatically increased as a reward. The VSL will decrease when the operating techniques do not meet the owner's specifications.

The CAT ID can be used to monitor parameters that affect the Driver Reward, which allows the driver to adjust the operating techniques, as required.

### “Wireless Communication Enable”

The “Wireless Communication Enable” parameter in the ECM allows the ECM to communicate through the SAE J1587 Data Link with certain systems of communication. Programming this parameter requires Factory Passwords.

With this system, the customer can remotely change the following parameters by the use of the Caterpillar FIS:

- Fuel Correction Factor
- Custom Data
- Maintenance Indicator Data

With this system, the customer can remotely extract the following information from the ECM:

- Current Totals
- Reports on Custom Data
- Fleet Trip Data
- Economy Model
- Maintenance Information
- Settings for Customer Parameters

The reports are processed for the owner of the fleet by the use of the Caterpillar FIS. The frequency and the timing of the downloading of the information can be at set intervals or the downloading of the information can be done manually.

## Programmable Parameters

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

System Configuration Parameters are set at the factory. System Configuration Parameters affect emissions or power ratings within an engine family. Factory Passwords must be obtained and factory Passwords must be used to change the System Configuration Parameters.

Customer Parameters are variable. Customer Parameters can be used to affect the following characteristics of the engine within the limits that are set by the factory, Caterpillar Engine Monitoring, and PTO operation:

- Cruise control
- Vehicle speed limits
- Progressive shifting
- RPM ratings
- Power ratings

Customer Passwords may be required to change Customer Specified Parameters.

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

Refer to Troubleshooting, “Customer Specified Parameters”.

## Passwords

System Configuration Parameters are protected by Factory Passwords. Factory passwords are calculated on a computer system that is available only to Caterpillar dealers. Since factory passwords contain alphabetic characters, only Cat ET may change System Configuration Parameters. System Configuration Parameters affect the power rating family or emissions.

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

Refer to Troubleshooting, "Customer Passwords" and Troubleshooting, "Factory Passwords".

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## Glossary

**SMCS Code:** 1900

**Note:** This glossary contains definitions of terminology for all of Caterpillar On-Highway Truck Engines. Some of the terms are only applicable to certain engines.

**A/C High Pressure Switch** – The A/C high pressure switch senses refrigerant pressure in the air conditioning system. The A/C high pressure switch opens the electrical contacts and the A/C high pressure switch closes the electrical contacts. The opening and closing of the electrical contacts depends on the pressure in the system. The electrical contacts control the cooling fan. This switch may be connected to the ECM in some applications.

**Accelerator Pedal Position** – The accelerator pedal position is the interpretation by the ECM of the signal from the accelerator pedal position sensor.

**Accelerator Pedal Position Sensor** – The accelerator pedal position sensor is an electronic sensor that is connected to the accelerator pedal. The accelerator pedal position sensor sends a Pulse Width Modulated signal to the ECM.

**ACERT** – Advanced Combustion Emissions Reduction Technology

**Active Diagnostic Code** – An active diagnostic code describes a condition that is currently present in order to alert the driver or the service technician of an abnormal parameter of engine operation. Refer to a Diagnostic Fault Code.

**Aftermarket Device** – An aftermarket device is a device or an accessory that is installed by the customer after the vehicle is delivered.

**Air-To-Air Aftercooler** – An air-to-air aftercooler is a device that is used on turbocharged engines in order to cool inlet air that has undergone compression. The inlet air is cooled after the inlet air passes through the turbocharger. The inlet air is passed through an aftercooler (heat exchanger) that uses ambient air for cooling. The inlet air that has been cooled advances to the inlet manifold.

**Alternating Current (AC)** – Alternating current is an electric current that reverses direction at a regular interval that is reoccurring.

**American Wire Gauge (AWG)** – AWG is a measure of the diameter of electrical wire. AWG is also a measure of the current carrying capacity of electrical wire. When the AWG number is smaller, the diameter of the wire is larger. When the AWG number is larger, the diameter of the wire is smaller.

**Analog Sensors** – Analog sensors produce a DC output signal. The sensors detect changes in temperature or pressure. The change is converted by the sensor to an electrical signal.

**Analog Sensor Return** – The common line (ground) for the analog sensor from the ECM is used as a ground for the analog sensors.

**Analog Sensor Supply** – The +5 volt supply from the ECM provides power to the analog sensors.

**Anti-Lock Brake System (ABS)** – An anti-lock brake system is a brake system that attempts to reduce a skid during brake operation. A power train electronic control can turn off the engine retarder, if necessary. Also, a power train electronic control can signal the engine ECM to deactivate the engine retarder.

**ATA Data Link (American Trucking Association)** – The ATA data link is a two wire electrical connection for communication with other microprocessor based devices. These devices are compatible with Standards for the American Trucking Association and Standards for the SAE (J1587 and J1708) such as trip recorders, electronic dashboards, power train controls, and maintenance systems. The data link is also the serial communication medium that is used for programming and troubleshooting Caterpillar truck engines.

**Atmospheric Pressure Sensor** – The atmospheric pressure sensor measures barometric pressure. The sensor sends a signal to the Engine Control Module (ECM). The signal is used in engine control and in engine operation.

**Auxiliary Pressure Sensor** – This sensor is an additional pressure sensor that is installed by the engine owner.

**Auxiliary Retarder Relay** – The brakes' solenoids are driven by an OEM installed relay, which is driven by the ECM.

**Auxiliary Temperature Sensor** – This sensor is an additional temperature sensor that is installed by the engine owner.

**Before Top Center (BTC)** – BTC is the 180 degrees of crankshaft rotation before the piston reaches the top center position in the normal direction of rotation.

**Boost** – The difference between the turbocharger outlet pressure and the atmospheric pressure is commonly referred to as boost.

**Boost Pressure Sensor** – The boost pressure sensor measures inlet manifold air pressure. The boost pressure sensor sends a signal to the ECM.

**Bypass Circuit** – A bypass circuit is a circuit that is used as a substitute circuit for an existing circuit. A bypass circuit is typically used as a test circuit.

**Calibration** – Calibration is an electronic adjustment of a sensor signal.

**Camshaft Position Sensor** – Refer to Secondary Engine Speed/Timing Sensor.

**Caterpillar Driver Information Display (CAT ID)** – The Caterpillar Driver Information Display is a digital readout of the performance parameters of the vehicle and performance parameters that are monitored by the ECM.

**Caterpillar Electronic Technician (Cat ET)** – Cat ET is an electronic service tool that uses a software program to run on a personal computer (PC). Cat ET is used to service Caterpillar products. This program has replaced the ECAP tool.

**Caterpillar Engine Monitoring** – Caterpillar Engine Monitoring is the part of the Caterpillar electronic engine control that monitors coolant temperature, oil pressure, intake manifold air temperature and coolant level. The monitoring alerts the operator of detected problems. Coolant temperature, intake manifold air temperature, and oil pressure sensors are supplied by Caterpillar and monitored by the ECM. The coolant level sensor is installed by the vehicle OEM but still monitored by the ECM. Aftermarket engine monitoring systems do not interface with the Caterpillar electronic engine control.

**Check Engine Lamp** – The check engine lamp is sometimes referred to as the diagnostic lamp. The check engine lamp is used to alert the operator of the presence of an active event. The lamp then flashes a diagnostic code.

**Clutch Pedal Position Switch** – The switch is typically supplied and installed by the OEM. This switch is typically a limit switch that is mounted near the clutch pedal. The switch is usually adjustable. This switch is in the normally closed position when the clutch pedal is released. Depressing the clutch pedal will open the circuit.

**Code** – Refer to the Diagnostic Fault Code and the Diagnostic Event Code.

**Cold Mode** – Cold mode is a mode for cold starting and for cold engine operation that includes timing that is retarded and low idle that is raised. This mode is used for engine protection, reduced smoke emissions and faster warm up time.

**Communication Adapter Tool** – The communication adapter provides a communication link between the ECM and Cat ET.

**Control Area Network (CAN) Data Link** – The CAN Data Link is a serial communications port that is used for communication with other microprocessor based devices. This is also referred to as the J1939 Data Link.

**Coolant Level Sensor** – This OEM installed sensor detects the absence or presence of coolant at the probe. The sensor then sends a signal to the ECM.

**Coolant Temperature Sensor** – This sensor detects the engine coolant temperature for Cold Mode operation and the Caterpillar Engine Monitoring. The Caterpillar Engine Monitoring must be enabled for the coolant temperature sensor to be used for monitoring purposes.

**Cooling Fan Override Switch** – This switch overrides control of the cooling fan relay so the cooling fan operates continuously. This switch is supplied and installed by the OEM.

**Cooling Fan Relay** – This relay is controlled by the ECM which uses information from the coolant temperature sensor, the engine retarder and the air conditioning high pressure switch. The air conditioning high pressure switch is not always installed. The relay and the air conditioning high pressure switch is supplied and installed by the OEM.

**Crankshaft Position Sensor** – Refer to Primary Engine Speed/Timing Sensor.

**Cruise Control Range** – The cruise control range is the speed range that is monitored by the cruise control. This speed range is typically the anticipated speed range on the open road. The cruise control range can be programmed with the low cruise limit and the high cruise limit.

**Custom Data** – Custom data is part of the fleet trip data that is stored in the ECM. This capability allows the vehicle owner to specify operating parameters for monitoring purposes while the engine is in service.

**Customer Specified Parameter** – A Customer Specified Parameter is a value that can be set and changed by the customer. The parameters can be protected by Customer Passwords.

**Desired Engine Speed** – The desired engine speed is input to the electronic governor within the ECM. The electronic governor uses the signal from the accelerator pedal position sensor, the engine speed sensor, the cruise control, and the Customer Parameters in order to determine desired speed.

**Desired RPM** – The desired rpm is input to the electronic governor within the ECM. The electronic governor uses the signal from the accelerator pedal position sensor, the engine speed sensor, the cruise control, and the Customer Parameters in order to determine desired rpm.

**Diagnostic Event Code** – These codes indicate an event that describes an abnormal engine condition such as a high coolant temperature. These codes are not necessarily an indication of problems within the electronic system.

**Diagnostic Fault Code** – A diagnostic fault code is sometimes referred to as a fault code. These codes indicate an electronic system malfunction or abnormal operating conditions.

**Diagnostic Flash Code** – The diagnostic flash codes are flashed on the check engine lamp. These flash codes indicate a malfunction in the electronic system or an event that is detected by the ECM.

**Diagnostic Lamp** – A diagnostic lamp is sometimes called the check engine lamp. The diagnostic lamp is used to warn the operator of the presence of an active diagnostic code.

**Digital Sensors** – Digital sensors produce an ON or OFF type of signal. Some sensors vary the ON or OFF time which is referred to as Pulse Width Modulation (PWM).

**Digital Sensor Return** – The common line (ground) from the ECM is used as a ground for the digital sensors.

**Digital Sensor Supply** – The supply from the ECM is used in order to power the digital sensors.

**Direct Current (DC)** – Direct current is the type of current that flows consistently in only one direction.

**DT, DT Connector, or Deutsch DT** – This is a type of connector that is used on Caterpillar truck engines. The connectors are manufactured by Deutsch.

**Dual Coil Vehicle Speed Sensor** – The dual coil vehicle speed sensor is a magnetic pickup that senses movement of the teeth on the output shaft of the transmission. The sensor contains two coils. This sensor provides two differential output signals.

**Duty Cycle** – Refer to Pulse Width Modulation.

**Electronic Engine Control** – The electronic engine control is a complete electronic system. The electronic engine control monitors the engine operation under all conditions. The electronic engine control also controls the engine operation under all conditions.

**Electronic Service Tool** – Refer to “Caterpillar Electronic Technician” (Cat ET).

**Electronically Controlled Unit Injector** – The electronically controlled unit injector is an injection pump which is a mechanically actuated, electronically controlled unit injector. This unit combines the pumping, electronic fuel metering and injecting elements in a single unit.

**Engine Control Module (ECM)** – The ECM is the engine’s control computer. The ECM provides power to the electronics. The ECM monitors data that is input from the engine’s sensors. The ECM acts as a governor in order to control engine rpm.

**Engine Coolant Diverter** – The engine coolant diverter is a normally open valve that allows coolant to flow through a radiator that cools the intake air. The radiator is located after the turbochargers and before the air-to-air aftercooler. Energizing the solenoid prevents the flow of coolant through the radiator in order to prevent overcooling of the engine when cold ambient air temperatures exist.

**Engine Monitoring System** – The Engine Monitoring System is a programmable system that allows the ECM to take actions if an engine parameter is out of a certain range. The actions are Warning, Derate, and Shutdown.

**Engine Oil Pressure Sensor** – This sensor measures engine oil pressure and the sensor sends a signal to the ECM.

**Engine Retarder Solenoids** – The engine retarder solenoids are installed by Caterpillar and the solenoids are driven by the ECM. These solenoids are used in place of relays such as the auxiliary brake that is installed by the OEM.

**Engine Speed/Timing Sensor** – This sensor provides a variable amplitude and Pulse Width Modulated signal to the ECM. The ECM interprets this signal as the crankshaft position and the engine speed.

**Erasable Programmable Read Only Memory (EPROM)** – An EPROM is a type of computer memory chip.

**Estimated Dynamic Timing** – The estimated dynamic timing is the estimate that is provided by the ECM of the actual injection timing.

**ET** – Refer to “Caterpillar Electronic Technician” (Cat ET).

**Ether Relay** – The ether relay is used in order to actuate the ether injection system. The relay is controlled by the ECM.

**Event** – Events indicate an event that describes an abnormal engine condition. These codes are not necessarily an indication of problems within the electronic system.

**Exhaust Brake Relay** – The brake solenoids are driven by an OEM installed relay, which is driven by the ECM.

**Failure Mode Identifier (FMI)** – This Identifier indicates the type of failure that has been experienced by the component. The FMI has been adopted from the SAE practice of J1587 diagnostics. The FMI follows the PID in the descriptions of the fault code. The descriptions for the FMI's are shown in the following list:

- 0 The data is valid but the data is above the normal operational range
- 1 The data is valid but the data is below the normal operational range
- 2 The data is erratic, intermittent, or incorrect.
- 3 The voltage is above normal or the voltage is shorted high
- 4 The voltage is below normal or the voltage is shorted low
- 5 The current is below normal or the circuit is open
- 6 The current is above normal or the circuit is grounded
- 7 The mechanical system is not responding properly
- 8 Abnormal frequency, pulse width, or period
- 9 Abnormal update
- 10 Abnormal rate of change
- 11 The failure mode is not identifiable
- 12 Damaged device or component
- 13 The device or the component is not calibrated
- 14 and 15 These locations are reserved for a future assignment

**Flash Code (FC)** – The flash codes are proprietary Caterpillar code numbers that are flashed on the diagnostic lamp. The flash codes are flashed on the check engine lamp. These flash codes indicate a malfunction in the electronic system or an event that is detected by the ECM.

**Flash Programming** – Flash programming is the method of programming or updating an ECM with Cat ET over the data link instead of replacing components. Flash programming installs the specific Personality Module that is used to control the engine. The Personality Module contains specific performance maps and features for a selected rating.

**Fleet Information Software (FIS)** – FIS is a software program that operates on a personal computer (PC). This program allows the user to review the trip information. The program also allows the user to reset the trip information which includes the Maintenance Indicator information.

**Fuel Position** – This is an internal signal within the ECM. The signal comes from the electronic governor and the signal then goes to the fuel injection control. The information that is gathered is based on the Desired RPM, the FRC Limit, the Rated Fuel Limit, and the actual engine rpm.

**Fuel Ratio Control (FRC)** – The FRC is a limit that is based on the control of the fuel to air ratio. The FRC is used for purposes of emission control. When the ECM senses a higher boost pressure (more air into the cylinder), the FRC increases the FRC Limit (more fuel into the cylinder).

**Fuel Temperature Sensor** – This sensor detects the fuel temperature. The ECM monitors the fuel temperature and the ECM adjusts the calculated fuel rate accordingly.

**Full Load Setting (FLS)** – The FLS is the number that represents the fuel system adjustment. This adjustment is made at the factory in order to help ensure the maximum fuel delivery of the fuel system. The correct value for this parameter is stamped on the engine information ratings plate. This parameter must be programmed. If the parameters are not programmed, the diagnostic code that is 253-02 Check Customer or System Parameters will be active.

**Full Torque Setting (FTS)** – The FTS is similar to the Full Load Setting. This parameter must be programmed. If the parameters are not programmed the diagnostic code that is 253-02 Check Customer or System Parameters will be active.

**Gear Down Protection** – This feature consists of the High Gear Limits that are programmable. High Gear Limits are used in order to promote driving in higher gears for increased fuel economy.

**Harness** – The harness is the bundle of wiring (loom) that connects all components of the electronic system.

**Hertz (Hz)** – Hertz is the measure of electrical frequency in cycles per second.

**High Pressure Oil Manifold** – The high pressure oil manifold is an oil gallery that is added to the cylinder head in order to supply the unit injectors with high pressure oil.

**High Pressure Oil Pump** – The high pressure oil pump is an axial piston pump that is driven by gears. The high pressure oil pump is used to raise the engine oil pressure in order to activate the unit injectors. The amount of oil pressure that is required to activate the unit injectors is called the actuation pressure.

**Histogram** – The histogram is a bar graph which may indicate the relative frequency of vehicle operation in specific operating ranges. A histogram can be used to show many relationships.

**Hydraulically Actuated Electronically Controlled Unit Injector (HEUI)** – The HEUI is an injection pump which is a hydraulically actuated, electronically controlled unit injector. This injector uses hydraulic forces to produce the high injection pressure. This unit combines the pumping, electronic fuel metering, and injecting elements in a single unit.

**Idle rpm Limit** – This is a programmable parameter which indicates the maximum allowable engine rpm that is allowed when the engine rpm is set with the cruise set/resume switch.

**Idle Shutdown Time** – This programmable parameter indicates a designated idle time in minutes that is allowed before shutdown.

**Idle/PTO Bump rpm** – This programmable parameter indicates the amount of change to the engine rpm that will occur when the switch for acceleration is toggled or the switch for deceleration is toggled.

**Injection Actuation Pressure Control Valve** – This is a dump valve that is controlled by an electrical signal that maintains high pressure for the high pressure oil manifold. The ECM controls the pressure in the high pressure oil manifold by inputs from the other sensors. The control valve regulates the high pressure oil to the hydraulic electronic unit injector through the high pressure oil manifold. Proper fuel injection pressure is necessary for desired engine operation.

**Injection Actuation Pressure Sensor** – An electrical sensor on the high pressure oil manifold converts oil pressure into an electrical signal for the ECM.

**Injector Codes** – The injector codes or injector trim codes are numeric codes or alphanumeric codes that are etched or stamped on individual injectors. These codes are used to fine tune the fuel delivery.

**Injector Trim Files** – Injector trim files are downloaded from a disk to the ECM. The trim files compensate for variances in manufacturing of the injector. The engine serial number must be known in order to obtain the correct trim file.

**Intake Manifold Air Temperature Sensor** – This sensor detects the air inlet temperature. The ECM monitors the inlet air temperature and other data in order to adjust injection timing and other performance functions.

**Intake Valve Actuation System Oil Pressure Sensor** – Monitors the pressure within the oil rail for the intake valve actuator. The sensor can detect mechanical problems with the intake valve actuation system such as leaking face seals.

**Intake Valve Actuation System Oil Pressure Solenoid** – Solenoid mounted at the end of the oil rail for the intake valve actuator. The solenoid is normally closed to allow pressure to build up in the rail.

**Intake Valve Actuator** – An actuator that allows the ECM to control the amount of time that the intake valve is open. The actuator traps engine oil in order to hold the intake valve open. The ECM can vary the time that the intake valve is open in order to optimize engine performance.

**Integrated Electronic Controls** – The engine is designed with the electronic controls as a necessary part of the system. The engine will not operate without the electronic controls.

**J1922 Data Link** – This data link is an SAE diagnostic communications data link that is used to communicate between the electronic engine and the power train components. Examples of power train components are the ABS/traction control system and the transmissions. This allows the power train component to control the engine during reduced traction or transmission shifts.

**J1939 Data Link** – This data link is an SAE diagnostic communications data link that is used to communicate between the electronic engine, the transmission, instrument clusters, and/or the power train controls.

**Key Switch Input** – When the input is energized, the ECM is powered up.

**Kickout Switch** – This term refers to the service brake switch and the clutch switch. These switches are used as an exit or a kickout for the cruise control set speed, the idle speed setting, or the PTO/Idle set speed.

**Latch Mode** – This is a programmable parameter for control of the exhaust brake. The exhaust brake engages when the service brake pedal is depressed. The exhaust brake remains engaged until the control detects a change in a control input.

**Logged Diagnostic Codes** – Logged diagnostic codes are codes which are stored in memory. These codes are meant to be an indicator of possible causes for intermittent problems. Refer to the Diagnostic Fault Code for more information.

**Maintenance Clear Switch** – The maintenance clear switch is required to reset the “PM1 Interval” diagnostic after maintenance on the engine is performed. This reset is necessary for the maintenance indicator to function.

**Maintenance Overdue Lamp** – This lamp will turn on when the Preventive Maintenance Interval occurs such as “PM1 Interval”.

**Mechanically Actuated Electronically Controlled Unit Injector (MEUI)** – The MEUI is an injection pump which is a mechanically actuated, electronically controlled unit injector. Mechanical forces that are produced from the camshaft are used to produce the high injection pressures. This unit combines the pumping, electronic fuel metering, and injecting elements in a single unit.

**Messenger** – Messenger is a digital display that can display the operating conditions for the engine.

**Oil Pressure Sensor** – This sensor measures engine oil pressure and the sensor signals the ECM.

**Open Circuit** – An open circuit is a condition that is caused by an open switch, or an electrical wire or a connection is broken. When this condition exists, the signal or the supply voltage can no longer reach the intended destination.

**Original Equipment Manufacturer (OEM)** – The OEM is the manufacturer of a vehicle that uses a Caterpillar engine for the power source.

**Overspeed Verify** – This feature is used to test the Overspeed Shutoff Circuit. The shutoff circuit is tripped at 75% of the Overspeed Shutoff Limit.

**Parameter** – A parameter is a value or a limit that is programmable. This helps determine specific characteristics or behaviors of the engine and/or vehicle.

**Parameter Identifier (PID)** – The PID is a two digit code or a three digit code which is assigned to each component in order to identify data via the data link to the ECM.

**Passive Magnetic Speed Sensor** – This sensor is a speed sensor that does not require a power and a ground connection. The sensor produces a signal that is based on the change in magnetic flux of a ferrous metal gear near the sensing tip.

**Password** – A password is a group of numeric characters or a group of alphanumeric characters that is designed to restrict access to parameters. The electronic system requires correct passwords in order to change Customer Specified Parameters (Customer Passwords) or certain engine specifications (Factory Passwords). Passwords are also required to clear certain diagnostic codes.

**Personality Module or Ratings Personality Module** – This module is attached to the inside of the ECM. The module contains all the instructions (software) for the ECM and the module contains the performance maps for a specific horsepower family.

**Power Cycled** – Power cycled happens when power to the ECM is cycled: on, off, and on. Power cycled refers to the action of cycling the keyswitch from any position to the OFF position, and to the START/RUN position.

**Power Take-Off (PTO)** – The PTO operates with the cruise control switches and the dedicated PTO On/Off switch. This mode permits the setting of constant engine speeds or the mode permits varying the speed with either the accelerator pedal in the cab or a remote accelerator.

**Power Train Data Link** – Refer to J1922 Data Link or J1939 Data Link.

**Powered Down** – Powered down occurs when power is removed from the ECM. Powered down refers to the action of cycling the keyswitch from any position to the OFF/RESET position.

**Powered Up** – Powered up occurs when power is applied to the ECM. Powered up refers to the action of cycling the keyswitch from the OFF/RESET position to the START position.

**Primary Engine Speed/Timing Sensor** – Determines the position of the crankshaft for injection timing and engine speed. The primary engine speed/timing sensor is primarily used after the engine has started.

**Pro-Link** – Pro-Link is an electronic service tool that is hand-held. The tool is manufactured by Micro Processor Systems, Inc. (MPSI). This tool is supplied with a Caterpillar cartridge in order to service a Caterpillar engine that is electronically controlled.

**Progressive Shifting** – This is a method of quickly upshifting through the lower gears without excessive engine rpm in each gear. Shifts are made above peak torque but below rated rpm. If the engine is driven to an excessively high engine rpm before shifting to the next gear, fuel is wasted. When the excessively high engine rpm ranges are used, the torque rise of the engine is not fully utilized. The two steps LoGr 1 and LoGr 2 give the opportunity for progressive shifting. LoGr 1 is typically set at no lower than peak torque plus 200 rpm. LoGr 2 is typically set at a point that is midway between the LoGr 1 rpm limit and the Top Engine Limit.

**PTO Configuration** – This is a programmable parameter that determines the best use of the ECM input and the ECM output for PTO applications.

**Pulse Width Modulation (PWM)** – The PWM is a signal that consists of pulses that are of variable width. These pulses occur at fixed intervals. The ratio of TIME ON versus total TIME OFF can be varied. This ratio is also referred to as a duty cycle.

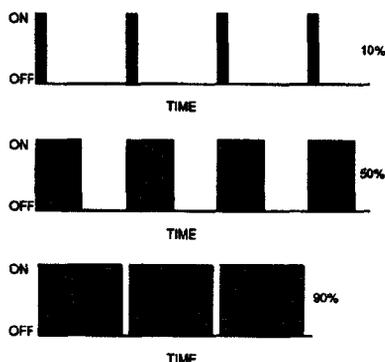


Illustration 12

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**Rated Fuel Limit** – This term indicates the maximum allowable fuel position (longest injection pulse). This position will produce rated power for this engine configuration.

**Reference Voltage** – The Reference Voltage is a regulated voltage and a steady voltage that is supplied by the ECM to a sensor. The reference voltage is used by the sensor to generate a signal voltage.

**Remote Shutdown** – The ECM disables the fuel injection signal when the Remote Shutdown Switch is closed. This causes the ECM to shut down the engine. However, the ECM remains active. The air shutoff solenoid is not activated when the remote shutdown switch is activated.

**Remote Station Operation** – This is a location that is outside of the vehicle cab. The functions such as the engine speed control are typically used for some type of PTO operation that is for pumping or for some other application that uses the engine power. These functions are controlled from the remote station.

**Retarder Enable Signal** – The retarder enable signal interfaces the ECM to the engine retarder. This will restrict operation of the engine brake during undesirable engine operating conditions. One operating condition is at a time when the engine is being fueled.

**Retarder Solenoids** – This refers to the engine retarder that is installed by Caterpillar. The solenoids are driven directly by the Caterpillar ECM. The solenoids are not driven through an OEM installed relay such as the auxiliary retarder.

**Secondary Engine Speed/Timing Sensor** – Determines the position of the camshaft during start-up. The secondary engine speed/timing sensor will be used if the signal from the primary engine speed/timing sensor is lost.

**Sensor** – The sensor is a device that is used to detect a change in pressure, temperature, or mechanical movement. The information that is detected is converted into an electrical signal.

**Service Brake Pedal Position Switch** – This switch is typically a pressure switch that is supplied and installed by the OEM. This switch is normally closed when the brake pedal is in the released position. Depressing the brake will open the circuit.

**Service Program Module (SPM)** – The service program module is a software program that is used to adapt the electronic service tool to a specific engine application.

**Short Circuit** – A short circuit is a condition that has an electrical circuit that is inadvertently connected to an undesirable point. An example of a short circuit is a wire which rubs against a vehicle frame and this rubbing eventually wears off the wire insulation. Electrical contact with the frame is made and a short circuit results.

**Signal** – The signal is a voltage or a waveform that is used in order to transmit information typically from a sensor to the ECM.

**Speed Burp** – A Speed Burp is a sudden, brief, unwanted change in the engine rpm.

**Standard SAE Diagnostic Communications Data Link** – Refer to the ATA Data Link.

**Starting Aid Switch** – This switch is used for injection of a starting aid in cold weather. An example of a starting aid is ether.

**Static Timing** – Static timing is the basis for correct fuel timing and valve mechanism operation. Static timing is determined by the timing ring and the alignment of the rear gear group.

**Subsystem** – A Subsystem that is used in this application is a part of the electronic system that relates to a particular function. An example of a subsystem is the throttle subsystem.

**Supply Voltage** – The supply voltage is a constant voltage that is supplied to a component in order to provide electrical power that is required for the component to operate. The power may be generated by the ECM or the power may be battery voltage that is supplied by the vehicle wiring.

**Suspect Parameter Number (SPN)** – The SPN is a three digit code which is assigned to each component in order to identify data via the data link to the ECM. This is used for J1939 diagnostics.

**System Configuration Parameters** – System Configuration Parameters are Parameters that affect the power rating family or emissions.

**T-Harness** – The T-Harness is a test harness that is designed to connect into the vehicle harness or the engine harness. This connection allows a normal circuit operation and the connection simultaneously provides a breakout T in order to measure the signals.

**Terminating Resistor** – This is used to terminate the J1939 CAN data link. Refer to the installation procedures.

**Theft Deterrent** – This feature uses a four digit code in order to prevent the engine from starting. The feature requires a password to be entered via the CAT ID.

**Timing Calibration** – The timing calibration is the adjustment of an electrical signal. This adjustment is made in order to correct the timing error between the camshaft and the engine speed/timing sensors or between the crankshaft and the engine speed/timing sensors.

**Top Center** – This refers to the crankshaft position when the engine piston position is at the highest point of travel. The engine must be turned in the normal direction of rotation in order to reach this point.

**Torque Limit** – This is a programmable parameter that limits the maximum torque which is based on the PTO configuration and PTO operation.

**Total Tattletale** – The Total Tattletale is the total number of changes to all the Customer Specified Parameters that are stored in the ECM.

**Transducer (Timing Calibration Probe)** – This is a device that converts a mechanical signal to an electrical signal. This probe requires a power source in order to operate.

**Transmission Style** – The “Transmission Style” is a programmable parameter that designates the type of transmission in the vehicle and the various circuits that are connected to the ECM. The relay for the transmission, cruise control, PTO/idle set speed, and the operation of the exhaust brake are affected by this parameter setting.

**Trip Recorder** – The trip recorder is an aftermarket device that is dedicated to recording the parameters of the vehicle and the parameters of the operating engine during the vehicle service. The trip recorder is used to analyze the driving habits and the recorder is used in order to produce the logs of the driver.

**Variable Valve Actuation** – Allows the engine to vary the closing of the valves in order to optimize emissions and engine performance.

**Vehicle Speed Sensor** – The vehicle speed sensor is an electromagnetic pickup that measures vehicle speed from the rotation of gear teeth in the drive train of the vehicle.

**Wastegate Solenoid** – Prevents pressurized air from reaches the turbocharger wastegate. Allows the engine to build boost pressure beyond the preset wastegate setting.

I01921225

## Electronic Service Tools

**SMCS Code:** 0785

Caterpillar electronic service tools are designed to help the service technician with the diagnosis and repair of electronic engines. Several tools are available to assist the service technician.

## Required Service Tools

Table 1

Part Number	Description
N/A	4 mm Allen Wrench
6V-2197	Transducer(Timing Calibration Probe)
7X-1171	Transducer Adapter(Timing Calibration Probe)
7X-1695	Cable(Timing Calibration)
1U-5804	Crimp Tool(12 to 18 AWG)
1U-5805	Wire Removal Tool(14 AWG Wire)
151-6320	Wire Removal Tool(16 and 18 AWG Wire)
167-9225	Harness(Service Tool Adapter)
140-2266	Cable(Seventy-Pin Breakout)
9U-7330 or 146-4080	Digital Multimeter Digital Multimeter(RS-232)
190-8900	Connector Repair Kit

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.

### Caterpillar Electronic Technician (Cat ET)

Cat ET can display the following information:

- Parameters
- Diagnostic codes
- Engine rating history
- Driver and fleet trip segments
- Histograms
- Custom data
- ECM date/time clock
- Maintenance intervals

Cat ET can also be used to perform the following functions:

- Diagnostic tests
- Sensor calibrations

- Flash programming
- Set parameters
- Copy the configuration for ECM replacement.
- Data logging
- Snapshot recorder

The following components are required to use Cat ET to service the engine.

Table 2

Required Electronic Service Tools for the Use of Cat ET	
Part Number	Description
	<b>Caterpillar Electronic Technician</b>
JERD2124	"Electronic Technician Program" (Cat ET)
JERD2125 or JERD2129	"Electronic Technician Truck Engine Data Subscription"  "Electronic Technician Engine/Machine Data Subscription"
171-4400 <sup>(1)</sup>	Communication Adapter II Gp

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

**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

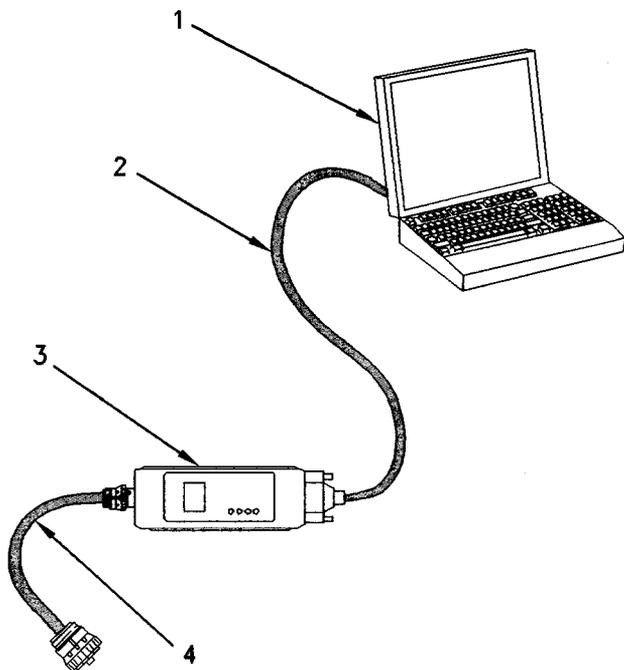


Illustration 13

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

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

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

1. Turn the keyswitch to the OFF/RESET position. If the keyswitch is not placed in the OFF/RESET position, the engine may start.
2. Connect cable (2) between the "COMPUTER" end of communication adapter (3) and the RS232 serial port of PC (1).
3. Connect cable (4) between the "DATA LINK" end of communication adapter (3) and the service tool connector.
4. Turn the keyswitch to the ON position. If Cat ET and the communication adapter do not communicate with the ECM, refer to Troubleshooting, "Electronic Service Tool Will Not Communicate With ECM".

## Optional Service Tools

Table 3

Part Number	Description
7X-6370	Adapter Cable As(3 Pin DT Breakout)
8T-8726	Adapter Cable As(3 Pin Breakout)
5P-7277	Voltage Tester
9U-5103	Socket(Slotted)
7X-1710	Multimeter Probe
1U-5718	Vacuum Pump
1U-8757	Tube(Fluid Sampling)
169-7372	Fluid Sampling Bottle
9S-9082	Engine Turning Tool
198-4240 or 1U-5470	Digital Pressure Indicator Engine Pressure Group
6V-9130	Temperature Adapter
124-5643	Cable(Service Tool Breakout)
125-3662	Cable(Sensor Bypass)
157-4829	Cable Adapter(9 Pin J1939 Dash)
7X-1403	Adapter Cable As(9 Pin Navistar Dash)
7X-1686	Cable Adapter(6 Pin Dash) Cable Adapter ( )
139-4166	Data Link Cable As(Eighteen Feet)

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## Replacing the ECM

**SMCS Code:** 1901-510

### Replacing the ECM with the Use of the ECM Replacement Feature

1. Ensure that the ECM is the problem by first connecting a test ECM. This is a temporary connection. Hang the test ECM on the side of the engine. Refer to Troubleshooting, "Test ECM Mode".
2. If the test ECM repairs the problem, reconnect the suspect ECM. Verify that the problem returns when the suspect ECM is reconnected.
3. Select the ECM Replacement Feature under the "Service/Copy Configuration" menu and load the parameters from the failed ECM.
4. Temporarily connect the new ECM by connecting both ECM connectors. Do not mount the ECM on the engine yet.

5. Flash program the personality module into the new ECM if the personality module is not already installed. The new ECM is shipped with a blank personality module.
6. Use the ECM replacement feature on the Caterpillar Electronic Technician (Cat ET) in order to program the new ECM.
7. Enter the value for the "Rating Number" parameter into the new ECM.
8. Check for active codes. Program any required parameters that have not been programmed.

**Note:** On initial powerup of a new ECM, the parameter "Rating Number" must be programmed to avoid activating a 253-02 Check Customer Or System Parameters.

9. If 22-13 Engine Speed Signal Calibration Not Performed is not active, install the new ECM on the engine. Otherwise, perform a timing calibration first.

## Replacing the ECM without the Use of the ECM Replacement Feature

1. Ensure that the ECM is the problem by first connecting a test ECM. This is a temporary connection. Hang the test ECM on the side of the engine. Flash program the identical personality module that was used in the suspect ECM into the test ECM. Program any parameters that are necessary to use the ECM for the test. For example, vehicle speed parameters need to be programmed to check the vehicle speed circuit. Program the parameters in the test ECM to be equal to the parameters in the suspect ECM.
2. If the test ECM repairs the problem, reconnect the suspect ECM. Verify that the problem returns when the suspect ECM is reconnected.
3. Obtain customer parameters from the failed ECM.
  - a. Obtain the customer passwords and record the customer passwords. If the customer (owner) has lost the passwords or if the customer (owner) has forgotten the passwords, proceed to Troubleshooting, "Customer Passwords" for more details.
  - b. Access the "Configuration" screen on Cat ET and record the customer parameters from the ECM that is being replaced. If the ECM does not communicate with Cat ET, obtain the required parameter list from the OEM.

- c. Use the Troubleshooting, "Customer Specified Parameters Worksheet" to record the customer parameters.
  - d. Record the injector codes. The injector codes can be found in the "Injector Codes Calibration" in "Calibrations" under the "Service" menu on Cat ET. Refer to Troubleshooting, "Injector Code - Calibrate" for more information.
4. Record ECM lifetime totals.
    - a. Use the Troubleshooting, "Customer Specified Parameters Worksheet (Current Totals Worksheet)" in order to record the old "ECM Current Totals".
  5. Temporarily connect the new ECM by connecting both ECM connectors. Do not mount the ECM to the engine until the timing calibration has been performed.
  6. Flash program the personality module into the new ECM if the personality module is not already installed. The new ECM is shipped with a blank personality module.
  7. Obtain factory passwords when the passwords are required.

**Note:** The following parameters can be programmed on a new ECM without factory passwords: "Full Load Setting (FLS)", "Full Torque Setting (FTS)", and "Engine Serial Number". System configuration parameters must be entered before the customer specified parameters are entered. If customer parameters are entered before the system configuration parameters, the Total Tattletale will change. It will then be necessary to obtain another set of factory passwords in order to change system configuration parameters.

8. Perform the following operations.
  - a. Use the Troubleshooting, "Factory Passwords Worksheet" to record the following information from the engine information plate: "Full Load Setting (FLS)", "Full Torque Setting (FTS)", and "Engine Serial Number".
  - b. Record the mileage from the vehicle odometer. Access the "Configuration" screen on Cat ET. When the screen for the "Factory Passwords" appears, record the following information: "ECM Serial Number", "Engine Serial Number", "ET Serial Number", "Total Tattletale", and "Reason Code".

- c. Leave Cat ET on the screen for the “Factory Passwords” and obtain the factory passwords. Complete the Troubleshooting, “Factory Passwords Worksheet”.

**9. Program the new ECM.**

**Note:** On initial powerup of a new ECM, the following parameters must be programmed to avoid activating 253-02 Check Customer Or System Parameters: “Full Load Setting (FLS)”, “Full Torque Setting (FTS)”, “Vehicle Speed Calibration” (ppm), “Rating Number”, “Engine Serial Number”, and “Injector Codes Calibration”.

- a. Access the “Configuration” screen on Cat ET. Enter the following parameters that are recorded on the worksheet: “Full Load Setting (FLS)”, “Full Torque Setting (FTS)”, and “Engine Serial Number”.
- b. Enter the customer specified parameters and the original customer passwords that are recorded on the worksheet.
- c. Use Cat ET to access current totals from the “Read/Change Current Totals” main menu. Record the information on the Troubleshooting, “Factory Passwords Worksheet” in order to obtain the factory passwords. Enter the totals from the original ECM that are recorded on the worksheet.
- d. Program the injector codes on Cat ET. Select the following screens in order: “Service”, “Calibrations”, “Injector Codes Calibration”. Refer to Troubleshooting, “Injector Code - Calibrate” for more information.
- e. Select the following screens in order to calibrate the engine timing: “Service”, “Calibrations”, and “Timing Calibration”. Calibrate the timing. Refer to Troubleshooting, “Engine Speed/Timing Sensor - Calibrate” for the proper procedure.

**10. Install the new ECM on the engine.**

## Sensors and Electrical Connectors

**SMCS Code:** 1900-NS; 7553-WW

Table 4

Connector	Function
J1/P1	ECM Connector
J2/P2	ECM Connector
J100/P100	Engine Coolant Temperature Sensor
J103/P103	Intake Manifold Air Temperature Sensor
J105/P105	Fuel Temperature Sensor
J200/P200	Boost Pressure Sensor
J201/P201	Engine Oil Pressure Sensor
J203/P203	Atmospheric Pressure Sensor
J300/P300	Injector Solenoid Harness
J400/P400	Timing Calibration Probe
J401/P401	Primary Engine Speed/Timing Sensor
J402/P402	Secondary Engine Speed/Timing Sensor
J403/P403	Accelerator Pedal Position Sensor

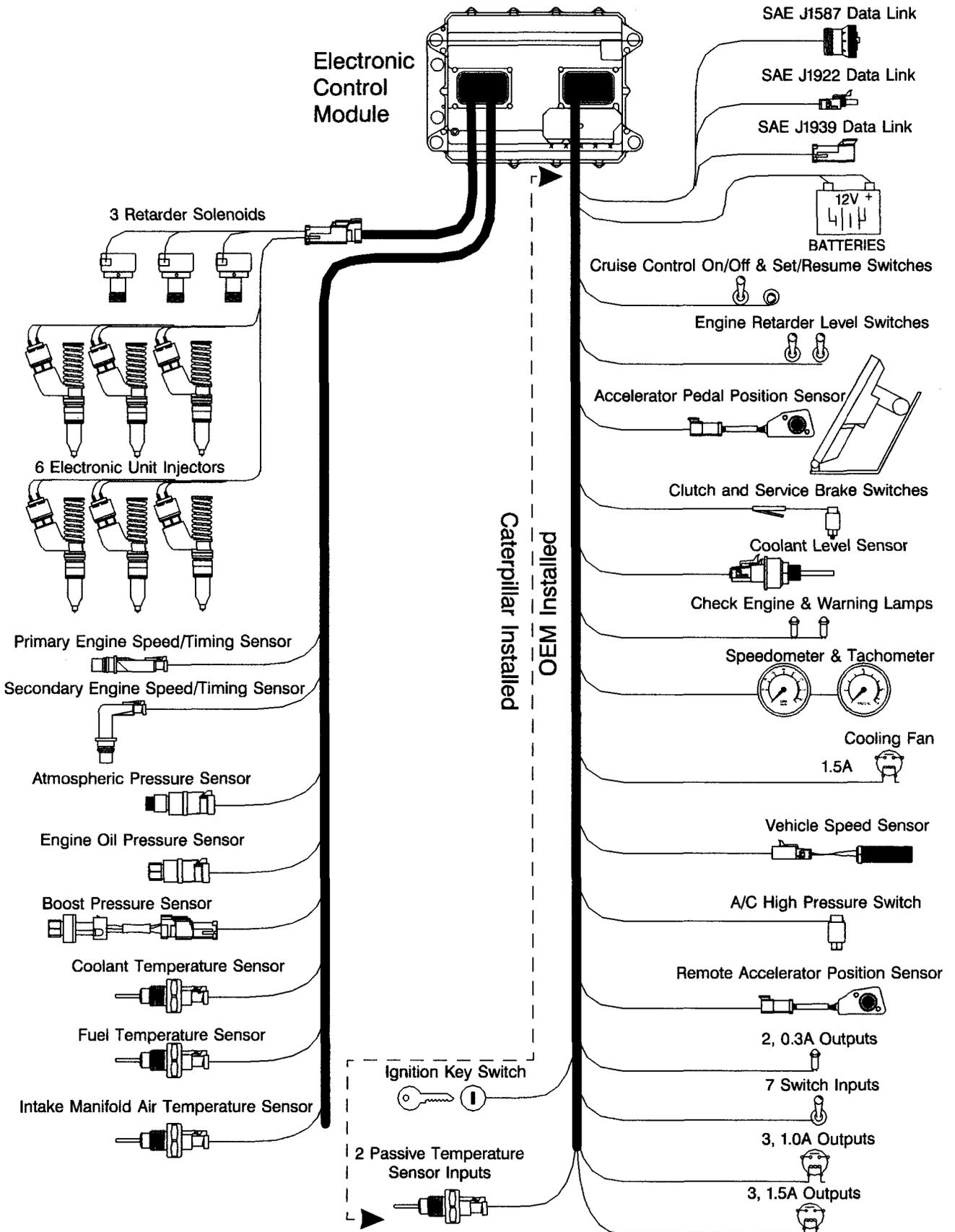


Illustration 14

Diagram of components

## C-10 and C-12 Engines

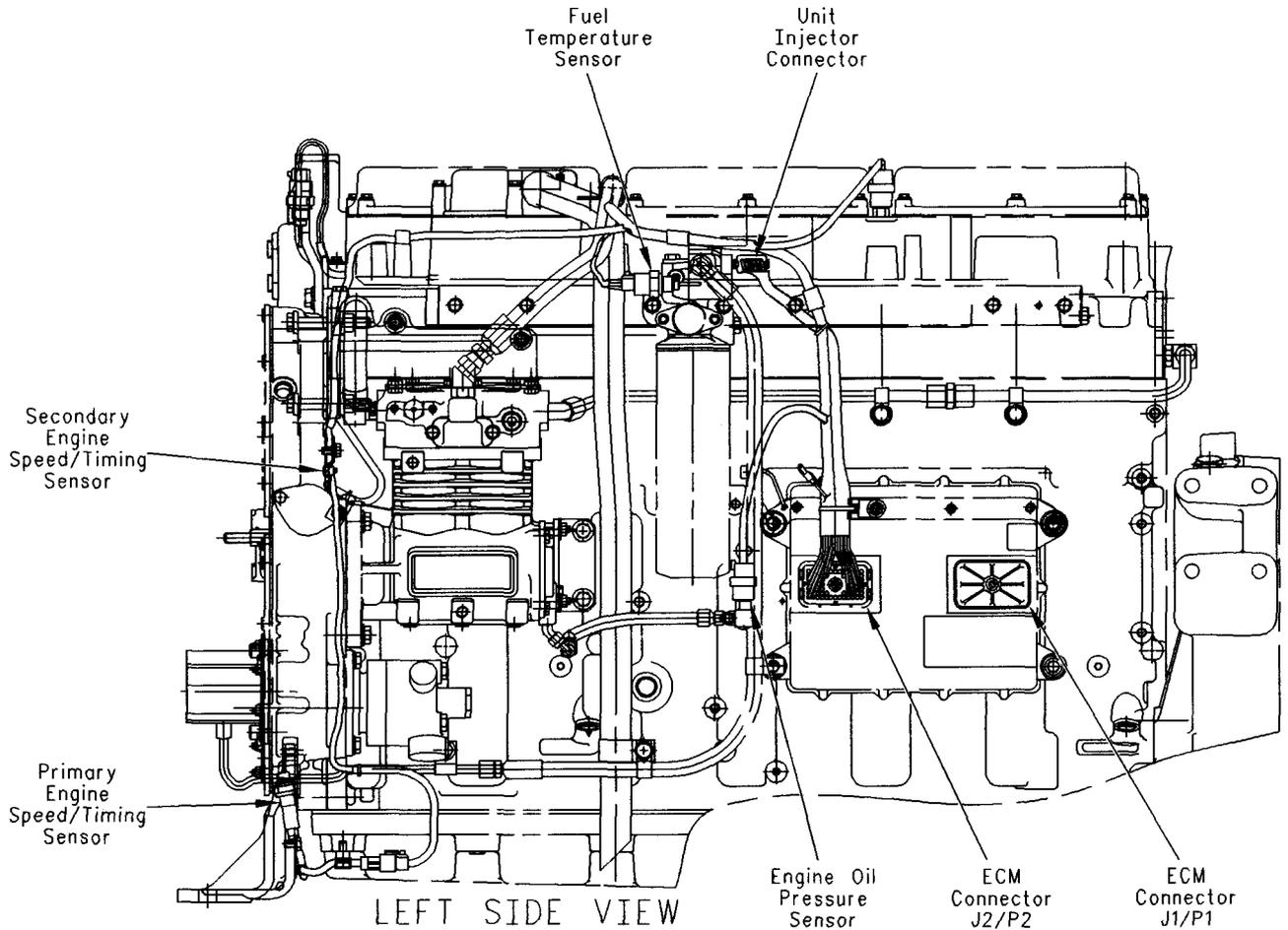


Illustration 15  
Left side view (typical example)

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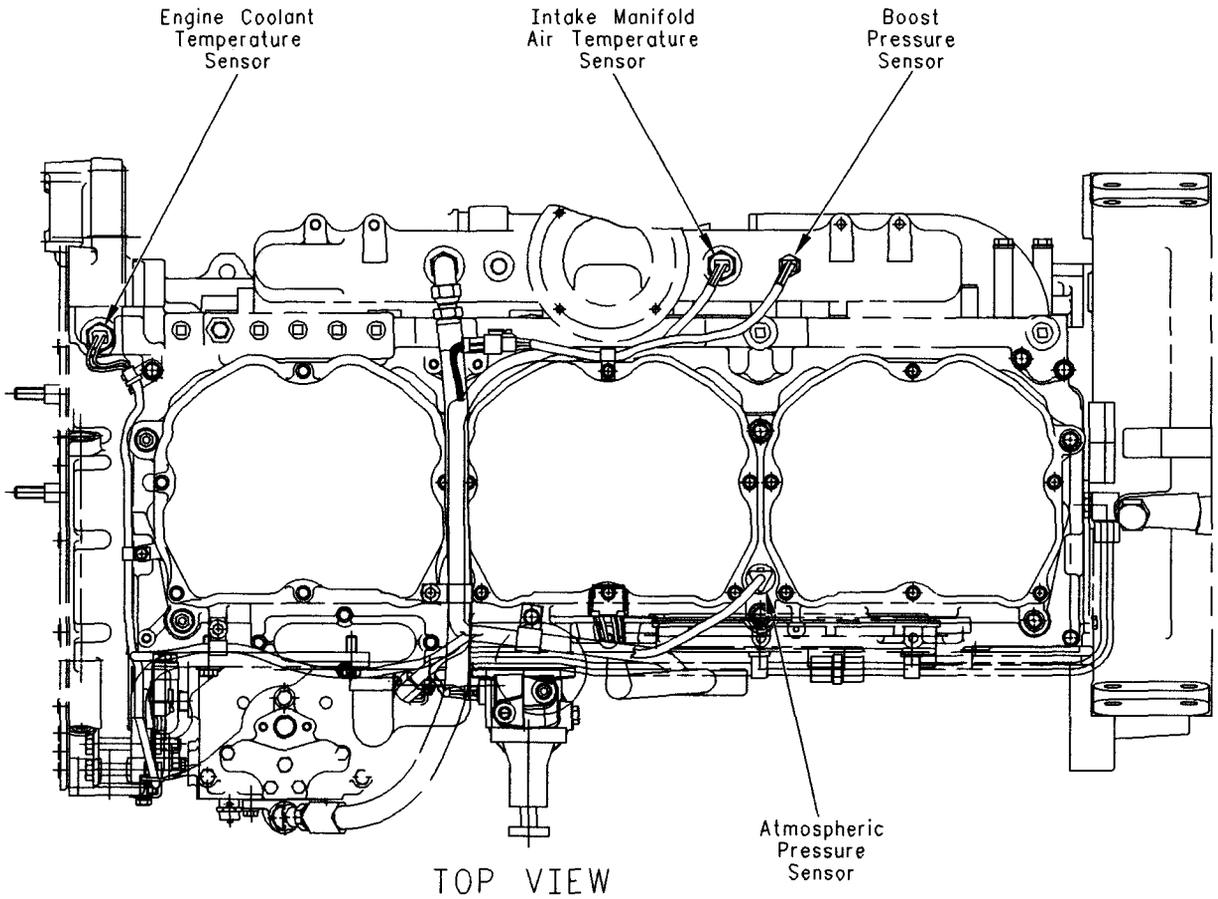


Illustration 16  
Top view (typical example)

# 3406E Engine

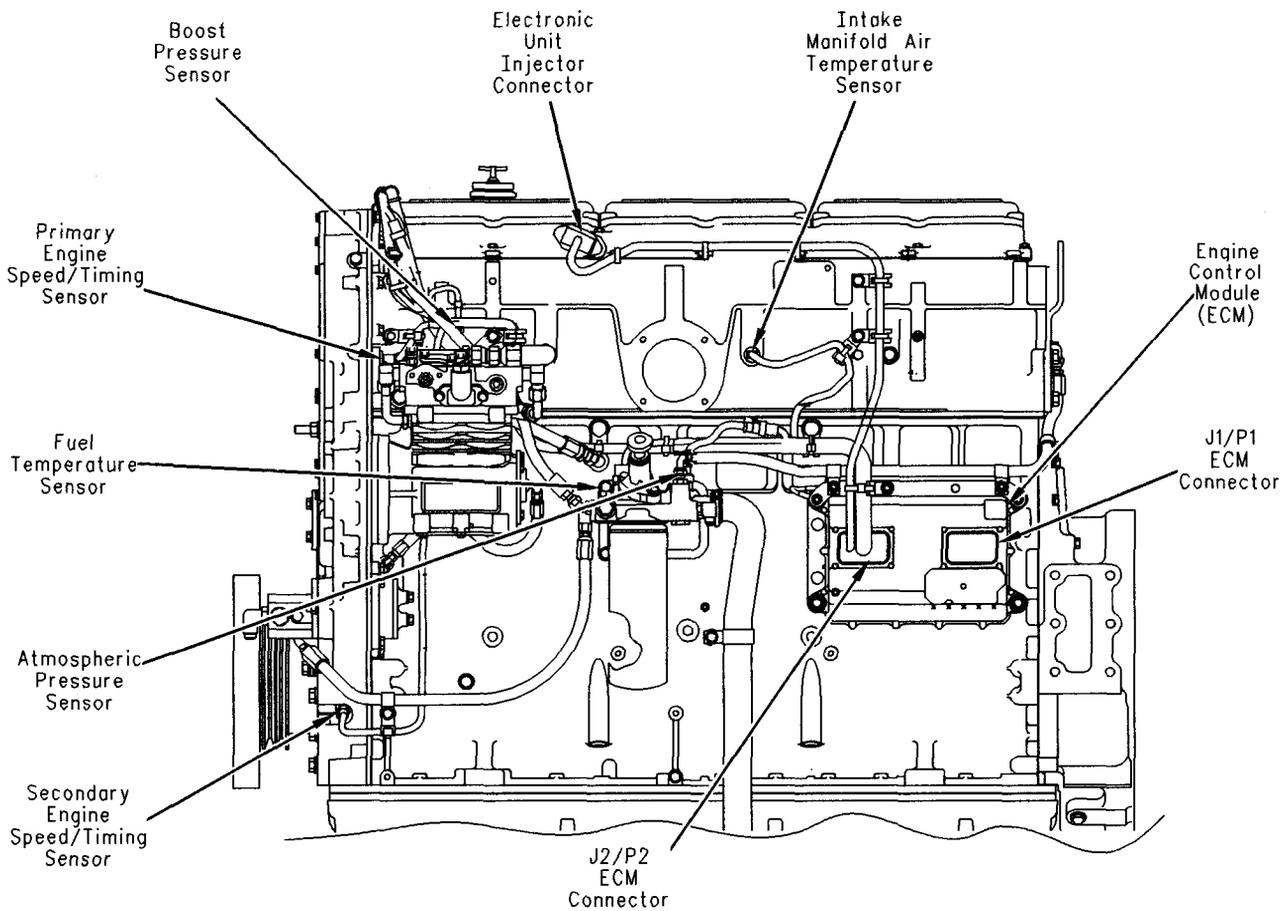
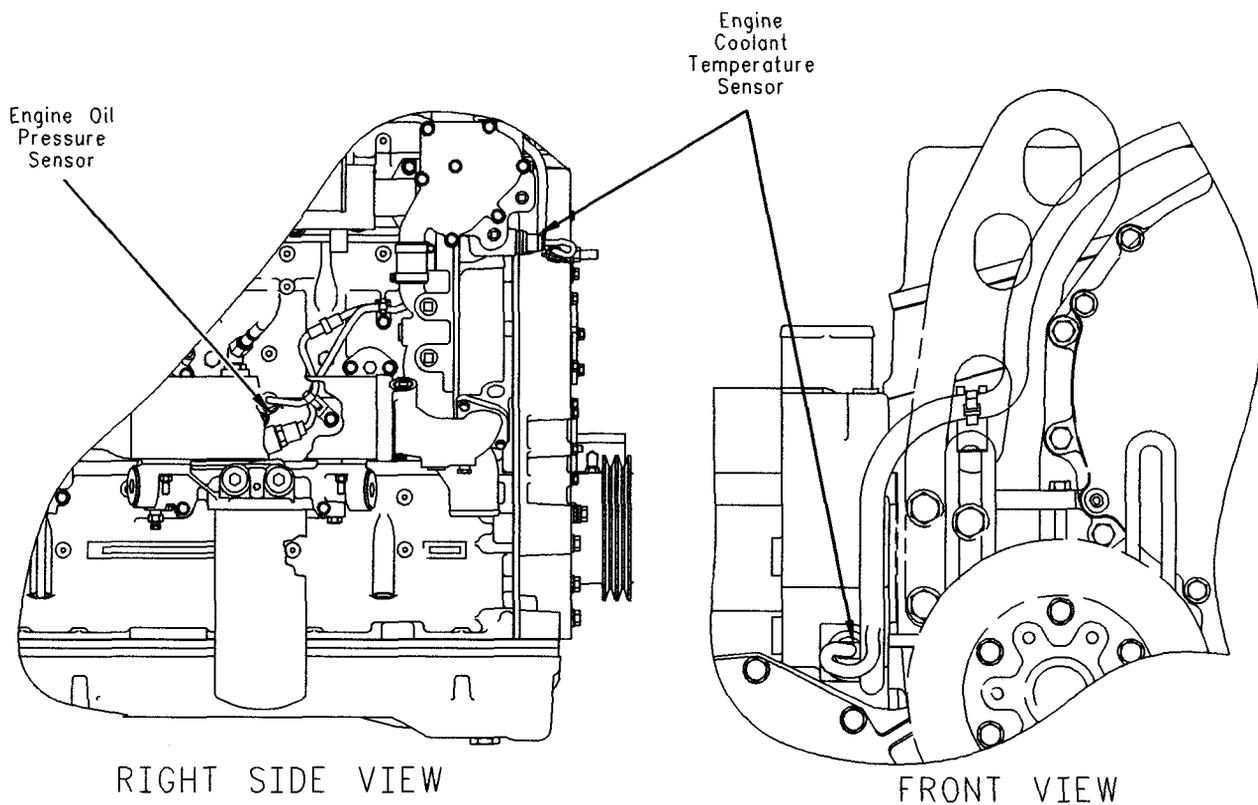


Illustration 17  
Left side view (typical example)

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Illustration 18  
Right side and front views (typical example)

# C-15, C-16 and C-18 Engines

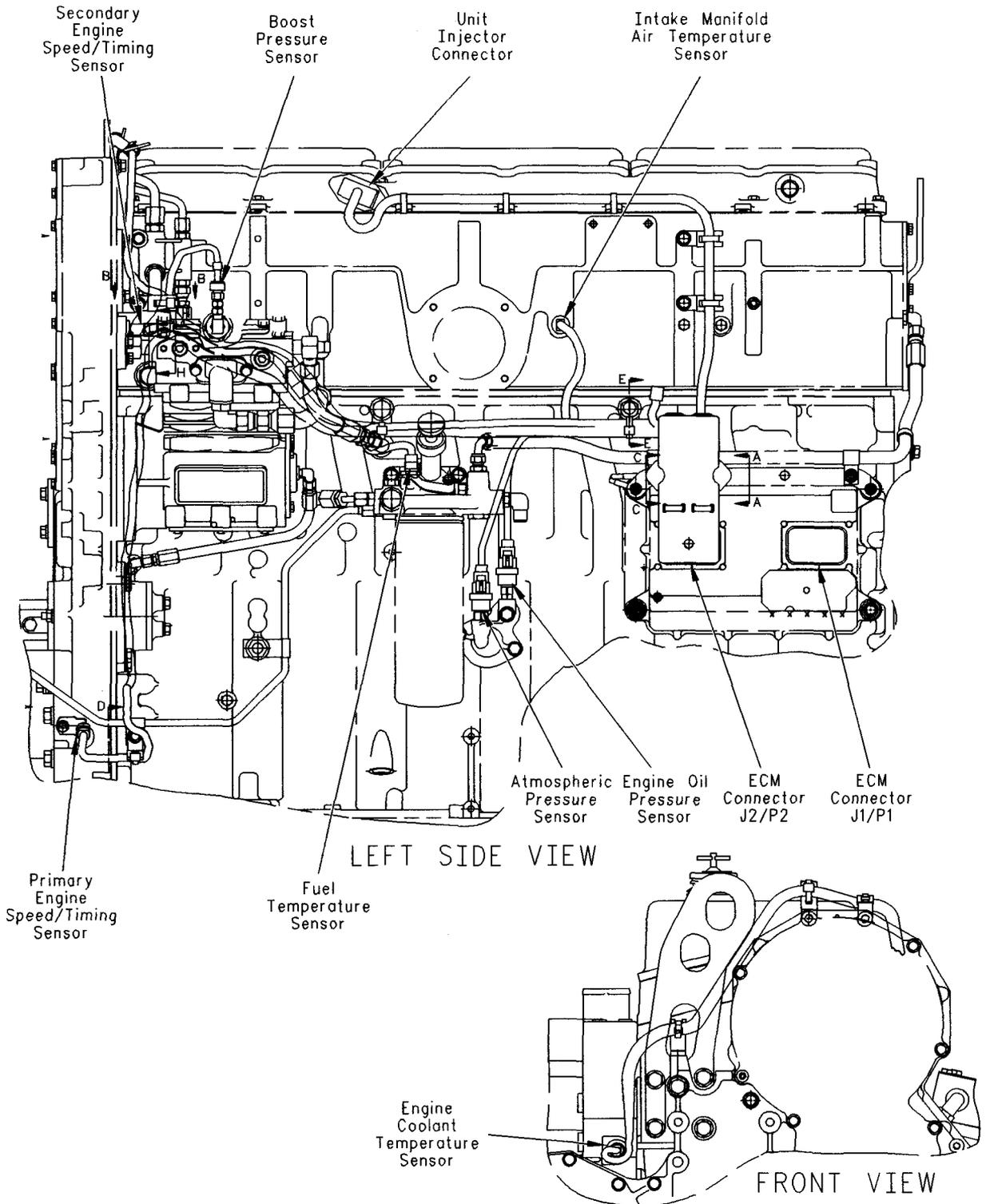


Illustration 19  
Left side view and top view (typical example)

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# Engine Wiring Harness Diagram

**SMCS Code:** 1408

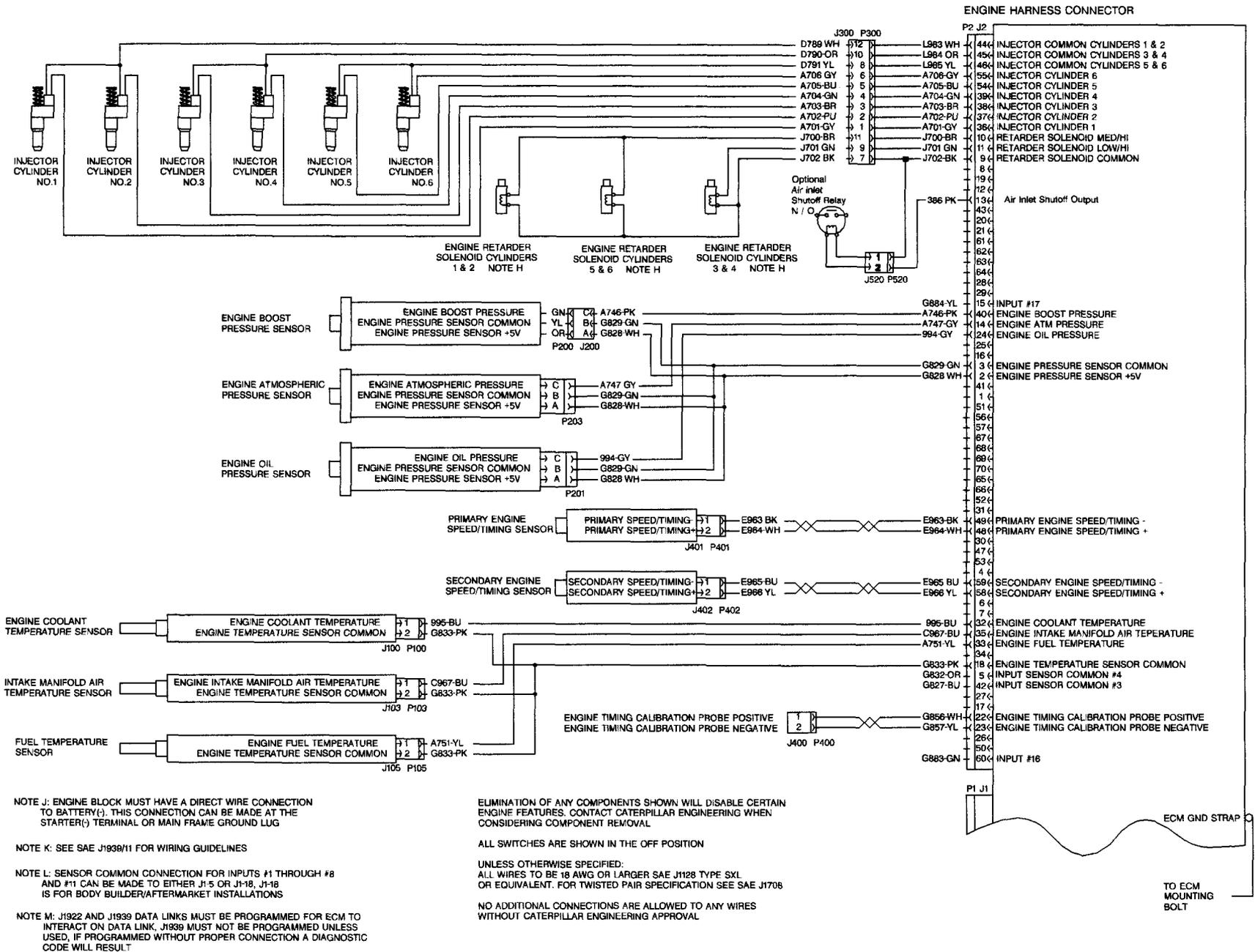


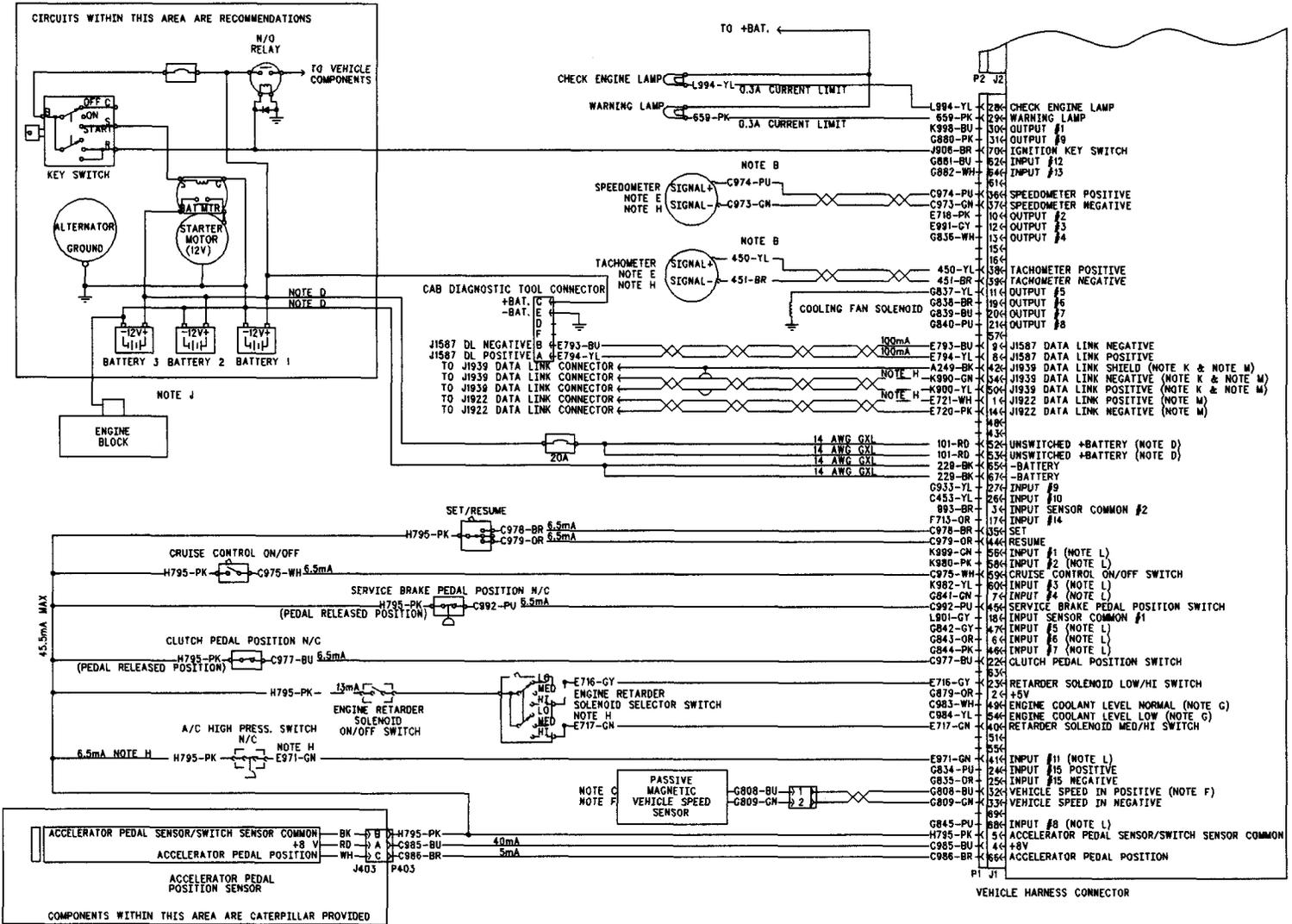
Illustration 20

g00995478

i01248643

# Vehicle Wiring Harness Diagram

**SMCS Code:** 1408



NOTE B: FOR SPEEDOMETERS OR TACHOMETERS WITH A SINGLE SIGNAL INPUT TERMINAL, EITHER ONE OF THE TWO SIGNAL OUTPUT LINES FROM THE ECM CAN BE USED, LEAVE THE REMAINING LINE DISCONNECTED, DO NOT CONNECT TO GROUND

NOTE C: "SINGLE" WINDING MAGNETIC PICKUP SENSOR RECOMMENDED

NOTE D: THESE CONNECTIONS ARE UNSWITCHED, DIRECT CONNECTION TO THE BATTERY IS NOT REQUIRED

NOTE E: THE ECM SPEEDOMETER AND TACHOMETER OUTPUT SIGNAL LINE VOLTAGES ARE ZERO-CROSSING SQUARE WAVES. THE SPEEDOMETER SIGNALS AT J1-37 AND J1-36 ARE COMPLEMENTS OF EACH OTHER. THE TACHOMETER SIGNALS AT J1-38 AND J1-39 ARE COMPLEMENTS OF EACH OTHER. MAXIMUM SIGNAL AMPLITUDE OF J1-36, J1-37, J1-38, AND J1-39 IS 10 VOLTS. AMPLITUDE WILL BE 5 VOLTS OR GREATER IF LOAD CURRENT IS LESS THAN 4mA

NOTE F: IF AN ELECTRONIC SIGNAL IS PROVIDED IN PLACE OF A PASSIVE MAGNETIC SENSOR, CONNECT THE ELECTRONIC SIGNAL INPUT TO THE +SIGNAL PIN. THE -SIGNAL PIN SHOULD NOT BE CONNECTED OR GROUNDED WITH ELECTRONIC SIGNAL INPUTS

NOTE H: THIS IS AN OPTIONAL FEATURE NOT AVAILABLE ON ALL SYSTEMS

(SEE OTHER PAGE FOR ADDITIONAL NOTES)

Illustration 21

g00665578

**CATERPILLAR**  
**3406E, C-10, C-12, C-15, C-16 AND C-18 TRUCK ENGINE**  
**PROGRAMMING PARAMETERS**  
**TABLE OF CONTENTS**

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# Programming Parameters

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## Programming Parameters

**SMCS Code:** 1901

Many programmable parameters affect the engine operation. These parameters may be changed with the electronic service tool. The parameters are stored in the ECM. The parameters are not stored in the personality module. Any parameter can be read. However, passwords protect parameters from unauthorized changes.

Two categories contain various parameters, System Configuration Parameters and Customer Specified Parameters. System Configuration Parameters can be altered with the electronic service tool only if the proper factory passwords are obtained.

Customer Specified Parameters can be changed with the electronic service tool only if the proper customer passwords are used. Refer to Troubleshooting, "Customer Passwords" and Troubleshooting, "Factory Passwords" for additional information.

## Programming a New ECM

The Engine Control Module or the ECM is the brain of the system. So when a problem occurs, it is easy to assume that the ECM is responsible. This is usually the wrong assumption. Most failures occur at the wiring and connectors or at a sensor input or sensor output. Follow the procedures in the Troubleshooting Guide, and do not replace an ECM on an assumption. However, when your troubleshooting indicates that a failure has in fact occurred in the ECM, refer to Troubleshooting, "Replacing the ECM".

**Note:** If a replacement for the ECM is required, the customer parameters and the timing calibration can be transferred from the suspect ECM to the replacement ECM. Timing calibration will not be necessary. This feature requires the electronic service tool and this feature is only possible if the suspect ECM can communicate with the electronic service tool.

## Test ECM Mode

**SMCS Code:** 1901

"Test ECM Mode" is a feature in the software that can be used to help troubleshoot an engine that may have a problem with the ECM. This feature allows a standard ECM to be used as a test ECM. This feature eliminates the need to stock a test ECM.

1. Use the "Copy Configuration" feature on the electronic service tool to copy the parameters from the suspect ECM.

**Note:** If the "ECM Replacement" feature can not be used, record the programmed values into the "Customer Specified Parameters Worksheet". Also record the System Configuration Parameters.

2. Disconnect the suspect ECM. Temporarily connect the test ECM to the engine. Do not mount the test ECM on the engine.
3. Use the "Copy Configuration" feature on the electronic service tool to program the test ECM.

**Note:** If the "ECM Replacement" feature can not be used, program the test ECM with the values from the "Customer Specified Parameters Worksheet" and the values from the System Configuration Parameters.

4. Start the "Test ECM Mode" on the electronic service tool. Access the feature through the "Service" menu. The electronic service tool will display the status of the test ECM and the hours that are remaining for the "Test ECM Mode".

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

When the "Test ECM Mode" is activated, an internal timer sets a 24 hour clock. This clock will count down only while the ECM is powered and the key switch is in the ON position. After the ECM has counted down the 24 hour period, the ECM will exit the "Test ECM Mode". The parameters, the accumulated mileage, and the engine serial number will be set.

Once an ECM has been activated in the "Test ECM Mode", the ECM will stay in the "Test ECM Mode" until the timer times out. If the ECM is used as a test ECM for more than one engine, the "Test ECM Mode" must be reactivated. Anytime prior to the "Test ECM Mode" timing out, the ECM can be reset to 24 hours.

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## Customer Passwords

**SMCS Code:** 0785

If Customer Passwords have been entered, then the Customer Passwords are required to change ANY customer parameter. Customer Parameters are those parameters that affect the vehicle speed limits, the power rating within an engine family and the PTO operation. Refer to Troubleshooting, "Customer Specified Parameters" for more detail on parameters that are customer programmable.

The Caterpillar Electronic Technician (Cat ET) may change Customer Parameters. To obtain customer passwords, contact the owner of the vehicle. If the owner has lost the owner's passwords, customer passwords may be read by using Cat ET.

**Note:** Factory passwords are required in order to read customer passwords.

Use the following procedure in order to read customer passwords with Cat ET:

1. Use Cat ET to access the "Utilities" menu. Then access "View Passwords" under the "Utilities" menu.
2. When the Factory Password screen appears, record the information that is listed on the Factory Passwords Worksheet. Refer to Troubleshooting, "Factory Passwords Worksheet".
3. Obtain the factory passwords. The information that is recorded on the Factory Passwords Worksheet must be provided. When the factory passwords are obtained, a permanent record of the access is generated at Caterpillar.
4. From the Factory Password screen, enter the Factory Passwords.
5. When the "Read Customer Passwords" screen appears, record the Customer Passwords. The Customer Passwords may then be used to change Customer Parameters.

## ECM Date/Time Stamped Information

**SMCS Code:** 0785

The date/time clock indicates the month, the day, the year and the time of day. This clock is used to time stamp the following Diagnostic Event Codes:

- 84-00 Vehicle Overspeed Warning
- 84-14 Quick Stop Occurrence
- 100-11 Very Low Oil Pressure
- 110-11 Very High Coolant Temperature
- 111-11 Very Low Coolant Level
- 190-00 Engine Overspeed Warning

The following types of ECM data are also time stamped information:

- Diagnostic snapshots
- Snapshots that are triggered by using the Set/Resume switch
- Quick Stop snapshots

## Adjustment of ECM Date/Time Clock

Before adjusting the ECM Date/Time Clock on a vehicle, ask the owner/operator if the time stamped information should be recorded. After the time stamped information is recorded, clear this information before adjusting the ECM Date/Time Clock. This is a very important step if the adjustment of the clock is a big adjustment. This will prevent unnecessary confusion if someone else views the information at a later date.

## Occurrence of Time Stamped Information

When the time stamped information is being viewed, remember that the vehicle may be based in a different time zone. Also remember the following two possibilities:

- Someone may have incorrectly set the clock.
- No one ever set the clock.

Compare the electronic control module's current time of day to the time stamped information in the ECM in order to determine the amount of time that has passed since the occurrence of the time stamped event. **DO NOT REPLACE AN ECM BECAUSE OF AN INCORRECT TIME OF DAY.** The following example indicates the proper use of the clock.

## Proper Use of ECM Date/Time Stamped Information

The Electronic Service Tool indicates that a diagnostic code occurred. The 190-00 Engine Overspeed Warning occurred on 19 November 1998 at 10:30:46. The Electronic Service Tool also indicates that the current time of day in the ECM is 24 November 1998 at 11:20:58. **This indicates that the problem occurred in the past (approximately one week and 50 minutes).**

Do not compare the electronic control module's time of day to the current time of day at your location. If the electronic control module's time of day differs significantly from the current time of day (wrong month), ensure that the important time stamped information is recorded. After recording the information, clear the code or the snapshot, and then adjust the clock.

## ECM Diagnostic Clock

The Diagnostic Clock should not be confused with the ECM Date/Time clock. The Diagnostic Clock records the actual hours of the ECM under power. The information from the diagnostic clock is used in order to log occurrences of diagnostic code and occurrences of event code . Logged diagnostic codes and logged event codes display the diagnostic clock hour of the first occurrence and the last occurrence and the total number of occurrences. The Diagnostic Clock does not represent actual Engine Hours. The clock increments any time of the ECM under power. This happens when the engine is running or when the engine is not running. Actual Engine Running hours (Total Time) can be obtained from the menu for Current Totals of Electronic Technician (ET).

## ECM Snapshot

**SMCS Code:** 0785

The engine ECM can record a snapshot of the engine parameters and vehicle parameters. The snapshot records the parameters for a period of 13 seconds that surrounds the event. The event is either a diagnostic code or an external trigger.

## Use Of Snapshot

Use Snapshots **ONLY** to help determine engine/vehicle operating conditions when an intermittent problem occurs. If an intermittent diagnostic code is causing problems, use the snapshot data. Snapshot data can be used to determine whether the problem seems to occur under specific circumstances. The following list of conditions is an example of some of the specific circumstances:

- Engine rpm
- Ranges of vehicle speed
- Ranges of Coolant temperature

Use this data to attempt to duplicate these conditions with the vehicle and get the code to reoccur.

**Replacement of electronic components should not be based on the Snapshot data alone.** When the snapshot information is triggered externally, the snapshot information is stored in frames during every 0.24 seconds. When the snapshot information is triggered by a diagnostic code, the snapshot information is stored in frames during every 0.48 seconds. Frequently, the parameters are changing at a rate that is different from 0.24 seconds. If too much emphasis is put on this information, the result could be a misdiagnosed problem. Also when snapshot information that is triggered by a diagnostic code is being viewed, the ECM sets a sensor value with an ACTIVE Diagnostic Code to a default value when the code is Active. This is the reason that the Sensor value suddenly jumps to a specific value at the trigger point and the Sensor value remains there for the rest of the snapshot frames. DO NOT attempt to interpret the information and DO NOT attempt to analyze the reason that the engine is operating from this historical information. Incorrect diagnoses will occur by looking at this information under a microscope. Incorrect diagnoses will occur because some of the parameters will not be set to the values that are expected. Even though the parameters are not related to the problem that is under investigation, the parameters can lead to incorrect diagnoses.

## Snapshot Information That Is Triggered By A Diagnostic Code

When a diagnostic code occurs the ECM records many of the status parameters that are available on the Caterpillar Electronic Technician (Cat ET). The ECM records this information for approximately 9 seconds before the code occurs, and approximately 4 seconds after the code.

## Snapshot Information That Is Triggered Externally

A snapshot can be triggered externally with either the Cruise Control Set/Resume Switch, or with Cat ET. Use the following procedure in order to trigger the snapshot with the Cruise Control Set/Resume Switch:

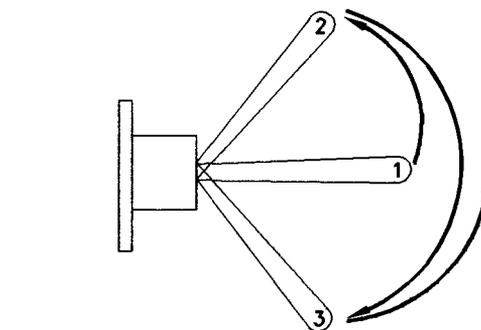


Illustration 22

g00627693

- (1) OFF position
- (2) SET position
- (3) RESUME position

1. Toggle the switch quickly from the OFF position (1) to the SET position (2).
2. Toggle the switch quickly from the SET position (2) to the RESUME position (3).
3. Toggle the switch quickly from the RESUME position (3) back to the OFF position (1).

**Note:** The switch must be toggled within a one second time period in order to take a snapshot of the engine parameters. The procedure can also be performed in the reverse order.

On Cat ET, the snapshot can be triggered from the Snapshot Recorder Tool. Refer to the instructions on the screen or the system's documentation for help.

## Quick Stop Snapshot

A snapshot can also be stored for a Quick Stop event if the Customer Parameter is programmed. The ECM stores the number of occurrences of the Quick Stop Event and a snapshot of the latest occurrence.

One data record is kept for the most recent Quick Stop event. The previous record is replaced by the most recent record.

Each Quick Stop record contains 60 frames of information. Frame 45 is the Quick Stop event. The record contains 44 frames before the Quick Stop event and 15 frames following the Quick Stop event. Each frame is separated by 1.0 second. Each frame of the Quick Stop record stores the following data:

- Engine RPM
- Throttle Position
- Clutch Switch

- Vehicle Speed
- Cruise Status
- Brake Switch

## Storage of Snapshots In The ECM

The ECM can store a maximum of two snapshots that are triggered by a Diagnostic Code, two snapshots that are triggered externally, and one Quick Stop Snapshot. The snapshots are stored in a circular buffer. The newest snapshot will replace the oldest snapshot.

The ECM stores the snapshots in memory. The memory is maintained through the Unswitched battery connections. If the Unswitched + battery pins are disconnected, or if the vehicle batteries are disconnected, the snapshot information is maintained by the internal battery in the ECM .

Also, the snapshots can be cleared manually by using Cat ET. Snapshots are automatically cleared by the ECM after 100 hours of operation. Snapshots are similar to Diagnostic Codes in this characteristic.

i01914316

## Factory Passwords

**SMCS Code:** 0785

Factory passwords are required to perform each of the following six functions:

### 1. Change the System Configuration Parameters.

When an ECM is replaced, the System Configuration Parameters must be programmed into the new ECM. A new ECM will allow these parameters to be programmed once without Factory Passwords. After the initial programming, these parameters are protected by factory passwords.

### 2. Rerate to another engine family

This requires changing the personality module code, which is protected by factory passwords. This includes changing from a non-multitorque personality module to a multitorque personality module.

### 3. Read customer passwords

If the owner loses the owner's customer passwords, the owner will not be able to program customer parameters. By using factory passwords, one can read customer passwords. Then use those customer passwords to program customer parameters.

### 4. Clear certain diagnostic codes.

### 5. Unlock a customer parameter that is locked.

If a customer parameter has been locked out, factory passwords are required to unlock the parameter. Also if a customer parameter has been locked out, factory passwords are required to change the parameter. Refer to Troubleshooting, "Customer Specified Parameters" for additional information.

### 6. Enable certain customer parameters.

- "ECM Wireless Communication Enable"

---

#### NOTICE

**Operating the engine with a Personality Module not designed for that engine will damage the engine. Be sure the Personality Module is correct for your engine.**

---

Certain other codes require customer passwords. The majority of logged codes do not require passwords to be cleared. Since the factory passwords contain alphabetic characters, the electronic service tool may perform these functions. In order to obtain the factory passwords, proceed as if you already have the password. At some point, if the factory passwords are actually needed, the electronic service tool will request the factory passwords and the electronic service tool will display the information that is required to obtain the passwords.

**Note:** The "Customer Parameter Lockout" may restrict changing some customer parameters unless factory passwords are obtained. If changing a customer parameter indicates that the factory passwords are required, the parameter has been locked out. Refer to Troubleshooting, "Customer Specified Parameters" for additional information.

i01180795

## Factory Passwords Worksheet

**SMCS Code:** 0785

**Note:** A mistake in recording these parameters will result in incorrect passwords.

Table 5

Dealer Code	
Customer's Name	
Address	
Telephone Number	
<b>Information From Engine Information Plate</b>	
Engine Serial Number	
Full Load Setting	
Full Torque Setting	
<b>Information From Vehicle Odometer</b>	
Engine's Miles (km)	
<b>Information From Factory Password Entry Screen on ET</b>	
Electronic Service Tool Serial Number	
Engine Serial Number	
ECM Serial Number	
Total Tattletale	
Reason Code	
From Interlock <sup>(1)</sup>	
To Interlock <sup>(1)</sup>	
<b>Factory Passwords</b>	
Factory Password (No. 1)	
Factory Password (No. 2)	

<sup>(1)</sup> This parameter is required when the engine is being rerated. This parameter is only displayed when the engine is being rerated.

i01850081

## Flash Programming

**SMCS Code:** 1901-591

1. Obtain the part number for the new flash file.
  - a. If the part number is not available, use the "Flash File Search" tool on the Service Technician Workbench (STW) or on SIS Web.

**Note:** The engine serial number must be obtained in order to use the "Flash File Search".

2. Connect the electronic service tool to the data link connector.
3. Turn the key switch to the ON position. Do not start the engine.

4. Select "WinFlash" from the "Utilities" menu on the electronic service tool.

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

5. 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 part number 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, search for the correct flash file.
  - e. When the correct flash file is selected, press the "Begin Flash" button.
  - f. The electronic service tool will indicate when flash programming has been successfully completed.
6. Start the engine and check for proper operation.
  - a. Program any parameters that were not programmed in the old flash file if a 253-02 Check Customer Or System Parameters is active.
  - b. The following parameters must be programmed on a new ECM to prevent a 253-02 Check Customer Or System Parameters:
    - "FLS"
    - "FTS"
    - "Vehicle Speed Calibration"
    - "Rating Number"
    - "Engine Serial Number"
    - "Injector Codes Calibration"

## “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.

i01183143

## Service Information Report

**SMCS Code:** 0336

After verifying the correct repair has been performed on the vehicle it is critical to provide brief, detailed information. This information helps Caterpillar better serve you and the Customer.

## Recommendations

### Customer’s Complaint

Provide a copy of the Troubleshooting, “Driver Questionnaire”. Include comments in as many categories as possible. The following information is of particular importance:

- Indicate whether the Check Engine Lamp was ON continuously or whether the Check Engine Lamp was ON intermittently.
- Indicate the symptoms of vehicle operation that are present.

### Cause of Failure

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

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

Be as specific as possible.

## Repair Procedure

Comments on the Repair Procedure should include the following types of information:

- The wiring harness was repaired.
- The FLS was changed per the factory’s instructions.

**CATERPILLAR**  
**3406E, C-10, C-12, C-15, C-16 AND C-18 TRUCK ENGINE**  
**CUSTOMER SPECIFIED PARAMETERS**  
**TABLE OF CONTENTS**

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## Customer Specified Parameters

i01914146

## Customer Specified Parameters

**SMCS Code:** 1901

Customer Specified Parameters allow the vehicle owner to influence the operating technique of a driver. Some parameters may affect engine operation in a way that would not be expected by an inadequately trained driver. These parameters may lead to power or performance complaints even though the engine's performance is within the engine's specification.

Customer parameters may be changed repeatedly as a customer's operation changes or as new drivers are assigned to a truck. Customer Passwords are required to change these parameters.

The following information is a brief description of the Customer Specified Parameters. The following parameter values are included with the descriptions:

- Minimum
- Maximum
- Default

The tables show values in an approximate range for metric units that is followed by the metric conversion to English units. The exact range of the parameter in metric units depends on the service tool that is being used. Each tool may use slightly different conversion factors.

## Customer Parameter Lockout

The Customer Parameter Lockout is available in order to restrict access to changing some of the available parameters. Locking out a parameter requires Customer Passwords (if used). Once a parameter is locked out, Factory Passwords are required to change the parameter. Also, once a parameter is locked out, Factory Passwords are required to unlock the parameter.

If a lockable parameter is not locked out, Factory Passwords are not required. A locked out parameter restricts the parameter from being changed directly by the operator. This helps vehicle owners that are encountering problems with operators that are obtaining Customer Passwords and altering some of these parameters.

A locked out parameter also provides an audit trail. The audit trail can be used to determine the following information:

- Time of change
- Operator during change

The following Customer Parameters are available for Lockout:

- "Multi-Torque Ratio"
- "Vehicle Speed Calibration"
- "Vehicle Speed Cal (J1939 - Trans)"
- "Vehicle Speed Cal (J1939 - ABS)"
- "Vehicle Speed Limit"
- "VSL Protection"
- "Soft Vehicle Speed Limit"
- "Low Speed Range Axle Ratio"
- "High Speed Range Axle Ratio"
- "Low Cruise Control Set Speed Limit"
- "High Cruise Control Set Speed Limit"
- "Top Engine Limit"
- "Transmission Style"
- "Top Gear Ratio"
- "Top Gear Minus One Ratio"
- "Top Gear Minus Two Ratio"
- "A/C Switch Fan On-Time"
- "Engine Retarder Delay"
- "Engine Monitoring Lamps"
- "Driver Reward Enable"
- "Fan Control Type"

When an attempt to change a locked out parameter occurs, the Factory Password screen will come up. If changing the parameter is required, follow the instructions on ET.

Factory Passwords are also required to change a parameter from a locked parameter to an unlocked parameter. If more than one parameter is locked out, and each one needs to be unlocked, one Factory Password is required.

## “Selected Engine Rating”

### “Rating Number”

The Rating Number is the selected Rating within a power rating family. The Personality Module defines the power rating family (242 kW (325 hp)) and the Personality Module may contain only one or several ratings. The rating number defines the power rating that is used within the power rating family. The following list illustrates examples of the power rating:

- 324 kW (435 hp) at a Governed Engine Speed of 1800 rpm
- 324 kW (435 hp) at a Governed Engine Speed of 2100 rpm

Both ratings will be displayed for Multi-Torque applications.

### “Multi-Torque Ratio”

This parameter is used to select the desired Multitorque trip point. Multitorque ratings allow the engine to provide additional torque, additional horsepower, and torque when the transmission is operating in higher gear. The additional torque allows the truck to crest a hill without downshifting and increases fuel economy. The “Multi-Torque” feature also helps to reduce wear. The trip point is determined by a ratio of engine speed versus vehicle speed. The three programmable options represent the different trip point values that are listed below.

Table 6

Programmable Option	Turn On Ratio (RPM to MPH)	Gear Range
MT-4	71.5	Top 4 Gears
MT-2	37.6	Top 2 Gears
MT-1	27.9	Top 1 Gear

**Note:** This feature is not used with standard engine ratings. This feature is only available for multitorque ratings.

Table 7

Type of Engine Rating	Alternatives	Default
Standard Ratings	Unavailable	Unavailable
Multitorque Ratings	MT-2, MT-1	MT-4

## “ECM Identification Parameters”

### “Vehicle ID”

“Vehicle ID” is the identification of the vehicle that is assigned by the customer. “Vehicle ID” is used only for the customer’s reference. “Vehicle ID” is not required by the ECM.

### “Security Access Parameters”

### “ECM Wireless Communication Enable”

The “ECM Wireless Communication Enable” determines if the ECM will transfer information over the data link through remote communications systems for customers.

The parameter will default out of Caterpillar to no access. The parameter can only be enabled by getting Factory Passwords. This feature can only be enabled after the truck has been delivered to the customer. Refer to Troubleshooting, “System Overview” for additional information.

Table 8

Alternative	Default
Yes	No

## “Vehicle Speed Parameters”

### “Vehicle Speed Calibration”

The “Vehicle Speed Calibration” is the value that is used by the ECM in order to translate the vehicle speed signal into kilometers per hour (miles per hour). This parameter is programmed in pulses per kilometer (PPKM) or pulses per mile (PPM). This parameter must be programmed. If the “Vehicle Speed Calibration” parameter is not programmed, 253-02 Check Customer or System Parameters (56) will be active. This parameter affects the cruise control and the ECM speedometer signal. Also, this parameter can affect the PTO operation, extended idle and trip totals.

Table 9

Minimum	Maximum	Default
2485 PPKM (4000 PPM)	93226 PPKM (150000 PPM)	8696 PPKM (14000 PPM)

### “Vehicle Speed Cal (J1939-Trans)”

#### NOV01 and newer software

**Note:** This parameter is not available on engine serial numbers W1A1-Up, MDP1-Up, and MEP1-Up.

The “Vehicle Speed Cal (J1939-Trans)” is used when the ECM is configured to use the speed of the transmission output shaft in order to calculate vehicle speed. The “Vehicle Speed Input” parameter must be programmed to “Vehicle Speed Cal J1939-Trans”. This value represents the revolution of the transmission output shaft as revolutions per kilometer (revolutions per mile). This parameter *must be programmed*. If this parameter is not programmed, the diagnostic code 253-02 that is Check Customer or System Parameters (56) will be active. This parameter affects the cruise control and the ECM speedometer signal. Also, this parameter can affect the PTO operation, extended idle and trip totals.

Table 10

Minimum	Maximum	Default
0	65000	Not Programmed

### “Vehicle Speed Cal (J1939-ABS)”

#### NOV01 and newer software

**Note:** This parameter is not available on engine serial numbers W1A1-Up, MDP1-Up, and MEP1-Up.

The “Vehicle Speed Cal (J1939-ABS)” is used to calculate vehicle speed by the use of the input from the wheel speed. The data from the wheel speed is transmitted via the J1939 data link. The “Vehicle Speed Input” parameter must be programmed to “Vehicle Speed Cal J1939-ABS”. The manufacturer of the ABS system must transmit tire revolutions per mile that is based on the tire size. If the tire size is *changed from the tire size that is programmed in the ABS system*, the “Vehicle Speed Cal (J1939-ABS)” must be changed. The value that is contained in the “Vehicle Speed Cal (J1939-ABS)” parameter is a ratio. If the actual tire size is equal to the tire size that is programmed in the ABS system, the “Vehicle Speed Cal (J1939-ABS)” parameter will be “1”. The ratio can be found by dividing the tire revolutions per mile that is transmitted by the ABS system by the actual tire revolutions per mile. Contact the manufacturer of the ABS system in order to verify that this message is supported.

If the “Vehicle Speed Input” parameter is programmed to “Vehicle Speed Cal J1939-ABS”, this parameter must be programmed. If this parameter is not programmed, the diagnostic code 253-02 that is Check Customer or System Parameters (56) will be active. This parameter affects the cruise control and the ECM speedometer signal. Also, this parameter can affect the PTO operation, extended idle and trip totals.

Table 11

Minimum	Maximum	Default
0	6.550	Not Programmed

### “Vehicle Speed Limit” (VSL)

The “Vehicle Speed Limit” (VSL) is the maximum vehicle speed that is allowed by the ECM. The ECM will shut off fuel above this speed. An inexperienced driver may think that something is wrong with the engine because the ECM will not fuel the engine above this vehicle speed limit. Vehicle speed limiting allows the implementation of a gear fast/run slow specification for the truck. The gear fast/run slow specification for the truck improves fuel economy while the parameter for the vehicle speed limit limits the maximum vehicle speed of the truck.

**Note:** The Driver Incentive Feature can be used to automatically adjust the VSL according to the driver’s operating techniques.

Table 12

Minimum	Maximum	Default
48 km/h (30 mph)	204 km/h (127 mph)	204 km/h (127 mph)

### “VSL Protection”

The “VSL Protection” is the maximum engine rpm when there is a problem with the vehicle speed signal that is detected by the ECM. The ECM limits the engine to this engine rpm when the ECM senses no vehicle speed signal, and a load on the engine. This is a feature that is used to prevent tampering by running without a Vehicle Speed input to the ECM.

**Note:** When this parameter is programmed to 2120 rpm, the ECM disables 84-01 Loss Of Vehicle Speed Signal (31) and 84-10 Vehicle Speed Rate of Change (36) and the “VSL Protection” may be exceeded by disconnecting the Vehicle Speed Sensor.

Table 13

Minimum	Maximum	Default
1300 rpm	2120 rpm	2120 rpm

### “Tachometer Calibration”

The “Tachometer Calibration” is used by the ECM to translate the engine speed signal into revolutions per minute for a tachometer. The “Tachometer Calibration” is programmed in pulses per revolution (PPR). The programmable range is from 12.0 PPR to 500.0 PPR in 0.1 PPR increments.

Table 14

Minimum	Maximum	Default
12.0 PPR	500.0 PPR	113.0 PPR

### “Soft Vehicle Speed Limit”

The “Soft Vehicle Speed Limit” operates in conjunction with the “Vehicle Speed Limit”. The “Soft Vehicle Speed Limit” limits the vehicle speed within the following range:

- The minimum value is 4 km/h (2.5 mph) below the programmed “Vehicle Speed Limit” at full load.
- The maximum value is 4 km/h (2.5 mph) above the selected “Vehicle Speed Limit” at no load.

Table 15

Alternative	Default
Yes	No

### “Low Speed Range Axle Ratio”

The “Low Speed Range Axle Ratio” must be programmed when a “Two-Speed Axle On/Off Switch” is used by the ECM to adjust the “Vehicle Speed Calibration”. When a two-speed axle is used, the change in gear ratios from the high speed range to the low speed range alters the calibration of the vehicle speed signal. Since the vehicle speed signal has been altered, a calibration adjustment is required to ensure that the ECM driven speedometer and the information that is stored in the ECM correctly reflect the actual vehicle speed. This parameter should be programmed to the “Low Speed Range Axle Ratio”. This parameter only requires programming when the “Two-Speed Axle Switch” parameter is enabled. The “Two-Speed Axle Switch” Parameter is enabled when the parameter is programmed to J1/P1:7, J1/P1:47, J1/P1:6, or J1/P1:46.

Table 16

Minimum	Maximum	Default
1.00	19.99	1.00

## “High Speed Range Axle Ratio”

The “High Speed Range Axle Ratio” must be programmed when a “Two-Speed Axle On/Off Switch” is used by the ECM to adjust the “Vehicle Speed Calibration”. When a two-speed axle is used, the change in gear ratios from the high speed range to the low speed range alters the calibration of the vehicle speed signal. Since the vehicle speed signal has been altered, a calibration adjustment is required to ensure that the ECM driven speedometer and the information that is stored in the ECM correctly reflect the actual vehicle speed. This parameter should be programmed to the “High Speed Range Axle Ratio”. This parameter only requires programming when the “Two-Speed Axle Switch” parameter is enabled. The “Two-Speed Axle Switch” parameter is enabled when the parameter is programmed to J1/P1:7, J1/P1:47, J1/P1:6, or J1/P1:46.

Table 17

Minimum	Maximum	Default
1.00	9.99	1.00

## “Cruise Control Parameters”

### “Low Cruise Control Speed Set Limit”

The “Low Cruise Control Speed Set Limit” sets the lowest vehicle speed that will allow the cruise control to be set. Programming this parameter to the maximum value disables cruise control.

Table 18

Minimum	Maximum	Default
24 km/h (15 mph)	204 km/h (127 mph)	204 km/h (127 mph)

### “High Cruise Control Speed Set Limit”

The “High Cruise Control Speed Set Limit” sets the highest vehicle speed that will allow the cruise control to be set. If a driver attempts to set a vehicle speed higher than this limit, the “High Cruise Control Speed Set Limit” will be the cruise set speed. If the “High Cruise Control Speed Set Limit” is programmed to a value that is greater than the Vehicle Speed Limit, the cruise control switches can be used to exceed the programmed Vehicle Speed Limit.

Table 19

Minimum	Maximum	Default
48 km/h (30 mph)	204 km/h (127 mph)	204 km/h (127 mph)

## “Engine Retarder Mode”

“Engine Retarder Mode” determines the operation of the Auxiliary Retarder Output and the Exhaust Retarder Output while the cruise control On/Off switch is in the ON position but the engine is not in cruise control. This does not determine engine retarder operation while the engine is in cruise control. Also, this does not allow engine retarder operation while the engine is in cruise control.

The following modes are allowable options:

- Coast
- Latch
- Manual

When the “Engine Retarder Mode” is programmed to the Coast mode, the engine retarder is enabled only while the service brakes are being applied. When the ECM is programmed to the Latch mode, the engine retarder stays enabled after the service brakes are released. A direct, immediate pressure on the brake pedal latches the engine retarder in the ON position and the engine retarder will remain in the ON position until the accelerator pedal is depressed.

When the ECM is programmed to the Manual mode, the cruise control switch is not required to be in the ON position. When the ECM is programmed to the Manual mode, the engine retarder will activate when all of the following conditions are met:

- The engine retarder switch is in the ON position.
- The engine rpm is greater than 800 rpm.
- The engine is not being fueled.

Table 20

Alternative	Default
Coast or Latch	Manual

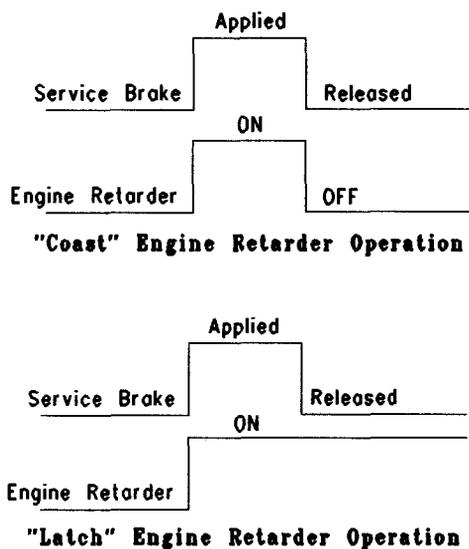


Illustration 23

g00631045

Coast and latch of engine retarder mode

## "Engine Retarder Minimum VSL Type"

The "Engine Retarder Minimum VSL Type" defines the use of the "Engine Retarder Minimum Vehicle Speed" parameter. The "Engine Retarder Minimum VSL Type" provides the following two options:

- Hard Limit
- Soft Limit

If the "Engine Retarder Minimum VSL Type" is programmed to the Hard Limit, the engine retarder will turn off when the value that is programmed into the Engine Retarder Minimum Vehicle Speed is reached.

If the "Engine Retarder Minimum VSL Type" is programmed to the Soft Limit, the engine retarder will remain on and the retarder will have a value that is below the value that is programmed in the Engine Retarder Minimum Vehicle Speed. The engine retarder will remain on until the parameters that would normally turn off the engine retarder are met.

In both cases, the engine retarder will remain off until vehicle speed is higher than the programmed value of the Engine Retarder Minimum Vehicle Speed and the engine retarder has been engaged again.

The following diagram illustrates the Engine Retarder operation for both options of the "Engine Retarder Minimum VSL Type". The Engine Retarder parameter is programmed to MANUAL and the parameter for the Engine Retarder Minimum Vehicle Speed is programmed to 48 km/h (30 mph).

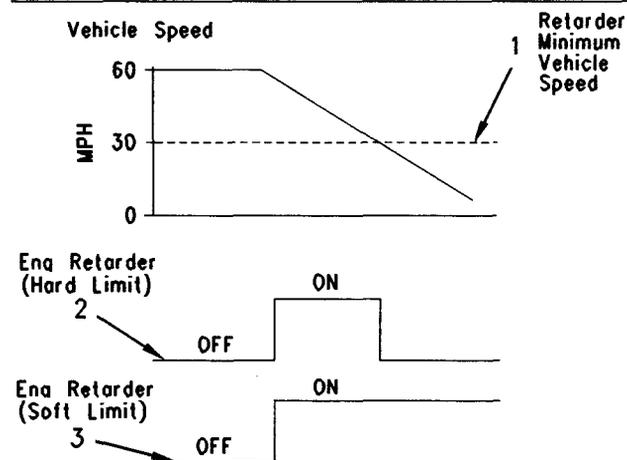


Illustration 24

g00631048

**Note:** When the vehicle speed drops below the Engine Retarder Minimum Vehicle Speed and the parameter is programmed to the Hard limit, the engine retarder turns off. When the vehicle speed drops below the Engine Retarder Minimum Vehicle Speed and the parameter is programmed to the Soft limit, the Engine retarder remains on.

If the Engine Retarder Minimum Vehicle Speed has been programmed to 0 km/h (0 mph), the programming of the parameter for the "Engine Retarder Minimum VSL Type" does not affect the operation of the Engine Retarder.

Table 21

Alternative	Default
Soft Limit	Hard Limit

## “Engine Retarder Minimum Vehicle Speed”

Engine Retarder Minimum Vehicle Speed determines the minimum vehicle speed limit for the engine retarders to turn ON. Below this vehicle speed, the ECM will not turn on the engine retarder unless the vehicle is stationary. If the vehicle is stationary, the vehicle speed is 0 km/h (0 mph). If the vehicle speed signal was not being read by the ECM, the vehicle could be moving but the vehicle speed signal would be 0 km/h (0 mph). If Engine Retarder Minimum Vehicle Speed is programmed to 0 km/h (0 mph) the engine retarder will operate at all vehicle speeds. This parameter affects both the engine retarder and any auxiliary retarder such as a BrakeSaver.

Table 22

Minimum	Maximum	Default
0 km/h (0 mph)	204 km/h (127 mph)	0 km/h (0 mph)

## “Auto Retarder in Cruise”

The “Auto Retarder in Cruise” determines the vehicle speed in kilometers per hour (km/h) or miles per hour (mph) above the cruise set speed when the engine retarder will be activated. The engine retarder switch must be in the ON position and the cruise control must be set for this feature to operate. Programming the “Auto Retarder in Cruise” parameter to zero disables this feature. This parameter affects the engine while the cruise control is activated.

**Note:** This parameter only affects the Factory installed engine retarder (compression brake). This parameter does not affect an auxiliary braking device or Brakesaver.

The actual level of braking is limited by the settings of the retarder switch. For example, the retarder will not come on if the retarder is switched off.

If Soft Cruise Control is programmed to YES, the retarder will not come on until the vehicle speed is 5 km/h (3 mph) above the cruise set speed. An Electronic Service Tool will change an attempt to program 2 km/h (1 mph) or 3 km/h (2 mph) for this parameter to 5 km/h (3 mph) if Soft Cruise Control is programmed to YES.

Table 23

Minimum	Maximum	Default
0 km/h (0 mph)	16 km/h (10 mph)	0 km/h (0 mph)

## “Auto Retarder in Cruise Increment”

“Auto Retarder in Cruise Increment” requires the “Auto Retarder in Cruise” parameter to be programmed above zero. “Auto Retarder in Cruise Increment” determines the increment in kilometers per hour (km/h) or miles per hour (mph) when the Medium level of engine retarder will activate. “Auto Retarder in Cruise Increment” also determines the increment in kilometers per hour (km/h) or miles per hour (mph) when the High level of engine retarder will activate. Programming the parameter to zero will allow the retarder to come on in the High mode when the programmed “Auto Retarder in Cruise” speed is reached. The “Auto Retarder in Cruise” speed must be set above the cruise set speed. This parameter affects the engine while the cruise control is activated. The actual level of braking is limited by the settings of the retarder switch. For example, the retarder will not come on if the retarder is switched off.

Table 24

Minimum	Maximum	Default
0 km/h (0 mph)	8 km/h (5 mph)	3 km/h (2 mph)

## “Cruise/Idle/PTO Switch Configuration”

“Cruise/Idle/PTO Switch Configuration” defines the function of the Set/Resume Switch for “ACCEL” mode and “DECCEL” mode. This parameter affects cruise control mode, idle mode and PTO mode.

Table 25

Alternative	Default
Set/Decel-Res/Accel	Set/Accel-Res/Decel

## “Soft Cruise Control”

“Soft Cruise Control” provides a 8 km/h (5 mph) operating range around the cruise control set speed in order to provide a smoother cruise control. “Soft Cruise Control” controls the cruise speed within the following range:

- 4 km/h (2.5 mph) below the set vehicle speed at full load
- 4 km/h (2.5 mph) above the set vehicle speed at no load

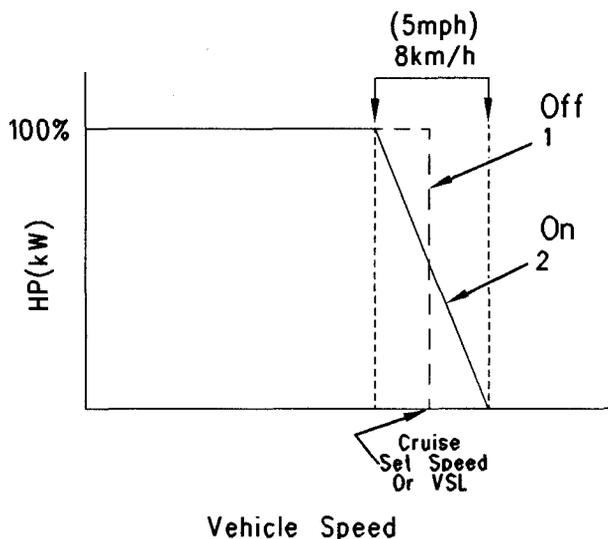


Illustration 25

g00670797

Table 26

Alternative	Default
No	Yes

### “Adaptive Cruise Control Enable”

Adaptive cruise control reduces the need to manually cancel cruise control when you approach a slower vehicle. The system responds by decreasing the cruise control set speed until a following distance is obtained. If the slower vehicle speeds up, the cruise control set speed will be adjusted in order to maintain the following distance. Adaptive cruise control will restore the original set speed when there are no vehicles within the range of control. Adaptive cruise control will not increase the cruise control set speed above the original setting. If the vehicle is approaching the target too rapidly, the ECM will turn off the cruise control.

Table 27

Alternative	Default
Enabled	Disabled

## “Idle Parameters”

### “Idle Vehicle Speed Limit”

The “Idle Vehicle Speed Limit” is the maximum vehicle speed for setting or maintaining a set engine rpm in the idle mode. In order to enter the idle mode, the engine rpm must be set by the Set/Resume switch while the Cruise Control On/Off switch is in the ON position. If the vehicle speed signal exceeds this value, the engine will not maintain the set engine rpm.

Table 28

Minimum	Maximum	Default
2 km/h (1 mph)	24 km/h (15 mph)	2 km/h (1 mph)

### “Idle RPM Limit”

The “Idle RPM Limit” is the maximum engine rpm in idle mode. The idle mode occurs if the engine rpm is set by the use of the Cruise Control On/Off switch and the Set/Resume switch. Refer to “Idle Vehicle Speed Limit”. The actual high limit of this parameter is determined by the programmed Top Engine Limit. The lower limit is determined by the programmed “Low Idle Engine rpm”.

Programming this parameter to 600 rpm will prevent the engine from idling at a constant rpm above the programmed Low Idle rpm.

Table 29

Minimum	Maximum	Default
600 rpm	TEL rpm	TEL rpm

### “Idle/PTO RPM Ramp Rate”

The “Idle/PTO RPM Ramp Rate” determines the rate of increase or decrease of engine rpm. This parameter determines rates of increase or decrease in engine rpm for the following functions:

- Idle rpm
- PTO rpm

The parameter can be set to a value between 5 rpm and 1000 rpm in one rpm increments.

**Note:** The parameter affects both idle control and PTO control. The idle mode occurs if the engine rpm is set by the use of the Cruise Control On/Off switch and the Set/Resume switch. The PTO mode occurs if the engine rpm is set by the use of the “PTO On/Off” switch and the Set/Resume switch.

Table 30

Minimum	Maximum	Default
5 rpm/sec	1000 rpm/sec	50 rpm/sec

### “Idle/PTO Bump RPM”

The “Idle/PTO Bump RPM” determines the increment or the decrement in engine rpm when the ACCEL switch or the DECEL switch is briefly toggled. The “Idle/PTO Bump RPM” also pertains to the dedicated PTO and idle. If a “PTO Engine RPM Set Speed” has been programmed, the “Idle/PTO Bump RPM” pertains only to the control of the engine rpm that is initiated by the use of the “Cruise Control On/Off” input circuit. If a PTO Engine rpm Set Speed has been programmed, the “Idle/PTO Bump RPM” also pertains to the control of the engine rpm that is initiated by the use of the “PTO On/Off” circuit.

Table 31

Minimum	Maximum	Default
5 rpm	500 rpm	20 rpm

### “Dedicated PTO Parameters”

#### “PTO Configuration”

The “PTO Configuration” determines the features that are available for Dedicated PTO applications and the input signals that are used for Dedicated PTO applications. When the “PTO Configuration” is turned off, the application does not use the PTO. The remaining PTO programmable options require a “PTO On/Off” circuit that is connected to ECM Input 1. A PTO Switch On Lamp can also be connected to Output 1 (ECM J1/P1:30).

If the ECM is programmed to the Cab Switches, the ECM will use the signals from the following two switches for PTO Control and Cruise Control:

- Cab Set switch (J1/P1:35)
- Resume switch (J1/P1:44)

If the ECM is programmed to “Remote Switches”, the ECM will monitor programmed signals such as the Remote Set switch and the Remote Resume switch. Signals from the cab controls will be ignored when the “PTO On/Off” circuit is on. The following components are cab controls:

- Brake Switch
- Clutch Switch
- Accelerator

- Cruise Control Switches

If the ECM is programmed to “Remote Throttle”, the ECM will monitor J1/P1:68 for the remote accelerator pedal. The ECM will monitor programmed signals and the ECM will ignore all cab controls when the “PTO On/Off” circuit is ON.

Table 32

Alternative	Default
Cab Switches Remote Switches Remote Throttle	Off

### “PTO Top Engine Limit”

The “PTO Top Engine Limit” is the top engine limit that is available by the use of a “PTO On/Off” circuit that is connected to Input 1 of ECM Connector J1/P1.

**Note:** The “PTO Configuration” must be programmed to Cab Switches, Remote Switches, or Remote Throttle before this parameter can be programmed.

Table 33

Minimum	Maximum	Default
600	TEL rpm	TEL rpm

### “PTO Engine RPM Set Speed (0 = Off)”

This parameter allows automatic ramping to the preset rpm when the PTO is engaged. “PTO to Set Speed” must be programmed to “Yes” for this parameter to function. When the PTO is engaged the rpm will change according to the programmed “PTO Ramp Rate”. This parameter is only available when the “PTO Configuration” is programmed to “Cab Switches”, “Remote Switches”, or “Remote Throttle”.

Table 34

Minimum	Maximum	Default
Low Idle	PTO TEL rpm	0

### “PTO Engine RPM Set Speed A”

**NOV99 and newer software**

The ECM controls this engine rpm. This control occurs when the "PTO ON/OFF" circuit is on and the "PTO Engine RPM Set speed Input A" switch is on. The RPM can be programmed to operate from Low Idle up to the PTO Top Engine Limit RPM. While the engine is operating at this set speed, all other inputs for speed control are ignored. The inputs for speed control that are ignored include the Cab Throttle switch, the Remote Throttle switch, the Set/Accel switch, and the Resume/Decel switch. This feature can also be used in conjunction with the "PTO to Set speed" feature and the "PTO Engine RPM Set Speed B" feature for multiple speed PTO operation. This feature can also override the "PTO to Set speed" feature and the "PTO Engine RPM Set Speed B" feature for multiple speed PTO operation.

The engine will only operate at this programmed speed when the "PTO ON/OFF" circuit is on and the "PTO Engine RPM Set Speed Input A" switch is on. The engine will operate at the programmed speed unless a condition that causes PTO operation kickout occurs. The conditions that will cause PTO operation kickout include the depression of the brake pedal, the depression of the clutch pedal, and the "PTO Vehicle Speed Limit" that is exceeded. The engine will return to low idle if the PTO operation is kicked out.

**Note:** The "PTO Configuration" parameter must be programmed to Cab Switches, Remote Switches, or Remote Throttle and the "PTO Engine RPM Set Speed Input A" parameter must be programmed to a dedicated switch input (J1/P1:6, J1/P1:46, J1/P1:58, or J1/P1:60) for this feature to function.

Table 35

Minimum	Maximum	Default
Low Idle rpm	PTO TEL rpm	0 rpm

## "PTO Engine RPM Set Speed Input B"

NOV99 and newer software

The ECM controls this engine rpm. This control occurs when the "PTO ON/OFF" circuit and the "PTO Engine RPM Set Speed Input B" switch is on and the "PTO Engine RPM Set Speed A" switch is off. The RPM can be programmed to operate from Low Idle up to the "PTO Top Engine Limit" RPM. While the engine is operating at this set speed, all other inputs for speed control are ignored except for the "PTO Engine RPM Set Speed A". The inputs for speed control that are ignored include the Cab Throttle switch, the Remote Throttle switch, the Set/Accel switch, and the Resume/Decel switch. This feature can also be used in conjunction with the "PTO to Set speed" feature for multiple speed PTO operation. This feature can also override the "PTO to Set speed" feature for multiple speed PTO operation.

The engine will only operate at this programmed speed when the "PTO ON/OFF" circuit and the "PTO Engine RPM Set Speed Input B" switch is on and the "PTO Engine RPM Set Speed A" switch is off. The engine will operate at the programmed speed unless a condition that causes PTO operation kickout occurs. The conditions that will cause PTO operation kickout include the depression of the brake pedal, the depression of the clutch pedal, and the "PTO Vehicle Speed Limit" that is exceeded. The engine will return to low idle if the PTO operation is kicked out.

**Note:** The "PTO Configuration" parameter must be programmed to Cab Switches, Remote switches, or Remote Throttle and the "PTO Engine RPM Set Speed Input B" parameter must be programmed to a dedicated switch input (J1/P1:6, J1/P1:46, J1/P1:58, or J1/P1:60) for this feature to function.

Table 36

Minimum	Maximum	Default
Low Idle rpm	PTO TEL rpm	0 rpm

## "PTO to Set Speed"

This parameter causes the ECM to proceed to the programmed "PTO Engine RPM Set Speed" when the "PTO ON/OFF" switch is on. "PTO Configuration" must be programmed to Cab Switches or Remote Switches before this parameter can be programmed.

**Note:** This parameter is not available for "PTO Configuration Remote Throttle".

Table 37

Alternative	Default
Yes	No

## “Maximum PTO Enable Speed”

### NOV01 and newer software

Note: This parameter is not available on engine serial numbers W1A1-Up, MDP1-Up, and MEP1-Up.

This parameter specifies the maximum engine speed for the engagement of the PTO mode. The PTO mode will engage when the engine rpm is equal to the programmed limit or less than the programmed limit. This parameter is only available when the “PTO Configuration” is programmed to “Cab Switches”, “Remote Switches”, or “Remote Throttle”.

Table 38

Minimum	Maximum	Default
Low Idle rpm	TEL rpm	TEL rpm

## “PTO Cab Controls RPM Limit”

This determines the engine rpm limit of the cab mounted Accelerator Pedal Position Sensor when “PTO Configuration” is programmed to “Cab Switches” and the “PTO On/Off” circuit is on. This parameter is intended to prevent engine overspeed when dedicated PTO is used.

- If the parameter is programmed to Low Idle, the Cab Controls are ignored.
- If the parameter is programmed to “Top Engine Limit” (TEL), the engine will operate to the programmed “Top Engine Limit”.
- If the parameter is programmed to “PTO TEL”, the engine will operate to the programmed “PTO Top Engine Limit”.

Note: “PTO Configuration” must be programmed to Cab Switches for this parameter to take effect. If “PTO Configuration” is programmed to Remote Switches or Remote Throttle, the ECM will always ignore the Cab Throttle when the “PTO On/Off” circuit is on.

Table 39

Alternative	Default
Low Idle TEL PTO TEL	TEL

## “PTO Kickout Vehicle Speed Limit” (VSL)

This is the maximum vehicle speed for setting or maintaining a set engine rpm in PTO mode. PTO mode is entered if the “PTO On/Off” Switch is on. (This uses Input 1.) If the vehicle speed signal exceeds this value, the engine will not maintain the set engine rpm.

Table 40

Minimum	Maximum	Default
2 km/h (1 mph)	204 km/h (127 mph)	2 km/h (1 mph)

## “Torque Limit”

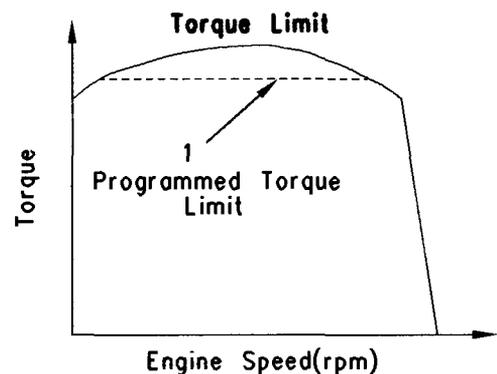


Illustration 26

g00628600

Operation of Torque limit

(1) Programmed torque limit

The parameter for the “Torque Limit” defines the maximum torque output of the engine during Dedicated PTO operation. This parameter provides temporary protection of equipment. The Torque limit of the engine is active when the circuit for the Torque Limit Switch is on. The maximum value is the Rated Torque of the engine. The “Torque Limit” is programmable to N·m (lb ft) of torque. Programming a value higher than the Rated Torque is limited by the ECM to Rated Torque. The torque limit is indicated by the dashed line in Illustration 26.

Table 41

Minimum	Maximum	Default
270 N·m (200 lb ft)	3400 N·m (2500 lb ft)	3400 N·m (2500 lb ft)

## “PTO Shutdown Time”

The “PTO Shutdown Time” sets the amount of idle time before the PTO shuts down. The time begins when the “PTO On/Off” circuit is on and there is no vehicle speed. The PTO Shutdown Timer will not begin counting if the engine is in Cold Mode. This parameter requires the “PTO Configuration” to be programmed to Cab Switches, Remote Switches or Remote Throttle for the timer to function.

**Note:** This feature does not shut down the vehicle's power. The ECM and the vehicle remain powered.

Table 42

Minimum	Maximum	Default
3 minutes	1440 minutes	0 minutes

## “PTO Shutdown Timer Maximum RPM”

### OCT99 and newer software

This parameter can be used to reset the PTO Shutdown Timer if engine speed goes above the programmed “PTO Shutdown Timer Maximum RPM”. Programming this parameter to 2120 rpm disables this feature. If this parameter is programmed to a value below 2120 rpm and the PTO Shutdown Timer is used, the timer will be reset when the engine RPM exceeds the programmed value.

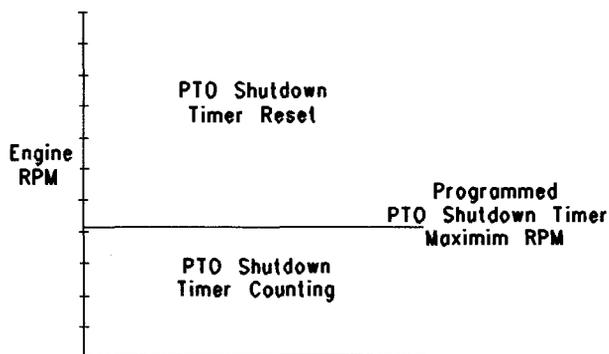


Illustration 27

g00671143

“PTO Shutdown Timer Maximum RPM” Graph

Table 43

Minimum	Maximum	Default
600 rpm	2120 rpm	2120 rpm

## “PTO Activates Cooling Fan”

This parameter requires the use of the ECM cooling fan circuit. When this parameter is programmed to Continuous Mode, the ECM will signal the cooling fan to run continuously when the “PTO On/Off” circuit is on. The cooling fan runs continuously in order to reduce changes in the load while the engine is being used for dedicated PTO applications. When this parameter is programmed to the normal mode, the operation of the fan is based on coolant temperature, inlet air temperature or air conditioning high head pressure. The “PTO Configuration” must be programmed to “Cab Switches”, “Remote Switches” or “Remote Throttle” before this parameter can be programmed. The “Fan Control Type” must be programmed to the “On/Off” setting or the “Three-Speed Fan Setting”.

Table 44

Alternative	Default
Continuous	Normal

## “Engine/Gear Parameters”

### “Lower Gears Engine RPM Limit”

The engine will accelerate at a slower rate when this limit is exceeded under normal driving conditions. This parameter is used to encourage the driver to shift to the next highest gear.

Table 45

Minimum	Maximum	Default
1100 rpm	TEL rpm	TEL rpm

### “Lower Gears Turn Off Speed”

The “Lower Gears Turn Off Speed” parameter is the vehicle speed which turns off the “Lower Gears Engine RPM Limit”. This must be matched with the “Lower Gears Engine RPM Limit” to the specific drive train for best performance.

Table 46

Minimum	Maximum	Default
5 km/h (3 mph)	48 km/h (30 mph)	5 km/h (3 mph)

### “Intermediate Gears Engine RPM Limit”

This parameter is similar to the “Lower Gears Engine RPM Limit”. The engine will accelerate at a slower rate when this limit is exceeded under normal driving conditions. This parameter is typically programmed to a slightly higher rpm than the “Lower Gears Engine RPM Limit”.

Table 47

Minimum	Maximum	Default
1100 rpm	TEL rpm	TEL rpm

### “Intermediate Gears Turn Off Speed”

This parameter is similar to the “Lower Gears Turn Off Speed”. This parameter is typically programmed to a slightly higher vehicle speed than the “Lower Gears Turn Off Speed”.

Table 48

Minimum	Maximum	Default
8 km/h (5 mph)	80 km/h (50 mph)	8 km/h (5 mph)

### “Gear Down Protection RPM Limit”

This parameter is the Engine RPM Limit when the vehicle speed is above the “Gear Down Protection Turn On Speed”. This is a hard limit. The ECM will not allow fuel to the engine above this limit. This parameter is used to encourage the driver to shift into overdrive or top gear.

Table 49

Minimum	Maximum	Default
1300 rpm	TEL rpm	TEL rpm

### “Gear Down Protection Turn On Speed”

This parameter is the Vehicle Speed when the “Gear Down Protection RPM Limit” is turned on. This must be matched to the specific drive train for best performance. Above this vehicle speed limit, the engine rpm will be limited by the “Gear Down Protection RPM Limit”.

Table 50

Minimum	Maximum	Default
48 km/h (30 mph)	204 km/h (127 mph)	204 km/h (127 mph)

### “Top Engine Limit” (TEL)

#### OCT99 and older software

This parameter is the maximum engine rpm when the engine is under load. The engine will still achieve Rated rpm under no load conditions.

**Note:** NOV99 and newer software does not allow the TEL to be adjusted.

Table 51

Minimum	Maximum	Default
1600 rpm	2120 rpm <sup>(1)</sup>	This value is dependent on the Engine Rating.

<sup>(1)</sup> A limited number of special ratings have a “Top Engine Limit” of 2150 rpm.

### “Top Engine Limit with Droop”

#### OCT99 and older software

When the “Top Engine Limit with Droop” is selected, the engine can exceed the TEL with a partial load. The rpm limit increases as load decreases to 150 rpm above the selected limit for no load.

**Note:** NOV99 and newer software do not allow the droop option to be selected.

Table 52

Alternative	Default
Yes	No

### “Low Idle Engine RPM”

The “Low Idle Engine RPM” is the minimum engine rpm.

Table 53

Minimum	Maximum	Default
600 rpm	750 rpm	600 rpm

### “Transmission Style”

This parameter indicates the type of transmission configuration that is installed in the vehicle to the ECM. This parameter is used by the ECM to read the signals from the following devices:

- Brake switch (No. 2)
- Clutch Switch
- Neutral switch

If an automatic transmission is installed, this parameter should be programmed to one of the following options:

- Automatic Option 1
- Automatic Option 2
- Automatic Option 3
- Automatic Option 4

The Manual selection requires a clutch pedal position switch to be connected to the ECM Connector J1/P1:24. The transmission selections with a neutral switch require a transmission neutral switch to be connected to the ECM Connector J1/P1:62. J1/P1:62 is the Input 12. The transmission selections with two brake switches require a second brake switch to be connected to the ECM Connector J1/P1:64. J1/P1:64 is the Input 13.

The Eaton Top 2 transmission is a manual transmission and the Eaton Top 2 transmission requires a clutch switch. The ECM operates two outputs in order to control shifting between the top two gears of an Eaton Top 2 transmission. A total of four parameters must be programmed for the system to operate correctly.

Table 54

"Transmission Style" Parameter Setting	Use of Switch			
	Service Brake No. 1	Service Brake No. 2	Clutch	Neutral
Manual Option 1	X		X	
Automatic Option 1	X			
Automatic Option 2	X	X		
Automatic Option 3	X	X		X
Automatic Option 4	X			X
Eaton Top 2	X		X	

Table 55

Alternative	Default
Automatic Option 1 Automatic Option 2 Automatic Option 3 Automatic Option 4 Eaton Top 2	Manual Option 1

### "Eaton Top 2 Override with Cruise Control Switch"

If this parameter is programmed to "YES" the Cruise Control On/Off switch can be used to disable Top 2 mode. If the Cruise Control On/Off switch is turned to the OFF position and the transmission is not in Top 2 mode, the Top 2 mode will be disabled. This condition is applicable to the manual mode of operation only. If the Cruise Control On/Off switch is turned to the ON position, the Top 2 mode will be enabled and the transmission will be allowed to shift automatically in the Top 2 gears. When the vehicle is operating in one of the Top 2 gears and the Top 2 mode is enabled, switching the Cruise Control On/Off switch to the OFF position will place the transmission in Hold mode. When the transmission is in the Hold mode, the transmission will not shift out of the currently selected gear. When the Cruise Control On/Off switch is returned to the ON position, the transmission will return to Top 2 mode. When the clutch is depressed and the transmission is in the Hold mode, the Manual mode will be enabled and the Top 2 will be disabled.

Table 56

Alternative	Default
Yes	No

### “Top Gear Ratio”

The “Top Gear Ratio” identifies the highest gear ratio for an Eaton Top 2 Transmission. For example, tenth gear for an Eaton Super 10 Top 2 transmission is the Top Gear. The programmable range is 0.000 to 3.750 in 0.001 increments. The default is 0.000. Refer to “Gear Ratios for Eaton Top 2 Transmission” for programmable values for each Eaton Top 2 transmission.

**Note:** This parameter must be precisely programmed to three decimal places to ensure the proper operation of the Eaton Top 2 and Caterpillar engine drive train in the top two gears.

Table 57

Minimum	Maximum	Default
0.000	3.750	0.000

### “Top Gear Minus One Ratio”

The “Top Gear Minus One Ratio” identifies the second highest gear ratio for an Eaton Top 2 Transmission. For example, ninth gear for an Eaton Super 10 Top 2 transmission is Top Gear Minus One. The programmable range is 0.000 to 3.750 in 0.001 increments. The default is 0.000. Refer to “Gear Ratios for Eaton Top 2 Transmission” for programmable values for each Eaton Top 2 transmission.

**Note:** This parameter must be precisely programmed to three decimal places to ensure the proper operation of the Eaton Top 2 and Caterpillar engine drive train in the top two gears.

Table 58

Minimum	Maximum	Default
0.000	3.750	0.000

### “Top Gear Minus Two Ratio”

The “Top Gear Minus Two Ratio” identifies the third highest gear ratio for an Eaton Top 2 Transmission. For example, eighth gear for an Eaton Super 10 Top 2 transmission is Top Gear Minus Two. The programmable range is 0.000 to 3.750 in 0.001 increments. The default is 0.000. Refer to “Gear Ratios for Eaton Top 2 Transmission” for programmable values for each Eaton Top 2 transmission.

**Note:** This parameter must be precisely programmed to three decimal places to ensure the proper operation of the Eaton Top 2 and Caterpillar engine drive train in the top two gears.

Table 59

Minimum	Maximum	Default
0.000	3.750	0.000

### “Gear Ratios for Eaton Top 2 Transmission”

Table 60

Transmission Model	Top Gear Minus Two Ratio	Top Gear Minus One Ratio	Top Gear Ratio
RTLO-XX610B-T2	1.352	1.000	0.741
RTLO-XX710B-T2	1.825	1.351	1.000
RTLO-XX713A-T2	1.000	0.856	0.730
RTLO-XX718B-T2	1.000	0.856	0.730

**Note:** The XX that appears in the model number of the transmission refers to the Nominal Torque Capacity. XX times 100 equals the Nominal Torque Capacity. For example, RTLO-14613A has a Nominal Torque Capacity of 14 times 100 or 1900 N·m (1400 lb ft).

The model designation of the transmission and other information are stamped on a tag on the transmission. The tag is located on the lower left side near the front of the transmission.

### “Governor Type”

#### NOV01 and newer software

**Note:** This parameter is not available on engine serial numbers W1A1-Up, MDP1-Up, and MEP1-Up.

This parameter determines the type of governor that controls the engine. Select “Full Range” for manual transmissions and for electronically shifted manual transmissions. Select “Min/Max” for automatic transmissions.

Table 61

Alternative	Default
Min/Max	Full Range

## “Timer Parameters”

### “Idle Shutdown Time”

The “Idle Shutdown Time” is the time (minutes) of engine idle before shutting down. The engine will only shut down if the ECM senses low engine load and no vehicle speed. The Idle Shutdown Timer will not begin counting if the engine is in Cold Mode. If this parameter is programmed to zero, this feature is disabled and the engine will idle until the keyswitch for the ignition is in the OFF position.

**Note:** This feature does not shut down the vehicle's power. The ECM and the vehicle remain powered.

Table 62

Minimum	Maximum	Default
3 minutes	1440 minutes	0 minutes

### “Idle Shutdown Timer Maximum RPM”

#### NOV99 and newer software

This parameter can be used to reset the “Idle Shutdown Timer” if engine speed goes above the programmed “Idle Shutdown Timer Maximum RPM”. Programming this parameter to 2120 rpm disables this feature. By disabling this feature, the “Idle Shutdown Timer” can not be overridden by increasing the engine rpm. If this parameter is programmed to a value below 2120 rpm and the “PTO Shutdown Timer” is used, the timer will be reset when the engine RPM exceeds the programmed value.

Table 63

Minimum	Maximum	Default
600 rpm	2120 rpm	2120 rpm

### “Allow Idle Shutdown Override”

This parameter determines if the clutch or the service brake can be used to override the idle shutdown timer during the driver alert. The driver alert is the last 90 seconds when the Check Engine Lamp begins flashing. This parameter requires the “Idle Shutdown Time” to be programmed to 3 or more minutes for the parameter to be enabled. When the “Idle Shutdown Time” is programmed to 0, the parameter is turned off.

In order to override the timer under the following conditions, depress the clutch or the service brake if the parameter is programmed to “Outside Temperature Based” or “J1587 Outside Temperature Based” and the driver alert is activated. Depression of the clutch or the service brake will override the timer:

- The outside temperature is below the programmed “Minimum Idle Shutdown Outside Temperature”.
- The outside temperature is above the “Maximum Idle Shutdown Outside Temperature”.

**Note:** When the timer is overridden, the engine will not shut down.

If the outside temperature is between the “Minimum Idle Shutdown Outside Temperature” and the “Maximum Idle Shutdown Outside Temperature”, the timer is not overridden and the engine will shut down. If the Outside Temperature Based option is programmed, an Air Temperature Sensor must be installed in order to measure the outside temperature. If the sensor is not installed, a 171-03 Outside Air Temp Sensor Open Circuit diagnostic code will be active. If the J1587 Outside Temperature Based option is programmed and a 171-11 No Ambient Air Temperature Data active diagnostic code exists, the idle shutdown timer will be disabled.

Table 64

Alternative	Default
No Outside Temperature Based (J1587) Outside Temperature Based	Yes

### “Minimum Idle Shutdown Outside Temperature”

This parameter determines the lower outside temperature limit when the “Allow Idle Shutdown Override” is programmed to one option of the options that follow:

- “Outside Temperature Based”
- “J1587 Outside Temperature Based”

Table 65

Minimum	Maximum	Default
-40 °C (-40 °F)	49 °C (120 °F)	49 °C (120 °F)

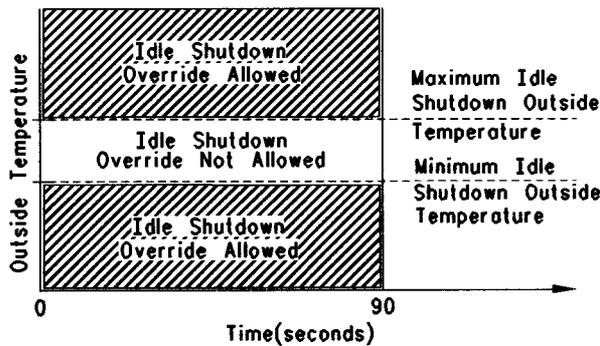


Illustration 28 g00631057  
The "Allow Idle Shutdown Override" is programmed to the "Outside Temperature Based" option or the "Outside Temperature Based (J1587)" option.

### "Maximum Idle Shutdown Outside Temperature"

This parameter determines the upper outside temperature limit when the "Allow Idle Shutdown Override" is programmed to one option of the options that follow:

- "Outside Temperature Based"
- "J1587 Outside Temperature Based"

Illustration 28 indicates that the "Allow Idle Shutdown Override" is allowed in the final 90 seconds of the timer's countdown. During the final 90 seconds, one of the following conditions must exist in order for the engine to be shut down:

- The outside temperature is below the programmed "Minimum Idle Shutdown Outside Temperature".
- The outside temperature is above the "Maximum Idle Shutdown Outside Temperature".

Table 66

Minimum	Maximum	Default
-40 °C (-40 °F)	49 °C (120 °F)	49 °C (120 °F)

### "A/C Switch Fan On-Time"

The input 11 to the ECM can be used for the connection of a normally closed high pressure A/C switch. The ECM has a built-in timer. The timer is used to prevent excessive cycling of the cooling fan clutch due to successive cycling of the A/C switch. Programming this parameter to 0 disables the function. Programming depends on the refrigerant, and the design of the air conditioning system as well as the use of the signal input. Program the timer to 1 second for the connection of this input to another system. Programming the timer to 1 second also provides a time delay. This feature requires the "Fan Control Type" to be programmed to the On/Off or the "Three-Speed Fan".

Table 67

Minimum	Maximum	Default
1 second	600 seconds	0 seconds

### "Fan with Engine Retarder in High Mode"

This parameter determines whether the Cooling Fan will turn on when the Engine Brake has been active for at least two seconds. This feature requires the "Fan Control Type" to be programmed to the On/Off or the "Three-Speed Fan". An On/Off or a "Three-Speed Fan" must be installed in order for this parameter to function.

Table 68

Alternatives	Default
Yes	No

### "Engine Retarder Delay"

This parameter provides a programmable delay after provisions to turn on the engine retarder or the engine brake are met.

Table 69

Minimum	Maximum	Default
0 seconds	3 seconds	0 seconds

### "Smart Idle Parameters"

#### "Battery Monitor and Engine Control Voltage"

OCT99 and newer software

This parameter is used to determine the voltage trip point. Below this trip point, the Battery Monitor and the Engine Speed Control System will automatically elevate engine idle in order to maintain ideal battery system voltage. This feature is used to promote additional battery life. The engine idle will only be increased if the vehicle is stopped and the transmission is out of gear. If these conditions are not met, the engine idle will not be adjusted. This feature will not function when the engine is operating in dedicated PTO mode ("PTO On/Off" switch in the ON position).

The recommended setting is 12.2 Volts for a 12 Volt system, and 24.5 Volts for a 24 Volt system.

**Note:** This feature requires the installation of a Neutral Switch on J1/P1. This is terminal 62 (Input 12). Engine speed will only be elevated when the transmission is in Neutral.

Table 70

Minimum	Maximum	Default
0 Volts	25.5 Volts	0 Volts

## "Engine Monitoring Parameters"

### "Engine Monitoring Mode"

This parameter determines the level of action that will be taken by the ECM in response to a condition that has the capability to damage the engine. The ECM reads the Caterpillar Coolant Temperature, Oil Pressure and Inlet Manifold Air Temperature. If the ECM has been programmed to monitor the OEM Installed Coolant Level Sensor, the ECM will read that sensor.

**Note:** NOV01 and newer software does not allow the "Engine Monitoring Mode" to be programmed to "Off" except on engine serial numbers W1A1-Up, MDP1-Up, and MEP1-Up.

Table 71

Alternative	Default
Derate Shutdown	Off Warning <sup>(1)</sup>

<sup>(1)</sup> This is for NOV01 and newer software except engine serial numbers W1A1-Up, MDP1-Up, and MEP1-Up.

### "Engine Monitoring Lamps"

#### NOV99 and newer software

This parameter determines the lamp requirements for the Engine Monitoring System. If this parameter is programmed to the Warning Lamp option, J1/P1:29 is available for the connection of a red Warning Lamp. The Warning Lamp is used to alert the operator that an engine problem is occurring. The Warning Lamp also indicates when the engine is being derated or the lamp will indicate that shutdown will take place.

If this parameter is programmed to Option 1, there will be up to three discrete lamp outputs that are available for use to indicate specific engine problems. "Option 1" configures J1/P1:29 for the connection of a Low Oil Pressure Lamp and "Option 1" also configures J1/P1:31 for the connection of a High Coolant Temperature Lamp. If the parameter for the Coolant Level Sensor is programmed to the 4 Pin option, then J1/P1:30 will also be available for the connection of a Low Coolant Level Warning Lamp. If the parameter for the Coolant Level Sensor is programmed to Off, then J1/P1:30 can be used to connect a PTO Switch On Lamp.

Table 72

Alternative	Default
Option 1	Warning Lamp

**Note:** The Engine Monitoring System must be programmed to one of the following items for the Warning Lamp to function.

- Warning
- Derate
- Shutdown

### "Coolant Level Sensor"

This parameter determines if the ECM monitors the input signal of the Coolant Level Sensor. This feature requires the Engine Monitoring Mode to be programmed to one of the following modes:

- Warning
- Derate
- Shutdown

Table 73

Alternative	Default
4 pin 2 wire Float Sensor	No

## “Maintenance Parameters”

### “Maintenance Indicator Mode”

The ECM records data that is related to the vehicle’s maintenance. If Distance is selected, all maintenance indications on the service tool will be displayed in distance. Typical maintenance indications are PM 1, PM 2 and the Cooling System Clean/Flush.

If Hour is selected, all maintenance indications on the service tool will be displayed in Hours. Typical maintenance indications are PM 1, PM 2 and the Cooling System Clean/Flush. The ECM provides PM 1 maintenance interval and last maintenance information.

Table 74

Alternative	Default
Manual Distance Manual Hours Automatic Distance Automatic Hours	Off

### “PM 1 Interval” (Manual Maintenance Indicator Mode)

The “PM 1 Interval” allows a maintenance interval (PM 1) to be specified by the user. This parameter (“PM 1 Interval”) must be programmed only when the Maintenance Indicator Mode is programmed to a Manual Mode (Distance or Hours).

Table 75

Manual Distance		
Minimum	Maximum	Default
8050 km (5000 miles)	56325 km (35000 miles)	24140 km (15000 miles)

Table 76

Manual Hours		
Minimum	Maximum	Default
100	750	300

### “Engine Oil Capacity” (Automatic Maintenance Indicator Mode)

The “PM 1 Interval” can be determined by the ECM. The ECM bases the “PM 1 Interval” on fuel usage. This parameter (“PM 1 Interval”) must be programmed only when the Maintenance Indicator Mode is programmed to an Automatic Mode (Distance or Hours). Capacity of the sump influences the maintenance interval.

Table 77

Minimum	Maximum	Default
19 L (20 qt)	57 L (60 qt)	Refer to Table 78.

Table 78

Engine Model	Default
C-10 and C-12	34 L (36 qt)
3406E, C-15, C-16 and C-18	38 L (40 qt)
3406E, C-15, C-16 and C-18 with a Rear Sump BrakeSaver	38 L (40 qt)
3406E, C-15, C-16 and C-18 with a Front Sump BrakeSaver	38 L (40 qt) <sup>(1)</sup>

<sup>(1)</sup> The 3406E, C-15, C-16 and C-18 Engines with a Front Sump BrakeSaver should be programmed to 49 L (52 qt).

## “Trip Parameters”

### “Fuel Correction Factor”

The “fuel correction factor” is available to fine tune all fuel data that will be stored in the future by the ECM. Caterpillar recommends changing this factor only after a significant operating interval that includes a comparison of actual tank fuel economy to the fuel economy that is recorded in the ECM. The operating interval should also reflect a typical route. The “Fuel Correction Factor” is a percentage that is programmable in 0.5 percent increments.

Table 79

Minimum	Maximum	Default
-63.5	+63.5	0

### “Calculating Fuel Correction Factor”

The following formula should be used to determine the new Fuel Correction Factor (NEW FCF).

$$\text{ERROR} = (\text{ECM} - \text{TANK}) / \text{TANK}$$

$$\text{NEW FCF} = ((100 + \text{OLD FCF}) \text{ ERROR}) + \text{OLD FCF}$$

Illustration 29

g00629908

OLD FCF – Fuel Correction Factor in ECM

TANK – Actual Fuel Economy

ECM – Fuel Economy in ECM Stored Trip Data

Refer to Illustration 30 as an example. The Actual TANK fuel economy is 7.1 mpg. The Fuel Economy in the ECM Stored Trip Data is 7.0 mpg over the same distance with an OLD FCF of -2.5.

$$\text{ERROR} = (7.0 - 7.1) / 7.1 = -0.0141$$

$$\text{NEW FCF} = ((100 + -2.5) \times [-0.0141]) + (-2.5) = -3.9$$

**-3.9 ROUNDED OFF TO THE NEAREST 0.5,**

$$\text{NEW FCF} = -4.0$$

Illustration 30

g00629939

## “Dash Display Access Parameters”

The following parameters establish a security access for the Caterpillar Driver Information Display:

- “Change Fuel Correction Factor”
- “PM 1 Reset”
- “Fleet Trip Reset”
- “State Selection”

**These parameters require a Caterpillar Driver Information Display for access.**

### “Change Fuel Correction Factor”

This parameter allows the driver to adjust the “Fuel Correction Factor”. An owner/operator would want the driver to be able to change this information, but a fleet operation might not want the driver to be able to change this information.

Table 80

Alternative	Default
Yes	No

### “PM 1 Reset”

This parameter determines the driver’s access for resetting the PM 1 (Maintenance) after the PM 1 has been performed. Maintenance Indicator Mode cannot be programmed to “OFF” for the “PM 1 Reset” parameter to take effect.

Table 81

Alternative	Default
Yes	No

### “Fleet Trip Reset”

This parameter determines the driver’s access for resetting the Fleet Trip Segment.

Table 82

Alternative	Default
Yes	No

### “State Selection”

Program this parameter to NO to disable this function of the Cat ID. The Cat ID will not show “State Selection” as an option to the driver. If this parameter is programmed to “YES” (default) the Cat ID will provide the feature of “State Selection”.

Programming this parameter to “NO” eliminates “State Selection”. Therefore, the storage of the trip data (“State Selection”) is eliminated.

Table 83

Alternative	Default
No	Yes

### “Theft Deterrent System Control”

When this parameter is used with a “Theft Deterrent Password”, this parameter prevents the engine from starting unless the password has been entered via the dash display of the CAT ID. Before the operator can use the feature of Theft Deterrent of the CAT ID, the system must be turned on. In order to turn on the theft deterrent, a service tool must be used to program the parameter for the theft deterrent to “YES”. The operator must first enter the password before the engine is shut off. This will enable the system. Enabling the system prevents the engine from starting without re-entering the password on the next attempted start.

Table 84

Alternative	Default
Yes, Auto-Enable <sup>(1)</sup>	No

(1) NOV99 and newer software

## “Theft Deterrent Password”

The “Theft Deterrent Password” is the password that is required by the ECM before the feature of Theft Deterrent is enabled. After the Theft Deterrent is enabled, the “Theft Deterrent Password” is the password that is required to restart the engine. All of the characters must be in the upper case.

Table 85

Alternative	Default
Four Characters A through Z 0 through 9	0000

## “Quick Stop Rate”

This parameter determines the rate of vehicle speed change that is used by the ECM to record a Quick Stop Event Code and a Quick Stop Snapshot. This parameter is programmable from 5 kilometers per hour per second (3 miles per hour per second) to 24 kilometers per hour per second (15 miles per hour per second). This parameter is also programmable to 0, which is the default value. Programming this parameter to 0 will disable this feature and no Quick Stop Events will be logged. Each Quick Stop Snapshot contains 60 frames of information. The no. 45 Frame is the “Quick Stop occurrence”. The Quick Stop Snapshot also contains 44 frames before the “Quick Stop occurrence” and 15 frames after the “Quick Stop occurrence”. Each frame is separated by 1.0 second.

Table 86

ECM Snapshot Frame Data	
Engine rpm Throttle Position Clutch Switch	Vehicle Speed Cruise Status Brake Switch

The most recent Quick Stop Snapshot is stored in the ECM memory. When a Quick Stop Event occurs the ECM replaces the old Quick Stop Snapshot with the new Quick Stop Snapshot. The ECM also logs a diagnostic event code for each “Quick Stop Occurrence”. The ECM stores a maximum of 255 occurrences.

Table 87

Alternative	Default
5 kilometers per hour per second ( 3 miles per hour per second) to 24 kilometers per hour per second (15 miles per hour per second)	0 kilometers per hour per second (0 miles per hour per second)

Note: Programming the “Quick Stop Rate” too low will cause an excessive number of Quick Stop Event Codes. A vehicle without a load or a trailer will be able to stop much more quickly than a vehicle with a heavy load. If too many Quick Stop Event Codes are being logged, the “Quick Stop Rate” should be increased. This will improve the detection of the exceptions when the exceptions occur.

## “Vehicle Activity Report”

### “Minimum Idle Time”

#### OCT99 and newer software

The “Vehicle Activity Report” provides a chronological order log of engine operation. This report records the following items: “vehicle starts”, “vehicle stops”, “idle time”, “driving time”, and “PTO time”. The “Minimum Idle Time” parameter can be used to adjust the recorded idle time. This is done in order to remove the time for the following occurrences: stopped in traffic, switching into PTO mode and switching out of PTO mode, and idling for other brief periods of time. If the “Minimum Idle Time” is programmed to a value above 0 minutes (default), the previous mode of operation will be logged until the idle time exceeds the programmed limit.

Table 88

Minimum	Maximum	Default
0 Minutes	1440 Minutes	0 Minutes

## “Driver Reward”

### “Driver Reward Enable”

#### MAR99 and newer software

“Driver Reward” is a feature that allows a truck owner to place emphasis on certain factors for desired operating habits. If the vehicle is operated in a manner that exceeds the owner’s specifications, the maximum vehicle speed limit can be automatically increased to a specified value as a reward to the driver. The “Driver Reward Enable” parameter provides a means in order to disable the “Driver Reward” feature. This parameter also provides a means in order to lock out the “Driver Reward” feature. An Electronic Service Tool is used for those areas with regulations that require a fixed maximum Vehicle Speed Limit.

Table 89

Alternatives	Default
Disabled	Enabled

## “Input Selections”

### “Fan Override Switch”

Four input connections can be used in order to connect the “Fan Override Switch”. The “Fan Override Switch” can be programmed to the following ECM pins:

- J1/P1:7 (Input 4)
- J1/P1:47 (Input 5)
- J1/P1:6 (Input 6)
- J1/P1:46 (Input 7)

The J1939 data link can also be used to control the “Fan Override Switch” on NOV01 and newer software.

This switch will allow the operator to turn on the cooling fan at any time for improved retarding and braking of the engine. This will also allow better engine cooling.

Table 90

Alternative	Default
J1/P1:7 J1/P1:47 J1/P1:6 J1/P1:46 J1939 - Body Controller J1939 - Cab Controller J1939 - Instrument Cluster	None

### “Ignore Brake/Clutch Switch”

The Input 5 to the ECM can be used to connect an “Ignore Brake/Clutch Switch”. The “Ignore Brake/Clutch Switch” is used for applications that require the mobile use of the vehicle with a set PTO engine set rpm that does NOT require the Brake or the Clutch to disengage the engine’s PTO operation. This parameter (“Ignore Brake/Clutch Switch”) must be programmed to J1/P1:47 to enable this feature.

Table 91

Alternative	Default
J1/P1:47	None

### “Torque Limit Switch”

The Input 4 to the ECM can be used to connect the “Torque Limit Switch” in order to limit the engine torque to a programmable value. This should only be used for temporary protection of equipment. The “Torque Limit Switch” parameter cannot be programmed if the “PTO Configuration” is programmed to “OFF”. If the “PTO Configuration” is programmed to “OFF”, the ECM will ignore the “Torque Limit Switch”. This parameter (“Torque Limit Switch”) must be programmed to J1/P1:7 to enable this feature.

Table 92

Alternative	Default
J1/P1:7	None

### “Diagnostic Enable”

The J1939 data link and input 7 can be used to connect the “Diagnostic Enable”. Diagnostic flash codes can be prompted by the use of the “Diagnostic Enable”. To initiate the flash codes, depress the momentary “Diagnostic Enable” until the Check Engine Lamp begins to flash. Refer to Troubleshooting, “Diagnostic Codes” for additional information regarding flash codes.

Table 93

Alternative	Default
J1/P1:46 J1939 - Body Controller J1939 - Cab Controller J1939 - Instrument Cluster	None

### “PTO On/Off Switch”

#### NOV01 and newer software

**Note:** This parameter is not available on engine serial numbers W1A1-Up, MDP1-Up, and MEP1-Up.

This parameter allows the connection of a “PTO On/Off Switch” using either the J1939 data link or J1/P1:56.

Table 94

Alternative	Default
J1939 - Body Controller J1939 - Cab Controller J1939 - Instrument Cluster	J1/P1:56

## “Remote PTO Set Switch”

The J1939 data link and input 2 can be used to connect the “Remote PTO Set Switch”. The “Remote PTO Set Switch” is used when the “PTO Configuration” is programmed to Remote Switches and the “PTO On/Off” switch is in the ON position.

Table 95

Alternative	Default
J1939 - Body Controller J1939 - Cab Controller J1939 - Instrument Cluster None	J1/P1:58

## “Remote PTO Resume Switch”

The J1939 data link and input 3 can be used to connect the “Remote PTO Resume Switch”. The “Remote PTO Resume Switch” is used when the “PTO Configuration” is programmed to Remote Switches and the “PTO On/Off” switch is in the ON position.

Table 96

Alternative	Default
J1939 - Body Controller J1939 - Cab Controller J1939 - Instrument Cluster None	J1/P1:60

## “PTO Engine RPM Set Speed Input A”

### NOV99 and newer software

The “PTO Engine RPM Set Speed Input A” switch can be connected to any one of the following locations: J1/P1:6, J1/P1:46, J1/P1:58, J1/P1:60, and J1939 data link. If the “PTO Engine RPM Set Speed Input A” parameter is programmed to the corresponding switch input option, the switch is used to control engine speed during PTO operation. The “PTO Configuration” parameter must be programmed to Cab Switches, Remote Switches or Remote Throttle and the “PTO Engine RPM Speed Input A” parameter must be programmed to a valid speed.

Table 97

Alternatives	Default
J1/P1:6 J1/P1:46 J1/P1:58 J1/P1:60 J1939 - Body Controller J1939 - Cab Controller J1939 - Instrument Cluster	None

## “PTO Engine RPM Set Speed Input B”

### NOV99 and newer software

The “PTO Engine RPM Set Speed Input B” switch can be connected to any one of the following locations: J1/P1:6, J1/P1:46, J1/P1:58, J1/P1:60, and J1939 data link. If the “PTO Engine RPM Set Speed Input B” parameter is programmed to the corresponding switch input option, the switch is used to control engine speed during PTO operation. The “PTO Configuration” parameter must be programmed to Cab Switches, Remote Switches or Remote Throttle and the “PTO Engine RPM Speed Input B” parameter must be programmed to a valid speed.

Table 98

Alternatives	Default
J1/P1:6 J1/P1:46 J1/P1:58 J1/P1:60	None

## “Starting Aid On/Off Switch”

### OCT99 and newer software

The “Starting Aid On/Off Switch” can be connected to either of the following locations: J1/P1:6, J1/P1:7, J1/P1:46, and J1/P1:47. The Starting Aid System does not require a switch for Automatic operation. A switch can be installed in order to allow the operator to disable the Automatic Starting Aid. If a switch is installed and the “Starting Aid On/Off Switch” parameter is programmed to the corresponding switch input, the switch will control the Starting Aid system. When the switch is in the ON position, the Starting Aid System will automatically enable the Starting Aid Output when conditions require the use of a starting aid. When the switch is in the Off position, the Starting Aid System will not function.

Table 99

Alternatives	Default
J1/P1:6 J1/P1:7 J1/P1:46 J1/P1:47	None

## “Two-Speed Axle Switch”

The J1939 data link and input 6 to the ECM is used to connect the “Two-Speed Axle On/Off Switch”. When a two-speed axle is used, the change in gear ratios from the high speed range to the low speed range alters the calibration of the vehicle speed signal. When this parameter is programmed to J1/P1:6 or J1939 and the switch is in the ON position the ECM automatically adjusts the vehicle speed calibration. This will ensure that the ECM driven speedometer and the information that is stored in the ECM correctly reflect the actual vehicle speed. The “High Speed Range Axle Ratio” and “Low Speed Range Axle Ratio” must also be programmed for this feature to function correctly.

Table 100

Alternative	Default
J1/P1:6 J1939 - Body Controller J1939 - Cab Controller J1939 - Instrument Cluster	None

## “Cruise Control On/Off Switch”

The “Cruise Control On/Off” input circuit is available for the connection of a “Cruise Control On/Off Switch” to ECM Connector J1/P1:59 or the J1939 data link. This switch is used to enable Cruise Control when the vehicle is moving. Also, this switch is used to control the engine idle rpm when the vehicle is stationary.

Table 101

Alternative	Default
J1939 - Body Controller J1939 - Cab Controller J1939 - Instrument Cluster	J1/P1:59

## “Cruise Control Set/Resume Switch”

The “Cruise Control Set/Resume” input circuits are available for the connection of a cruise control set/resume switch. This parameter can be programmed to J1/P1:35 & 44 or J1939. If the parameter is set to J1/P1:35 & 44, the Set input should be connected to J1/P1:35 and the Resume input should be connected to J1/P1:44. This switch is used in conjunction with the Cruise Control On/Off Switch to perform the following functions:

- Control the operation of the cruise control while the vehicle is moving.
- Adjust the engine idle rpm while the vehicle is stationary.

- Enable the Diagnostic Flash Codes on the Check Engine Lamp.

When the “PTO Configuration” is programmed to Cab Switches, the “Cruise Control Set/Resume Switch” is also used with the “PTO On/Off” switch to control the engine rpm in PTO Mode.

Table 102

Alternative	Default
J1939 - Body Controller J1939 - Cab Controller J1939 - Instrument Cluster	J1/P1:35 & 44

## “Cruise Control Pause Switch”

### NOV01 and newer software

**Note:** This parameter is not available on engine serial numbers W1A1-Up, MDP1-Up, and MEP1-Up.

This parameter configures an input for use as a cruise control pause switch. This functionality is only available for use over a J1939 data link.

Table 103

Alternative	Default
J1939 - Body Controller J1939 - Cab Controller J1939 - Instrument Cluster	None

## “Clutch Pedal Position Switch”

The Input for the “Clutch Pedal Position Switch” is available for the connection of a Clutch Pedal Position Switch to ECM Connector J1/P1:22 or the J1939 data link. This input is used when the “Transmission Style” is programmed to the Manual Mode. When the “Transmission Style” is programmed to the Manual Mode, an input that is used to determine the position of the clutch pedal is required.

Table 104

Alternative	Default
J1939 - Body Controller J1939 - Cab Controller J1939 - Instrument Cluster	J1/P1:22

## “Retarder Off/Low/Medium/High Switch”

The input for the “Retarder Solenoid Low/Hi Switch” and the input for the “Retarder Solenoid Med/Hi Switch” are available for the connection of a selector switch for the engine retarder solenoid. The Retarder Switch can be connecting by the use of the J1939 data link or using J1/P1:23 & 40. If J1/P1:23 & 40 is used, the Low/Hi Input should be connected to ECM Connector J1/P1:23 and the Med/Hi Input should be connected to ECM Connector J1/P1:40. This switch controls the operation of the Engine Retarder Solenoids.

Table 105

Alternative	Default
J1939 - Body Controller J1939 - Cab Controller J1939 - Instrument Cluster	J1/P1:23 & 40

## “Service Brake Pedal Position Switch 1”

The Input for “Service Brake Pedal Position Switch 1” is available for the connection of a Service Brake Pedal Position Switch. The “Service Brake Pedal Position Switch 1” can be connected by the use of the J1939 data link or by the use of ECM connector J1/P1:45. The input is used to determine the position of the service brake pedal. The position of the service brake pedal can affect the following functions:

- Cruise
- Idle
- PTO
- Idle Shutdown

Table 106

Alternative	Default
J1939 - Body Controller J1939 - Cab Controller J1939 - Instrument Cluster	J1/P1:45

## “Accelerator Pedal Position”

The Input for the “Accelerator Pedal Position” is available for the connection of an Accelerator Pedal Position Sensor. The Sensor’s signal line should be connected to ECM Connector J1/P1:66. This parameter (“Accelerator Pedal Position”) must be programmed to J1/P1:66. The input is used to determine the position of the Accelerator Pedal.

Table 107

Alternative	Default
	J1/P1:66

## “Vehicle Speed Input”

### NOV01 and newer software

**Note:** This parameter is not available on engine serial numbers W1A1-Up, MDP1-Up, and MEP1-Up.

The ECM has an input circuit that can be used to receive vehicle speed information. The ECM input can receive the vehicle speed information in either of the following ways:

- A vehicle speed sensor can be connected to the input.
- A signal wire from an electronic control can be connected to the input.

The “Vehicle Speed Input” parameter must be programmed to “J1/P1:32 & 33” to use this option.

The ECM can also be configured to receive vehicle speed information from an Electronic Transmission Control Unit via the J1939 data link. The transmission must be capable of supporting the “J1939 ETC1 Broadcast Message”. The “Vehicle Speed Input” must be programmed to “J1939-Trans”.

The ECM can also be configured to receive vehicle speed information from the ABS system via the J1939 data link. The ABS system must be capable of supporting the “J1939 High Resolution Wheel Speed Broadcast Message”. The “Vehicle Speed Input” must be programmed to “J1939-ABS”.

**Note:** The “J1939-ABS” option is only available with NOV01 and newer Personality Modules. This option is not available for engine serial numbers W1A1-Up, MDP1-Up, and MEP1-Up.

Table 108

Alternative	Default
J1939 - ABS J1939 - Trans	J1/P1:32 & 33

## “Output Selections”

### “Engine Running Output”

The Output 2, Output 3, or Output 4 is available for the connection of an Engine Running Output Relay that is used to prevent engagement of the starter while the engine is running. The “Engine Running Output” can be programmed to J1/P1:10, J1/P1:12 or J1/P1:13. The “Engine Running Output” comes on when the engine is running. The “Engine Running Output” turns off when the engine rpm is 0. The relay is normally closed so cranking can be achieved immediately at powerup. During cranking, the ECM energizes the “Engine Running Output” once engine low idle rpm has been achieved. The relay is de-energized when the engine speed falls by 100 rpm below the programmed low idle. The programmed low idle range is 600 rpm to 750 rpm.

Table 109

Alternative	Default
J1/P1:10 J1/P1:12 J1/P1:13	None

### “Engine Shutdown Output”

The Output 2, Output 3 or Output 4 is available for the connection of an Engine Shutdown Output Relay that is used to shut down the vehicle electrical system after the idle timer has expired. The “Engine Shutdown Output” can be programmed to J1/P1:10, J1/P1:12 or J1/P1:13. The “Engine Shutdown Output” comes on after the engine runs for more than 3 seconds. The “Engine Shutdown Output” turns off when the engine rpm is at least 100 rpm below the low idle rpm for more than 3 seconds.

Table 110

Alternative	Default
J1/P1:10 J1/P1:12 J1/P1:13	None

### “Auxiliary Brake”

The Auxiliary Brake Output is for use with a BrakeSaver or other Aftermarket braking devices. The Output 3 is available for the connection of an auxiliary Brake Relay. This parameter (“Auxiliary Brake”) must be programmed to J1/P1:12. Operation of the auxiliary brake and the relay is inhibited during undesirable engine operating conditions. The time period of fueling the engine is an undesirable engine operating condition.

Table 111

Alternative	Default
J1/P1:12	None

### “Starting Aid Output”

#### NOV99 and newer software

Output 2, Output 3 or Output 4 is available for the connection of the Starting Aid Output Relay/Solenoid. If a Starting Aid Switch is not used, the “Starting Aid Output” will turn on automatically when operating conditions require the use of a Starting Aid. If the “Starting Aid On/Off Switch” parameter is programmed and a switch connected to the corresponding switch input, the “Starting Aid Output” will not function when the switch is in the OFF position.

Table 112

Alternatives	Default
J1/P1:10 J1/P1:12 J1/P1:13	None

### “Air Inlet Shutoff Relay Control”

The Air Inlet Shutoff is available for certain engine ratings that operate in areas with large amounts of combustible gases. The air inlet shutoff will protect the engine from an engine overspeed when these gases are present. If this option is installed, the “Air Inlet Shutoff Relay Control” cannot be turned off. J1/P1:62 must be connected to the +Battery in order for the air inlet shutoff to operate.

Table 113

Alternatives	Default
	Unavailable

### “Fan Control Type”

If the ECM is used to operate the cooling fan, this parameter must be programmed to “On/Off”, “Three-Speed Fan”, or “Variable Speed Fan Option S”. Options are “None” (default), “On/Off”, “Three-Speed Fan”, and “Variable Speed Fan Option S”. This parameter should be programmed to “None” if the ECM is not connected to the cooling fan relay or the cooling fan solenoid. Also, this parameter should be programmed to “None” if the ECM is not operating the cooling fan relay or the cooling fan solenoid. When this parameter is programmed to “None”, the service technician can use an Electronic Service Tool to determine that the ECM is not connected to the fan circuit.

Table 114

Alternative	Default
On/Off Three-Speed Fan Variable Speed Fan Option S	None

## “PTO Active Output”

### NOV01 and newer software

**Note:** This parameter is not available on engine serial numbers W1A1-Up, MDP1-Up, and MEP1-Up.

The “PTO Active Output” parameter allows the use of an output when the engine is in PTO mode. The PTO switch must be on in order for the “PTO Active Output” to function. The “PTO Active Output” will stay active until there is a kickout of PTO mode or the PTO switch is turned to the OFF position.

Table 115

Alternative	Default
J1/P1:19	None

## Data Link Parameters

### “Power Train Data Link”

This parameter (“Power Train Data Link”) determines if the ECM will communicate to a power train device by the use of the SAE J1922 data link or the J1939 data link. If the vehicle is not using the data link for communication to the power train systems, this parameter should be programmed to “None”. The following systems are examples of power train systems:

- Traction control systems
- Anti-lock brake systems
- Electronically controlled transmissions

**Note:** In addition, the J1939 data link is sometimes used for instrument cluster communications.

Table 116

Alternative	Default
J1922 J1939 J1922 and J1939	None

## Injector Codes

Injector Codes are etched on each injector. The Injector Codes can be viewed from the electronic service tool and the injector codes can be changed from the electronic service tool. The technician must select the Service screen, the Calibration screen and the Injector Codes Calibration screen in order to view the injector codes. Also, the technician must select the Service screen, the Calibration screen and the Injector Codes Calibration screen in order to change the injector codes. The injector code must match the code on the corresponding injector. When an injector is replaced, reprogram the new code for the new injector.

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## Customer Specified Parameters Table

SMCS Code: 1901

Table 117

Table for Customer Specified Parameters		
"Parameter"	Available Range or Options	Default
<b>"Selected Engine Rating"</b>		
"Rating Number"	Dependent on engine power	Unavailable
"Multitorque Ratio"	Unavailable (Standard Ratings) "MT-1", "MT-2", or "MT-4" (Multi-Torque Ratings)	"MT-4" (Multi-Torque)
<b>"ECM Identification Parameters"</b>		
"Vehicle ID"	17 Digits Available characters are dependent on the service tools.	all zeroes
<b>"Security Access Parameters"</b>		
"ECM Wireless Communication Enable"	"Yes" "No"	"No"
<b>"Vehicle Speed Parameters"</b>		
"Vehicle Speed Calibration"	2485 to 93226 PPKM (4000 to 150000 PPM)	8696 PPKM (14000 PPM)
"Vehicle Speed Cal (J1939 - Trans)"	0 to 6500	Not Programmed
"Vehicle Speed Cal (J1939 - ABS)"	0 to 6.550	Not Programmed
"Vehicle Speed Limit"	48 to 204 km/h (30 to 127 mph)	204 km/h (127 mph)
"VSL Protection"	1300 to TEL rpm	TEL rpm
"Tachometer Calibration"	12.0 to 500.0 pulses per revolution	113.0 pulses per revolution
"Soft Vehicle Speed Limit"	"Yes" "No"	"No"
"Low Speed Range Axle Ratio"	1.00 to 19.99	1.00
"High Speed Range Axle Ratio"	1.0 to 9.9	1.00
<b>"Cruise Control Parameters"</b>		
"Low Cruise Control Speed Set Limit"	24 to 204 km/h (15 to 127 mph)	204 km/h (127 mph)
"High Cruise Control Speed Set Limit"	48 to 204 km/h (30 to 127 mph)	204 km/h (127 mph)
"Engine Retarder Mode"	"Coast" "Latch" "Manual"	"Manual"
"Engine Retarder Minimum VSL Type"	"Hard Limit" "Soft Limit"	"Hard Limit"
"Engine Retarder Minimum Vehicle Speed"	0 to 204 km/h (0 to 127 mph)	0 km/h (0 mph)
"Auto Retarder in Cruise"	0 to 16 km/h (0 to 10 mph)	0 km/h (0 mph)
"Auto Retarder in Cruise Increment"	0 to 8 km/h (0 to 5 mph)	3 km/h (2 mph)

(continued)

(Table 117, contd)

<b>Table for Customer Specified Parameters</b>		
<b>"Parameter"</b>	<b>Available Range or Options</b>	<b>Default</b>
"Cruise/Idle/PTO Switch Configuration"	"Set/Accel-Reset/Decel" "Set/Decel-Reset/Accel"	"Set/Accel-Reset/Decel"
"Soft Cruise Control"	"Yes" "No"	"Yes"
"Adaptive Cruise Control Enable"	"Disabled" "Enabled"	"Disabled"
<b>"Idle Parameters"</b>		
"Idle Vehicle Speed Limit"	2 to 24 km/h (1 to 15 mph)	2 km/h (1 mph)
"Idle RPM Limit"	600 rpm to TEL rpm	TEL rpm
"Idle/PTO RPM Ramp Rate"	5 to 1000 rpm/sec	50 rpm/sec
"Idle/PTO Bump RPM"	5 to 500 rpm	20 rpm
<b>"Dedicated PTO Parameters"</b>		
"PTO Configuration"	"Off" "Cab Switches" "Remote Switches" "Remote Throttle"	"Off"
"PTO Top Engine Limit"	600 to TEL rpm	TEL rpm
"PTO Engine RPM Set Speed (0 = Off)"	Low Idle to PTO TEL rpm	0
"PTO Engine RPM Set Speed A"	Low Idle rpm to PTO TEL rpm	0
"PTO Engine RPM Set Speed B"	Low Idle rpm to PTO TEL rpm	0
"PTO to Set Speed"	"Yes" "No"	"No"
"Maximum PTO Enable Speed"	Low Idle to TEL rpm	TEL rpm
"PTO Cab Controls RPM Limit"	"Low idle rpm" "TEL rpm" "PTO TEL rpm"	"TEL rpm"
"PTO Kickout Vehicle Speed Limit"	2 to 204 km/h (1 to 127 mph)	2 km/h (1 mph)
"Torque Limit"	270 N·m (200 lb ft) to Rated Torque	3400 N·m (2500 lb ft)
"PTO Shutdown Time"	3 to 1440 minutes	0
"PTO Shutdown Timer Maximum RPM"	600 to 2120 rpm	2120 rpm
"PTO Activates Cooling Fan"	"Normal" "Continuous"	"Normal"
<b>"Engine/Gear Parameters"</b>		
"Lower Gears Engine RPM Limit"	1100 to TEL rpm	TEL rpm
"Lower Gears Turn Off Speed"	5 to 48 km/h (3 to 30 mph)	5 km/h (3 mph)
"Intermediate Gears Engine RPM Limit"	1100 to TEL rpm	TEL rpm
"Intermediate Gears Turn Off Speed"	8 to 80 km/h (5 to 50 mph)	8 km/h (5 mph)
"Gear Down Protection RPM Limit"	1300 to TEL rpm	TEL rpm
"Gear Down Protection Turn On Speed"	48 to 204 km/h (30 to 127 mph)	204 km/h (127 mph)
"Top Engine Limit (TEL)"	1600 to 2120 rpm	Dependent on the engine rating
"Top Engine Limit with Droop"	"Yes" "No"	"No"

(continued)

(Table 117, contd)

<b>Table for Customer Specified Parameters</b>		
<b>"Parameter"</b>	<b>Available Range or Options</b>	<b>Default</b>
"Low Idle Engine RPM"	600 to 750 rpm	600 rpm
"Transmission Style"	"Manual Option 1" "Automatic Option 1" "Automatic Option 2" "Automatic Option 3" "Automatic Option 4" "Eaton Top 2"	"Manual Option 1"
"Eaton Top 2 Override with Cruise Switch"	"Yes" "No"	"No"
"Top Gear Ratio"	0.000 to 3.750	0.000
"Top Gear Minus One Ratio"	0.000 to 3.750	0.000
"Top Gear Minus Two Ratio"	0.000 to 3.750	0.000
"Governor Type"	"Min/Max" "Full Range"	"Full Range"
<b>"Timer Parameters"</b>		
"Idle Shutdown Time"	3 to 1440 minutes	0 minutes
"Idle Shutdown Timer Maximum RPM"	600 to 2120 rpm	2120 rpm
"Allow Idle Shutdown Override"	"Yes" "No" "Outside Temperature Based" "J1587 Outside Temperature Based"	"Yes"
"Minimum Idle Shutdown Outside Temperature"	-40° to 49°C (-40° to 120°F)	49 °C (120 °F)
"Maximum Idle Shutdown Outside Temperature"	-40° to 49°C (-40° to 120°F)	49 °C (120 °F)
"A/C Switch Fan On-Time"	1 to 600 seconds	0 seconds
"Fan with Engine Retarder in High Mode"	"Yes" "No"	"No"
"Engine Retarder Delay"	0.0 to 3.0 seconds	0.0 seconds
<b>"Smart Idle Parameters"</b>		
"Battery Monitor and Engine Control Voltage"	0 to 25.5 volts	0 volts
<b>"Engine Monitoring Parameters"</b>		
"Engine Monitoring Mode"	"Warning" "Derate" "Shutdown"	"Warning"
"Engine Monitoring Lamps"	"Warning Lamp" "Option 1"	"Warning Lamp"
"Coolant Level Sensor"	"No" "4-pin" "2-wire Float Sensor"	"No"
<b>"Maintenance Parameters"</b>		

(continued)

(Table 117, contd)

<b>Table for Customer Specified Parameters</b>		
<b>"Parameter"</b>	<b>Available Range or Options</b>	<b>Default</b>
"Maintenance Indicator Mode"	"Off" "Manual Distance" "Manual Hours" "Automatic Distance" "Automatic Hours"	"Off"
"PM 1 Interval (Manual Maintenance Indicator Mode)"	8050 to 56325 km (5000 to 35000 miles) 100 to 750 hours	24140 km (15000 miles) 300 hours
"Engine Oil Capacity" (Automatic Maintenance Indicator Mode)	19 to 57 L (20 to 60 qt)	C-10: 34 L (36 qt) C-12: 34 L (36 qt) 3406E, C-15, C-16, C-18: 38 L (40 qt)
<b>"Trip Parameters"</b>		
"Fuel Correction Factor"	-63.5 to 63.5	0
"Dash-Change Fuel Correction Factor"	"Yes" "No"	"No"
"Dash-PM 1 Reset"	"Yes" "No"	"No"
"Dash-Fleet Trip Reset"	"Yes" "No"	"No"
"Dash-State Selection"	"Yes" "No"	"Yes"
"Theft Deterrent System Control"	"Yes" "No" "Auto-Enable"	"No"
"Theft Deterrent Password"	Four Characters	0000
"Quick Stop Rate"	5 to 24 km/h per second ( 3 to 15 mph per second)	0 km/h second (0 mph per second)
<b>"Vehicle Activity Report"</b>		
"Minimum Idle Time"	0 to 1440 minutes	0 minutes
<b>"Driver Reward"</b>		
"Driver Reward Enable"	"Disabled" "Enabled"	"Enabled"
<b>"Input Selections"</b>		
"Fan Override Switch"	"None" " J1/P1:7" "J1/P1:47" "J1/P1:6" "J1/P1:46" "J1939 - Body Controller" "J1939 - Cab Controller" "J1939 - Instrument Cluster"	"None"
"Ignore Brake/Clutch Switch"	"None" "J1/P1:47"	"None"
"Torque Limit Switch"	"None" "J1/P1:7"	"None"

(continued)

(Table 117, contd)

<b>Table for Customer Specified Parameters</b>		
<b>"Parameter"</b>	<b>Available Range or Options</b>	<b>Default</b>
"Diagnostic Enable"	"None" "J1/P1:46" "J1939 - Body Controller" "J1939 - Cab Controller" "J1939 - Instrument Cluster"	"None"
"PTO On/Off Switch"	"J1/P1:56" "J1939 - Cab Controller" "J1939 - Body Controller" "J1939 - Instrument Cluster"	"J1/P1:56"
"Remote PTO Set Switch"	"None" "J1/P1:58" "J1939 - Body Controller" "J1939 - Cab Controller" "J1939 - Instrument Cluster"	"J1/P1:58"
"Remote PTO Resume Switch"	"None" "J1/P1:60" "J1939 - Body Controller" "J1939 - Cab Controller" "J1939 - Instrument Cluster"	"J1/P1:60"
"PTO Engine RPM Set Speed Input A"	"J1/P1:6" "J1/P1:46" "J1/P1:58" "J1/P1:60" "J1939 - Body Controller" "J1939 - Cab Controller" "J1939 - Instrument Cluster"	"None"
"PTO Engine RPM Set Speed Input B"	"J1/P1:6" "J1/P1:46" "J1/P1:58" "J1/P1:60"	"None"
"Two-Speed Axle Switch"	"None" "J1/P1:6" "J1939 - Body Controller" "J1939 - Cab Controller" "J1939 - Instrument Cluster"	"None"
"Cruise Control On/Off Switch"	"J1/P1:59" "J1939 - Body Controller" "J1939 - Cab Controller" "J1939 Instrument Cluster"	"J1/P1:59"
"Cruise Control Set/Resume Switch"	"J1/P1:35 & 44" "J1939 - Body Controller" "J1939 - Cab Controller" "J1939 - Instrument Cluster"	"J1/P1:35 & 44"
"Cruise Control Pause Switch"	"None" "J1939 - Cab Controller" "J1939 - Body Controller" "J1939 - Instrument Cluster"	"None"
"Clutch Pedal Position Switch"	"J1/P1:22" "J1939 - Body Controller" "J1939 - Cab Controller" "J1939 - Instrument Cluster"	"J1/P1:22"

(continued)

(Table 117, contd)

<b>Table for Customer Specified Parameters</b>		
<b>"Parameter"</b>	<b>Available Range or Options</b>	<b>Default</b>
"Retarder Off/Low/Medium/High Switch"	"J1/P1:23 & 40" "J1939 - Body Controller" "J1939 - Cab Controller" "J1939 - Instrument Cluster"	"J1/P1:23 & 40"
"Service Brake Pedal Position Switch 1"	"J1/P1:45" "J1939 - Body Controller" "J1939 - Cab Controller" "J1939 - Instrument Cluster"	"J1/P1:45"
"Accelerator Pedal Position"	"J1/P1:66"	"J1/P1:66"
"Vehicle Speed Input"	"J1/P1:32 & 33" "J1939 - Trans" "J1939 - ABS"	"J1/P1:32 & 33"
<b>"Output Selections"</b>		
"Engine Running Output"	"None" "J1/P1:10" "J1/P1:12" "J1/P1:13"	"None"
"Engine Shutdown Output"	"None" "J1/P1:10" "J1/P1:12" "J1/P1:13"	"None"
"Auxiliary Brake"	"None" "J1/P1:12"	"None"
"Starting Aid Output"	"J1/P1:10" "J1/P1:12" "J1/P1:13"	"None"
"Air Inlet Shutoff Relay Control"	"None" "J2/P2:13"	"None"
"Fan Control Type"	"None" "On/Off" "Three-Speed Fan" "Variable Speed Fan Option S"	"None"
"PTO Active Output"	"None" "J1/P1:19"	"None"
<b>"Customer Passwords"</b>		
"Customer Password (1)"	8 Digits Available characters are dependent on the service tools.	
"Customer Password (2)"		
<b>"Data Link Parameters"</b>		
"Power Train Data Link"	"None" "J1922" "J1939" "J1922 and J1939"	"None"

i01762595

# Customer Specified Parameters Worksheet

SMCS Code: 1901

Table 118

Selected Engine Rating	
"Rating Number"	
"Multitorque Ratio"	

Table 119

ECM Identification Parameters	
"Vehicle ID"	

Table 120

Security Access Parameters	
"ECM Wireless Communication Enable"	

Table 121

Vehicle Speed Parameters	
"Vehicle Speed Calibration"	
"Vehicle Speed Cal (J1939 - Trans)"	
"Vehicle Speed Cal (J1939 - ABS)"	
"Vehicle Speed Limit (VSL)"	
"VSL Protection"	
"Tachometer Calibration"	
"Soft Vehicle Speed Limit"	
"Low Speed Range Axle Ratio"	
"High Speed Range Axle Ratio"	

Table 122

Cruise Control Parameters	
"Low Cruise Control Speed Set Limit"	
"High Cruise Control Speed Set Limit"	
"Engine Retarder Mode"	
"Engine Retarder Minimum VSL Type"	
"Engine Retarder Minimum Vehicle Speed"	
"Auto Retarder in Cruise"	
"Auto Retarder in Cruise Increment"	
"Cruise/Idle/PTO Switch Configuration"	
"Soft Cruise Control"	
"Adaptive Cruise Control Enable"	

Table 123

Idle Parameters	
"Idle Vehicle Speed Limit"	
"Idle RPM Limit"	
"Idle/PTO RPM Ramp Rate"	
"Idle/PTO Bump RPM"	

Table 124

<b>Dedicated PTO Parameters</b>	
"PTO Configuration"	
"PTO Top Engine Limit"	
"PTO Engine RPM Set Speed (0 = Off)"	
"PTO Engine RPM Set Speed"	
"PTO Engine RPM Set Speed A"	
"PTO Engine RPM Set Speed B"	
"PTO to Set Speed"	
"Maximum PTO Enable Speed"	
"PTO Cab Controls RPM Limit"	
"PTO Kickout Vehicle Speed Limit"	
"Torque Limit"	
"PTO Shutdown Time"	
"PTO Shutdown Timer Maximum RPM"	
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Table 125

<b>Engine/Gear Parameters</b>	
"Lower Gears Engine rpm Limit"	
"Lower Gears Turn Off Speed"	
"Intermediate Gears Engine RPM Limit"	
"Intermediate Gears Turn Off Speed"	
"Gear Down Protection RPM Limit"	
"Gear Down Protection Turn On Speed"	
"Top Engine Limit" (TEL)	
"Top Engine Limit with Droop"	
"Low Idle Engine RPM"	
"Transmission Style"	
Eaton Top 2 Override with Cruise Switch	
"Top Gear Ratio"	
"Top Gear Minus One Ratio"	
"Top Gear Minus Two Ratio"	
"Governor Type"	

Table 126

<b>Timer Parameters</b>	
"Idle Shutdown Time"	
"Idle Shutdown Timer Maximum RPM"	
"Allow Idle Shutdown Override"	
"Minimum Idle Shutdown Outside Temp"	
"Maximum Idle Shutdown Outside Temp"	
"A/C Switch Fan On-Time"	
"Fan with Engine Retarder in High Mode"	
"Engine Retarder Delay"	

Table 127

<b>Smart Idle Parameters</b>	
"Battery Monitor and Engine Control Voltage"	

Table 128

Engine Monitoring Parameters	
"Engine Monitoring Mode"	
"Engine Monitoring Lamps"	
"Coolant Level Sensor"	

Table 129

Maintenance Parameters	
"Maintenance Indicator Mode"	
"PM 1 Interval" (Manual Maintenance Indicator Mode)	
"Engine Oil Capacity" (Automatic Maintenance Indicator Mode)	

Table 130

Trip Parameters	
"Fuel Correction Factor"	
"Dash - Change Fuel Correction Factor"	
"Dash - PM 1 Reset"	
"Dash - Fleet Trip Reset"	
"Dash - State Selection"	
"Theft Deterrent System Control"	
"Theft Deterrent Password"	
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Table 131

Vehicle Activity Report	
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Table 132

Driver Reward	
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Table 133

Input Selections	
"Fan Override Switch"	
"Ignore Brake/Clutch Switch"	
"Torque Limit Switch"	
"Diagnostic Enable"	
"PTO On/Off Switch"	
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"PTO Engine RPM Set Speed Input B"	
"Starting Aid On/Off Switch"	
"Two Speed Axle Switch"	
"Cruise Control On/Off Switch"	
"Cruise Control Set/Resume Switch"	
"Cruise Control Pause Switch"	
"Clutch Pedal Position Switch"	
"Retarder Off/Low/Medium/High Switch"	
"Service Brake Pedal Position Switch #1"	
"Accelerator Pedal Position"	
"Vehicle Speed Input"	

Table 134

Output Selections	
"Engine Running Output"	
"Engine Shutdown Output"	
"Auxiliary Brake"	
"Starting Aid Output"	
"Air Inlet Shutoff Relay Control"	
"Fan Control Type"	
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Table 135

<b>Customer Passwords</b>	
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Table 136

<b>Data Link Parameters</b>	
"Power train Data Link"	

## Injector Codes

Table 137

<b>Injector Codes</b>	
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Injector Code (2)	
Injector Code (3)	
Injector Code (4)	
Injector Code (5)	
Injector Code (6)	

## Lifetime Totals Worksheet

Table 138

<b>Lifetime Totals Worksheet</b>	
Total Time	
Total PTO Time	
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Total Distance	
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Total PTO Fuel	
Total Idle Fuel	
Total Maximum Fuel	
Average Load Factor	

**CATERPILLAR**  
**3406E, C-10, C-12, C-15, C-16 AND C-18 TRUCK ENGINE**  
**SYSTEM CONFIGURATION PARAMETERS**  
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# System Configuration Parameters

i01182873

## System Configuration Parameters

**SMCS Code:** 1901

System Configuration Parameters affect the emissions of the engine or the power of the engine. System Configuration Parameters are programmed at the factory. System Configuration Parameters would never need to be changed through the life of the engine normally. System Configuration Parameters must be reprogrammed if an ECM is replaced. Unless the engine rating has changed, System Configuration Parameters do not need to be reprogrammed when the Personality Module is replaced. Proper values for these parameters are stamped on the engine information ratings plate. The engine information ratings plate is located on the valve cover or the air inlet manifold. Factory Passwords are required to change these parameters. The following information is a description of the System Configuration Parameters.

### “Full Load Setting”

“Full Load Setting” is a number that represents the adjustment to the fuel system that was made at the factory in order to fine tune the fuel system. The correct value for this parameter is stamped on the engine information ratings plate. A new ECM requires this parameter to be programmed to avoid generating a 253-02 Check Customer Or System Parameters (56) Diagnostic Code.

### “Full Torque Setting”

“Full Torque Setting” is similar to “Full Load Setting”. This parameter must be programmed to avoid generating a 253-02 Check Customer Or System Parameters (56) Diagnostic Code.

### Personality Module Code

The Personality Module Code is a code that prevents the use of an incorrect personality module for this engine. Each horsepower family and each emission certification has a different code that is associated with the horsepower family or the emission certification.

When a personality module is replaced this code must match the code that is stored in the ECM. If the personality module code does not match the code that is stored in the ECM, both of the following situations will exist:

- The engine will only run at low idle.
- A 253-02 Check Customer Or System Parameters (56) Diagnostic Code will also be generated.

**Note:** The flash programming of a personality module replaces the personality module.

When the engine is being rerated, programming this code to 0 will prompt the ECM to read the stored code and programming this code to 0 will prompt the ECM to match the stored code to the Personality Module Code. This code does not need to be programmed when a personality module is replaced under both of the following conditions:

- The new personality module is from the same family.
- The new personality module is from the same emission year.

If the Personality Module is from a different family, the following components may need to be changed: pistons, injectors, and other components. The engine information ratings plate must also be changed in order to reflect the new rating.

Some vehicle systems such as the cooling system or the transmission may also require changes when the engine is rerated. Please contact the local OEM dealer for further information.

### “Engine Serial Number”

The “Engine Serial Number” should be programmed to match the engine serial number that is stamped on the engine information plate. When a new ECM is delivered, the engine serial number in the ECM is not programmed.

### “Personality Module Release Date”

This parameter is defined by the Personality Module and this parameter is not programmable. The “Personality Module Release Date” is used to provide the version of the software. The Customer parameters and the software change levels can be monitored by this date. The date is provided in the month and the year (NOV99). NOV is the month (November). 99 is the year (1999).

# CATERPILLAR

## 3406E, C-10, C-12, C-15, C-16 AND C-18 TRUCK ENGINE

### TROUBLESHOOTING WITHOUT A DIAGNOSTIC CODE

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# Troubleshooting without a Diagnostic Code

i01891617

## Can Not Reach Top Engine RPM

**SMCS Code:** 1915-035

### Probable Causes

**Note:** If this problem occurs under load, refer to Troubleshooting, "Low Power/Poor or No Response to Throttle".

The probable root causes are listed in order below:

- Diagnostic codes
- Customer specified parameters (normal operation)
- Cold mode
- Accelerator pedal position sensor
- Vehicle speed signal
- Fuel supply
- Power train data link
- Air intake and exhaust system

### Recommended Actions

#### 1. Check for diagnostic codes.

- a. Connect the electronic service tool to the data link connector.
- b. Check for active diagnostic codes and/or logged diagnostic codes.

Certain diagnostic codes will limit the engine speed.

- c. Troubleshoot all active diagnostic codes before continuing with this procedure.

#### 2. Check customer specified parameters.

- a. Verify that the complaint is not normal operation (programmed parameter).
- b. Access the "Configuration" screen on the electronic service tool.

- c. Check the following parameters:

- "Vehicle Speed Limit"
- "Lower Gears Engine RPM Limit"
- "Intermediate Gears Engine RPM Limit"
- "Gear Down Protection Engine RPM Limit"
- "Top Engine Limit"
- "VSL Protection"
- "PTO Top Engine Limit" with the PTO On/Off Switch turned ON.
- "PTO Vehicle Speed Limit" with the PTO On/Off Switch turned ON.

- d. Set each parameter to the parameter's maximum value one at a time and determine whether the problem is corrected.

#### 3. Check Cold Mode operation.

**Note:** This is normal operation if the problem occurs only after start-up in cold weather.

- a. Monitor the electronic service tool in order to verify that the engine has progressed from Cold Mode.

"Cold Mode" is indicated in the upper corner of any status screen.

#### 4. Check the accelerator pedal position sensor.

- a. Use the Cruise/Idle On/Off Switch to put the engine in idle mode.
- b. Vary the engine rpm with the Set/Resume switches.

If both of the following conditions are met, monitor the status of the accelerator pedal position sensor.

- The engine is stable by using idle mode to control the engine rpm.
- The engine is unstable by using the accelerator pedal position sensor.

If the status of the accelerator pedal position sensor is unstable, refer to Troubleshooting, "Accelerator Pedal (Throttle) Position Sensor Circuit - Test".

5. Monitor the vehicle speed signal. Ensure the accuracy of the vehicle speed signal by comparing the vehicle speed signal to the actual vehicle speed.

If the vehicle speed is greater than the VSL, the engine rpm is limited to the programmed "VSL Protection". If a problem is discovered, refer to Troubleshooting, "Vehicle Speed Circuit - Test".

## Can Not Reach Vehicle Speed Limit

**SMCS Code:** 7463-035

### Probable Causes

The probable root causes are listed in order below:

- Diagnostic codes
- Customer specified parameters (normal operation)
- Cold mode
- Electronic system problem
- Fuel supply
- Air intake system or exhaust system
- Leakage in Air-to-Air Aftercooler Core

### Recommended Actions

1. Check for diagnostic codes.
  - a. Connect the electronic service tool to the data link connector.
  - b. Turn the key switch to the ON position.
  - c. Check for active diagnostic codes and logged diagnostic codes.

Certain diagnostic codes will limit the vehicle speed to 45 mph.

- d. Troubleshoot all diagnostic codes before continuing with this procedure.
2. Check customer specified parameters.
  - a. Verify that the complaint is not due to normal operation (programmed parameter).
  - b. Access the "Configuration" screen on the electronic service tool.
  - c. Check the following parameters:
    - "Vehicle Speed Limit"
    - "Soft Vehicle Speed Limit"
    - "Lower Gears Engine RPM Limit"

#### 6. Check the fuel supply.

- a. Monitor the exhaust for smoke while the engine is being cranked.

If no smoke is present, there may be a problem with the fuel quality or there may be a problem with the fuel supply.

- b. Check the fuel quality. Refer to Testing and Adjusting, "Fuel Quality - Test". Also refer to the Truck Performance and Driveability Diagnostic Guide, LEBT3477.
- c. Check the fuel pressure. Refer to Testing and Adjusting, "Fuel System Pressure - Test".
- d. Ensure that the fuel system has been primed. Refer to Testing and Adjusting, "Fuel System - Prime".
- e. Check for fuel supply lines that are restricted.
- f. Check the fuel filters.
- g. If the temperature is below 0 °C (32 °F), check for solidified fuel (wax).
- h. Check for air in the fuel system. Refer to Testing and Adjusting, "Air in Fuel - Test".

#### 7. Check the "Powertrain Data Link". Ensure that the power train data link is not limiting the power.

- a. Monitor the "Powertrain Data Link" status screen while the vehicle is experiencing problems.

If the "Powertrain Data Link" status screen indicates that the "Powertrain Data Link" is limiting the power or the rpm, verify that this is not normal operation. If this is not normal operation, refer to the vehicle OEM for repairs.

#### 8. Air intake and exhaust system

- a. Clean plugged air filters or replace plugged air filters. Refer to the Operation and Maintenance Manual.
- b. Check the air intake and the exhaust system for restrictions and/or leaks. Refer to Testing and Adjusting for more information.

- “Intermediate Gears Engine RPM Limit”
- “Gear Down Protection Engine RPM Limit”
- “VSL Protection”
- “Top Engine Limit”
- Incorrect programming of the Vehicle Speed calibration (ppm).
- “PTO Top Engine Limit” with the PTO On/Off Switch turned ON.
- “Maximum PTO Vehicle Speed” with the PTO On/Off Switch turned ON.

- d.** Set each parameter to the parameter’s maximum value one at a time and determine whether the problem is corrected.

**Note:** The “Soft Vehicle Speed Limit” will not allow the vehicle to achieve the programmed VSL under all engine load conditions. Programming the “Soft Vehicle Speed Limit” to NO may be required to eliminate the complaint.

### 3. Check cold mode operation.

**Note:** This is normal operation if the problem occurs only after start-up in cold weather.

- a.** Check the status screen on the electronic service tool.

“Cold Mode” is indicated in the upper corner of any status screen when cold mode is active.

### 4. Check for an electronic system problem.

- a.** Monitor the fuel position, the “Rated Fuel Limit”, and the “FRC Fuel Limit”.

While the vehicle is operating under full load, the parameters should meet the following conditions:

- The fuel position is equal to the “Rated Fuel Limit”.
- The fuel position is less than the “FRC Fuel Limit”.

If the fuel position is equal to the “Rated Fuel Limit” and the fuel position is less than the “FRC fuel Limit”, the electronics are operating correctly. Go to Step 6.

- 5.** If the fuel position is not equal to the “Rated Fuel Limit” and/or the fuel position is not less than the “FRC Fuel Limit”, perform the following tests in order:

- a.** When the engine is OFF, turn the key switch to the ON position. Check the boost pressure on the electronic service tool.

When the engine is OFF, the boost pressure should be 0 kPa (0 psi).

- b.** Monitor the status of the accelerator pedal position sensor. Operate the engine at high idle with the vehicle in Neutral.

If the engine can not reach the programmed “Top Engine Limit”, check the duty cycle for the accelerator pedal position sensor in order to ensure that the duty cycle is within calibration (75 to 90 Percent at high idle).

If the accelerator pedal position is unstable, check the duty cycle of the accelerator pedal position sensor. Check the duty cycle by slowly operating the accelerator pedal in order to verify that the duty cycle is within calibration. The accelerator pedal position sensor is within calibration when both of the following conditions are met:

- 10 to 22 percent at low idle
- 75 to 90 percent at high idle

Also, ensure that the duty cycle changes as the pedal position changes.

If a problem with the accelerator pedal position sensor is suspected, refer to Troubleshooting, “Accelerator Pedal (Throttle) Position Sensor Circuit - Test”.

**Note:** If the engine exceeds the “Top Engine Limit”, the “Top Engine Limit with Droop” is programmed to YES.

- 6.** Monitor the vehicle speed signal. Ensure the accuracy of the vehicle speed signal by comparing the vehicle speed signal to the actual vehicle speed.

If the vehicle speed is greater than the VSL, the Power is limited. If a problem is discovered, refer to Troubleshooting, “Vehicle Speed Circuit - Test”.

- 7.** Check the “Powertrain Data Link”. Ensure that the SAE J1939 Powertrain Data Link is not limiting the power.

- a.** Monitor the “Powertrain Data Link” status screen while the vehicle is experiencing problems.

If the "Powertrain Data Link" status screen indicates that the "Powertrain Data Link" is limiting the power or the rpm, verify that this is not normal operation. If this is not normal operation, refer to the vehicle OEM for repairs.

## 8. Check the fuel supply.

- a. Monitor the exhaust for smoke while the engine is being cranked.

If no smoke is present, there may be a problem with the fuel quality or there may be a problem with the fuel supply.

- b. Check the fuel quality. Refer to Testing and Adjusting, "Fuel Quality - Test". Also refer to the Truck Performance and Driveability Diagnostic Guide, LEBT3477.
- c. Check the fuel pressure. Refer to Testing and Adjusting, "Fuel System Pressure - Test".
- d. Ensure that the fuel system has been primed. Refer to Testing and Adjusting, "Fuel System - Prime".
- e. Check for fuel supply lines that are restricted.
- f. Check the fuel filters.
- g. If the temperature is below 0 °C (32 °F), check for solidified fuel (wax).
- h. Check for air in the fuel system. Refer to Testing and Adjusting, "Air in Fuel - Test".

9. Check the air intake system for restrictions or leakage. Check the exhaust system for restrictions or leakage. Refer to Testing and Adjusting, "Air Inlet and Exhaust System - Inspect".

10. Check for leakage in the Air-to-Air Aftercooler Core. Refer to Testing and Adjusting, "Aftercooler - Test".

i01186789

## Check Engine Lamp or Warning Lamp Is Malfunctioning

**SMCS Code:** 7431-035

### Probable Causes

The probable root causes are listed in order below:

- Intermittent Diagnostic Codes
- Burned out bulb
- Problem with Lamp circuit (Vehicle)
- The Lamp does not come on.
- Short in Set/Resume Switch Circuit
- Short in Vehicle Harness

### Recommended Actions

Perform the following diagnostic procedures in order:

1. Check for logged diagnostic codes and active diagnostic codes with an Electronic Service Tool.
2. In order to check the Check Engine Lamp, turn the ignition key to the ON position while the engine is OFF.

The Check Engine Lamp should turn on. Then, the Check Engine Lamp should turn off. The Check Engine Lamp will flash if there is an Active Diagnostic Code.

- a. If the Check Engine Lamp does not operate correctly remove the Check Engine Lamp (terminal 28) from the ECM connector (seventy terminal).
- b. Connect the Check Engine Lamp (terminal 28) to the Ground Stud. Turn the ignition key switch to the ON position.
- c. Observe the Check Engine Lamp.

If the Check Engine Lamp comes on, check the power connection and the ground connection of the ECM. Refer to Troubleshooting, "Check Engine Lamp Circuit - Test" for additional information.

If the lamp does not come on, check the lamp in order to ensure that the lamp is not burned out. Also, check the wiring in order to ensure that there is not an open circuit.

3. In order to check the Warning Lamp, start the engine.

The Warning Lamp should come on for at least 2 seconds. Then, the Warning Lamp should turn off. The Warning Lamp will remain on or flash if there is a problem with the engine.

- a. If the Warning Lamp does not operate correctly remove the Warning Lamp (terminal 29) from the ECM connector (seventy terminal).
- b. Connect the Warning Lamp (terminal 29) to the Ground Stud. Turn the ignition key switch to the ON position.

- c. Observe the Warning Lamp.

If the Warning Lamp comes on, check the power connection and the ground connection of the ECM. Refer to Troubleshooting, "Warning Lamp Circuit - Test" for additional information.

If the lamp does not come on, check the lamp in order to ensure that the lamp is not burned out. Also, check the wiring in order to ensure that there is not an open circuit.

4. Connect an Electronic Service Tool. Observe the status screen for the Cruise Control Set/Resume Switch.

If the status screen indicates that the switch is ON and the switch is not in the ON position, the switch is shorted out. Refer to Troubleshooting, "Cruise Control Switch Circuit - Test".

5. Monitor the Check Engine Lamp while the Check Engine Lamp (terminal 28) is removed from the ECM connector (seventy terminal). Also, the technician could monitor the Check Engine Lamp while the ECM Connector (P1) is disconnected.

If the lamp remains on and the pin has been removed from the ECM, there is a short circuit to ground in the vehicle harness.

6. Monitor the Warning Lamp while the Warning Lamp (terminal 29) is removed from the ECM connector (seventy terminal). Also, the technician could monitor the Warning Lamp while the ECM Connector (P1) is disconnected.

If the lamp remains on and the pin has been removed from the ECM, there is a short circuit to ground in the vehicle harness.

i01661891

## Cooling Fan Is Always ON

**SMCS Code:** 1350-035

### Probable Causes

The probable root causes are listed in order below:

- OEM Vehicle component failure

- PTO Mode
- A/C High Pressure Switch circuit
- Manual Fan Override Switch

### Recommended Actions

Perform the following diagnostic procedures in order:

1. Check for OEM Vehicle component failure.
  - a. Inspect the ECM Vehicle Harness Connector J1/P1. Check for a wire that goes into terminal 13 (Output 4) and/or terminal 11 (Output 5).

If a wire is not connected to terminal 13 (Output 4) and/or terminal 11 (Output 5), the ECM is not connected to the Cooling Fan System. The problem is in the OEM Vehicle system.

If a wire is connected to the ECM Vehicle Harness Connector J1/P1, proceed to Step 4.b.

- b. Turn the ignition key to the ON position while the engine is OFF.
- c. Connect the Caterpillar Electronic Technician (ET).
- d. Access the parameter for the "Fan Control Type".

Ensure that the parameter for the "Fan Control Type" is programmed to On/Off control for an On/Off fan or ensure that the parameter for the "Fan Control Type" is programmed to Three-Speed Fan control for a three-speed fan.

If the fan is an On/Off fan, proceed to Step 1.e.

If the fan is a three-speed fan, proceed to Step 1.h.

- e. Access the "On/Off Cooling Fan" test.
- f. Ensure that any fan override switches on the dash are in the OFF position.
- g. Listen for the solenoid and/or the relay to click as the test is activated and deactivated.

If the solenoid and/or the relay is clicking, the ECM and the circuit to the solenoid and/or the relay are operating correctly.

If the solenoid and/or the relay are not clicking, refer to Troubleshooting, "Cooling Fan Circuit and A/C High Pressure Switch Circuit - Test".

- h.** Access the "Three-Speed Fan Slip Output" test.
- i.** Listen for the Slip Solenoid to click as the test is activated and deactivated.

If the Slip Solenoid is clicking, the ECM and the circuit to the Slip Solenoid are operating correctly.

If the Slip Solenoid is not clicking, refer to Troubleshooting, "Cooling Fan Circuit and A/C High Pressure Switch Circuit - Test".

- 2.** Check the "PTO Activates Cooling Fan" parameter.

**Note:** If the problem occurs in PTO mode, continue with this step. If the problem does not occur in PTO mode, skip this step.

- a.** Connect ET to the cab data link connector.
- b.** Access the configuration parameters on ET.
- c.** Check the "PTO Activates Cooling Fan" parameter.
- d.** If the parameter is programmed to "Continuous" the cooling fan will run continuously while the engine is in PTO mode.

- 3.** Check the A/C High Pressure Switch circuit.

- a.** Connect ET to the cab data link connector.
- b.** Access the status screen for the "A/C Fan Input".

If the status screen for the "A/C Fan Input" indicates that the "A/C Fan Input" is Disabled, the ECM is not programmed to use the signal input for the A/C High Pressure Switch. The ECM will not turn the fan ON because of a high A/C Pressure. The problem is in the OEM Vehicle system.

If the status screen for the "A/C Fan Input" indicates that the "A/C Fan Input" is OFF, ON or COUNTING, the ECM is programmed to turn the fan ON because the A/C High Pressure Switch circuit is open. If the status screen for the "A/C Fan Input" indicates OFF, ON or COUNTING, proceed to Step 3.c.

- c.** Start the engine. Allow the engine to idle. Watch the Electronic Service Tool Status screen that indicates the status of the "A/C Fan Input".

If the status screen indicates OFF at any time and the fan is still ON, the A/C High Pressure Switch circuit is operating correctly. The problem is in the OEM Vehicle system.

If the status screen indicates ON and/or COUNTING, the ECM is turning the fan ON because the A/C High Pressure Switch circuit is open. Refer to Troubleshooting, "Cooling Fan Circuit and A/C High Pressure Switch Circuit - Test".

- 4.** Check the Manual Fan Override Switch.

- a.** Connect ET to the cab data link connector.
- b.** Access the parameter for the "Fan Override Switch".
- c.** Check the parameter for the "Fan Override Switch". Ensure that the Fan Override Switch is programmed to one of the options for Input Selections.

If the parameter is programmed to one of the four available outputs, check the input for the Fan Override Switch. The four available options for Input Selections are the following connections:

- J1/P1:6
- J1/P1:7
- J1/P1:46
- J1/P1:47

- d.** Access the status screen for the "Fan Override Switch".

If the status is ON, either the Manual Fan Override Switch is ON or there is a short in the circuit for the "Fan Override Switch". Refer to Troubleshooting, "Cooling Fan Circuit and A/C High Pressure Switch Circuit - Test".

i01764266

## Cruise Control, Idle, or PTO Can Not Be Set

**SMCS Code:** 1915-035

### Probable Causes

The probable root causes are listed below:

- Customer Specified Parameters (normal operation)
- Cruise Control Pause Switch
- On/Off switch for Cruise Control and Idle Control
- PTO On/Off Switch
- Set/Resume Switch
- Circuit for Service Brake Switch
- Transmission Neutral Switch Circuit
- Clutch Switch Circuit
- Vehicle Speed Circuit
- Adaptive Cruise Control

### Recommended Actions

Perform the following diagnostic procedures in order:

1. When the Cruise Control or the Idle Control is set with the Cruise Control On/Off switch, use Cat ET in order to check the Configuration. Check the following parameters:
  - "Low Cruise Control Set Speed Limit"
  - "High Cruise Control Set Speed Limit"
  - "Idle Vehicle Speed Limit"
  - "Idle rpm Limit"

**Note:** If the vehicle speed exceeds the "High Cruise Control Set Speed Limit" and the driver attempts to set a cruise control speed, the cruise set speed will be the "High Cruise Control Set Speed Limit". If the vehicle speed is below the "Low Cruise Control Set Speed Limit", the Cruise Control can not be set or resumed. If the engine rpm is above the Idle rpm Limit and the driver attempts to set an Idle engine rpm the Idle engine rpm will be the Idle rpm Limit. If the driver attempts to set an Idle engine rpm and the vehicle speed exceeds the Idle Vehicle Speed Limit, the Idle will not activate. Refer to Troubleshooting, "Cruise Control Switch Circuit - Test".

2. Connect Cat ET to the data link connector. Check the status screen for the following kickouts:

- Cruise Kickout

If the cruise control pause switch was the cause of the last kickout, the cruise control pause switch may be preventing normal operation of the cruise control.

- a. Check the position of the cruise control pause switch. If the switch is in the ON position, the switch will prevent normal operation of the cruise control. Change the switch to the OFF position. Verify that the repair eliminates the problem.
- b. If the cruise control pause switch is in the OFF position and the switch is still causing the cruise kickout, the switch is bad or the wiring is shorted.
- c. Check the switch for proper operation. If the switch is bad, replace the switch. If the switch is working, the wiring is probably shorted. Refer to Troubleshooting, "Electrical Connectors - Inspect".

3. When the PTO is set with a dedicated PTO On/Off switch, use Cat ET to check the Configuration. Check the following parameters:

- "PTO Configuration"
- "PTO Vehicle Speed Limit"
- "PTO Top Engine Limit"
- "PTO Cab Controls RPM Limit"

Refer to Troubleshooting, "PTO Switch Circuit - Test" for additional information.

4. Connect Cat ET to the data link connector. Check the Status Screen for the following controls:
  - On/Off switch for Cruise Control and Idle Control

- PTO On/Off Switch
  - Set/Resume Switch
  - Circuit for Service Brake Switch
  - Transmission Neutral Switch
  - Clutch Switch
  - Vehicle Speed
- a. Turn on the On/Off switch for Cruise Control and Idle Control while the status screen on Cat ET is being viewed. The status screen should indicate that the switch is changing ON and OFF. If the problem is related to the On/Off switch for Cruise Control and Idle Control, refer to Troubleshooting, "Cruise Control Switch Circuit - Test".
  - b. Toggle the Set/Resume switch from SET to RESUME while the status screen on Cat ET is being viewed. The status screen should indicate that the switch is changing ON and OFF. If the problem is related to the Set/Resume switch, refer to Troubleshooting, "Cruise Control Switch Circuit - Test".
  - c. Depress the Service Brake while the status screen on Cat ET is being viewed. The status screen should indicate that the pedal is being depressed or released. If the problem is related to the Service Brake switch, refer to Troubleshooting, "Service Brake Pedal Position (Switch 1) Circuit - Test".
  - d. Depress the Clutch while the status screen on Cat ET is being viewed. The status screen should indicate that the pedal is being depressed or released. If the problem is related to the Clutch switch, refer to Troubleshooting, "Clutch Pedal Position Switch Circuit - Test".
  - e. Shift the transmission to NEUTRAL while the status screen on Cat ET is being viewed. The status screen should indicate that the transmission is being shifted to NEUTRAL. If the problem is related to the Transmission Neutral Switch, refer to Troubleshooting, "Neutral Switch Circuit - Test".
  - f. Check the vehicle speed while the vehicle is being driven in order to determine that the vehicle speed that is indicated by Cat ET does not vary significantly from the vehicle speed that is indicated by the speedometer. Possible root causes for problems with the vehicle speed circuit could be an incorrect Vehicle Speed Calibration or an intermittent speed signal. If the problem is not apparent, refer to Troubleshooting, "Vehicle Speed Circuit - Test".
5. Check the Adaptive Cruise Control for proper operation.
    - a. Toggle the cruise control switch to the OFF position and to the ON position twice within 10 seconds. This will disable the Adaptive Cruise Control.
    - b. Attempt to set the cruise control. Operate the vehicle under the same conditions that caused the problem.
    - c. If the problem still exists, then the problem is not the Adaptive Cruise Control.
    - d. If the problem is fixed, refer to Eaton for the proper troubleshooting procedure.

i01642805

## Driver Questionnaire

**SMCS Code:** 0336

Table 139

Ask the driver to answer the following questions before attempting to repair an intermittent problem, or a problem with symptoms but no diagnostic codes. Use this and the response guideline to these questions on the next page.		
Questions	Yes	Comments
1. Ask the driver if the Check Engine Lamp turned on during the problem or if the Check Engine Lamp turned on after the problem. The Check Engine Lamp stays on for the following time period:		
2. Ask the driver for the number of occurrences for this problem. Ask the driver to duplicate the problem if the problem can be duplicated in less than one hour.		
3. Ask the driver if other shops have worked on the same problem. If the answer is yes, ask the names of the shops. Also ask for the time period for the work that was performed.		
4. Ask the driver if the engine completely shut down. Ask the driver if the restart required the use of the ignition key switch. Ask the driver for the waiting period before the driver could restart the engine after the shutdown.		
5. Ask the driver if the engine had a hesitation, a speed burp or a misfire without a complete shutdown.		
6. Ask the driver if the radio, dash gauges or lights momentarily turn off during an occurrence of the problem. Ask the driver if there are any other observations about the truck's components.		
7. Ask the driver if the problem occurs only at specific engine loads. Ask the driver for additional details.		
8. Ask the driver if the problem occurs at a specific engine operating temperature. If the problem occurs at a specific engine operating temperature, record the engine temperature.		
9. Ask the driver if the problem occurs only at specific outside temperatures or temperature ranges. If the problem occurs only at specific outside temperatures or temperature ranges, record the outside temperature or temperature range.		
10. Ask the driver if the problem occurs during any other specific conditions.		
11. Ask the driver if the problem occurs at a specific vehicle speed. If the problem occurs at a specific vehicle speed, record the vehicle speed.		
12. Ask the driver if the vehicle kicked out of cruise control mode, idle mode or PTO mode.		
13. Ask the driver if the problem occurs during the use of the accelerator. During this time, the engine is not in cruise control mode or PTO mode.		
14. Ask the driver if the problem occurs at a specific engine rpm. If the problem occurs at a specific engine rpm record the engine rpm.		

i01891626

## Driver Questionnaire Response

SMCS Code: 0336

Table 140

<p>1. If the check engine lamp turned on there will be a logged diagnostic code. Refer to Troubleshooting, "Troubleshooting with a Diagnostic Code" in order to determine if the driver's indicated symptoms agree with the symptoms that are associated with the diagnostic code. If the driver's symptoms do not match the symptoms of the diagnostic code, troubleshooting the diagnostic code will not correct the problem. Review the snapshots that are associated with each diagnostic code in order to determine the operating conditions of the engine during the occurrence of the problem. Try to duplicate these conditions. If there are not any logged diagnostic codes, check the ECM battery connections. Refer to Troubleshooting, "Ignition Key Switch Circuit and Battery Supply Circuit - Test".</p>
<p>2. If the problem is easily repeatable, take the vehicle for a test drive while the electronic service tool is connected to the data link connector. Note the conditions when the problem occurs. The operator should be prepared to take snapshot data by using the electronic service tool or the Cruise Control Set/Resume switches. Ensure that you operate the vehicle after correcting the problem. During vehicle operation, duplicate the operating conditions before releasing the vehicle in order to verify that the problem has been corrected.</p>
<p>3. If the vehicle has been to other shops for the same problem, call the other shops in order to determine the type of work that has been done. Avoid replacing the same components again, unless you are absolutely sure that the components are the problem. If a component has recently been changed, it is unlikely that the component will fail again.</p>
<p>4. Troubleshoot the reason that the engine will not start. Repair the reason that the engine does not start. When you repair the reason that the engine did not start you should repair the reason that the engine shut down. If the engine shut down completely, check the ECM battery connections, the ground connections, the fuel system, the fuel, the primary engine speed/timing sensor and the secondary engine speed/timing sensor. If the engine will not restart, refer to Troubleshooting, "Engine Cranks but Will Not Start".</p>
<p>5. If the problem is easily repeatable, refer to Troubleshooting, "Engine Misfires, Runs Rough or Is Unstable". If the problem is not easily repeatable, refer to Troubleshooting, "Intermittent Low Power or Power Cutout".</p>
<p>6. If other devices on the vehicle are affected, something is wrong with the vehicle wiring. Refer to Troubleshooting, "Ignition Key Switch Circuit and Battery Supply Circuit Test" for information on inspecting the ECM battery connections.</p>
<p>7. Operate the engine under similar load conditions. Check the low pressure fuel lines for restrictions. Also check the fuel/water separator and the fuel tanks for foreign objects that are blocking the fuel supply.</p>
<p>8. Operate the engine at this temperature. Attempt to duplicate the problem.</p>
<p>9. When possible, troubleshoot the problem in this temperature range.</p>
<p>10. If the problem seems to occur during the rain or a washing, thoroughly inspect the connectors for moisture. Refer to Troubleshooting, "Electrical Connectors - Inspect".</p>
<p>11. If the problem occurs at a specific vehicle speed, check the parameters that affect vehicle speed in order to verify that the parameters are programmed close to the vehicle speed of the occurrence of the problem. Check the following parameters:  "Vehicle Speed Limit"  "VSL Protection"  "Low Cruise Control Speed Set Limit"  "High Cruise Control Speed Set Limit"  "Idle Vehicle Speed Limit"  "PTO Vehicle Speed Limit"  "Engine/Gear Speed Limit"  Set each parameter to the maximum value one at a time and verify that the problem is corrected.</p>
<p>12. If the vehicle kicks out of cruise control mode, idle mode or PTO mode and it can be duplicated, check the status screen on the electronic service tool. Check the status of the Cruise Kickout, the Idle Kickout or the PTO Kickout. If the problem can not be duplicated, inspect the vehicle speed circuit, the service brake circuit and the clutch switch circuit and switch adjustment, the circuit for the neutral switch and the circuits for the cruise/idle/pto switches, as required.</p>

(continued)

(Table 140, contd)

13. Check for logged diagnostic codes that are associated with the accelerator pedal position sensor. Refer to Troubleshooting, "Accelerator Pedal (Throttle) Position Sensor Circuit - Test".

14. If the problem occurs at a specific engine rpm, check the "VSL Protection", the "Idle rpm Limit", the "Top Engine Limit", the "PTO Top Engine Limit" and the Progressive Shift Parameters. These parameters are programmable. Set each parameter to the maximum value one at a time and verify that the problem is corrected.

i01891623

## ECM Will Not Accept Factory Passwords

**SMCS Code:** 1901-035

### Probable Causes

The probable root causes are listed in order below:

- Incorrect password
- Incorrect Serial Number
- Incorrect reason code
- Error on Entered Information

### Recommended Actions

Perform the following diagnostic procedures in order:

1. Verify that the electronic service tool is on the factory password screen. Also, verify that the electronic service tool expects factory passwords rather than customer passwords.
2. Verify the following information:
  - a. Verify that the Engine Serial Number that is used to calculate the password is from the electronic service tool screen rather than the engine information plate.

For example, the Engine Serial Number that is programmed in a new ECM is XXX00000. If the Electronic Service Tool indicates that the Engine Serial Number is XXX00000, this Engine Serial Number must be used to obtain factory passwords. DO NOT use the information on the engine information plate.

- b. Verify that all of the information on the electronic service tool is the information that was supplied to Caterpillar in order to obtain the password.

- c. Verify that the information was obtained from the ECM that is being programmed. DO NOT accept the information from the old ECM in order to program factory passwords on a replacement ECM. DO NOT copy the information from the old ECM in order to program factory passwords on a replacement ECM.

- d. Verify that all characters in the ECM and/or the electronic service tool serial number have been supplied.

3. Verify that the correct passwords were entered in the upper case only. Also check the characters in the password for accuracy.

4. Turn the key switch to the OFF position and retry.

**Note:** Ensure that the recorded information that is used to request the password is an exact match to the information that is displayed on the electronic service tool.

5. If rechecking the passwords does not correct the problem, change a customer parameter from the current value to another value and then change the customer parameter back to the original value. Then revert to the screen and proceed to obtain factory passwords again.

**Note:** Changing a parameter with the above method changes the Total Tattletale. The new Tattletale will require obtaining a new password.

6. Verify that the correct reason code from the factory password screen was entered. Do not assume the reason code. This must be obtained from the electronic service tool. Reason codes are assigned for specific purposes and reason codes are not interchangeable.

7. Turn the key switch to the OFF position and retry.

**Note:** Ensure that the information that is entered is an exact match to the information that is displayed on the electronic service tool.

i01748834

## Electronic Service Tool Will Not Communicate with ECM

**SMCS Code:** 0785-035; 1901-035

### Probable Causes

- Configuration for the communications adapter
- Electrical connectors
- Communication adapter and/or cables
- Electrical power supply to the service tool connector
- Cat ET and related hardware
- Electrical power supply to the ECM
- Override switches
- Personality module (flash file)
- ATA Data Link

### Recommended Actions

Start the engine. If the engine starts, but the ECM will not communicate with the Caterpillar Electronic Technician (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 the service tool connector. Refer to Troubleshooting, "Electrical Connectors - Inspect".

### Communication Adapter and/or Cables

1. If you are using a Communication Adapter II, ensure that the firmware and driver files for the communication adapter are the most current files that are available. If the firmware and driver files do not match, the communication adapter will not communicate with Cat ET.
2. Disconnect the communication adapter and the cables from the service tool connector. Reconnect the communication adapter to the service tool connector.
3. Verify that the correct cable is being used between the communication adapter and the service tool connector. Refer to Troubleshooting, "Electronic Service Tools".

### Electrical Power Supply to the Service Tool Connector

Verify that battery voltage is present between terminals A and B of the service tool connector. If the communication adapter is not receiving power, the display on the communication adapter will be blank.

### Cat ET and Related Hardware

In order to eliminate Cat ET and the related hardware as the problem, connect Cat ET to a different engine. If the same problem occurs on a different engine, check Cat ET and the related hardware in order to determine the cause of the problem.

### Electrical Power Supply to the ECM

Check power to the ECM. Refer to Troubleshooting, "Ignition Key Switch Circuit and Battery Supply Circuit - Test".

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

### Override Switches

1. Ensure that the ignition key switch is in the ON position. Ensure that there are no override switches that are creating the problem.

2. Ensure that there are no aftermarket devices that are preventing battery voltage from reaching the ECM.
3. Start the engine and then connect Cat ET. Some type of override switch is interrupting the power to the ECM under the following condition: If communication occurs with the engine running but no communication occurs with the key switch in the ON position.

### Personality Module (Flash File)

Ensure that the correct personality module is properly installed in the ECM.

**Note:** The personality module that is provided in a new ECM is blank. The engine will not start and the engine will not communicate with Cat ET until the personality module has been flashed. Refer to Troubleshooting, "Flash Programming".

### ATA Data Link

Troubleshoot the ATA Data Link for possible problems. Refer to Troubleshooting, "ATA (SAE J1587 / J1708) Data Link Circuit - Test".

i01908311

## Engine Cranks but Will Not Start

**SMCS Code:** 1000-035

### Probable Causes

The probable root causes are listed in order below:

- Key switch
- Communications between the ECM and the Caterpillar Electronic Technician (Cat ET)
- Aftermarket engine protection devices
- Power to ECM
- Personality Module
- ECM
- Electrical connections to the electronic unit injector
- Engine speed/timing signal
- Engine software
- Theft deterrent

- Fuel supply
- Combustion problem

### Recommended Actions

Perform the following diagnostic procedures in order:

1. Check the key switch.
  - a. Connect Cat ET to the data link connector.
  - b. Access the status for "Ignition Key Switch".
  - c. Slowly cycle the key switch ON and OFF while the status for "Ignition Key Switch" is being monitored. The status should indicate the state of the switch.

If the ECM will not communicate and the key switch is in the ON position, refer to Step 3.

**Note:** If the Engine Shutdown Output feature is used, the status for "Ignition Key Switch" may indicate that the switch is ON even though the key switch is turned to the OFF position.

2. Check the communications between the ECM and Cat ET.
  - a. Connect Cat ET to the data link connector.
  - b. Ensure that the key switch is in the ON position. Attempt to access one of the status screens on Cat ET.

If Cat ET indicates that the ECM will not communicate go to Step 3. If the ECM communicates go to Step 6.

**Note:** A new ECM has a personality module that is not programmed. A new ECM that is not programmed will cause this symptom. Accessing the ECM status in "WinFlash" without programming the personality module will cause the engine not to start or accessing the ECM status in "WinFlash" without programming the personality module will cause the engine not to communicate. Cycling the key switch from the OFF to the ON position will correct this problem.

3. Check aftermarket engine protection devices. These devices usually interrupt power to the ECM and the ECM will not communicate with Cat ET.
  - a. Check for the correct installation of the aftermarket engine protection device.
  - b. Check for the correct operation of the aftermarket engine protection device.

**c.** Verify that the ECM is receiving battery voltage.

**4.** Check the electrical power supply to the ECM.

**a.** Check the power connection of the ECM and the ground connection of the ECM.

**b.** Verify that the ECM is receiving battery voltage when the key switch is turned ON. Refer to Troubleshooting, "Ignition Key Switch Circuit and Battery Supply Circuit - Test".

**5.** Check the personality module.

A new ECM has a Personality Module that is not programmed. The engine will not start until the personality module has been flashed. Also, the engine will not communicate until the personality module has been flashed.

**6.** Check the ECM.

Before replacing the ECM, try to flash program the existing ECM. Refer to Troubleshooting, "Flash Programming".

If the ECM is suspected of being the problem, temporarily connect a test ECM. This will show whether the problem has been resolved or the problem has not been resolved.

**7.** Check the electrical connections to the electronic unit injectors.

**a.** Ensure that the J300/P300 Electronic Unit Injector connector is fully connected and ensure that the J300/P300 Electronic Unit Injector Connector is free of corrosion.

**b.** Check for logged diagnostic codes that are related to the injectors. Refer to Troubleshooting, "Injector Solenoid Circuit - Test" if diagnostic codes that are related to the injectors are present.

**8.** Check the engine speed/timing signal.

**a.** Observe the engine rpm on Cat ET while the engine is being cranked.

This may require Cat ET to be powered directly by the vehicle batteries or this may require Cat ET to be powered directly by a separate power source (12 VDC). Refer to Illustration 31.

If Cat ET displays 0 rpm and the engine is being cranked, there is a problem in the circuit for the secondary engine speed/timing sensor or the circuit for the primary engine speed/timing sensor. Refer to Troubleshooting, "Engine Speed/Timing Circuit - Test".

If an engine rpm is present, check the sensor installation. If the sensor is not properly installed, the sensor may read RPM but the sensor may not be able to sense the tooth pattern. The ability to sense the tooth pattern is necessary to determine the crankshaft position. Engine rpm is present when the engine rpm is 50 rpm or more. Go to Step 9

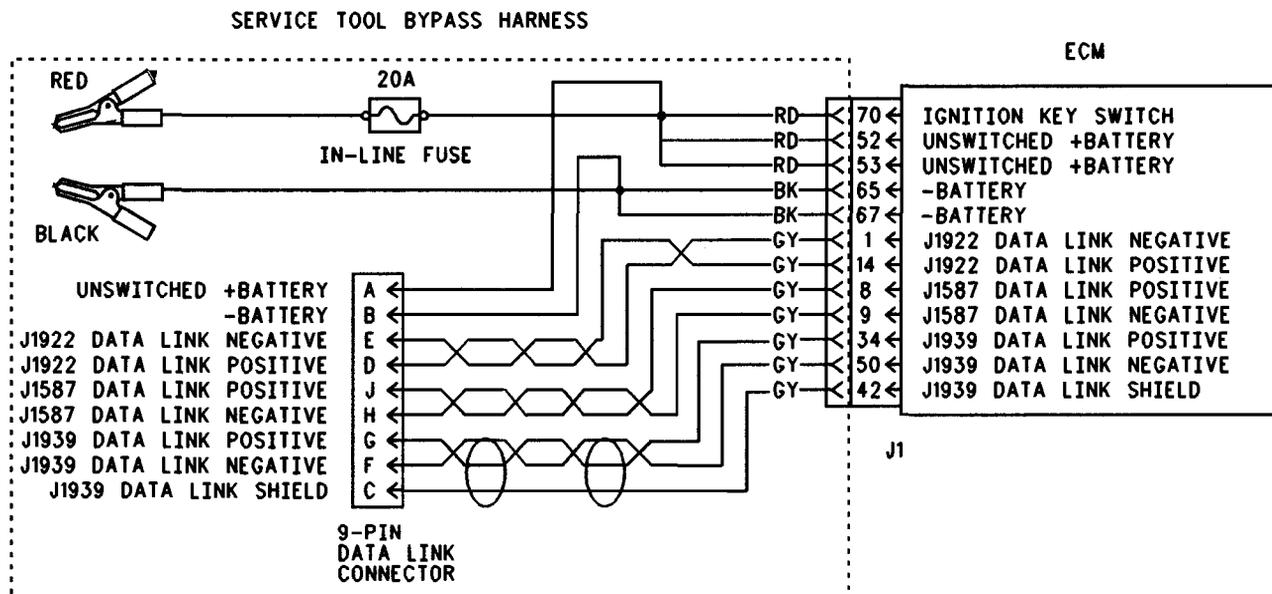


Illustration 31

g00732318

## Bypass harness

- 9.** Check for the correct engine software. Connect Cat ET to the service tool connector. Ensure that 252-11 Incorrect Engine Software is not active.

If the diagnostic code is present, refer to Troubleshooting, "ECM Memory - Test".

Connect Cat ET to the service tool connector. Check for the following diagnostic codes:

- 224-11 Theft Deterrent Active
- 224-14 Theft Deterrent Active with Engine Cranking

- 10.** Ensure that the theft deterrent (if equipped) is not active. Turn the key switch to the ON position. Observe the display screen on the CAT ID.

If the display screen on the CAT ID indicates that the theft deterrent is enabled, the theft deterrent passwords must be entered before the engine will start.

- 11.** Check the fuel supply.

- a.** Monitor the exhaust for smoke while the engine is being cranked.

If no smoke is present, there may be a problem with the fuel quality or there may be a problem with the fuel supply.

- b.** Check the fuel quality. Refer to Testing and Adjusting, "Fuel Quality - Test". Also refer to Truck Performance and Driveability Diagnostic Guide, LEBT3477.

- c.** Check the fuel pressure. Refer to Testing and Adjusting, "Fuel System Pressure - Test".

- d.** Ensure that the fuel system has been primed. Refer to Testing and Adjusting, "Fuel System - Prime".

- e.** Check for fuel supply lines that are restricted.

- f.** Check the fuel filters.

- g.** If the temperature is below 0 °C (32 °F), check for solidified fuel (wax).

- 12.** Check for combustion problems.

Examples of combustion problems are shown in the following list:

- Outside temperatures are too cold.
- Mechanical problem

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## Engine Misfires, Runs Rough or Is Unstable

**SMCS Code:** 1000-035

### Probable Causes

The probable root causes are listed in order below:

**Note:** If the problem is intermittent and the problem can not be duplicated, refer to Troubleshooting, "Intermittent Low Power or Power Cutout".

- Individual malfunctioning cylinder
- Fuel supply
- Accelerator pedal position sensor
- Power train data link
- Speed/timing sensors

### Recommended Actions

Perform the following diagnostic procedures in order:

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

1. Check for an individual malfunctioning cylinder.
  - a. Ensure that the J300/P300 Electronic Unit Injector Connector is fully connected and ensure that the J300/P300 Electronic Unit Injector Connector is free of corrosion.
  - b. Ensure that the J2/P2 ECM connector is fully connected and ensure that the J2/P2 ECM connector is free of corrosion.
  - c. Connect the Caterpillar Electronic Technician (Cat ET). Access the "Cylinder Cutout Test" by selecting "Diagnostic Tests" under the "Diagnostics" menu. Run the "Cylinder Cutout Test" in order to disable each cylinder. Disabling each cylinder allows the technician to isolate the misfiring cylinders.

If the misfiring cylinder can be isolated to a specific cylinder, refer to Troubleshooting, "Injector Solenoid Circuit - Test".

2. Check the fuel supply.
  - a. Monitor the exhaust for smoke while the engine is being cranked.
 

If white smoke is present, there may be a problem with the fuel quality.
  - b. Check the fuel quality. Refer to Testing and Adjusting, "Fuel Quality - Test". Also refer to the Truck Performance and Driveability Diagnostic Guide, LEBT3477.
  - c. Check the fuel pressure. Refer to Testing and Adjusting, "Fuel System Pressure - Test".
  - d. Ensure that the fuel system has been primed. Refer to Testing and Adjusting, "Fuel System - Prime".
  - e. Check for fuel supply lines that are restricted.
  - f. Check the fuel filters.
  - g. If the temperature is below 0 °C (32 °F), check for solidified fuel (wax).
  - h. Check for air in the fuel system. Refer to Testing and Adjusting, "Air in Fuel - Test".
3. If the problem does not occur during cruise control, check the accelerator pedal position sensor.
  - a. Use the Cruise/Idle On/Off Switch to put the engine in idle mode.
  - b. Vary the engine rpm with the Set/Resume switches.

If both of the following conditions are met, connect Cat ET and monitor the status of the accelerator pedal position sensor.

- The engine is stable by using idle mode to control the engine rpm.
- The engine is unstable by using the accelerator pedal position sensor.

If the status of the accelerator pedal position sensor is unstable, refer to Troubleshooting, "Accelerator Pedal (Throttle) Position Sensor Circuit - Test".

4. Check the "Power train Data Link". Ensure that the SAE J1922 or the SAE J1939 Power train Data Link is not limiting the power.
  - a. Connect Cat ET to the data link connector.

- b.** Monitor the “Power train Data Link” status screen while the vehicle is experiencing problems.

If the “Power train Data Link” status screen indicates that the “Power train Data Link” is limiting the power or the rpm, verify that this is not normal operation. If this is not normal operation, refer to the vehicle OEM for repairs.

- 5.** Check the primary engine speed/timing sensor.

If the signal from the primary engine speed/timing sensor is lost intermittently, the engine may misfire. The misfiring may occur when the signal source becomes the secondary engine speed/timing sensor. Ensure that the primary engine speed/timing sensor is properly installed. Also, ensure that the wiring is not damaged or pulled too tightly. This may cause an intermittent connection. Also, ensure that the crankshaft gear and the timing plate are not damaged. Refer to the following publication for additional information: Troubleshooting, “Engine Speed/Timing Sensor Circuit - Test”

- 6.** Check the secondary engine speed/timing sensor.

If the signal for the secondary engine speed/timing sensor is lost during engine start-up, additional time may be required to start the engine. The engine may also misfire during this time until the ECM determines the proper firing order. Refer to Troubleshooting, “Engine Speed/Timing Circuit - Test”.

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## Engine Retarder (Compression Brake) Will Not Turn ON

**SMCS Code:** 1129-035

### Probable Causes

The probable root causes are listed in order below:

- Customer Specified Parameter (Engine Retarder)
- Cruise Control On/Off Switch
- Engine Retarder On/Off Switch
- Retarder Off/Low/Medium/High Switch
- Accelerator Pedal Position Sensor
- Clutch Switch
- Additional Customer Specified Parameters

- PTO On/Off Switch

### Recommended Actions

Perform the following diagnostic procedures in order:

- 1.** Check the Engine Retarder Mode.

If the Engine Retarder Mode is programmed to Latch or Coast, the engine retarder will not activate unless the service brake pedal is depressed.

If the Engine Retarder Mode is programmed to Manual, service brakes are not required.

- 2.** Check the Engine Retarder On/Off Switch and the Retarder Off/Low/Medium/High Switch.

**Note:** The Engine Retarder On/Off Switch must be in the ON position in order to permit engine retarder operation.

- a.** Connect an Electronic Service Tool to the Cab Data Link Connector.
- b.** Turn the ignition key to the ON position while the engine is OFF.
- c.** Access the status screen for the Engine Retarder Switch.
- d.** Move the engine retarder switches to each of the available levels while the status of the switch is being watched on the Electronic Service Tool. The available levels of the engine retarder switches have the following designations:

- Off
- Low
- Medium
- High

**Note:** Some vehicles may have a set of switches on the dash and the shift lever.

If the status for the Engine Retarder Switches does not correspond to the position of the Engine Retarder Switches, refer to Troubleshooting, “Retarder (Compression Brake) Solenoid circuit - Test”.

- 3.** Check the Accelerator Pedal Position Sensor and the Clutch Switch.

- a.** Connect an Electronic Service Tool to the Cab Data Link Connector.

- b. Turn the ignition key to the ON position while the engine is OFF.
- c. Access the status screen for the Accelerator Pedal Position.
- d. Depress the accelerator pedal and release the accelerator pedal several times while the status screen for the accelerator pedal is being watched.

The Accelerator Pedal Position should be in a range of 3 to 100 percent. If the Accelerator Pedal Position is not in a range of 3 to 100 percent, refer to Troubleshooting, "Accelerator Pedal (Throttle) Position Sensor Circuit - Test".

- e. Access the status screen for the Clutch Switch.
- f. Depress the clutch pedal and release the clutch pedal several times while the status screen for the Clutch Switch is being watched.

The status screen for the Clutch Switch should indicate that the clutch pedal is being depressed and released. When the clutch pedal is being depressed the status screen should indicate ON. When the clutch pedal is being released the status screen should indicate OFF. If the status of the Clutch Switch does not correspond to the position of the clutch pedal, refer to Troubleshooting, "Accelerator Pedal (Throttle) Position Sensor Circuit - Test".

4. Check additional Customer Specified Parameters.
  - a. Connect an Electronic Service Tool to the Cab Data Link Connector.
  - b. Turn the ignition key to the ON position while the engine is OFF.
  - c. Access the Customer Specified Parameters screen.
  - d. Review the programming of the following parameters:
    - "Engine Retarder Minimum Vehicle Speed"
    - "Engine Retarder Minimum Vehicle Speed Type"
    - "Engine Retarder Delay"

**"Engine Retarder Minimum Vehicle Speed"** – The engine retarder will not turn ON below the programmed value when the programmed value is greater than 0 km/h (0 mph).

**"Engine Retarder Minimum Vehicle Speed Type"** – When vehicle speed drops below the Engine Retarder Minimum Vehicle Speed and this parameter is programmed to Hard Limit the engine retarder turns OFF. When vehicle speed drops below the Engine Retarder Minimum Vehicle Speed and this parameter is programmed to Soft Limit the engine retarder remains ON.

**"Engine Retarder Delay"** – This parameter provides a programmable delay after the conditions that turn ON the Engine Retarder are met.

If the problem is due to the programming of any of the listed parameters, refer to Troubleshooting, "Customer Specified Parameters".

#### 5. Check the PTO On/Off Switch.

**Note:** If the "PTO Configuration" (Customer Specified Parameter) is programmed to Cab Switches, Remote Switches or Remote Throttle, the Engine Retarder is disabled when the PTO On/Off circuit is in the ON position.

- a. Connect an Electronic Service Tool to the Cab Data Link Connector.
- b. Turn the ignition key to the ON position while the engine is OFF.
- c. Access the status screen for the PTO On/Off Switch.

If the status of the PTO On/Off Switch does not correspond to the position of the PTO On/Off Switch, refer to Troubleshooting, "PTO Switch Circuit - Test".

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## Engine Vibration

**SMCS Code:** 1000-035

### Probable Causes

The probable root causes are listed in order below:

- Mounting Brackets
- Unbalance of the Clutch Disc

- Alignment of the Clutch Disc
- Misfiring Cylinder
- Resonance of the Vehicle

## Recommended Actions

Perform the following diagnostic procedures in order:

1. Check for loose mounting brackets.
  - a. Start the engine.
  - b. Run the engine through the entire Idle Speed range. Check all vibrating components for the following problems:
    - Loose mounts
    - Broken mounts
    - Loose brackets
    - Broken brackets
    - Loose fasteners
    - Broken fasteners

2. Check for unbalance of the Clutch Disc and/or misalignment of the Clutch Disc.
  - a. Start the engine.
  - b. Run the engine through the entire Idle Speed range while the clutch is disengaged.

If the vibrations are reduced, there is a balance problem with the clutch disc or the clutch disc is out of alignment.
  - c. Repair the clutch disc or replace the clutch disc.

3. Check for a misfiring cylinder.

Further analysis requires the use of a vibration instrument. Any instrument that can accurately measure the displacement of the vibration and the frequency of the vibration will be sufficient. The **4C-3030** Vibration Analyzer can be used to provide a quick identification and complete identification of all vibration frequencies that are present in a constant speed measurement. Refer to Special Instruction , SEHS7914, "Troubleshooting Vibration In Vehicular Equipment" for additional information.

If the frequency of the vibration is half of the engine rpm (half order), the vibration is caused by a misfiring cylinder.

If the frequency of the vibration is 3 times the engine rpm (third order), no corrective action can be taken on the engine because this is the firing frequency of the engine. The problem is in the resonance of the cab or the problem is in the resonance of the chassis.

4. Check for a problem regarding the resonance of the vehicle.
  - a. Measure the vibration of the engine through the entire speed range.
  - b. Record the speed of the vibrations when the filter is out.
  - c. Record the amplitudes of the vibrations when the filter is out.

If all of the amplitudes are less than 4.0 mils, the engine performance is within the specification.
  - d. If the amplitudes are greater than 4.0 mils, run the engine at high idle when the filter is installed.
  - e. Check all vibrations over 4.0 mils for each of the following orders of frequency:
    - Vibrations of the first order
    - Vibrations of the second order
    - Vibrations of the third order
    - Vibrations of any other order

Perform the following tests in order to check the vibrations:

1. Check the vibrations of the first order.
  - a. Remove the vibration damper.
  - b. Recheck the vibration.

If the amplitude of the vibration is less than 4.0 mils, check the damper pilot.

If the runout of the damper pilot is less than 0.10 mm (0.004 inch), install a new damper.

If the runout of the damper pilot is greater than 0.10 mm (0.004 inch), correct the runout.

- c.** If the amplitude of the vibration was greater than 4.0 mils after the removal of the damper, remove the transmission's pressure plate and clutch disc.
- d.** Recheck the vibration.
- e.** If the amplitude of the vibration was greater than 4.0 mils after the removal of the transmission's pressure plate and clutch disc, an engine component is out-of-balance. The following components could be out-of-balance:
- BrakeSaver
  - Connecting rod
  - Crankshaft
- f.** If the amplitude of the vibration was less than 4.0 mils after the removal of the transmission's pressure plate and clutch disc, check the flywheel runout and the flywheel housing runout.

If the flywheel runout and the flywheel housing runout are within the specification, there is a problem with the clutch and/or a problem with the transmission.

**2.** Check the vibrations of the second order.

There is a heavy piston and connecting rod or there is a light piston or connecting rod.

**3.** Check the vibrations of the third order.

The vibration is being caused by the frequency of the firing order. A problem with resonance exists within the vehicle.

**4.** Check any other significant orders of vibration.

- a.** Check all driven accessories.
- b.** Check all fan blades.
- c.** Check for excessive gear backlash.

## Engine Will Not Crank

**SMCS Code:** 1000-035

### Probable Causes

**Note:** This is NOT an electronic system problem. Refer to Testing and Adjusting for additional information.

The probable root causes are listed in order below:

- Batteries
- Starting circuit
- Starting motor solenoid
- Starting motor
- Flywheel Ring Gear
- Transmission
- PTO
- Engine accessory
- Hydraulic cylinder lock
- Internal engine problem

### Recommended Actions

Perform the following diagnostic procedures in order:

- 1.** 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".
- 2.** Check the vehicle wiring to the starting motor solenoid. Refer to the OEM vehicle manual.
- 3.** Check the engine start switch and the relay for switch power.
- 4.** Inspect the starting motor cables for damage or loose connections.

5. If the starting motor cables are corroded, remove the starting motor cables and clean the starting motor cables.
6. Test starting motor operation.
7. Inspect flywheel ring gear for damage.
8. Ensure free movement of the driveline.
9. Remove engine accessories that may lock up the engine and inspect engine accessories that may lock up the engine.

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

- Air compressor
- Power steering pump
- Engine oil pump

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

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

11. Disassemble the engine. Inspect the internal components for the following conditions:

- Seizure
- Broken components
- Bent components

Refer to Disassembly and Assembly.

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## Excessive Black Smoke

**SMCS Code:** 1088-035

### Probable Causes

The probable root causes are listed in order below:

- Air Inlet System or Exhaust System
- Valve Lash
- Electronic Unit Injector
- Boost Pressure Sensor
- Atmospheric Pressure Sensor

- Electronic System problem
- Personality Module

### Recommended Actions

Perform the following diagnostic procedures in order:

1. Check the Air Inlet System for restrictions or leakage. Check the Exhaust System for restrictions or leakage. Refer to Testing and Adjusting, "Air Inlet and Exhaust System - Inspect".
2. Check the valve lash. Refer to Testing and Adjusting, "Engine Valve Lash - Inspect/Adjust".
3. Check the Electronic Unit Injector.
  - a. Ensure that the Electronic Unit Injector Connector (J300/P300) is fully connected and ensure that the Electronic Unit Injector Connector (J300/P300) is free of corrosion.
  - b. Ensure that the ECM Engine Harness Connector (J2/P2) is fully connected and ensure that the Engine Harness Connector (J2/P2) is free of corrosion.
  - c. Connect an Electronic Service Tool. Use the Cylinder Cutout Test. Access the Cylinder Cutout Test by selecting the "Diagnostic Menu" and the "Diagnostics Test Menu". Run the Cylinder Cutout Test in order to disable each cylinder. Disabling each cylinder allows the technician to isolate the misfiring cylinders.
 

If the misfiring cylinder can be isolated to a specific cylinder, refer to Troubleshooting, "Injector Solenoid Circuit - Test".

4. Check the Boost Pressure Sensor and the Atmospheric Pressure Sensor.
  - a. Connect an Electronic Service Tool.
  - b. While the problem is occurring, check for Diagnostic Codes that are related to the Boost Pressure Sensor and the Atmospheric Pressure Sensor. If a Diagnostic Code is found, refer to Troubleshooting, "Engine Pressure Sensor Open or Short Circuit - Test".
5. Check for an Electronic System problem.
  - a. Connect an Electronic Service Tool.
  - b. Monitor the Fuel Position, the Rated Fuel Limit and the FRC Fuel Limit.

While the vehicle is operating under full load, the parameters should meet the following conditions:

- The Fuel Position is equal to the Rated Fuel Limit.
- The Fuel Position is less than the FRC Fuel Limit.

If the Fuel Position is equal to the Rated Fuel Limit and the Fuel Position is less than the FRC Fuel Limit, the Electronics are operating correctly. Go to Step 7.

6. If the Fuel Position is not equal to the Rated Fuel Limit and/or the Fuel Position is not less than the FRC Fuel Limit, perform the following tests in order:

- a. Connect an Electronic Service Tool.
- b. When the engine is OFF, turn the Ignition Key Switch to the ON position. Check the boost pressure on an Electronic Service Tool Status Screen.

When the engine is OFF, the boost pressure should be 0 kPa (0 psi).

- c. Monitor the status of the Accelerator Pedal Position Sensor. Operate the engine at high idle with the vehicle in Neutral.

If the engine can not reach the programmed "Top Engine Limit", check the Accelerator Pedal Position Duty Cycle in order to ensure that the Accelerator Pedal Position Duty Cycle is within calibration (75 to 90 Percent at high idle).

If the accelerator pedal position is unstable, check the Accelerator Pedal Position Duty Cycle. Check the Accelerator Pedal Position Duty Cycle by slowly operating the accelerator pedal in order to verify that the Accelerator Pedal Position Sensor is within calibration. The Accelerator Pedal Position Sensor is within calibration when both of the following conditions are met:

- 10 to 22 percent at low idle
- 75 to 90 percent at high idle

Also, ensure that the duty cycle changes as the pedal position changes.

If a problem with the Accelerator Pedal Position Sensor is suspected, refer to Troubleshooting, "Accelerator Pedal (Throttle) Position Sensor Circuit - Test".

**Note:** If the engine exceeds the Top Engine Limit, the "Top Engine Limit with Droop" is programmed to YES.

7. Monitor the vehicle speed signal. Ensure the accuracy of the vehicle speed signal by comparing the vehicle speed signal to the actual vehicle speed.

If the vehicle speed is greater than the VSL, the Power is limited. If a problem is discovered, refer to Troubleshooting, "Vehicle Speed Circuit - Test".

8. Check the "Power train Data Link". Ensure that the SAE J1922 or the SAE J1939 Power train Data Link is not limiting the power.

- a. Connect an Electronic Service Tool.
- b. Monitor the "Power train Data Link" Status screen while the vehicle is experiencing problems.

If the "Power train Data Link" Status screen indicates that the "Power train Data Link" is limiting the power or the rpm, verify that this is not normal operation. If this is not normal operation, refer to the vehicle OEM for repairs.

9. Check the ECM or the Personality Module.
  - a. Connect an Electronic Service Tool.
  - b. Verify that the correct Personality Module has been installed.

Refer to Troubleshooting, "ECM Memory - Test".

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## Excessive Fuel Consumption

**SMCS Code:** 1250-035

### Probable Causes

The probable root causes are listed in order below:

- Vehicle Operation
- Vehicle Specifications
- Fuel Supply

- Air Inlet System or Exhaust System

## Recommended Actions

Perform the following diagnostic procedures in order:

### 1. Inspect the ECM Totals.

- Inspect the ECM Totals for idle time.
- Inspect the Fleet Trip Histograms for excessive idling or poor driving habits.
- Check the following items:
  - Load factor
  - Average vehicle speed
  - Vehicle Speed Limit

Look for excessively high values for these items.

- Consider the following environmental conditions:
  - Wind
  - Snow

### 2. Check the vehicle specifications.

Check the specifications on the following items:

- Gearing or Power train
- Vehicle Aerodynamics
- Heavy Loads

### 3. Check the fuel supply.

- Monitor the exhaust for smoke while the engine is being cranked.

If no smoke is present, there may be a problem with the fuel quality or there may be a problem with the fuel supply.

- Check the fuel quality. Refer to Testing and Adjusting, "Fuel Quality - Test". Also refer to the Truck Performance and Driveability Diagnostic Guide, LEBT3477.
- Check the fuel pressure. Refer to Testing and Adjusting, "Fuel System Pressure - Test".
- Ensure that the fuel system has been primed. Refer to Testing and Adjusting, "Fuel System - Prime".

- Check for fuel supply lines that are restricted.
  - Check the fuel filters.
  - If the temperature is below 0 °C (32 °F), check for solidified fuel (wax).
  - Check for air in the fuel system. Refer to Testing and Adjusting, "Air in Fuel - Test".
- ### 4. Check the Air Inlet System for restrictions or leakage. Check the Exhaust System for restrictions or leakage. Refer to Testing and Adjusting, "Air Inlet and Exhaust System - Inspect".

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## Excessive White Smoke

**SMCS Code:** 1088-035

### Probable Causes

The probable root causes are listed in order below:

- Normal Operation
- Fuel Supply
- Atmospheric Pressure circuit
- Coolant Temperature circuit
- Electronic Unit Injector
- Combustion problem

### Recommended Actions

Perform the following diagnostic procedures in order:

#### 1. Be aware of normal operating conditions.

Cold outside temperatures can affect the production of white smoke.

#### 2. Check the fuel supply.

- Monitor the exhaust for smoke while the engine is being cranked.

If no smoke is present, there may be a problem with the fuel quality or there may be a problem with the fuel supply.

- Check the fuel quality. Refer to Testing and Adjusting, "Fuel Quality - Test". Also refer to the Truck Performance and Driveability Diagnostic Guide, LEBT3477.

- c. Check the fuel pressure. Refer to Testing and Adjusting, "Fuel System Pressure - Test".
  - d. Ensure that the fuel system has been primed. Refer to Testing and Adjusting, "Fuel System - Prime".
  - e. Check for fuel supply lines that are restricted.
  - f. Check the fuel filters.
  - g. If the temperature is below 0 °C (32 °F), check for solidified fuel (wax).
  - h. Check for air in the fuel system. Refer to Testing and Adjusting, "Air in Fuel - Test".
3. Check the Atmospheric Pressure circuit.
    - a. Connect an Electronic Service Tool.
    - b. Check for Diagnostic Codes that are related to the Atmospheric Pressure circuit.
    - c. Monitor the status of the Atmospheric Pressure Sensor on the Electronic Service Tool status screen. Compare the value for the atmospheric pressure on the status screen to the actual atmospheric pressure.
    - d. If the atmospheric pressure on the status screen is at least 7 kPa (1 psi) greater than the actual atmospheric pressure, inspect the crankcase breather for restrictions.
    - e. Remove a valve cover.
    - f. Recheck the atmospheric pressure on the status screen.
    - g. If removing the crankcase breather solves the problem, replace the crankcase breather.
    - h. If the crankcase breather is not restricted or removing the valve cover does not eliminate the problem, proceed to Step 4.
  4. Check the Coolant Temperature circuit.
    - a. Connect an Electronic Service Tool.
    - b. Check for Diagnostic Codes that are related to the Coolant Temperature circuit.
    - c. Monitor the status of the Coolant Temperature Sensor on the Electronic Service Tool status screen. If an Active Open or Short Circuit Diagnostic Code is detected, refer to Troubleshooting, "Engine Temperature Sensor Open or Short Circuit - Test".
  5. Check the Electronic Unit Injector.
    - a. Ensure that the Electronic Unit Injector Connector (J300/P300) is fully connected and ensure that the Electronic Unit Injector Connector (J300/P300) is free of corrosion.
    - b. Ensure that the ECM Engine Harness Connector (J2/P2) is fully connected and ensure that the Engine Harness Connector (J2/P2) is free of corrosion.
    - c. Connect an Electronic Service Tool. Use the Cylinder Cutout Test. Access the Cylinder Cutout Test by selecting the "Diagnostic Menu" and the "Diagnostics Test Menu". Run the Cylinder Cutout Test in order to disable each cylinder. Disabling each cylinder allows the technician to isolate the misfiring cylinders.
 

If the misfiring cylinder can be isolated to a specific cylinder, refer to Troubleshooting, "Injector Solenoid Circuit - Test".
  6. Check for combustion problems.
 

Examples of combustion problems are shown in the following list:

    - Outside temperatures are too cold.
    - Mechanical problem

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## Intermittent Cruise Control, Idle, or PTO Kickout

**SMCS Code:** 1915-035

### Probable Causes

The probable root causes are listed below:

- A clutch pedal position switch that is incorrectly adjusted
- Malfunctioning On/Off switch for cruise control and idle control
- Malfunctioning switch for Service Brake Pedal Position
- Malfunctioning Transmission Neutral Switch
- Vehicle Speed circuit problem
- Battery power or ground to the ECM

- Adaptive cruise control

## Recommended Actions

Perform the following diagnostic procedures in order:

1. Connect Cat ET to the data link connector. Check the Status Screen for the last item that caused the Kickout for the Cruise Control, the Idle Control or the PTO Control.

**Note:** Cat ET will only provide access to the last cause of the Kickout. If the ECM is powered down and the ECM is powered up, the display on Cat ET will be blank. The ECM is powered down when the ignition key switch is turned to the OFF position. It may be necessary to take the vehicle for a test drive in order to repeat the problem. Check Cat ET before the ECM is turned off by the keyswitch.

If Cat ET indicates "Switch Turned Off", go to Step 2.

If Cat ET indicates "Brake", "Clutch" or "Neutral" go to Step 3.

If the Cat ET indicates "Bad Vehicle Speed", "Vehicle Speed < Limit" or "Vehicle Speed >= Limit" go to Step 4.

2. If Cat ET indicates "Switch Turned Off", the ECM has detected an open circuit in the On/Off switch circuit. This pertains to the cruise control, the idle control or the PTO. Perform the following tests in order:

- a. Ensure that the operator has not actually turned off the Cruise Control On/Off Switch or the PTO On/Off Switch.
- b. Check the Status Screen on Cat ET while the switch is being used. If the problem is not apparent check the switch and the wiring.
- c. If the problem is related to the Cruise Control or Idle Control refer to Troubleshooting, "Cruise Control Circuit, Service Brake Pedal Position (Switch 1) Circuit, and Clutch Pedal Position Switch Circuit - Test".
- d. If the problem is related to the PTO refer to Troubleshooting, "PTO Switch Circuit - Test".

3. If Cat ET indicates "Brake", "Clutch" or "Neutral", the ECM has detected an open circuit in the switch circuit for the Service Brake, the switch circuit for the Clutch or the Transmission Neutral switch circuit. Perform the following tests in order:

- a. Ensure that the operator has not actually depressed the service brake pedal or the clutch pedal. Also ensure that the operator has not actually shifted the transmission to neutral.
- b. Check the status screen on Cat ET while the service brake or the clutch is being used. If the problem is not apparent check the switches. Check the service brake switch for the air system. Ensure that the treadle valve is operating freely. A treadle valve that is not operating freely can cause pressure spikes. Check the clutch switch adjustment and the return spring.
- c. If the problem is related to the Cruise Control or Idle Control refer to Troubleshooting, "Cruise Control Circuit, Service Brake Pedal Position (Switch 1) Circuit, and Clutch Pedal Position Switch Circuit - Test".
- d. If the problem is related to the PTO refer to Troubleshooting, "PTO Switch Circuit - Test".

4. If Cat ET indicates "Bad Vehicle Speed", the vehicle speed signal is erratic or intermittent. This relates to Cruise Control only.

If Cat ET indicates "Vehicle Speed < Limit", the vehicle speed signal was lost at least briefly. This pertains to Cruise Control only.

If Cat ET indicates "Vehicle Speed >= Limit", the vehicle speed signal exceeded the programmed Idle/PTO Vehicle Speed Limit or the vehicle speed limit is erratic or intermittent. This pertains to Idle Control and PTO Control only.

Perform the following diagnostic procedure in order:

- a. Inspect the Vehicle speed sensor for debris on the sensor. Inspect the vehicle speed circuit.
- b. Check the vehicle speed that is displayed on the status screen on Cat ET while the vehicle is parked. Adjust the engine rpm up and down. Also check the vehicle speed while the vehicle is being driven in order to determine that the vehicle speed that is indicated by Cat ET does not vary significantly from the vehicle speed that is indicated by the speedometer. If the problem is not apparent, refer to Troubleshooting, "Vehicle Speed Circuit - Test".
- c. Inspect both ECM connectors for moisture. Refer to Troubleshooting, "Inspecting Electrical Connectors".

5. A problem with the battery power, the ground to the ECM or the vehicle wiring can cause erratic engine rpm or other more severe problems. If this is a suspected cause, refer to Troubleshooting, "Ignition Key Switch Circuit and Battery Supply Circuit Test".
6. Check for proper operation of the Adaptive Cruise Control.
  - a. Toggle the cruise control switch to the OFF position and to the ON position twice within 10 seconds. This will disable the Adaptive Cruise Control.
  - b. Attempt to set the cruise control. Operate the vehicle under the same conditions that caused the problem.
  - c. If the problem still exists, then the problem is not the Adaptive Cruise Control.
  - d. If the problem is fixed, refer to Eaton for the proper troubleshooting procedure.

i01908313

## Intermittent Engine Shutdown

**SMCS Code:** 1000-035

### Probable Causes

The probable root causes are listed in order below:

- Diagnostic codes
- Battery power or ground to the ECM
- Aftermarket engine protection devices
- Fuel supply
- Engine speed/timing sensors
- ECM or personality module

**Note:** Induce the engine to shut down before attempting to troubleshoot the problem.

### Recommended Actions

Perform the following diagnostic procedures in order:

1. Check for diagnostic codes.
  - a. Connect the Caterpillar Electronic Technician (Cat ET).

- b. Check for active diagnostic codes on Cat ET.

**Note:** Certain diagnostic codes will cause the engine to shutdown. Troubleshoot all diagnostic codes before continuing with this procedure.

2. Check the Battery power or ground to the ECM.

- a. Ensure that the following connectors have been installed correctly:

- J1/P1 and J2/P2 ECM connectors
- J300/P300 Injector connector
- J401/P401 Primary engine speed/timing sensor connector
- J402/P402 Secondary engine speed/timing sensor connector

- b. If the problem occurs only after engine warm-up and the problem disappears after the engine cooldown, the circuit breakers may be tripping because of the heat. Check the circuit breakers on the vehicle in order to determine if the circuit breakers reset automatically.

3. Check aftermarket engine protection devices. These devices usually interrupt power to the ECM and the ECM will not communicate with Cat ET.

- a. Check for the correct installation of the aftermarket engine protection device.

- b. Check for the correct operation of the aftermarket engine protection device.

- c. Verify that the ECM is receiving battery voltage.

4. Check the fuel supply.

- a. Monitor the exhaust for smoke while the engine is being cranked.

If no smoke is present, there may be a problem with the fuel quality or there may be a problem with the fuel supply.

- b. Check the fuel quality. Refer to Testing and Adjusting, "Fuel Quality - Test". Also refer to Truck Performance and Driveability Diagnostic Guide, LEBT3477.

- c. Check the fuel pressure. Refer to Testing and Adjusting, "Fuel System Pressure - Test".

- d. Ensure that the fuel system has been primed. Refer to Testing and Adjusting, "Fuel System - Prime".
- e. Check for fuel supply lines that are restricted.
- f. Check the fuel filters.
- g. If the temperature is below 0 °C (32 °F), check for solidified fuel (wax).

#### 5. Check the Engine Speed/Timing Sensors.

Refer to Troubleshooting, "Engine Speed/Timing Sensor Circuit - Test".

#### 6. Check the ECM or the personality module.

Refer to Troubleshooting, "ECM Memory - Test".

i01190888

## Intermittent Low Power or Power Cutout

**SMCS Code:** 1000-035

### Probable Causes

The probable root causes are listed in order below:

- Poor electrical connections
- "Engine Monitoring"
- Battery power or ground to the ECM
- Air Inlet System (Boost)
- Accelerator Pedal Position Sensor
- Fuel Supply
- Vehicle Speed Circuit
- Powertrain Control
- Torque Limit Switch

### Recommended Actions

Perform the following diagnostic procedures in order:

1. Check the vehicle harness and the connectors. Refer to Troubleshooting, "Inspecting Electrical Connectors".
2. Check the parameters for "Engine Monitoring".
  - a. Connect an Electronic Service Tool.

- b. Check for Diagnostic Codes that are capable of Derating the engine when "Engine Monitoring" is programmed to "Derate" or "Shutdown".
  - 110-00 High Coolant Temperature Warning (61)
  - 110-11 Very High Coolant Temperature (61)
  - 111-11 Very Low Coolant Level (62)
  - 100-11 Very Low Oil Pressure (46)

#### 3. Check the Battery power or ground to the ECM.

- a. Ensure that the following connectors have been installed correctly:

- ECM connectors (J1/P1 and J2/P2) with seventy pins
- Injector connector (J300/P300)
- Crankshaft Position Sensor connector (J401/P401)
- Camshaft Position Sensor connector (J402/P402)

- b. Use an Electronic Service Tool to check for a 168-02 Intermittent Battery (51) Diagnostic Code. Check the power connections for the ECM and the ground connections for the ECM. If a problem is suspected, wire a bypass. Refer to Troubleshooting, "Ignition Key Switch Circuit and Battery Supply Circuit - Test".

#### 4. Check for an Electronic System problem.

- a. Connect an Electronic Service Tool.
- b. Monitor the Fuel Position, the Rated Fuel Limit and the FRC Fuel Limit.

While the vehicle is operating under full load, the parameters should meet the following conditions:

- The Fuel Position is equal to the Rated Fuel Limit.
- The Fuel Position is less than the FRC Fuel Limit.

If the Fuel Position is equal to the Rated Fuel Limit and the Fuel Position is less than the FRC Fuel Limit, the Electronics are operating correctly. Go to Step 6.

**5.** If the Fuel Position is not equal to the Rated Fuel Limit and/or the Fuel Position is not less than the FRC Fuel Limit, perform the following tests in order:

- a.** Connect an Electronic Service Tool.
- b.** When the engine is OFF, turn the Ignition Key Switch to the ON position. Check the boost pressure on an Electronic Service Tool Status Screen.

When the engine is OFF, the boost pressure should be 0 kPa (0 psi).

- c.** Monitor the status of the Accelerator Pedal Position Sensor. Operate the engine at high idle with the vehicle in Neutral.

If the engine can not reach the programmed "Top Engine Limit", check the Accelerator Pedal Position Duty Cycle in order to ensure that the Accelerator Pedal Position Duty Cycle is within calibration (75 to 90 Percent at high idle).

If the accelerator pedal position is unstable, check the Accelerator Pedal Position Duty Cycle. Check the Accelerator Pedal Position Duty Cycle by slowly operating the accelerator pedal in order to verify that the Accelerator Pedal Position Sensor is within calibration. The Accelerator Pedal Position Sensor is within calibration when both of the following conditions are met:

- 10 to 22 percent at low idle
- 75 to 90 percent at high idle

Also, ensure that the duty cycle changes as the pedal position changes.

If a problem with the Accelerator Pedal Position Sensor is suspected, refer to Troubleshooting, "Accelerator Pedal (Throttle) Position Sensor Circuit - Test".

**Note:** If the engine exceeds the Top Engine Limit, the "Top Engine Limit with Droop" is programmed to YES.

**6.** Monitor the vehicle speed signal. Ensure the accuracy of the vehicle speed signal by comparing the vehicle speed signal to the actual vehicle speed.

If the vehicle speed is greater than the "VSL", the Power is limited. If a problem is discovered, refer to Troubleshooting, "Vehicle Speed Circuit - Test".

**7.** Check the "Power train Data Link". Ensure that the SAE J1922 or the SAE J1939 Power train Data Link is not limiting the power.

- a.** Connect an Electronic Service Tool.
- b.** Monitor the "Power train Data Link" Status screen while the vehicle is experiencing problems.

If the "Power train Data Link" Status screen indicates that the "Power train Data Link" is limiting the power or the rpm, verify that this is not normal operation. If this is not normal operation, refer to the vehicle OEM for repairs.

**8.** Check the fuel supply.

- a.** Monitor the exhaust for smoke while the engine is being cranked.

If no smoke is present, there may be a problem with the fuel quality or there may be a problem with the fuel supply.

- b.** Check the fuel quality. Refer to Testing and Adjusting, "Fuel Quality - Test". Also refer to the Truck Performance and Driveability Diagnostic Guide, LEBT3477.
- c.** Check the fuel pressure. Refer to Testing and Adjusting, "Fuel System Pressure - Test".
- d.** Ensure that the fuel system has been primed. Refer to Testing and Adjusting, "Fuel System - Prime".
- e.** Check for fuel supply lines that are restricted.
- f.** Check the fuel filters.
- g.** If the temperature is below 0 °C (32 °F), check for solidified fuel (wax).
- h.** Check for air in the fuel system. Refer to Testing and Adjusting, "Air in Fuel - Test".

**9.** Check the Torque Limit Switch.

- a.** Connect an Electronic Service Tool.
- b.** Check the setting for the Customer Parameter for the "Torque Limit".

If the "Torque Limit" is programmed below 3400 N·m (2500 lb ft), check the status screen for the Torque Limit Switch. Ensure that the status screen indicates that the Torque Limit Switch is OFF. If the status of the Torque Limit Switch is ON and a Torque Limit is programmed, the system is operating correctly. If the switch that is connected to this signal input is not switching ON and switching OFF, refer to Troubleshooting, "PTO Switch Circuit - Test".

i01816258

## Low Power/Poor or No Response to Throttle

**SMCS Code:** 1000-035

### Probable Causes

The probable root causes are listed in order below:

- Customer specified parameters (normal operation)
- Cold mode operation
- PTO on/off switch
- Electronic system problem
- Fuel supply
- Leakage in air-to-air aftercooler core
- Air inlet system or exhaust system
- Individual malfunctioning cylinder
- Torque limit switch

### Recommended Actions

Perform the following tests in order:

1. Check customer specified parameters.
  - a. Verify that the complaint is not normal operation (programmed parameter).
  - b. Connect the electronic service tool.
  - c. Check the following parameters:
    - "Rating Number"
    - "Top Engine Limit"
    - "Vehicle Speed Limit"

- "Lower Gears Engine RPM Limit"
- "Intermediate Gears Engine RPM Limit"
- "Gear Down Protection Engine RPM Limit"

**Note:** If the "Rating Number" is programmed to 0, the engine is limited to 119 kW (160 hp).

- d. Set each parameter to the parameter's maximum value one at a time and determine whether the problem is corrected.

2. Check cold mode operation.

**Note:** This is normal operation if the problem occurs only after start-up in cold weather.

- a. Connect the electronic service tool.
- b. Monitor the electronic service tool in order to verify that the engine has progressed from cold mode.

An active cold mode is indicated in the upper corner of any status screen.

3. Check the PTO on/off switch.
  - a. Verify that the PTO on/off switch is in the OFF position.
  - b. Connect the electronic service tool.
  - c. Verify that the status for the "PTO On/Off Switch" on the electronic service tool corresponds to the position of the switch.
  - d. Cycle the PTO on/off switch while you observe the status screen.
4. Check for an electronic system problem.
  - a. Connect the electronic service tool.
  - b. Monitor the "Fuel Position", the "Rated Fuel Limit" and the "FRC Fuel Limit" on the status screen.

While the vehicle is operating under full load, the parameters should meet the following conditions:

- The "Fuel Position" is equal to the "Rated Fuel Limit".
- The "Fuel Position" is less than the "FRC Fuel Limit".

If the "Fuel Position" is equal to the "Rated Fuel Limit" and the "Fuel Position" is less than the "FRC Fuel Limit", the Electronics are operating correctly. Go to Step 6.

5. If the "Fuel Position" is not equal to the "Rated Fuel Limit" and/or the "Fuel Position" is not less than the "FRC Fuel Limit", perform the following tests in order:

- a. Connect the electronic service tool.
- b. When the engine is OFF, turn the ignition key switch to the ON position. Check the status for "Boost Pressure" on the electronic service tool.

When the engine is OFF, the boost pressure should be 0 kPa (0 psi).

- c. Monitor the status of the accelerator pedal position sensor. Operate the engine at high idle with the vehicle in Neutral.

If the engine can not reach the programmed "Top Engine Limit", check the duty cycle of the accelerator pedal position in order to ensure that the duty cycle is within calibration (75 to 90 Percent at high idle).

If the accelerator pedal position is unstable, check the duty cycle of the accelerator pedal position. Check the duty cycle of the accelerator pedal position by slowly operating the accelerator pedal in order to verify that the accelerator pedal position sensor is within calibration. The accelerator pedal position sensor is within calibration when both of the following conditions are met:

- 10 to 22 percent at low idle
- 75 to 90 percent at high idle

Also, ensure that the duty cycle changes as the pedal position changes.

If a problem with the accelerator pedal position sensor is suspected, refer to Troubleshooting, "Accelerator Pedal (Throttle) Position Sensor Circuit - Test".

**Note:** If the engine exceeds the "Top Engine Limit", the "Top Engine Limit with Droop" is programmed to YES.

6. Monitor the vehicle speed signal. Ensure the accuracy of the vehicle speed signal by comparing the vehicle speed signal to the actual vehicle speed.

If the vehicle speed is greater than the "VSL", the power is limited. If a problem is discovered, refer to Troubleshooting, "Vehicle Speed Circuit - Test".

7. Check the "Powertrain Data Link". Ensure that the SAE J1922 or the SAE J1939 Powertrain Data Link is not limiting the power.

- a. Connect the electronic service tool.
- b. Monitor the "Powertrain Data Link" status screen while the vehicle is experiencing problems.

If the "Powertrain Data Link" status screen indicates that the "Powertrain Data Link" is limiting the power or the rpm, verify that this is not normal operation. If this is not normal operation, refer to the vehicle OEM for repairs.

8. Check the fuel supply.

- a. Monitor the exhaust for smoke while the engine is being cranked.

If no smoke is present, there may be a problem with the fuel quality or there may be a problem with the fuel supply.

- b. Check the fuel quality. Refer to Testing and Adjusting, "Fuel Quality - Test". Also refer to the Truck Performance and Driveability Diagnostic Guide, LEBT3477.
- c. Check the fuel pressure. Refer to Testing and Adjusting, "Fuel System Pressure - Test".
- d. Ensure that the fuel system has been primed. Refer to Testing and Adjusting, "Fuel System - Prime".
- e. Check for fuel supply lines that are restricted.
- f. Check the fuel filters.
- g. If the temperature is below 0 °C (32 °F), check for solidified fuel (wax).
- h. Check for air in the fuel system. Refer to Testing and Adjusting, "Air in Fuel - Test".

9. Check for leakage in the Air-to-Air Aftercooler Core. Refer to Testing and Adjusting, "Aftercooler - Test".

10. Check the air inlet system for restrictions or leakage. Check the exhaust system for restrictions or leakage. Refer to Testing and Adjusting, "Air Inlet and Exhaust System - Inspect".

11. Check for an individual malfunctioning cylinder.

- a. Ensure that the J300/P300 Injector Solenoid Harness connector is fully connected and free of corrosion.
- b. Ensure that the J2/P2 ECM connector is fully connected and free of corrosion.
- c. Connect the electronic service tool. Use the "Cylinder Cutout Test". Access the "Cylinder Cutout Test" by selecting the "Diagnostic Menu" and the "Diagnostics Test Menu". Run the "Cylinder Cutout Test" in order to disable each cylinder. Disabling each cylinder allows the technician to isolate the misfiring cylinders.

If the misfiring cylinder can be isolated to a specific cylinder, refer to Troubleshooting, "Injector Solenoid Circuit - Test".

- d. Perform a PAR Test (Performance Analysis Report).

## 12. Check the torque limit switch.

- a. Connect the electronic service tool.
- b. Check the setting for the customer parameter for the "Torque Limit".

If the "Torque Limit" is programmed below 3400 N·m (2500 lb ft), check the status screen for the torque limit switch. Ensure that the status screen indicates that the torque limit switch is OFF. If the status of the torque limit switch is ON and a "Torque Limit" is programmed, the system is operating correctly. If the torque limit switch that is connected to this signal input is not switching ON and switching OFF, refer to Troubleshooting, "PTO Switch Circuit - Test".

i01191691

## Poor Acceleration or Response

**SMCS Code:** 1000-035

### Probable Causes

The probable root causes are listed in order below:

- Customer Specified Parameters (normal operation)
- Cold Mode Operation
- Individual malfunctioning cylinder
- "Power train Data Link"
- Personality Module

- Torque Limit Switch

## Recommended Actions

Perform the following diagnostic procedures in order:

1. Check Customer Specified Parameters.
  - a. Verify that the complaint is not normal operation (programmed parameter).
  - b. Connect an Electronic Service Tool.
  - c. Check the following parameters:
    - "Lower Gears Engine RPM Limit"
    - "Intermediate Gears Engine RPM Limit"
    - "Gear Down Protection Engine RPM Limit"
  - d. Set each parameter to the parameter's maximum value one at a time and determine whether the problem is corrected.

## 2. Check Cold Mode Operation.

**Note:** This is normal operation if the problem occurs only after start-up in cold weather.

- a. Connect an Electronic Service Tool.
- b. Monitor the Electronic Service Tool in order to verify that the engine has progressed from Cold Mode.

An Active Cold Mode is indicated in the upper corner of any Status Screen.

## 3. Check for an individual malfunctioning cylinder.

- a. Ensure that the Electronic Unit Injector Connector (J300/P300) is fully connected and ensure that the Electronic Unit Injector Connector (J300/P300) is free of corrosion.
- b. Ensure that the ECM Engine Harness Connector (J2/P2) is fully connected and ensure that the Engine Harness Connector (J2/P2) is free of corrosion.
- c. Connect an Electronic Service Tool. Use the Cylinder Cutout Test. Access the Cylinder Cutout Test by selecting the "Diagnostic Menu" and the "Diagnostics Test Menu". Run the Cylinder Cutout Test in order to disable each cylinder. Disabling each cylinder allows the technician to isolate the misfiring cylinders.

If the misfiring cylinder can be isolated to a specific cylinder, refer to Troubleshooting, "Injector Solenoid Circuit - Test".

4. Check the "Power train Data Link". Ensure that the SAE J1922 or the SAE J1939 Power train Data Link is not limiting the power.

- a. Connect an Electronic Service Tool.
- b. Monitor the "Power train Data Link" Status screen while the vehicle is experiencing problems.

If the "Power train Data Link" Status screen indicates that the "Power train Data Link" is limiting the power or the rpm, verify that this is not normal operation. If this is not normal operation, refer to the vehicle OEM for repairs.

5. Check the ECM or the Personality Module.

- a. Connect an Electronic Service Tool.
- b. Verify that the correct Personality Module has been installed.

Refer to Troubleshooting, "ECM Memory - Test".

6. Check the Torque Limit Switch.

- a. Connect an Electronic Service Tool.
- b. Check the setting for the Customer Parameter for the "Torque Limit".

If the "Torque Limit" is programmed below 3400 N·m (2500 lb ft), check the status screen for the Torque Limit Switch. Ensure that the status screen indicates that the Torque Limit Switch is OFF. If the status of the Torque Limit Switch is ON and a "Torque Limit" is programmed, the system is operating correctly. If the switch that is connected to this signal input is not switching ON and switching OFF, refer to Troubleshooting, "PTO Switch Circuit - Test".

# CATERPILLAR

## 3406E, C-10, C-12, C-15, C-16 AND C-18 TRUCK ENGINE

### TROUBLESHOOTING WITH A DIAGNOSTIC CODE

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# Troubleshooting with a Diagnostic Code

i01907469

## Diagnostic Codes

SMCS Code: 1900

Table 141

Flash Code	Code	Description of Code
00	52-11	Air Inlet Shutoff Shutdown
	84-14	Quick Stop Occurrence
	171-03	Ambient Air Temperature voltage high
	171-04	Ambient Air Temperature voltage low
	171-11	Ambient Air Temperature Data Lost
	224-11	Theft Deterrent Active
	224-14	Theft Deterrent Active with Engine Cranking
	246-11	Brake Pedal Switch #1 Fault
	247-11	Brake Pedal Switch #2 Fault
01	71-00	Idle Shutdown Override
12	111-02	Coolant Level signal invalid
	111-03	Coolant Level voltage high
	111-04	Coolant Level voltage low
13	174-03	Fuel Temperature voltage high
	174-04	Fuel Temperature voltage low
14	121-05	Low/High Retarder current low
	121-06	Low/High Retarder current high
	122-05	Med/High Retarder current low
	122-06	Med/High Retarder current high
21	41-03	8 Volt Supply voltage high
	41-04	8 Volt Supply voltage low
	232-03	5 Volt Supply voltage high
	232-04	5 Volt Supply voltage low
24	100-03	Oil Pressure voltage high
	100-04	Oil Pressure voltage low
25	102-00	Excessive Boost Pressure
	102-03	Boost Pressure voltage high
	102-04	Boost Pressure voltage low
26	108-03	Barometric Pressure voltage high
	108-04	Barometric Pressure voltage low

(continued)

(Table 141, contd)

Flash Code	Code	Description of Code
27	110-03	Coolant Temperature voltage high
	110-04	Coolant Temperature voltage low
28	91-13	Throttle Sensor Calibration
29	30-08	PTO Throttle signal invalid
	30-13	PTO Throttle out of calibration
31	84-01	Vehicle Speed loss of signal
32	91-08	Throttle Position Invalid
34	64-12	Secondary Engine Speed loss of signal
	190-12	Primary Engine Speed loss of signal
35	190-00	Engine Overspeed Warning
36	84-02	Vehicle Speed signal invalid
	84-08	Vehicle Speed signal out of range
	84-10	Vehicle Speed signal rate of change
38	105-03	Intake Manifold Air Temperature voltage high
	105-04	Intake Manifold Air Temperature voltage low
41	84-00	Vehicle Overspeed Warning
42	22-11	Primary to Secondary Engine Speed Signal Calibration
	22-13	Engine Speed Signal Calibration Not Performed
46	100-01	Low Oil Pressure Warning
	100-11	Very Low Oil Pressure
47	71-01	Idle Shutdown
	71-14	PTO Shutdown
51	168-02	ECM Battery Power Intermittent
55	N/A	No Diagnostic Code Detected
56	253-02	Check Customer or System Parameters
	253-11	Check Transmission Customer Parameters
58	231-11	J1939 Data Link Fault
	249-11	J1922 Data Link Fault
59	252-11	Engine Software Incorrect
61	110-00	High Coolant Temperature Warning
	110-11	Very High Coolant Temperature
62	111-01	Low Coolant Level Warning
	111-11	Very Low Coolant Level

(continued)

(Table 141, contd)

Flash Code	Code	Description of Code
64	105-00	High Intake Manifold Air Temperature Warning
	105-11	Very High Intake Manifold Air Temperature
65	174-00	High Fuel Temperature Warning
66	54-05	Auxiliary Output #06 current low
	54-06	Auxiliary Output #06 current high
67	55-05	Auxiliary Output #07 current low
	55-06	Auxiliary Output #07 current high
68	191-07	Transmission Not Responding
71	43-02	Key Switch Fault
72	1-11	Cylinder #1 Injector current fault
	2-11	Cylinder #2 Injector current fault
73	3-11	Cylinder #3 Injector current fault
	4-11	Cylinder #4 Injector current fault
74	5-11	Cylinder #5 Injector current fault
	6-11	Cylinder #6 Injector current fault

i01501859

## No Diagnostic Code Detected (55)

**SMCS Code:** 1900

### Conditions Which Generate This Code:

A Flash Code 55 indicates that the system has not detected any system faults since the last powerup.

### System Response:

This code will not appear on a service tool. The check engine lamp is used to display the flash code. For more information on flash codes, refer to Troubleshooting, "Check Engine Lamp Circuit - Test".

### Troubleshooting:

There are no problems that require troubleshooting.

### Results:

- OK – STOP.

## 0001-11 Cylinder #1 Injector current fault (72)

**SMCS Code:** 1290-038

### Conditions Which Generate This Code:

The ECM detects one of the following items after attempting to operate the injector:

- A low current condition (open circuit) exists in the wiring for the No. 1 cylinder injector solenoid.
- A high current condition (short circuit) in the injector solenoid for the No. 1 cylinder exists.

### System Response:

The ECM will log the diagnostic code and the ECM will trigger a snapshot. The check engine lamp will illuminate while this diagnostic code is active. The automatic "Cylinder Cutout Test" will not work when there is an active diagnostic code.

### Possible Performance Effect:

The injector may not operate while the diagnostic codes are active. The following conditions may exist:

- Engine misfires
- Low power

### Troubleshooting:

Perform the following diagnostic procedure: "Injector Solenoid Circuit - Test"

### Results:

- OK – STOP.

i01901879

## 0002-11 Cylinder #2 Injector current fault (72)

**SMCS Code:** 1290-038

### Conditions Which Generate This Code:

The ECM detects one of the following items after attempting to operate the injector:

- A low current condition (open circuit) exists in the wiring for the No. 2 cylinder injector solenoid.

- A high current condition (short circuit) in the injector solenoid for the No. 2 cylinder exists.

**System Response:**

The ECM will log the diagnostic code and the ECM will trigger a snapshot. The check engine lamp will illuminate while this diagnostic code is active. The automatic "Cylinder Cutout Test" will not work when there is an active diagnostic code.

**Possible Performance Effect:**

The injector may not operate while the diagnostic codes are active. The following conditions may exist:

- Engine misfires
- Low power

**Troubleshooting:**

Perform the following diagnostic procedure: "Injector Solenoid Circuit - Test"

**Results:**

- OK – STOP.

i01901960

## 0003-11 Cylinder #3 Injector current fault (73)

**SMCS Code:** 1290-038

**Conditions Which Generate This Code:**

The ECM detects one of the following items after attempting to operate the injector:

- A low current condition (open circuit) exists in the wiring for the No. 3 cylinder injector solenoid.
- A high current condition (short circuit) in the injector solenoid for the No. 3 cylinder exists.

**System Response:**

The ECM will log the diagnostic code and the ECM will trigger a snapshot. The check engine lamp will illuminate while this diagnostic code is active. The automatic "Cylinder Cutout Test" will not work when there is an active diagnostic code.

**Possible Performance Effect:**

The injector may not operate while the diagnostic codes are active. The following conditions may exist:

- Engine misfires
- Low power

**Troubleshooting:**

Perform the following diagnostic procedure: "Injector Solenoid Circuit - Test"

**Results:**

- OK – STOP.

i01901988

## 0004-11 Cylinder #4 Injector current fault (73)

**SMCS Code:** 1290-038

**Conditions Which Generate This Code:**

The ECM detects one of the following items after attempting to operate the injector:

- A low current condition (open circuit) exists in the wiring for the No. 4 cylinder injector solenoid.
- A high current (short circuit) in the injector solenoid for the No. 4 cylinder exists.

**System Response:**

The ECM will log the diagnostic code and the ECM will trigger a snapshot. The check engine lamp will illuminate while this diagnostic code is active. The automatic "Cylinder Cutout Test" will not work when there is an active diagnostic code.

**Possible Performance Effect:**

The injector may not operate while the diagnostic codes are active. The following conditions may exist:

- Engine misfires
- Low power

**Troubleshooting:**

Perform the following diagnostic procedure: "Injector Solenoid Circuit - Test"

**Results:**

- OK – STOP.

i01901999

## 0005-11 Cylinder #5 Injector current fault (74)

**SMCS Code:** 1290-038

### Conditions Which Generate This Code:

The ECM detects one of the following items after attempting to operate the injector:

- A low current condition (open circuit) exists in the wiring for the No. 5 cylinder injector solenoid.
- A high current condition (short circuit) exists in the injector solenoid for the No. 5 cylinder.

### System Response:

The ECM will log the diagnostic code and the ECM will trigger a snapshot. The check engine lamp will illuminate while this diagnostic code is active. The automatic "Cylinder Cutout Test" will not work when there is an active diagnostic code.

### Possible Performance Effect:

The injector may not operate while the diagnostic codes are active. The following conditions may exist:

- Engine misfires
- Low power

### Troubleshooting:

Perform the following diagnostic procedure: "Injector Solenoid Circuit - Test"

### Results:

- OK – STOP.

i01902006

## 0006-11 Cylinder #6 Injector current fault (74)

**SMCS Code:** 1290-038

### Conditions Which Generate This Code:

The ECM detects one of the following items after attempting to operate the injector:

- A low current condition (open circuit) exists in the wiring for the No. 6 cylinder injector solenoid.

- A high current condition (short circuit) exists in the injector solenoid for the No. 6 cylinder.

### System Response:

The ECM will log the diagnostic code and the ECM will trigger a snapshot. The check engine lamp will illuminate while this diagnostic code is active. The automatic "Cylinder Cutout Test" will not work when there is an active diagnostic code.

### Possible Performance Effect:

The injector may not operate while the diagnostic codes are active. The following conditions may exist:

- Engine misfires
- Low power

### Troubleshooting:

Perform the following diagnostic procedure: "Injector Solenoid Circuit - Test"

### Results:

- OK – STOP.

i01816316

## 0022-11 Primary to Secondary Engine Speed Signal Calibration (42)

**SMCS Code:** 1912-038

### Conditions Which Generate This Code:

The ECM detects the following conditions:

- A timing calibration has been successfully completed.
- The primary speed/timing sensor and the secondary speed/timing sensor are off by more than 3 degrees.

### System Response:

The ECM will use the default timing.

### Possible Performance Effect:

The engine may run rough when this code is active.

**Troubleshooting:****Test Step 1. Engine Overspeed**

- A.** Check the ECM for indications of an engine overspeed.
- B.** If there are indications of an engine overspeed, check the cluster gear for proper alignment. Also check the cluster gear for damage. Refer to Testing and Adjusting, "Gear Group (Front) - Time".

**Expected Result:**

The cluster gear is properly aligned and there is no damage to the cluster gear.

**Results:**

- OK – Proceed to Test Step 2.
- Not OK – The cluster gear is not aligned correctly or there is damage to the cluster gear.

**Repair:** Align the cluster gear or repair the cluster gear.

Run the engine until the engine reaches operating temperature.

Verify that the repair eliminates the problem.

STOP.

**Test Step 2. Accident**

- A.** Determine whether the vehicle has been involved in an accident.

If the vehicle was involved in an accident, then the cluster gear may have been damaged.

- B.** Check the cluster gear for damage.

**Expected Result:**

The cluster gear is not damaged.

**Results:**

- OK – Proceed to Test Step 3.
- Not OK – There is damage to the cluster gear.

**Repair:** Repair the cluster gear.

Run the engine until the engine reaches operating temperature.

Verify that the repair eliminates the problem.

STOP.

**Test Step 3. Cylinder Head**

- A.** Determine whether the cylinder head was removed.
- B.** If the cylinder head was removed, the backlash for the camshaft may be out of the specification.
- C.** Check the backlash for the camshaft. Refer to Testing and Adjusting, "Gear Group (Front) - Time".

**Expected Result:**

The backlash for the camshaft should be within specifications.

**Results:**

- OK – Proceed to Test Step 4.
- Not OK – The backlash for the camshaft is not within specifications.

**Repair:** Adjust the backlash for the camshaft.

Refer to Testing and Adjusting, "Gear Group (Front) - Time".

Run the engine until the engine reaches operating temperature.

Verify that the repair eliminates the problem.

STOP.

**Test Step 4. Engine Speed/Timing Sensors**

- A.** Check the engine speed/timing sensors for proper installation. The engine speed/timing sensors can not be interchanged.
- B.** Verify that the sensor wires are connected properly. Refer to the electrical schematic for proper wiring. Make sure that the positive terminal on the ECM is connected to the positive terminal on the engine speed/timing sensors. Also, make sure that the negative terminal on the ECM is connected to the negative terminal on the engine speed/timing sensors.

**Expected Result:**

The engine speed/timing sensors are properly installed. Also, the engine speed/timing sensors are wired correctly.

**Results:**

- OK

**Repair:** Refer to Troubleshooting, "Engine Speed/Timing Sensor Circuit - Test".

STOP.

- Not OK – There is a problem with the installation or the wiring of the engine speed/timing sensors.

**Repair:** Install the sensors properly or repair the wiring.

Run the engine until the engine reaches operating temperature.

Verify that the repair eliminates the problem.

STOP.

i01816317

## 0022-13 Engine Speed Signal Calibration Not Performed (42)

**SMCS Code:** 1912-038

### Conditions Which Generate This Code:

The ECM detects the following conditions:

- A timing calibration has never been performed on a new ECM or the timing is off by more than 3 degrees.

### System Response:

The ECM uses default timing.

### Possible Performance Effect:

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

### Troubleshooting:

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

### Results:

- OK – STOP.

i01852956

## 0030-08 PTO Throttle signal invalid (29)

**SMCS Code:** 1913-038

### Conditions Which Generate This Code:

The ECM detects the following conditions:

- The "PTO Configuration" is programmed to "Remote Throttle".
- The ECM is not receiving a valid signal from the PTO throttle.
- The ECM has been powered for at least three seconds.

**Note:** If the "PTO Configuration" is programmed to "Remote Throttle", the ECM must receive a proper signal from the remote throttle at all times. The remote throttle signal must be present even when the PTO ON/OFF switch is in the OFF position.

### System Response:

The ECM returns the engine to low idle when the problem is detected. "DIAG" will be displayed next to the status for "Throttle Position" on the electronic service tool.

### Possible Performance Effect:

The engine will remain at low idle while the diagnostic code is active.

### Troubleshooting:

Perform the following diagnostic procedure: "Remote PTO Accelerator Position Sensor Circuit - Test"

### Results:

- OK – STOP.

i01852958

## 0030-13 PTO Throttle out of calibration (29)

**SMCS Code:** 1913-038

### Conditions Which Generate This Code:

The ECM detects the following conditions:

- The duty cycle of the signal for the PTO throttle is less than 5 percent or more than 95 percent for more than two seconds.
- The PTO Configuration is programmed to "Remote Throttle".
- The ECM has been powered for at least three seconds.

**System Response:**

The ECM returns the engine to low idle when the problem is detected. "DIAG" will be displayed next to the status for "Throttle Position" on the electronic service tool.

**Possible Performance Effect:**

The engine will remain at low idle while the diagnostic code is active.

**Troubleshooting:**

**Note:** The Remote Accelerator Pedal Position Sensor can not be calibrated.

Perform the following diagnostic procedure: "Remote PTO Accelerator Position Sensor Circuit - Test"

**Results:**

- OK – STOP.

i01901711

**0041-03 8 Volt Supply voltage high (21)**

**SMCS Code:** 5574-038

**Conditions Which Generate This Code:**

The ECM detects the following conditions:

- The 8 volt supply is more than 8.5 VDC for more than one second.
- The ECM has been powered for more than three seconds.

**System Response:**

An active diagnostic code may not cause any noticeable effect on engine response unless the voltage is above 12 or 13 VDC.

**Possible Performance Effect:**

The engine may be limited to low idle.

**Note:** The 8 volt supply provides power to the accelerator pedal position sensor.

**Troubleshooting:**

Perform the following diagnostic procedure: "Accelerator Pedal (Throttle) Position Sensor Circuit - Test"

**Results:**

- OK – STOP.

i01901712

**0041-04 8 Volt Supply voltage low (21)**

**SMCS Code:** 5574-038

**Conditions Which Generate This Code:**

The ECM detects the following conditions:

- The 8 volt supply is less than 7.5 VDC for more than one second.
- The ECM has been powered for more than three seconds.

**System Response:**

An active diagnostic code may not cause any noticeable effect on engine response unless the voltage drops below 6.5 VDC.

**Possible Performance Effect:**

The engine may be limited to Low Idle.

**Note:** The 8 volt supply provides power to the accelerator pedal position sensor.

**Troubleshooting:**

Perform the following diagnostic procedure: "Accelerator Pedal (Throttle) Position Sensor Circuit - Test"

**Results:**

- OK – STOP.

i01901710

**0043-02 Key Switch Fault (71)**

**SMCS Code:** 1408-038; 1553-038

**Conditions Which Generate This Code:**

The ECM detects the following condition:

- The key switch was rapidly cycled at least three times within the last second.

This indicates that the battery circuit to the key switch has an intermittent condition or a low battery condition while the engine is running.

**Note:** This code can be generated by rapidly cycling the key switch. Some control modules on the vehicle require this action in order to prompt flash codes. If this occurs, clear the logged diagnostic codes in order to prevent future confusion or an incorrect diagnosis.

**Note:** This code can also be generated when an attempt is made in order to restart the engine immediately after a shutdown. The engine may not start if the engine speed did not reach 0 rpm prior to the restart.

#### **System Response:**

This response depends on the amount of time that occurs in the fault mode.

The electronic service tool will display the state of the key switch on the status screen. The Check Engine Lamp and the Warning Lamps may come on as if the key switch was turned on and the engine started.

#### **Possible Performance Effect:**

The engine may experience burps in engine rpm, and engine shutdowns that are intermittent or incomplete. The ECM may stop the fuel injection process.

#### **Troubleshooting:**

Perform the following diagnostic procedure: "Ignition Key Switch Circuit and Battery Supply Circuit - Test"

#### **Results:**

- OK – STOP.

i01854999

## **0052-11 Air Inlet Shutoff Shutdown (00)**

**SMCS Code:** 1078-038

#### **Conditions Which Generate This Code:**

This code indicates that the engine was shutdown due to an engine overspeed condition.

The ECM detects the following conditions:

- Engine speed is greater than 2500 rpm.
- "Air Inlet Shutoff Relay Control" is programmed to J2/P2:13.
- There is no detected vehicle speed.
- There are no active vehicle speed faults.
- All required interlocks are set.

#### **System Response:**

The ECM will disable the unit injectors and the ECM will activate the air inlet shutoff relay. "J2/P2:13 Air Inlet Shutoff Relay Control ON" will be displayed next to the status for "Air Inlet Shutoff Relay Control" on the electronic service tool.

#### **Possible Performance Effect:**

The engine will shut down.

#### **Troubleshooting:**

#### **Talk to the Operator**

Determine the reason for the engine overspeed.

#### **Results:**

- OK – The reason for the engine overspeed was determined. STOP.
- Not OK – The reason for the engine overspeed was not determined.

**Repair:** If there is a problem with the Air Inlet Shutoff circuit, refer to Troubleshooting, "Air Inlet Shutoff Circuit - Test".

STOP.

i01855346

## **0054-05 Auxiliary Output #06 current low (66)**

**SMCS Code:** 1901-038

#### **Conditions Which Generate This Code:**

The ECM detects the following conditions:

- There is a low current condition (open circuit) in the circuit for the lockout solenoid for more than two seconds.
- The "Transmission Style" is programmed to "Eaton Top 2".

i01855453

**System Response:**

The solenoid that is currently enabled will remain in the ON position until neutral is detected. Then manual operation occurs until the system powers down. Manual operation is defined as both solenoids OFF.

**Possible Performance Effect:**

The ECM disables the Eaton Top 2 mode.

**Troubleshooting:**

Perform the following diagnostic procedure: "Eaton Top 2 Transmission Circuit - Test"

**Results:**

- OK – STOP.

i01855368

**0054-06 Auxiliary Output #06 current high (66)**

**SMCS Code:** 1901-038

**Conditions Which Generate This Code:**

The ECM detects the following conditions:

- There is a high current condition (short circuit) in the circuit for the lockout solenoid for more than two seconds.
- The "Transmission Style" is programmed to "Eaton Top 2".

**System Response:**

The solenoid that is currently enabled will remain in the ON position until neutral is detected. Then manual operation occurs until the system powers down. Manual operation is defined as both solenoids OFF.

**Possible Performance Effect:**

The ECM disables the Eaton Top 2 mode.

**Troubleshooting:**

Perform the following diagnostic procedure: "Eaton Top 2 Transmission Circuit - Test"

**Results:**

- OK – STOP.

**0055-05 Auxiliary Output #07 current low (67)**

**SMCS Code:** 1901-038

**Conditions Which Generate This Code:**

The ECM detects the following conditions:

- There is a low current condition (open circuit) in the circuit for the shift solenoid.
- The "Transmission Style" is programmed to "Eaton Top 2".

**System Response:**

The solenoid that is currently enabled will remain in the ON position until neutral is detected. Then manual operation occurs until the system powers down. Manual operation is defined as both solenoids OFF.

**Possible Performance Effect:**

The ECM disables the Eaton Top 2 mode.

**Troubleshooting:**

Perform the following diagnostic procedure: "Eaton Top 2 Transmission Circuit - Test"

**Results:**

- OK – STOP.

i01855454

**0055-06 Auxiliary Output #07 current high (67)**

**SMCS Code:** 1901-038

**Conditions Which Generate This Code:**

The ECM detects the following conditions:

- There is a high current condition (short circuit) in the circuit for the shift solenoid.
- The "Transmission Style" is programmed to "Eaton Top 2".

**System Response:**

The solenoid that is currently enabled will remain in the ON position until neutral is detected. Then manual operation occurs until the system powers down. Manual operation is defined as both solenoids OFF.

**Possible Performance Effect:**

The ECM disables the Eaton Top 2 mode.

**Troubleshooting:**

Perform the following diagnostic procedure: "Eaton Top 2 Transmission Circuit - Test"

**Results:**

- OK – STOP.

i01905821

## 0064-12 Secondary Engine Speed loss of signal (34)

**SMCS Code:** 1912-038

**Conditions Which Generate This Code:**

The ECM detects the following conditions:

- The signal for the secondary engine speed/timing sensor is intermittent or lost.

**System Response:**

The engine may misfire or the engine may run rough during starting. The check engine lamp will not be illuminated for this code unless the code has been active for ten hours.

**Possible Performance Effect:**

There should not be a noticeable change in engine response unless the signal for the primary engine speed/timing sensor is lost. The engine will shut down if both the signal for the primary engine speed/timing sensor and the signal for the secondary engine speed/timing sensor are lost.

**Troubleshooting:**

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

**Results:**

- OK – STOP.

## 0071-00 Idle Shutdown Override (01)

**SMCS Code:** 1901-038

**Conditions Which Generate This Code:**

The ECM detects one of the following conditions:

- The "Allow Idle Shutdown Override" parameter is programmed to "Yes" and the status of the brake switch or the clutch switch changes.
- The "Allow Idle Shutdown Override" parameter is programmed to "J1587 Outside Temp Based" or "Outside Temperature Based". The outside temperature is above the maximum programmed temperature or the outside temperature is below the minimum programmed temperature.

The ECM also detects the following conditions:

- The idle shutdown timer is within the final 90 seconds.
- The "Idle Shutdown Time" parameter is programmed to at least three minutes.

**System Response:**

The idle shutdown timer stops counting. "OVERRIDE" will be displayed next to the status for "Idle Shutdown Status" on the electronic service tool.

**Note:** The idle shutdown timer will not begin counting again for shutdown until the vehicle is moved and the accelerator pedal is depressed.

Customer passwords are required to clear this diagnostic code.

**Possible Performance Effect:**

None

**Troubleshooting:**

Perform the following diagnostic procedure: "Idle Shutdown Timer - Test"

**Results:**

- OK – STOP.

i01857558

## 0071-01 Idle Shutdown (47)

**SMCS Code:** 1901-038**Conditions Which Generate This Code:**

The ECM detects the following conditions:

- The idle shutdown timer has expired and the engine has shut down.
- The "Idle Shutdown Time" parameter is programmed to at least three minutes.
- Vehicle speed is 0 mph.
- Coolant temperature is greater than 38 °C (100.4 °F).

**System Response:**

The ECM remains powered after the engine shutdown. "COUNTING" will be displayed next to the status for "Idle Shutdown Status" on the electronic service tool.

Customer Passwords are required to clear this diagnostic code.

**Possible Performance Effect:**

The engine is shut down.

**Troubleshooting:**

Perform the following diagnostic procedure: "Idle Shutdown Timer - Test"

**Results:**

- OK – STOP.

i01857561

## 0071-14 PTO Shutdown (47)

**SMCS Code:** 1901-038**Conditions Which Generate This Code:**

The ECM detects the following conditions:

- The timer for the PTO has expired and the engine has shut down.
- The PTO On/Off switch is in the ON position.
- The "PTO Configuration" parameter is programmed to "Cab Switches", "Remote Switches", or "Remote Throttle".

- The "PTO Shutdown Time" parameter is programmed to at least three minutes.

**System Response:**

The ECM remains powered after the engine shutdown. "NOT ACTIVE" will be displayed next to the status for "PTO Shutdown" on the electronic service tool.

Customer Passwords are required to clear this diagnostic code.

**Possible Performance Effect:**

The engine is shut down.

**Troubleshooting:**

Perform the following diagnostic procedure: "PTO Shutdown Timer - Test"

**Results:**

- OK – STOP.

i01863221

## 0084-00 Vehicle Overspeed Warning (41)

**SMCS Code:** 7463-038**Conditions Which Generate This Code:**

The ECM detects one of the following conditions:

- The "Soft Vehicle Speed Limit" parameter is programmed to "No" and the vehicle speed exceeds the programmed "Vehicle Speed Limit" by more than 10 MPH for more than 20 seconds.
- The "Soft Vehicle Speed Limit" parameter is programmed to "Yes" and the vehicle speed exceeds the programmed "Vehicle Speed Limit" by more than 15 MPH for more than 20 seconds.

**System Response:**

The ECM will not energize the injector solenoids while the diagnostic code is active. "VEHICLE SPEED LIMIT" will be displayed on the status screen when the vehicle speed limit is exceeded.

Customer passwords are required to clear this code.

**Possible Performance Effect:**

Injection is disabled until the vehicle speed falls below the programmed "Vehicle Speed Limit".

### Troubleshooting:

This diagnostic code does not necessarily indicate that there is an electronic problem. If the vehicle speed calibration is wrong, perform the following procedure:

Perform the following diagnostic procedure: "Vehicle Speed Circuit - Calibrate"

### Results:

- OK – STOP.

i01863422

## 0084-01 Vehicle Speed loss of signal (31)

**SMCS Code:** 7463-038

### Conditions Which Generate This Code:

The ECM detects the following conditions:

- The vehicle speed signal indicates that the vehicle speed is 0 MPH.
- Engine speed is greater than the programmed "VSL Protection" minus 100 RPM for at least 0.06 seconds.
- Desired engine speed is greater than the programmed "VSL Protection".
- The change in engine speed is less than 133 RPM per second for at least 0.06 seconds.
- The "VSL Protection" parameter is programmed to a value that is less than 2120 rpm.

The following condition must also be met if the "Vehicle Speed Input" is programmed to "J1939-ABS" or "J1939-Trans".

- The message for vehicle speed is not received over the J1939 data link for more than 0.5 seconds.

### System Response:

The ECM will limit engine rpm to the programmed "VSL Protection". If the ECM is providing the speedometer signal, the speedometer will show 0 rpm. "DIAG" will be displayed next to the status for "Vehicle Speed" on the electronic service tool.

### Possible Performance Effect:

The ECM will limit engine rpm to the programmed "VSL Protection".

**Note:** A fuel system restriction has been known to cause this diagnostic code although this occurrence is not common. This situation exists because the injectors are unable to provide sufficient fuel in order to achieve the desired rpm under normal load conditions. Because the ECM cannot reach the desired rpm under the normal load conditions, the ECM suspects that the vehicle is under load. This should only occur when the vehicle is in motion.

### Troubleshooting:

Check the fuel pressure in order to ensure that a fuel system restriction is not the cause of the problem when the vehicle is not moving.

Perform the following diagnostic procedure: "Vehicle Speed and Speedometer Circuit - Test"

### Results:

- OK – STOP.

i01863534

## 0084-02 Vehicle Speed signal invalid (36)

**SMCS Code:** 7463-038

### Conditions Which Generate This Code:

The ECM detects the following conditions:

- The vehicle speed signal indicates a constant MPH.
- Engine speed is greater than 950 rpm for at least 0.06 seconds.
- The "VSL Protection" parameter is programmed to a value that is less than 2120 rpm.

### System Response:

"DIAG" will be displayed next to the status for "Vehicle Speed" on the electronic service tool.

### Possible Performance Effect:

Engine rpm is limited to the programmed "VSL Protection" for one hour.

**Troubleshooting:**

This code may indicate tampering with the vehicle speed circuit.

Perform the following diagnostic procedure: "Vehicle Speed and Speedometer Circuit - Test"

**Results:**

- OK – STOP.

i01863538

**0084-08 Vehicle Speed signal out of range (36)**

**SMCS Code:** 7463-038

**Conditions Which Generate This Code:**

The ECM detects the following conditions:

- The vehicle speed signal indicates that vehicle speed is greater than 127.5 MPH for more than two seconds.
- The "VSL Protection" parameter is programmed to a value that is less than 2120 rpm.

**System Response:**

Vehicle speed is set to 0 km/h (0 mph). If the ECM is providing the speedometer signal, the speedometer will not display vehicle speed. "DIAG" will be displayed next to the status for "Vehicle Speed" on the electronic service tool.

**Possible Performance Effect:**

The ECM will limit the engine speed to the programmed "VSL Protection".

**Troubleshooting:**

Perform the following diagnostic procedure: "Vehicle Speed and Speedometer Circuit - Test"

**Results:**

- OK – STOP.

**0084-10 Vehicle Speed signal rate of change (36)**

**SMCS Code:** 7463-038

**Conditions Which Generate This Code:**

The ECM detects the following conditions:

- The vehicle speed signal changes more than 5 MPH on eight consecutive readings in three seconds.
- The engine speed is greater than the programmed "VSL Protection" minus 100 rpm.
- The "VSL Protection" parameter is programmed to a value that is less than 2120 rpm.

**Note:** If the ABS is the source of the vehicle speed, the ABS must not be active.

**System Response:**

"DIAG" will be displayed next to the status for "Vehicle Speed" on the electronic service tool. The check engine lamp will illuminate.

**Possible Performance Effect:**

Engine rpm is limited to the programmed "VSL Protection" for eight seconds.

**Troubleshooting:**

Perform the following diagnostic procedure: "Vehicle Speed and Speedometer Circuit - Test"

**Results:**

- OK – STOP.

i01863535

**0084-14 Quick Stop Occurrence**

**SMCS Code:** 7463-038

**Conditions Which Generate This Code:**

The ECM detects the following conditions:

- The vehicle speed slows at a rate that exceeds the "Quick Stop Rate" that is programmed.
- The service brake is applied.

**System Response:**

The ECM records the engine speed, vehicle speed, the throttle position, cruise control status, clutch switch status and brake switch status.

Customer passwords are required to clear this diagnostic code.

**Possible Performance Effect:**

None

**Troubleshooting:**

This diagnostic code does not represent an electronic system fault.

An excessive number of occurrences may be caused by the following circumstance:

- The parameter for the “Quick Stop Rate” may be set too low.

**Note:** This setting can be affected by the load on the vehicle. If the vehicle is operated without a trailer or with no load, the vehicle will stop faster than the same vehicle with a heavy load.

**Expected Result:**

**Results:**

- OK – STOP.

i01864487

## 0091-08 Throttle Position Invalid (32)

**SMCS Code:** 1913-038

**Conditions Which Generate This Code:**

The ECM detects the following conditions:

- The signal frequency from the accelerator pedal position sensor is less than 150 Hz or the signal frequency is greater than 1050 Hz for more than two seconds.
- The ECM has been powered for at least three seconds.

**System Response:**

The ECM sets the “Throttle Position” to 0%. “DIAG” will be displayed next to the status for “Throttle Position” on the electronic service tool.

**Possible Performance Effect:**

The engine will remain at low idle while the diagnostic code is active.

**Troubleshooting:**

Perform the following diagnostic procedure: “Accelerator Pedal (Throttle) Position Sensor Circuit - Test”

**Results:**

- OK – STOP.

i01864488

## 0091-13 Throttle Position out of calibration (32)

**SMCS Code:** 1913-038

**Conditions Which Generate This Code:**

The ECM detects the following conditions:

- The duty cycle for the accelerator pedal position sensor is less than 5 percent or the duty cycle is greater than 95 percent for more than two seconds.
- The ECM has been powered for at least three seconds.

**System Response:**

The ECM sets “Throttle Position” to 0%. “DIAG” will be displayed next to the status for “Throttle Position” on the electronic service tool.

**Possible Performance Effect:**

The engine will remain at low idle while the diagnostic code is active.

**Troubleshooting:**

Perform the following diagnostic procedure: “Accelerator Pedal (Throttle) Position Sensor Circuit - Test”

**Results:**

- OK – STOP.

i01907616

## 0100-01 Low Oil Pressure Warning (46)

**SMCS Code:** 1924-038

### Conditions Which Generate This Code:

The ECM detects the following conditions:

- The engine oil pressure is below the trip line in Illustration 32 or Illustration 33 for more than eight seconds.

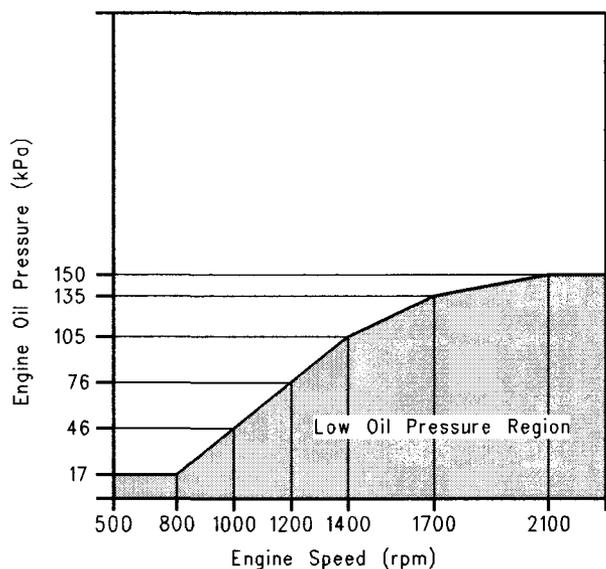


Illustration 32

g00997504

C-10 and C-12 low oil pressure

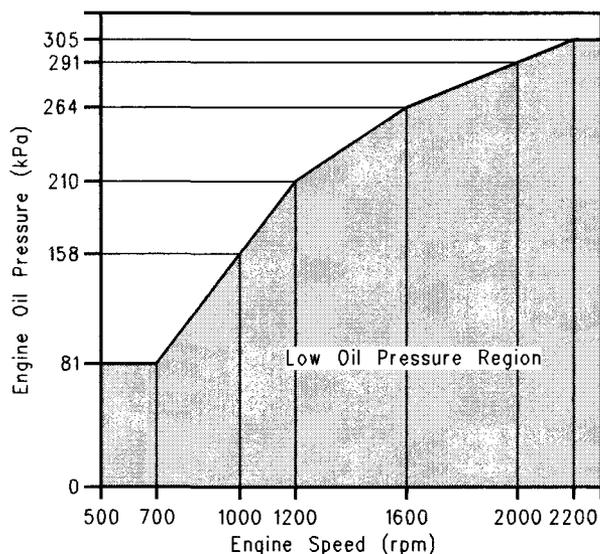


Illustration 33

g00997505

3406E, C-15, C-16, and C-18 low oil pressure

### System Response:

The Caterpillar Electronic Technician (Cat ET) will display "LOW OIL PRESSURE" and "DIAG" next to the status for "Engine Oil Pressure". The check engine lamp and the warning lamp will illuminate.

Customer passwords are required to clear this diagnostic code.

### Possible Performance Effect:

None

### Troubleshooting:

#### Test Step 1. Check the Engine Oil Level

**A.** Check the engine oil level.

#### Expected Result:

The engine oil level is OK.

#### Results:

- **OK** – The engine oil level is OK. Proceed to Test Step 2.
- **Not OK** – The engine oil level is low.

**Repair:** Add engine oil to the proper level. Refer to the Operation and Maintenance Manual for more information.

**STOP.**

#### Test Step 2. Verify Proper Sensor Installation

**A.** Check the installation of the engine oil pressure sensor.

**B.** Check the wiring of the engine oil pressure sensor. Refer to the Electrical Schematic for the proper wiring. Ensure that all of the wires and connectors are properly connected.

#### Expected Result:

The sensor is properly installed and the wiring is correct.

#### Results:

- **OK** – The sensor is properly installed. Proceed to Test Step 3.
- **Not OK** – The sensor is not installed properly.

**Repair:** Install the engine oil pressure sensor properly. Repair the wiring and/or the connectors to the sensor.

Verify that the repair eliminates the problem.

STOP.

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

- A. Connect Cat ET to the data link connector.
- B. Check for active diagnostic codes that are related to the barometric pressure sensor (atmospheric pressure) or the boost pressure sensor.

#### Expected Result:

There are no diagnostic codes that are related to the barometric pressure sensor (atmospheric pressure) or the boost pressure sensor.

#### Results:

- OK – There are no diagnostic codes. Proceed to Test Step 4.
- Not OK – There is a diagnostic code that is related to the barometric pressure sensor (atmospheric pressure) and/or the boost pressure sensor.

**Repair:** Troubleshoot the diagnostic code before continuing with this procedure.

STOP.

### Test Step 4. Check the Status Screen

- A. Turn the key switch to the ON position. The engine should be off.
- B. Monitor the status for “Boost Pressure” and “Engine Oil Pressure” on Cat ET.

#### Expected Result:

“Boost Pressure” and “Engine Oil Pressure” should be less than 10 kPa (2 psi).

#### Results:

- OK – The boost pressure and the engine oil pressure are less than 10 kPa (2 psi). Proceed to Test Step 6.
- Not OK - Boost Pressure – The boost pressure is greater than 10 kPa (2 psi). Proceed to Test Step 8.
- Not OK - Engine Oil Pressure – The engine oil pressure is greater than 10 kPa (2 psi). Proceed to Test Step 9.

- Not OK - Both – The boost pressure and the engine oil pressure are greater than 10 kPa (2 psi). Proceed to Test Step 5.

### Test Step 5. Check the Supply Voltage to the Pressure Sensors

- A. Disconnect the barometric pressure sensor (atmospheric pressure), the boost pressure sensor, and the engine oil pressure sensor.
- B. Turn the key switch to the ON position.
- C. Measure the voltage between terminal A (Engine Pressure Sensor +5V) and terminal B (Engine Pressure Sensor Common) of each pressure sensor connector on the engine harness.

#### Expected Result:

The voltage is  $5.0 \pm 0.16$  VDC.

#### Results:

- OK – The voltage is within the range.

**Repair:** Reconnect the engine oil pressure sensor and the boost pressure sensor.

Temporarily connect a new barometric pressure sensor (atmospheric pressure).

If the new sensor fixes the problem, reconnect the suspect sensor.

If the problem returns, permanently replace the sensor.

Verify that the repair eliminates the problem.

STOP.

- Not OK – There is a problem with the 5 volt supply.

**Repair:** Check the J2/P2 ECM connector and the sensor connectors for corrosion and moisture.

Check the 5 volt supply wire. Verify that the wire is not cut and that the wire is completely inserted into the connectors for the pressure sensors on the engine harness.

Verify that the repair eliminates the problem.

STOP.

### Test Step 6. Install a Pressure Gauge

- A. Remove the engine oil pressure sensor.

- B.** Install a 1U-5470 Engine Pressure Group into the oil gallery with a Tee fitting in the port for the engine oil pressure sensor.
- C.** Connect the engine oil pressure sensor to the Tee fitting.
- D.** Turn the key switch to the ON position.
- E.** Monitor the status for "Engine Oil Pressure" on Cat ET.
- F.** Start the engine and run the engine at low idle.
- G.** Compare the pressure reading on the gauge to the pressure reading on Cat ET.
- H.** Monitor the status screen and the gauge while you increase the engine speed.

**Expected Result:**

The gauge and the status screen are within 35 kPa (5.0 psi) of each other.

**Results:**

- **OK** – The sensor is functioning properly. Proceed to Test Step 7.
- **Not OK** – The sensor is not functioning properly.

**Repair:** Temporarily install a new engine oil pressure sensor.

If the new sensor repairs the problem, reinstall the suspect sensor.

If the problem returns, replace the sensor.

Verify that the repair eliminates the problem.

STOP.

**Test Step 7. Compare the Readings to the Oil Pressure Map**

- A.** Compare the readings from the pressure gauge to the oil pressure maps in Illustration 32 or Illustration 33.

**Expected Result:**

The engine oil pressure is above the trip points in Illustration 32 or Illustration 33.

**Results:**

- **OK** – The engine oil pressure appears to be OK at this time. STOP.

- **Not OK** – The engine oil pressure is lower than the trip line on the oil pressure map. There is a mechanical problem.

**Repair:** Refer to Testing and Adjusting, "Engine Oil Pressure - Test".

STOP.

**Test Step 8. Check the Supply Voltage to the Boost Pressure Sensor**

- A.** Disconnect the boost pressure sensor.
- B.** Turn the key switch to the ON position.
- C.** Measure the voltage between terminal A (Engine Pressure Sensor +5V) and terminal B (Engine Pressure Sensor Common) of the connector for the boost pressure sensor on the engine harness.

**Expected Result:**

The voltage is  $5.0 \pm 0.16$  VDC.

**Results:**

- **OK** – The voltage is within the range.

**Repair:** Temporarily connect a new boost pressure sensor.

If the new sensor fixes the problem, reconnect the suspect sensor.

If the problem returns, permanently replace the sensor.

Verify that the repair eliminates the problem.

STOP.

- **Not OK** – There is a problem with the 5 volt supply.

**Repair:** Check the sensor connector for corrosion and moisture.

Check the 5 volt supply wire. Verify that the wire is not cut and that the wire is completely inserted into the connector for the boost pressure sensor on the engine harness.

Verify that the repair eliminates the problem.

STOP.

**Test Step 9. Check the Supply Voltage to the Engine Oil Pressure Sensor**

- A.** Disconnect the engine oil pressure sensor.
- B.** Turn the key switch to the ON position.

- **C.** Measure the voltage between terminal A (Engine Pressure Sensor +5V) and terminal B (Engine Pressure Sensor Common) of the connector for the engine oil pressure sensor on the engine harness.

#### Expected Result:

The voltage is  $5.0 \pm 0.16$  VDC.

#### Results:

- OK – The voltage is within the range.

**Repair:** Temporarily connect a new engine oil pressure sensor.

If the new sensor fixes the problem, reconnect the suspect sensor.

If the problem returns, permanently replace the sensor.

Verify that the repair eliminates the problem.

STOP.

- Not OK – There is a problem with the 5 volt supply.

**Repair:** Check the sensor connector for corrosion and moisture.

Check the 5 volt supply wire. Verify that the wire is not cut and that the wire is completely inserted into the connector for the engine oil pressure sensor on the engine harness.

Verify that the repair eliminates the problem.

STOP.

i01814727

## 0100-03 Oil Pressure voltage high (24)

**SMCS Code:** 1924-038

#### Conditions Which Generate This Code:

The ECM detects the following conditions:

- The signal voltage from the engine oil pressure sensor is greater than 4.8 VDC for more than eight seconds.
- The ECM has been powered for at least two seconds.

- The engine is not running or the engine coolant temperature is greater than 38 °C (100.4 °F).

#### System Response:

The ECM will default to 600 kPa (87.0 psi) for engine oil pressure. "DIAG" will be displayed next to the status for "Engine Oil Pressure" on the electronic service tool.

#### Possible Performance Effect:

The engine may experience low power when this diagnostic code is active.

#### Troubleshooting:

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

#### Results:

- OK – STOP.

i01814729

## 0100-04 Oil Pressure voltage low (24)

**SMCS Code:** 1924-038

#### Conditions Which Generate This Code:

The ECM detects the following conditions:

- The signal voltage from the engine oil pressure sensor is less than 0.2 VDC for more than eight seconds.
- The ECM has been powered for at least two seconds.
- The engine is not running or atmospheric pressure is greater than 80 kPa (11.6 psi).

#### System Response:

The ECM will default to 600 kPa (87.0 psi) for engine oil pressure. "DIAG" will be displayed next to the status for "Engine Oil Pressure" on the electronic service tool.

#### Possible Performance Effect:

The engine may experience low power when this code is active.

**Troubleshooting:**

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

**Results:**

- OK – STOP.

i01907618

**0100-11 Very Low Oil Pressure (46)**

**SMCS Code:** 1924-038

**Conditions Which Generate This Code:**

The ECM detects the following conditions:

- The engine oil pressure is below the trip line in Illustration 34 or Illustration 35 for more than eight seconds.

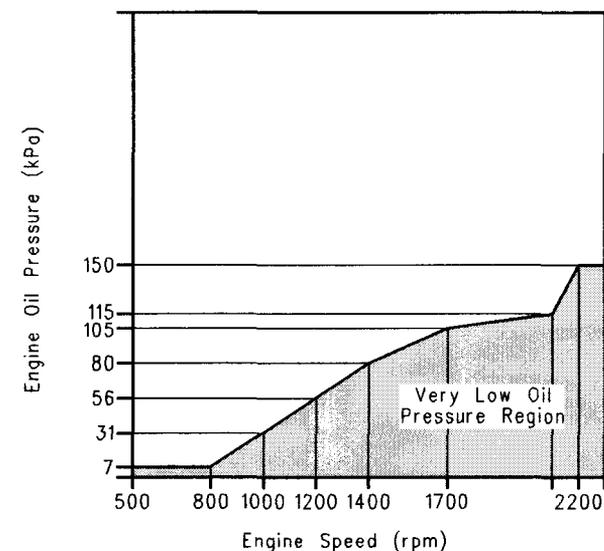


Illustration 34

g00998095

C-10 and C-12 map for very low oil pressure

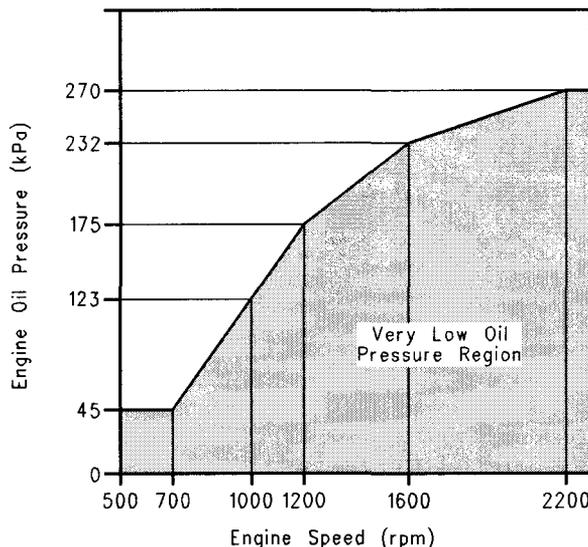


Illustration 35

g00998096

3406E, C-15, C-16, and C-18 map for very low oil pressure

**System Response:**

The Caterpillar Electronic Technician (Cat ET) will display "LOW OIL PRESSURE" and "DIAG" next to the status for "Engine Oil Pressure". The check engine lamp and the warning lamp will illuminate.

Customer passwords are required to clear this diagnostic code.

**Possible Performance Effect:**

The ECM will use the default torque map. The engine speed is limited to 1350 RPM and the vehicle speed is limited to 72 km/h (45 mph).

**Note:** If the "Engine Monitoring" parameter is programmed to "Shutdown", the engine will be shutdown after this code has been active for 30 seconds.

**Note:** If "Engine Monitoring" is programmed to "Warning" the engine power will not be affected.

**Troubleshooting:**

**Test Step 1. Check the Engine Oil Level**

**A.** Check the engine oil level.

**Expected Result:**

The engine oil level is OK.

**Results:**

- OK – The engine oil level is OK. Proceed to Test Step 2.

- **Not OK** – The engine oil level is low.

**Repair:** Add engine oil to the proper level. Refer to the Operation and Maintenance Manual for more information.

STOP.

### Test Step 2. Verify Proper Sensor Installation

- Check the installation of the engine oil pressure sensor.
- Check the wiring of the engine oil pressure sensor. Refer to the Electrical Schematic for the proper wiring. Ensure that all of the wires and connectors are properly connected.

#### Expected Result:

The sensor is properly installed and the wiring is correct.

#### Results:

- **OK** – The sensor is properly installed. Proceed to Test Step 3.
- **Not OK** – The sensor is not installed properly.

**Repair:** Install the engine oil pressure sensor properly. Repair the wiring and/or the connectors to the sensor.

Verify that the repair eliminates the problem.

STOP.

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

- Connect Cat ET to the data link connector.
- Check for active diagnostic codes that are related to the barometric pressure sensor (atmospheric pressure) or the boost pressure sensor.

#### Expected Result:

There are no diagnostic codes that are related to the barometric pressure sensor (atmospheric pressure) or the boost pressure sensor.

#### Results:

- **OK** – There are no diagnostic codes. Proceed to Test Step 4.

- **Not OK** – There is a diagnostic code that is related to the barometric pressure sensor (atmospheric pressure) and/or the boost pressure sensor.

**Repair:** Troubleshoot the diagnostic code before continuing with this procedure.

STOP.

### Test Step 4. Check the Status Screen

- Turn the key switch to the ON position. The engine should be off.
- Monitor the status for “Boost Pressure” and “Engine Oil Pressure” on Cat ET.

#### Expected Result:

“Boost Pressure” and “Engine Oil Pressure” should be less than 10 kPa (2 psi).

#### Results:

- **OK** – The boost pressure and the engine oil pressure are less than 10 kPa (2 psi). Proceed to Test Step 6.
- **Not OK - Boost Pressure** – The boost pressure is greater than 10 kPa (2 psi). Proceed to Test Step 8.
- **Not OK - Engine Oil Pressure** – The engine oil pressure is greater than 10 kPa (2 psi). Proceed to Test Step 9.
- **Not OK - Both** – The boost pressure and the engine oil pressure are greater than 10 kPa (2 psi). Proceed to Test Step 5.

### Test Step 5. Check the Supply Voltage to the Pressure Sensors

- Disconnect the barometric pressure sensor (atmospheric pressure), the boost pressure sensor, and the engine oil pressure sensor.
- Turn the key switch to the ON position.
- Measure the voltage between terminal A (Engine Pressure Sensor +5V) and terminal B (Engine Pressure Sensor Common) of each pressure sensor connector on the engine harness.

#### Expected Result:

The voltage is  $5.0 \pm 0.16$  VDC.

**Results:**

- **OK** – The voltage is within the range.

**Repair:** Reconnect the engine oil pressure sensor and the boost pressure sensor.

Temporarily connect a new barometric pressure sensor (atmospheric pressure).

If the new sensor fixes the problem, reconnect the suspect sensor.

If the problem returns, permanently replace the sensor.

Verify that the repair eliminates the problem.

STOP.

- **Not OK** – There is a problem with the 5 volt supply.

**Repair:** Check the J2/P2 ECM connector and the sensor connectors for corrosion and moisture.

Check the 5 volt supply wire. Verify that the wire is not cut and that the wire is completely inserted into the connectors for the pressure sensors on the engine harness.

Verify that the repair eliminates the problem.

STOP.

**Test Step 6. Install a Pressure Gauge**

- Remove the engine oil pressure sensor.
- Install a 1U-5470 Engine Pressure Group into the oil gallery with a Tee fitting in the port for the engine oil pressure sensor.
- Connect the engine oil pressure sensor to the Tee fitting.
- Turn the key switch to the ON position.
- Monitor the status for "Engine Oil Pressure" on Cat ET.
- Start the engine and run the engine at low idle.
- Compare the pressure reading on the gauge to the pressure reading on Cat ET.
- Monitor the status screen and the gauge while you increase the engine speed.

**Expected Result:**

The gauge and the status screen are within 35 kPa (5.0 psi) of each other.

**Results:**

- **OK** – The sensor is functioning properly. Proceed to Test Step 7.

- **Not OK** – The sensor is not functioning properly.

**Repair:** Temporarily install a new engine oil pressure sensor.

If the new sensor repairs the problem, reinstall the suspect sensor.

If the problem returns, replace the sensor.

Verify that the repair eliminates the problem.

STOP.

**Test Step 7. Compare the Readings to the Oil Pressure Map**

- Compare the readings from the pressure gauge to the oil pressure maps in Illustration 34 or Illustration 35.

**Expected Result:**

The engine oil pressure is above the trip points in Illustration 34 or Illustration 35.

**Results:**

- **OK** – The engine oil pressure appears to be OK at this time. STOP.

- **Not OK** – The engine oil pressure is lower than the trip line on the oil pressure map. There is a mechanical problem.

**Repair:** Refer to Testing and Adjusting, "Engine Oil Pressure - Test".

STOP.

**Test Step 8. Check the Supply Voltage to the Boost Pressure Sensor**

- Disconnect the boost pressure sensor.
- Turn the key switch to the ON position.
- Measure the voltage between terminal A (Engine Pressure Sensor +5V) and terminal B (Engine Pressure Sensor Common) of the connector for the boost pressure sensor on the engine harness.

**Expected Result:**

The voltage is  $5.0 \pm 0.16$  VDC.

**Results:**

- OK – The voltage is within the range.

**Repair:** Temporarily connect a new boost pressure sensor.

If the new sensor fixes the problem, reconnect the suspect sensor.

If the problem returns, permanently replace the sensor.

Verify that the repair eliminates the problem.

STOP.

- Not OK – There is a problem with the 5 volt supply.

**Repair:** Check the sensor connector for corrosion and moisture.

Check the 5 volt supply wire. Verify that the wire is not cut and that the wire is completely inserted into the connector for the boost pressure sensor on the engine harness.

Verify that the repair eliminates the problem.

STOP.

**Test Step 9. Check the Supply Voltage to the Engine Oil Pressure Sensor**

- A. Disconnect the engine oil pressure sensor.
- B. Turn the key switch to the ON position.
- C. Measure the voltage between terminal A (Engine Pressure Sensor +5V) and terminal B (Engine Pressure Sensor Common) of the connector for the engine oil pressure sensor on the engine harness.

**Expected Result:**

The voltage is  $5.0 \pm 0.16$  VDC.

**Results:**

- OK – The voltage is within the range.

**Repair:** Temporarily connect a new engine oil pressure sensor.

If the new sensor fixes the problem, reconnect the suspect sensor.

If the problem returns, permanently replace the sensor.

Verify that the repair eliminates the problem.

STOP.

- Not OK – There is a problem with the 5 volt supply.

**Repair:** Check the sensor connector for corrosion and moisture.

Check the 5 volt supply wire. Verify that the wire is not cut and that the wire is completely inserted into the connector for the engine oil pressure sensor on the engine harness.

Verify that the repair eliminates the problem.

STOP.

i01909510

**0102-00 Excessive Boost Pressure**

**SMCS Code:** 1917-038

**Conditions Which Generate This Code:**

The ECM detects the following conditions:

- The actual boost pressure is higher than the desired boost pressure.

**System Response:**

Boost pressure is set to 0 kPa (0 psi). "DIAG" will be displayed next to the status for "Boost Pressure" on the Caterpillar Electronic Technician (Cat ET).

**Possible Performance Effect:**

The engine may experience low power when the diagnostic code is active.

**Troubleshooting:**

Determine the cause of the excessive boost pressure such as a wastegate for the turbocharger that has failed or a line for the wastegate that has been pinched.

**Results:**

- OK – STOP.

i01814736

## 0102-03 Boost Pressure voltage high (25)

**SMCS Code:** 1917-038**Conditions Which Generate This Code:**

The ECM detects the following conditions:

- The signal voltage from the boost pressure sensor is greater than 4.8 VDC for more than two seconds.
- The ECM has been powered for at least two seconds.
- The engine is not running or the rack position is less than 50% with the engine retarder off.

**System Response:**

The ECM will default to 0 kPa (0.0 psi) for boost pressure. The ECM will use the default torque map. "DIAG" will be displayed next to the status for "Boost Pressure" on the electronic service tool.

**Possible Performance Effect:**

The engine will experience low power when this diagnostic code is active.

**Troubleshooting:**

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

**Results:**

- OK – STOP.

i01814738

## 0102-04 Boost Pressure voltage low (25)

**SMCS Code:** 1917-038**Conditions Which Generate This Code:**

The ECM detects the following conditions:

- The signal voltage from the boost pressure sensor is less than 0.2 VDC for more than one second.
- The ECM has been powered for at least two seconds.

**System Response:**

The ECM will default to 0 kPa (0 psi) for boost pressure. The ECM will use the default torque map. "DIAG" will be displayed next to the status for "Boost Pressure" on the electronic service tool.

**Possible Performance Effect:**

The engine will experience low power when this diagnostic code is active.

**Troubleshooting:**

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

**Results:**

- OK – STOP.

i01909721

## 0105-00 High Intake Manifold Air Temperature Warning (64)

**SMCS Code:** 1921-038**Conditions Which Generate This Code:**

The ECM detects the following conditions:

- The intake manifold air temperature is greater than 90 °C (194.0 °F) for more than four seconds.
- The engine has been running for at least 30 seconds.
- The engine coolant temperature is above 99 °C (210.0 °F).

**System Response:**

"DIAG" will be displayed next to the status for "Intake Manifold Air Temperature" on the electronic service tool. The warning lamp will turn on if the "Engine Monitoring Lamps" parameter is programmed to "Warning Lamp". The check engine lamp will turn on if the "Engine Monitoring Lamps" parameter is programmed to "Option 1".

Customer passwords are required to clear this diagnostic code.

**Possible Performance Effect:**

None

**Troubleshooting:**

This diagnostic code indicates an excessive temperature in the intake manifold.

## Check the Aftercooler

- A. Check the air-to-air aftercooler for debris and/or restriction to the air flow.

### Expected Result:

There are no restrictions to the air flow through the air-to-air aftercooler.

### Results:

- OK – There are no restrictions in the air flow.

**Repair:** Determine the cause of the high temperatures. Heavy loads and high ambient air temperatures could cause the temperature to be above the trip point.

STOP.

- Not OK – There are restrictions in the air flow.

**Repair:** Remove the restrictions in the air flow.

Verify that the repair eliminates the problem.

STOP.

i01814169

## 0105-03 Intake Manifold Air Temperature voltage high (38)

**SMCS Code:** 1921-038

### Conditions Which Generate This Code:

The ECM detects the following conditions:

- The signal voltage from the intake manifold air temperature sensor is greater than 4.9 VDC for more than eight seconds.
- Engine coolant temperature is above  $-10\text{ }^{\circ}\text{C}$  ( $15.0\text{ }^{\circ}\text{F}$ ).
- The ECM has been powered for at least two seconds.

### System Response:

The ECM will default to  $85\text{ }^{\circ}\text{C}$  ( $185.0\text{ }^{\circ}\text{F}$ ) for the intake manifold air temperature. "DIAG" will be displayed next to the status for "Intake Manifold Air Temperature" on the electronic service tool. The ECM will turn on the cooling fan.

### Possible Performance Effect:

None

### Troubleshooting:

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

### Results:

- OK – STOP.

i01814165

## 0105-04 Intake Manifold Air Temperature voltage low (38)

**SMCS Code:** 1921-038

### Conditions Which Generate This Code:

The ECM detects the following conditions:

- The signal voltage from the intake manifold air temperature sensor is less than 0.2 VDC for more than eight seconds.
- The ECM has been powered for at least two seconds.

### System Response:

The ECM will default to  $85\text{ }^{\circ}\text{C}$  ( $185.0\text{ }^{\circ}\text{F}$ ) for the intake manifold air temperature. "DIAG" will be displayed next to the status for "Intake Manifold Air Temperature" on the electronic service tool. The ECM will turn on the cooling fan.

### Possible Performance Effect:

None

### Troubleshooting:

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

### Results:

- OK – STOP.

i01905825

## 0105-11 Very High Intake Manifold Air Temperature (64)

**SMCS Code:** 1921-038**Conditions Which Generate This Code:**

The ECM detects the following conditions:

- The intake manifold air temperature is greater than 109 °C (228 °F) for more than two seconds.
- The engine has been running for at least 30 seconds.
- The engine coolant temperature is above 99 °C (210 °F).

**System Response:**

“DIAG” will be displayed next to the status for “Intake Manifold Air Temperature” on the electronic service tool. The warning lamp will turn on if the “Engine Monitoring Lamps” parameter is programmed to “Warning Lamp”. The check engine lamp will turn on if the “Engine Monitoring Lamps” is programmed to “Option 1”.

Customer Passwords are required to clear this diagnostic code.

**Possible Performance Effect:**

None

**Troubleshooting:****Check the Aftercooler**

- Check the air-to-air aftercooler for debris and/or restriction to the air flow.

**Expected Result:**

There are no restrictions to the air flow through the air-to-air aftercooler.

**Results:**

- OK – There are no restrictions in the air flow.

**Repair:** Determine the cause of the high temperatures. Heavy loads and high ambient air temperatures could cause the temperature to be above the trip point.

STOP.

- Not OK – There are restrictions in the air flow.

**Repair:** Remove the restrictions in the air flow.

Verify that the repair eliminates the problem.

STOP.

i01901959

## 0108-03 Barometric Pressure voltage high (26)

**SMCS Code:** 1923-038**Conditions Which Generate This Code:**

The ECM detects the following conditions:

- The signal voltage from the atmospheric pressure sensor is greater than 4.9 VDC for more than 30 seconds.
- The ECM has been powered for at least two seconds.

**System Response:**

The ECM will default to 100 kPa (15 psi) for atmospheric pressure. “DIAG” will be displayed next to the status for “Atmospheric Pressure” on the electronic service tool.

**Possible Performance Effect:**

The engine may experience low power while this code is active.

**Troubleshooting:**

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

**Results:**

- OK – STOP.

i01901977

## 0108-04 Barometric Pressure voltage low (26)

**SMCS Code:** 1923-038**Conditions Which Generate This Code:**

The ECM detects the following conditions:

- The signal voltage from the atmospheric pressure sensor is less than 0.2 VDC for more than 30 seconds.
- The ECM has been powered for at least two seconds.

- The engine is not running or the engine has been running for more than ten seconds.

**System Response:**

The ECM will default to 100 kPa (15 psi) for atmospheric pressure. "DIAG" will be displayed next to the status for "Atmospheric Pressure" on the electronic service tool.

**Possible Performance Effect:**

The engine may experience low power while this code is active.

**Troubleshooting:**

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

**Results:**

- OK – STOP.

**0110-00 High Coolant Temperature Warning (61)**

i01907621

**SMCS Code:** 1906-038

**Conditions Which Generate This Code:**

The ECM detects the following conditions:

- The engine coolant temperature is greater than 103 °C (217 °F) for the C-10 or C-12.
- The engine coolant temperature is greater than 108 °C (226 °F) for the 3406E, C-15, C-16 and C-18.
- The engine has been running at least 30 seconds.

**System Response:**

"DIAG" will be displayed next to the status for "Engine Coolant Temperature" on the Caterpillar Electronic Technician (Cat ET). The check engine lamp and the warning lamp will illuminate.

**Note:** If a high coolant temperature lamp is installed, the high coolant temperature lamp will turn on instead of the warning lamp.

Customer passwords are required to clear this diagnostic code.

**Possible Performance Effect:**

None

**Troubleshooting:**

**Check the Cooling System**

Refer to Testing and Adjusting, "Cooling System - Check".

**Results:**

- OK – STOP.

i01814161

**0110-03 Coolant Temperature voltage high (27)**

**SMCS Code:** 1906-038

**Conditions Which Generate This Code:**

The ECM detects the following conditions:

- The signal voltage from the engine coolant temperature sensor is greater than 4.9 VDC for more than eight seconds.
- The ECM has been powered for at least two seconds.
- The engine has been running for more than seven minutes.

**System Response:**

The ECM will default to 90 °C (194.0 °F) for engine coolant temperature. "DIAG" will be displayed next to the status for "Engine Coolant Temperature" on the electronic service tool. The ECM will activate the cooling fan after this code has been active for more than eight seconds.

**Possible Performance Effect:**

None

**Troubleshooting:**

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

**Results:**

- OK – STOP.

i01814160

## 0110-04 Coolant Temperature voltage low (27)

**SMCS Code:** 1906-038

### Conditions Which Generate This Code:

The ECM detects the following conditions:

- The signal voltage from the engine coolant temperature sensor is less than 0.2 VDC for more than eight seconds.
- The ECM has been powered for at least two seconds.

### System Response:

The ECM will default to 90 °C (194.0 °F) for engine coolant temperature. "DIAG" will be displayed next to the status for "Engine Coolant Temperature" on the electronic service tool. The ECM will activate the cooling fan after this code has been active for more than eight seconds.

### Troubleshooting:

None

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

### Results:

- OK – STOP.

i01907623

## 0110-11 Very High Coolant Temperature (61)

**SMCS Code:** 1906-038

### Conditions Which Generate This Code:

The ECM detects the following conditions:

- The engine coolant temperature is greater than 106 °C (223 °F) for the C-10 or C-12.
- The engine coolant temperature is greater than 111 °C (232 °F) for the 3406E, C-15, C-16 and C-18.
- The engine has been running for at least 30 seconds.

### System Response:

"DIAG" will be displayed next to the status for "Engine Coolant Temperature" on the Caterpillar Electronic Technician (Cat ET). The check engine lamp and the warning lamp will illuminate.

If a high coolant temperature lamp is installed, the high coolant temperature lamp will turn on instead of the warning lamp.

Customer passwords are required to clear this diagnostic code.

### Possible Performance Effect:

The engine will be derated to the default torque map and vehicle speed will be limited to 72 km/h (45 mph).

**Note:** If the "Engine Monitoring" parameter is programmed to "Shutdown", the engine will be shutdown once this code has been active for 20 seconds.

**Note:** If the "Engine Monitoring" parameter is programmed to "Warning", the engine power is not affected.

### Troubleshooting:

## Check the Cooling System

Refer to Testing and Adjusting, "Cooling System - Check".

### Results:

- OK – STOP.

i01856577

## 0111-01 Low Coolant Level Warning (62)

**SMCS Code:** 5574-038-CLT

### Conditions Which Generate This Code:

The ECM detects the following conditions:

- The coolant level is low for more than ten seconds.
- The "Coolant Level Sensor" parameter is programmed to "4-pin" or "2-wire Float Sensor".
- The engine has been running for at least 30 seconds.

**System Response:**

The ECM will display “Low” and “DIAG” next to the status for “Engine Coolant Level” on the electronic service tool. The check engine lamp and the warning lamp will turn on while this code is active.

**Note:** If a lamp for low coolant level is installed, the lamp for low coolant level will turn on instead of the warning lamp.

Factory passwords are required to clear this diagnostic code.

**Possible Performance Effect:**

None

**Troubleshooting:****Test Step 1. Check the Coolant Level**

**A.** Check the engine coolant level. Refer to the Operation and Maintenance Manual for more information.

**Expected Result:**

The engine coolant level is normal.

**Results:**

- **OK** – The engine coolant level is normal.

**Repair:** Ensure that the coolant level sensor is properly installed.

**STOP.**

- **Not OK** – The engine coolant level is low.

**Repair:** Add coolant to the engine. Refer to the Operation and Maintenance Manual for more information.

Proceed to Test Step 2.

**Test Step 2. Check for Leaks in the Cooling System**

- A.** Check for leaking engine coolant.
- B.** Check for coolant in the engine oil.

**Expected Result:**

There are no leaks. There is no coolant in the engine oil.

**Results:**

- **OK** – The engine is not losing any engine coolant.

**Repair:** Ensure that the engine coolant level is normal.

Run the engine until the engine reaches normal operating temperatures.

Stop the engine and allow the engine to cool.

Recheck the engine coolant level. If the coolant level is low, add more engine coolant.

**STOP.**

- **Not OK** – The engine is leaking engine coolant or there is coolant in the engine oil.

**Repair:** Repair the leaks.

Verify that the repair eliminates the problem.

**STOP.**

i01856833

**0111-02 Coolant Level signal invalid (12)**

**SMCS Code:** 5574-038-CLT

**Conditions Which Generate This Code:**

The ECM detects the following conditions:

- The coolant level sensor is sending an invalid signal for more than ten seconds.
- The “Coolant Level Sensor” parameter is programmed to “4-pin” or “2-wire Float Sensor”.
- The ECM has been powered for at least two seconds.

**System Response:**

The ECM will default to OK for engine coolant level. “DIAG” will be displayed next to the status for “Engine Coolant Level” on the electronic service tool.

**Possible Performance Effect:**

None

**Troubleshooting:**

Perform the following diagnostic procedure:  
“Coolant Level Sensor Circuit - Test”

**Results:**

- OK – STOP.

i01855647

**0111-03 Coolant Level voltage high (12)**

**SMCS Code:** 5574-038-CLT

**Conditions Which Generate This Code:**

The ECM detects the following conditions:

- The signal voltage from the coolant level sensor is greater than 4.5 VDC for more than ten seconds.
- The “Coolant Level Sensor” parameter is programmed to “2-wire Float Sensor”.
- The ECM has been powered for at least two seconds.

**System Response:**

The ECM will default to OK for coolant level. “DIAG” will be displayed next to the status for “Engine Coolant Level” on the electronic service tool.

**Possible Performance Effect:**

None

**Troubleshooting:**

Perform the following diagnostic procedure:  
“Coolant Level Sensor Circuit - Test”

**Results:**

- OK – STOP.

i01855649

**0111-04 Coolant Level voltage low (12)**

**SMCS Code:** 5574-038-CLT

**Conditions Which Generate This Code:**

The ECM detects the following conditions:

- The signal voltage from the coolant level sensor is less than 0.5 VDC for more than ten seconds.

- The “Coolant Level Sensor” parameter is programmed to “2-wire float sensor”.
- The ECM has been powered for at least two seconds.

**System Response:**

The ECM will default to “OK” for coolant level. “DIAG” will be displayed next to the status for “Engine Coolant Level” on the electronic service tool.

**Possible Performance Effect:**

None

**Troubleshooting:**

Perform the following diagnostic procedure:  
“Coolant Level Sensor Circuit - Test”

**Results:**

- OK – STOP.

i01856872

**0111-11 Very Low Coolant Level (62)**

**SMCS Code:** 5574-038-CLT

**Conditions Which Generate This Code:**

The ECM detects the following conditions:

- The coolant level is very low for more than 20 seconds.
- The “Coolant Level Sensor” parameter is programmed to “4-pin” or “2-wire Float Sensor”.
- The engine has been running for at least 30 seconds.

**System Response:**

The ECM will display “Low” and “DIAG” next to the status for “Engine Coolant Level” on the electronic service tool. The check engine lamp and the warning lamp will turn on while this code is active.

**Note:** If a lamp for low coolant level is installed, the lamp for low coolant level will turn on instead of the warning lamp.

Factory passwords are required to clear this diagnostic code.

**Possible Performance Effect:**

The engine power is derated by 35% at a rate of 1% per second. The vehicle speed is limited to a maximum of 72 km/h (45 mph).

**Note:** If “Engine Monitoring” is programmed to Shutdown, the engine will be shutdown once this diagnostic code has been active for 30 seconds.

**Troubleshooting:****Test Step 1. Check the Coolant Level**

- A.** Check the engine coolant level. Refer to the Operation and Maintenance Manual for more information.

**Expected Result:**

The engine coolant level is normal.

**Results:**

- OK – The engine coolant level is normal.

**Repair:** Ensure that the coolant level sensor is properly installed.

STOP.

- Not OK – The engine coolant level is low.

**Repair:** Add coolant to the engine. Refer to the Operation and Maintenance Manual for more information.

Proceed to Test Step 2.

**Test Step 2. Check for Leaks in the Cooling System**

- A.** Check for leaking engine coolant.
- B.** Check for coolant in the engine oil.

**Expected Result:**

There are no leaks. There is no coolant in the engine oil.

**Results:**

- OK – The engine is not losing any engine coolant.

**Repair:** Ensure that the engine coolant level is normal.

Run the engine until the engine reaches normal operating temperatures.

Stop the engine and allow the engine to cool.

Recheck the engine coolant level. If the coolant level is low, add more engine coolant.

STOP.

- Not OK – The engine is leaking engine coolant or there is coolant in the engine oil.

**Repair:** Repair the leaks.

Verify that the repair eliminates the problem.

STOP.

i01822141

**0121-05 Low/High Retarder current low (14)**

**SMCS Code:** 1129-038

**Conditions Which Generate This Code:**

The ECM detects the following conditions:

- The ECM detects a low current condition (open circuit) for one second while the ECM is attempting to energize the solenoid for cylinder 3 and cylinder 4.
- The engine retarder switch is in the Low or High position.

**System Response:**

The ECM will turn on the check engine lamp.

**Possible Performance Effect:**

The engine retarder may not activate.

**Troubleshooting:**

Perform the following diagnostic procedure: “Retarder (Compression Brake) Solenoid Circuit - Test”

**Results:**

- OK – STOP.

i01822140

## 0121-06 Low/High Retarder current high (14)

**SMCS Code:** 1129-038**Conditions Which Generate This Code:**

The ECM detects the following conditions:

- The ECM detects a high current condition (short circuit) for one second while the ECM is attempting to energize the solenoid for cylinder 3 and cylinder 4.
- The engine retarder switch is in the Low or High position.

**System Response:**

The ECM will turn on the check engine lamp.

**Possible Performance Effect:**

The engine retarder may not activate.

**Troubleshooting:**

Perform the following diagnostic procedure:  
"Retarder (Compression Brake) Solenoid Circuit - Test"

**Results:**

- OK – STOP.

i01822450

## 0122-05 Med/High Retarder current low (14)

**SMCS Code:** 1129-038**Conditions Which Generate This Code:**

The ECM detects the following conditions:

- The ECM detects a low current condition (open circuit) for one second while the ECM is attempting to energize the solenoids for cylinder 1, cylinder 2, cylinder 5, and cylinder 6.
- The engine retarder switch is in the Medium or High position.

**System Response:**

The ECM will turn on the check engine lamp.

**Possible Performance Effect:**

The engine retarder may not activate.

**Troubleshooting:**

Perform the following diagnostic procedure:  
"Retarder (Compression Brake) Solenoid Circuit - Test"

**Results:**

- OK – STOP.

i01822446

## 0122-06 Med/High Retarder current high (14)

**SMCS Code:** 1129-038**Conditions Which Generate This Code:**

The ECM detects the following conditions:

- The ECM detects a high current condition (short circuit) for one second while the ECM is attempting to energize the solenoids for cylinder 1, cylinder 2, cylinder 5, and cylinder 6.
- The engine retarder switch is in the Medium or High position.

**System Response:**

The ECM will turn on the check engine lamp.

**Possible Performance Effect:**

The engine retarder may not activate.

**Troubleshooting:**

Perform the following diagnostic procedure:  
"Retarder (Compression Brake) Solenoid Circuit - Test"

**Results:**

- OK – STOP.

## 0168-02 ECM Battery Power Intermittent (51)

**SMCS Code:** 1401-038

### Conditions Which Generate This Code:

This condition indicates that the battery circuit to the ECM has a battery condition that is intermittent while the engine is running. If battery voltage disappears without returning, the ECM will not log this diagnostic code and the engine will shut down.

The ECM detects the following conditions:

- The key switch is in the ON position.
- The engine is running.
- The engine is not cranking.
- The ECM has been powered for at least three seconds.

The ECM will detect one of the following conditions:

- The battery voltage drops below 6 VDC for at least 0.50 seconds.
- Three voltage readings in the past seven seconds were below 6 VDC.

### System Response:

The ECM may stop injecting fuel. This may be dependent on the length of time of the occurrence of the fault.

The Check Engine Lamp and the Warning Lamp may come on as if the ignition key switch was just turned on and the engine started.

### Possible Performance Effect:

The engine may experience changes in the engine rpm, and intermittent engine shutdowns or complete engine shutdowns while the conditions that cause this diagnostic code are present.

### Troubleshooting:

Perform the following diagnostic procedure: "Ignition Key Switch Circuit and Battery Supply Circuit - Test"

### Results:

- OK – STOP.

## 0171-03 Ambient Air Temperature voltage high

**SMCS Code:** 1928-038

### Conditions Which Generate This Code:

The ECM detects the following conditions:

- The signal voltage from the ambient air temperature sensor is greater than 4.92 VDC for more than eight seconds.
- The "Allow Idle Shutdown Override" parameter is programmed to "Outside Temperature Based" or "J1587 Outside Temperature Based".
- The ECM has been powered for at least two seconds.

### System Response:

The ECM will default to 65 °C (149 °F) for outside air temperature. "DIAG" will be displayed next to the status for "Outside Temperature Sensor" on the electronic service tool.

### Possible Performance Effect:

"Allow Idle Shutdown Override" is disabled while this code is Active.

### Troubleshooting:

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

### Results:

- OK – STOP.

## 0171-04 Ambient Air Temperature voltage low

**SMCS Code:** 1928-038

### Conditions Which Generate This Code:

The ECM detects the following conditions:

- The signal voltage from the ambient air temperature sensor is less than 0.2 VDC for more than eight seconds.

- The “Allow Idle Shutdown Override” parameter is programmed to “Outside Temperature Based” or “J1587 Outside Temperature Based”.
- The ECM has been powered for at least two seconds.

**System Response:**

The ECM will default to 65 °C (149 °F) for outside air temperature. “DIAG” will be displayed next to the status for “Outside Temperature Sensor” on the electronic service tool.

**Possible Performance Effect:**

“Allow Idle Shutdown Override” is disabled while this code is active.

**Troubleshooting:**

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

**Results:**

- OK – STOP.

i01901704

## 0171-11 Ambient Air Temperature Data Lost

**SMCS Code:** 1928-038**Conditions Which Generate This Code:**

The ECM detects the following conditions:

- The ECM is not receiving information about the ambient air temperature from the SAE J1587 data link.

The “Allow Idle Shutdown Override” is programmed to the J1587 Outside Temp Based option.

**System Response:**

The temperature based idle shutdown override is disabled. Outside air temperature is set to 65 °C (149 °F).

**Possible Performance Effect:**

None

**Troubleshooting:**

Perform the following diagnostic procedure: “ATA (SAE J1587 / J1708) Data Link Circuit - Test”

**Results:**

- OK – STOP.

i01864495

## 0174-00 High Fuel Temperature Warning (65)

**SMCS Code:** 1922-038**Conditions Which Generate This Code:**

The ECM detects the following conditions:

- The fuel temperature is above 90 °C (194 °F) for more than 30 seconds.
- The engine has been running for at least three minutes.

**System Response:**

“DIAG” is displayed next to the status for “Fuel Temperature” on the electronic service tool.

Customer passwords are required to clear this diagnostic code.

**Possible Performance Effect:**

None

**Troubleshooting:**

No troubleshooting is required.

**Results:**

- OK – STOP.

i01814156

## 0174-03 Fuel Temperature voltage high (13)

**SMCS Code:** 1922-038**Conditions Which Generate This Code:**

The ECM detects the following conditions:

- The signal voltage from the fuel temperature sensor is greater than 4.9 VDC for more than eight seconds.
- Engine coolant temperature is above –10 °C (15.0 °F).
- The ECM has been powered for at least two seconds.

**System Response:**

The ECM will default to the lower of engine coolant temperature or 50 °C (122.0 °F) for fuel temperature. "DIAG" will be displayed next to the status for "Fuel Temperature" on the electronic service tool.

**Possible Performance Effect:**

None

**Troubleshooting:**

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

**Results:**

- OK – STOP.

i01814157

## 0174-04 Fuel Temperature voltage low (13)

**SMCS Code:** 1922-038

**Conditions Which Generate This Code:**

The ECM detects the following conditions:

- The signal voltage from the fuel temperature sensor is less than 0.2 VDC for more than eight seconds.
- The ECM has been powered for at least two seconds.

**System Response:**

The ECM will default to the lower of engine coolant temperature or 50 °C (122.0 °F) for fuel temperature. "DIAG" will be displayed next to the status for "Fuel Temperature" on the electronic service tool.

**Possible Performance Effect:**

None

**Troubleshooting:**

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

**Results:**

- OK – STOP.

## 0190-00 Engine Overspeed Warning (35)

**SMCS Code:** 1912-038

**Conditions Which Generate This Code:**

The ECM detects the following conditions:

- The engine speed exceeded 2600 rpm for more than 0.6 seconds.
- A valid engine speed/timing signal is detected.
- The ECM has been powered for at least three seconds.

**System Response:**

The ECM will not energize the injectors above the programmed "Top Engine Limit". "Top Engine Limit" will be displayed on the status screen on the electronic service tool.

Factory passwords are required to clear this diagnostic code.

**Possible Performance Effect:**

The engine will lose power above 2600 rpm.

**Troubleshooting:**

There are no problems that require troubleshooting.

This diagnostic code indicates an excessive engine speed. This diagnostic code does not indicate a problem with the ECM or the Engine Speed/Timing Sensor.

**Results:**

- OK – STOP.

i01905839

## 0190-12 Primary Engine Speed loss of signal (34)

**SMCS Code:** 1912-038

**Conditions Which Generate This Code:**

The ECM detects the following conditions:

- The signal from the primary engine speed/timing sensor is intermittent or lost.

**System Response:**

The ECM will use the secondary engine speed/timing sensor to determine engine speed. The check engine lamp will not be illuminated for this code unless the code has been active for 10 hours.

**Possible Performance Effect:**

There may be a slight change in engine response when the ECM is switched to the secondary engine speed/timing sensor.

**Troubleshooting:**

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

**Results:**

- OK – STOP.

i01855314

**0191-07 Transmission Not Responding (68)**

**SMCS Code:** 3174-038

**Conditions Which Generate This Code:**

The ECM detects the following conditions:

- Three attempts to complete an Eaton Top 2 shift were unsuccessful.
- The "Transmission Style" is programmed to "Eaton Top 2".

**System Response:**

The solenoid that is currently enabled will remain in the ON position until neutral is detected. Then Manual operation occurs until the system powers down. Manual operation is defined as both solenoids OFF.

**Possible Performance Effect:**

The ECM disables the Eaton Top 2 mode.

**Troubleshooting:**

Perform the following diagnostic procedure: "Eaton Top 2 Transmission Circuit - Test"

**Results:**

- OK – STOP.

i01641096

**0224-11 Theft Deterrent Active (00)**

**SMCS Code:** 1901-038

**Conditions Which Generate This Code:**

The theft deterrent feature has been enabled. The correct password must be entered in order to disable the theft deterrent. Then, the engine can be started.

**Note:** This diagnostic code represents an event. This diagnostic code does not represent an electronic system fault.

The ECM will operate in the "Secure Idle" mode if the theft deterrent password is entered. The engine must be running in order to operate in the "Secure Idle" mode. The ECM will be in the "Secure Idle" mode until the theft deterrent password is entered again.

**System Response:**

**Electronic System Response** The diagnostic code is active only. The diagnostic code will be active when the theft deterrent feature is enabled.

**Service Tool Display and Lamps** Caterpillar Electronic Technician (ET) will not display a status. The Check Engine Lamp will be illuminated.

**Engine Response** The engine will not start until the correct password is entered. The engine will be limited to the Low Idle rpm if the "Secure Idle" mode is active.

**Troubleshooting:**

This diagnostic code indicates that the theft deterrent feature has been enabled. There is no electronic system fault.

No Troubleshooting is required.

**Results:**

- OK – STOP.

i01901708

**0224-14 Theft Deterrent Active with Engine Cranking (00)**

**SMCS Code:** 1901-038

**Conditions Which Generate This Code:**

The ECM detects the following conditions:

- The engine is cranking.
- The theft deterrent is active.

**System Response:**

The diagnostic code is active only. The diagnostic code will be active when the theft deterrent is enabled and the engine is cranking for more than 5 seconds.

**Possible Performance Effect:**

The engine will not start until the correct password is entered.

**Troubleshooting:**

Enter the correct passwords.

There are no problems that require troubleshooting.

**Results:**

- OK – STOP.

**0231-02 J1939 Data Incorrect (58)**

i01852913

**SMCS Code:** 1901-038

**Conditions Which Generate This Code:**

The ECM detects the following condition:

- The parameter "Powertrain Data Link" must be programmed to J1939.

The ECM also detects one of the following conditions:

- The ECM is unsuccessful in receiving a specific message from a device.

or

- The device is broadcasting a fault code.

or

- The device is broadcasting a code that is not supported.

**System Response:**

J1939 communications to the engine and from the engine are terminated for the specific message while this code is active. The functionality of some features may be affected while this code is active. Traction control or transmission controls may be disabled. "Diag" or "J1939 No Support" will be displayed next to the status on the electronic service tool.

**Possible Performance Effect:**

Features that utilize the J1939 data link may not work properly or the features may be disabled.

Perform the following diagnostic procedure: "Powertrain Data Link Circuit - Test"

**Results:**

- OK – STOP.

i01225728

**0231-11 J1939 Data Link Fault (58)**

**SMCS Code:** 1901-038

**Conditions Which Generate This Code:**

This condition indicates that the SAE J1939 Data Link is not communicating correctly.

**System Response:**

**Electronic System Response** The Communications with other control modules that use the SAE J1939 Data Link may be interrupted while the Diagnostic Code is Active.

**Note:** If the vehicle is not using the J1939 Data Link, program the "Power Train Data Link" (Customer Parameter) to "None" or J1922. After the "Power Train Data Link" is programmed correctly the following Active Diagnostic Code should be repaired:

- 231-11 J1939 Data Link Fault (58)

**Troubleshooting:**

Contact the OEM dealer in order to determine if the vehicle was built in order to use the J1922 or J1939 Data Link. If the vehicle is not using the J1922 or J1939 Data Link, program the "Power Train Data Link" (Customer Parameter) to "None". This will repair the problem.

If the vehicle is using the J1922 or J1939 Data Link for Power Train Control, proceed with the following procedure:

Perform the following diagnostic procedure:  
"Powertrain Data Link Circuit - Test"

**Results:**

- OK – STOP.

i01617802

## 0231-12 J1939 Device Not Responding

**SMCS Code:** 1901-038

**Conditions Which Generate This Code:**

This condition indicates that the J1939 data link has a short circuit or an open circuit. All of the following conditions must be met:

- The parameter "Powertrain Data Link" must be programmed J1939.
- The ECM is unsuccessful in receiving a response to a message that has been transmitted for 10 seconds.

**Electronic System Response J1939**

communications to the engine and from the engine are terminated while this code is active. The functionality of some features may be affected while this code is active. Traction control or transmission controls may be disabled.

**Service Tool Display or Lamps** The Caterpillar Electronic Technician (ET) will display "NO COMM" on the status screen next to the inputs that are not receiving communications.

Perform the following diagnostic procedure:  
"Powertrain Data Link Circuit - Test"

**Results:**

- OK – STOP.

i01814912

## 0232-03 5 Volt Supply voltage high (21)

**SMCS Code:** 5574-038

**Conditions Which Generate This Code:**

The ECM detects the following conditions:

- The 5 volt supply is greater than 5.16 VDC for more than one second.
- The ECM has been powered for at least three seconds.

**System Response:**

The ECM sets all of the pressure sensors to the default values below:

- Atmospheric Pressure 100 kPa (15.0 psi)
- Boost pressure 0 kPa (0.0 psi)
- Engine Oil Pressure 600 kPa (87.0 psi)

The ECM will use a default torque map. "DIAG" will be displayed next to the status for all of the pressure sensors on the electronic service tool.

**Possible Performance Effect:**

The engine will experience low power when this diagnostic code is active.

**Troubleshooting:**

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

**Results:**

- OK – STOP.

i01814917

## 0232-04 5 Volt Supply voltage low (21)

**SMCS Code:** 5574-038

**Conditions Which Generate This Code:**

The ECM detects the following conditions:

- The 5 volt supply is less than 4.84 VDC for more than one second.
- The ECM has been powered for at least three seconds.

**System Response:**

The ECM sets all of the pressure sensors to the default values below:

- Atmospheric Pressure 100 kPa (15 psi)
- Boost pressure 0 kPa (0 psi)
- Engine Oil Pressure 600 kPa (87 psi)

The ECM will use a default torque map. "DIAG" will be displayed next to the status for all of the pressure sensors on the electronic service tool.

**Possible Performance Effect:**

The engine will experience low power when this diagnostic code is active.

**Troubleshooting:**

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

**Results:**

- OK – STOP.

i01855532

## 0246-11 Brake Pedal Switch #1 Fault

**SMCS Code:** 1435-038-BRK

**Conditions Which Generate This Code:**

The ECM detects the following conditions:

- The status of the service brake pedal position switch 1 and the service brake pedal position switch 2 do not match for at least 15 seconds.
- The engine is running.
- The ECM has been powered for at least three seconds.

**Note:** The "Transmission Style" parameter must be programmed to Automatic Option 2 or Automatic Option 3.

**System Response:**

This diagnostic code will prevent cruise control, PTO operation, or idle operation.

**Possible Performance Effect:**

The engine will disengage or the engine will not allow the setting of the Cruise Control, the PTO, or the Idle speed.

**Troubleshooting:**

Perform the following diagnostic procedure: "Service Brake Pedal Position (Switch 1) Circuit -Test"

**Results:**

- OK – STOP.

i01855537

## 0247-11 Brake Pedal Switch #2 Fault

**SMCS Code:** 1435-038-BRK

**Conditions Which Generate This Code:**

The ECM detects the following conditions:

- The status of the service brake pedal position switch 2 and the service brake pedal position switch 1 do not match for more than 15 seconds.
- The engine is running.
- The ECM has been powered for at least three seconds.

**Note:** The "Transmission Style" parameter must be programmed to Automatic Option 2 or Automatic Option 3.

**System Response:**

This diagnostic code will prevent cruise control, PTO operation, or idle operation.

**Possible Performance Effect:**

The engine will disengage or the engine will not allow setting of the cruise control, the PTO, or the idle speed.

**Troubleshooting:**

Perform the following diagnostic procedure: "Service Brake Pedal Position (Switch 2) Circuit - Test"

**Results:**

- OK – STOP.

i01643896

## 0249-11 J1922 Data Link Fault (58)

**SMCS Code:** 1901-038

**Conditions Which Generate This Code:**

This condition indicates that the SAE J1922 Data Link is not communicating correctly.

**System Response:**

**Electronic System Response** The Communications with other control modules that use the SAE J1922 Data Link are disabled while the Diagnostic Code is Active.

**Note:** If the vehicle is not using the J1922 Data Link for the vehicle's Power Train Control, program the "Power Train Data Link" (Customer Parameter) to "None". After the "Power Train Data Link" is programmed correctly the following Active Diagnostic Code should be repaired:

- 249-11 Powertrain Data Link (58)

**Troubleshooting:**

Contact the OEM dealer in order to determine if the vehicle was built in order to use the J1922 or J1939 Data Link for Power Train Control. If the vehicle is not using the J1922 or J1939 Data Link for Power Train Control, program the "Power Train Data Link" (Customer Parameter) to "None". This will repair the problem.

If the vehicle is using the J1922 or J1939 Data Link for Power Train Control, proceed with the following procedure:

Perform the following diagnostic procedure: "Powertrain Data Link Circuit - Test"

**Results:**

- OK – STOP.

i01822603

**0252-11 Engine Software Incorrect (59)**

**SMCS Code:** 1901-038

**Conditions Which Generate This Code:**

The ECM detects the following conditions:

- The engine software and the ECM are not compatible.

**System Response:**

The ECM will turn on the check engine lamp.

Factory passwords are required to clear this diagnostic code.

**Possible Performance Effect:**

The engine will not start.

**Troubleshooting:**

Perform the following diagnostic procedure: "ECM Memory - Test"

**Results:**

- OK – STOP.

i01643894

**0253-02 Check Customer or System Parameters (56)**

**SMCS Code:** 1901-038

**Conditions Which Generate This Code:**

This condition indicates a Customer Specified Parameter or a System Configuration Parameter that requires programming has not been programmed. Once this parameter has been programmed, the code may still be active. This can happen if there is yet another parameter that requires programming.

**System Response:**

**Electronic System Response** The fault is Active only and the fault is not Logged. If the Personality Module Code of the new Personality Module does not match the Code of the old Personality Module, the engine is limited to low idle. If the "Rating Number" has not been programmed, the ECM limits the engine to 119 kW (160 hp). When a new ECM is initially powered up, the following parameters must be programmed to avoid this diagnostic code:

- "FLS" (Full Load Setting)
- "FTS" (Full Torque Setting)
- "Vehicle Speed Calibration"
- "Rating Number"
- "Engine Serial Number"
- "Injector Codes Calibration"

**Engine Response** The ECM will limit the engine to low idle if the parameter is the FLS or the FTS. The ECM may also limit the power if the parameter is a rating number.

**Troubleshooting:**

Perform the following diagnostic procedure: "ECM Memory - Test"

**Results:**

- OK – STOP.

i01225847

## 0253-11 Check Transmission Customer Parameters (56)

**SMCS Code:** 1901-038

### Conditions Which Generate This Code:

This condition indicates that the "Transmission Style" parameter is programmed to the Eaton Top 2 and any one of the following parameters are not programmed:

- "Top Gear Ratio"
- "Top Gear Minus One Ratio"
- "Top Gear Minus Two Ratio"

### System Response:

**Engine Response** The engine will not operate above low idle.

### Troubleshooting:

Program the "Transmission Style" parameter that is Eaton Top 2 to the correct setting. If an Eaton Top 2 Transmission is not used, program the correct "Transmission Style" parameter to the correct setting.

### Results:

- OK – STOP.

# CATERPILLAR

## 3406E, C-10, C-12, C-15, C-15 AND C-18 TRUCK ENGINE

### DIAGNOSTIC FUNCTIONAL TESTS

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# Diagnostic Functional Tests

i01907586

## 5 Volt Engine Pressure Sensor Supply Circuit - Test

**SMCS Code:** 5574-038**System Operation Description:****Use this procedure under the following situation:**

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

- 232-03 5 Volt Supply voltage high
- 232-04 5 Volt Supply voltage low

Also, use this procedure to troubleshoot the system when you have been directed here by another troubleshooting procedure.

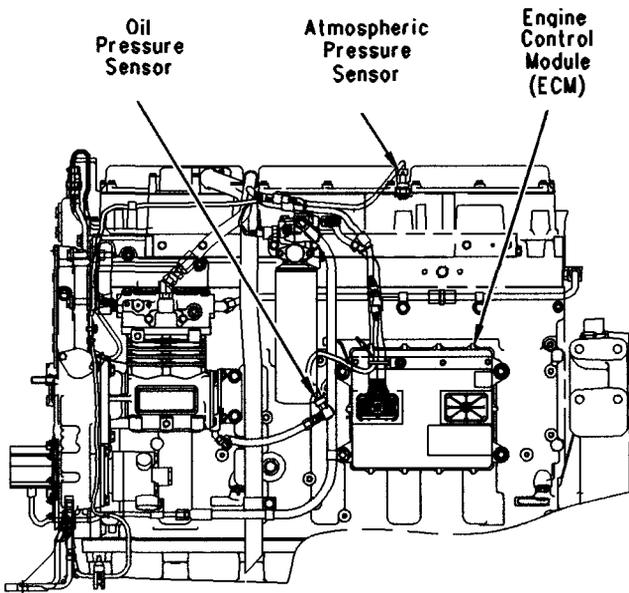
**The following background information is related to this procedure:**

The Engine Control Module (ECM) supplies the following sensors with regulated 5 VDC:

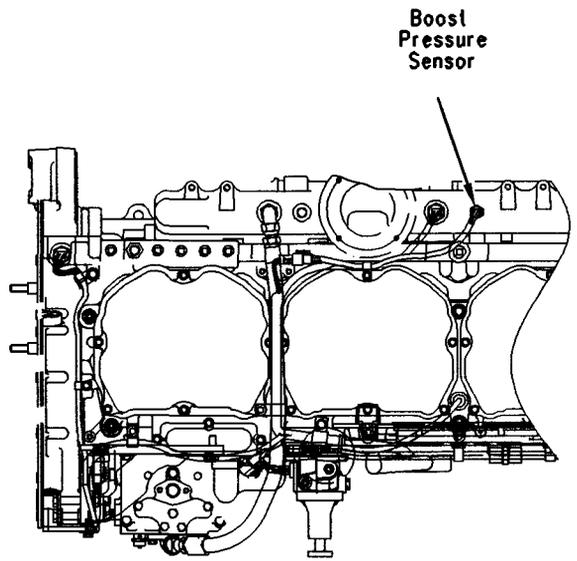
- Atmospheric pressure sensor
- Boost pressure sensor
- Engine oil pressure sensor

The supply for the +5 V engine pressure sensor is routed from the ECM to terminal A of each pressure sensor connector. The supply voltage is  $5.0 \pm 0.16$  VDC.

The +5 V diagnostic code is probably caused by a short circuit to ground or a short circuit to another voltage source in the harness.



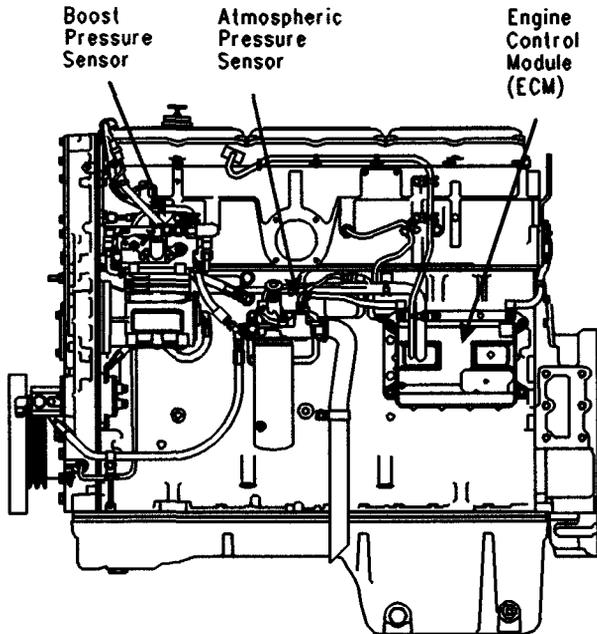
C-10 AND C-12 LEFT SIDE VIEW



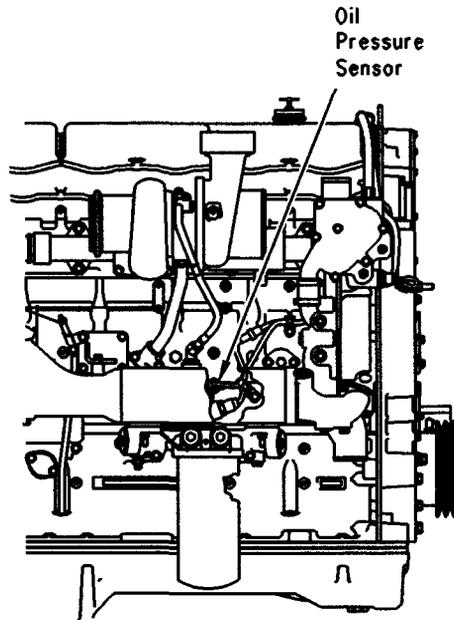
C-10 AND C-12 TOP VIEW

Illustration 36  
Sensor locations for C-10 and C-12 engines

g00692909



3406E LEFT SIDE VIEW



3406E RIGHT SIDE VIEW

Illustration 37  
Sensor locations for 3406E engines

g00662230

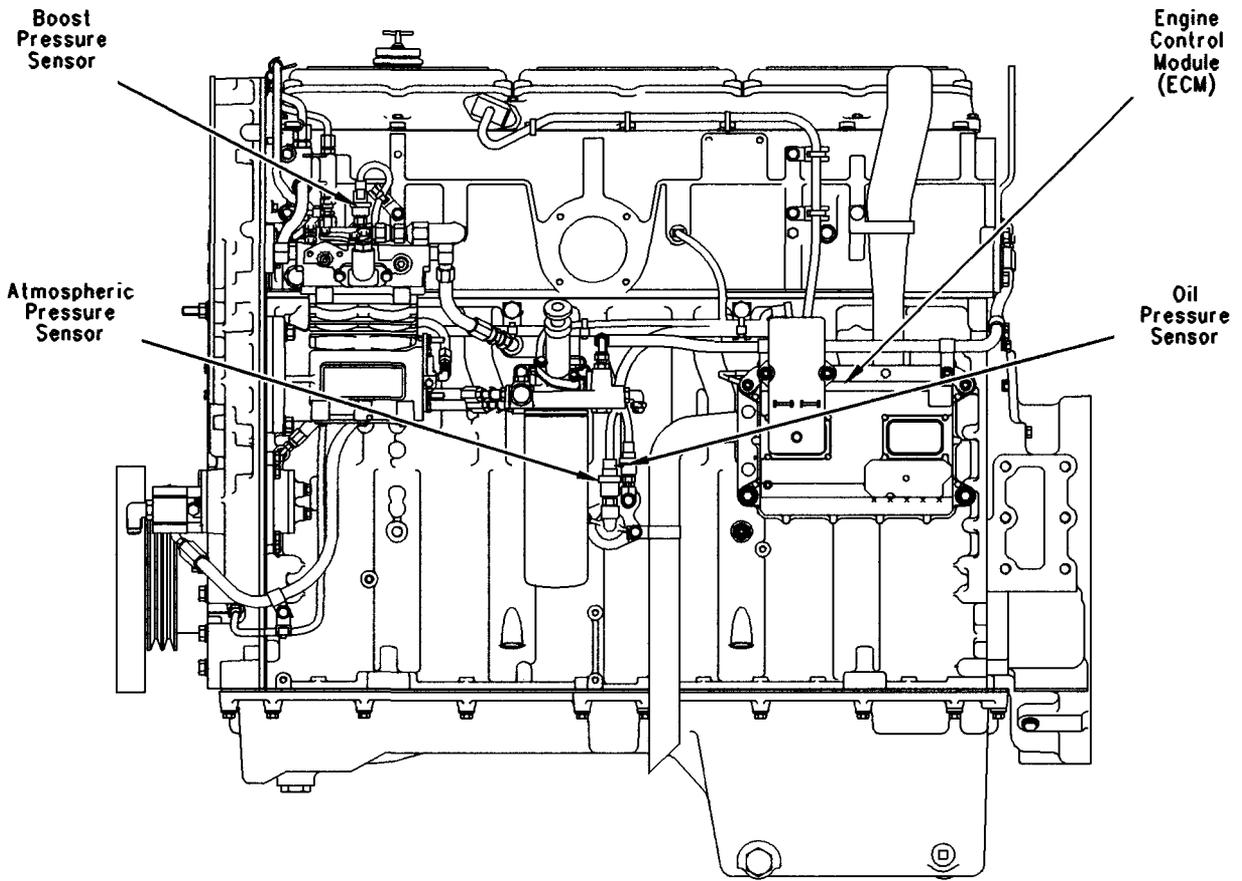


Illustration 38  
 Sensor locations for C-15, C-16 and C-18 engines

g00693763

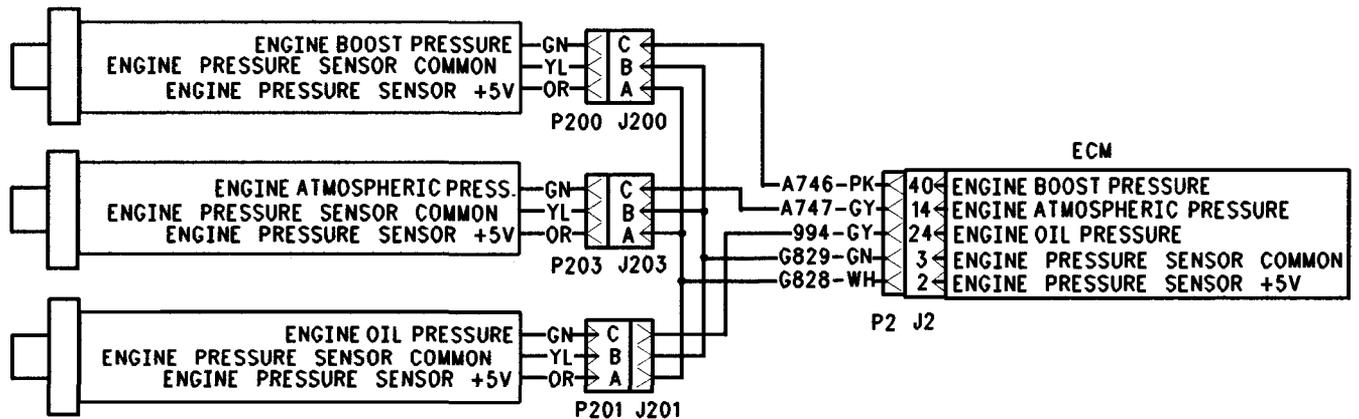


Illustration 39  
 Schematic

g00662235

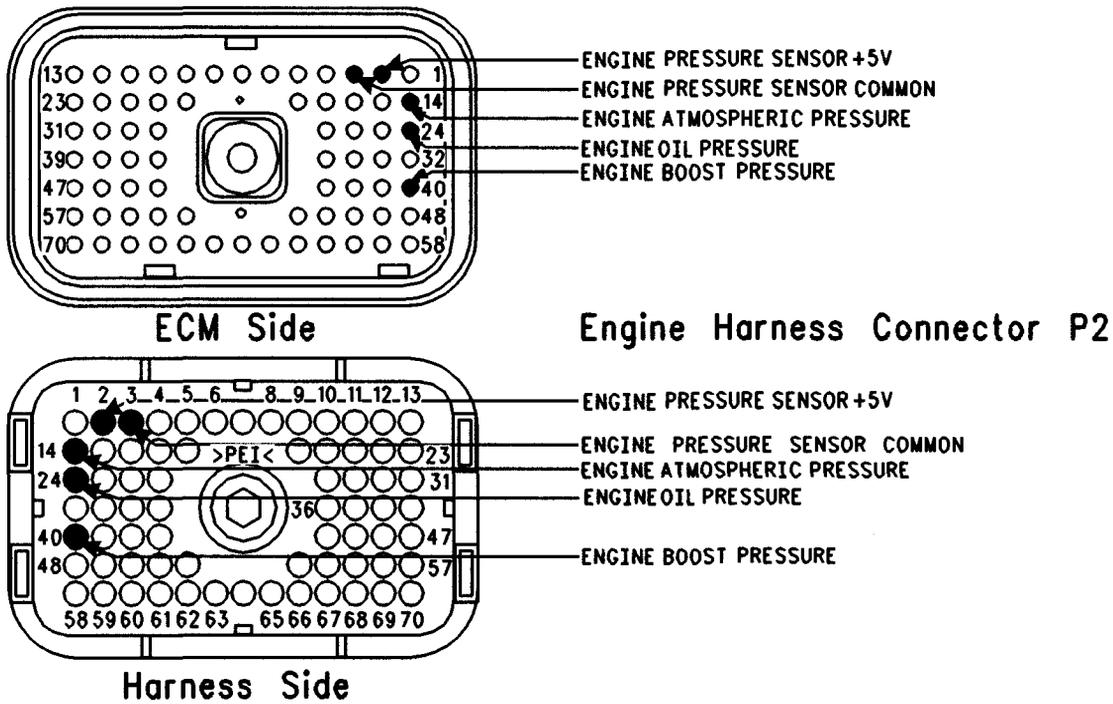


Illustration 40  
P2 ECM connector

g00662237

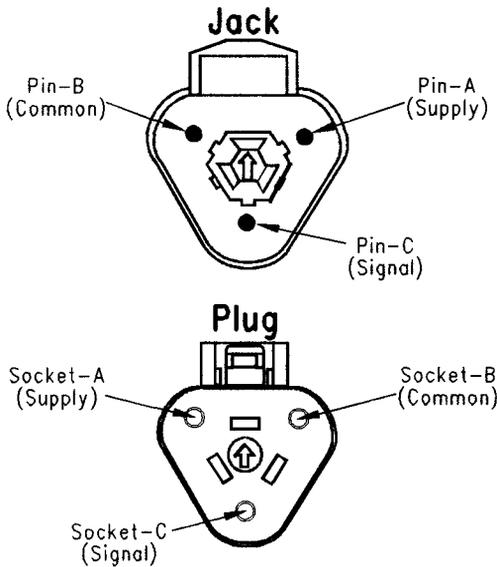


Illustration 41  
Sensor connector

g00810608

### Test Step 1. Disconnect the ECM Connector and Check for Active Diagnostic Codes

A. Turn the key switch to the OFF position.

- B. Connect the Caterpillar Electronic Technician (Cat ET) to the data link connector.
- C. Disconnect the P2 ECM connector from the ECM.
- D. Check the ECM connector for corrosion and moisture.
- E. Turn the key switch to the ON position.
- F. Check for active diagnostic codes on Cat ET.

**Note:** A "voltage high" diagnostic code (open circuit) should be active for all of the engine pressure sensors.

#### Expected Result:

The 5 volt diagnostic codes are not active. A "voltage high" diagnostic code (open circuit) should be active for all of the engine pressure sensors.

#### Results:

- OK – The 5 volt diagnostic codes are not active.  
Repair: Reconnect the P2 ECM connector.  
Proceed to Test Step 2.

- **Not OK** – The 5 volt diagnostic codes are still active.

**Repair:** Connect a test ECM.

If the test ECM fixes the problem, reconnect the suspect ECM.

If the problem returns, permanently install the new ECM.

Verify that the repair eliminates the problem.

**STOP.**

## Test Step 2. Disconnect the Sensors

- Turn the key switch to the ON position.
- Monitor the active diagnostic code screen on Cat ET.
- Disconnect the pressure sensors one at a time. Wait for 30 seconds after each pressure sensor is disconnected.

**Note:** The 5 volt diagnostic code will become inactive if a pressure sensor is the cause of the 5 volt diagnostic code.

- Ensure that all of the pressure sensors are disconnected.

### Expected Result:

The 5 volt diagnostic code is still active when all of the pressure sensors are disconnected.

### Results:

- **OK** – The 5 volt diagnostic code is still active.

**Repair:** Leave all of the pressure sensors disconnected.

Proceed to Test Step 4.

- **Not OK** – The 5 volt diagnostic code disappears when the pressure sensors are disconnected.

**Repair:** Reconnect all of the pressure sensors except the suspect sensor.

Proceed to Test Step 3.

## Test Step 3. Check the Signal Wire

- Turn the key switch to the ON position.

**Note:** The suspect sensor should be disconnected.

- Measure the voltage between terminal C (Signal) and terminal B (Pressure Sensor Common) of the connector for the suspect sensor on the engine harness.

### Expected Result:

The voltage should be less than 7.0 VDC.

### Results:

- **OK** – The voltage is within the range.

**Repair:** Temporarily connect a new sensor.

If the problem is resolved with the new sensor, reconnect the suspect sensor.

If the problem returns, replace the suspect sensor.

Verify that the repair eliminates the problem.

**STOP.**

- **Not OK** – The voltage is greater than 7.0 VDC.

**Repair:** Inspect the signal wire for a short circuit to a voltage source.

Repair the signal wire or replace the signal wire.

Verify that the repair eliminates the problem.

**STOP.**

## Test Step 4. Determine the Condition that is Present

- Turn the key switch to the ON position.
- Access the active diagnostic code screen on Cat ET.

### Expected Result:

232-03 or 232-04 is active.

### Results:

- **232-03** – Proceed to Test Step 5.
- **232-04** – Proceed to Test Step 7.

## Test Step 5. Measure the 5 Volt Supply to the Sensor

- Turn the key switch to the ON position.

**Note:** All of the pressure sensors should be disconnected.

- B.** Measure the voltage between terminal A (Pressure Sensor +5V) and chassis ground for each pressure sensor.

**Expected Result:**

The voltage should be  $5.0 \pm 0.16$  VDC.

**Results:**

- **OK** – The 5 volt supply is within the range. Proceed to Test Step 6.
- **Not OK** – The voltage is greater than 5.16 volts.

**Repair:** Check the 5 volt supply wire for a short to a higher voltage source.

Repair the 5 volt supply wire or replace the 5 volt supply wire.

Verify that the repair eliminates the problem.

STOP.

**Test Step 6. Check the Common Wire**

- A.** Turn the key switch to the ON position.
- B.** Measure the voltage between terminal A (Pressure Sensor +5V) and terminal B (Pressure Sensor Common) on all of the pressure sensors.
- C.** While the voltage is monitored, perform a 45 N (10 lb) pull test on the common wires for the 5 volt supply.
- P2:3 (Pressure Sensor Common)
  - P2:42 (Pressure Sensor Common (Actuator))

**Expected Result:**

The voltage should be  $5.0 \pm 0.16$  VDC.

**Results:**

- **OK** – The voltage is within the range.

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

STOP.

- **Not OK** – The voltage is not within the range.

**Repair:** Inspect the common wire for an open circuit.

Repair the common wire or replace the common wire.

Verify that the repair eliminates the problem.

STOP.

**Test Step 7. Check the Resistance of the Harness**

- A.** Turn the key switch to the OFF position.
- B.** Verify that all of the sensors are disconnected.
- C.** Measure the resistance between terminal A (Pressure Sensor +5V) and terminal B (Pressure Sensor Common) of each connector for the pressure sensor on the engine harness.

**Expected Result:**

The resistance should be greater than 20,000 Ohms, or "OL" is displayed on the multimeter.

**Results:**

- **OK** – The 5 volt supply and the pressure sensor common are not shorted.

**Repair:** Check the 5 volt supply for a short to ground.

Repair the 5 volt supply wire or replace the 5 volt supply wire.

Verify that the repair eliminates the problem.

STOP.

- **Not OK** – There is a short between the 5 volt supply and the pressure sensor common.

**Repair:** Locate the short between the 5 volt supply and the pressure sensor common.

Repair the faulty wiring or replace the faulty wiring.

Verify that the repair eliminates the problem.

STOP.

i01878777

**Accelerator Pedal (Throttle) Position Sensor Circuit - Test**

**SMCS Code:** 1913-038

**System Operation Description:**

**Accelerator Pedal Position Sensor**

The accelerator pedal position sensor is used to provide a throttle position signal to the ECM. Sensor output is a constant frequency signal with a pulse width that varies with the pedal position. This output signal is referred to as either a duty cycle or a pulse width modulated signal (PWM) and this output signal is expressed as a percentage between 3 and 100 percent.

The pedal mounted accelerator pedal position sensor is attached directly to the accelerator pedal assembly and the pedal mounted accelerator pedal position sensor requires no adjustment.

The accelerator pedal position sensor will produce a duty cycle of 10 to 22 percent at low idle and 75 to 90 percent when the accelerator pedal is fully depressed. The percent of duty cycle is translated in the ECM into an accelerator pedal position of 3 to 100 percent.

The accelerator pedal position sensor is powered by the ECM supply voltage (+8 VDC) from connector P1:4 to terminal "A" of the accelerator pedal position sensor connector. The accelerator pedal position sensor can be replaced separately from the pedal assembly. An incorrectly calibrated pedal assembly can not be adjusted. The entire pedal assembly must be replaced.

If the vehicle is using the ECM dedicated PTO functions, the accelerator pedal position sensor will be ignored while the engine is in PTO mode and the "PTO Configuration" is programmed to one of the following parameters:

- Remote Switches
- Remote Throttle

**Note:** In the cab switches configuration, the cab accelerator pedal can be used in order to control the engine rpm for the PTO operation. The cab accelerator pedal can also be ignored in the "Cab Switches" PTO configuration. Programming of customer parameters is required in order to ignore the cab accelerator pedal in the "Cab switches" configuration.

The ECM is in PTO mode if the "PTO On/Off Switch" is on. This can be checked with the electronic service tool. Refer to Troubleshooting, "PTO Switch Circuit - Test" for testing if the PTO is being used.

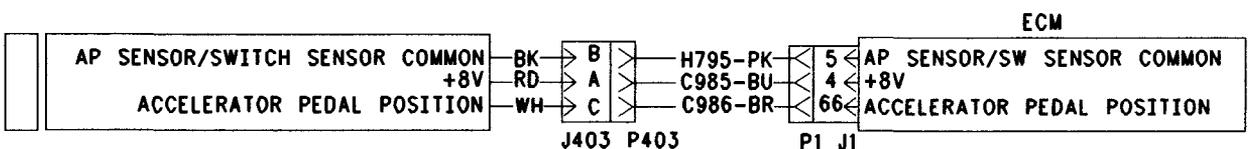


Illustration 42

Schematic for cab accelerator pedal position sensor

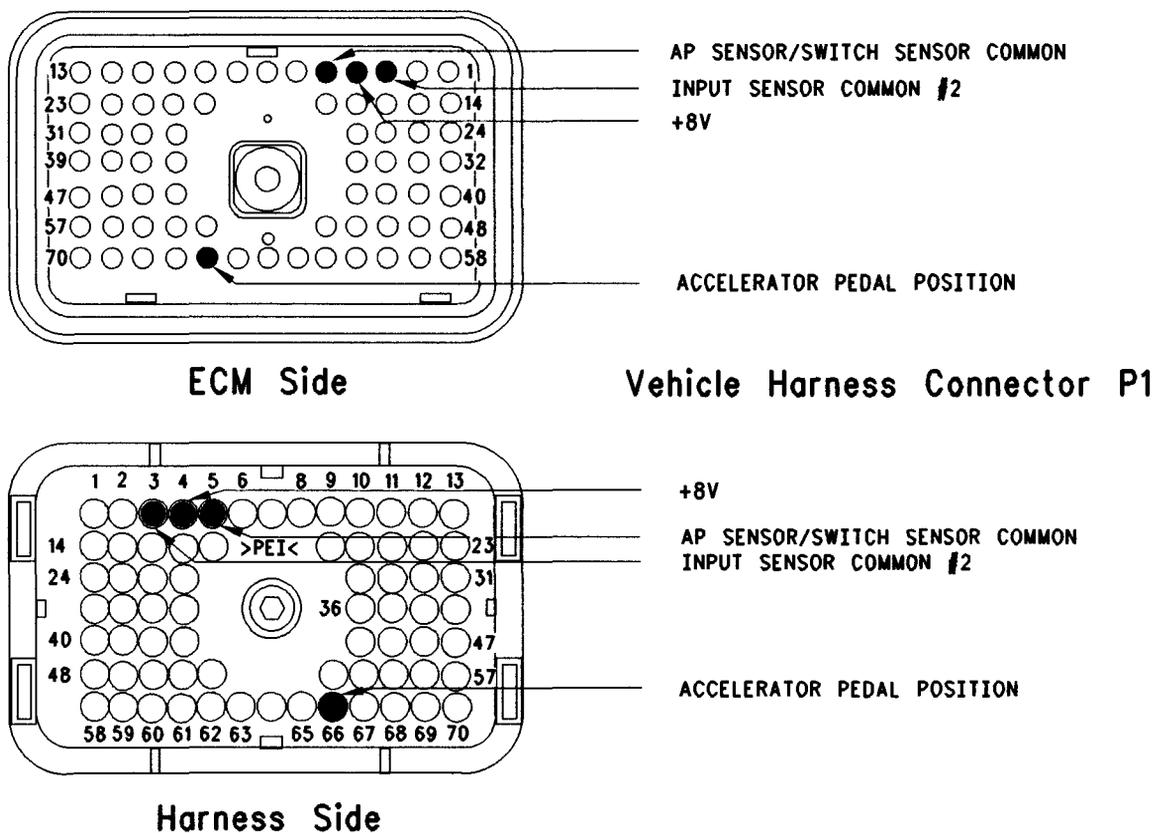


Illustration 43  
 Terminal locations for ECM

g00668027

**Test Step 1. Monitor the Status for the “Accelerator Pedal Position”**

- A. Connect the electronic service tool to the data link connector.
- B. Turn the key switch to the ON position.
- C. Access the status for the “Accelerator Pedal Position”.
- D. While the status is monitored, depress the accelerator pedal and release the accelerator pedal.

**Expected Result:**

The status for the “Accelerator Pedal Position” is 100% when the accelerator is fully depressed. The status for the “Accelerator Pedal Position” is 0% when the accelerator is fully released.

**Results:**

- OK – The accelerator pedal position sensor is operating correctly.

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

Verify that the engine is not in PTO mode. PTO mode may cause the accelerator pedal position sensor to be ignored.

Verify that all required parameters are programmed. Certain unprogrammed parameters may cause the engine to be limited to low idle. Refer to Troubleshooting, “System Configuration Parameters”.

**STOP.**

- Not OK – The accelerator pedal position sensor is not operating correctly. Proceed to Test Step 2.

**Test Step 2. Monitor the Duty Cycle**

- A.** Turn the key switch to the ON position.
- B.** Access the following display screen in order:
- “Service”
  - “Calibrations”
  - “Monitor Throttle Position Sensor”
- C.** While the duty cycle is being monitored, depress the accelerator pedal and release the accelerator pedal.

**Expected Result:**

The duty cycle is 10% to 22% when the accelerator pedal is released. The duty cycle is 75% to 90% when the accelerator pedal is depressed.

**Results:**

- **OK** – The duty cycle is within the specified range.

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

Verify that the engine is not in PTO mode. PTO mode may cause the accelerator pedal position sensor to be ignored.

Verify that all required parameters are programmed. Certain unprogrammed parameters may cause the engine to be limited to low idle. Refer to Troubleshooting, “System Configuration Parameters”.

**STOP.**

- **Not OK** – The duty cycle is not within the range. Proceed to Test Step 3.

**Test Step 3. Inspect Electrical Connectors and Wiring**

- A.** Thoroughly inspect the J1/P1 ECM connector, the firewall bulkhead connector and the accelerator pedal position sensor connector. Refer to Troubleshooting, “Electrical Connectors - Inspect” for details.
- B.** Perform a 45 N (10 lb) pull test on each of the wires in the ECM connector that are associated with the accelerator pedal position sensor:

- P1:3
- P1:4
- P1:5

- P1:66

- C.** Check the ECM connector (Allen Head Screw) for the proper torque of 6.0 N·m (55 lb in).
- D.** Check the harness and wiring for abrasion and pinch points from the accelerator pedal position sensor to the ECM.

**Expected Result:**

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

**Results:**

- **OK** – Proceed to Test Step 4.
- **Not OK**

**Repair:** Perform the following repair:

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

Verify that the repair eliminates the problem.

**STOP.**

**Test Step 4. Check for Active Diagnostic Codes**

- A.** Turn the key switch to the ON position.
- B.** Check for active diagnostic codes on the electronic service tool.

**Note:** When the ECM automatically calibrates new duty cycle values for the low idle throttle position and the high idle throttle position the ECM assumes 22 percent duty cycle at low idle and 75 percent duty cycle at high idle. As a result, you may notice that the throttle position status reaches 100 percent well before the accelerator pedal is fully depressed. This is normal. After some cycling of the accelerator pedal to the high idle position, the ECM will adjust the calibration automatically. The ECM will adjust the calibration automatically provided that the high idle stop position is within the 75 to 90 percent duty cycle range, and the low idle is in the 10 to 22 percent duty cycle range. During normal operation, you may also notice that more movement of the accelerator pedal is required for the throttle position status to increase above 3 percent. You may also observe that the status reaches the 100 percent value prior to the limit of the high idle position. This is done in order to ensure that the throttle reaches these two critical points for engine operation.

**Expected Result:**

**Result 1** 91-08 or 91-13 is Active.

**Result 2** 41-03 is Active.

**Result 3** 41-04 is Active.

**Results:**

- **Result 1** – Proceed to Test Step 5.
- **Result 2** – Proceed to Test Step 10.
- **Result 3** – Proceed to Test Step 12.

**Test Step 5. Check the Supply Voltage at the Sensor for the Accelerator Pedal Position Sensor**

- A.** Install a breakout T with 3 terminals at the accelerator pedal position sensor connector J403/P403.
- B.** Turn the key switch to the ON position.
- C.** Measure the voltage at terminal "A" (+8 V) with reference to terminal "B" (Accelerator/Switch Sensor Common).

**Expected Result:**

The measured voltage is between 7.5 VDC and 8.5 VDC for the pedal mounted throttle position sensor that is used in the cab.

**Results:**

- **OK** – Proceed to Test Step 6.
- **Not OK** – The sensor is not receiving the correct voltage.

**Repair:** Inspect the electrical connectors and wiring.

Repair the faulty wiring.

Verify that the repair eliminates the problem.

STOP.

**Test Step 6. Check the Duty Cycle at the Sensor**

**Note:** Performing certain steps within this procedure requires the use of a multimeter that is capable of measuring a PWM duty cycle.

- A.** Turn the key switch to the OFF position.

- B.** Remove the signal wire for the accelerator pedal position sensor (terminal "C") from P403. This is the harness side of the accelerator pedal position sensor connector.
- C.** Install a breakout T with 3 terminals between the J403 and the P403 Accelerator pedal position sensor connector.
- D.** Connect the multimeter probes to terminal "C" (Accelerator Pedal Position) and terminal "B" (Accelerator/Switch Sensor Common) of the breakout T.
- E.** While the duty cycle is being monitored on the multimeter, depress the accelerator pedal and release the accelerator pedal.

**Expected Result:**

The duty cycle is between 10% and 22% when the accelerator pedal is fully released. The duty cycle is between 75% and 90% when the accelerator pedal is fully depressed.

**Results:**

- **OK** – The accelerator pedal position sensor is working correctly.

**Repair:** Insert the signal wire into terminal C of the P403 connector.

Proceed to Test Step 7.

- **Not OK** – Leave the PWM probe connected to the breakout T. Insert the wire (terminal C) into the vehicle harness connector. The accelerator pedal position sensor or the accelerator pedal assembly is faulty. Proceed to Test Step 8.

**Test Step 7. Check the Duty Cycle of the Accelerator Pedal Position Sensor at the ECM**

**Note:** Performing certain steps within this procedure requires the use of a multimeter that is capable of measuring a PWM duty cycle.

- A.** Turn the key switch to the OFF position.
- B.** Remove the wire for the accelerator pedal position sensor P1:66.

**Note:** You may be required to disconnect the P1 ECM connector in order to remove the terminal for the signal input of the accelerator pedal position sensor.

- C. Connect the multimeter probes between the removed wire and P1:5 (Accelerator/Switch Sensor Common).
- D. Reconnect the P1 ECM connector to the ECM.
- E. Turn the key switch to the ON position.
- F. While the duty cycle output of the accelerator pedal position sensor is being monitored on the multimeter, depress the accelerator pedal and release the accelerator pedal.
- G. Turn the key switch to the OFF position.
- H. Reinsert the signal wire into P1:66 of the P1 ECM connector.
- E. Display the duty cycle output of the accelerator pedal position sensor while the sensor slot is released. Use a screwdriver to advance the sensor slot to the maximum position. Refer to Illustration 44.

When the sensor is removed from the accelerator pedal assembly, the following diagnostic code may be generated:

- 91-13 Throttle Sensor Calibration (28)

This is normal. The diagnostic code should disappear when the sensor is properly assembled back into the accelerator pedal assembly.

### **Expected Result:**

The duty cycle is between 10% and 22% when the accelerator pedal is fully released. The duty cycle is between 75% and 90% when the accelerator pedal is fully depressed.

### **Results:**

- **OK** – A good signal from the accelerator pedal position sensor is reaching the ECM. Verify that the ECM is receiving the proper battery voltage. If the ECM is receiving the proper battery voltage, temporarily connect a test ECM and verify that the problem is resolved. If the problem disappears with the test ECM, reconnect the suspect ECM. If the problem returns with the suspect ECM, replace the ECM. **STOP**.
- **Not OK** – There is a problem with signal wire for the accelerator pedal position sensor in the vehicle wiring harness. Proceed to Test Step 9.

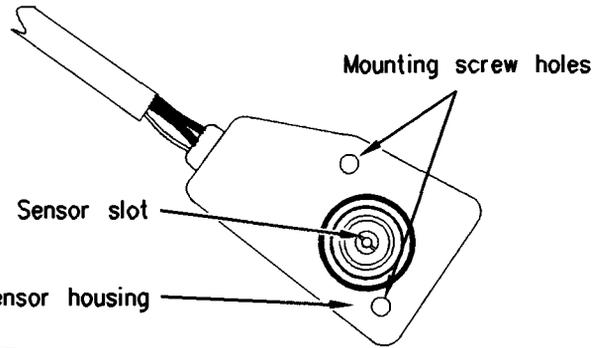
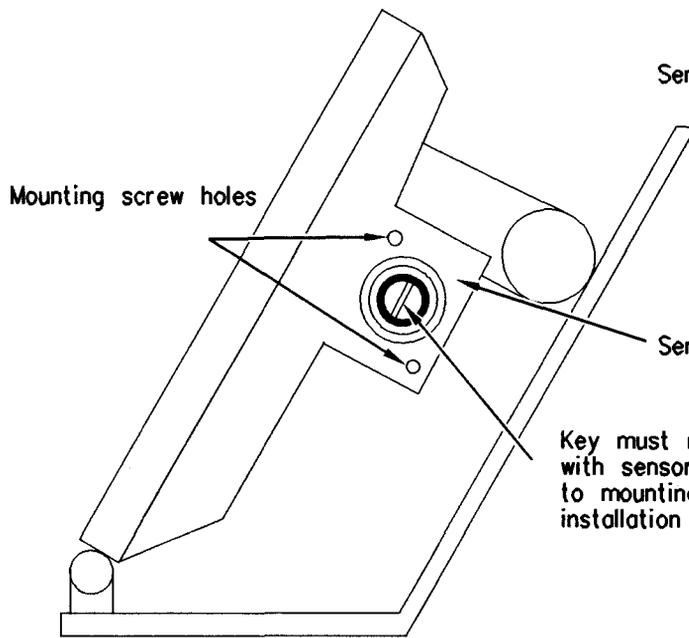
## **Test Step 8. Remove the Accelerator Pedal Position Sensor from the Accelerator Pedal Assembly**

- A. Turn the key switch to the OFF position.
- B. Remove the accelerator pedal position sensor from the accelerator pedal assembly. Note sensor orientation in the accelerator pedal assembly, and the sensor pigtail routing prior to sensor removal. Thoroughly inspect the pigtail for signs of abrasion.
- C. Connect the multimeter that is capable of measuring a PWM duty cycle to terminal "C" of the breakout T.
- D. Turn the key switch to the ON position.

- A Mate sensor to accelerator pedal assembly. Key must match up with the sensor slot. Check the sensor housing for a flush fit to the pedal assembly mounting surface (This ensures slot on sensor has mated correctly with the pedal assembly key.)
- B Ensure the sensor is oriented the same as it was prior to removal to ensure sensor harness pigtail is routed correctly.
- C Line up screw holes and install mounting screws.

**NOTE:** Procedure is identical for the suspended accelerator pedal assembly.

### Accelerator Pedal Assembly



### Accelerator Block Assembly

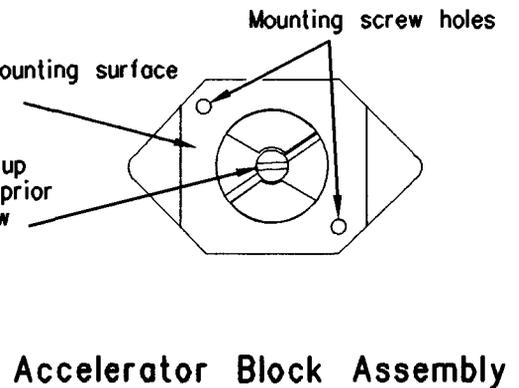


Illustration 44  
Accelerator pedal assembly

g00706977

#### Expected Result:

When the sensor is removed from the accelerator pedal assembly and the sensor slot is released, the duty cycle is 10 percent or less. When the sensor slot is moved to the maximum position, the duty cycle increases to 90 percent or more.

#### Results:

- OK – The accelerator pedal position sensor is working correctly. Clear any diagnostic codes that were caused by performing this test procedure. Refer to the OEM dealer for correct replacement of the accelerator pedal assembly. STOP.

- Not OK – The accelerator pedal position sensor is faulty. Check the accelerator pedal assembly in order to ensure that the accelerator pedal assembly is not causing damage to the sensor. If the accelerator pedal assembly is causing damage to the sensor, refer to the OEM dealer for correct replacement of the accelerator pedal assembly. If the accelerator pedal assembly appears OK, replace the accelerator pedal position sensor. STOP.

#### Test Step 9. Route the Supply Bypass Wires to the Accelerator Pedal Position Sensor

- A. Turn the key switch to the OFF position.

- B.** Remove the signal wire for the accelerator pedal position sensor from P1:66.
- C.** Remove terminal "C" (Accelerator Pedal Position) from the accelerator pedal position sensor connector.
- D.** Route new wiring from the ECM to the accelerator pedal position sensor.
- E.** Turn the key switch to the ON position.
- F.** Check the duty cycle of the accelerator pedal position sensor on the electronic service tool while the accelerator pedal assembly is being moved over the full range.

**Expected Result:**

The duty cycle is between 10% and 22% when the accelerator pedal is fully released. The duty cycle is between 75% and 90% when the accelerator pedal is fully depressed.

**Results:**

- OK

**Repair:** Perform the following repair:

The wiring from the ECM to the accelerator pedal position sensor appears faulty. Permanently install new wiring.

Verify that the repair eliminates the problem.

**STOP.**

- **Not OK** – Double check the wiring, the J1/P1 ECM connector and the sensor connector. If a problem still exists, restart the test procedure.  
**STOP.**

**Test Step 10. Short the +8 Volt Supply at the Sensor**

- A.** Turn the key switch to the Off position.
- B.** Connect a breakout T between the J403 and the P403 Accelerator Pedal Position Sensor connectors.
- C.** Insert a jumper wire between terminal A and terminal B of the breakout T.
- D.** Turn the key switch to the On position.
- E.** Check for active diagnostic codes on the electronic service tool.

**Expected Result:**

The 41-03 changes to 41-04 when the jumper wire is installed.

**Results:**

- **OK** – There is a problem with the accelerator pedal position sensor.

**Repair:** Remove the breakout T.

Temporarily connect a new sensor.

If the new sensor eliminates the problem, reconnect the suspect sensor.

If the problem returns, permanently replace the sensor.

Verify that the repair eliminates the problem.

**STOP.**

- **Not OK** – Proceed to Test Step 11.

**Test Step 11. Short the +8 Volt Supply at the ECM**

- A.** Turn the key switch to the Off position.
- B.** Connect a **140-2266** Cable (Seventy-Pin Breakout) between the J1 and P1 ECM connectors.
- C.** Insert a jumper wire between terminal 4 and terminal 5 of the breakout T.
- D.** Turn the key switch to the On position.
- E.** Check for active diagnostic codes on the electronic service tool.

**Expected Result:**

The 41-03 changes to 41-04 when the jumper wire is installed.

**Results:**

- **OK** – There is a problem with the wiring between the ECM and the accelerator pedal position sensor.

**Repair:** Remove the breakout T.

Inspect the wiring between the ECM and the sensor.

Repair the faulty wiring.

Verify that the repair eliminates the problem.

STOP.

- **Not OK** – There may be a problem with the ECM.

**Repair:** Remove the breakout T.

Temporarily connect a test ECM.

If the test ECM fixes the problem, reconnect the suspect ECM.

If the problem returns, permanently replace the ECM.

Verify that the repair eliminates the problem.

STOP.

### Test Step 12. Disconnect the Sensor

- A.** Turn the key switch to the Off position.
- B.** Disconnect the J403/P403 Accelerator Pedal Position Sensor connector.
- C.** Turn the key switch to the On position.
- D.** Check for active diagnostic codes on the electronic service tool.

#### Expected Result:

The 41-04 changes to 41-03 when the jumper wire is installed.

#### Results:

- **OK** – There is a problem with the accelerator pedal position sensor.

**Repair:** Temporarily connect a new sensor.

If the new sensor eliminates the problem, reconnect the suspect sensor.

If the problem returns, permanently replace the sensor.

Verify that the repair eliminates the problem.

STOP.

- **Not OK** – Proceed to Test Step 13.

### Test Step 13. Remove the +8 Volt Supply Wires from the ECM

- A.** Turn the key switch to the Off position.

**B.** Remove the wires from P1:4 and P1:5.

**C.** Turn the key switch to the On position.

**D.** Check for active diagnostic codes on the electronic service tool.

#### Expected Result:

The 41-04 changes to 41-03 when the wires are removed.

#### Results:

- **OK** – There is a problem with the wiring between the ECM and the accelerator pedal position sensor.

**Repair:** Inspect the wiring between the ECM and the sensor.

Repair the faulty wiring.

Verify that the repair eliminates the problem.

STOP.

- **Not OK** – There may be a problem with the ECM.

**Repair:** Temporarily connect a test ECM.

If the test ECM fixes the problem, reconnect the suspect ECM.

If the problem returns, permanently replace the ECM.

Verify that the repair eliminates the problem.

STOP.

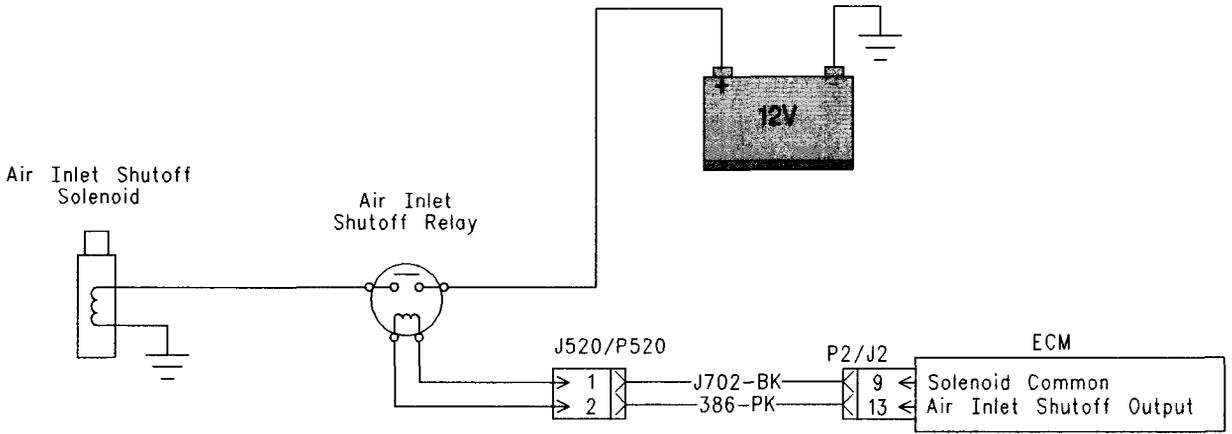
i01620144

## Air Inlet Shutoff Circuit - Test

**SMCS Code:** 1078-038

#### System Operation Description:

The Air Inlet Shutoff is available for certain engine ratings that operate in areas with large amounts of combustible gases. The air inlet shutoff will protect the engine from an overspeed when these gases are present. When an overspeed is detected, a relay activates the air inlet shutoff and injection is disabled until the engine speed reaches 0 rpm. This is accomplished by closing a flap in order to cut off the air supply to the engine. Once the Air Inlet Shutoff is activated the flap must be manually reset before the engine can be restarted.



**Note:** Refer to electrical schematic for more information

Illustration 45  
Schematic

g00838497

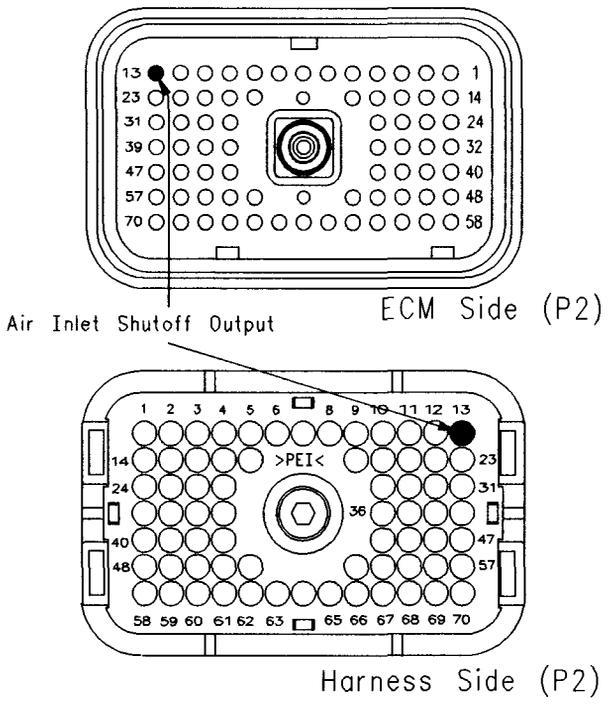


Illustration 46

g00848591

Terminal locations for the ECM connector P2

**Test Step 1. Perform the “Air Inlet Shutoff System Control Test”**

- A.** Turn the keyswitch to the OFF position.
- B.** Connect the Caterpillar Electronic Technician (ET) to the cab data link connector.

- C.** Turn the keyswitch to the ON position.
- D.** Start the engine. Increase the engine speed from low idle to 1400 rpm to 1600 rpm.
- E.** Go to the “Air Inlet Shutoff System Control Test” on ET.
- F.** Start the test.

**Expected Result:**

Fuel injection is disabled. The air inlet shutoff is activated and the engine is shutdown.

**Results:**

- **OK** – The engine is shutdown when the “Air Inlet Shutoff System Control Test” is activated. The air inlet shutoff is working correctly.

**Repair:** Reset the air inlet shutoff system. Talk to the operator in order to determine the reason for the overspeed.

**STOP.**

- **Not OK** – The engine did not shut down. Proceed to Test Step 2.

**Test Step 2. Check the Interlock for the Air Inlet Shutoff**

- A.** Verify that J1/P1:62 (Output 12) is connected to the +Battery.

**Expected Result:**

J1/P1:62 is connected to the +Battery.

**Results:**

- **OK** – J1/P1:62 (Output 12) is connected to the +Battery. Proceed to Test Step 3.
- **Not OK** – J1/P1:62 (Output 12) is not connected to the +Battery.

Repair: Connect J1/P1:62 to the +Battery.

Repeat Test Step 1.

**Test Step 3. Inspect Electrical Connectors and Wiring**

- A.** Turn the keyswitch to the OFF/RESET position.
- B.** Thoroughly inspect the J1/P1 ECM connector and all other connectors in the circuit. Refer to Troubleshooting, “Electrical Connectors - Inspect” for details.
- C.** Perform a 45 N (10 lb) pull test on the wires that are associated with the air inlet shutoff system.
- D.** Check the ECM connector (allen head screw) for the proper torque of 6.0 N·m (55 lb in).
- 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 should be completely coupled and/or inserted and the harness and wiring should be free of corrosion, abrasion or pinch points.

**Results:**

- **OK** – All the wires and connections are OK. Proceed to Test Step 4.
- **Not OK**

Repair: Perform the following repair:

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

Verify that the repair eliminates the problem.

STOP.

**Test Step 4. Perform the “Air Inlet Shutoff Relay Output” Test**

- A.** Turn the keyswitch to the OFF position.

- B.** Connect ET to the cab data link connector.

- C.** Turn the keyswitch to the ON position. Do not start the engine.

- D.** Go to the “Air Inlet Shutoff Relay Output” test on ET.

- E.** Start the test and listen for a click from the relay for the air inlet shutoff.

**Expected Result:**

The relay is active.

**Results:**

- **OK** – A click is heard. The relay is active. Proceed to Test Step 5.
- **Not OK** – There is a problem with the relay circuit. Proceed to Test Step 7.

**Test Step 5. Check the Supply Voltage to the Air Inlet Shutoff Solenoid**

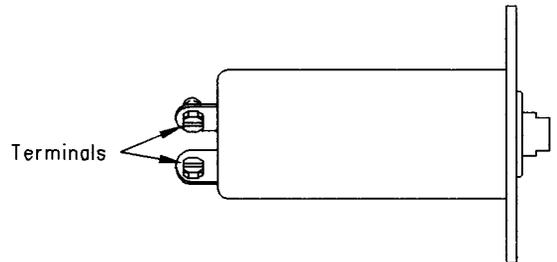


Illustration 47

g00850138

**Air Inlet Shutoff Solenoid**

- A.** Disconnect the air inlet shutoff solenoid.
- B.** Turn the keyswitch to the ON position.
- C.** Proceed to the “Air Inlet Shutoff Relay Output” test on ET.
- D.** Activate the relay for the air inlet shutoff solenoid.
- E.** Use signal reading probes to measure the voltage across the two terminals of the air inlet shutoff solenoid.

**Note:** Air inlet shutoff systems that were produced after February 2002 may use a one second pulse to control the relay. The relay will only be activated for one second. A voltage test lamp may be used in place of a multimeter.

**Expected Result:**

The supply voltage should be greater than 10 VDC or the test lamp illuminates for at least one second.

**Results:**

- **OK** – The ECM is properly controlling the relay for the air inlet shutoff solenoid, but the air inlet shutoff solenoid is not working. Proceed to Test Step 6.
- **Not OK** – The air inlet shutoff solenoid is not receiving the correct signal. Proceed to Test Step 10.

**Test Step 6. Check the Resistance of the Solenoid**

- Disconnect the wires for the air inlet shutoff solenoid.
- Measure the resistance of the air inlet shutoff solenoid.
- Reconnect the wires for the air inlet shutoff solenoid.

**Expected Result:**

Resistance should be 15 to 20 Ohms.

**Results:**

- **OK** – The resistance of the air inlet shutoff solenoid is OK.

**Repair:** Check electrical connections. Refer to Troubleshooting, “Electrical Connectors - Inspect” for more information.

**STOP.**

- **Not OK** – The resistance of the solenoid is out of specification.

**Repair:** Replace the air inlet shutoff solenoid.

Verify that the repair eliminates the problem.

**STOP.**

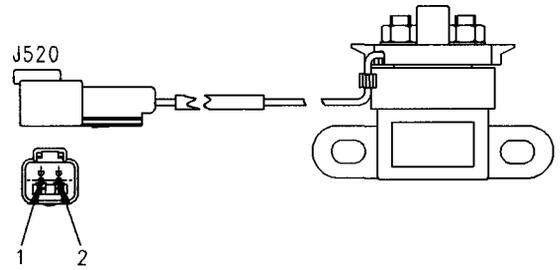
**Test Step 7. Check the Resistance of the Relay**

Illustration 48  
Relay Terminals

g00850059

- Turn the keyswitch to the OFF/RESET position.
- Unplug the relay for the air inlet shutoff solenoid.
- Measure the resistance between J520:1 (Solenoid Common) and J520:2 (Air Inlet Shutoff Output).

**Expected Result:**

The resistance should be between 5 Ohms and 10 Ohms.

**Results:**

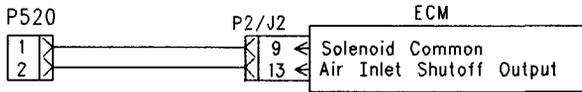
- **OK** – The resistance of the relay is OK. Proceed to Test Step 8.
- **Not OK** – The relay is faulty.

**Repair:** Replace the relay.

Verify that the repair eliminates the problem.

**STOP.**

### Test Step 8. Check the Signal Voltage to the Relay



Note: Refer to electrical schematic for more information

Illustration 49 g00850154  
Schematic for the Relay Signal

- A. Unplug the relay for the air inlet shutoff solenoid.
- B. Turn the keyswitch to the ON position.
- C. Proceed to the "Air Inlet Shutoff Relay Output" test on ET.
- D. Activate the system for the air inlet shutoff solenoid.
- E. Measure the voltage between P520:1 (Solenoid Common) and P520:2 (Air Inlet Shutoff Output).

#### Expected Result:

The voltage should be  $12.0 \pm 4.0$  VDC.

#### Results:

- OK – The relay is receiving the signal from the ECM. Proceed to Test Step 9.
- Not OK – The relay is not receiving the signal from the ECM. Proceed to Test Step 11.

### Test Step 9. Check the Power Supply to the Relay

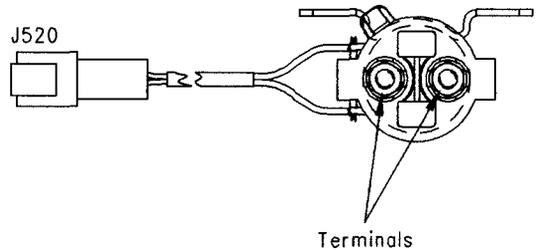


Illustration 50 g00850141  
Air Inlet Shutoff Relay

- A. Measure the voltage between the +Battery terminal of the relay and the engine ground.

#### Expected Result:

The voltage should be  $12.0 \pm 4.0$  VDC.

#### Results:

- OK – The relay is receiving power. Proceed to Test Step 10.
- Not OK – There is a problem in the wiring between the relay and the +Battery terminal.

Repair: Repair the circuit.

Verify that the repair eliminates the problem.

STOP.

### Test Step 10. Check the Output Voltage of the Relay

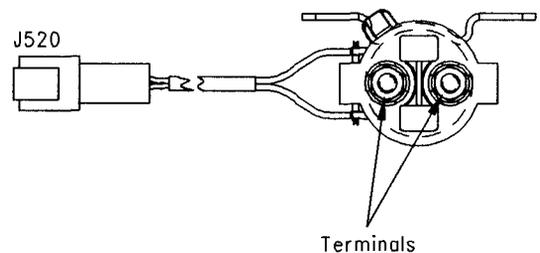


Illustration 51 g00850141  
Air Inlet Shutoff Relay

- A. Ensure that all connectors are connected to the wiring harness.
- B. Turn the keyswitch to the ON position.
- C. Go to the "Air Inlet Shutoff Relay Output" test on ET.
- D. Activate the system for the air inlet shutoff solenoid.
- E. Measure the voltage from the output terminal on the relay to the engine ground.

**Expected Result:**

The voltage should be  $12.0 \pm 4.0$  VDC.

**Results:**

- OK – There is a problem in the wiring between the relay and the air inlet shutoff solenoid.

Repair: Repair the circuit.

Verify that the repair eliminates the problem.

STOP.

- Not OK – The relay is not sending power to the air inlet shutoff solenoid. The relay is bad.

Repair: Replace the relay for the air inlet shutoff. Verify that the repair eliminates the problem.

STOP.

**Test Step 11. Check for Shorts in the Wiring Harness between the Relay and the ECM**

Solenoid Common      Air Inlet Shutoff Output

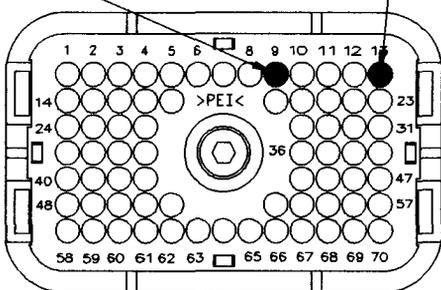


Illustration 52      g00848592  
ECM connector P1 (Harness Side)

- A. Ensure that the keyswitch is in the OFF/RESET position.
- B. Disconnect the J2/P2 ECM connector.

- C. Unplug the relay for the air inlet shutoff.

- D. Measure the resistance between P2:13 (Air Inlet Shutoff Output) and P2:9 (Solenoid Common).

**Expected Result:**

The resistance should be greater than 20,000 Ohms.

**Results:**

- OK – There are no shorts in the wiring harness. Proceed to Test Step 12.
- Not OK – There is a short in the wiring harness between the ECM and the relay.

Repair: Repair the circuit.

Verify that the repair eliminates the problem.

STOP.

**Test Step 12. Check the Relay Signal at the ECM**

Air Inlet Shutoff Output      Solenoid Common

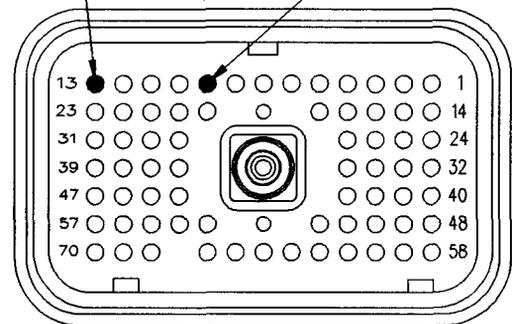


Illustration 53      g00848593  
ECM connector P1 (ECM side)

Solenoid Common      Air Inlet Shutoff Output

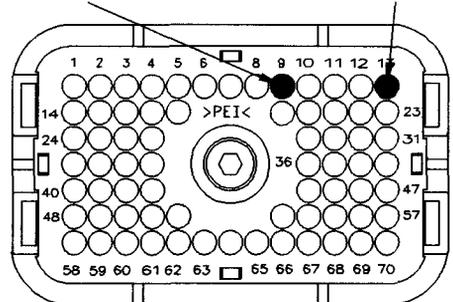


Illustration 54      g00848592  
ECM connector P1 (Harness side)

- A. Turn the keyswitch to the OFF/RESET position.

- B.** Remove the wire from P2:13 (Air Inlet Shutoff Output) in the P2 ECM connector.
- C.** Turn the keyswitch to the ON position.
- D.** Activate the "Air Inlet Shutoff Relay Output" test on ET.
- E.** Measure the voltage between the open terminal at P2:13 (Air Inlet Shutoff Output) and P2:9 (Solenoid Common).
- F.** Turn the keyswitch to the OFF/RESET position.
- G.** Reinstall the wire to P2:13 (Air Inlet Shutoff Output).

**Expected Result:**

The voltage should be  $12.0 \pm 4.0$  VDC.

**Results:**

- **OK** – The ECM is supplying the correct voltage. There is an open circuit in the harness.

**Repair:** Repair the circuit.

Verify that the repair eliminates the problem.

**STOP.**

- **Not OK** – The ECM is not supplying the correct voltage.

**Repair:** Verify your results. Replace the ECM. Refer to Troubleshooting, "Replacing the ECM" before replacing the ECM.

Verify that the repair eliminates the problem.

**STOP.**

i01622223

## ATA (SAE J1587 / J1708) Data Link Circuit - Test

**SMCS Code:** 1901-038

**System Operation Description:****Use this procedure under the following situation:**

Use this procedure if the Caterpillar Electronic Technician (ET) will not power up or ET will not communicate with the ECM through the cab data link connector.

**The following background information is related to this procedure:**

The ATA data link (American Trucking Association) is the standard data link that is used by the ECM to communicate with electronic service tools. The SAE specification J1587 defines the format of the messages and data that is being communicated. The SAE specification J1708 defines the hardware requirements and the protocol of the serial communications. The Caterpillar Electronic Technician (ET) is an example of one of the electronic service tools. Some electronic dashboards use this data link to receive information. Some automatic transmissions also receive information from this data link.

The ECM provides the following two ATA data link connection terminals from the ECM vehicle harness connector J1:

- J1:9 (J1587 Data Link Negative)
- J1:8 (J1587 Data Link Positive)

The vehicle OEM provides twisted pair wiring from the ECM to the cab data link connector.

Remember that there are potentially several devices that are installed in the vehicle and remember that these devices are connected to the ATA data link at one time. These devices include dash displays, trip recorders and transmission controls. These devices may cause problems with the data link. These problems can disrupt communications to the engine ECM and from the engine ECM.

**Communication**

When the ignition key switch is in the OFF position, the ECM may communicate with ET. The communications may be disrupted and the communications may require frequent reconnection. In order to avoid this problem, turn the ignition key switch to the ON position when ET is being used.

ET may indicate the following error message:

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

This message will indicate that the latest version of ET has not been installed or this message will indicate that the software in the ECM is newer than the software for ET.

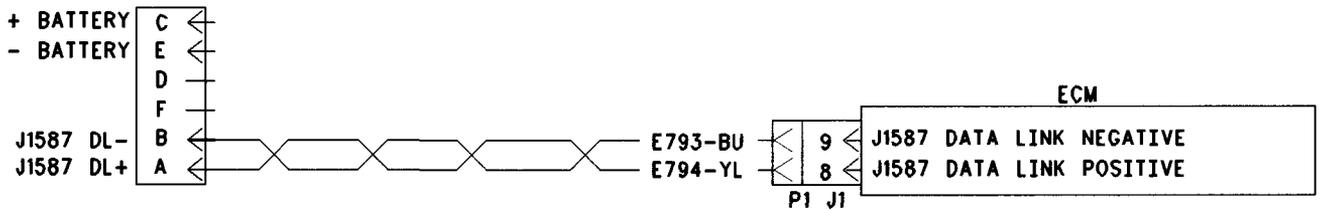


Illustration 55  
Schematic for ATA Data Link with 6-pin connector

g00650338

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

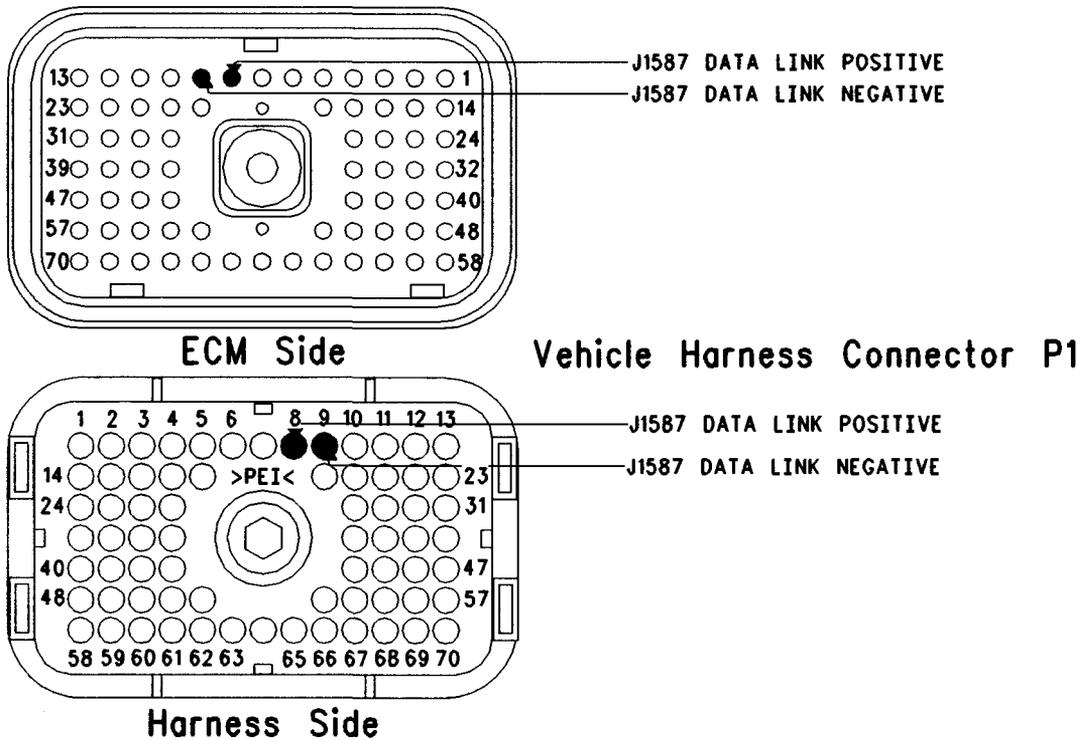


Illustration 56  
Terminal locations for ECM

g00650339

**A.** Thoroughly inspect the following electrical connectors:

- ECM vehicle harness connector J1/P1
- Cab data link connector
- Firewall bulkhead connector
- Electronic service tool connectors

- ATA data link (terminal 8 and terminal 9) in the connectors

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

**B.** Perform a 45 N (10 lb) pull test on each of the wires in the ECM connector that are associated with the ATA data link.

**C.** Check the ECM connector (Allen Head Screw) for the proper torque of 6.0 N·m (55 lb in).

- D.** Check the harness and wiring for abrasion and pinch points from the connector to the ECM.

Refer to Illustration 56.

**Expected Result:**

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

**Results:**

- OK – Proceed to Test Step 2.
- Not OK

**Repair:** Perform the following repair:

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

Verify that the repair eliminates the problem.

STOP.

**Test Step 2. Determine the Type of Problem with the Data Link**

**A.** Connect ET to the cab data link connector.

**B.** Start the engine.

**Expected Result:**

**Result 1** The engine starts. The electronic service tool powers up and ET communicates without error.

**Result 2** The engine starts. ET powers up but an error is displayed.

**Result 3** The engine cranks but the engine will not start regardless of the condition of ET.

**Result 4** The engine will not crank regardless of the condition of ET.

**Result 5** The engine starts but ET does not power up.

**Note:** Check the display screen or check the communication adapter display in order to determine if ET has powered up. ET will display information that shows if the tool is getting power. If ET or the communication adapter powers up, the cab data link connector is receiving power.

**Results:**

- **Result 1** – There is not a problem with the ATA data link at this time. If an intermittent condition exists, thoroughly inspect all wiring and connectors.

**Repair:** Perform the following diagnostic procedure:

Troubleshooting, “Electrical Connectors - Inspect”

STOP.

- **Result 2** – ET displays an error message. The ECM is receiving battery power. Proceed to Test Step 5.

- **Result 3** –

**Repair:** Perform the following diagnostic procedure:

Troubleshooting, “Engine Cranks But Will Not Start”

STOP.

- **Result 4** –

**Repair:** Perform the following diagnostic procedure:

Troubleshooting, “Engine Will Not Crank”

STOP.

- **Result 5** – ET does not power up or the communications adapter does not power up. Ensure that the ECM is receiving the correct battery power. Proceed to Test Step 3.

### Test Step 3. Check the Battery Voltage Supply to the Cab Data Link Connector

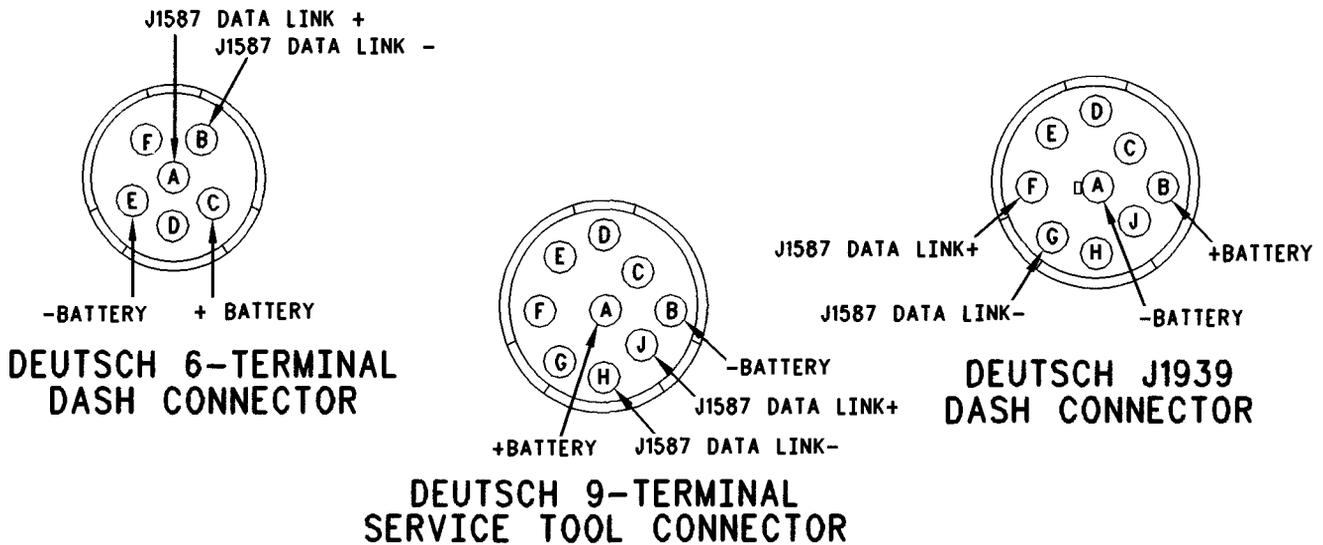


Illustration 57  
ATA Data Link connector

g00650354

- A.** Turn the ignition key switch to the ON position.
- B.** Use a multimeter in order to measure the voltage from the + Battery terminal of the cab data link connector to the - Battery terminal of the cab data link connector.

Refer to Illustration 57.

#### Expected Result:

The voltage is between 11.0 and 13.5 VDC for a 12 Volt system or between 22.0 and 27.0 VDC for a 24 Volt system.

#### Results:

- **OK** – The cab data link connector is currently receiving the correct voltage. Proceed to Test Step 4.
- **Not OK** – The cab data link connector is not receiving the correct voltage.

**Repair:** Inspect the wiring and fuses to the connector. Repair the wiring or batteries and/or replace the wiring or batteries, as required. Send the vehicle to the OEM dealer for repair, if necessary.

Verify that the repair eliminates the problem.

**STOP.**

### Test Step 4. Change Electronic Service Tool Components

- A.** If another vehicle or another ECM is available with a Caterpillar electronic engine, connect ET to the other vehicle by using the same cables.
- B.** Turn the ignition key switch to the ON position. Determine if ET operates correctly on the other vehicle.
- C.** If another engine is not available in the shop, find a different set of electronic service tool cables. Ensure that the set of electronic service tool cables is a complete set.
- D.** Connect ET to the cab data link connector by using the new cables.
- E.** Turn the ignition key switch to the ON position.
- F.** If changing cables allows the electronic service tool to operate properly, use the following procedure:
  - a.** Replace the pieces from the old set of cables into the new set of cables that operates. Replace one piece at a time.
  - b.** Repower ET after each of the pieces is replaced. Use this method to find the faulty piece.
- G.** If changing cables does not allow ET to operate properly, connect another ET.

H. Turn the ignition key switch to the ON position.

**Expected Result:**

**Result 1** The original ET works on another vehicle.

**Result 2** A different ET works on the original vehicle while the engine is being tested.

**Results:**

- Result 1 – Proceed to Test Step 5.
- Result 2

Repair: Send the faulty ET for repairs.

STOP.

**Test Step 5. Check the Battery Voltage at the ECM**

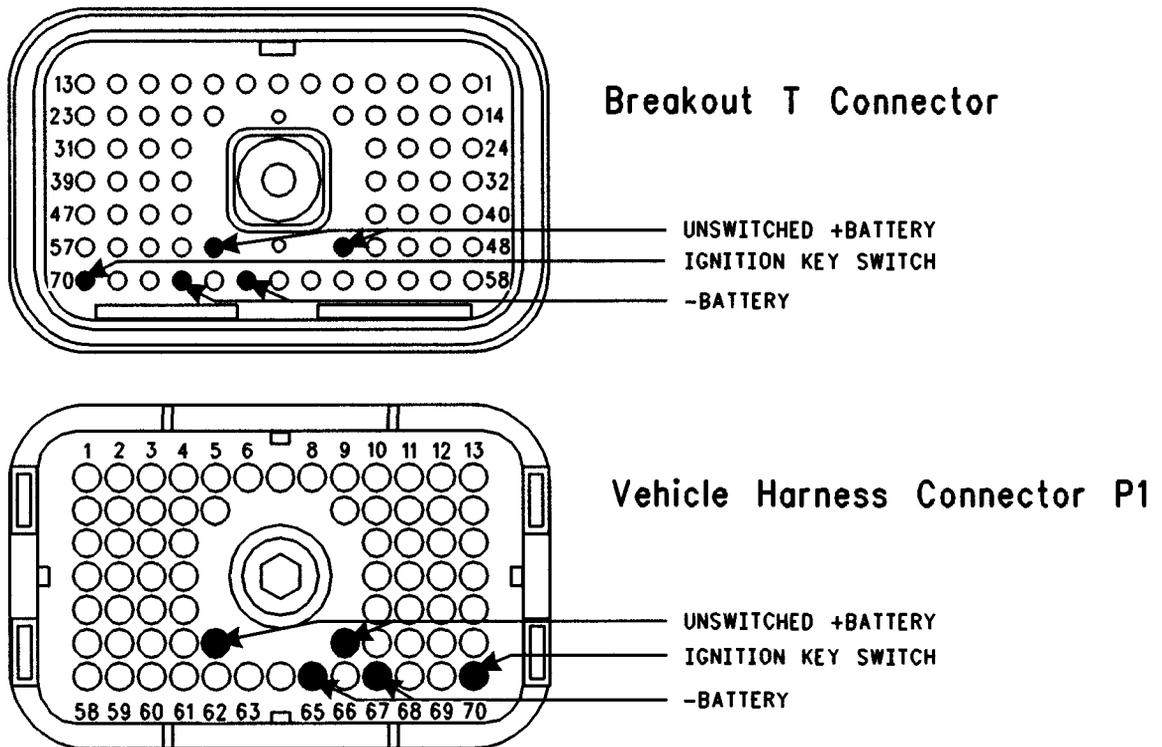


Illustration 58

g00650356

ECM Breakout T-connector and terminal locations for ECM P1

- A. Ensure that ET is connected to the cab data link connector.
  - B. Disconnect vehicle harness connector P1 from ECM connector J1 and insert a 70-Terminal breakout T.
  - C. Turn the ignition key switch to the ON position.
  - D. Measure the voltage between P1:52 (Unswitched +Battery) and P1:65 (-Battery).
  - E. Measure the voltage between P1:70 (Ignition Key Switch) and P1:65 (-Battery).
- Refer to Illustration 58.

**Expected Result:**

The voltage is between 11.0 and 13.5 VDC for a 12 Volt system or between 22.0 and 27.0 VDC for a 24 Volt system.

**Results:**

- **OK** – The ECM is currently receiving the correct voltage. Proceed to Test Step 6.
- **Not OK** – The ECM is not receiving the correct voltage. Ensure that there is not an aftermarket engine protection switch that is overriding battery power to the ECM.

**Repair:** Perform the following diagnostic procedure:

Troubleshooting, "Ignition Key Switch Circuit and Battery Supply Circuit - Test"

STOP.

**Test Step 6. Connect ET Directly to the ECM**

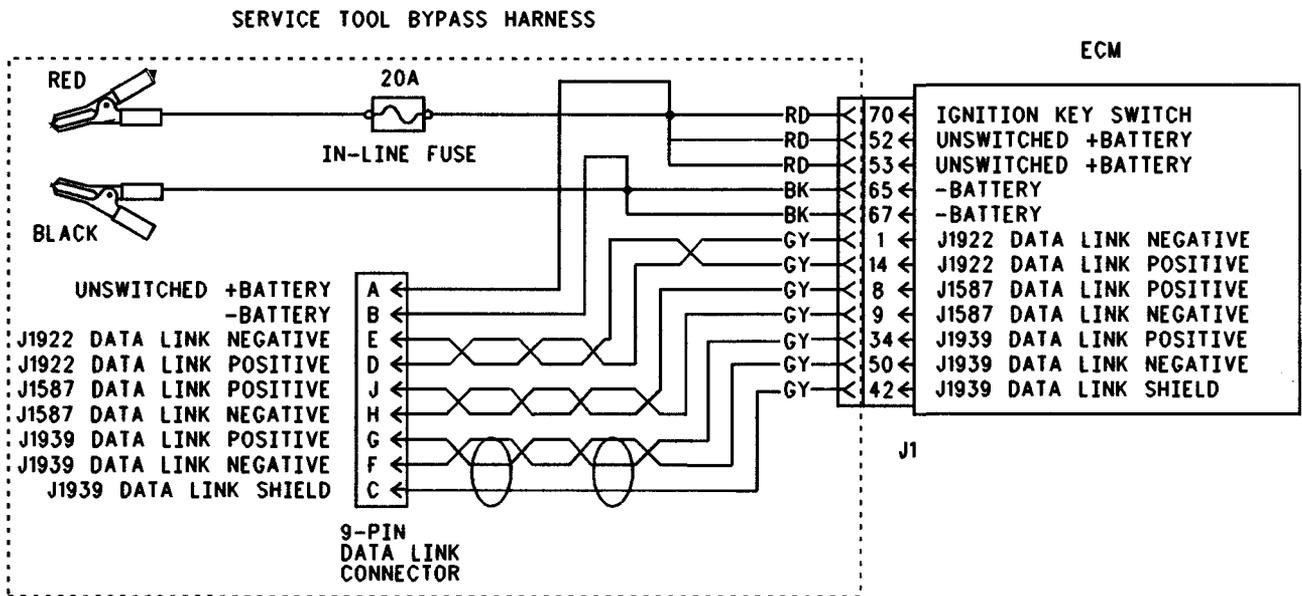


Illustration 59

g00732318

**WARNING**

Batteries give off flammable fumes which can explode.

To avoid injury or death, do not strike a match, cause a spark, or smoke in the vicinity of a battery.

**NOTICE**

Do Not connect the Bypass Harness to the battery until the 20 Amp in-line fuse has been removed from the +Battery line. If the fuse is not removed before connection to the battery a spark may result.

- A. Turn the ignition key switch to the ON position.
- B. Disconnect vehicle harness connector J1/P1 from the ECM.
- C. Install an electronic service tool power bypass cable. Connect a bypass harness to ECM connector J1.

Refer to Illustration 59 for the bypass harness.

**Note:** This bypass directly connects the circuit for the ignition key switch to the ECM. The ECM will remain powered until the connection to the unswitched battery line "+" is disconnected. Remove the 20 Amp fuse from the in-line fuse holder to power down the ECM. Do not connect the bypass to the battery posts without first removing the 20 Amp in-line fuse or do not remove the bypass from the battery posts without first removing the 20 Amp in-line fuse.

#### Expected Result:

ET is operating correctly.

#### Results:

- OK

Repair: Perform the following repair:

There is a problem in the vehicle wiring, or another device in the vehicle is causing problems on the data link. Either determine the device that is causing the problem or send the vehicle to the OEM dealer for repair.

Verify that the repair eliminates the problem.

STOP.

- Not OK – Verify that the 20 Amp fuse in the bypass harness is not open. A fuse that is open is a blown fuse. Proceed to Test Step 7.

### Test Step 7. Connect ET and the ECM to Another Battery



#### WARNING

Batteries give off flammable fumes which can explode.

To avoid injury or death, do not strike a match, cause a spark, or smoke in the vicinity of a battery.

#### NOTICE

Do Not connect the Bypass Harness to the battery until the 20 Amp in-line fuse has been removed from the +Battery line. If the fuse is not removed before connection to the battery a spark may result.

- A. Connect the battery wires from the bypass harness to a different battery that is not on the vehicle.

#### Expected Result:

ET is operating correctly.

#### Results:

- OK – The vehicle battery is causing the problem.

Repair: Perform the following diagnostic procedure:

Troubleshooting, "Ignition Key Switch Circuit and Battery Supply Circuit - Test"

STOP.

- Not OK

Repair: Perform the following repair:

1. Temporarily connect a test ECM.
2. Remove all jumpers and replace all connectors.
3. Recheck the system for active diagnostic codes.
4. Repeat the Test Step.
5. If the problem is resolved with the test ECM, reconnect the suspect ECM.
6. If the problem returns with the suspect ECM, replace the ECM.
7. Verify that the repair eliminates the problem.

STOP.

i01622295

## Auxiliary Brake Circuit - Test

SMCS Code: 1129-038-AX

#### System Operation Description:

Use this procedure under the following situation:

Use this procedure in order to determine if the auxiliary brake circuit is operating properly.

**The following background information is related to this procedure:**

**Auxiliary Brake Operation (Auxiliary Retarder)**

The auxiliary brake output circuit is provided by the ECM in order to indicate that conditions are acceptable for an auxiliary brake to operate. Operation of the auxiliary brake output is inhibited during undesirable engine operating conditions. The time period of fueling the engine is an undesirable engine operating condition. The "Auxiliary Brake" parameter must be programmed to J1/P1:12 in order to enable the auxiliary brake output. The output will function on the corresponding output that is selected.

- ECM connector J1/P1:12

In typical applications, the auxiliary brake output circuit operates a relay, which switches battery power in order to energize the auxiliary brake solenoids. An "Engine Brake On" switch will be wired in series with the relay and the "Engine Brake On" switch must be ON before the auxiliary brake will operate.

The ECM does not read the OEM installed Auxiliary Brake Relay Switches in order to determine operation. Only the conditions that are listed below are used to determine operation. The OEM installed auxiliary brake relay switches determine the path of the signal.

In order to ensure the proper operation of the auxiliary brake, the following conditions must be met:

- Engine speed is above 800 rpm.
- The percent of accelerator pedal position is equal to 7 percent or the percent of accelerator pedal position is less than 7 percent.
- The clutch pedal is released.

These conditions must be met regardless of the following parameters:

- Customer Specified Settings for the Engine Retarder
- Auto Retarder in Cruise
- Engine Retarder Minimum Vehicle Speed

Additional operating requirements must be met if the "Cruise/Idle On/Off Switch" is in the ON position.

**Cruise Control Switch in the ON position**

When the cruise control switch is in the ON position, two special options allow the engine retarder to operate only after the driver depresses the service brake pedal. The customer programmable modes of operation are listed below:

- Coast mode
- Latch mode
- Manual mode

The Coast mode engages the engine retarder when the driver depresses the service brake pedal. The retarder disengages when the driver releases the service brake pedal.

The Latch mode engages the retarder when the driver depresses the service brake pedal. The retarder remains engaged until the control detects a change in a control input. Examples of a change in a control input are illustrated on the following list:

- Depressing the accelerator pedal
- Depressing the clutch pedal
- The engine speed drops below 800 rpm.

The third option for the "Engine Retarder Parameter" is Manual mode. In the Manual mode, the retarder operates in the same manner regardless of the position of the cruise control switch. Unlike the Latch mode and the Coast mode, depressing the service brake pedal is not required to initiate the retarder in the Manual mode.

**Note:** Latch mode and Coast mode determine engine retarder operation only when the cruise control switch is in the ON position. Latch mode and Coast mode do not determine engine retarder operation when the engine is active in cruise control. Latch mode and Coast mode require the initiation of the service brake before acting. The initiation of the service brake disengages cruise control.

The "Auto Retarder in Cruise" parameter does not affect the operation of the auxiliary brake output circuit. The "Auto Retarder in Cruise" parameter is used only when the retarder is connected to the engine wiring harness.

**Note:** If the "PTO Configuration" is programmed to "Cab Switches", "Remote Switches", or "Remote Throttle", the Auxiliary Brake Output is disabled whenever the PTO On/Off circuit is on. If the vehicle is equipped with an Anti-Lock Brake System (ABS), the vehicle may have an additional relay in the switch circuit for the auxiliary brake solenoids. This is installed so the ABS system can turn off the auxiliary brake solenoids, if necessary. The relay should have normally closed contacts.



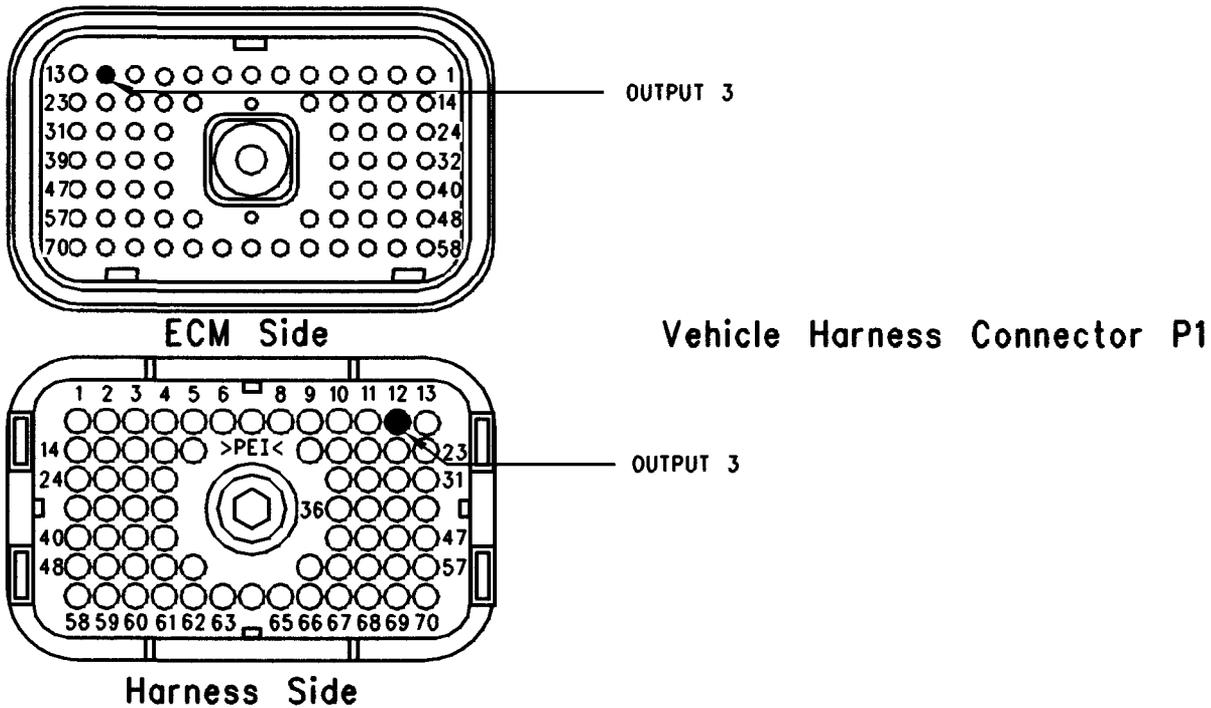


Illustration 61  
Terminal locations for ECM

g00715816

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

- A. Thoroughly inspect ECM vehicle harness connector J1/P1, and the firewall bulkhead connector. Refer to Troubleshooting, "Electrical Connectors - Inspect" for details.
- B. Perform a 45 N (10 lb) pull test on P1:12:  
  
Refer to Illustration 61.
- C. Check the ECM Connector (Allen Head Screw) for the proper torque of 6.0 N·m (55 lb in).
- D. Check the harness and wiring for abrasion and pinch points from the sensor to the ECM.

#### Expected Result:

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

#### Results:

- OK – Proceed to Test Step 2.

- Not OK – Repair the wiring or replace the wiring, if necessary. Repair the connectors or replace the connectors, if necessary. Ensure that all of the seals are in the proper place. Ensure that all of the connectors are connected properly. Verify that the repair eliminates the problem. **STOP.**

### Test Step 2. Ensure Correct Parameter Programming

- A. Connect the Caterpillar Electronic Technician (ET) to the cab data link connector.
- B. Turn the ignition key switch to the ON position.
- C. Access the customer specified parameter screen in order to make sure that the ECM is programmed to use the auxiliary brake output.
- D. Ensure that the auxiliary brake output is connected to the programmed output.

#### Expected Result:

The circuit is connected to the correct ECM terminal that is selected for the auxiliary brake output.

#### Results:

- OK – Proceed to Test Step 3.

- Not OK – Program the customer parameter to the correct terminal. STOP.

### Test Step 3. Check the Parameter for “Engine Retarder Minimum Vehicle Speed”

- Connect ET to the cab data link connector.
- Turn the ignition key switch to the ON position.
- Access the customer parameters screen in order to view the parameter for “Engine Retarder Minimum Vehicle Speed”. Refer to Troubleshooting, “Customer Specified Parameters” for additional information regarding “Engine Retarder Minimum Vehicle Speed”.
- Ensure that the vehicle is not experiencing a problem due to this parameter.

#### Expected Result:

The problem is due to this parameter.

#### Results:

- OK – Explain the proper operation of the retarder and auxiliary retarder solenoids to driver. STOP.
- Not OK – Proceed to Test Step 4.

### Test Step 4. Use ET to Check the Accelerator Pedal Position and the Clutch Switch

- Connect ET to the cab data link connector.
- Turn the ignition key switch to the ON position.
- Use the following procedure to check the accelerator pedal position:
  - Access the status screen on ET for the accelerator pedal position.
  - While the status screen is being monitored, depress the accelerator pedal several times and release the accelerator pedal several times.
- Use the following procedure to check the clutch pedal position switch:
  - Access the status screen on ET for the clutch pedal position switch.
  - While the status screen is being monitored, depress the clutch pedal several times and release the clutch pedal several times.

#### Expected Result:

The accelerator pedal position is between 3 and 100 percent, and the clutch pedal position switch indicates that the pedal is being depressed and released.

**Note:** The clutch pedal position switch is turned on when the clutch pedal is depressed. The clutch pedal position switch is turned off when the clutch pedal is released.

#### Results:

- OK – Proceed to Test Step 5.
- Not OK – There is a problem with the accelerator pedal position.

**Repair:** Perform the following diagnostic procedure:

Troubleshooting, “Accelerator Pedal (Throttle) Position Sensor Circuit - Test”

STOP.

- Not OK – There is a problem with the clutch pedal position.

**Repair:** Perform the following diagnostic procedure:

Troubleshooting, “Clutch Pedal Position Switch Circuit - Test”

STOP.

### Test Step 5. Use ET to Check the Relay and Solenoids

- Turn the ignition key switch to the ON position.
- Access the “Auxiliary Brake Special Test” on ET. Access the following display screens in order:
  - “Diagnostics”
  - “Diagnostic Tests”
  - “Auxiliary Brake Special Tests”
- Turn the dash switches to the “High Braking Level” for the auxiliary brake. This is not the retarder solenoid switches that are connected to the ECM vehicle harness connector J1/P1:23 & 40.

- D.** While you listen for the relay and solenoids to click, cycle the “Auxiliary Brake Special Test” from the ON position to the OFF position back to the ON position.

**Note:** You may need to be near the engine in order to hear the click of the relay and solenoids.

**Expected Result:**

The relay and solenoids are operating.

**Results:**

- **OK** – The ECM is operating correctly. If the auxiliary brake or the relay is not operating, send the vehicle to the OEM dealer for repair. **STOP.**
- **Not OK** – Proceed to Test Step 6.

**Test Step 6. Use ET to Check the ECM**

- A.** Connect ET to the cab data link connector.
- B.** Turn the ignition key switch to the OFF position.
- C.** Disconnect the ECM vehicle harness connector J1/P1.
- D.** Connect a 70-Terminal Breakout T between ECM connectors J1 and P1.
- E.** Connect a voltage test lamp to terminal 65 (–Battery) and terminal 12 (Output 3) of the Breakout T.
- F.** Turn the ignition key switch to the ON position.
- G.** Access the “Auxiliary Brake Special Test” on ET.
- H.** While you monitor the voltage test lamp, cycle the “Special Test” from the ON position to the OFF position back to the ON position.
- I.** Stop the “Special Test”.

**Note:** A multimeter can not be used in place of the voltage test lamp when the ECM outputs are being tested.

**Expected Result:**

The voltage test lamp turns on when the test is active. The voltage test lamp turns off when the test is not active.

**Results:**

- **OK** – The ECM is operating correctly. The problem is in the vehicle wiring. Inspect the vehicle wiring and then repair the vehicle wiring. Otherwise, send the vehicle to the OEM dealer for repair. Verify that the original condition is resolved. **STOP.**
- **Not OK** – Temporarily connect a test ECM. Use the “Auxiliary Brake Output Special Test” on ET to check the ECM. If the problem is resolved with the test ECM, install the suspect ECM. If the problem returns with the suspect ECM, replace the ECM. Verify that the repair eliminates the problem. **STOP.**

i01770843

## Check Engine Lamp Circuit - Test

**SMCS Code:** 7431-038

**System Operation Description:**

**Use this procedure under the following situation:**

The check engine lamp is suspected of operating incorrectly.

The check engine lamp is the only standard lamp on these engines. All other lamps are optional.

**The following background information is related to the following procedure:**

**Check Engine Lamp**

The check engine lamp is used to provide the following functions:

- Indicate the existence of an active diagnostic code.
- Indicate driver alert status of the idle shutdown timer.
- Read diagnostic flash codes.

**Power Up Lamp Check**

At powerup, the lamp will turn on for five seconds. The lamp will continue to flash if there is an active diagnostic code.

**Operation with an Active Diagnostic Code**

While the engine is operating, the lamp will turn on for a minimum of five seconds when certain fault conditions exist. If certain fault conditions exist, the lamp will operate in the following manner:

- The check engine lamp will turn on for five seconds.
- The check engine lamp will turn off for a short time.
- The check engine lamp will turn on for another five seconds.

The check engine lamp will continue to operate in this manner while the fault condition exists.

### **Indication of the Driver Alert Status of the Idle Shutdown Timer**

During the final 90 seconds of the operation of the idle shutdown timer, the check engine lamp will begin to flash. The flashing of the check engine lamp indicates that an engine shutdown is near.

### **Flashing Out Diagnostic Flash Codes**

The flash codes are two-digit representations of diagnostic codes. The PID-FMI diagnostic code should be used for troubleshooting. The PID is the Parameter Identifier. The FMI is the Failure Mode Identifier. A 110-03 is an example of a PID-FMI diagnostic code. Flash codes provide an indication of a failure. Flash codes are not as specific as diagnostic codes. Flash codes only indicate that a failure has occurred. Flash codes do not indicate the specific type of failure. For example, the Flash code (27) is used for a 110-03 Fault code and a 110-04 Fault code. Flash codes should not be used for troubleshooting.

Diagnostic flash codes that are active can be viewed at any time. Turn the cruise control On/Off switch to the OFF position. Hold the Set/Resume switch in either the SET position or the RESUME position until the lamp begins to flash. Then release the Set/Resume switch.

The Flash Code is determined by the blinking of the check engine lamp. The lamp will blink for the first digit of the flash code, and the lamp will pause for five seconds. Then, the lamp will blink for the second digit.

Some vehicles are equipped with a diagnostic enable switch. The diagnostic enable switch is used to flash the diagnostic codes by grounding the input of the diagnostic enable switch from P1:46 (Input 7) to P1:5 (Sensor Common).

**Note:** The check engine lamp should not continuously flash the diagnostic flash codes. If the set switch, the resume switch, or the diagnostic enable switch has not been used, then the circuit is probably shorted to ground.

### **Electrical Connection of the Check Engine Lamp**

One terminal of the check engine lamp must be connected to battery voltage through the vehicle wiring. The other terminal is connected to the ECM at the vehicle harness connector J1/P1:28 (Check Engine Lamp).

The ECM provides a path to ground in order for the lamp to turn on.

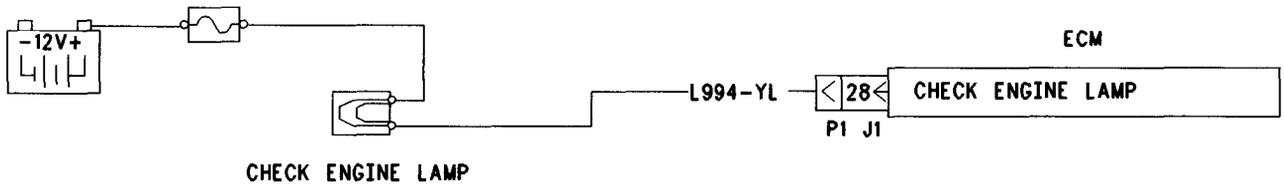


Illustration 62  
 Schematic for Lamp

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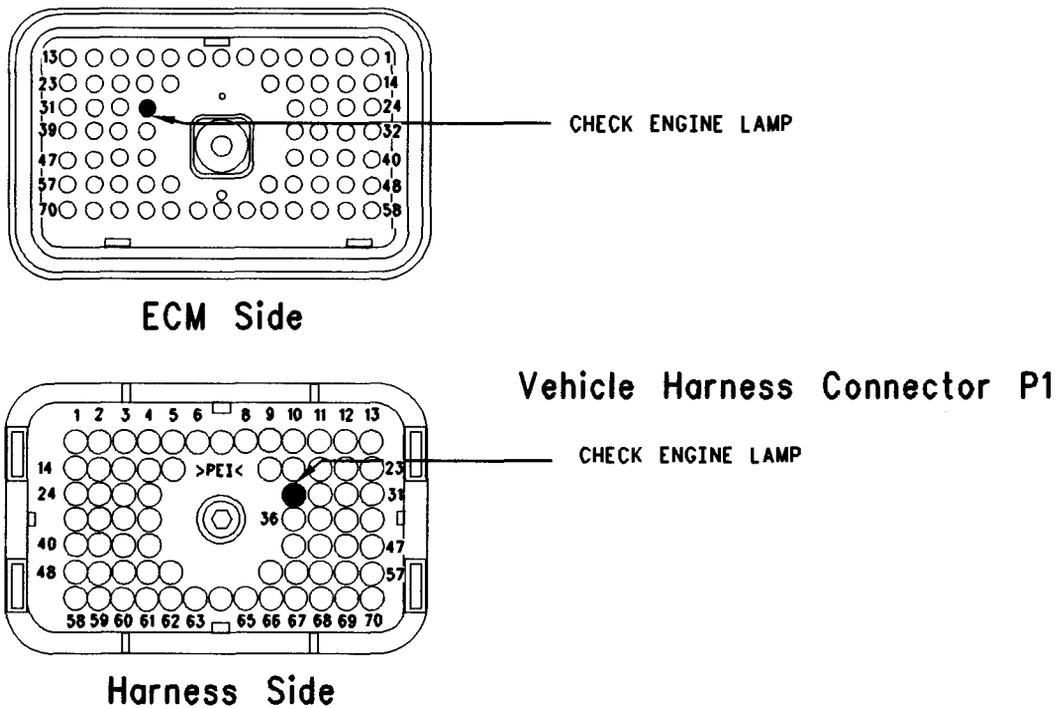


Illustration 63  
 Terminal locations for ECM

g00676965

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

- A. Thoroughly inspect J1/P1 ECM vehicle harness connector, the firewall bulkhead connector, and J1:28 (Check Engine Lamp). Refer to Troubleshooting, "Electrical Connectors - Inspect" for details.
- B. Perform a 45 N (10 lb) pull test on each of the wires in the ECM connector that are associated with the check engine lamp:

- C. Check the ECM connector (Allen Head Screw) for the proper torque of 6.0 N·m (55 lb in).
- D. Check the harness and wiring for abrasion and pinch points from the battery to the ECM.

**Expected Result:**

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

Refer to Illustration 63.

**Results:**

- OK – Proceed to Test Step 2.
- 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.

STOP.

**Test Step 2. Check for Normal Operation of the Lamp**

- A.** Monitor the check engine lamp.
- a.** Turn the ignition key switch to the ON position. The lamp should turn on for five seconds. Then, the lamp should turn off.
  - b.** The lamp will continue flashing if there is an active diagnostic code. If there is an active diagnostic code, connect the Caterpillar Electronic Technician (Cat ET) in order to read the active diagnostic code. Troubleshoot the problem.

**Expected Result:**

The check engine lamp turns on and the check engine lamp turns off per the above description.

**Results:**

- OK – The check engine lamp appears to operating correctly at this time. STOP.
- Not OK – Proceed to Test Step 3.

**Test Step 3. Test the Lamp Circuit**

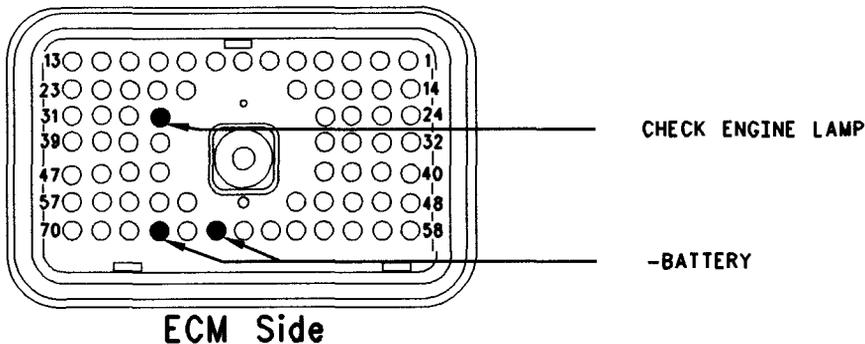


Illustration 64

g00676968

**A.** Disconnect ECM vehicle harness connector J1/P1.

**B.** Fabricate a jumper wire 100 mm (4 inch) long. Crimp a Deutsch pin to both ends of the wire.

- C. Insert the jumper into P1:28 (Check Engine Lamp).
- D. Connect the other side of the jumper wire to P1:65 (-Battery).
- E. Turn the ignition key switch to the ON position.
- F. While the lamp is being watched, insert the jumper wire and remove the jumper wire.

Refer to Illustration 64.

**Expected Result:**

**Result 1** The check engine lamp turns on while the jumper is connected to both sockets. Also, the check engine lamp turns off when the jumper is removed from one of the sockets.

**Result 2** The check engine lamp does not turn on while the jumper is connected to both sockets.

**Result 3** The lamp will stay on while the ECM vehicle harness connector is disconnected.

**Results:**

- **Result 1** – The check engine lamp circuit is functioning properly. Proceed to Test Step 4.
- **Result 2** – The lamp did not turn on. The vehicle's lamp circuit is not functioning properly. The lamp is probably burned out or there is a problem in the wiring from the cab to either the ECM or the +Battery connection. Repair the lamp circuit or send the vehicle to the OEM dealer for repairs. STOP.
- **Result 3**

**Repair:** Perform the following diagnostic procedure:

The circuit between the ECM and the lamp is shorted to chassis ground. Repair the circuit or send the vehicle to the OEM dealer for repairs.

STOP.

## Test Step 4. Check ECM Operation of the Check Engine Lamp

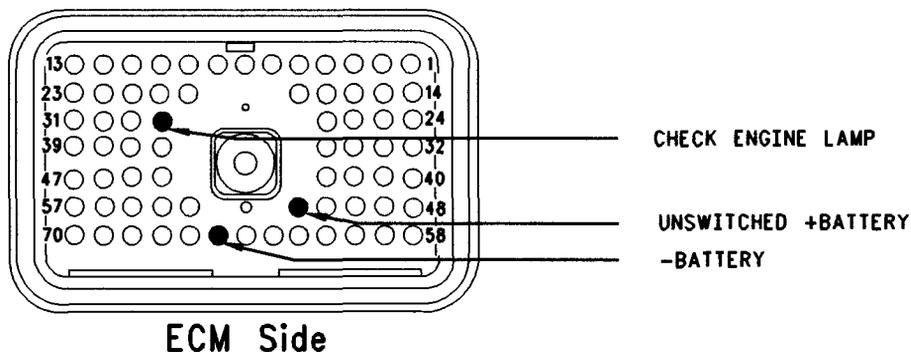


Illustration 65  
ECM Breakout T-connector

g00642525

- A. Disconnect ECM vehicle harness connector J1/P1.
- B. Insert a breakout T between ECM vehicle harness connector J1 and ECM vehicle harness connector P1.
- C. Connect a voltage test lamp probe to terminal 65 (-Battery) and connect the other probe to terminal 52 (Unswitched +Battery) of the breakout T.
- D. The test lamp should turn on. If the test lamp does not turn on, either the test lamp is faulty or the wiring to the ECM is faulty. Continue with this step if the lamp turns on.
- E. Leave the voltage test lamp probe connected to terminal 52 (Unswitched +Battery).
- F. Connect the other probe of the test lamp to Terminal 28 (Check Engine Lamp) of the breakout T.

Refer to Illustration 65.

- G. Watch the voltage test lamp. Turn the ignition key switch to the ON position.
- H. The lamp should turn on for five seconds. Then, the lamp should turn off. The lamp will continue flashing if there is an active diagnostic code. If there is an active diagnostic code, connect Cat ET in order to read the active diagnostic code. Troubleshoot the problem.

### Expected Result:

The check engine lamp turns on and the check engine lamp turns off per the above description.

### Results:

- OK – The ECM is operating correctly. There is a problem in the vehicle wiring or the lamp. Repair the vehicle wiring or the lamp, as required. STOP.
- Not OK – Temporarily connect a test ECM. Check the operation of the check engine lamp when the test ECM is installed. If the problem is resolved with the test ECM, then reconnect the suspect ECM. If the problem returns with the suspect ECM, then replace the ECM. STOP.

i01866339

## Clutch Pedal Position Switch Circuit - Test

**SMCS Code:** 1435-038-P9

### System Operation Description:

#### Use this procedure under the following situation:

The clutch pedal position switch is suspected of preventing normal operation of cruise control, idle set speed, or PTO operation.

The following switch circuits can also prevent the correct operation of the cruise control, idle set speed or PTO operation:

- Service Brake Pedal Position (Switch 1)
- Service Brake Pedal Position (Switch 2)
- Neutral Switch
- Cruise Control Set/Resume Switch

- Cruise Control On/Off Switch
- PTO On/Off Switch

The switches are described in the respective circuit tests in Troubleshooting.

All of the following customer programmable parameters can affect cruise control, idle set speed, and PTO operation:

- “Low Cruise Control Speed Set Limit”
- “High Cruise Control Speed Set Limit”
- “Idle Vehicle Speed Limit”
- “Cruise/Idle/PTO Switch Configuration”
- “Idle/PTO Bump rpm”
- “Idle/PTO rpm Ramp Rate”
- “PTO Vehicle Speed Limit”

The vehicle speed calibration can also affect the cruise control, the idle set speed, and the PTO if the vehicle speed calibration is incorrectly programmed. Refer to Troubleshooting, “Customer Specified Parameters”.

### Clutch Switch

The clutch pedal position switch is normally closed when the pedal is released. Depressing the clutch pedal should open the circuit. This switch is OEM supplied. The clutch pedal position switch is typically a limit switch that is mounted near the pedal. The clutch pedal position switch is usually adjustable.

### The following background information is related to this procedure:

The kickout switch refers to the switch that is used to exit the cruise control, the PTO, or the idle set speed.

The operation of the Caterpillar electronic engine cruise control is similar to the operation of the cruise controls that are installed in automobiles. The operation of idle and PTO are similar to the operation of cruise except that the Idle and the PTO govern engine rpm instead of vehicle speed.

**Note:** Idle in this procedure is an engine idle rpm above the programmed low idle rpm. Idle is set by using the cruise control On/Off switch and the Set/Resume switch. Refer to Troubleshooting, “PTO Switch Circuit - Test” for additional information regarding the programmable options for the dedicated PTO.

### Usage of Transmission Style Switches

The “Transmission Style” parameter determines the switches that will be used. The following switches can be used with being dependent on the parameter setting:

- Clutch Pedal Position
- Neutral
- Service Brake Pedal Position (Switch 1)
- Service Brake Pedal Position (Switch 2)

Refer to Table 2 for additional information.

Table 142

Setting For Transmission Style Parameter	Switch Usage.			
	Service Brake Switch 1	Service Brake Switch 2	Clutch	Neutral
Manual Option 1	X		X	
Automatic Option 1	X			
Automatic Option 2	X	X		
Automatic Option 3	X	X		X
Automatic Option 4	X			X
Eaton Top 2	X		X	

If the “Transmission Style” parameter is programmed to one of the following options, the input for the clutch pedal position switch is not used:

- Automatic Option 1
- Automatic Option 2
- Automatic Option 3
- Automatic Option 4

A Service Brake Pedal Position (Switch 1) is required for all configurations. The Service Brake Pedal Position (Switch 1) connects to the ECM through connector P1:45. The Service Brake Pedal Position (Switch 2) connects to the ECM through connector P1:64. The clutch pedal position switch connects to the ECM through connector P1:22. The neutral switch connects to the ECM through Connector P1:62.

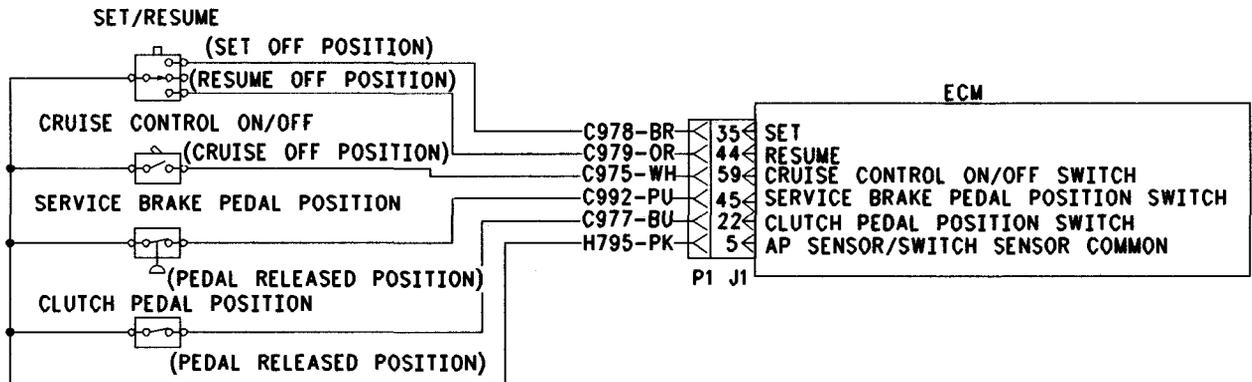


Illustration 66

g00643881

Schematic for cruise control switch, service brake pedal position switch 1 and clutch pedal position switch

### Test Step 1. Check the Status for the "Clutch Pedal Position Switch"

- A. Connect the electronic service tool to the data link connector.
- B. Turn the key switch to the ON position.
- C. Check the status of the "Clutch Pedal Position Switch".
- D. Depress the clutch.
- E. Check the status of the "Clutch Pedal Position Switch".

#### Expected Result:

The status for the "Clutch Pedal Position Switch" is "Off" when the clutch is released. The status for the "Clutch Pedal Position Switch" is "On" when the clutch is depressed.

#### Results:

- OK – The clutch pedal position switch is operating correctly. STOP.
- Not OK – The clutch pedal position switch is not operating correctly. Proceed to Test Step 2.

### Test Step 2. Determine the Configuration of the Clutch Pedal Position Switch

- A. Determine if the wiring for the clutch pedal position switch is wired directly to the ECM or through the J1939 data link.

**Note:** J1/P1:22 can only be used for the clutch pedal position switch. If the clutch pedal position switch is wired to J1/P1:22, the clutch pedal position switch is wired directly to the ECM.

- B. Verify that the "Clutch Pedal Position Switch" parameter is programmed to reflect the proper wiring.

#### Expected Result:

The clutch pedal position switch is wired directly to the ECM.

#### Results:

- OK – The clutch pedal position switch is wired directly to the ECM.

**Repair:** Verify that the "Clutch Pedal Position Switch" parameter is programmed to "J1/P1:22".

Proceed to Test Step 3.

- Not OK – The clutch pedal position switch uses the J1939 data link.

**Repair:** Verify that the "Clutch Pedal Position Switch" parameter is programmed "J1939 - Body Controller", "J1939 - Cab Controller", or "J1939 - Instrument Cluster".

Refer to Troubleshooting, "Powertrain Data Link Circuit - Test".

STOP.

### Test Step 3. Inspect Electrical Connectors and Wiring

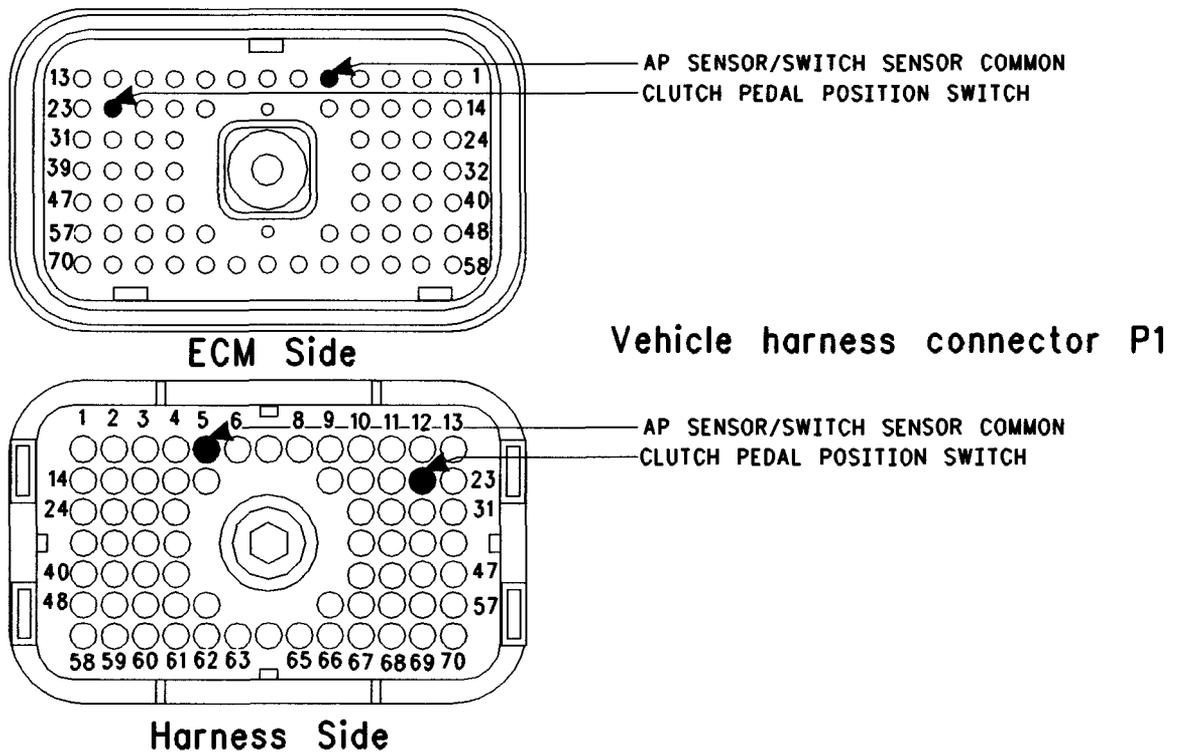


Illustration 67

g00702005

**A.** Thoroughly inspect the J1/P1 ECM connector, the firewall bulkhead connector and the terminals for the following switches in the connectors:

- J1/P1:22 (Clutch Pedal Position Switch)
- J1/P1:5 (AP Sensor/Switch Sensor Common)

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

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

Refer to Illustration 67.

**C.** Check the ECM connector (Allen Head Screw) for the proper torque of 6.0 N·m (55 lb in).

**D.** Check the harness and wiring for abrasion and pinch points from the sensor to the ECM.

**Expected Result:**

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

**Results:**

- OK – Proceed to Test Step 4.
- 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 4. Check the Switch Circuit

- A. Turn the key switch to the Off position.
- B. Fabricate a jumper wire 100 mm (4 inch) long. Crimp a Deutsch pin to both ends of the wires.
- C. Disconnect the P1 ECM connector.
- D. Connect a 140-2266 Cable (Seventy-Pin Breakout) between the J1 and P1 ECM connectors.
- E. Install the jumper into terminal 22 (Clutch Pedal Position Switch) of the breakout T. Connect the other end of the jumper to terminal 5 (AP Sensor/Switch Sensor Common) of the breakout T.
- F. Turn the key switch to the On position.
- G. Connect the electronic service tool to the data link connector.
- H. Access the status for the "Clutch Pedal Position Switch" on the electronic service tool.
- I. While the status for the "Clutch Pedal Position Switch" is being monitored on the electronic service tool, remove the jumper from terminal 5 (AP Sensor/Switch Sensor Common). Insert the jumper into terminal 5 (AP Sensor/Switch Sensor Common).

#### Expected Result:

When the jumper wire is installed, the status for the "Clutch Pedal Position Switch" is "Off". When the jumper wire is removed, the status for the "Clutch Pedal Position Switch" is "On".

#### Results:

- OK – The ECM is functioning properly.

**Repair:** Remove the breakout T and reconnect the P1 ECM connector to the ECM.

Proceed to Test Step 5.

- Not OK – The ECM is not functioning properly.

**Repair:** Perform the following repair:

1. Temporarily connect a test ECM.

2. Remove the breakout T and reconnect the P1 ECM connector to the ECM.
3. If the problem is resolved with the test ECM, reconnect the suspect ECM.
4. If the problem returns with the suspect ECM, replace the ECM.
5. Verify that the repair eliminates the problem.

STOP.

#### Test Step 5. Insert a Jumper at the Clutch Switch

- A. Turn the key switch to the Off position.
- B. Find the clutch switch in the vehicle.
- C. Disconnect the wires from the clutch switch terminals.
- D. Turn the key switch to the On position.
- E. Connect the electronic service tool to the data link connector.
- F. Access the status screen on the electronic service tool.
- G. While the status for the "Clutch Pedal Position Switch" is being monitored on the electronic service tool, connect the switch wires and disconnect the switch wires.

#### Expected Result:

When the switch wires are connected the status for the "Clutch Pedal Position Switch" is "Off". When the switch wires are disconnected the status for the "Clutch Pedal Position Switch" is "On".

#### Results:

- OK – The wiring between the clutch pedal position switch and the ECM is OK.

**Repair:** Replace the faulty switch.

Verify that the repair eliminates the problem.

STOP.

- Not OK – There is a problem in the harness between the switch and the ECM. Proceed to Test Step 6.

**Test Step 6. Insert a Jumper at the Bulkhead Connector**

- A. Turn the key switch to the Off position.
- B. Fabricate a jumper wire 100 mm (4 inch) long. Crimp a Deutsch pin to both ends of the wires.
- C. Locate the clutch switch terminal and find the AP Sensor/Switch Sensor Common terminal on the engine side of the bulkhead connector.
- D. Insert the jumper wire between the two terminals in the engine side of the bulkhead connector.
- E. Turn the key switch to the On position.
- F. Connect the electronic service tool to the data link connector.
- G. Access the status for the "Clutch Pedal Position Switch" on the electronic service tool.
- H. While the status for the "Clutch Pedal Position Switch" is being monitored on the electronic service tool, remove the jumper wire between the two terminals and insert the jumper wire between the two terminals.

**Expected Result:**

When the jumper wire is installed, the status for the "Clutch Pedal Position Switch" is "Off". When the jumper wire is removed, the status for the "Clutch Pedal Position Switch" is "On".

**Results:**

- OK – The problem is in the vehicle wiring between the bulkhead connector and the switch.

**Repair:** Perform the following repair:

Inspect the vehicle wiring and repair the vehicle wiring, as required. If the problem still exists with the wiring, send the vehicle to the OEM dealer.

**STOP.**

- Not OK – The problem is in the vehicle wiring between the bulkhead connector and the ECM.

**Repair:** Perform the following repair:

Inspect the vehicle wiring and repair the vehicle wiring, as required. If the problem still exists with the wiring, send the vehicle to the OEM dealer.

**STOP.**

**Coolant Level Sensor Circuit - Test**

**SMCS Code:** 5574-038-CLT

**System Operation Description:**

The coolant level sensor is an OEM installed component for the vehicle. This sensor is the only optional sensor for "Engine Monitoring". "Engine Monitoring" is a programmable feature of the Caterpillar ECM. The sensor is selectable through a customer programmable parameter and the customer programmable parameter may be protected by customer passwords. Some OEM installed coolant level sensors are not connected to the Engine Control Module (ECM). Do not confuse an OEM installed "Coolant Level Sensor" that is independent of "Engine Monitoring" with the "Coolant Level Sensor" that is used for "Engine Monitoring".

The sensor operates as a coolant level sensor. The sensor indicates the presence or the absence of coolant at the sensor probe. There are two options if a coolant level sensor is installed.

- "4-pin"
- "2-wire Float Sensor"

If a coolant level sensor is not installed or the coolant level sensor is independent from the ECM, the parameter should be programmed to "None".

**"4-pin"**

The sensor is powered from the ECM through the ECM connector J1/P1:2 (+5 VDC). The signal wires for the coolant level sensor are connected to pins J1/P1:54 (Coolant Level Low) and to J1/P1:49 (Coolant Level Normal) on the ECM. The sensor common is connected to the ECM connector J1/P1:5 (AP Sensor/Switch Sensor Common).

If coolant is present at the sensor probe, "Coolant Level Low" has an output of near 0 VDC. If coolant is present at the sensor probe, "Coolant Level Normal" has an output near +5 VDC. If coolant is not present at the sensor probe, the "Coolant Level Low" output would be near +5 VDC. If coolant is not present at the sensor probe, the "Coolant Level Normal" output would be near 0 VDC.

**"2-wire Float Sensor"**

The sensor is powered with +5 VDC from the ECM through ECM connector J1/P1:26. The sensor is also connected to J1/P1:5 (AP Sensor/Switch Sensor Common).

Resistance through the sensor is varied by the coolant level. The voltage at the normal operating range is between 0.75 VDC and 1.75 VDC.

**Note:** The “Coolant Level Sensor” is set when the coolant level sensor is programmed to “4-Pin” or “2-wire Float Sensor”. If this parameter is set and a sensor is not installed, the following diagnostic code will be logged:

- 111-02 Coolant Level signal invalid

The “Engine Monitoring Lamps” parameter is used in order to determine if a single warning lamp is used for the engine monitoring system or if discrete lamps are used for each monitored condition. If the “Engine Monitoring Lamps” parameter is programmed to “Warning Lamp”, a single lamp is connected to J1/P1:29. If the “Engine Monitoring Lamps” parameter is programmed to “Option 1” and a coolant level sensor is installed, then a discrete lamp for low coolant level is connected to J1/P1:30. The “Coolant Level Sensor” parameter must be programmed for the lamp to operate correctly.

### Test Step 1. Check for an Active Coolant Level Sensor Fault

- Connect the Caterpillar Electronic Technician (Cat ET) to the data link connector.
- Turn the key switch to the ON position.
- Check for active diagnostic codes on Cat ET.

#### Expected Result:

One of the following diagnostic codes is active.

- 111-02 Coolant Level signal invalid
- 111-03 Coolant Level voltage high
- 111-04 Coolant Level voltage low

#### Results:

- OK – Proceed to Test Step 2.
- Not OK – 111-01, 111-11, or 111-14 is active.

**Repair:** Refer to Troubleshooting, “Troubleshooting with a Diagnostic Code” for the proper troubleshooting procedure.

STOP.

- **No Codes** – If none of the specified diagnostic codes are present, clear all diagnostic codes. If a problem is still suspected with the coolant level sensor, proceed to Test Step 2.

### Test Step 2. Determine the type of Coolant Level Sensor

- Check the coolant level sensor in order to determine the type of sensor that is installed on the vehicle.

#### Expected Result:

A “4-pin” or “2-wire Float Sensor” is installed.

#### Results:

- “4-pin” – Proceed to Test Step 3.
- “2-wire Float” – Proceed to Test Step 9.
- None

**Repair:** If a coolant level sensor is not installed, change the “Coolant Level Sensor” parameter to “None”.

Verify that the repair eliminates the problem.

STOP.

### Test Step 3. Inspect Electrical Connectors and Wiring

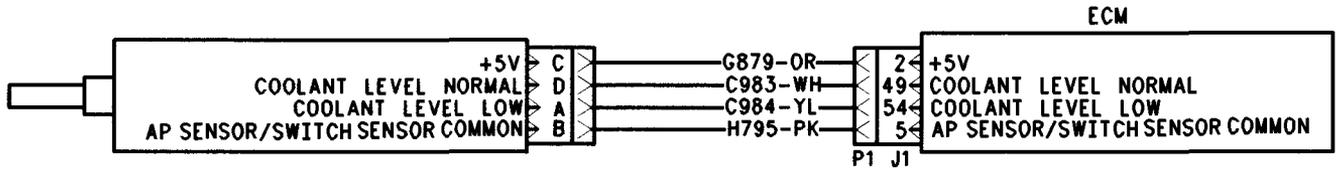


Illustration 68

g00650999

Schematic for "4-pin" coolant level sensor

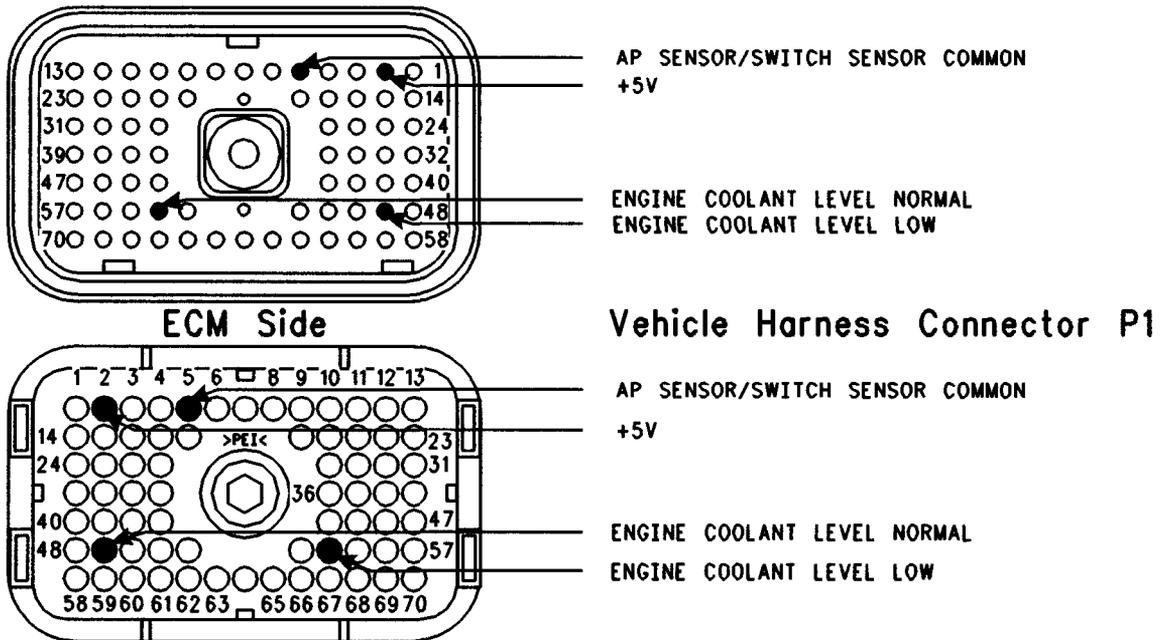


Illustration 69

g00651001

Terminal locations for ECM

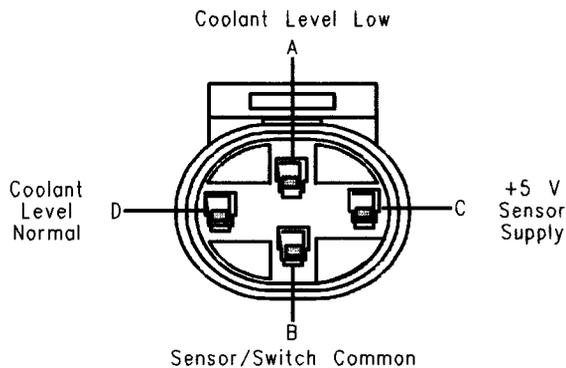


Illustration 70

g00999065

Connector for the "4-pin" coolant level sensor

- A. Thoroughly inspect the J1/P1 ECM connector, the connector for the coolant level sensor and the terminals in the connectors. Refer to Troubleshooting, "Electrical Connectors - Inspect" for details.
- B. Perform a 45 N (10 lb) pull test on each of the wires in the ECM connector that are associated with the following connections:
  - J1/P1:2
  - J1/P1:5
  - J1/P1:49
  - J1/P1:54

Refer to Illustration 69.

- C. Check the ECM connector (Allen Head Screw) for the proper torque of 6.0 N·m (55 lb in).
- D. Check the harness and wiring for abrasion and pinch points from the sensor to the ECM.

**Expected Result:**

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

**Results:**

- OK – Proceed to Test Step 4.
- 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. Clear all diagnostic codes.

STOP.

**Test Step 4. Check the Supply Voltage at the Sensor**

- A. Turn the key switch to the OFF position.
- B. Disconnect the coolant level sensor from the harness.
- C. Turn the key switch to the ON position.
- D. Measure the voltage at the harness connector between Terminal C (+5 V Sensor Supply) and Terminal B (AP Sensor/Switch Sensor Common).

**Expected Result:**

The measured voltage is between 4.5 VDC and 5.5 VDC.

**Results:**

- OK – The voltage is within the proper range. Proceed to Test Step 6.
- Not OK – There is a problem with the sensor supply. Proceed to Test Step 5.

**Test Step 5. Check the Supply Voltage at the ECM**

- A. Turn the key switch to the OFF position.
- B. Disconnect the J1/P1 ECM connector.
- C. Install a 140-2266 Cable (Seventy-Pin Breakout) between ECM connector J1 and ECM connector P1.

**Note:** The P1 ECM connector must be connected to the breakout T in order for the ECM to receive battery voltage.

- D. Turn the key switch to the ON position.
- E. Measure the voltage between Terminal 2 (+5 V Sensor Supply) and Terminal 5 (AP Sensor/Switch Sensor Common) at the breakout T.

**Expected Result:**

The measured voltage is between 4.5 VDC and 5.5 VDC.

**Results:**

- **OK** – The problem is located in the harness wiring.

**Repair:** Remove the breakout T. Reconnect the J1/P1 ECM connectors.

Measure the voltage between Terminal C and chassis ground at the connector for the coolant level sensor on the vehicle harness.

If the voltage is between 4.5 VDC and 5.5 VDC, the problem is with the common wire. If the voltage is not within the proper range, the problem is with the supply wire.

Repair the wiring or replace the wiring, as required.

Verify that the repair eliminates the problem.

**STOP.**

- **Not OK** – There may be a problem with the ECM.

**Repair:** Temporarily connect a test ECM. Ensure that the “Engine Monitoring” and the “Coolant Level Sensor” are programmed to match the old ECM.

Check the test ECM by measuring the voltage between Terminal 2 and Terminal 5 at the breakout T.

If the test ECM fixes the problem, reconnect the suspect ECM.

If the problem returns with the suspect ECM, permanently replace the ECM.

Verify that the repair eliminates the problem.

**STOP.****Test Step 6. Check the Circuit for the Coolant Level Sensor**

- Turn the key switch to the OFF position.
- Insert a jumper wire between Terminal D (Coolant Level Normal) and Terminal B (AP Sensor/Switch Sensor Common) at the harness connector.
- Turn the key switch to the ON position.
- While the jumper wire is in place, access the status for “Coolant Level” on Cat ET.
- Check for active diagnostic codes.
- Turn the key switch to the OFF position.

**Expected Result:**

The status for “Coolant Level” indicates “LOW” while the jumper wire is in place. A 111-01 Low Coolant Level Warning is active while the jumper wire is in place.

**Results:**

- **OK** – The ECM responded correctly. Proceed to Test Step 7.
- **Not OK** – Proceed to Test Step 8.

**Test Step 7. Check the Circuit for the Coolant Level Low**

- Turn the key switch to the OFF position.
- Insert a jumper wire between Terminal A (Coolant Level Low) and Terminal B (AP Sensor/Switch Sensor Common) at the harness connector.
- Turn the key switch to the ON position.
- Check for active diagnostic codes on Cat ET.
- Check the status for “Coolant Level” on Cat ET.

**Expected Result:**

There are no active diagnostic codes while the jumper wire is in place. The status for “Coolant Level” displays “OK”.

**Results:**

- **OK** – The harness and the ECM are working correctly.

**Repair:** Remove the jumper wire.

Replace the sensor and reconnect the harness to the sensor.

Verify that the repair eliminates the problem.

**STOP.**

- **Not OK** – Proceed to Test Step 8.

**Test Step 8. Check the ECM for Proper Operation**

- Disconnect the J1/P1 ECM connector.
- Install a breakout T between the J1 and P1 ECM connectors.
- Fabricate two jumper wires 100 mm (4 inch) long. Crimp a Deutsch pin to both ends of each wire.
- Turn the key switch to the ON position.

**E.** Monitor the status for “Coolant Level” on Cat ET. Insert a jumper wire between Terminal 49 (Coolant Level Normal) and Terminal 5 (AP Sensor/Switch Sensor Common) of the breakout T.

**F.** Monitor the status for “Coolant Level” while the jumper is being inserted and removed. Wait for 30 seconds between the insertion of the jumper and the removal of the jumper. The status for “Coolant Level” will display “Low” while the jumper wire is in place. Also, the following diagnostic code should be active:

- 111-01 Low Coolant Level Warning

**Note:** 111-14 Low Coolant Level Warning will be active during the first six hours of engine operation.

**G.** Record the result.

**H.** Monitor the status for “Coolant Level” on Cat ET. Insert a jumper wire between Terminal 54 (Coolant Level Low) and Terminal 5 (AP Sensor/Switch Sensor Common) of the breakout T.

**I.** Monitor the status for “Coolant Level” while the jumper is being inserted and removed. Wait for 30 seconds between the insertion of the jumper and the removal of the jumper. The status for “Coolant Level” will display “OK” while the jumper wire is in place. Also, there should be no active diagnostic codes.

### **Expected Result:**

The “Coolant Level” status behaves in the following manner:

- The status for “Coolant Level” indicates “Low” when the jumper wire is installed between Terminal 49 and Terminal 5. Also, 111-01 Low Coolant Level Warning is active.

**Note:** 111-14 Low Coolant Level Warning will be active during the first six hours of engine operation.

- The status for “Coolant Level” indicates “OK” when the jumper wire is installed between Terminal 54 and Terminal 5. Also, there are no active diagnostic codes.

### **Results:**

- **OK** – The ECM is functioning properly.

**Repair:** Repair the harness or replace the harness, as required.

Verify that the repair eliminates the problem. Clear all diagnostic codes.

**STOP.**

- **Not OK**

**Repair:** Temporarily connect a test ECM. Ensure that the “Engine Monitoring” and the “Coolant Level Sensor” are programmed to match the old ECM.

Repeat this Test Step with the test ECM.

If the test ECM fixes the problem, reconnect the suspect ECM.

If the problem returns with the suspect ECM, permanently replace the ECM.

Verify that the repair eliminates the problem.

**STOP.**

## Test Step 9. Inspect Electrical Connectors and Wiring

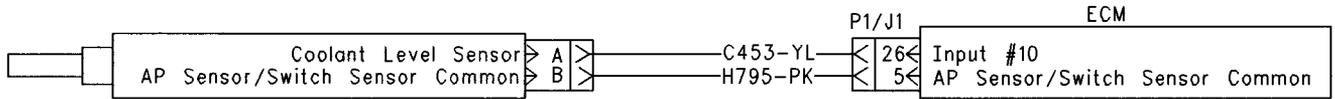


Illustration 71

g00907746

Schematic for "2-wire Float Sensor"

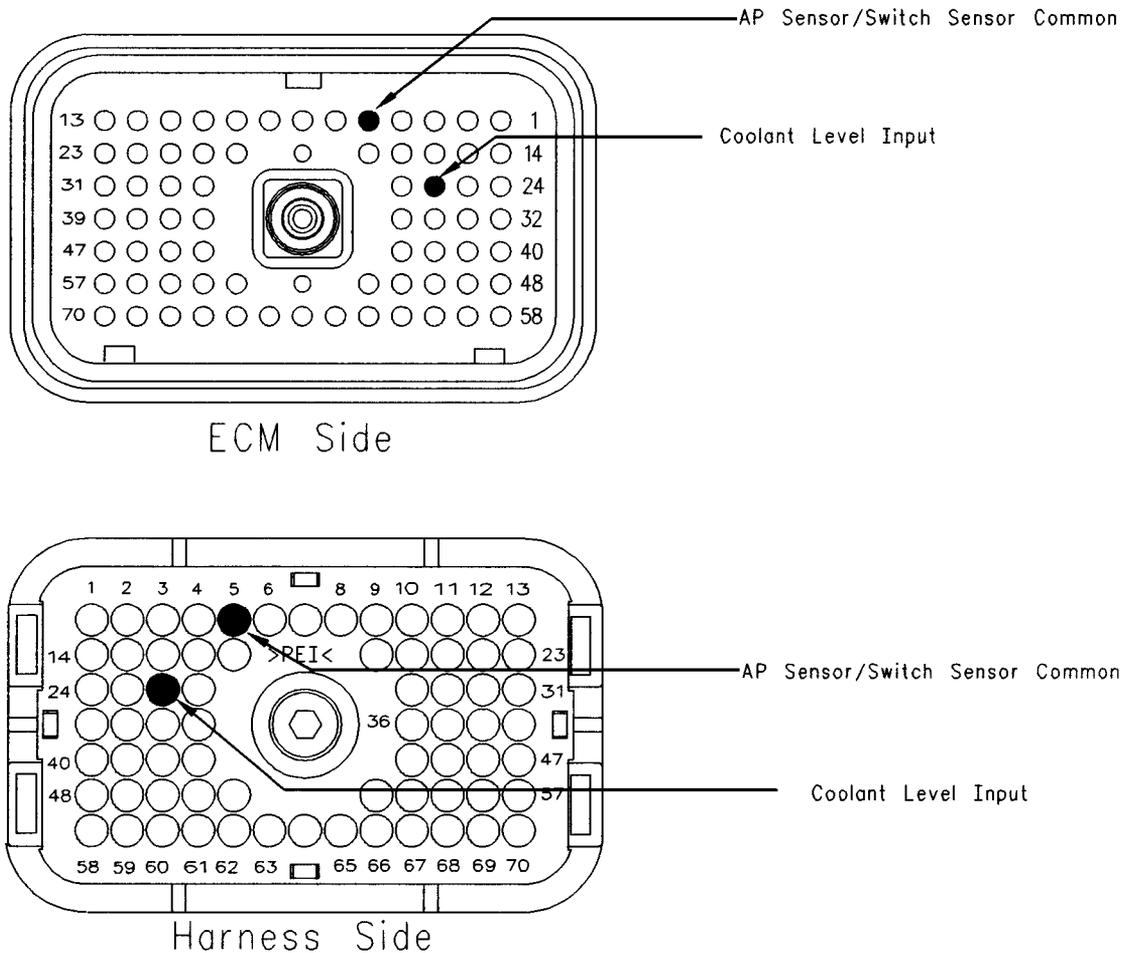


Illustration 72

g00884766

Terminal locations for ECM

- A.** Thoroughly inspect the J1/P1 ECM connector, the connector for the coolant level sensor and the terminals for the coolant level sensor in the connectors. Refer to Troubleshooting, "Electrical Connectors - Inspect" for details.
- B.** Perform a 45 N (10 lb) pull test on each of the wires in the ECM connector that are associated with the following connections:
  - P1/J1:26 (Coolant level input)
  - P1/J1:5 (AP sensor/switch sensor common)

Refer to Illustration 72.

- C.** Check the ECM connector (allen head screw) for the proper torque of 6.0 N·m (55 lb in).
- D.** Check the harness and wiring for abrasion and pinch points from the sensor to the ECM.

**Expected Result:**

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

**Results:**

- OK – Proceed to Test Step 10.
- 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. Clear all diagnostic codes.

STOP.

**Test Step 10. Verify that the Diagnostic Code is Still Active**

- A. Turn the key switch to the ON position. Wait at least 15 seconds for activation of the diagnostic codes.
- B. Check for active diagnostic codes on Cat ET.

**Expected Result:**

One of the following diagnostic codes is active.

- 111-02 Coolant Level signal invalid
- 111-03 Coolant Level voltage high
- 111-04 Coolant Level voltage low

**Results:**

- 111-02 – A fault for the coolant level sensor is active. Proceed to Test Step 11.
- 111-03 – A “voltage high” diagnostic code (open circuit) is active at this time. Proceed to Test Step 15.
- 111-04 – A “voltage low” diagnostic code (short circuit) is active at this time. Proceed to Test Step 13.

**Test Step 11. Disconnect the Coolant Level Sensor and Check the Supply Voltage (+5 VDC)**

- A. Turn the key switch to the OFF position.

- B. Disconnect the coolant level sensor from the harness.
- C. Use a multimeter to measure the voltage at the harness connector.
- D. Turn the key switch to the ON position.

**Expected Result:**

The measured voltage is between 4.5 VDC and 5.5 VDC.

**Results:**

- OK – The correct voltage is reaching the sensor.  
**Repair:** Replace the sensor.  
STOP.
- Not OK – Proceed to Test Step 12.

**Test Step 12. Disconnect the Terminal for the Sensor Supply (+5 VDC) from the ECM Connector**

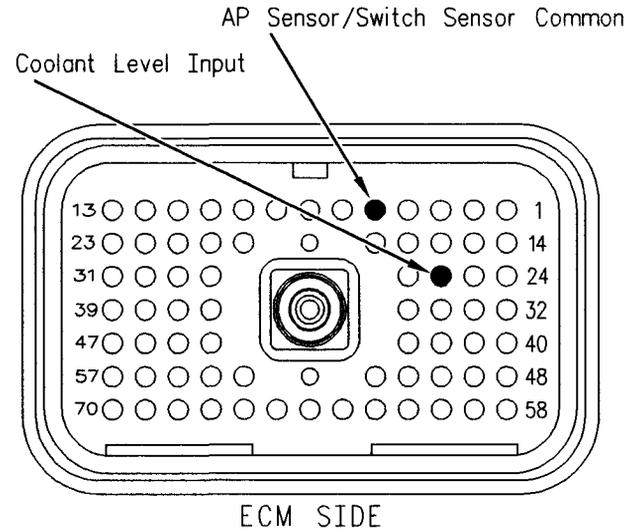


Illustration 73 g00884813

Terminal locations on the breakout T (2-wire float sensor)

- A. Turn the key switch to the OFF position.
- B. Disconnect the J1/P1 ECM connector.
- C. Install a breakout T between ECM connector J1 and ECM connector P1.
- D. Turn the key switch to the ON position.

- E.** Measure the voltage at the breakout T from terminal 26 to terminal 5.

Refer to Illustration 73.

**Expected Result:**

The measured voltage is between 4.5 VDC and 5.5 VDC.

**Results:**

- **OK** – The problem is located in the harness wiring.

**Repair:** Repair the wiring or replace the wiring, as required.

Verify that the repair eliminates the problem.

**STOP.**

- **Not OK** – The problem is on the ECM side.

**Repair:** Temporarily connect a test ECM. Ensure that the “Engine Monitoring” and the “Coolant Level Sensor” are programmed to match the old ECM. Check the test ECM by measuring the voltage at the breakout T from terminal 26 to terminal 5 again. If the problem is resolved with the test ECM, reconnect the suspect ECM. If the problem returns with the suspect ECM, replace the ECM.

**STOP.**

**Test Step 13. Disconnect the Sensor in order to Create an Open Circuit**

- Turn the key switch to the OFF position.
- Disconnect the coolant level sensor at the sensor in order to create an open circuit.
- Turn the key switch to the ON position. Wait at least 15 seconds for activation of the diagnostic codes.
- Check for active diagnostic codes on Cat ET.

**Expected Result:**

111-03 Coolant Level voltage high is now active.

**Results:**

- **OK** – There is a “voltage high” diagnostic code (open circuit) when the connector is disconnected.

**Repair:** There is a short in the coolant level sensor.

- Repair the sensor or replace the sensor.

- Verify that the repair eliminates the problem.

**STOP.**

- **Not OK** – There is still a “voltage low” diagnostic code (short circuit). Proceed to Test Step 14.

**Test Step 14. Create an Open Circuit at the ECM**

- Turn the key switch to the OFF position.
- Remove the wires from P1:26 and J1:5 in order to create an open circuit at the ECM.
- Turn the key switch to the ON position. Wait at least 15 seconds for activation of the diagnostic codes.
- Check for active diagnostic codes on Cat ET.

**Expected Result:**

111-03 Coolant Level voltage high is now active.

**Results:**

- **OK** – There is a short circuit in the harness between the ECM and the coolant level sensor. Proceed to Test Step 17.
- **Not OK** – The “voltage low” diagnostic code (short circuit) is still present.

**Repair:** Perform the following procedure:

- Temporarily connect a test ECM. Refer to Troubleshooting, “Programming Parameters” before replacing the ECM.
- If the test ECM fixes the problem, reconnect the suspect ECM. If the problem returns, permanently install the new ECM.

**STOP.**

**Test Step 15. Create a Short Circuit at the Sensor**

- Turn the key switch to the OFF position.
- Disconnect the coolant level sensor at the sensor.
- Fabricate a jumper wire between terminal 1 and terminal 2 of the connector for the coolant level sensor in order to create a short circuit.
- Turn the key switch to the ON position. Wait at least 15 seconds for activation of the diagnostic codes.
- Check for active diagnostic codes on Cat ET.

**Expected Result:**

111-04 Coolant Level voltage low is now active.

**Results:**

- **OK** – There is an open circuit in the coolant level sensor.

**Repair:** Perform the following procedure:

1. Repair the coolant level sensor or replace the coolant level sensor.
2. Verify that the repair eliminates the problem.

**STOP.**

- **Not OK** – The “voltage high” diagnostic code (open circuit) is still active. Proceed to Test Step 16.

**Test Step 16. Create a Short Circuit at the ECM**

- A. Turn the key switch to the OFF position.
- B. Remove the wires from P1:26 and P1:5.
- C. Fabricate a jumper wire between P1:26 and P1:5 in order to create a short circuit.
- D. Turn the key switch to the ON position. Wait at least 15 seconds for activation of the diagnostic codes.
- E. Check for active diagnostic codes on Cat ET.

**Expected Result:**

111-04 Coolant Level voltage low is now active.

**Results:**

- **OK** – There is a problem in the harness between the ECM and the solenoid. Proceed to Test Step 17.
- **Not OK** – There is still a “voltage high” diagnostic code (open circuit).

**Repair:** Perform the following procedure:

1. Temporarily connect a test ECM. Refer to Troubleshooting, “Programming Parameters” before replacing the ECM.

2. If the test ECM fixes the problem, reconnect the suspect ECM. If the problem returns, permanently install the new ECM.

**STOP.**

**Test Step 17. Bypass the Harness Wiring between the ECM and the Solenoid**

- A. Turn the key switch to the OFF position.
- B. Remove the wires from P1:26 and P1:5. Also remove the wires from the connector for the coolant level sensor.
- C. Fabricate two jumper wires to reach from the ECM to the connector for the coolant level sensor. Crimp Deutsch sockets to both ends of each wire.
- D. Connect one wire between P1:26 and terminal 1 of the coolant level sensor. Connect the other wire between P1:5 and terminal 2 of the coolant level sensor.
- E. Turn the key switch to the ON position. Wait at least 15 seconds for activation of the diagnostic codes.

**Expected Result:**

There are no active diagnostic codes.

**Results:**

- **OK** – There was a problem in the harness.

**Repair:** Perform the following repair:

1. Permanently replace the faulty wiring.
2. Clear all diagnostic codes.
3. Verify that the repair eliminates the problem.

**STOP.**

- **Not OK** – Bypassing the harness did not fix the problem.

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

Restart this procedure and carefully perform each step.

**STOP.**

i01907624

## Cooling Fan Circuit and A/C High Pressure Switch Circuit - Test

**SMCS Code:** 1356-038; 1435-038-PX

### System Operation Description:

#### Use this procedure under the following situation:

The cooling fan (Output 5) or the A/C high pressure switch (Input 11) is suspected of incorrect operation.

**Note:** Not all vehicle manufacturers, or all trucks for a manufacturer use the Caterpillar cooling fan circuit. Prior to troubleshooting, determine if the vehicle is using the ECM cooling fan circuit.

Check the following items in order to determine if a vehicle is using the ECM cooling fan circuit:

- The "Fan Control Type" parameter must be programmed to "On/Off", "Three-Speed Fan", or "Variable Speed Fan Option S". The Caterpillar factory default is None.
- A wire is present in the ECM vehicle harness connector J1/P1:11 which is Output 5 (Cooling Fan Solenoid). This occurs if an "On/Off" type of fan is used.
- A wire is present in the vehicle harness connector J1/P1:11 which is Output 5 (Slip Solenoid). A wire is also present in the vehicle harness connector J1/P1:13 which is Output 4 (Brake Solenoid). This occurs if a Three-Speed Fan is used.
- Perform the Special Test for the "On/Off Cooling Fan" or the special tests for the "Three-Speed Fan". Access each menu in the order that follows: "Diagnostics", "Diagnostic Tests", and "Special Test". Activating and then deactivating the circuit should cause the air solenoid to click if the circuit is working properly.

#### The following background information is related to this procedure:

##### Cooling Fan

The signal for the cooling fan is provided by the ECM in order to control the cooling fan. An input from one of the following items may cause the fan to turn on:

- Engine Coolant Temperature Sensor
- Intake Manifold Air Temperature Sensor
- Engine Retarder Switches

- PTO On/Off Switch
- OEM installed A/C High Pressure Switch
- Fan Override Switch

The control unit for the A/C may be connected to the A/C high pressure switch (Input 11) instead of a switch.

The output for the cooling fan is intended to connect directly to the circuit for the cooling fan solenoid. The solenoid and clutch configuration must be selected in order for the ECM output to turn the fan "Off". The fan will remain on for a minimum of 30 seconds. The fan will not remain on for 30 seconds during engine start-up. The fan will not remain on for 30 seconds if the "A/C Pressure Switch Fan On Time" is programmed to less than 30 seconds. During engine start-up, the ECM will keep the fan on for two seconds after the engine has reached the programmed low idle (600 to 750 rpm). The fan will be on continuously if the electrical circuit to the cooling fan air solenoid valve has an open circuit or if the ECM fan relay circuit is opened.

##### Cooling Fan On Conditions (On/Off Fan)

The ECM will turn on the cooling fan, if any of the following conditions are met:

- Engine speed is less than 2250 rpm.
- The engine is not running.
- The engine is cranking.
- The temperature of the coolant temperature sensor for the C-10 and the C-12 engines is greater than 96 °C (205 °F).
- The temperature of the coolant temperature sensor for the 3406E, C-15, C-16 and C-18 engines is greater than 102 °C (216 °F).
- Active diagnostic code for the coolant temperature sensor
- The intake manifold air temperature is greater than 87 °C (189 °F).
- The intake manifold air temperature is greater than 72 °C (162 °F) while the boost pressure is greater than 70 kPa (10 psi).
- The "Fan with Engine Retarder in High Mode" is programmed to "YES" and the retarder has been on at least two seconds.
- The "A/C Switch Fan On-Time" is programmed to a value above 0 and the A/C high pressure switch is Open.

- The ECM is counting after the A/C high pressure switch has closed.
- The "PTO Activates Cooling Fan" parameter is programmed to "Continuous" and the PTO On/Off switch is on.
- The manual fan override switch is on.

The last four items in the list are programmed by the customer in the "Configuration" screen on the Caterpillar Electronic Technician (Cat ET).

**Note:** With OCT99 and newer software, the ECM will turn the cooling fan "Off" for 10 seconds during an engine shutdown.

### Cooling Fan OFF Conditions

The cooling fan will be turned off by the ECM if engine rpm exceeds 2300 rpm or when all the following circumstances are met:

- The engine coolant temperature for the C-10 or the C-12 engines is less than 92 °C (198 °F).
- The engine coolant temperature for the 3406E, C-15, C-16 and C-18 engines is less than 98 °C (208 °F).
- The fan has been on for at least 30 seconds.
- The intake manifold air temperature is less than 53 °C (127 °F).
- The "Fan with Engine Retarder in High Mode" strategy is not active.
- The "A/C High Pressure Switch Strategy" is not active.
- The "PTO Activates Cooling Fan" strategy is not active.
- The manual fan override switch is off.

### Three-Speed Fan

The Three-Speed Fan operates in three modes:

- Brake
- Slip
- Direct

The fan is operating at full speed when the "Direct" mode is used. The "Slip" mode is used most often. The "Fan Control Type" parameter must be programmed to "Three-Speed Fan". Two outputs are required for Three-Speed fan control. Output 4 is used for the brake solenoid. Output 5 is used for the slip solenoid. The function of these outputs is automatically determined by the ECM when the "Fan Control Type" parameter is programmed to "Three-Speed Fan". The fan is turned on in the event of a failure in the output circuit. An example would be an open circuit. The ECM provides the power in order to turn off the fan. If the power is interrupted due to an open circuit, the fan will run continuously. This provides a fail safe operation. The ECM turns Off the output circuit power in order to turn on the fan. Additional switching devices that are in the circuit create an open circuit in order to turn the fan "On". Both of the output drivers are in the ON position while the Brake mode is active. However, the fan is off. In Slip mode, Output 4 is off and Output 5 is on. During Direct mode, both output drivers are off. The fan is on at full speed. The ECM controls the mode for the fan. The mode is based on the following conditions:

- Coolant temperature
- Intake manifold air temperature
- Engine operating conditions

### Cooling Fan Trip Points (Three-Speed Fan)

The hysteresis can occur when different modes are selected. The trip points are set at different values. The values depend on increasing temperature and decreasing temperature. The ECM will operate the cooling fan under the conditions that are listed in the following charts and graphics.

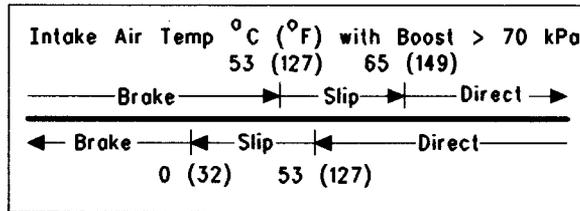
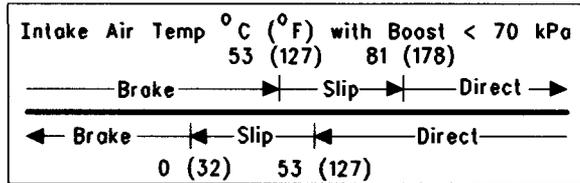
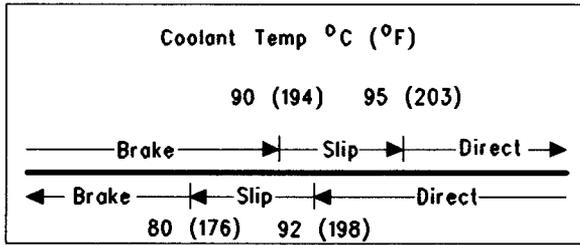


Illustration 74

g00783987

Trip Points for a Three-Speed Fan (C-10 and C-12)

Table 143

Trip Points for a Three-Speed Fan (C-10 and C-12)				
Mode	Coolant Temperature	Intake Manifold Air Temperature	Intake Manifold Air Temperature with Boost that is Less Than 70 kPa (10 psi)	Intake Manifold Air Temperature with Boost that is Greater Than 70 kPa (10 psi)
Brake Mode to Slip Mode	90 °C (194 °F)	53 °C (127 °F)		
Slip Mode to Direct Mode	95 °C (203 °F)		81 °C (178 °F)	65 °C (149 °F)
Direct Mode to Slip Mode	92 °C (198 °F)	53 °C (127 °F)		
Slip Mode to Brake Mode	80 °C (176 °F)	0 °C (32 °F)		

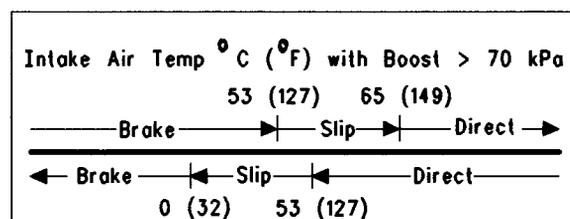
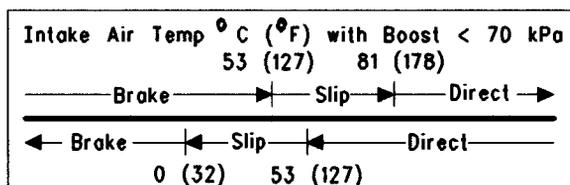
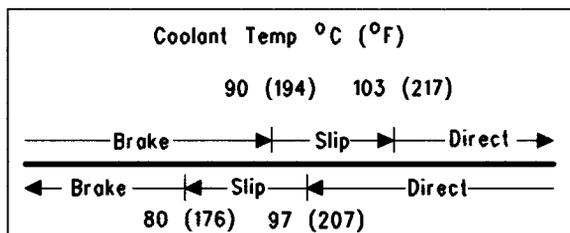


Illustration 75 g00784050  
Trip Points for a Three-Speed Fan (3406E, C-15, C-16 and C-18)

Table 144

Trip Points for a Three-Speed Fan (3406E, C-15, C-16 and C-18)				
Mode	Coolant Temperature	Intake Manifold Air Temperature	Intake Manifold Air Temperature with Boost that is Less Than 70 kPa (10 psi)	Intake Manifold Air Temperature with Boost that is Greater Than 70 kPa (10 psi)
Brake Mode to Slip Mode	90 °C (194 °F)	53 °C (127 °F)		
Slip Mode to Direct Mode	103 °C (217 °F)		81 °C (178 °F)	65 °C (149 °F)
Direct Mode to Slip Mode	97 °C (207 °F)	53 °C (127 °F)		
Slip Mode to Brake Mode	80 °C (176 °F)	0 °C (32 °F)		

The following conditions will also cause the Three-Speed Fan to operate in Direct Mode:

- The engine retarder is on and the engine retarder selector switch is in the High position. The "Fan with Engine Retarder in High Mode" parameter must be programmed to "Yes".
- The PTO On/Off Switch is on. The "PTO Activates Cooling Fan" parameter is programmed to "Yes".

- The A/C high pressure switch is active. The "A/C Pressure Switch Fan On-Time" is programmed to a value that is greater than 0 seconds.

**Note:** There may be an initial delay before the fan is in the Direct mode. Activation of the fan is dependent on the operating conditions.

**A/C High Pressure Switch Input Connected to A/C Control Unit.**

An OEM supplied air conditioning control may be used. The air conditioning control determines when the cooling fan should operate. This is based on the following input information: A/C high pressure switch, low pressure switch, and evaporator thermostat. The fan output for the air conditioning control is designed to interface with the ECM. The fan output may be connected to the input for the A/C high pressure switch. The input for the A/C high pressure switch is Input 11 of the ECM Connector J1/P1:41. The fan is in the ON position when the A/C high pressure switch is in the OPEN position. This type of control has a time delay. Typically, the "A/C Switch Fan On-Time" is programmed to one second since the air conditioning control provides an additional time delay.

### **The Cooling Fan Control can be Operated Independently of the ECM.**

Operation of the cooling fan control can be controlled independently of the ECM. The OEM installed air conditioning high pressure switch may be used for independent cooling fan control. A cab mounted override switch in the solenoid circuit can also operate the cooling fan.

### **Troubleshooting**

Before troubleshooting the cooling fan circuit, determine the type of fan drive system that is used. The fan drive can use the following controls in order to control the fan:

- Normally open with a pneumatic air solenoid
- Normally closed with a pneumatic air solenoid
- Normally open with an electrically controlled solenoid
- Normally closed with an electrically controlled solenoid

The following OEM installed components may affect the operation of the cooling fan in some applications:

- OEM installed, normally open relay
- The A/C high pressure switch is connected to the ECM or the A/C high pressure switch is independent of the ECM.
- Cab mounted manual override switch
- A timer that keeps the fan in the ON position
- Cooling fan air solenoid valve

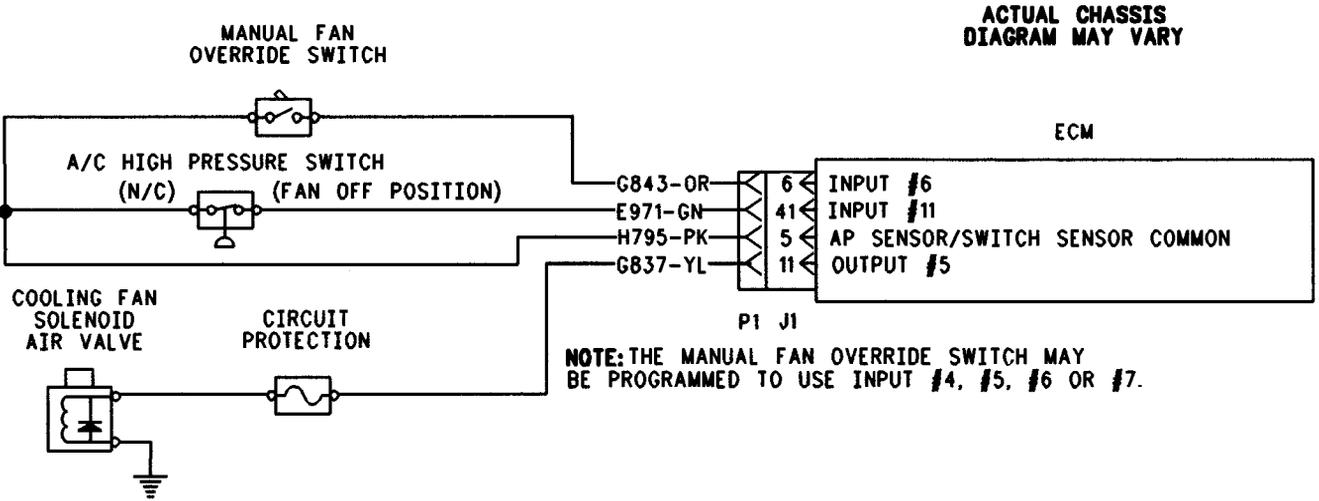


Illustration 76

g00675576

This schematic represents the ON/OFF fan with a direct solenoid connection to the ECM and the A/C Pressure Switch connected to the ECM input.

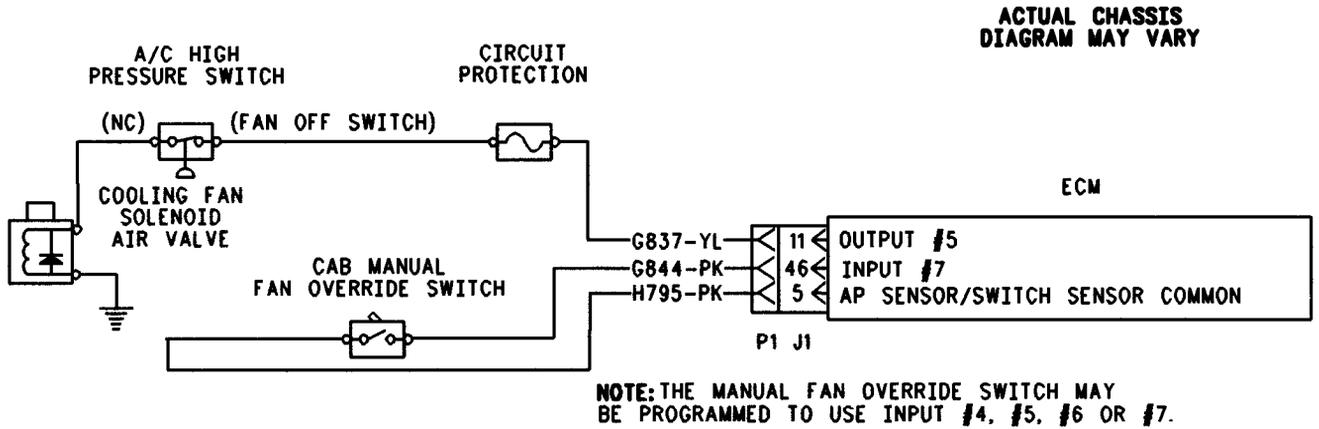


Illustration 77

g00675579

This schematic represents the ON/OFF fan with direct solenoid connection to the ECM and the A/C High Pressure Switch not connected to the ECM input.

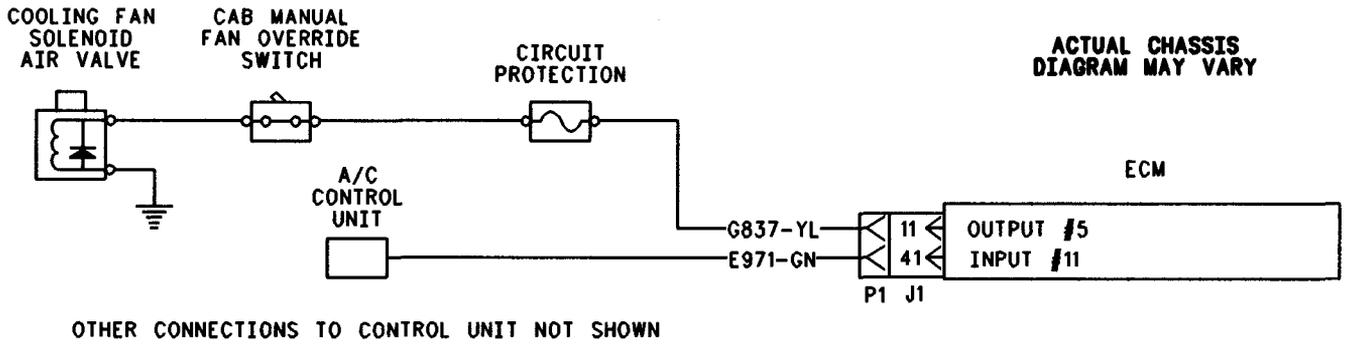


Illustration 78

g00675587

This schematic represents the ON/OFF fan with direct solenoid connection to the ECM and the A/C Control Unit is connected to the ECM input.

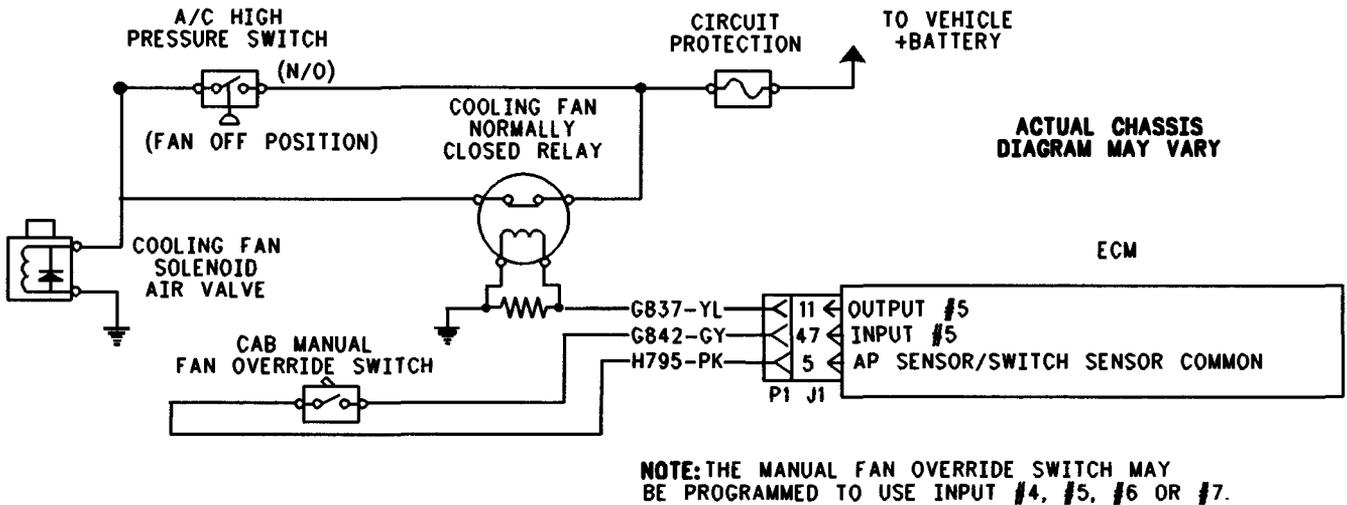


Illustration 79

g00675591

This schematic represents the ON/OFF fan with a normally closed relay and the A/C High Pressure Switch not connected to the ECM input.

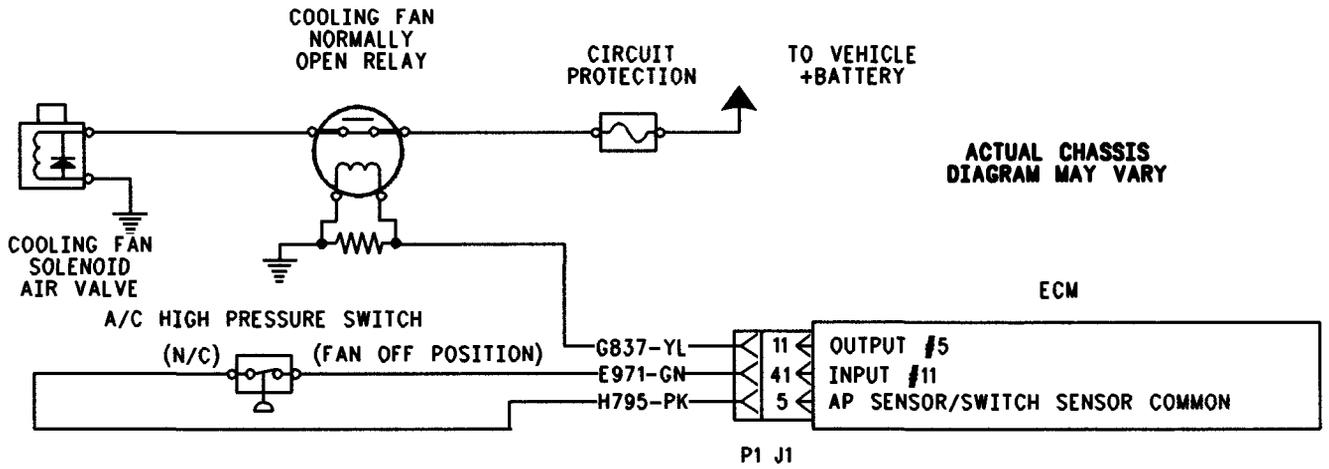


Illustration 80

g00675623

This schematic represents the ON/OFF fan with a normally open relay connection and an A/C High Pressure Switch connected to the ECM input.

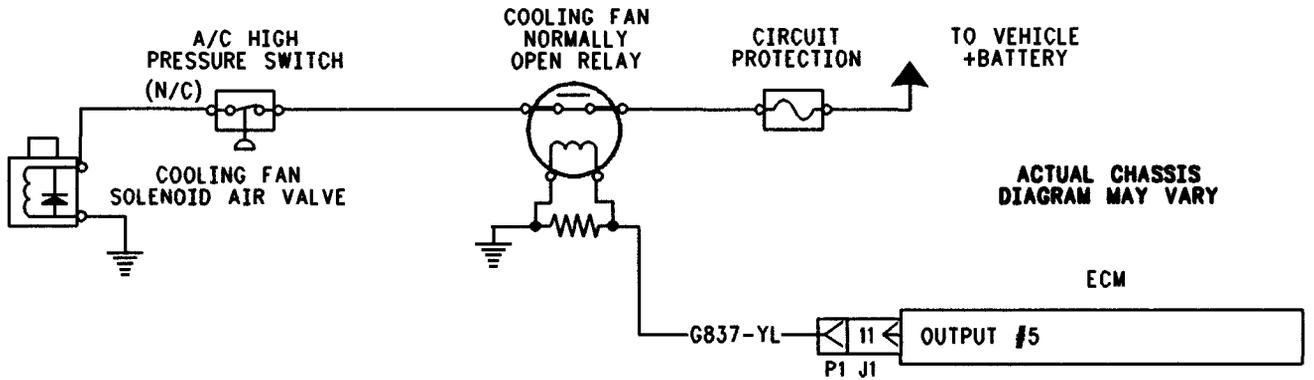


Illustration 81

g00675640

This schematic represents the ON/OFF fan with a normally open relay connection and an A/C High Pressure Switch connected to the ECM input.

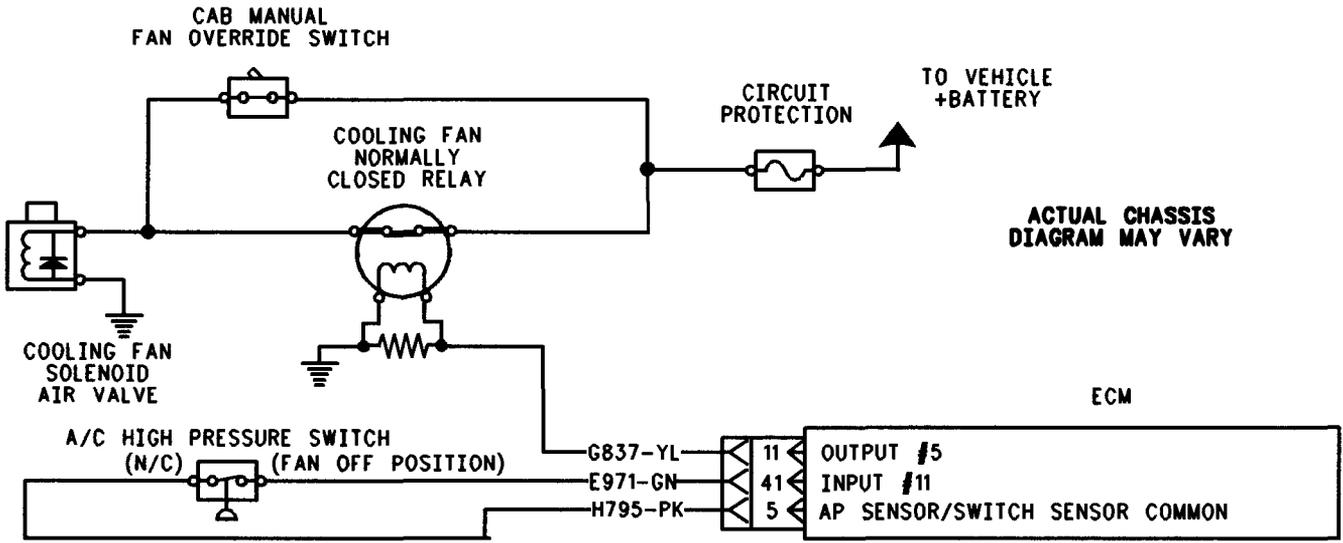


Illustration 82

g00675642

This schematic represents the ON/OFF fan with a normally closed relay connection and an A/C High Pressure Switch connected to the ECM input.

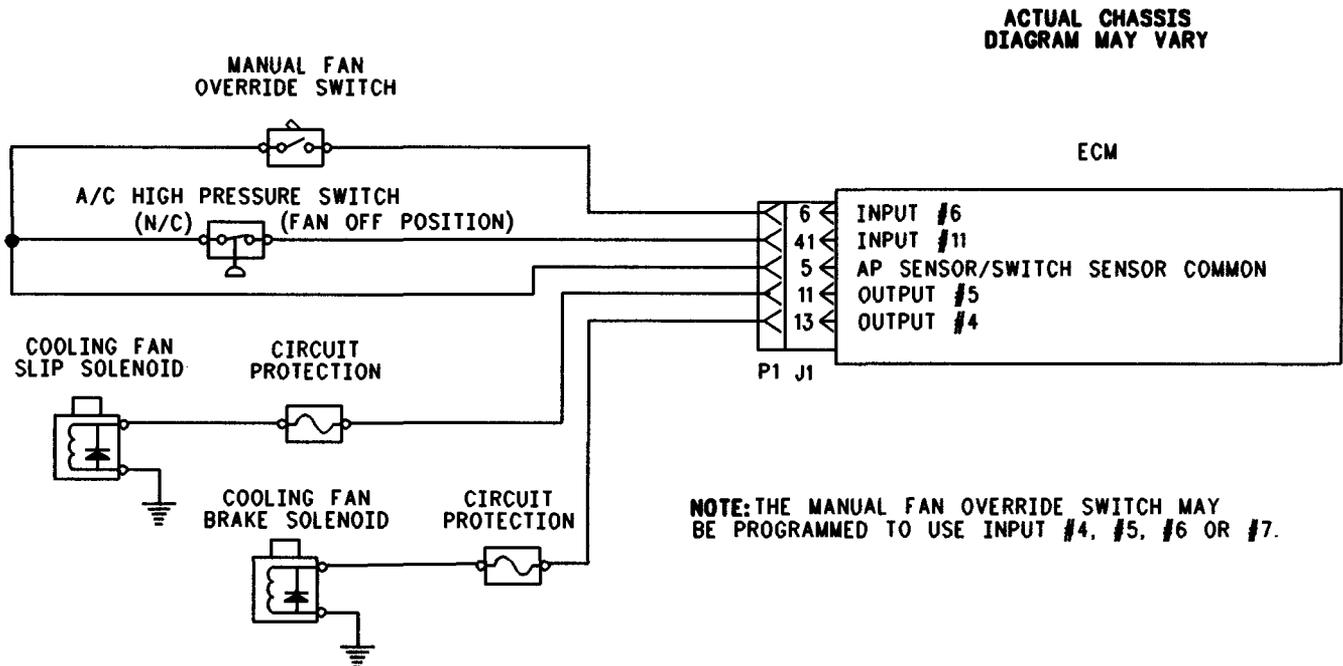


Illustration 83

g00675646

Three-Speed Fan with Direct Solenoid Connection

**Test Step 1. Check the Electrical Connectors and the Wiring**

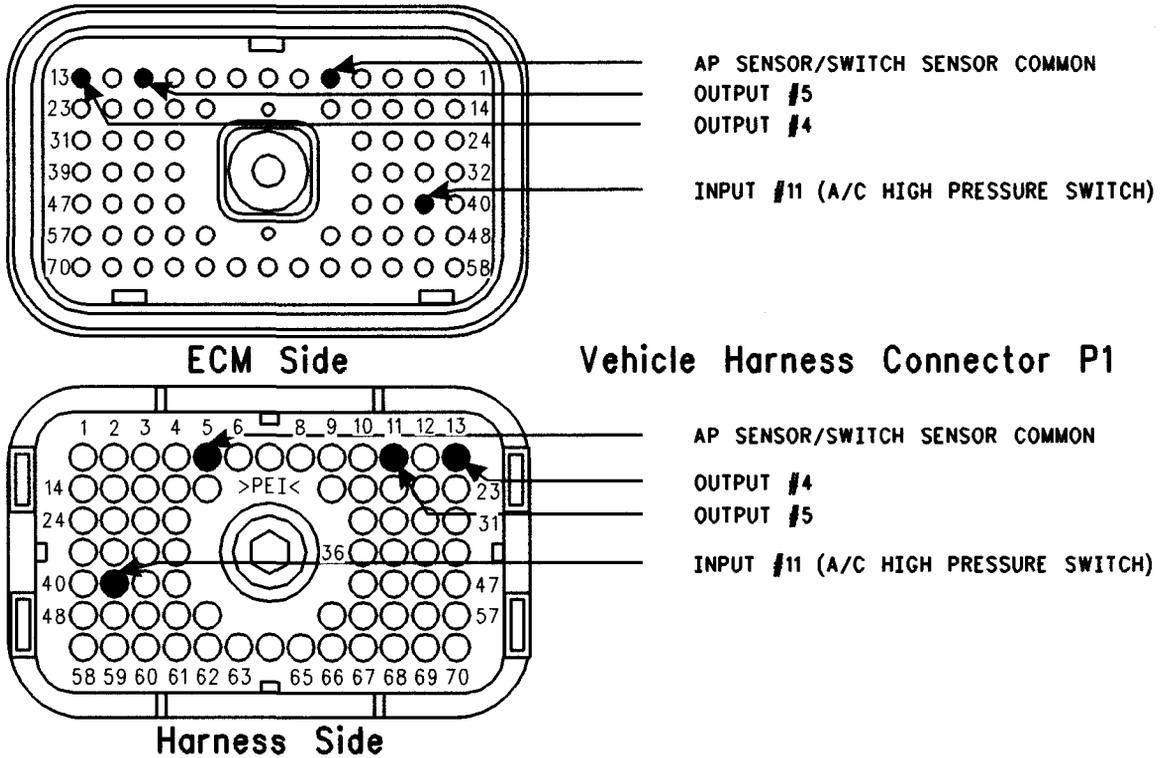


Illustration 84

g00675876

Terminal locations for the ECM

- A.** Thoroughly inspect the ECM Vehicle Harness Connector J1/P1, the A/C High Pressure Switch Connector, the connections to the Cooling Fan Solenoid, and the firewall bulkhead connectors. Refer to Troubleshooting, “Electrical Connectors - Inspect” for details.
- B.** Perform a 45 N (10 lb) pull test on each of the wires in the ECM connector that are associated with the following connections:
  - Cooling Fan
  - A/C High Pressure Switch
- C.** Check the ECM connector (Allen Head Screw) for the proper torque of 6.0 N·m (55 lb in).
- D.** Check the harness and the wiring for abrasion and pinch points from the battery to the ECM. Then, check from the key switch to the ECM.

- E.** Ensure that the ECM is wired to the cooling fan on the vehicle and/or the A/C high pressure switch. Check for wires that are connected to terminal 11 (Output 5) and for wires that are connected to terminal 41. Input 11 is the A/C high pressure switch of vehicle harness connector P1. If a Three-Speed Fan is used, check for a wire that is connected to terminal 13 (Output 4).

Refer to Illustration 84 for terminal locations for the ECM.

**Expected Result:**

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

**Results:**

- OK – Proceed to Test Step 2.
- Not OK

**Repair:** Repair the wiring or replace the wiring, if necessary. Repair the connectors or replace the connectors, if necessary. Ensure that all of the seals are in the proper place. Ensure that all of the connectors are connected properly.

Verify that the repair eliminates the problem.

**STOP.**

- **ECM Not Wired To Fan or Switch** – If the ECM is not wired to the cooling fan on the vehicle and/or the A/C high pressure switch, then the ECM is not being used for fan control. **STOP.**

## Test Step 2. Check the Programming of the “Fan Control Type” Parameter

- Connect Cat ET to the data link connector.
- Check the “Fan Control Type” parameter. Ensure that the parameter is programmed to either “On-Off” or to “Three-Speed Fan”, if the ECM is used to control the fan. If the parameter is programmed to “None” and the ECM is connected to the fan, then the fan will always be ON.

### Expected Result:

The “Fan Control Type” parameter is programmed to match the vehicle wiring. This is determined in the previous step.

### Results:

- **OK** – Proceed to Test Step 3.
- **Not OK** – Program the “Fan Control Type” to the correct setting and then recheck the system. If conditions are not resolved, then proceed to Test Step 3.

## Test Step 3. Check the A/C Pressure Switch

- Connect Cat ET to the data link connector.
- Turn the key switch to the ON position.
- View the following customer specified parameters.
  - “Fan Control Type”
  - “A/C Switch Fan On-Time”

Ensure that the “A/C Switch Fan On-Time” is programmed to a greater value than “0”. If the “A/C Switch Fan On-Time” is programmed to “0”, then the “A/C High Pressure Switch Input” (Input 11) is not used.

**Note:** If the “Fan Control Type” parameter indicates “None”, then the cooling fan driver is not used.

View the “A/C High Pressure Switch” status on Cat ET.

### Expected Result:

The status of the A/C high pressure switch indicates “ON” or “OFF”.

### Results:

- **OK** – The status of the A/C high pressure switch is on or off. Proceed to Test Step 4.
- **Not OK** – The status of the A/C high pressure switch is “Unavailable”. The ECM is not programmed to use the A/C high pressure switch. Proceed to Test Step 5.

## Test Step 4. Check the Operation of the A/C Pressure Switch

- Connect Cat ET to the data link connector.
- Turn the key switch to the ON position.
- Access the “A/C High Pressure Switch” status screen on Cat ET.
- Fabricate a jumper wire 100 mm (4 inch) long. Crimp a Deutsch pin to both ends of the wire.
- Disconnect the “A/C High Pressure Switch” from the vehicle harness at the switch and use the jumper wire to short the two terminals in the harness connector together.
- Remove the jumper wire and then insert the jumper wire. At the same time, view the “A/C High Pressure Switch” status on the service tool status screen.

### Expected Result:

The status screen indicates that the “A/C High Pressure Switch” is turning to the ON position. Then, the “A/C High Pressure Switch” is turning to the OFF position.

### Results:

- **OK** – The A/C high pressure switch harness is OK. Proceed to Test Step 6.
- **Not OK** – Proceed to Test Step 7.

## Test Step 5. Check Active Codes or Logged Codes

- Connect Cat ET to the data link connector.

- B.** Turn the key switch to the ON position.
- C.** Access the “Logged Diagnostic Codes” and the “Active Diagnostic Codes” on Cat ET.
- D.** Check for the following diagnostic codes.
- 110-00 High Coolant Temperature Warning
  - 110-11 Very High Coolant Temperature
  - 110-03 Coolant Temp Sensor Open Circuit
  - 110-04 Coolant Temp Sensor Short Circuit

Record any logged diagnostic codes. Record any active diagnostic codes.

**Expected Result:**

**Result 1** None of the diagnostic codes that are listed are logged or active.

**Result 2** Diagnostic code 110-00, or 110-11 is logged or active.

**Result 3** Diagnostic code 110-03 or 110-04 is logged or active.

**Results:**

- **Result 1** – Proceed to Test Step 8.
- **Result 2** – The cooling fan is on because of a high coolant temperature.

**Repair:** Perform the following diagnostic procedure: Testing and Adjusting, “Cooling System - Check”

STOP.

- **Result 3** – The cooling fan is on because of a coolant temperature sensor fault.

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

STOP.

**Test Step 6. Check the A/C Pressure Switch by use of a Voltmeter**

- A.** Connect Cat ET to the data link connector.
- B.** Turn the key switch to the OFF position.
- C.** Ensure that the A/C high pressure switch is disconnected from the vehicle harness at the switch terminals.

- D.** Connect a multimeter and measure the resistance between the two terminals of the A/C high pressure switch. The switch must be closed in order to check the resistance.

**Expected Result:**

The resistance measures 10 Ohms or less.

**Results:**

- **OK** – The ECM, the A/C high pressure switch, and the wiring are electrically OK.

**Repair:** Check the A/C pressure or send the vehicle to the OEM dealer for repairs.

STOP.

- **Not OK**

**Repair:** Replace the A/C high pressure switch.

Verify that the repair eliminates the problem.

STOP.

## Test Step 7. Check the ECM

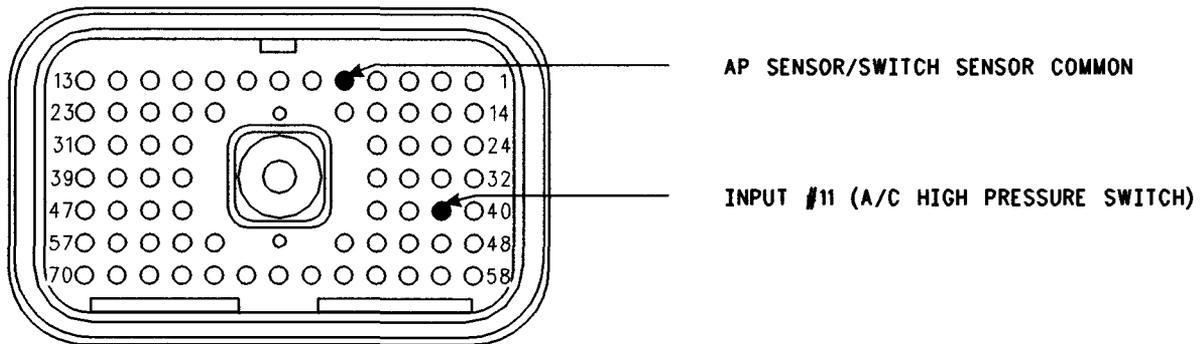


Illustration 85

g00676088

Connector for the Breakout T

- A.** Connect Cat ET to the data link connector.
- B.** Turn the key switch to the OFF position.
- C.** Disconnect the ECM vehicle harness connector J1/P1.
- D.** Remove terminal 41 (Output 11) from the vehicle harness connector P1.
- E.** Install a 140-2266 Cable (Seventy-Pin Breakout) between connectors J1 and P1.
- F.** Fabricate a jumper wire 100 mm (4 inch) long. Crimp a Deutsch pin to both ends of the wire.
- G.** Connect the jumper wire to terminal 5 (AP Sensor/Switch Common) and to terminal 41 (Input 11) of the breakout T.  
  
Refer to Illustration 85.
- H.** Turn the key switch to the ON position.
- I.** Access the "A/C High Pressure Switch" status screen on Cat ET.
- J.** Remove the jumper wire and then insert the jumper wire. At the same time, watch the "A/C High Pressure Switch" status on Cat ET.

### Expected Result:

The status screen indicates that the "A/C High Pressure Switch" status is off when the jumper wire is in place. The status screen indicates "ON" when the jumper wire is removed.

### Results:

- OK – The ECM is OK.

**Repair:** If a problem still exists, then the problem is in the OEM wiring. Repair the problem or send the vehicle to the OEM dealer for repair. Verify that the repair eliminates the problem.

### STOP.

- Not OK

**Repair:** Temporarily connect a test ECM. Ensure that the "A/C Pressure Switch Fan On-Time" parameter is programmed in the same manner as the suspect ECM. Use Cat ET to check the ECM. If the problem is resolved with the test ECM, install the suspect ECM. If the problem returns with the suspect ECM, replace the ECM.

Verify that the repair eliminates the problem.

### STOP.

## Test Step 8. Check Intake Manifold Air Temperature and the Coolant Temperature

- A.** Connect Cat ET to the data link connector.
- B.** Turn the key switch to the ON position.
- C.** Monitor the status for "Engine Coolant Temperature" and "Intake Manifold Air Temperature" in order to verify that the temperatures are changing as the engine warms up.

### Expected Result:

The "Engine Coolant Temperature" and the "Intake Manifold Air Temperature" appear to have the correct reading.

### Results:

- OK – Proceed to Test Step 9.

- Not OK

**Repair:** Temporarily connect another sensor. Test the new sensor by checking "Intake Manifold Air Temperature" and "Engine Coolant Temperature" again. If the problem is resolved with the new sensor, then install the old sensor in order to verify that the problem returns. If the problem returns, then replace the old sensor.

Verify that the repair eliminates the problem.

STOP.

## Test Step 9. Check the Circuit for the Cooling Fan Solenoid

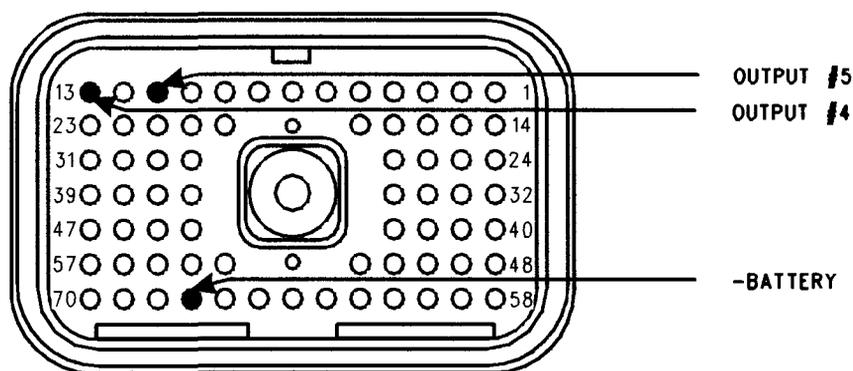


Illustration 86

g00676097

Connector for the breakout T

- Connect Cat ET to the data link connector.
- Turn the key switch to the ON position.
- Access the "On-Off Cooling Fan Special Test" for a fan that cycles "Off" and "On". Access the "Three-Speed Fan Slip Output" or the "Three-Speed Fan Brake Output Special Test" for a Three-Speed Fan. Access each menu in the order that follows: Diagnostics, Diagnostic Tests, and Special Test.

NOTE: If any override switches are installed, the switch must be in the OFF position.

- Cycle the "Special Test" to the ON position and to the OFF position. Listen for the solenoid to click. You may need to be near the engine in order to hear the click of the solenoid.

### Expected Result:

An audible clicking is heard, and the solenoid appears to be operating properly.

### Results:

- OK – The cooling fan circuit from the ECM to the solenoid is functioning properly at this time.

**Repair:** If a problem still exists, then the problem is in the OEM wiring. Repair the problem or send the vehicle to the OEM dealer for repair.

Verify that the repair eliminates the problem.

STOP.

- Not OK – Proceed to Test Step 10.

## Test Step 10. Check the ECM

- Turn the key switch to the OFF position.
- Disconnect the ECM vehicle harness connector J1/P1.
- Remove terminal 11 (Output 5) from the vehicle harness connector P1.
- Connect a breakout T between the J1 and P1 ECM connectors.

E. Connect a voltage test lamp between terminal 11 (Output 5) and terminal 67 (Negative Battery) of the breakout T.

F. Turn the key switch to the ON position.

G. For a fan that cycles on and off, access the "On/Off Cooling Fan Special Test" on Cat ET.

Cycle the "On/Off Cooling Fan Special Test" to the ON position and to the OFF position. At the same time, watch the voltage test lamp.

H. For a Three-Speed Fan, access the "Three-Speed Fan Slip Output" and the "Three-Speed Fan Brake Output" in the special tests.

Cycle the "Three-Speed Fan Slip Output" to the ON position and to the OFF position. At the same time, watch the voltage test lamp.

Connect the voltage test lamp to terminal 13 (Output 4) and terminal 67 (-Battery) of the breakout T.

Cycle the "Three-Speed Fan Brake Output" to the ON position and to the OFF position. At the same time, watch the voltage test lamp.

Refer to Illustration 86 for the location of Output 4 and Output 5.

NOTE: A multimeter can not be used in place of the voltage test lamp when the ECM output is tested.

### Expected Result:

The voltage test lamp turns to the ON position when the test is "Active". The voltage test lamp turns to the OFF position when the test is "Not Active".

### Results:

- OK – The ECM cooling fan relay is functioning properly.

**Repair:** If a problem still exists, then the problem is in the OEM wiring. Repair the problem or send the vehicle to the OEM dealer for repair.

Verify that the repair eliminates the problem.

STOP.

- Not OK

**Repair:** Temporarily connect a test ECM. Use the special test to check the ECM cooling fan circuit. If the problem is resolved with the test ECM, install the suspect ECM. If the problem returns with the suspect ECM, replace the ECM.

Verify that the repair eliminates the problem.

STOP.

i01866689

## Cruise Control Switch Circuit - Test

**SMCS Code:** 7332-038

### System Operation Description:

#### Use this procedure under the following situation:

One of the following switches is suspected of preventing normal operation of cruise control, idle set speed, or PTO operation:

- Cruise Control On/Off Switch
- Cruise Control Set/Resume Switch
- Cruise Control Pause Switch

The following switch circuits can also prevent the correct operation of the cruise control, idle set speed or PTO operation:

- Service Brake Pedal Position (Switch 1)
- Service Brake Pedal Position (Switch 2)
- Neutral Switch
- PTO On/Off Switch

The switches are described in the respective circuit tests in Troubleshooting.

All of the following customer programmable parameters can affect cruise control, idle set speed, and PTO operation:

- Adaptive Cruise Control
- "Low Cruise Control Speed Set Limit"
- "High Cruise Control Speed Set Limit"
- "Idle Vehicle Speed Limit"
- "Cruise/Idle/PTO Switch Configuration"
- "Idle/PTO Bump rpm"
- "Idle/PTO rpm Ramp Rate"
- "PTO Kickout Vehicle Speed Limit"

The vehicle speed calibration can also affect the cruise control, the idle set speed, and the PTO if the vehicle speed calibration is incorrectly programmed. Refer to Troubleshooting, "Customer Specified Parameters".

### **Cruise Control On/Off Switch**

This switch must be on before cruise control or controlled idle can be activated. This switch is on when the switch is closed. When the switch is closed the following terminals are connected:

- J1/P1:59 (Cruise Control ON/OFF Switch)
- J1/P1:5 (AP Sensor/Switch Sensor Common)

**Note:** If the vehicle is programmed to use the dedicated PTO, the PTO On/Off switch overrides the cruise control On/Off switch. The PTO On/Off switch will override the cruise control On/Off switch if the vehicle speed is within the programmed range for the "PTO Kickout Vehicle Speed Limit" parameter.

### **Set/Resume Switch**

While the cruise control On/Off Switch is in the ON position and the vehicle speed is within the range of the programmed "Low Cruise Control Speed Set Limit" and the "High Cruise Control Speed Set Limit", momentarily pressing the set switch will activate the cruise or controlled idle, and the ECM will maintain the current speed.

Pressing the resume switch will cause the vehicle speed to ramp to the last cruise control set speed. This assumes that the vehicle speed is above the low cruise control speed set limit for cruise control or the vehicle speed is below the Idle/PTO vehicle speed limit for the idle and the PTO.

After a speed has been set, pressing and holding the Set/Resume switch in position will cause the engine to establish a new set speed. The system's reaction depends on the programming of the "Cruise/Idle/PTO Switch Configuration".

When the Set/Resume switch is momentarily pressed, the cruise set point will change one mph. The rate of change is dependent on the programmed "Idle/PTO Bump RPM" when an idle speed is set.

### **Cruise Control Pause Switch**

The cruise control pause switch is used to temporarily disable cruise control. The cruise control cannot be set while the cruise control pause switch is in the On position.

### **Adaptive Cruise Control**

The adaptive cruise control is a J1939 based option. A radar is used in order to detect vehicles. When a vehicle is detected the cruise control set speed is reduced in order to maintain a following distance. This option must be enabled with the electronic service tool. Factory passwords are required to enable this option.

If a problem is suspected with the adaptive cruise control, the feature can be disabled. Toggle the cruise control switch to the OFF position and to the ON position twice within 10 seconds.

### **The following background information is related to this procedure:**

The kickout switch refers to the switch that is used to exit the cruise control, the PTO, or the idle set speed.

The operation of the Caterpillar electronic engine cruise control is similar to the operation of the cruise controls that are installed in automobiles. The operation of idle and PTO are similar to the operation of cruise except that the idle and the PTO govern engine rpm instead of vehicle speed.

**Note:** Idle in this procedure is an engine idle rpm above the programmed low idle rpm. Idle is set with the cruise control On/Off switch and the Set/Resume switch. Refer to Troubleshooting, "PTO Switch Circuit - Test" for additional information regarding the programmable options for the dedicated PTO.

### **Usage of Transmission Style Switches**

The "Transmission Style" parameter determines the switches that will be used. The following switches can be used with being dependent on the parameter setting:

- Clutch Pedal Position
- Neutral
- Service Brake Pedal Position (Switch 1)
- Service Brake Pedal Position (Switch 2)

Refer to Table 3 for additional information.

Table 145

Setting For Transmission Style Parameter	Switch Usage.			
	Service Brake Switch 1	Service Brake Switch 2	Clutch	Neutral
<b>Manual</b>	X		X	
<b>Automatic Option 1</b>	X			
<b>Automatic Option 2</b>	X	X		
<b>Automatic Option 3</b>	X	X		X
<b>Automatic Option 4</b>	X			X
<b>Eaton Top 2</b>	X		X	

If the "Transmission Style" parameter is programmed to one of the following options, the input for the clutch pedal position switch is not used:

- Automatic Options 1
- Automatic Option 2
- Automatic Option 3
- Automatic Option 4

A service brake pedal position (Switch 1) is required for all configurations. The service brake pedal position (Switch 1) connects to the ECM through connector P1:45. The service brake pedal position (Switch 2) connects to the ECM through connector P1:64. The clutch pedal position switch connects to the ECM through connector P1:22. The neutral switch connects to the ECM through connector P1:62.

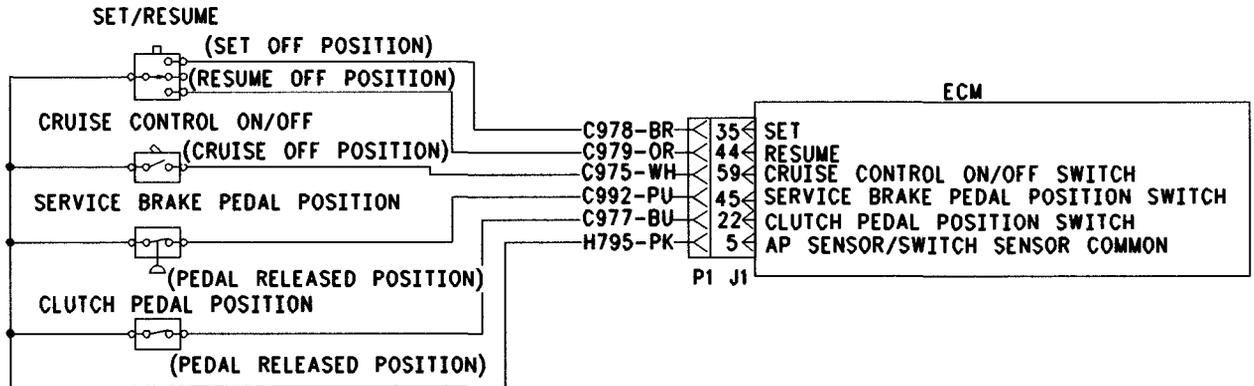


Illustration 87

g00643881

Schematic for cruise control switch, service brake pedal position switch 1 and clutch pedal position switch

### Test Step 1. Check the Status of the Cruise Control On/Off Switch

- A. Connect the electronic service tool to the data link connector.
- B. Turn the key switch to the ON position.
- C. Monitor the status for the "Cruise/Idle On-Off Switch" while the cruise control On/Off switch is cycled.

#### Expected Result:

The status for the "Cruise/Idle On-Off Switch" is "On" when the cruise control On/Off switch is in the On position. The status for the "Cruise/Idle On-Off Switch" is "Off" when the cruise control On/Off switch is in the Off position.

#### Results:

- OK – The cruise control On/Off switch is working properly. Proceed to Test Step 2.
- Not OK – The cruise control On/Off switch is not working properly. Proceed to Test Step 3.

### Test Step 2. Check the Status of the Set/Resume Switch

- A. Put the cruise control On/Off switch in the On position.

- B. Monitor the status for the "Cruise Control Set/Resume/Accel/Decel Switch J1/P1:35 & 44" while the Set/Resume switch is cycled.

#### Expected Result:

The status for the "Cruise Control Set/Resume/Accel/Decel Switch J1/P1:35 & 44" is "Set Switch On" when the Set/Resume switch is in the Set position. The status for the "Cruise Control Set/Resume/Accel/Decel Switch J1/P1:35 & 44" is "Resume Switch On" when the Set/Resume switch is in the Resume position.

#### Results:

- OK – The cruise control Set/Resume switch is working properly. STOP.
- Not OK – The cruise control Set/Resume switch is not working properly. Proceed to Test Step 3.

### Test Step 3. Determine the Configuration of the Cruise Control Switches

- A. Determine if the wiring for the cruise control switches is wired directly to the ECM or through the J1939 data link.
- B. Verify that the "Cruise Control On/Off Switch" and the "Cruise Control Set/Resume/Accel/Decel Switch" parameters are programmed to reflect the proper wiring.

**Expected Result:**

The cruise control switches are wired directly to the ECM.

**Results:**

- **OK** – The cruise control switches are wired directly to the ECM.

**Repair:** Verify that the “Cruise Control On/Off Switch” and the “Cruise Control Set/Resume/Accel/Decel Switch” parameters are programmed correctly.

Proceed to Test Step 4.

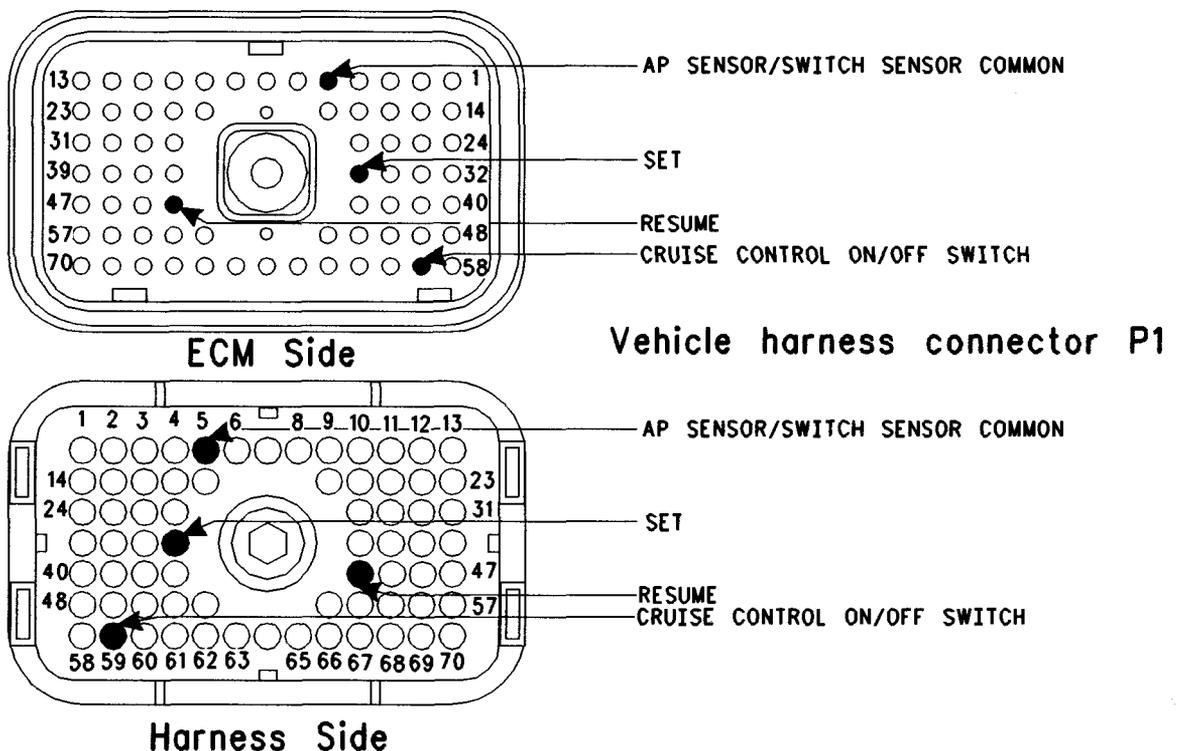
- **Not OK** – The cruise control switches are wired through the J1939 data link.

**Repair:** Verify that the “Cruise Control On/Off Switch” and the “Cruise Control Set/Resume/Accel/Decel Switch” parameters are programmed to “J1939 - Body Controller”, “J1939 - Cab Controller”, or “J1939 - Instrument Cluster”.

Refer to Troubleshooting, “Powertrain Data Link Circuit - Test”.

STOP.

**Test Step 4. Inspect Electrical Connectors and Wiring**



**A.** Thoroughly inspect the J1/P1 ECM connector, the firewall bulkhead connector and the terminals for the following switches in the connectors:

- J1/P1:5 (AP Sensor/Switch Sensor Common)
- J1/P1:35 & 44 (Set/Resume Switch)
- J1/P1:59 (Cruise Control On/Off Switch)

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

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

Refer to Illustration 88.

**C.** Check the ECM connector (Allen Head Screw) for the proper torque of 6.0 N·m (55 lb in).

**D.** Check the harness and wiring for abrasion and pinch points from the sensor to the ECM.

#### Expected Result:

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

#### Results:

- OK – Proceed to Test Step 5.
- 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 5. Check the Switch Circuit at the ECM

Table 146

Table for Status of the Cruise Control Switch Input		
Condition of Switch Circuit	Switch Status	Circuit
Jumper wire is not installed.	OFF	Open
Cruise/Idle On/Off Switch terminal 59 connected to terminal 5.	ON	Shorted
Set Switch Terminal 35 connected to terminal 5.	Set Switch ON	Shorted
Resume Switch (Terminal 44) connected to terminal 5.	Resume Switch ON	Shorted

- A. Turn the key switch to the OFF position.
- B. Fabricate a jumper wire 100 mm (4 inch) long. Crimp a Deutsch pin to both ends of the wires.
- C. Disconnect vehicle harness connector P1 from the ECM.
- D. Connect a 140-2266 Cable (Seventy-Pin Breakout) between the J1 and P1 ECM connectors.
- E. Install the jumper into the suspect switch socket of the breakout T. Connect the other end of the jumper to ECM connector P1:5 (AP Sensor/Switch Sensor Common) of the breakout T.
- F. Turn the key switch to the ON position.
- G. While the status for the suspect switch is being monitored on the status screen slowly remove the jumper from terminal 5 and slowly insert the jumper from terminal 5 (AP Sensor/Switch Sensor Common) of the breakout T.

Refer to Table 146.

**Expected Result:**

The switch status changes per the information in Table 146.

**Results:**

- OK – The ECM is functioning properly.

**Repair:** Remove the breakout T and reconnect the J1 and P1 ECM connectors.

Proceed to Test Step 6.

- Not OK – The ECM is not functioning properly.

**Repair:** Perform the following repair:

1. Temporarily connect a test ECM.
2. Remove the breakout T and reconnect the J1 and P1 ECM connectors.
3. If the problem is resolved with the test ECM, reconnect the suspect ECM.
4. If the problem returns with the suspect ECM, replace the ECM.
5. Verify that the repair eliminates the problem.

STOP.

## Test Step 6. Insert a Jumper at the Suspect Switch

Table 147

Table for Status of the Cruise Control Switch Input		
Condition of Switch Circuit	Switch Status	Circuit
The wires are disconnected.	OFF	Open
The wires for the Cruise/Idle On/Off Switch are Connected.	ON	Shorted
Set Switch wires are Connected.	Set Switch ON	Shorted
The Resume Switch wires are Connected.	Resume Switch ON	Shorted

- A. Turn the key switch to the OFF position.
- B. Find the suspect switch in the vehicle.
- C. Disconnect the wires from the suspect switch terminals.
- D. Turn the key switch to the ON position.
- E. While the status for the suspect switch is being monitored on the status screen connect the suspect switch wires and disconnect the suspect switch wires.

Refer to Table 147.

### Expected Result:

The switch status changes per the information in Table 147.

### Results:

- OK

Repair: Perform the following repair:

Replace the faulty switch.

Verify that the repair eliminates the problem.

STOP.

- Not OK – There is a problem in the harness between the switch and the ECM. Proceed to Test Step 7.

## Test Step 7. Insert a Jumper at the Bulkhead Connector

Table 148

Table for Status of the Cruise Control Switch Input		
Condition of Switch Circuit	Switch Status	Circuit
The wires are disconnected.	OFF	Open
The wires for the Cruise/Idle On/Off Switch are Connected.	ON	Shorted
The Set Switch wires are Connected.	Set Switch ON	Shorted
The Resume Switch wires are Connected.	Resume Switch ON	Shorted

- A. Turn the key switch to the OFF position.
- B. Fabricate a jumper wire 100 mm (4 inch) long. Crimp a Deutsch pin on both ends of the wires.
- C. Find the terminal for the suspect switch and the sensor common on the engine side of the bulkhead connector.
- D. Insert the jumper wire between the two terminals in the engine side of the bulkhead connector.
- E. Turn the key switch to the ON position.
- F. While the status for the suspect switch is being monitored on the status screen remove the jumper wire between the two terminals, and insert the jumper wire between the two terminals.

Refer to Table 148.

### Expected Result:

The switch status changes per the information in Table 148.

### Results:

- OK – The problem is in the vehicle wiring between the bulkhead connector and the switch.

**Repair:** Perform the following repair:

Inspect the vehicle wiring and repair the vehicle wiring, as required. If the problem still exists with the wiring, send the vehicle to the OEM dealer.

**STOP.**

- Not OK – The problem is in the vehicle wiring between the bulkhead connector and the ECM.

**Repair:** Perform the following repair:

Inspect the vehicle wiring and repair the vehicle wiring, as required. If the problem still exists with the wiring, send the vehicle to the OEM dealer.

**STOP.**

i01867516

## Diagnostic Enable Switch Circuit - Test

**SMCS Code:** 7332-038-NQ

### System Operation Description:

### Use this procedure under the following situation:

The circuit for the diagnostic enable switch is suspected of incorrect operation.

### Diagnostic Enable Switch

The diagnostic enable switch is used to prompt diagnostic flash codes on the check engine lamp. For more information, refer to the "Flashing Out Diagnostic Flash Codes" section in Troubleshooting, "Check Engine Lamp Circuit - Test". If the "Diagnostic Enable Switch" parameter is programmed to "None" (default), then the feature is not used. If the "Diagnostic Enable Switch" parameter is programmed to J1/P1:46, then the feature is available and the switch circuit should be connected to J1/P1:46 ECM vehicle harness connector.

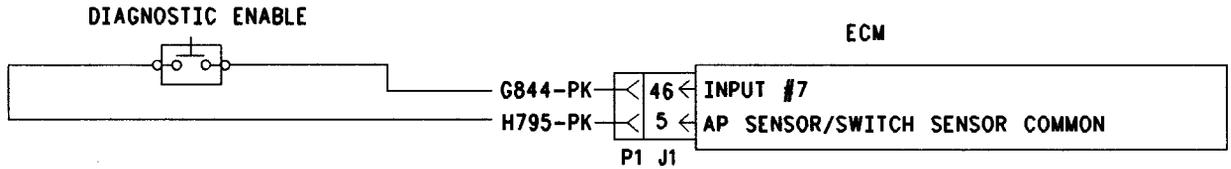


Illustration 89  
Schematic for Diagnostic Enable Switch

g00682326

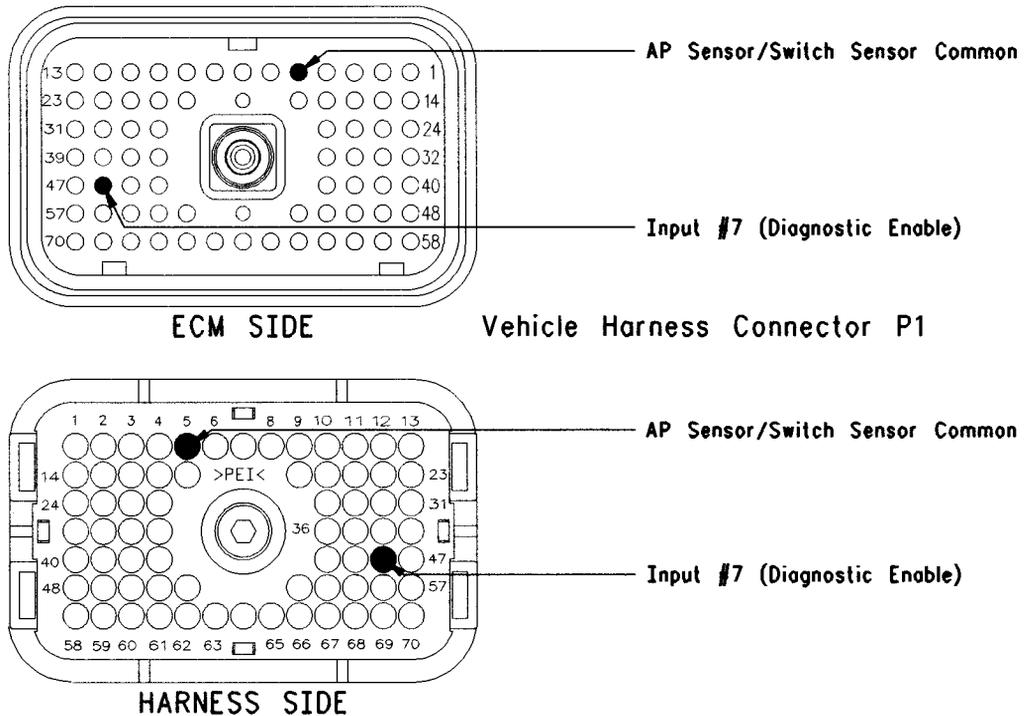


Illustration 90  
Terminal locations for the ECM

g00682338

**Test Step 1. Check the Status of the “Diagnostic Enable”**

- A.** Connect the electronic service tool to the data link connector.
- B.** Turn the key switch to the On position.
- C.** Observe the status for “Diagnostic Enable” while the diagnostic enable switch is operated in the On position and the Off position.

**Note:** If the status for the “Diagnostic Enable” indicates “Not Installed”, then the “Diagnostic Enable” parameter has not been programmed.

**Expected Result:**

The status for “Diagnostic Enable” should indicate “On” when the switch is in the On position. The status for “Diagnostic Enable” should indicate “Off” when the switch is in the Off position.

**Results:**

- **OK** – The switch is operating normally.

**Repair:** If the check engine lamp is not operating correctly, refer to Troubleshooting, “Check Engine Lamp Circuit - Test”.

**STOP.**

- **Not OK** – The ECM is not reading the switch status change. Proceed to Test Step 2.

## Test Step 2. Determine the Configuration of the Diagnostic Enable Switch

- A. Determine if the wiring for the diagnostic enable switch is wired directly to the ECM or through the J1939 data link.
- B. Verify that the “Diagnostic Enable” parameter is programmed to reflect the proper wiring.

### Expected Result:

The diagnostic enable switch is wired directly to the ECM.

### Results:

- **OK** – The diagnostic enable switch is wired directly to the ECM. Proceed to Test Step 3.
- **Not OK** – The diagnostic enable switch is wired through the J1939 data link.

**Repair:** Verify that the “Diagnostic Enable” parameter is programmed to “J1939 - Body Controller”, “J1939 - Cab Controller”, or “J1939 - Instrument Cluster”.

Refer to Troubleshooting, “Powertrain Data Link Circuit - Test”.

**STOP.**

## Test Step 3. Check the Electrical Connectors and the Wiring

- A. Thoroughly inspect the J1/P1 ECM connector, the connectors, and the firewall bulkhead connectors. Refer to Troubleshooting, “Electrical Connectors - Inspect” for details.
- B. Perform a 45 N (10 lb) pull test on each of the wires in the ECM connector that are associated with the suspect switch circuit.
- C. Check the ECM connector (Allen Head Screw) for the proper torque of 6.0 N·m (55 lb in).
- D. Check the harness and the wiring for abrasion and pinch points from the battery to the ECM. Then, check from the ignition key switch to the ECM.

Refer to Illustration 90 for terminal locations for the ECM.

### Expected Result:

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

### Results:

- **OK** – Proceed to Test Step 1.
- **Not OK** – Repair the wiring and connectors or replace the wiring or the connectors. Ensure that all of the seals are properly connected. Verify that the repair eliminates the problem. **STOP.**

## Test Step 4. Check the Switch Circuit for the ECM

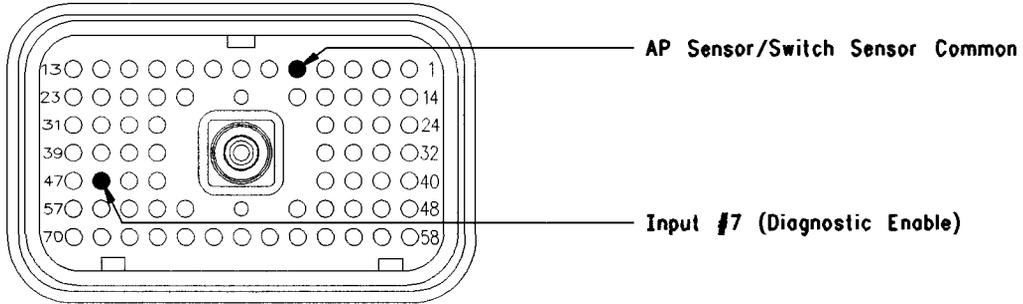


Illustration 91

g00682354

Connector for breakout T

- A. Turn the key switch to the OFF position.
- B. Install a 140-2266 Cable (Seventy-Pin Breakout) between the J1 and P1 ECM connectors.
- C. Fabricate a jumper wire 100 mm (4 inch) long. Crimp a Deutsch pin to both ends of the wire.
- D. Insert the jumper wire into terminal 46 (Diagnostic Enable Switch Input) of the breakout T. Connect the other end of the jumper wire to terminal 5 (AP Sensor/Switch Sensor Common) of the breakout T.
- E. Turn the key switch to the On position.
- F. While the status for "Diagnostic Enable" is monitored, remove the jumper wire and insert the jumper wire from terminal 5.

### Expected Result:

The status for "Diagnostic Enable" is "On" when the jumper wire is in place. The status for "Diagnostic Enable" is "Off" when the jumper wire is removed.

### Results:

- OK – The ECM is functioning properly at this time.  
**Repair:** Remove the breakout T and reconnect the J1/P1 ECM connector.  
Proceed to Test Step 5.
- Not OK – The ECM is not functioning properly.

**Repair:** Temporarily connect a test ECM. If the problem is resolved with the test ECM, install the suspect ECM. If the problem returns with the suspect ECM, replace the ECM.

Verify that the repair eliminates the problem.

**STOP.**

## Test Step 5. Insert a Jumper Wire at the Switch

- A. Turn the key switch to the OFF position.
- B. Fabricate a jumper wire 100 mm (4 inch) long. Crimp a Deutsch pin to each end of the wire.
- C. Insert the jumper wire between the two terminals of the diagnostic enable switch.
- D. Turn the key switch to the ON position.
- E. While the status for "Diagnostic Enable" is monitored, remove the jumper wire and insert the jumper wire at the switch terminals.

### Expected Result:

The status for "Diagnostic Enable" is "On" when the jumper wire is in place. The status for "Diagnostic Enable" is "Off" when the jumper wire is removed.

### Results:

- OK  
**Repair:** Replace the diagnostic enable switch.  
Verify that the repair eliminates the problem.  
**STOP.**

- Not OK – There is a problem in the wire harness between the diagnostic enable switch and the ECM. Proceed to Test Step 6.

**Test Step 6. Insert a Jumper Wire at the Bulkhead Connector**

- A. Turn the key switch to the OFF position.
- B. Fabricate a jumper wire 100 mm (4 inch) long. Crimp a Deutsch pin to each end of the wire.
- C. Locate the suspect switch socket in the engine side of the ECM bulkhead connector.
- D. Insert the wire jumper pin between the switch socket and the sensor common connection. Install the jumper wire on the engine side of the ECM bulkhead connector.
- E. Turn the key switch to the ON position.
- F. While the status for "Diagnostic Enable" is monitored, remove the jumper wire and insert the jumper wire at the bulkhead connector.

**Expected Result:**

The status for "Diagnostic Enable" is "On" when the jumper wire is in place. The status for "Diagnostic Enable" is "Off" when the jumper wire is removed.

**Results:**

- **OK** – The problem is in the vehicle wiring between the bulkhead connector and the switch. Inspect the vehicle wiring and then repair the vehicle wiring. Otherwise, send the vehicle to the OEM dealer for repair. Verify that the original condition is resolved. **STOP.**
- **Not OK** – The problem is in the vehicle wiring between the bulkhead connector and the ECM. Inspect the vehicle wiring and then repair the vehicle wiring. Otherwise, send the vehicle to the OEM dealer for repair. Verify that the original condition is resolved. **STOP.**

i01901371

**Eaton Top 2 Transmission Circuit - Test****SMCS Code:** 3174-038**System Operation Description:****Use this procedure under the following situation:**

The "Transmission Style" parameter is programmed to Eaton Top 2 and one of the following diagnostic codes is active or easily repeatable:

- 54-05 Auxiliary Output #06 current low
- 54-06 Auxiliary Output #06 current high

- 55-05 Auxiliary Output #07 current low
- 55-06 Auxiliary Output #07 current high
- 191-07 Transmission Not Responding

**The following background information is related to this procedure:****Overview Of The Transmission**

The engine ECM controls shifts between the top two gears of an Eaton Top 2 transmission. The shift points are based on engine speed and load for added driving ease. When the transmission is in the Top 2 gears, the ECM will perform the following functions:

- Shift the transmission between the top 2 gears automatically.
- Increase or decrease engine speed during a Top 2 shift.
- Momentarily interrupt the cruise control or the engine brake during the shift. Then, the cruise control or the engine brake will resume.

**Note:** Top gear refers to tenth gear in a ten speed transmission, and top gear refers to thirteenth gear in a thirteen speed transmission. Top gear minus one refers to ninth gear in a ten speed transmission, and top gear minus one refers to twelfth gear in a thirteen speed transmission. Top gear minus two refers to eighth gear in a ten speed transmission, and top gear minus two refers to eleventh gear in a thirteen speed transmission.

**Transmission Upshift By The ECM**

Upshift the transmission through the shift pattern to top gear minus two. Use double clutching during the lever shifts. Break torque during button shifts.

When the engine has reached the shift point use double clutching and move the shift lever into the Top Gear Minus One position (automatic position).

**Note:** Leave the shift button in the forward position so that the shift button is ready for downshifting into the Top Gear Minus Two position.

When the engine has reached the upshift point the ECM will automatically shift the transmission into Top Gear. The ECM shifts the transmission into Top Gear by turning on the shift solenoid and turning off the lockout solenoid.

**Transmission Downshift By The ECM**

Once the engine has reached the shift point, the ECM will automatically downshift the transmission from Top Gear to Top Gear Minus One. The ECM downshifts the transmission from Top Gear to Top Gear Minus One by turning on the lockout solenoid and turning off the shift solenoid.

In order to downshift from Top Gear Minus One to Top Gear Minus Two, make sure that the shift button is in the forward position. Once the engine has reached the shift point, move the gearshift lever to the next lower lever position by double clutching.

Continue downshifting through the shift pattern by double clutching during shifts with the gearshift lever. Break torque during button shifts.

### **Eaton Top 2 Override with Cruise Control Switch**

If this parameter is programmed to YES the cruise control On/Off switch can be used to disable Top 2 mode. If the cruise control On/Off switch is turned to the OFF position and the transmission is not in Top 2 mode, the Top 2 mode will be disabled. This condition is applicable to the manual mode of operation only. If the cruise control On/Off switch is turned to the ON position, the Top 2 mode will be enabled and the transmission will be allowed to shift automatically in the Top 2 gears. When the vehicle is operating in one of the Top 2 gears and the Top 2 mode is enabled, switching the cruise control On/Off switch to the OFF position will place the transmission in hold mode. When the transmission is in the Hold mode, the transmission will not shift out of the currently selected gear. When the cruise control On/Off switch is returned to the ON position, the transmission will return to Top 2 mode. When the clutch is depressed and the transmission is in the hold mode, the Manual mode will be enabled and the Top 2 will be disabled.

### **System Problems**

If the system malfunctions, the transmission will typically default to manual operation. When the system is in manual operation, Top 2 is inactive. For some malfunctions, the system will detect a failure. When the system detects a failure, the operator must allow time out of the timer in the ECM. The ECM will complete the countdown in nine seconds. During the countdown, the ECM will try to complete the shift. Once the ECM has completed the countdown, the operator must place the transmission in neutral in order to obtain manual operation. The Top 2 function will be inactive until the vehicle is stopped and the key switch is turned off.

### **Wiring Connections Of The ECM**

The control interface between the ECM and the Eaton Top 2 transmission consists of the following outputs:

- Eaton Top 2 shift solenoid (No. 7 Output)
- Eaton Top 2 lockout solenoid (No. 6 Output)

The ECM will turn on the Eaton Top 2 shift solenoid (No. 7 Output) when Top 2 is active in order to engage top gear. The ECM will turn off the Eaton Top 2 shift solenoid (No. 7 Output) at all other times, if the "Transmission Style" is programmed to Eaton Top 2.

The ECM will turn on the Eaton Top 2 lockout solenoid (No. 6 Output) when Top 2 is active in order to engage top gear minus one. The ECM will turn off the Eaton Top 2 lockout solenoid (No. 6 Output) at all other times, if the "Transmission Style" is programmed to Eaton Top 2.

### **Customer Specified Parameters**

The following parameters must be programmed per the following list in order for the Eaton Top 2 transmission to function properly:

- **"Transmission Style"** Eaton Top 2
- **"Top Gear Ratio"** Programmed range 0.000 to 3.750
- **"Top Gear Minus One Ratio"** Programmed range 0.000 to 3.750
- **"Top Gear Minus Two Ratio"** Programmed range 0.000 to 3.750
- **"Eaton Top 2 Override with Cruise Switch"** Yes or No

**Note:** Each gear ratio must be precisely programmed to three decimal places per the following table for the model of transmission that is installed:

Table 149

Transmission Model	Top Gear Minus Two Ratio	Top Gear Minus One Ratio	Top Gear Ratio
RTLO-XX610B-T2 10 Over	1.352	1.000	0.741
RTL-XX710B-T2 10 Direct	1.825	1.351	1.000
RTLO-XX713A-T2 13 Over	1.000	0.856	0.730
RTLO-XX718B-T2 18 Over	1.000	0.856	0.730

**Note:** The XX that appears in the model number of the transmission refers to the nominal torque capacity. XX times 100 equals the nominal torque capacity. For example, RTLO-14610B has a nominal torque capacity of 14 times 100 or 1900 N·m (1400 lb ft).

The model designation of the transmission and other information are stamped on a tag on the transmission. The tag is located on the lower left side near the front of the transmission.

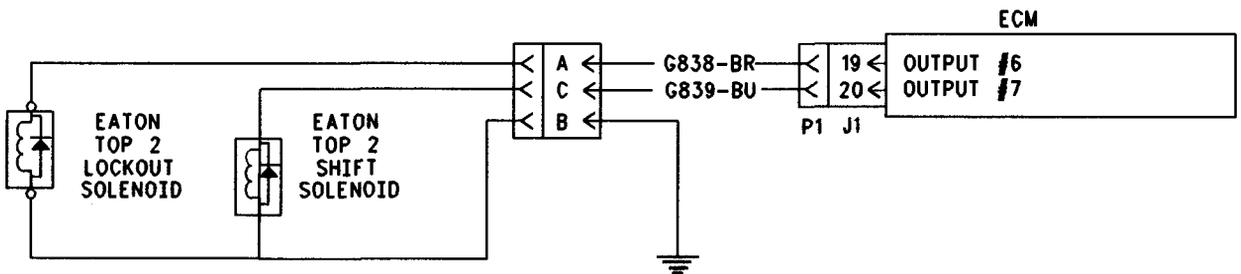


Illustration 92

g00653688

Schematic for Eaton Top 2 transmission

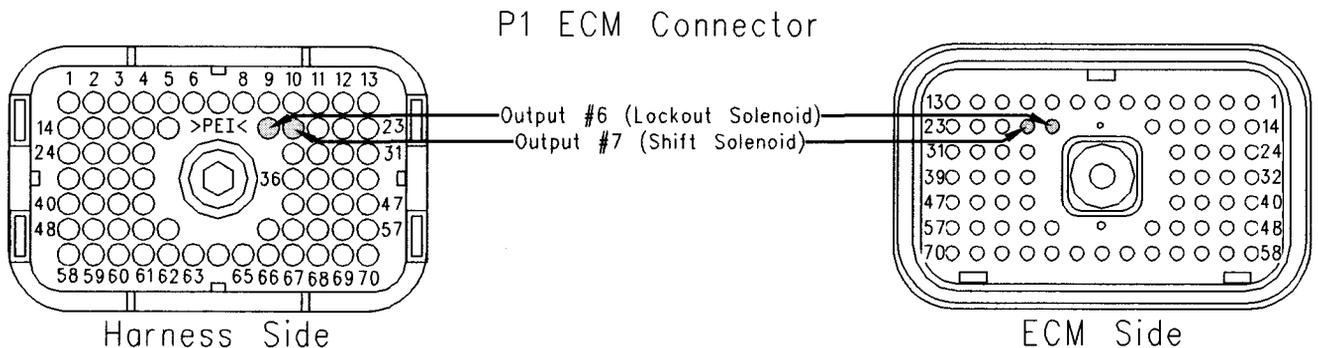


Illustration 93

g00991803

P1 ECM connector

## Test Step 1. Check for Active/Logged Diagnostic Codes

- A. Connect the electronic service tool to the data link connector.
- B. Turn the key switch to the ON position.
- C. Monitor the active diagnostic code screen on the electronic service tool.
- D. Check and record active/logged diagnostic codes:
  - 54-05 Auxiliary Output #06 current low
  - 54-06 Auxiliary Output #06 current high
  - 55-05 Auxiliary Output #07 current low
  - 55-06 Auxiliary Output #07 current high
  - 191-07 Transmission Not Responding

**Note:** If the “Eaton Top 2 Override With Cruise Switch” parameter is programmed to “YES” and the cruise control On/Off switch is in the OFF position, the operation of Top 2 is disabled.

### Expected Result:

One or more of the listed codes are active or logged.

### Results:

- **191-07 Only** – Diagnostic code 191-07 is the only active diagnostic code or the only logged diagnostic code that is present. Proceed to Test Step 6.
- **Any Code** – Any single diagnostic code or any combination of diagnostic codes is present. Proceed to Test Step 2.
- **No Codes** – If a transmission problem is still suspected, send the vehicle to the OEM dealer for service to the Eaton transmission. **STOP.**

## Test Step 2. Inspect Electrical Connectors and Wiring

- A. Thoroughly inspect ECM vehicle harness connector J1/P1, the firewall bulkhead connector and the Eaton Top 2 solenoid connector. Refer to Troubleshooting, “Electrical Connectors - Inspect” for details.
- B. Perform a 45 N (10 lb) pull test on each of the wires in the ECM connector that are associated with the Eaton Top 2 solenoids.

Refer to Illustration 93.

- C. Check the ECM connector (Allen Head Screw) for the proper torque of 6.0 N·m (55 lb in).
- D. Check the harness and wiring for abrasion and pinch points from the data link connectors back to the ECM.

### Expected Result:

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

### Results:

- **OK** – Proceed to Test Step 3.
- **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 3. Check the Solenoids

- A. Connect the electronic service tool to the data link connector.
- B. Turn the key switch to the ON position.
- C. Access the customer specified parameters screen on the electronic service tool.
- D. Verify that the “Transmission Style” is programmed to Eaton Top 2.
- E. Access the special tests for the “Shift Solenoid” and the “Lockout Solenoid” on the electronic service tool. Access the following display screens in order:
  - “Diagnostics”
  - “Diagnostic Tests”
  - “Special Tests”
  - “Shift Solenoid” and “Lockout Solenoid”
- F. Use the following procedure for either of the following active diagnostic codes or logged diagnostic codes:

- 55-05 Auxiliary Output #07 current low
  - 55-06 Auxiliary Output #07 current high
- a. Move the splitter button to the rear position.
  - b. Ensure that the air system pressure is equal to or greater than 620 kPa (90 psi).
  - c. While you listen for the solenoid to shift, cycle the special test for the "Shift Solenoid" from the ON position to the OFF position back to the ON position.

**Note:** You may need to be near the transmission in order to hear the shift.

- G.** Use the following procedure for either of the following active diagnostic codes or logged diagnostic codes:
- 54-05 Auxiliary Output #06 current low
  - 54-06 Auxiliary Output #06 current high
- a. Move the splitter button to the forward position.
  - b. Ensure that the air system pressure is equal to or greater than 620 kPa (90 psi).
  - c. While you listen for the solenoid to shift, cycle the special test for the "Lockout Solenoid" from the ON position to the OFF position back to the ON position.

**Note:** You may need to be near the transmission in order to hear the shift.

**Note:** 191-07 Transmission Not Responding may occur when one of the following diagnostic codes occurs during vehicle operation:

- 54-05 Auxiliary Output #06 current low
- 54-06 Auxiliary Output #06 current high
- 55-05 Auxiliary Output #07 current low
- 55-06 Auxiliary Output #07 current high

### Expected Result:

The solenoid is operating correctly when the test is activated.

### Results:

- OK – The ECM, the relay, and the solenoid are operating correctly.

**Repair:** Clear all logged diagnostic codes.

**STOP.**

- Not OK – Proceed to Test Step 4.

### Test Step 4. Use the Special Test at the Solenoid Connector

- A. Turn the key switch to the OFF position.
- B. Disconnect the Eaton Top 2 solenoid connector.
- C. Use the following procedure for either of the following active diagnostic codes or logged diagnostic codes:
  - 55-05 Auxiliary Output #07 current low
  - 55-06 Auxiliary Output #07 current high
  - a. Connect a voltage test lamp between pin "B" (Sensor Common) and pin "C" (No. 7 Output) on the ECM side of the Eaton Top 2 solenoid connector.
- D. Connect the electronic service tool to the data link connector.
- E. Turn the key switch to the ON position.
- F. Access the special test for the "Shift Solenoid" on the electronic service tool. Access the following display screens in order:
  - "Diagnostics"
  - "Diagnostic Tests"
  - "Special Test"
  - "Shift Solenoid"
- G. While you monitor the voltage test lamp, cycle the special test for the "Shift Solenoid" from the ON position to the OFF position and back to the ON position.
- H. Stop the special test for the "Shift Solenoid".

**Note:** When the key switch is turned on and the solenoid connector is disconnected, the following diagnostic code will occur during performance of the special test for the "Lockout Solenoid":

- 54-05 Output #6 Open Circuit (66)

Clear this logged code when this step is completed.

- I. Use the following procedure for either of the following active diagnostic codes or logged diagnostic codes:

- 54-05 Auxiliary Output #06 current low
- 54-06 Auxiliary Output #06 current high
- a. Connect a voltage test lamp between pin “B” (Sensor Common) and pin “A” (No. 6 Output) on the ECM side of the Eaton Top 2 solenoid connector.

**J.** Connect the electronic service tool to the data link connector.

**K.** Turn the key switch to the ON position.

**L.** Access the special test for the “Shift Solenoid” and the “Lockout Solenoid” on the electronic service tool. Access the following display screens in order:

- “Diagnostics”
- “Diagnostic Tests”
- “Special Test”
- “Lockout Solenoid”

**M.** While you monitor the voltage test lamp, cycle the special test for the “Lockout Solenoid” from the ON position to the OFF position and back to the ON position.

**N.** Stop the special test for the “Lockout Solenoid”.

**Note:** When the key switch is turned on and the solenoid connector is disconnected, the following diagnostic code will occur during performance of the special test for the “Lockout Solenoid”:

- 55-05 Auxiliary Output #07 current low

Clear this logged code when this step is completed.

### **Expected Result:**

The voltage test lamp behaves in the following manner:

- The voltage test lamp turns on when the test is active.
- The voltage test lamp turns off when the test is not active.

### **Results:**

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

**Repair:** Temporarily connect the suspect solenoids. Clear all logged diagnostic codes. Complete a test drive of the truck. If the diagnostic code is logged after attempting to use the Top 2 feature, replace the solenoids. Repeat the test drive in order to ensure that the problem has been corrected. Clear all logged diagnostic codes.

Verify that the repair eliminates the problem.

**STOP.**

- **Not OK** – The problem is in the harness wiring or the ECM. Remove the voltage test lamp. Proceed to Test Step 5.

### **Test Step 5. Use the Electronic Service Tool to Check the ECM**

**A.** Turn the key switch to the OFF position.

**B.** Disconnect the ECM vehicle harness connector J1/P1.

**C.** Connect a 140-2266 Cable (Seventy-Pin Breakout) to the ECM connector J1.

**D.** Use the following procedure for either of the following diagnostic codes:

- 55-05 Auxiliary Output #07 current low
- 55-06 Auxiliary Output #07 current high

a. Remove terminal 20 from vehicle harness connector P1.

b. Connect P1 to the breakout T.

**E.** Connect a voltage test lamp to terminal 67 (–Battery) and terminal 20 (No. 7 Output) of the breakout T.

**Note:** The No. 7 Output is the shift solenoid.

**F.** Connect the electronic service tool to the data link connector.

**G.** Turn the key switch to the ON position.

**H.** Access the special test for the “Shift Solenoid” on the electronic service tool. Access the following display screens in order:

- “Diagnostics”
- “Diagnostic Tests”
- “Special Test”
- “Shift Solenoid”

I. While you monitor the voltage test lamp, cycle the special test for the "Shift Solenoid" from the ON position to the OFF position and back to the ON position.

J. Stop the special test for the "Shift Solenoid".

K. Use the following procedure for either of the following diagnostic codes:

- 54-05 Auxiliary Output #06 current low
- 54-06 Auxiliary Output #06 current high

a. Remove terminal 19 from vehicle harness connector P1.

b. Connect P1 to the breakout T.

L. Connect a voltage test lamp to terminal 67 (-Battery) and terminal 19 (No. 6 Output) of the breakout T.

**Note:** The No. 6 Output is the lockout solenoid.

M. Connect the electronic service tool to the data link connector.

N. Turn the key switch to the ON position.

O. Access the special test for the "Lockout Solenoid" on the electronic service tool. Access the following display screens in order:

- "Diagnostics"
- "Diagnostic Tests"
- "Special Test"
- "Lockout Solenoid"

P. While you monitor the voltage test lamp, cycle the special test for the "Lockout Solenoid" from the ON position to the OFF position and back to the ON position.

Q. Stop the special test for the "Lockout Solenoid".

#### **Expected Result:**

The voltage test lamp behaves in the following manner:

- The voltage test lamp turns on when the test is active.
- The voltage test lamp turns off when the test is not active.

**Note:** When all of the following conditions exist a 54-05 and 55-05 diagnostic code will occur:

- The key switch is turned on.
- The ECM connector J1/P1 is disconnected.
- The "Transmission Style" is programmed to Eaton Top 2.

This is normal. Clear these diagnostic codes after this test step is completed.

#### **Results:**

- OK

**Repair:** Clear any diagnostic codes that were caused during this step. Repair the vehicle harness from the Eaton Top 2 solenoid connector to ECM connector P1 or replace the vehicle harness from the Eaton Top 2 solenoid connector to ECM connector P1.

Verify that the repair eliminates the problem.

**STOP.**

- Not OK

**Repair:** Temporarily connect a test ECM. Remove all jumpers and replace all connectors. Recheck the system for active diagnostic codes. Repeat this test step. If the problem is resolved with the test ECM, reconnect the suspect ECM. If the problem returns with the suspect ECM, replace the ECM.

Verify that the repair eliminates the problem.

**STOP.**

### **Test Step 6. Check Gear Ratios**

**A.** Connect the electronic service tool to the data link connector.

**B.** Turn the key switch to the ON position.

**C.** Access the customer specified parameters screen on the electronic service tool.

**D.** Verify that the three parameters for gear ratios are correctly programmed.

Refer to Table 149.

#### **Expected Result:**

The parameters for the gear ratios are programmed correctly.

#### **Results:**

- OK

**Repair:** If a transmission problem is still suspected, send the vehicle to the OEM dealer for service to the Eaton Transmission.

STOP.

- Not OK

**Repair:** Consult the OEM dealer in order to determine the proper values for the gear ratios and program the proper values for the gear ratios.

STOP.

i01906649

## ECM Memory - Test

**SMCS Code:** 1901-038

### System Operation Description:

#### Use this procedure under the following situation:

One of the following diagnostic codes is present:

- 252-11 Engine Software Incorrect
- 253-02 Check Customer or System Parameters

Also, use this procedure if the integrity of the customer parameters or the system parameters in the ECM is questionable. Also, use this procedure if the data for the engine lifetime totals is questionable.

#### The following background information is related to this procedure:

The engine control module (ECM) is the computer which controls the Caterpillar electronic truck engine. The personality module contains the software that controls the operation of the computer (ECM).

The personality module software is the instructions that are used by the ECM to control the engine. For this reason, updating the personality module to a different version may cause some engine functions to behave in a different manner.

### Performance Maps

Performance maps define characteristics for various operating conditions. These characteristics are used to achieve optimum performance while emissions requirements are being met. Examples of these characteristics are included in the following list:

- Fuel rate

- Timing

These characteristics are programmed into the personality module at the factory only.

### Microprocessor

The ECM uses a microprocessor to perform the computing that is required to perform the following functions:

- Governing
- Controlling timing
- Generating diagnostic codes
- Communicating with service tools

The microprocessor reads the instructions from the software in the personality module.

### Programmable Parameters

Programmable parameters are stored in permanent memory. This includes both customer specified parameters and system configuration parameters. Refer to Troubleshooting, "Customer Specified Parameters" for details on customer specified parameters and refer to Troubleshooting, "System Configuration Parameters" for details on system configuration parameters.

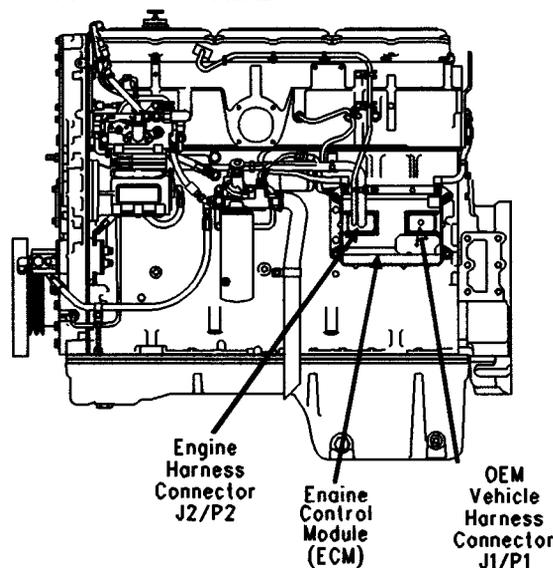


Illustration 94

ECM and harness connectors

g00658319

### Logged Diagnostics

Logged diagnostics are stored by the ECM into memory so a permanent record of the diagnostic code is retained. Logged faults that are not critical are automatically cleared after 100 hours.

### Input Circuits

Input circuits filter electrical noise for sensor signals. Also, input circuits protect internal circuits from potentially damaging voltage levels.

### Output Circuits

Output circuits provide the voltage or current that is required to energize components that are connected to the ECM.

### Power Circuits

Power circuits provide clean stable electrical power to internal circuits and external sensors.

## Test Step 1. Inspect Electrical Connectors and Wiring

- A.** Thoroughly inspect ECM vehicle harness connector J1/P1 and the battery connections. Refer to Troubleshooting, "Electrical Connectors - Inspect" for details.
- B.** Perform a 45 N (10 lb) pull test on each of the following wires in the ECM connector:
  - Ignition key switch (terminal 70)
  - +Battery (terminals 52 and 53)
  - -Battery (terminals 65 and 67)
  - ATA Data Link (terminals 8 and 9)
- C.** Check the ECM connector (Allen Head Screw) for the proper torque of 6.0 N·m (55 lb in).
- D.** Check the harness and wiring for abrasion and pinch points from the data link connectors back to the ECM.

### Expected Result:

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

### Results:

- OK – Proceed to Test Step 2.
- 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 Diagnostic Codes

Connect the Caterpillar Electronic Technician (Cat ET) and check for diagnostic codes.

### Expected Result:

**Result 1** The following diagnostic code requires troubleshooting:

- 252-11 Engine Software Incorrect

**Result 2** The following diagnostic code requires troubleshooting:

- 253-02 Check Customer or System Parameters

**Result 3** Scrambled parameters or data require troubleshooting.

### Results:

- **Result 1** – Proceed to Test Step 3.
- **Result 2** – Proceed to Test Step 4.
- **Result 3** – Proceed to Test Step 5.

## Test Step 3. Check the Part Number of the ECM Personality Module

- A.** Connect Cat ET to the data link connector.
- B.** Turn the key switch to the ON position.
- C.** Read the customer specified parameters. Refer to Troubleshooting, "Programming Parameters".
- D.** Ensure that the personality module part number agrees with the original engine arrangement.

### Expected Result:

The correct personality module is installed in the ECM for the engine.

### Results:

- OK

**Repair:** The diagnostic code 252-11 must be cleared if the correct personality module has been installed. Clearing this diagnostic code requires factory passwords and resetting the personality module code to zero.

STOP.

- Not OK

**Repair:** Reprogram the ECM with the correct personality module. Refer to Troubleshooting, "Flash Programming".

Verify that the repair eliminates the problem.

STOP.

### Test Step 4. Determine Parameters that Require Programming

**A.** Connect Cat ET to the data link connector.

**B.** Turn the key switch to the ON position.

**C.** Check the active diagnostic codes. Note any parameters that are listed in the following active diagnostic code:

- 253-02 Check Customer or System Parameters (56)

**Expected Result:**

The ECM allows the parameters that are listed under the following active diagnostic code in the active diagnostic code screen to be programmed:

- 253-02 Check Customer or System Parameters (56)

**Results:**

- OK

**Repair:** Ensure that the cause of all diagnostic codes is repaired.

STOP.

- Not OK

**Repair:** Temporarily connect a test ECM. Ensure that the test ECM will allow the programming of the parameters. If the test ECM does not allow the programming of the parameters, the old ECM is OK. Something is wrong in the vehicle wiring. Check the battery supply circuit to the ECM and repair, as required.

Verify that the repair eliminates the problem.

STOP.

### Test Step 5. Review Parameters and Data

**A.** Turn the key switch to the ON position.

**B.** Check for active diagnostic codes and/or logged diagnostic codes on Cat ET.

**C.** Review the customer and system parameters.

**D.** Review the engine lifetime totals.

**Expected Result:**

The parameters and totals are scrambled.

**Results:**

- OK

**Repair:** Try to reprogram the suspect parameter or parameters. If the ECM does not maintain the parameters, temporarily connect a test ECM. Ensure that the test ECM will allow the programming of the parameters. If the test ECM does not allow the programming of the parameters, the old ECM is OK. Something is wrong in the vehicle wiring. Check the battery supply circuit to the ECM and repair, as required.

Verify that the repair eliminates the problem.

STOP.

- Not OK – The ECM is OK. STOP.

i01720712

## Electrical Connectors - Inspect

**SMCS Code:** 7553-040-WW

**System Operation Description:**

Most electrical problems are caused by poor connections. The following procedure will assist in detecting problems due to connectors. If a problem is found in an electrical connector, repair the connector and verify that the problem does not return. Do NOT cut connector wires unless terminals are being replaced. Repair the connectors with a 1U-5804 Crimp Tool. The wedges on the DT connectors are easily removed with a 147-6456 Removal Tool.

Intermittent electrical problems often disappear 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 any connectors. If the status of a diagnostic code is changed due to disconnecting and reconnecting a connector, there are several possible reasons. The likely problems are loose or improperly crimped terminals, moisture, corrosion, or connectors not mated securely.

ALWAYS crimp the terminals on the wires with the 1U-5804 Crimp Tool. Do not solder the terminals.

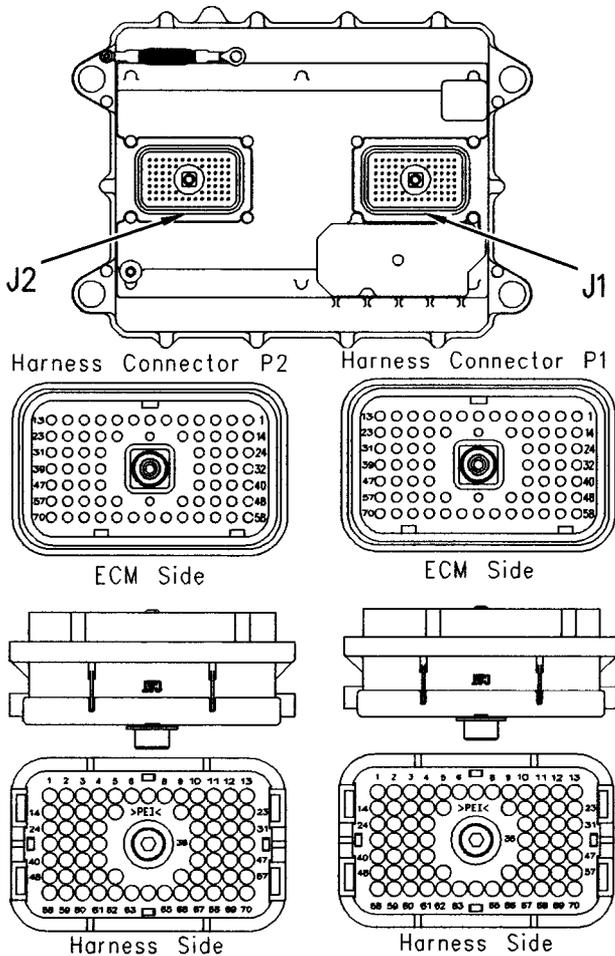
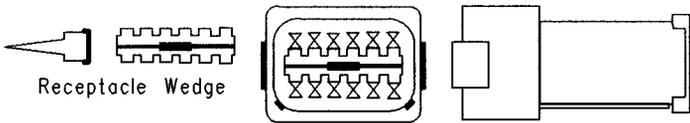
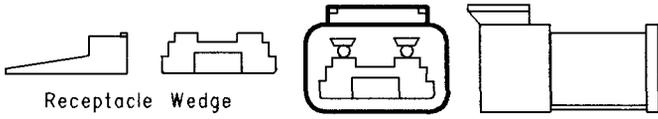


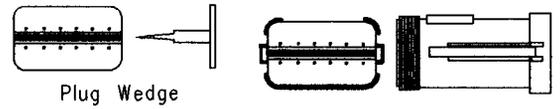
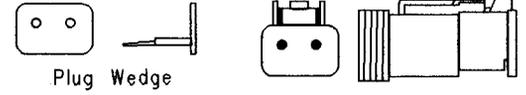
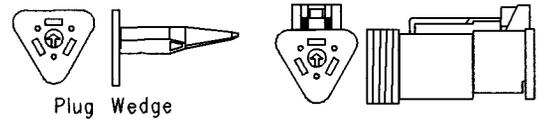
Illustration 95  
 ECM connectors (AMP)

g00693506

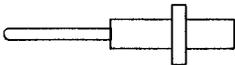
Deutsch DT Connector Receptacles



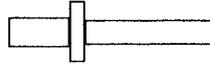
Deutsch DT Connector Plugs



Deutsch and AMP Pin Contact



Deutsch and AMP Socket Contact



Deutsch and AMP Sealing Plug

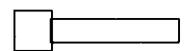


Illustration 96  
Deutsch connector receptacles and plugs

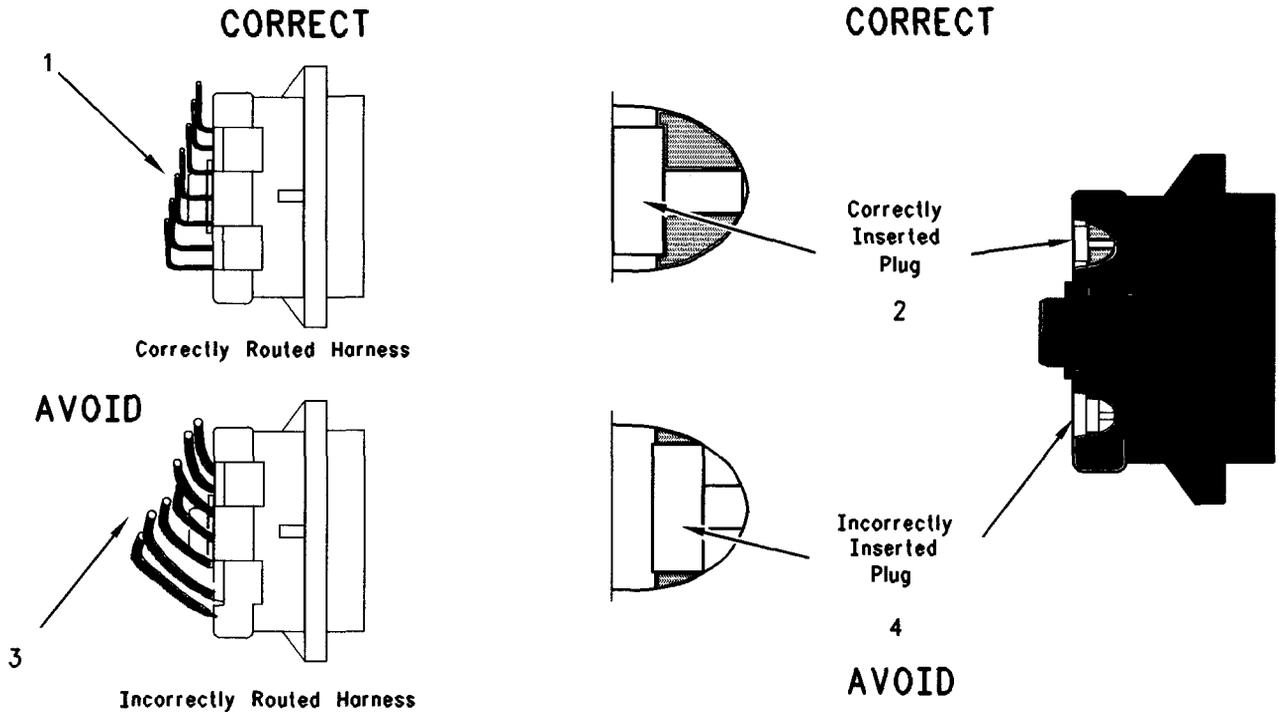


Illustration 97

g00640158

Routing of the Harness and insertion of the plug

- (1) Correctly routed harness
- (2) Correctly inserted plug
- (3) Incorrectly routed harness
- (4) Incorrectly inserted plug

**Test Step 1. Check the Locking of the DT Connector (Deutsch) and Check the Lock Ring of the HD Style Connector (Deutsch)**

- A.** Ensure that the connector is properly locked. Also ensure that the two halves of the connector can not be pulled apart.
- B.** Verify that the latch tab of the connector is properly latched. Also verify that the latch tab of the connector returns to the locked position.

**Expected Result:**

The connector will securely lock. The connector and the locking mechanism are without cracks or breaks.

**Results:**

- OK – Proceed to Test Step 2.
- Not OK

**Repair:** Repair the connector or replace the connector, as required.

Verify that the repair eliminates the problem.

STOP.

**Test Step 2. Check the Allen Head Screw on the ECM Connector**

- A.** Ensure that the allen head screw is properly tightened. Be careful not to overtighten the screw and break the screw.
- B.** Do not exceed 6.0 N·m (55 lb in) of torque on the allen head screw.

**Expected Result:**

The ECM connector is secure and the allen head screw is properly torqued.

**Results:**

- OK – Proceed to Test Step 3.
- Not OK

**Repair:** Repair the connector or replace the connector, as required.

Verify that the repair eliminates the problem.

STOP.

### Test Step 3. Perform a Pull Test on Each Wire Terminal Connection

- A.** Each terminal and each connector should easily withstand 45 N (10 lb) of pull 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.
- B.** The DT connectors use a green wedge to lock the terminals in place. Ensure that the green wedge is not missing and that the green wedge is installed properly on the DT connectors.

**Note:** Terminals should always be crimped onto the wires by using a crimp tool. Do not solder terminals. Use the 1U-5804 Crimp Tool.

#### 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 – Proceed to Test Step 4.
- Not OK

**Repair:** Repair the circuit.

Verify that the repair eliminates the problem.

**STOP.**

### Test Step 4. Perform the “Wiggle Test” on Cat ET

- A.** Select the “Wiggle Test” from the diagnostic tests on Cat ET.
- B.** Press the “OK” button after you adhere to the warning.
- C.** Choose the appropriate group of parameters to monitor.
- D.** Press the “Start” button. Wiggle the wiring harness in order to reproduce intermittent problems.
- E.** 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 – Proceed to Test Step 5.
- Not OK

**Repair:** Repair the circuit.

Verify that the repair eliminates the problem.

**STOP.**

### Test Step 5. Check Wires for Nicks or Abrasion in the Insulation

- A.** Carefully inspect each wire for signs of abrasion, nicks, or cuts.

The following areas are locations that should be checked:

- Exposed insulation
- Points of rubbing wire against the engine
- Points of rubbing wire against a sharp point

- B.** Check all of the hold down clamps for the harness in order to verify that the harness is properly clamped. Also check all of the hold down clamps for the harness in order to verify that the harness is not compressed by the clamp. Pull back the harness sleeves in order to check for a flattened portion of wire. The flattened portion of wire is caused by the clamp that holds the harness.

#### Expected Result:

The wires are free of abrasion, nicks, or cuts and the harness is properly clamped.

#### Results:

- OK – Proceed to Test Step 6.
- Not OK

**Repair:** Repair the wires or replace the wires, as required.

Verify that the repair eliminates the problem.

**STOP.**

## Test Step 6. Check Connectors for Moisture or Corrosion

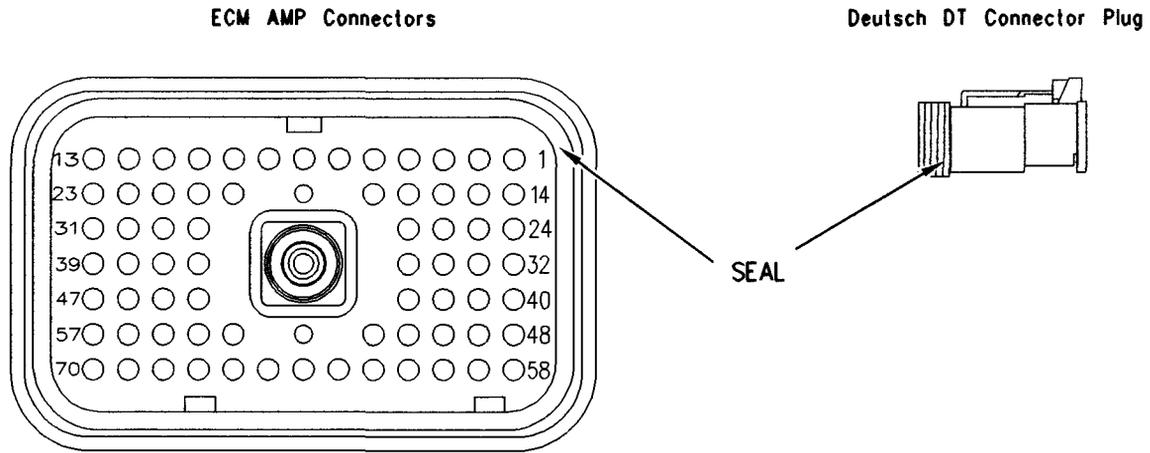


Illustration 98  
Connector seals

g00705443

- A. Ensure that the connector seals and the white sealing plugs are in place. If any of the seals or plugs are missing, replace the seal or plug. If necessary, replace the connector.
- B. Check all of the wiring harnesses in order to verify that the harness does not make a sharp bend out of a connector. This will deform the connector seal and this will create a path for the entrance of moisture.

Thoroughly inspect the J1/P1 and J2/P2 ECM connectors for evidence of moisture entry.

**Note:** It is normal to see some minor seal abrasion on the ECM Connector seals. Minor seal abrasion will not allow the entry of moisture.

- C. 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 reoccur. Simply drying the connector will not fix the problem. Likely paths for the entrance of moisture are illustrated in the following list:

- Missing seals
- Improperly installed seals
- Nicks in exposed insulation
- Improperly mated connectors

Moisture can also travel from one connector through the inside of a wire to the ECM Connector. If moisture is found in the ECM connector, thoroughly check all connectors and wires on the harness that connect to the ECM. The ECM is not the source of the moisture. Do not replace an ECM if moisture is found in either ECM connector.

**Note:** 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. Do not use any cleaners that contain 1,1,1 trichloro-ethylene because 1,1,1 trichloro-ethylene may damage the connector.

### Expected Result:

All of the connectors should be completely coupled and all of the seals should be completely inserted. The harness and the wiring should be free of corrosion, abrasion or pinch points.

### Results:

- OK – Proceed to Test Step 7.
- 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 by running the engine for several minutes and by checking 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 that have moisture. These wires may have moisture that is trapped inside the insulation. Verify that the repair eliminates the problem.

STOP.

### **Test Step 7. Inspect the Connector Terminals**

- A.** 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 – Proceed to Test Step 8.
- Not OK

**Repair:** Repair the terminals and/or replace the terminals, as required.

Verify that the repair eliminates the problem.

STOP.

## Test Step 8. Check Individual Pin Retention into the Socket

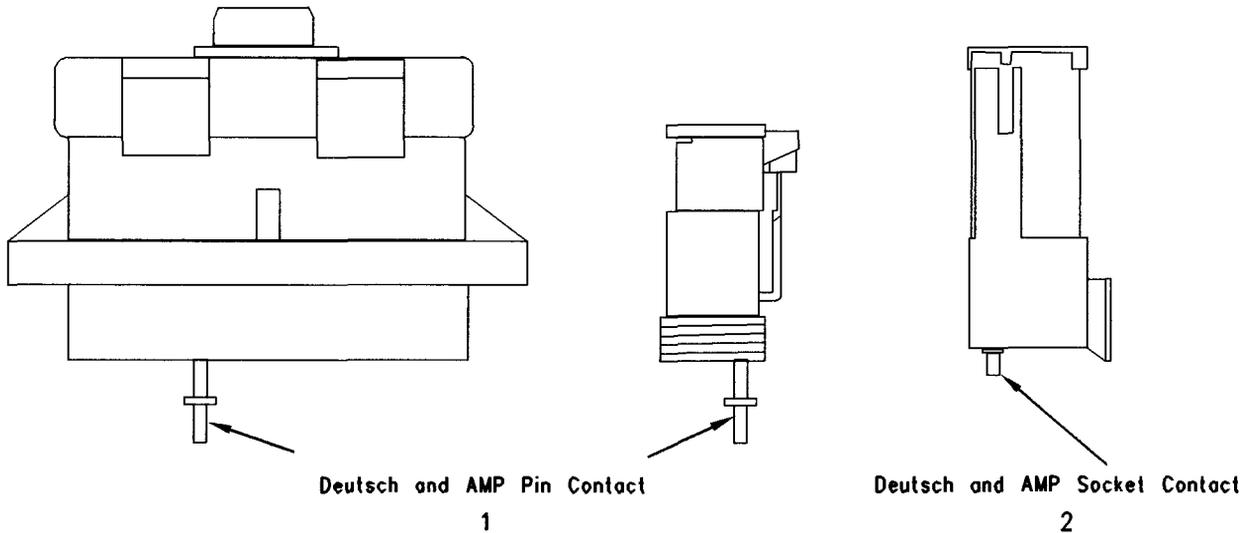


Illustration 99

g00640220

(1) Contact of the pin

(2) Contact of the socket

**Note:** This is especially important for intermittent problems.

i01907603

- A.** Use a new pin. Insert the pin into each socket one at a time in order to check for a good grip on the pin by the socket.
- B.** Use a new socket. Insert the socket over each pin one at a time in order to check for a good grip on the pin by the socket. The pins are located on the mating side of the connector.
- C.** The contact terminal should stay connected when the connector is held in the position shown in Illustration 99. The contact terminal is the pin or the socket.

### Expected Result:

The pins and the sockets appear to be OK.

### Results:

- OK – STOP.
- Not OK

**Repair:** Repair the terminals and/or replace the terminals.

Verify that the repair eliminates the problem.

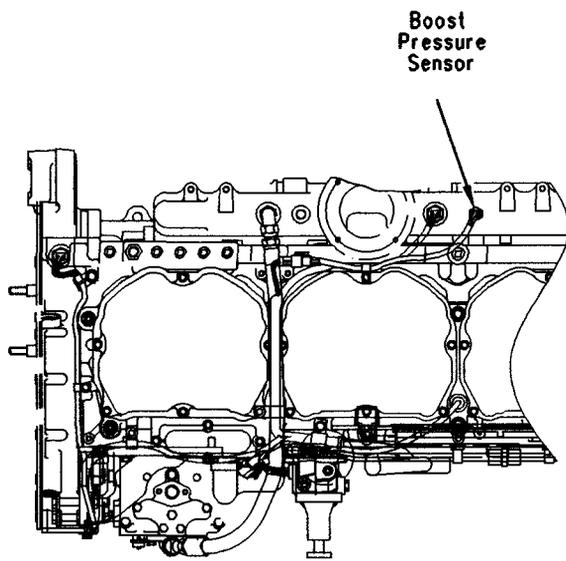
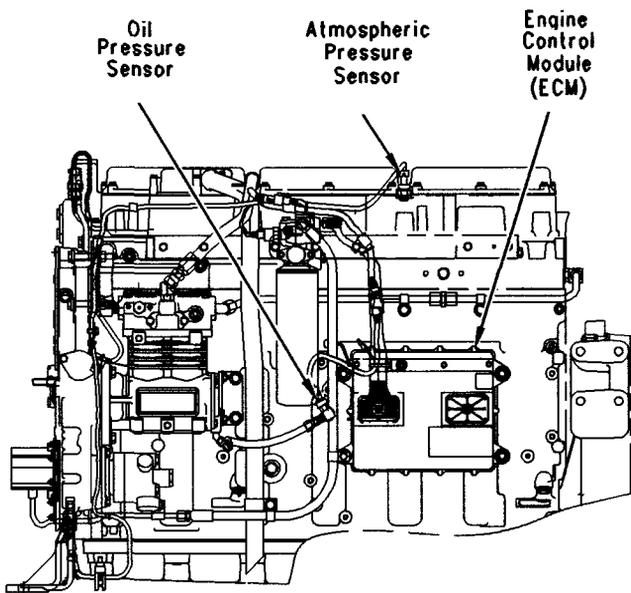
**STOP.**

## Engine Pressure Sensor Open or Short Circuit - Test

**SMCS Code:** 1917-038; 1923-038; 1924-038

### System Operation Description:

The troubleshooting procedures for the diagnostic codes of each pressure sensor are identical. The Engine Control Module (ECM) sends a 5 Volt supply to terminal A of each sensor. The sensor common connection is connected to terminal B of each sensor. The signal voltage from terminal C of each sensor is sent to the appropriate terminal at the J2/P2 ECM connector.

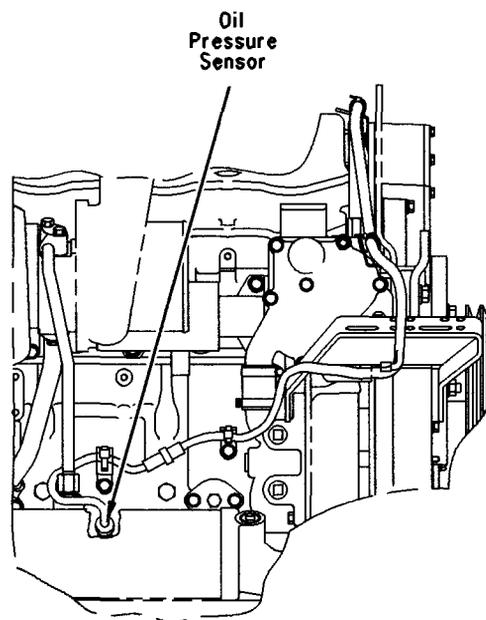
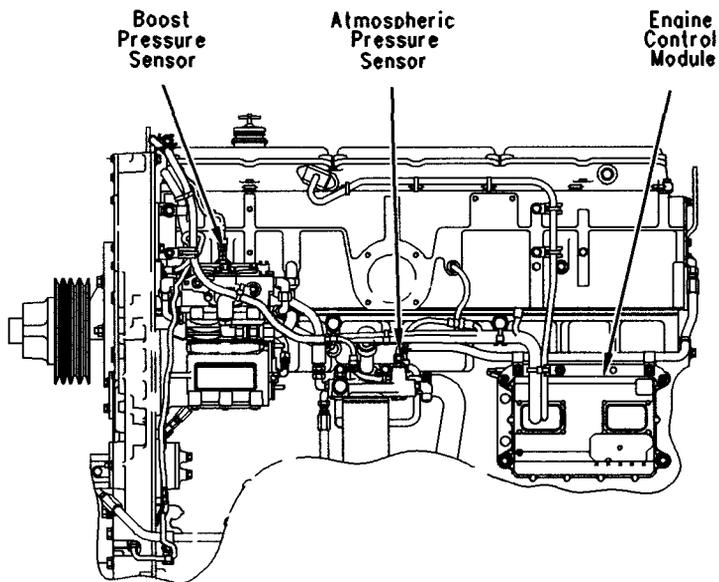


C-10 AND C-12 LEFT SIDE VIEW

C-10 AND C-12 TOP VIEW

Illustration 100  
C-10 and C-12 Pressure sensors

g00692909



3406E LEFT SIDE VIEW

3406E RIGHT SIDE VIEW

Illustration 101  
3406E Pressure sensors

g00692936

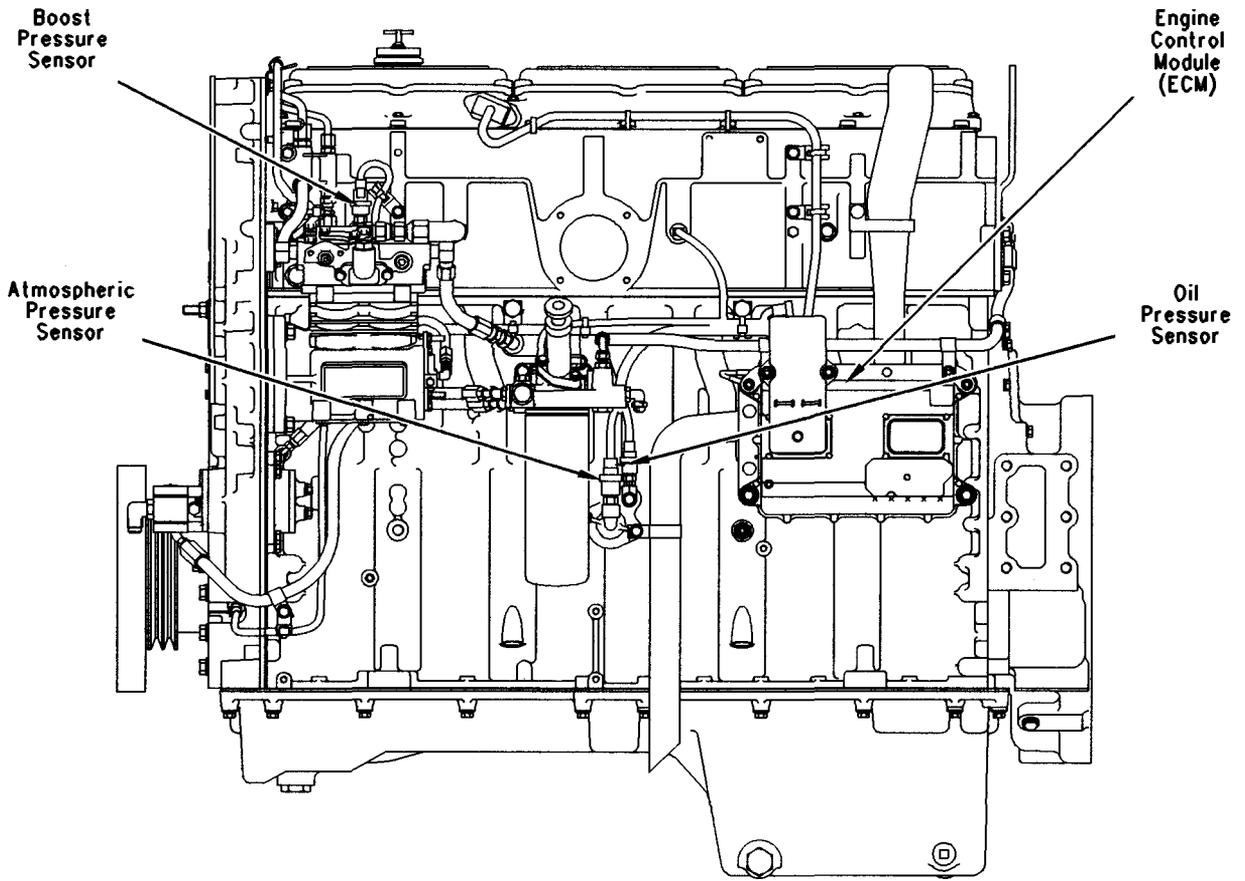


Illustration 102

g00693763

C-15, C-16 and C-18 Pressure sensors

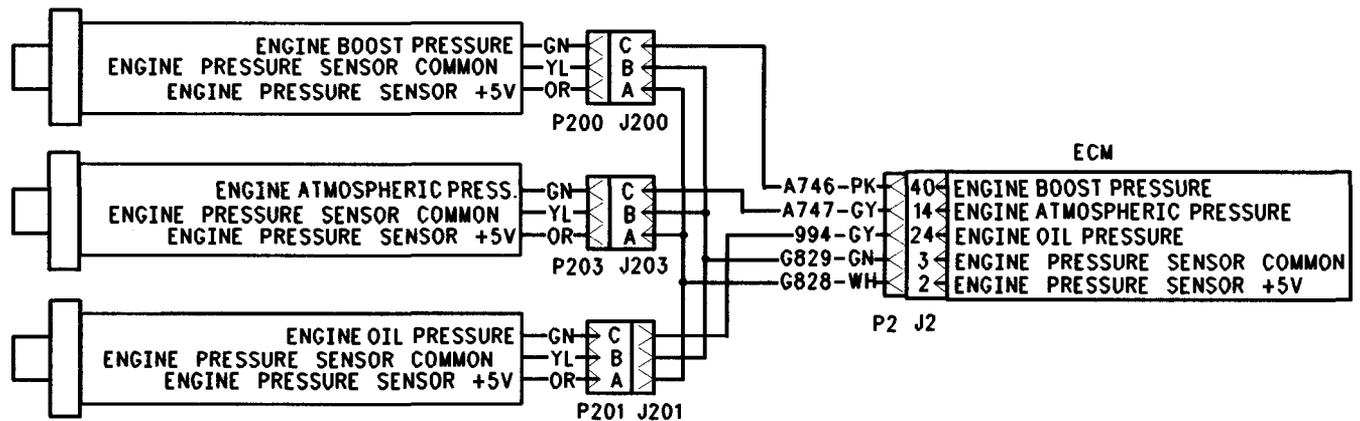


Illustration 103

g00662235

Schematic for engine pressure sensors

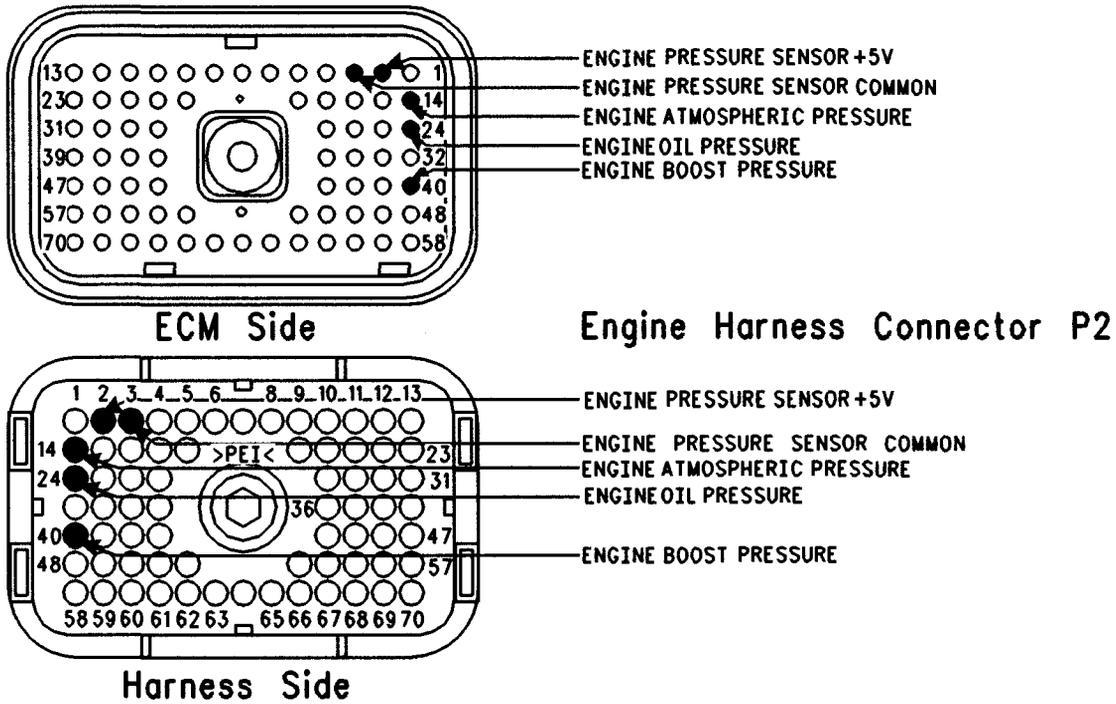


Illustration 104  
Terminal locations for ECM

g00662237

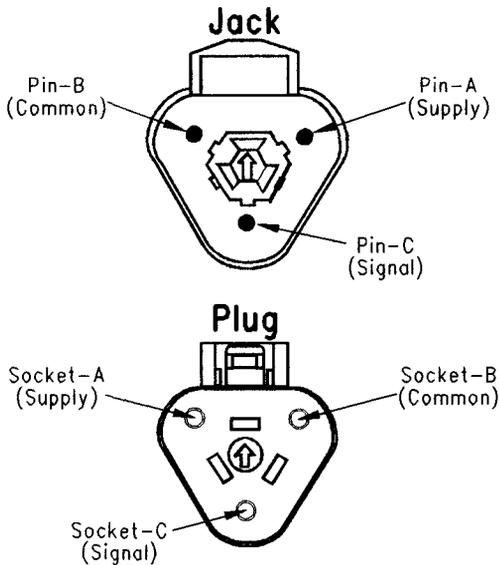


Illustration 105  
Sensor connector

g00810608

### Test Step 1. Check for Active +5 V Sensor Supply Diagnostic Codes

**A.** Connect the Caterpillar Electronic Technician (Cat ET) to the data link connector.

**B.** Turn the key switch to the ON position. Wait at least 15 seconds for activation of the diagnostic codes.

**C.** Verify if any of the following diagnostic codes are active:

- 232-03 5 Volt Supply voltage high
- 232-04 5 Volt Supply voltage low

#### Expected Result:

None of the preceding diagnostic codes are active.

#### Results:

- OK – Proceed to Test Step 2.
- Not OK

**Repair:** Perform the following diagnostic procedure: Troubleshooting, "5 Volt Engine Pressure Sensor Supply Circuit - Test".

STOP.

## Test Step 2. Inspect Electrical Connectors And Wiring

**A.** Thoroughly inspect the J2/P2 ECM connector and the connectors for any suspect sensors. Refer to Troubleshooting, “Electrical Connectors - Inspect” for details.

**B.** 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.

Refer to Illustration 104.

**C.** Check the ECM connector (Allen Head Screw) for the proper torque of 6.0 N·m (55 lb in).

**D.** Check the harness and wiring for abrasion and pinch points from the sensors back to the ECM.

### Expected Result:

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

### Results:

- OK – Proceed to Test Step 3.
- 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.

Clear all logged diagnostic codes.

STOP.

## Test Step 3. Determine the Condition that is Present

**A.** Turn the key switch to the ON position. Wait at least 15 seconds for activation of the diagnostic codes.

**B.** Monitor the active diagnostic code screen on Cat ET.

**C.** Determine if the problem is related to a “voltage high” diagnostic code (open circuit) or a “voltage low” diagnostic code (short circuit).

### Expected Result:

Either a “voltage low” diagnostic code (short circuit) is active or a “voltage high” diagnostic code (open circuit) is active.

### Results:

- **Voltage Low (Short)** – A “voltage low” diagnostic code (short circuit) is active at this time. Proceed to Test Step 4.
- **Voltage High (Open)** – A “voltage high” diagnostic code (open circuit) is active at this time. Proceed to Test Step 7.

## Test Step 4. Disconnect the Suspect Sensor

**A.** Turn the key switch to the OFF position.

**B.** Disconnect the sensor with the “voltage low” diagnostic code (short circuit).

**C.** Turn the key switch to the ON position. Wait at least 15 seconds for activation of the diagnostic codes.

**D.** Check for an active “voltage high” diagnostic code (open circuit) for the disconnected sensor.

### Expected Result:

A “voltage high” diagnostic code (open circuit) for the disconnected sensor is now active.

### Results:

- **OK** – A “voltage low” diagnostic code (short circuit) was active before disconnecting the sensor. A “voltage high” diagnostic code (open circuit) became active after disconnecting the sensor.

**Repair:** Temporarily connect a new sensor.

Check for active diagnostic codes.

If the new sensor fixes the problem, reconnect the suspect sensor.

If the problem returns, permanently install the new sensor.

Verify that the repair eliminates the problem.

STOP.

- **Not OK** – There is a short circuit between the sensor and the ECM.

**Repair:** Leave the suspect sensor disconnected.

Proceed to Test Step 5.

### Test Step 5. Create an Open Circuit at the ECM

- A. Turn the key switch to the OFF position.
- B. Remove the signal wire of the suspect sensor from the P2 ECM connector.
- C. Turn the key switch to the ON position.
- D. Check for active diagnostic codes.

#### Expected Result:

A "voltage high" diagnostic code (open circuit) became active after disconnecting the signal wire.

#### Results:

- **OK** – A "voltage low" diagnostic code (short circuit) was active before disconnecting the sensor. A "voltage high" diagnostic code (open circuit) became active after disconnecting the sensor. Proceed to Test Step 6.
- **Not OK** – There is still a "voltage low" diagnostic code (short circuit).

**Repair:** Connect a test ECM.

If the test ECM fixes the problem, reconnect the suspect ECM.

If the problem returns, permanently replace the suspect ECM.

Verify that the repair eliminates the problem.

**STOP.**

### Test Step 6. Check the Resistance of the Harness

- A. Turn the key switch to the OFF position.
- B. Verify that the suspect sensor is disconnected.
- C. Measure the resistance between terminal B (Pressure Sensor Common) and terminal C (Signal) of the connector for the suspect sensor on the engine harness.

#### Expected Result:

The resistance is greater than 20,000 Ohms, or "OL" is displayed on the multimeter.

#### Results:

- **OK** – The resistance is greater than 20,000 Ohms, or "OL" is displayed on the multimeter.

**Repair:** Check the signal wire for a short to ground.

Repair the faulty wiring or replace the faulty wiring.

Verify that the repair eliminates the problem.

**STOP.**

- **Not OK** – There is a short between the pressure sensor common and the signal wire.

**Repair:** Locate the short between the pressure sensor common and the signal wire.

Repair the faulty wiring or replace the faulty wiring.

Verify that the repair eliminates the problem.

**STOP.**

### Test Step 7. Measure the Sensor Supply Voltage

- A. Turn the key switch to the OFF position.
- B. Disconnect the suspect sensor.
- C. Turn the key switch to the ON position.
- D. Measure the voltage from terminal A (Pressure Sensor +5V) to terminal B (Pressure Sensor Common).

#### Expected Result:

The voltage is  $5.0 \pm 0.16$  VDC.

#### Results:

- **OK** – The sensor supply voltage is correct.

**Repair:** Leave the sensor disconnected.

Proceed to Test Step 8.

- **Not OK** – The sensor supply voltage is out of the range.

**Repair:** Check the 5 volt supply wire for an open circuit.

Repair the faulty wiring or replace the faulty wiring.

Verify that the repair eliminates the problem.

STOP.

### Test Step 8. Create a Short Circuit at the Sensor

- A. Turn the key switch to the ON position.
- B. Monitor the active diagnostic code screen.
- C. Install a jumper wire between terminal C (Signal) and terminal B (Pressure Sensor Common) of the sensor connector. Wait at least 15 seconds for activation of the "voltage low" diagnostic code (short circuit).

#### Expected Result:

A "voltage low" diagnostic code (short circuit) is active when the jumper wire is installed. A "voltage high" diagnostic code (open circuit) is active when the jumper wire is removed.

#### Results:

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

**Repair:** Temporarily connect a new sensor.

If the new sensor fixes the problem, reconnect the suspect sensor.

If the problem returns, permanently replace the suspect sensor.

Verify that the repair eliminates the problem.

STOP.

- Not OK – The "voltage high" diagnostic code (open circuit) remains active when the jumper wire is installed.

**Repair:** Remove the jumper wire.

Proceed to Test Step 9.

### Test Step 9. Create a Short Circuit at the ECM

- A. Turn the key switch to the OFF position.
- B. Disconnect the J2/P2 ECM connector.
- C. Turn the key switch to the ON position.

A "voltage high" diagnostic code (open circuit) should be active for the suspect sensor.

- D. Monitor the active diagnostic code screen. Wait at least 15 seconds for activation of the code.

**Note:** When the P2 ECM connector is disconnected, all of the "voltage high" diagnostic codes (open circuit) for the pressure sensors will be active. This is normal.

- E. Install a jumper wire between the terminal for the signal of the suspect sensor and the pressure sensor common on the ECM. Wait at least 15 seconds for activation of the "voltage low" diagnostic code (short circuit).

#### Expected Result:

A "voltage low" diagnostic code (short circuit) is active for the suspect sensor.

#### Results:

- OK – The ECM is operating properly.

**Repair:** Leave the P2 ECM connector disconnected.

Proceed to Test Step 10.

- Not OK – The "voltage high" diagnostic code (open circuit) is still active when the jumper wire is installed.

**Repair:** Temporarily connect a test ECM.

If the test ECM fixes the problem, reconnect the suspect ECM.

If the problem returns, permanently replace the ECM.

Verify that the repair eliminates the problem.

STOP.

### Test Step 10. Check the Resistance of the Harness

- A. Turn the key switch to the OFF position.
- B. Verify that the suspect sensor is disconnected.
- C. Check the resistance between terminal A (Pressure Sensor +5V) and terminal C (Signal) of the connector for the suspect sensor on the engine harness.

#### Expected Result:

The resistance is greater than 20,000 Ohms or "OL" is displayed on the multimeter.

#### Results:

- OK – There is an open circuit in the signal wire.

**Repair:** Locate the open in the signal wire.

Repair the faulty wiring or replace the faulty wiring.

Verify that the repair eliminates the problem.

**STOP.**

- **Not OK** – There is a short between the 5 volt supply and the signal wire.

**Repair:** Locate the short between the 5 volt supply and the signal wire.

Repair the faulty wiring or replace the faulty wiring.

Verify that the repair eliminates the problem.

**STOP.**

The “Engine Running Output” activates when the engine is running. This can be used to prevent the engagement of the starter motor while the engine is running. The ECM can be connected to a relay that disables the starter. The relay is normally closed so cranking can be achieved immediately at powerup. During cranking, the ECM energizes the “Engine Running Output” once engine rpm reaches 50 rpm below low idle. The output is de-energized when the engine speed falls by 100 rpm below the programmed low idle. The low idle rpm is programmable. The range for low idle is between 600 rpm and 750 rpm.

i01637520

## Engine Running Output Circuit - Test

**SMCS Code:** 1901-038

### System Operation Description:

### Use this procedure under the following situation:

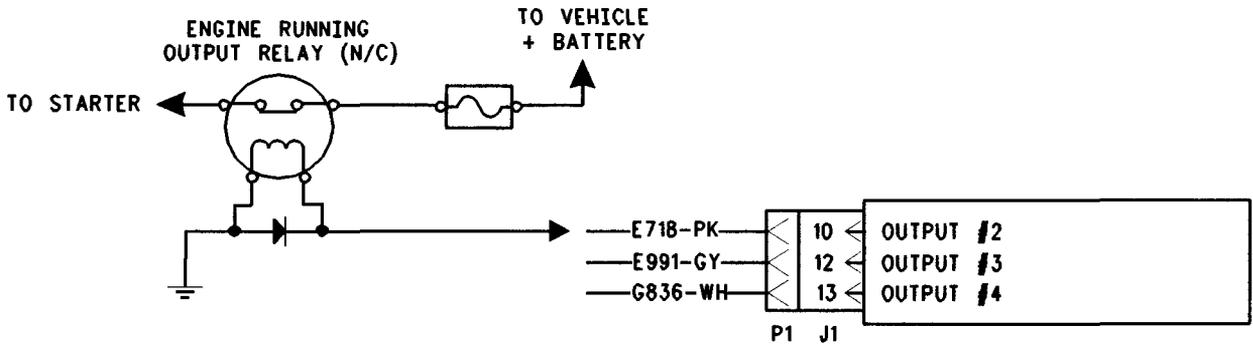
The engine running output circuit is suspected of incorrect operation.

### The following background information is related to this procedure:

#### Engine Running Output

The “Engine Running Output” can be programmed to J1/P1:10, J1/P1:12, or J1/P1:13. The “Engine Running Output” will function on the following corresponding output that is selected:

- ECM Connector J1/P1:10
- ECM Connector J1/P1:12
- ECM Connector J1/P1:13



NOTE: ENGINE RUNNING OUTPUT PARAMETER MUST BE PROGRAMMED TO THE OUTPUT SELECTION. OUTPUT 2, 3, OR 4 MAY BE USED.

Illustration 106

g00656153

Circuit for engine running output

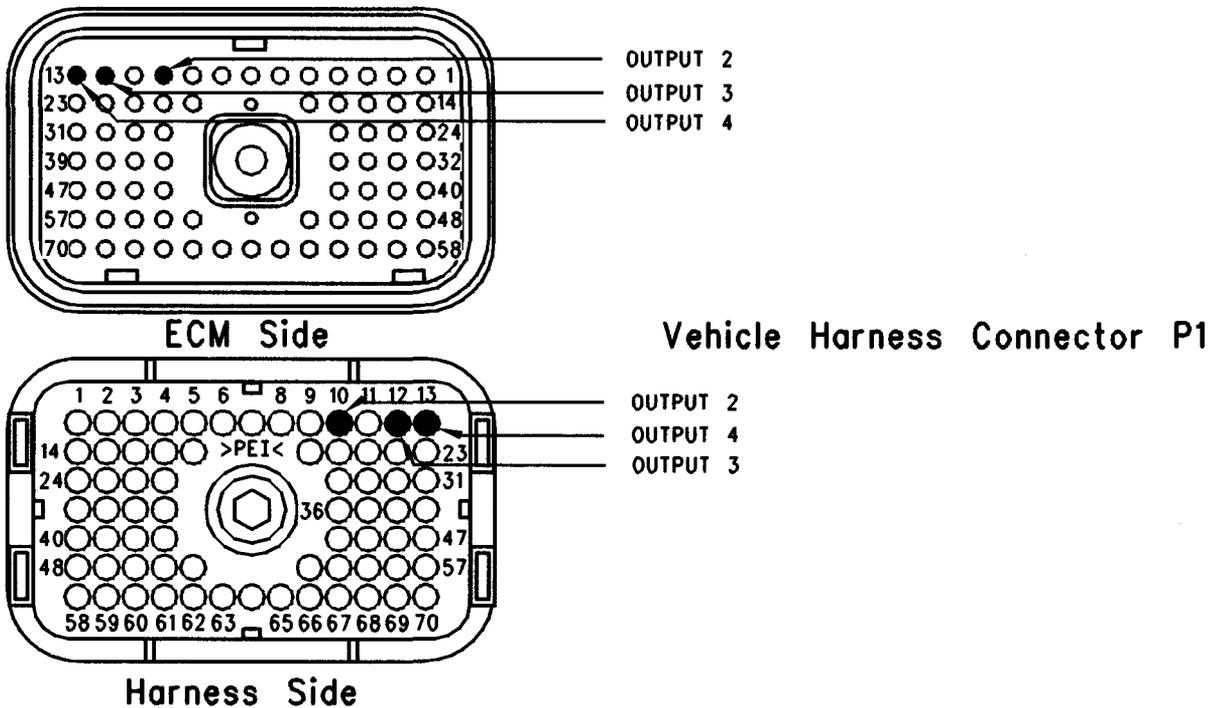


Illustration 107

g00656156

Terminal locations for ECM

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

**A.** Thoroughly inspect ECM vehicle harness connector J1/P1, and the firewall bulkhead connector. Refer to Troubleshooting, "Electrical Connectors - Inspect" for details.

**B.** Perform a 45 N (10 lb) pull test on terminal 10, terminal 12, or terminal 13 in the ECM connector.

Refer to Illustration 107.

**C.** Check the ECM connector (allen head screw) for the proper torque of 6.0 N-m (55 lb in).

- D.** Check the harness and wiring for abrasion and pinch points from the sensor to the ECM.

**Expected Result:**

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

**Results:**

- **OK** – Proceed to Test Step 2.
- **Not OK** – Repair the wiring or replace the wiring, if necessary. Repair the connectors or replace the connectors, if necessary. Ensure that all of the seals are in the proper place. Ensure that all of the connectors are connected properly. Verify that the repair eliminates the problem. **STOP**.

**Test Step 2. Ensure Correct Parameter Programming**

- A.** Connect the Caterpillar Electronic Technician (ET) to the cab data link connector.
- B.** Turn the ignition key switch to the ON position.
- C.** Access the customer specified parameter screen in order to make sure that the ECM is programmed to use the “Engine Running Output”.
- D.** Ensure that the “Engine Running Output” circuit is connected to the programmed output.

**Expected Result:**

The circuit is connected to the correct ECM terminal that is selected for the “Engine Running Output”.

**Results:**

- **OK** – Proceed to Test Step 3.
- **Not OK** – Update the customer specified parameter in order to match the correct output terminal. **STOP**.

**Test Step 3. Use ET to Check the Relay**

- A.** Turn the ignition key switch to the ON position.
- B.** Access the “Engine Running Output Special Test” on ET. The “Engine Running Output Special Test” will enable the “Engine Running Output” when the test is active.

- C.** Begin the “Engine Running Output Special Test” and listen for the relay to click. You may need to be near the engine in order to hear the click.

**Expected Result:**

The relay will activate when the special test is turned “On”.

**Results:**

- **OK** – The ECM and vehicle components are operating correctly. **STOP**.
- **Not OK** – Proceed to Test Step 4.

**Test Step 4. Use ET to Check the ECM**

- A.** Connect ET to the cab data link connector.
- B.** Turn the ignition key switch to the OFF position.
- C.** Disconnect the ECM vehicle harness connector J1/P1.
- D.** Connect a 70-Terminal Breakout T between ECM connectors J1 and P1.
- E.** If the “Engine Running Output” is programmed to J1/P1:10, connect a voltage test lamp to terminal 10 (Output 2) and terminal 65 (-Battery) of the breakout T.
- F.** If the “Engine Running Output” is programmed to J1/P1:12, connect a voltage test lamp to terminal 12 (Output 3) and terminal 65 (-Battery) of the breakout T.
- G.** If the “Engine Running Output” is programmed to J1/P1:13, connect a voltage test lamp to terminal 13 (Output 4) and terminal 65 (-Battery) of the breakout T.
- H.** Turn the ignition key switch to the ON position.
- I.** Access the appropriate “Engine Running Output Special Test” on ET.
- J.** Cycle the corresponding “Engine Running Output Special Test” to the ON position and to the OFF position and watch the voltage test lamp.
- K.** Stop the special test.

**Note:** A multimeter can not be used in place of the voltage test lamp when the ECM outputs are being tested.

**Expected Result:**

The voltage test lamp turns on when the "Engine Running Output Special Test" is active. The voltage test lamp also turns off when the "Engine Running Output Special Test" is not active.

**Results:**

- **OK** – The ECM is OK. The problem is in the vehicle wiring. Inspect the vehicle wiring and then repair the vehicle wiring. Otherwise, send the vehicle to the OEM dealer for repair. Verify that the original condition is resolved. **STOP**.
- **Not OK** – Temporarily connect a test ECM. Use the "Engine Running Output Special Test" on ET to check the ECM. If the problem is resolved with the test ECM, install the suspect ECM. If the problem returns with the suspect ECM, replace the ECM. Verify that the repair eliminates the problem. **STOP**.

i01637482

## Engine Shutdown Output Circuit - Test

**SMCS Code:** 1901-038**System Operation Description:****Use this procedure under the following situation:**

The Engine Shutdown Output Circuit is suspected of incorrect operation.

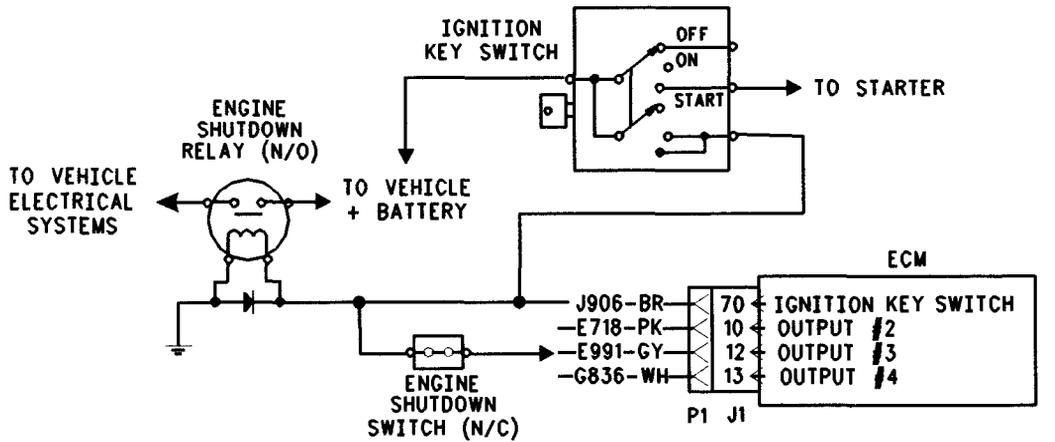
**The following background information is related to this procedure:****Shutdown Output**

The "Engine Shutdown Output" can be programmed to J1/P1:10, J1/P1:12, or J1/P1:13.

The "Engine Shutdown Output" will function on the corresponding Output that is selected:

- ECM Connector J1/P1 Terminal 10
- ECM Connector J1/P1 Terminal 12
- ECM Connector J1/P1 Terminal 13

The shutdown output allows the ECM to shut down portions of the vehicle's electrical system at shutdown. This reduces the consumption of electrical power (battery draw) after the truck is shut down. The system activates a normally open relay (Shutdown Output Relay) when the engine begins running. This permits the driver to turn the ignition key switch to the OFF position without causing the engine to shutdown. When the Idle Shutdown Timer completes the countdown and the Idle Shutdown Timer shuts down the engine, the ECM turns off the relay. This interrupts the power to the ECM. The current draw on the batteries is then dependent on the items that are not powered through the Shutdown Output Relay Circuit.



NOTE: ENGINE SHUTDOWN OUTPUT PARAMETER MUST BE PROGRAMMED TO THE OUTPUT SELECTION. OUTPUT 2, 3, OR 4 MAY BE USED.

Illustration 108  
Circuit for shutdown output

g00656155

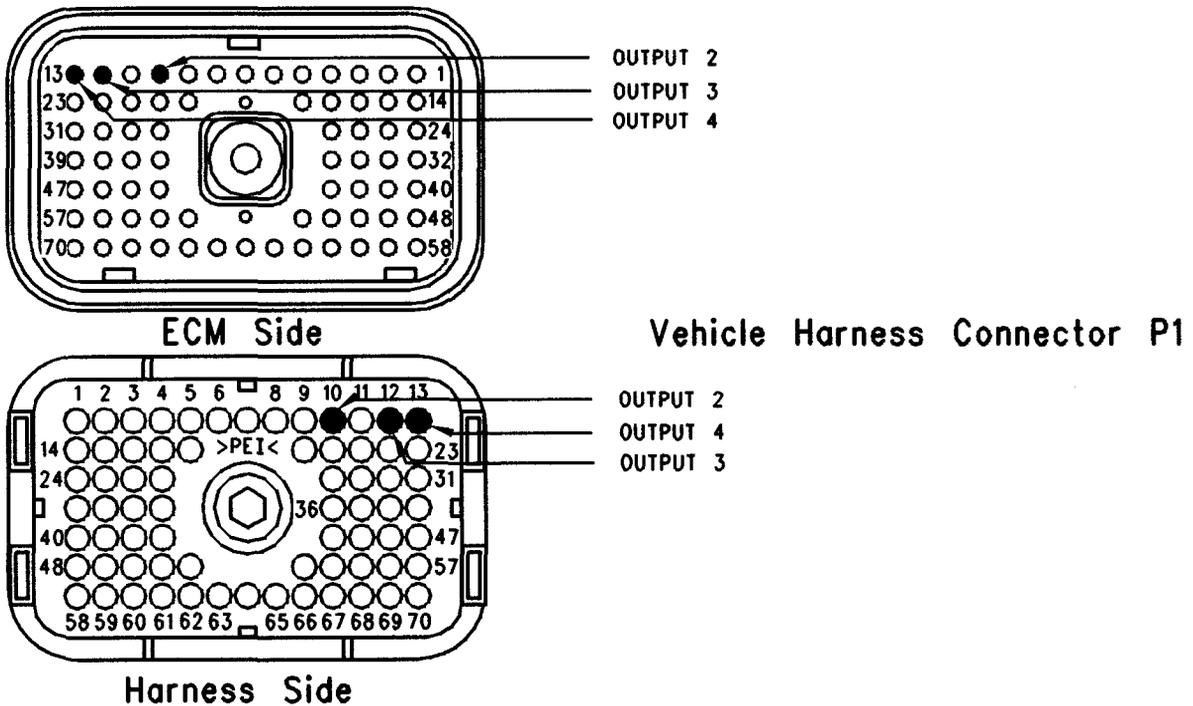


Illustration 109  
Terminal locations for ECM

g00656156

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

**A.** Thoroughly inspect ECM vehicle harness connector J1/P1, and the firewall bulkhead connector. Refer to Troubleshooting, "Electrical Connectors - Inspect" for details.

**B.** Perform a 45 N (10 lb) pull test on terminal 10, terminal 12, or terminal 13 in the ECM connector.

Refer to Illustration 109.

- C. Check the ECM connector (allen head screw) for the proper torque of 6.0 N·m (55 lb in).
- D. Check the harness and wiring for abrasion and pinch points from the sensor to the ECM.

**Expected Result:**

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

**Results:**

- OK – Proceed to Test Step 2.
- Not OK – Repair the wiring or replace the wiring, if necessary. Repair the connectors or replace the connectors, if necessary. Ensure that all of the seals are in the proper place. Ensure that all of the connectors are connected properly. Verify that the repair eliminates the problem. STOP.

**Test Step 2. Check the Programmable Parameters**

- A. Connect the Caterpillar Electronic Technician (ET) to the cab data link connector.
- B. Turn the ignition key switch to the ON position.
- C. Access the customer specified parameter screen in order to make sure that the ECM is programmed to use the engine shutdown output.
- D. Ensure that the circuit for the engine shutdown output is connected to the programmed output.

**Expected Result:**

The circuit is connected to the correct ECM terminal that is selected for the “Engine Shutdown Output”.

**Results:**

- OK – Proceed to Test Step 3.
- Not OK – Update the customer specified parameter in order to match the correct output terminal. STOP.

**Test Step 3. Connect ET in order to Check the Relay**

- A. Turn the ignition key switch to the ON position.
- B. Access the “Engine Shutdown Output Special Test” on ET. The “Engine Shutdown Output Special Test” will enable the “Engine Shutdown Output” when the test is active.

- C. While you listen for the relay to click, begin the “Engine Shutdown Output Special Test”.

**Note:** You may need to be near the relay in order to hear the click.

**Expected Result:**

The relay activates when the special test is enabled.

**Results:**

- OK – The ECM and vehicle components are operating correctly. STOP.
- Not OK – Proceed to Test Step 4.

**Test Step 4. Use ET to Check the ECM**

- A. Connect ET to the cab data link connector.
- B. Turn the ignition key switch to the OFF position.
- C. Disconnect the ECM vehicle harness connector J1/P1.
- D. Connect a 70 Terminal Breakout T between connectors J1 and P1.
- E. If the “Engine Shutdown Output” is programmed to J1/P1:10, connect a voltage test lamp to terminal 10 (Output 2) and terminal 65 (-Battery) of the breakout T.
- F. If the “Engine Shutdown Output” is programmed to J1/P1:12, connect a voltage test lamp to terminal 12 (Output 3) and terminal 65 (-Battery) of the breakout T.
- G. If the “Engine Shutdown Output” is programmed to J1/P1:13, connect a voltage test lamp to terminal 13 (Output 4) and terminal 65 (-Battery) of the breakout T.
- H. Turn the ignition key switch to the ON position.
- I. Access the “Engine Shutdown Special Test” on ET.
- J. While you monitor the voltage test lamp, cycle the “Special Test” from the ON position to the OFF position back to the ON position.
- K. Stop the “Special Test”.

**Note:** A multimeter can not be used in place of the voltage test lamp when the ECM outputs are being tested.

**Expected Result:**

The voltage test lamp turns on when the "Engine Shutdown Output Special Test" is active. The voltage test lamp turns off when the "Engine Shutdown Output Special Test" is not active.

**Results:**

- **OK** – The ECM is operating correctly. The problem is in the vehicle wiring. Inspect the vehicle wiring and then repair the vehicle wiring. Otherwise, send the vehicle to the OEM dealer for repair. Verify that the original condition is resolved. **STOP**.
- **Not OK** – Temporarily connect a test ECM. Use "Engine Shutdown Output Special Test" on ET to check the ECM. If the problem is resolved with the test ECM, install the suspect ECM. If the problem returns with the suspect ECM, replace the ECM. Verify that the repair eliminates the problem. **STOP**.

i01907625

## Engine Speed/Timing Sensor Circuit - Test

**SMCS Code:** 1912-038

**System Operation Description:****Use this procedure under the following situation:**

- There is an active diagnostic code or an easily repeated diagnostic code that is associated with either the primary engine speed/timing sensor or the secondary engine speed/timing sensor.
- You have been directed to this test from Troubleshooting, "Troubleshooting without a Diagnostic Code".

**The following background information is related to this procedure:**

The engine uses two engine speed/timing sensors. One sensor picks up the camshaft gear and the other sensor picks up the crankshaft gear. Both of the engine speed/timing sensors detect the reference for engine speed and timing from a unique pattern on the gear. The ECM counts the time between pulses that is created by the sensor as the gear rotates in order to determine rpm.

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

After locating the No. 1 cylinder, the ECM triggers each injector in the correct firing order and at the correct unit injector timing. The actual timing and duration of each injection is based on engine rpm and load. If the engine is running and the signal from the primary engine speed/timing sensor is lost, a slight change in engine performance will be noticed when the ECM performs the changeover to the secondary engine speed/timing sensor. Loss of the signal from the secondary engine speed/timing sensor during engine operation will not result in any noticeable change in engine performance. However, if the signal from the secondary engine speed/timing sensor is not present during start-up the following conditions may exist:

- The engine may require a slightly longer period of time to start-up.
- The engine may run rough for a few seconds until the ECM determines the proper firing order by the use of the primary engine speed/timing sensor only.

The engine will start and the engine will run when only one sensor signal is present from either of the sensors. The loss of the signal from both of the sensors during engine operation will result in the termination of injection and the shutting down the engine by the ECM. The loss of the signal from both of the sensors during start-up will prevent the engine from starting.

Both sensors are magnetic sensors. The two sensors are not interchangeable. Do not switch the positions of the sensor. If the sensors are replaced, a timing calibration is NOT necessary for the engine. **Timing calibration is only necessary after replacing an ECM that will not communicate.**

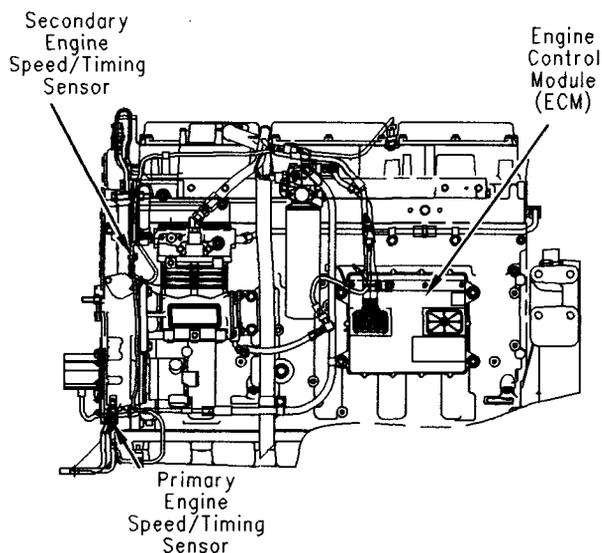


Illustration 110  
C-10 and C-12 Engine  
Left side engine view  
g00994866

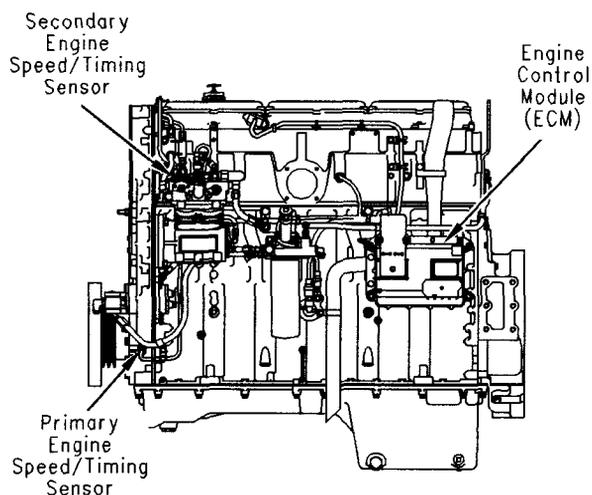


Illustration 112  
C-15, C-16 and C-18 Engine  
Left side engine view  
g00994867

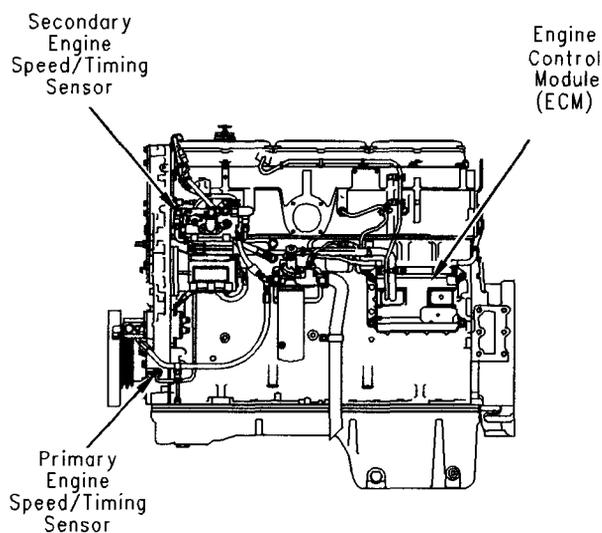


Illustration 111  
3406E Engine  
Left side engine view  
g00995766

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

**When the sensors are being installed, complete all of the following tasks:**

- Lubricate the O-ring with oil.
- Ensure that the sensor has a connector face seal inside the connector body. If a seal is damaged or missing, replace the seal.
- Ensure that the sensor is fully seated into the engine before tightening the bracket bolt.
- Ensure that the connector is latched on both sides.
- Ensure that the harness is properly secured, and ensure that the tie-wraps are placed in the correct location.

**Intermittent Faults That Are Due To The Wiring Harness Terminals**

A problem with the engine wiring harness has been identified. This problem may cause the ECM to detect several intermittent speed signal conditions on the following engines:

- **C-10** (3CS00001-05369)
- **C-12** (2KS00001-15070)
- **3406E** (1MM00390-00838)
- **3406E** (2WS08900-20705)

If the intermittent condition occurs, the ECM will log the following diagnostic codes:

- 190-12 Primary Engine Speed loss of signal
- 64-12 Secondary Engine Speed loss of signal

The occurrence of these faults generally has no effect on engine performance, although the faults are occasionally accompanied by a speed burp of the engine.

Measure the sensor resistance through the engine harness, when both of the following conditions are met:

- The engine falls within the serial number ranges that are listed above.
- The engine has logged several 190-12 and/or 64-12 fault codes.

If the speed/timing sensors have the correct resistance, perform the following procedure in order:

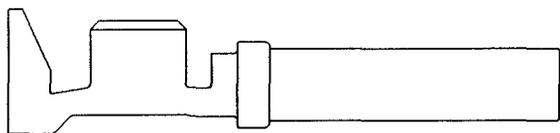


Illustration 113

g00660038

Socket that is stamped and formed

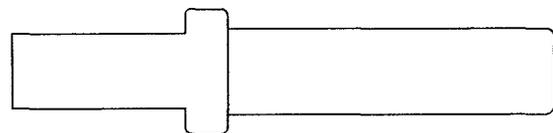


Illustration 114

g00660039

Socket that is machined

- Remove one of the terminals of the harness socket from the connector for the engine speed/timing sensor P401 or P402. The sockets that are present at the sensor end of the wiring harness will be one of two types. The socket will be either a socket that is stamped and formed or a socket that is machined. The socket that is stamped and formed will have fingers that are crimped onto the wire insulation. Refer to Illustration 113. The socket that is machined can only be crimped onto the electrical conductor or wire. Refer to Illustration 114.
- If the sockets that are stamped and formed are present in the sensor harness connectors, the sockets must be cut back at the sensor harness ends of the sensor harness for the engine speed/timing sensors, and each socket must be replaced by an 8T-8730 Connector Socket that is machined. The socket terminals in the connector assembly should be removed from the 2-pin connector. The 2-pin connector is a Deutsch DT-2 connector. The socket terminals should be changed, and reinserted. Perform this procedure on each wire one at a time in order to eliminate the chance of reversing the polarity of the connection. If machined terminals are already installed in the sensor harness connectors for the engine speed/timing sensors, resume troubleshooting at Test Step 3.
- There is generally sufficient wire length in the engine harness in order to perform this repair. Cut back the socket terminals close to the ends of the sensor wires. Leave the wire as long as possible.
- The wire tie-wraps for the speed-timing sensor harness can be loosened and the slack in the harness can be pushed toward the sensor, if necessary. Maintain at least 1 twist per inch in the speed-timing sensor harnesses from the ECM to the sensor.
- Ensure that the wiring is not pulled too tightly at the sensor connector. If the wiring is pulled too tightly at the sensor connector, intermittent connections may develop as vibrations occur.
- While this service is being performed on the C-10 and the C-12 engines, ensure that the wire tie-wrap for the primary engine speed/timing sensor on the engine front support is snug. This tie dampens excessive movement of the sensor wires during normal engine operation. If the wire tie-wrap for the harness is damaged or missing, install a new tie approximately 102 mm (4 inch) from the sensor.
- Ensure that the software that is installed in the ECM is dated no earlier than March 1999. If the software is dated earlier than March 1999, flash the latest software into the ECM. Clear all of the fault codes that are related to the engine speed/timing sensors.

- Do Not replace the engine speed/timing sensors. To check the work that has been performed, start the engine and disconnect the primary engine speed/timing sensor. A slight speed burp may occur when the primary engine speed/timing sensor is disconnected. If the engine runs properly and the primary engine speed/timing sensor is disconnected, the engine repair has been accomplished without reversing the polarity of the wiring.

**Note:** If the above installation is not performed one wire at a time, the polarity of the wiring can accidentally be reversed. If the polarity of the wire for the secondary engine speed/timing sensor is reversed, the engine may start. The engine will run adequately until a failure of the primary engine speed/timing sensor occurs. At this point, the engine will run poorly. If the polarity of the wire for the primary engine speed/timing sensor is reversed, the engine may not start. If the polarities of both the engine speed/timing sensors are reversed, the engine will not start.

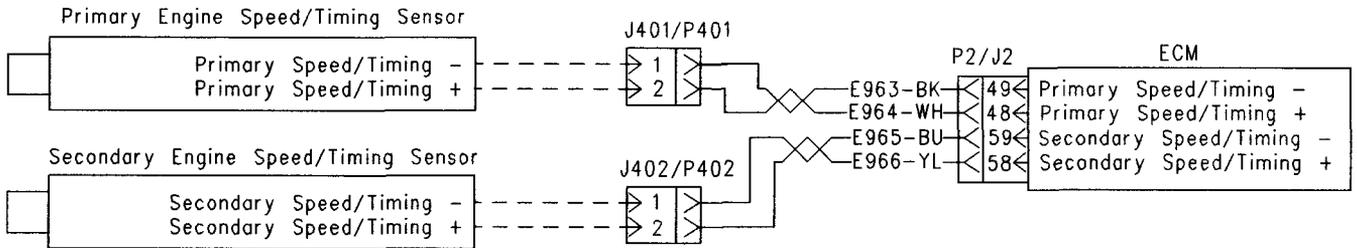


Illustration 115

g00955785

Schematic for engine speed/timing sensors

P2 ECM Connector

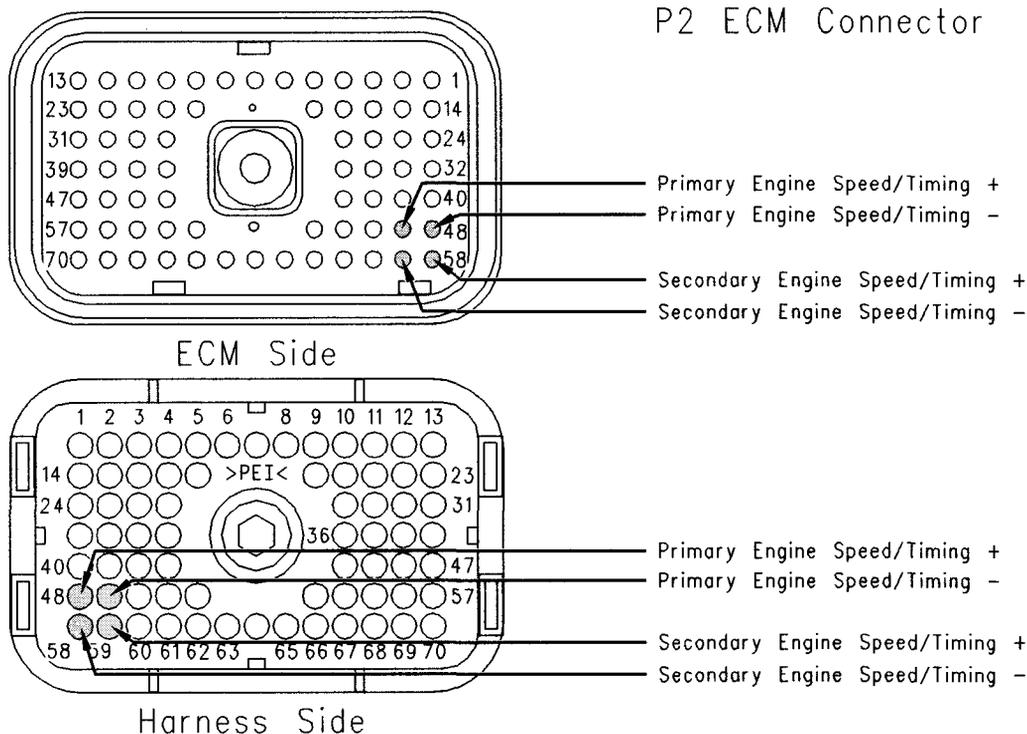


Illustration 116  
P2 ECM connector

g00956357

**Test Step 1. Check for Diagnostic Codes**

- A. Connect the Caterpillar Electronic Technician (Cat ET) to the data link connector.
- B. Turn the key switch to the ON position.
- C. Check for one of the following logged diagnostic codes or active diagnostic codes:
  - 22-11 Primary to Secondary Engine Speed Signal Calibration
  - 64-12 Secondary Engine Speed loss of signal
  - 190-12 Primary Engine Speed loss of signal

**Note:** If the diagnostic code is logged but not active, run the engine until the engine is at normal operating temperature. The problem may only occur when the engine is at the normal operating temperature. If the engine will not start, monitor the engine rpm on Cat ET while the engine is being cranked. Cat ET may need to be powered from another battery while the engine is being cranked. This is done in order to ensure that Cat ET does not reset.

**Note:** If there are occurrences of the 64-12 and 190-12 faults, refer to the following information in the System Operation Section:

- Intermittent Faults That Are Due To The Wiring Harness Terminals

**Expected Result:**

One or more of the diagnostic codes that are listed above are logged or active.

**Note:** If you have been directed here from Troubleshooting, "Troubleshooting without a Diagnostic Code" for the following reason, select "No Engine rpm":

- The engine rpm was not indicated on Cat ET.

**Results:**

- **64-12, 190-12 or 22-11** – There is an active diagnostic code or a logged diagnostic code. Proceed to Test Step 3.
- **Not OK** – If none of the codes that are listed are active diagnostic codes or logged diagnostic codes and the engine is not running properly, refer to the appropriate symptoms in the service manual. **STOP.**

- No Engine rpm – Engine rpm is not indicated on Cat ET. Proceed to Test Step 2.

## Test Step 2. Check the Installation of the Sensors and the Bracket

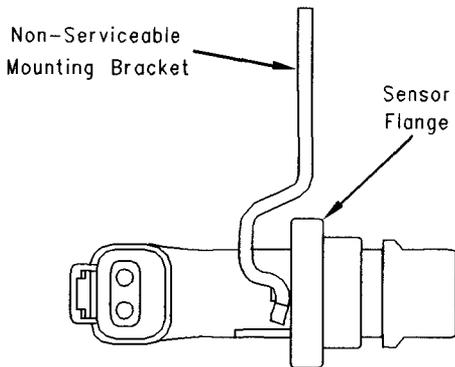


Illustration 117

g00956355

### Flange of the sensor and mounting bracket

- A.** The flange of the sensor should be flush against the engine in order to ensure proper operation.
- B.** Inspect the bracket in order to ensure that the installation allows the flange of the sensor to be flush against the engine.

Verify that the bracket is not bent.

**Note:** The bracket cannot be replaced separately.

- C.** Ensure that one O-ring has been installed on the sensor, and ensure that the O-ring is free of damage.

- D.** If the following diagnostic code is active, there may be a problem with the assembly of the engine:

- 22-11 Primary to Secondary Engine Speed Signal Calibration

Refer to Illustration 117.

### Expected Result:

The sensors and the bracket are properly installed.

### Results:

- OK – The sensors and the bracket are properly installed. Proceed to Test Step 3.

- Not OK

**Repair:** Perform the following procedure in order to properly install the sensors and the bracket:

1. Loosen the bolt that holds the sensor mounting bracket to the engine.

2. Seat the sensor and tighten the bolt.

If the sensor will not seat, repair the sensor or replace the sensor, as required.

**Note:** The sensor must not be removed from the bracket.

3. Ensure that the sensor is properly oriented and that the harness is secured in the proper location.
4. Verify that the repair eliminates the problem.

STOP.

## Test Step 3. Measure the Sensor Resistance Through the Engine Harness

- A.** Turn the key switch to the OFF position.
- B.** Thoroughly inspect the J2/P2 ECM connector. Refer to Troubleshooting, "Electrical Connectors - Inspect" for details.
- C.** Perform a 45 N (10 lb) pull test on the following wires in the P2 ECM connector that are associated with the engine speed/timing sensors:
  - Terminal 48
  - Terminal 49
  - Terminal 58
  - Terminal 59

Refer to Illustration 116.

- D.** Ensure that the latch tab on the connector is properly latched and ensure that the latch tab is fully latched.
- E.** Check the ECM connector (allen head screw) for the proper torque of 6.0 N-m (55 lb in).
- F.** Repair the harness or repair the connector if a problem is found.
- G.** Ensure that the wiring harness is correctly routed and secured at the proper locations.
- H.** Ensure that the harness wiring is not pulled too tightly. When the harness wiring is pulled too tightly, vibrations or movement can cause intermittent connections.
- I.** Inspect the harness wiring for nicks and abrasions.
- J.** If the harness and the connector are OK, disconnect ECM connector J2/P2.

**K. Primary engine speed/timing sensor**

Refer to Illustration 116.

- a. Use a multimeter to measure the sensor resistance (Ohms) between P2:48 (Primary Speed/Timing Positive) and P2:49 (Primary Speed/Timing Negative).
- b. Check for an intermittent open circuit or short circuit by moving the harness while the measurement for resistance is being taken. Pull the wires that are directly behind the sensors or shake the wires that are directly behind the sensors.

Resistance ..... 75.0 to 230.0 Ohms

**L. Secondary engine speed/timing sensor**

Refer to Illustration 116.

- a. Use a multimeter to measure the sensor resistance (Ohms) between P2:58 (Secondary Speed/Timing Positive) and P2:59 (Secondary Speed/Timing Negative).
- b. Check for an intermittent open circuit or short circuit by moving the harness while the measurement for resistance is being taken. Pull the wires that are directly behind the sensors or shake the wires that are directly behind the sensors.

Resistance ..... 600 to 1800 Ohms

**Expected Result:**

The readings agree with the values that are listed above.

**Results:**

- OK – Neither a short circuit nor an open circuit is indicated. Proceed to Test Step 5.
- Not OK – The sensor resistance is not within the acceptable range when the sensor resistance is measured through the engine harness. Proceed to Test Step 4.

**Test Step 4. Measure the Resistance of the Sensor at the Sensor**

- A.** Turn the key switch to the OFF position.
- B.** Check the harness and the wiring for abrasion and pinch points from the sensor back to the ECM.

- C.** Disconnect the suspect sensor from the engine harness.

- D.** Thoroughly inspect J401/P401 or J402/P402 connectors. Refer to Troubleshooting, "Electrical Connectors - Inspect" for details.

**E. Primary engine speed/timing sensor**

- a. Use a multimeter to measure the sensor resistance (Ohms) between J401:2 (Primary Speed/Timing Positive) and J401:1 (Primary Speed/Timing Negative).

Resistance ..... 75.0 to 230.0 Ohms

**F. Secondary engine speed/timing sensor**

- a. Use a multimeter to measure the sensor resistance (Ohms) between J402:2 (Secondary Speed/Timing Positive) and J402:1 (Secondary Speed/Timing Negative).

Resistance ..... 600 to 1800 Ohms

**Note:** Timing calibration is not necessary following replacement of the engine speed/timing sensors. Refer to the information in the System Operation Section regarding the installation of sensors.

**Expected Result:**

The readings agree with the values that are listed above.

**Results:**

- OK – The sensor resistance is correct. Proceed to Test Step 5.
- Not OK – The sensor resistance is out of the range.

**Repair:** Perform the following procedure in order to check and install the new sensor:

- 1.** Before installing the new sensor, measure the resistance of the new sensor.

If the new sensor resistance is in the correct range, install the new sensor in the engine, as follows:

- a. Loosen the bolt that holds the sensor mounting bracket to the engine.
- b. Ensure that one O-ring is installed and free of damage.
- c. Seat the sensor and tighten the bolt.

If the sensor will not seat, repair the sensor or replace the sensor, as required.

**Note:** The sensor must not be removed from the bracket.

- d. Ensure that the sensor is properly oriented and that the harness is secured in the proper location.

2. Verify that the repair eliminates the problem.

STOP.

### Test Step 5. Install the Bypass Harness for the Engine Speed/Timing Sensors

- A. Turn the key switch to the OFF position.
- B. Disconnect the J2/P2 ECM connector.
- C. Use the following procedure for the primary engine speed/timing sensor:
  - a. Install a 16 AWG wire from J2/P2:48 to P401:2.
  - b. Install a 16 AWG wire from J2/P2:49 to P401:1.

**Note:** Twisted pair wiring is required. Ensure that the wires have at least one twist per inch.

- D. Use the following procedure for the secondary engine speed/timing sensor:
  - a. Install a 16 AWG wire from J2/P2:58 to P402:2.
  - b. Install a 16 AWG wire from J2/P2:59 to P401:1.

**Note:** Twisted pair wiring is required. Ensure that the wires have at least one twist per inch.

- E. Reconnect the J2/P2 ECM connector.
- F. Start the engine in order to determine if the bypass harness repairs the problem.

#### Expected Result:

The problem is corrected with the installation of the bypass harness.

#### Results:

- OK

**Repair:** Permanently install a new section of harness.

STOP.

- Not OK

**Repair:** Verify that the correct terminals have been installed in the correct location of the P2 ECM connector. If the temporary harness was installed correctly, install the original wiring.

Proceed to Test Step 6.

### Test Step 6. Check the ECM

- A. Turn the key switch to the OFF position.
- B. Temporarily connect a test ECM.
- C. Start the engine. Run the engine in order to repeat the conditions when the problem occurs.
- D. If the problem is resolved with the test ECM, reconnect the suspect ECM.
- E. If the problem returns with the suspect ECM, replace the ECM.

Verify that the repair eliminates the problem.

#### Expected Result:

The problem remains with the suspect ECM.

#### Results:

- OK

**Repair:** If the problem is resolved with the test ECM and the problem returns with the suspect ECM, replace the ECM.

Verify that the repair eliminates the problem.

STOP.

- Not OK

**Repair:** Replace the sensor.

Verify that the repair eliminates the problem.

STOP.

i01907626

## Engine Temperature Sensor Open or Short Circuit - Test

**SMCS Code:** 1906-038; 1921-038; 1922-038; 1928-038

#### System Operation Description:

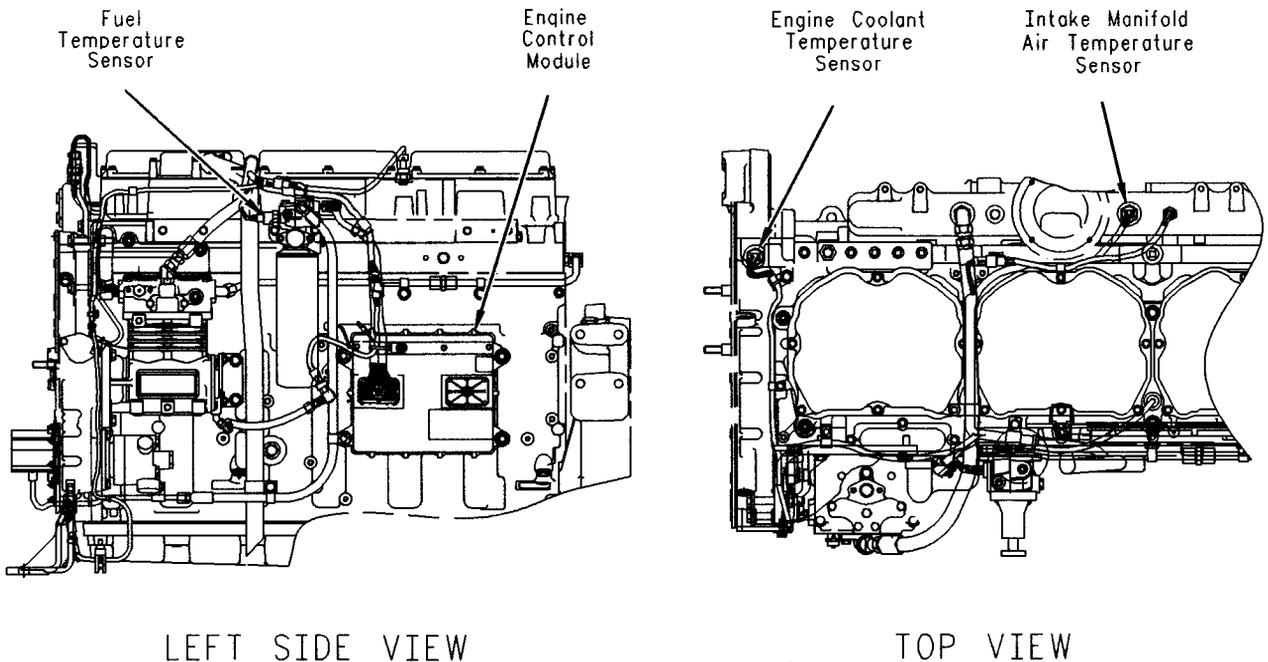
**Use this procedure under the following situation:**

There is an active diagnostic code or a diagnostic code can easily be activated. This procedure covers open circuit diagnostic codes and short circuit diagnostic codes that are associated with the following sensors:

- Coolant Temperature Sensor
- Intake Manifold Air Temperature Sensor
- Fuel Temperature Sensor
- Optional Ambient Air Temperature Sensor

**The following background information is related to this procedure:**

The troubleshooting procedures for the diagnostic codes of each temperature sensor are identical. The temperature sensors are sensors that have two terminals. Terminal 2 is the common wire that is shared between all temperature sensors. The common wire provides a path to ground. Terminal 1 connects to a unique terminal on the J2/P2 ECM connector for each temperature sensor. 5 volts are supplied to the temperature sensor through terminal 1.



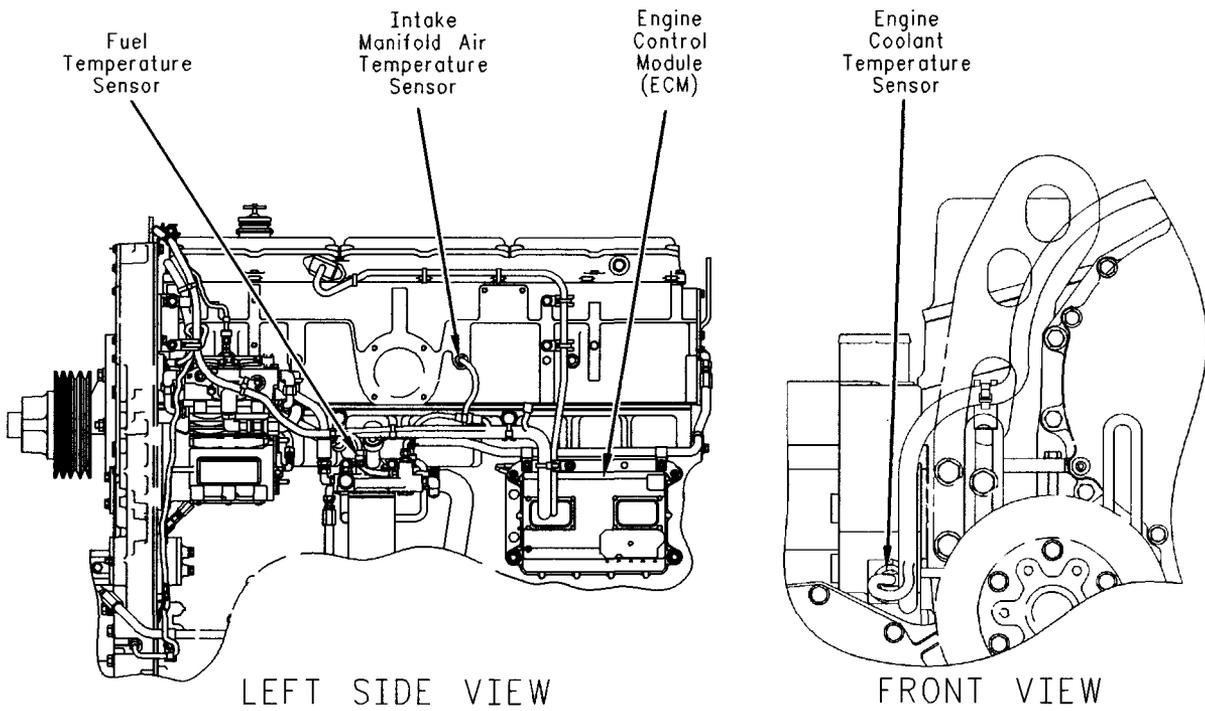


Illustration 119  
3406E Temperature sensors

g00995917

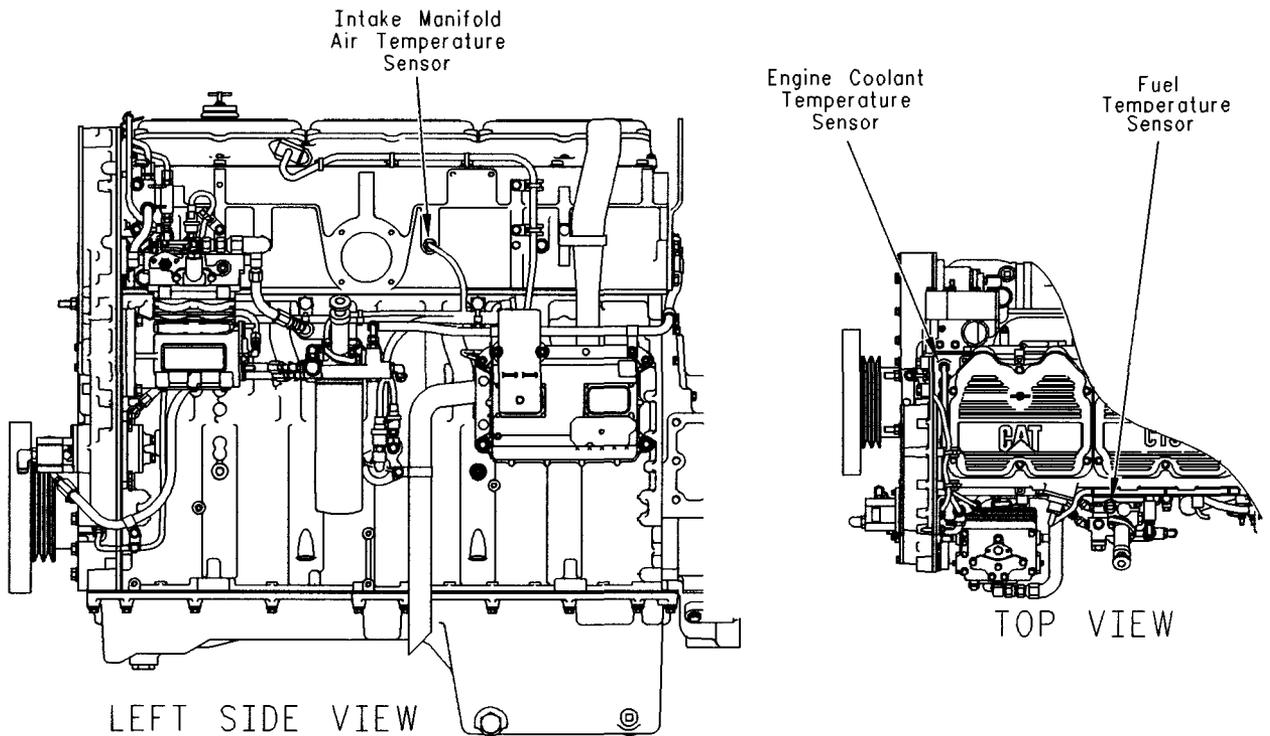


Illustration 120  
C-15, C-16 and C-18 Temperature sensors

g00994860

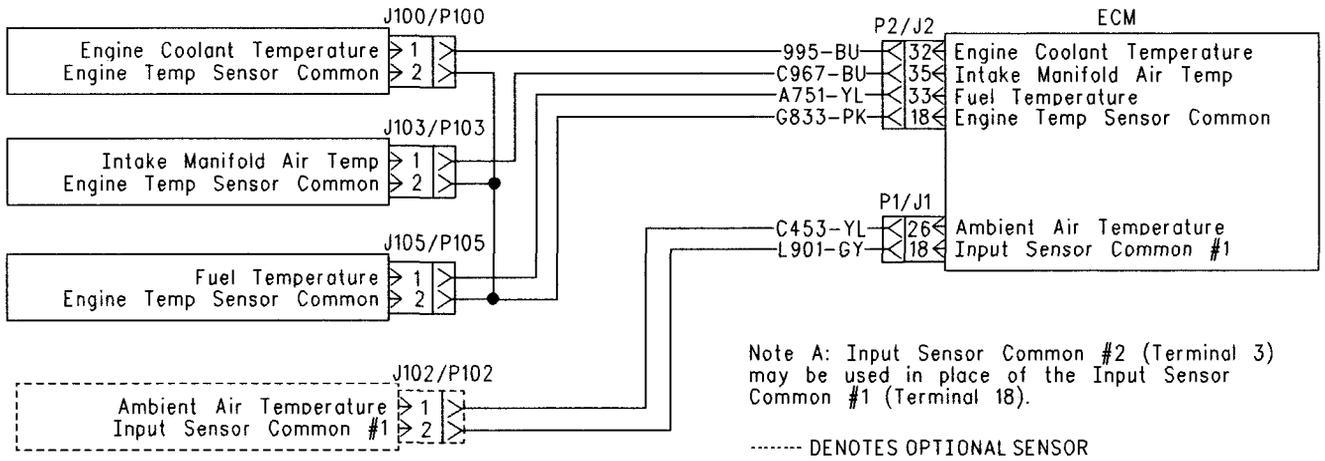


Illustration 121  
 Schematic for engine temperature sensors

g00970545

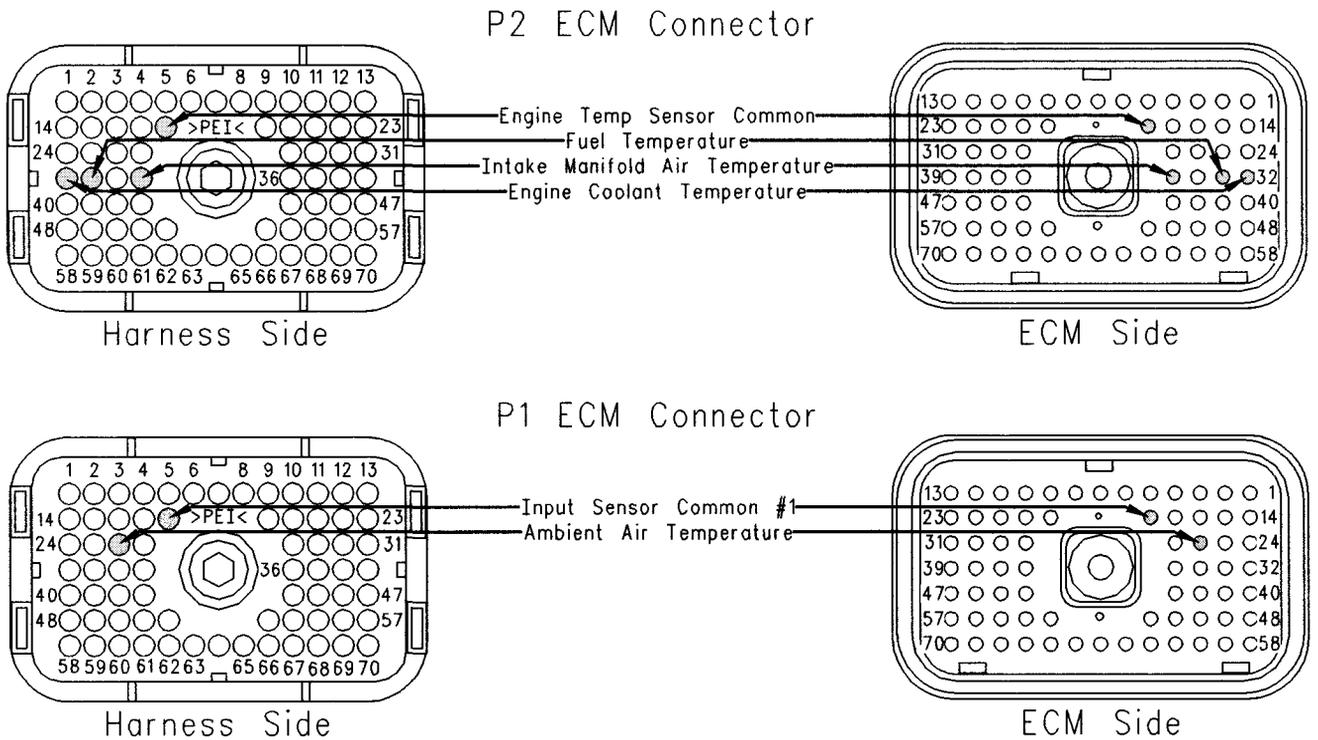


Illustration 122  
 P1 and P2 ECM connectors

g00970546

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

**A.** Thoroughly inspect the J2/P2 ECM connector and the suspect sensor connector. Refer to Troubleshooting, "Electrical Connections - Inspect" for details.

**B.** Perform a 45 N (10 lb) pull test on each of the wires in the sensor connector and the ECM connector that are associated with the active diagnostic code.

- C. Verify that the latch tab of the connector is properly latched and that the latch tab of the connector has returned to the Fully Latching position.
- D. Check the ECM Connector (allen head screw) for the proper torque of 6.0 N·m (55 lb in).
- E. Check the harness and wiring for abrasion and pinch points from the sensor to the ECM.

**Expected Result:**

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

**Results:**

- OK – Proceed to Test Step 2.
- 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. Determine the Condition that is Present**

- A. Connect the electronic service tool to the data link connector.
- B. Turn the key switch to the ON position. Wait at least 15 seconds for activation of the diagnostic codes.
- C. Check for active diagnostic codes on the electronic service tool.
- D. Determine if the problem is related to a “voltage high” diagnostic code (open circuit) or a “voltage low” diagnostic code (short circuit).

**Expected Result:**

A “voltage high” diagnostic code (open circuit) or a “voltage low” diagnostic code (short circuit) is active.

**Results:**

- **Voltage High (Open)** – A “voltage high” diagnostic code (open circuit) is active at this time. Proceed to Test Step 6.

- **Voltage Low (Short)** – A “voltage low” diagnostic code (short circuit) is active at this time. Proceed to Test Step 3.

**Test Step 3. Disconnect the Suspect Sensor**

- A. Turn the key switch to the OFF position.
- B. Disconnect the sensor with the “voltage low” diagnostic code (short circuit).
- C. Turn the key switch to the ON position. Wait at least 15 seconds for activation of the diagnostic codes.
- D. Check for an active “voltage high” diagnostic code (open circuit) on the electronic service tool.

**Expected Result:**

A “voltage high” diagnostic code (open circuit) for the suspect sensor is now active.

**Results:**

- OK – A “voltage high” diagnostic code (open circuit) for the suspect sensor is now active.

**Repair:** Temporarily connect a new sensor.

If the new sensor fixes the problem, reconnect the suspect sensor.

If the problem returns, permanently replace the sensor.

Verify that the repair eliminates the problem.

STOP.

- Not OK – There is a short circuit between the sensor harness connector and the ECM.

**Repair:** Leave the sensor disconnected.

Proceed to Test Step 4.

**Test Step 4. Disconnect the ECM Connector**

- A. Turn the key switch to the OFF position.
- B. Disconnect the J2/P2 ECM connector. Thoroughly inspect both halves of the connector for signs of corrosion or moisture.

**Note:** If the Ambient Air Temperature Sensor is being tested, a 140-2266 Cable (Seventy-Pin Breakout) is required in order to maintain the battery connections.

**C.** Turn the key switch to the ON position. Wait at least 15 seconds for activation of the code.

**D.** Check for active diagnostic codes on the electronic service tool.

**Note:** When the J2/P2 ECM connector is disconnected, all of the “voltage high” diagnostic codes (open circuit) for the temperature sensors will be active. This is normal.

**Expected Result:**

“Voltage high” diagnostic codes (open circuit) are active when the J2/P2 ECM connector is disconnected.

**Results:**

- **OK** – The ECM is working properly.

**Repair:** Leave the ECM connector disconnected.

Proceed to Test Step 5.

- **Not OK** – A “voltage low” diagnostic code (short circuit) is still active for the suspect sensor.

**Repair:** Temporarily connect a test ECM.

If the test ECM fixes the problem, reconnect the suspect ECM.

If the problem returns, permanently replace the suspect ECM.

Verify that the repair eliminates the problem.

**STOP.**

**Test Step 5. Check the Resistance**

**A.** Turn the key switch to the OFF position.

**B.** Verify that the suspect sensor and the ECM connector are disconnected.

**C.** Measure the resistance between terminal 1 and terminal 2 of the sensor connector.

**Expected Result:**

The resistance is greater than 20,000 Ohms or “OL” is displayed on the multimeter.

**Results:**

- **OK** – There is a problem with the supply wire.

**Repair:** Check the supply wire of the suspect sensor for a short to ground.

Repair the faulty wiring or replace the faulty wiring.

Verify that the repair eliminates the problem.

**STOP.**

- **Not OK** – There is a short between the supply wire and the common wire.

**Repair:** Locate the short between the supply wire and the common wire.

Repair the faulty wiring or replace the faulty wiring.

Verify that the repair eliminates the problem.

**STOP.**

**Test Step 6. Create a Short at the Sensor**

**A.** Fabricate a jumper wire 150 mm (6 inch) long.

**B.** Turn the key switch to the ON position.

**C.** Monitor the active diagnostic code screen.

**D.** Install the jumper wire between terminal 1 and terminal 2 of the sensor connector.

**Expected Result:**

A “voltage low” diagnostic code (short circuit) is active when the jumper wire is installed.

**Results:**

- **OK** – A “voltage low” diagnostic code (short circuit) is active.

**Repair:** Temporarily connect a new sensor.

If the new sensor fixes the problem, reconnect the suspect sensor.

If the problem returns, permanently replace the suspect sensor.

Verify that the repair eliminates the problem.

**STOP.**

- **Not OK** – A “voltage high” diagnostic code (open circuit) is still active.

**Repair:** Remove the jumper wire.

Proceed to Test Step 7.

**Test Step 7. Create a Short at the ECM**

- A.** Turn the key switch to the OFF position.
- B.** Disconnect the P2 ECM connector.
- C.** Fabricate a jumper wire 150 mm (6 inch) long.
- D.** Install the jumper wire between the terminal for the sensor supply of the suspect sensor and the terminal for the sensor common.

**Expected Result:**

A "voltage low" diagnostic code (short circuit) is active when the jumper wire is installed.

**Results:**

- **OK** – A "voltage low" diagnostic code (short circuit) is active when the jumper wire is installed.

Repair: Reconnect the P2 ECM connector.

- **Not OK** – A "voltage high" diagnostic code (open circuit) is still active.

Repair: Temporarily connect a test ECM.

If the test ECM fixes the problem, reconnect the suspect ECM.

If the problem returns, permanently replace the suspect ECM.

Verify that the repair eliminates the problem.

STOP.

**Test Step 8. Check the Voltage at the Sensor**

- A.** Turn the key switch to the ON position.
- B.** Verify that the sensor is disconnected.
- C.** Measure the voltage between terminal 1 of the sensor connector and chassis ground.

**Expected Result:**

The voltage should be  $5.0 \pm 0.5$  volts.

**Results:**

- **OK** – The voltage is within the range.

Repair: Check for an open circuit in the common wire.

Repair the faulty wiring or replace the faulty wiring.

Verify that the repair eliminates the problem.

STOP.

- **Not OK** – The voltage is not within the range.

Repair: If the voltage is above 5.5 VDC, check the supply wire for a short to a voltage source.

If the voltage is below 4.5 VDC, check the supply wire for an open circuit.

Repair the faulty wiring or replace the faulty wiring.

Verify that the repair eliminates the problem.

STOP.

i01868212

**Fan Override Switch Circuit - Test**

**SMCS Code:** 7332-038

**System Operation Description:****Use this procedure under the following situation:**

The circuit for the fan override switch is suspected of incorrect operation.

**Note:** This procedure is intended for troubleshooting a fan override switch that is connected to an ECM input circuit. This procedure is not intended for a fan override switch that is installed in the cooling fan output circuit.

**Fan Override Switch**

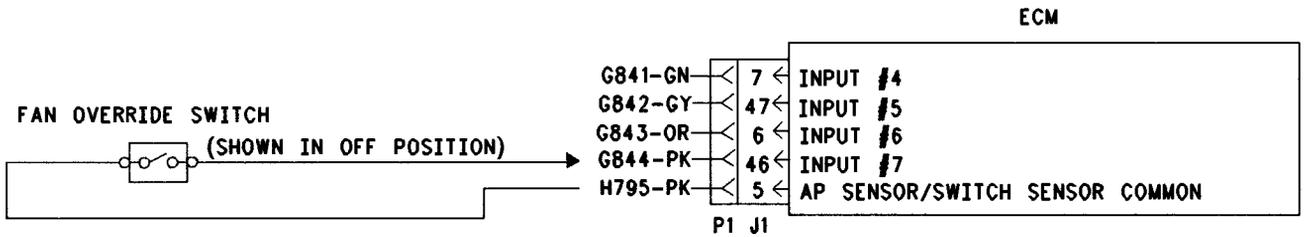
The fan override switch is used to turn on the cooling fan. Using a fan override switch can provide the following benefits:

- Helpful for troubleshooting problems with the cooling fan
- Additional cooling
- Additional braking horsepower under certain operating conditions

The circuit for the fan override switch can be installed on four different inputs. Programming of the "Customer Specified Parameters" is required to select the desired input for the fan circuit. If the "Fan Override Switch" parameter is programmed to "None" (default), this feature is not used. If the "Fan Override Switch" parameter is programmed to one of the available options, then the fan override switch is available. The switch circuit should be connected to the input that was specified. The available options that are for the fan override switch are (J1/P1:7, J1/P1:47, J1/P1:6, J1/P1:46).

**Note:** The wiring for your particular application may be slightly different. The circuits for the sensor common are used interchangeably by the OEM of the vehicle. The following circuits are common within the ECM:

- The "Input Sensor Common 1" is terminal 18.
- The "Input Sensor Common 2" is terminal 3.
- The "AP Sensor/Switch Sensor Common" is terminal 5.



**NOTE: INPUT #4, #5, #6 OR #7 MAY BE USED. THE FAN OVERRIDE SWITCH PARAMETER MUST BE PROGRAMMED TO THE INPUT SELECTION.**

Illustration 123

Schematic for the fan override switch

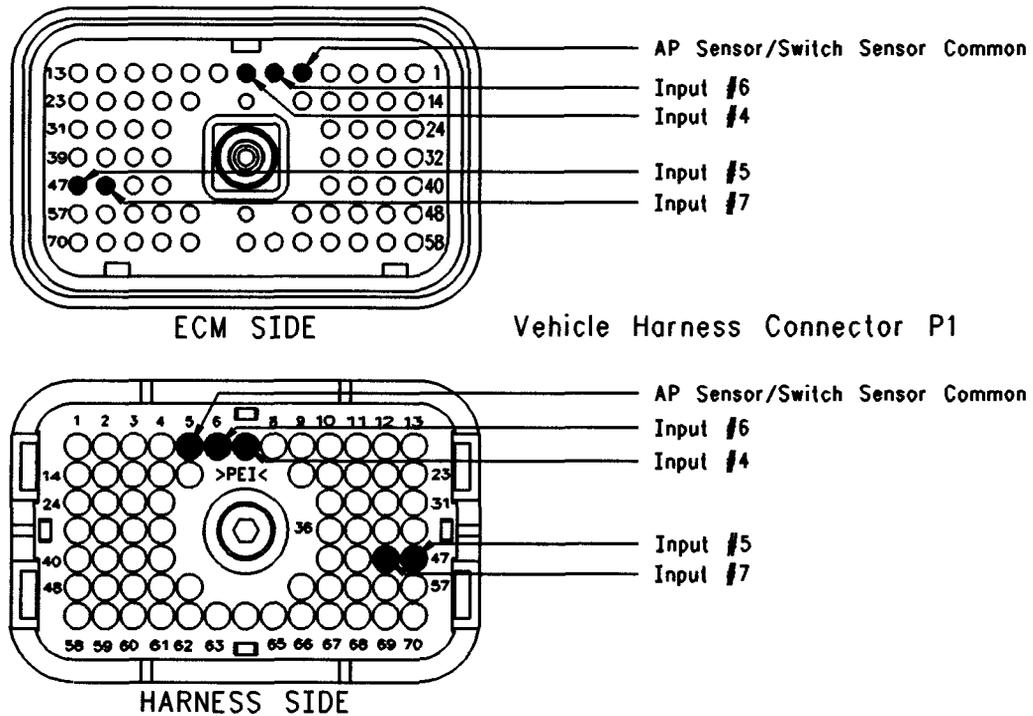


Illustration 124  
 Terminal Locations for the ECM

g00682184

**Test Step 1. Check the Status of the “Fan Override Switch”**

- A. Connect the electronic service tool to the data link connector.
- B. Turn the key switch to the ON position.
- C. Monitor the status for the “Fan Override Switch” while the fan override switch is moved to the ON position and the OFF position.

**Note:** If the status for the “Fan Override Switch” indicates “Not Installed”, then the “Fan Override Switch” parameter has not been programmed.

**Expected Result:**

The status for the “Fan Override Switch” should be “On” when the switch is in the On position. The status for the “Fan Override Switch” should be “Off” when the switch is in the Off position.

**Results:**

- OK – The switch is operating normally. STOP.
- Not OK – The ECM is not reading the change in switch status. Proceed to Test Step 2.

**Test Step 2. Determine the Configuration of the Fan Override Switch**

- A. Determine if the fan override switch is wired directly to the ECM or through the J1939 data link.
- B. Verify that the “Fan Override Switch” parameter is programmed to reflect the proper wiring.

**Expected Result:**

The fan override switch is wired directly to the ECM.

**Results:**

- OK – The fan override switch is wired directly to the ECM. Proceed to Test Step 3.
- Not OK – The fan override switch is wired through the J1939 data link.

**Repair:** Verify that the “Fan Override Switch” parameter is programmed to “J1939 - Body Controller”, “J1939 - Cab Controller”, or “J1939 - Instrument Cluster”.

Refer to Troubleshooting, “Powertrain Data Link Circuit - Test”.

STOP.

### **Test Step 3. Check the Electrical Connectors and the Wiring**

- A.** Thoroughly inspect the J1/P1 ECM connector, the connectors, and the firewall bulkhead connectors. Refer to Troubleshooting, "Electrical Connectors - Inspect" for details.
- B.** Perform a 45 N (10 lb) pull test on each of the wires in the ECM connector that are associated with the suspect switch circuit.
- C.** Check the ECM connector (allen head screw) for the proper torque of 6.0 N·m (55 lb in).
- D.** Check the harness and the wiring for abrasion and pinch points from the battery to the ECM. Then, check from the key switch to the ECM.

Refer to Illustration 124 for terminal locations for the ECM.

#### **Expected Result:**

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

#### **Results:**

- OK – Proceed to Test Step 4.
- Not OK

**Repair:** Repair the wiring and connectors or replace the wiring or the connectors. Ensure that all of the seals are properly connected.

Verify that the repair eliminates the problem.

**STOP.**

### Test Step 4. Check the Switch Circuit for the ECM

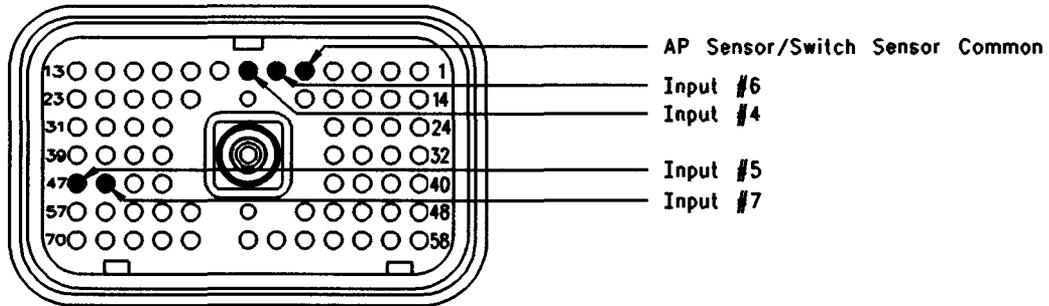


Illustration 125  
 Connector for breakout T

g00682199

- A. Turn the key switch to the OFF position.
- B. Install a 140-2266 Cable (Seventy-Pin Breakout) between the J1 and P1 ECM connectors.
- C. Fabricate a jumper wire 100 mm (4 inch) long. Crimp a Deutsch pin to each end of the wire.
- D. Insert the jumper wire into the suspect switch socket of the breakout T. Connect the other end of the jumper wire to terminal 5 (AP Sensor/Switch Sensor Common) of the breakout T.
- E. Turn the key switch to the ON position.
- F. While the status for the "Fan Override Switch" is monitored, remove the jumper wire and then insert the jumper wire.

**Expected Result:**

The status for the "Fan Override Switch" is "On" when the jumper wire is inserted. The status for the "Fan Override Switch" is "Off" when the jumper wire is removed.

**Results:**

- OK – The ECM is functioning properly at this time.

**Repair:** Remove the breakout T and reconnect the J1 and P1 ECM connectors.

Proceed to Test Step 5.

- Not OK – The ECM is not functioning properly.

**Repair:** Temporarily connect a test ECM. If the problem is resolved with the test ECM, install the suspect ECM. If the problem returns with the suspect ECM, replace the ECM.

Verify that the repair eliminates the problem.

STOP.

### Test Step 5. Insert a Jumper Wire at the Switch

- A. Turn the key switch to the OFF position.
- B. Fabricate a jumper wire 100 mm (4 inch) long. Crimp a Deutsch pin to each end of the wire.
- C. Insert the jumper wire between the two switch terminals of the fan override switch.
- D. Turn the key switch to the ON position.
- E. While the status for the "Fan Override Switch" is monitored, remove the jumper wire and then insert the jumper wire.

**Expected Result:**

The status for the "Fan Override Switch" is "On" when the jumper wire is inserted. The status for the "Fan Override Switch" is "Off" when the jumper wire is removed.

**Results:**

- OK

**Repair:** Replace the fan override switch.

Verify that the repair eliminates the problem.

STOP.

- Not OK – There is a problem in the wire harness between the fan override switch and the ECM. Proceed to Test Step 6.

## Test Step 6. Insert a Jumper Wire at the Bulkhead Connector

- A. Turn the key switch to the OFF position.
- B. Fabricate a jumper wire 100 mm (4 inch) long. Crimp a Deutsch pin to each end of the wire.
- C. Insert the wire jumper pin between the terminals for the fan override switch on the engine side of the ECM bulkhead connector.
- D. Turn the key switch to the ON position.
- E. While the status for the "Fan Override Switch" is monitored, remove the jumper wire and then insert the jumper wire.

### Expected Result:

The status for the "Fan Override Switch" is "On" when the jumper wire is inserted. The status for the "Fan Override Switch" is "Off" when the jumper wire is removed.

### Results:

- OK – The problem is in the vehicle wiring between the bulkhead connector and the switch.

**Repair:** Inspect the vehicle wiring and then repair the vehicle wiring. Otherwise, send the vehicle to the OEM dealer for repair.

Verify that the original condition is resolved.

STOP.

- Not OK – The problem is in the vehicle wiring between the bulkhead connector and the ECM.

**Repair:** Inspect the vehicle wiring and then repair the vehicle wiring. Otherwise, send the vehicle to the OEM dealer for repair.

Verify that the original condition is resolved.

STOP.

i01815718

## Idle Shutdown Timer - Test

**SMCS Code:** 1901-038

### System Operation Description:

**Use this procedure under the following situation:**

The idle shutdown is suspected of incorrect operation.

**The following background information is related to this procedure:**

### "Idle Shutdown Timer"

The "Idle Shutdown Timer" is intended to improve fuel economy by limiting idling time.

The "Idle Shutdown Timer" is a "Customer Specified Parameter" that may be programmed for any period from 3 to 1440 minutes.

The timer is activated when all of the following conditions are met regardless of the position of the parking brake:

- The vehicle speed is 0.
- The engine is not in "Cold Mode" or "Dedicated PTO Mode".
- The engine is not under load.

The timer can be reset by moving the vehicle or the timer can be reset by quickly depressing the accelerator pedal and releasing the accelerator pedal.

The check engine lamp will begin to rapidly flash 90 seconds before the programmed time expires. During this 90 second time period, the following conditions can disable the timer:

- The driver moves the clutch pedal.
- The driver moves the service brake pedal.

The following event code will be logged when the driver overrides the timer by the use of the clutch pedal or the brake pedal during the 90 second period:

- 71-00 Idle Shutdown Override (01)

If the parameter for the "Allow Idle Shutdown Override" is programmed to "NO", the timer can not be overridden by the use of the clutch pedal or the brake pedal during the final 90 second period. "YES" is the factory default that is programmed for the parameter for the "Allow Idle Shutdown Override". The allowance of the override is the default.

With OCT99 and newer software, an additional parameter can be programmed to allow the timer to be reset above a specified engine speed. When the "Idle Shutdown Timer Maximum RPM" parameter is programmed to a value below the Top Engine Limit, the timer can be reset by increasing engine rpm above a programmed limit. The timer will be reset until engine rpm drops below the programmed value. The timer will begin counting again. The factory default of 2120 rpm disables this feature. The "Top Engine Limit" is 2120 rpm.

If the timer is activated and the timer is allowed to shut down the engine the following event code will be generated:

- 71-01 Idle Shutdown Occurrence (47)

Code 71-01 records the event and the code does not indicate an electrical system malfunction or an electronic system malfunction. Disable the timer by programming "Idle Shutdown Timer" to 0 (Caterpillar Factory Default).

The ECM will shut down the engine but not the vehicle electrical system when the "Idle Shutdown Timer" time expires. The "Engine Shutdown Output" can be used to shut down the vehicle electrical system after the "Idle Shutdown Timer" time has expired.

The "Idle Shutdown Timer" feature can be temporarily disabled by the use of the Caterpillar Electronic Technician (ET). The "Idle Shutdown Timer" feature can be temporarily disabled through the "System Troubleshooting Settings" screen in order to help troubleshoot other problems. Temporarily disabling this feature avoids engine shutdowns when you are troubleshooting other systems. The use of this method eliminates the need to temporarily alter the customer specified parameter of "Idle Shutdown Timer".

**Note:** If the following diagnostic code is active, the "Idle Shutdown Timer" will not operate.

- 84-08 Vehicle Speed Out Of Range (36)

**Note:** The timer will be overridden if the following conditions exist.

- The "Allow Idle Shutdown Timer Override" is programmed to "Outside Temperature Based" or "J1587 Outside Temperature Based".
- The temperature that is being sensed by the ECM is below the minimum air temperature that is programmed or the air temperature is above the maximum air temperature that is programmed.

## Test Step 1. Verify Activation of the "Idle Shutdown Timer"

- A. Connect ET to the cab data link connector.
- B. Access the "Customer Parameters" on ET.
  - a. Access the following display screens in order:
    - "Service"
    - "Configuration"
  - b. Record the programmed time for the "Idle Shutdown Timer". The "Idle Shutdown Timer" must be between 3 and 1440 minutes. If the "Idle Shutdown Timer" is programmed to 0, then the timer is disabled.
  - c. Record the programmed status of the parameter for the "Allow Idle Shutdown Override" and the "Idle Shutdown Timer Maximum RPM".
- C. Start the engine. Allow the engine to warm up until the coolant temperature is 38 °C (100 °F). Allow the engine to operate at the programmed low idle and turn off any unnecessary accessory devices.

- D. Ensure that all unnecessary loads are turned off.

With OCT99 and newer software, the "Idle Shutdown Timer Maximum RPM" can be programmed to allow the timer to be reset by increasing the engine RPM above the programmed limit. Ensure that the accelerator is not being depressed so that the rpm increases beyond the programmed limit.

- a. Park the vehicle.
- b. Ensure that the "Vehicle Speed" on the status screen on ET is 0 km/h (0 mph).
- c. Ensure that the engine speed on the status screen is at "Low Idle".
- d. Ensure that the clutch pedal is not depressed. Ensure that the brake pedal is not depressed.
- e. Ensure that the status of the PTO On/Off Switch is off.
- f. Observe the "Idle Shutdown Status".

### Expected Result:

**Result 1** The "Idle Shutdown Status" indicates "Counting".

**Result 2** The "Idle Shutdown Status" indicates "Not Active".

**Results:**

- **Result 1** – The ECM is reading the proper conditions for the activation of the “Idle Shutdown Timer”. Proceed to Test Step 2.
- **Result 2** – The ECM is not reading the proper conditions for activation of the “Idle Shutdown Timer”. Proceed to Test Step 3.

**Test Step 2. Verify the Driver Alert Function for Idle Shutdown and the Override Function for Idle Shutdown**

**A.** Connect ET to the cab data link connector.

**B.** Access the “Customer Parameters” on ET.

**a.** Access the following display screens in order:

- “Service”
- “Configuration”

**b.** Record the programmed time for the “Idle Shutdown Timer”. The “Idle Shutdown Timer” must be between 3 and 1440 minutes. If the “Idle Shutdown Timer” is programmed to 0, the timer is disabled.

**c.** Reprogram the “Idle Shutdown Timer” to 3 minutes for this test.

**C.** Observe the following items during the 90 second period before the programmed shutdown time:

- Check Engine Lamp
- Idle Shutdown Status

**D.** If the customer parameter of “Allow Idle Shutdown Override” is programmed to “YES”, perform either of the following actions in order to override the shutdown:

- Press the clutch pedal.
- Press the service brake pedal.

**Note:** This action must be accomplished while the check engine lamp is flashing. The check engine lamp flashes during the 90 second period before the programmed shutdown time.

**E.** Reprogram the “Idle Shutdown Timer” to the value that was recorded earlier for this test.

**Expected Result:**

During the 90 second period before the scheduled shutdown, the status should change from “Counting” to “Driver Alert” and the check engine lamp should flash rapidly. If the “Allow Idle Shutdown Override” is programmed to “YES”, the “Idle Shutdown Status” should change to “Override” after the pedals are depressed.

**Result 1** The “Idle Shutdown Timer” behaves in the manner that is described above.

**Result 2** The check engine lamp did not flash during the alert.

**Result 3** The ECM did not sense a change in the status of the service brake.

**Result 4** The ECM did not sense a change in the status of the clutch.

**Results:**

● **Result 1** – The “Idle Shutdown Timer” is operating properly. **STOP.**

● **Result 2** – The check engine lamp did not flash during the alert.

**Repair:** Perform the following diagnostic procedure: Troubleshooting, “Check Engine Lamp Circuit - Test”

**STOP.**

● **Result 3** – The ECM did not sense a change in the status of the service brake.

**Repair:** Perform the following diagnostic procedure: Troubleshooting, “Service Brake Pedal Position (Switch 1) Circuit - Test”

**STOP.**

● **Result 4** – The ECM did not sense a change in the status of the clutch.

**Repair:** Perform the following diagnostic procedure: Troubleshooting, “Clutch Pedal Position Switch Circuit - Test”

**STOP.**

**Test Step 3. Check the State of the Related Conditions when the Vehicle is Parked**

**A.** Check the state of the following related conditions when the vehicle is parked:

- Ensure that the vehicle speed is 0 km/h (0 mph) on ET or the dash display.
- Ensure that the engine is not in cold mode. (The status screen on ET will indicate that the "Cold Mode" is "Active" in the corner of the display screen.)
- Ensure that the PTO On/Off switch is OFF.
- Ensure that the engine is at low idle.

**Expected Result:**

**Result 1** Vehicle speed is not indicated as 0 km/h (0 mph).

**Result 2** The status screen on ET indicates that the engine is in cold mode.

**Result 3** The status of the PTO On/Off switch is not "OFF".

**Result 4** The engine is not at low idle.

**Results:**

- **Result 1** – Vehicle speed is not indicated as 0 km/h (0 mph).

**Repair:** Perform the following diagnostic procedure: Troubleshooting, "Vehicle Speed Circuit - Test"

**STOP.**

- **Result 2** – The status screen on ET indicates that the engine is in cold mode.

**Repair:** The engine must not be in "Cold Mode" operation while this test procedure is being performed. Allow the engine to run until the coolant temperature exceeds 20 °C (68 °F). Troubleshoot and repair any related conditions.

**STOP.**

- **Result 3** – The status of the PTO On/Off Switch is not "OFF".

**Repair:** Perform the following diagnostic procedure: Troubleshooting, "PTO Switch Circuit - Test"

**STOP.**

- **Result 4** – The engine is not at low idle.

**Repair:** Return the engine to low idle. Perform the test procedure again.

**STOP.**

## Ignition Key Switch Circuit and Battery Supply Circuit - Test

**SMCS Code:** 1401-038; 1553-038

**System Operation Description:**

The following diagnostic codes indicate a problem with the power supply to the ECM:

- 168-02 ECM Battery Power Intermittent
- 43-02 Key Switch Fault

**Note:** This code can be generated by rapidly cycling the key switch. Some control modules on the vehicle require this action in order to prompt flash codes. If this occurs, clear the logged diagnostic codes in order to prevent future confusion or an incorrect diagnosis.

**The following background information is related to this procedure:**

The ECM receives electrical power (battery voltage) through the wiring that is supplied by the vehicle manufacturer. The ECM input at connector P1:70 (Ignition Key Switch) receives battery voltage from the key switch when the key switch is in the ON position or the START position. When the ECM detects battery voltage at this input, the ECM will power up. When battery voltage is removed from this input, the ECM will power down.

The cause of an intermittent power supply to the ECM can occur on either the positive side ("Unswitched +Battery") or the negative side ("–Battery"). Both sides are routed from the ECM to the battery. The two Unswitched +Battery connections should be routed through a dedicated protection circuit.

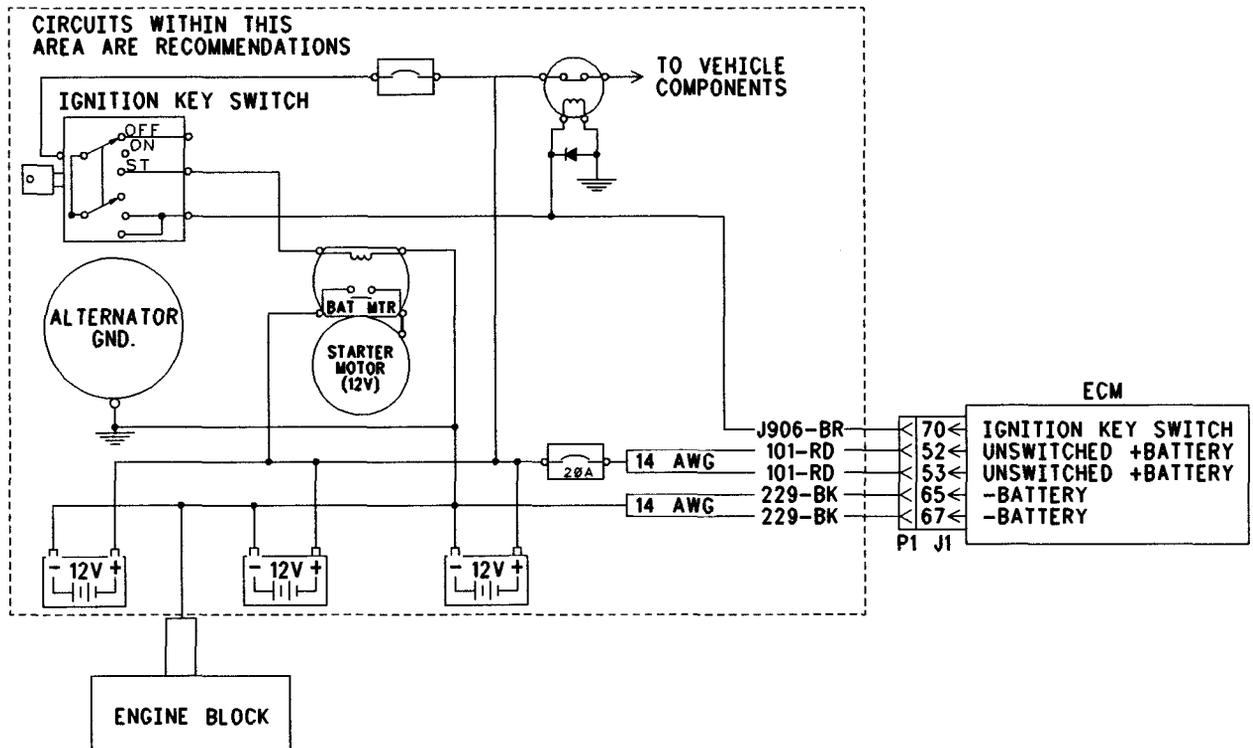
Some vehicles may be equipped with an engine protection shutdown system or an idle timer shutdown system that interrupts electrical power to the ECM in order to shut down the engine. Also, some vehicles may be equipped with an engine protection shutdown system or an idle timer shutdown system that interrupts electrical power to the key switch. The engine protection shutdown system can be an aftermarket device and the idle timer shutdown system can be external to the ECM. Some of these systems will not supply power to the ECM until one of the following conditions is met:

- The engine is cranked.
- The engine oil pressure achieves acceptable limits.
- An override button is pressed.

Keep in mind that these devices may be the cause of intermittent power to the ECM.

Usually, battery power to the data link connector is available and the battery power to the cab data link connector is independent of the key switch. Therefore, you will be able to power up the Caterpillar Electronic Technician (Cat ET), but you may not be able to communicate with the engine ECM. The engine ECM requires the key switch to be in the ON position in order to maintain communications. The ECM may power down a short time after connecting to Cat ET if the key switch is in the OFF position. This is normal.

For intermittent problems such as intermittent shutdowns that could be caused by vehicle wiring, temporarily bypassing the vehicle wiring may be an effective means of determining the root cause. If the symptoms disappear with the bypass wiring, the vehicle wiring is the cause of the problem. A means of bypassing vehicle wiring is explained in this test procedure. This is especially important for vehicles that do not provide dedicated circuits for the unswitched battery and the key switch.



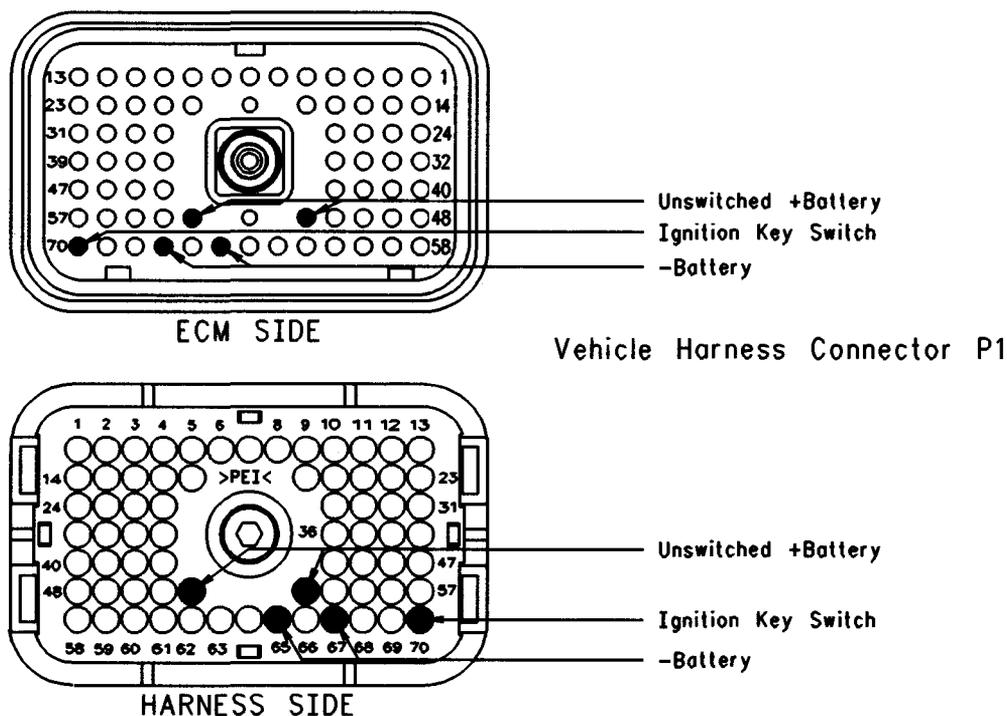


Illustration 127

g00640974

Terminal locations for ECM

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

**A.** Thoroughly inspect J1/P1 ECM connector, the battery connections and the connections to the key switch. Refer to Troubleshooting, “Electrical Connectors - Inspect” for details.

**B.** Perform a 45 N (10 lb) pull test on each of the wires in the ECM connector that are associated with the following connections:

- J1/P1:52 & 53 (Unswitched +Battery)
- J1/P1:65 & 67 (-Battery)
- J1/P1:70 (Ignition Key Switch)

**C.** Check the ECM connector (allen head screw) for the proper torque of 6.0 N·m (55 lb in).

**D.** Check the harness and wiring for abrasion and pinch points from the battery to the ECM, and from the key switch to the ECM.

#### Expected Result:

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

#### Results:

- **OK, Troubleshooting a 43-02 Code** – Proceed to Test Step 2.
- **OK, Troubleshooting a 168-02 Code** – Proceed to Test Step 3.
- **Not OK** – There is a problem with the connectors or wiring.

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

**STOP.**

### Test Step 2. Check the Status for the Ignition Key Switch

**A.** Turn the key switch to the OFF position.

**B.** Connect Cat ET to the data link connector and access the status screen that shows the status for “Ignition Key Switch”.

**C.** Monitor the status for “Ignition Key Switch” while the key switch is being cycled slowly from the ON position to the OFF position.

**Note:** Cat ET may indicate that a new ECM has been detected. This condition is normal, due to a powerdown of the ECM with the key switch in the OFF position.

**Note:** Cycling the key switch several times may cause additional 43-02 faults to be logged. This is normal. Clear any logged faults.

### Expected Result:

The status for "Ignition Key Switch" changes from "On" with the key switch in the ON position to "Off" with the key switch in the OFF position.

### Results:

- OK – The key switch input is functioning properly at this time.

**Repair:** If an intermittent connection is suspected, refer to Troubleshooting, "Electrical Connectors - Inspect". Excessive cycling of the key switch can cause this fault to be logged. This is normal. Clear any logged faults.

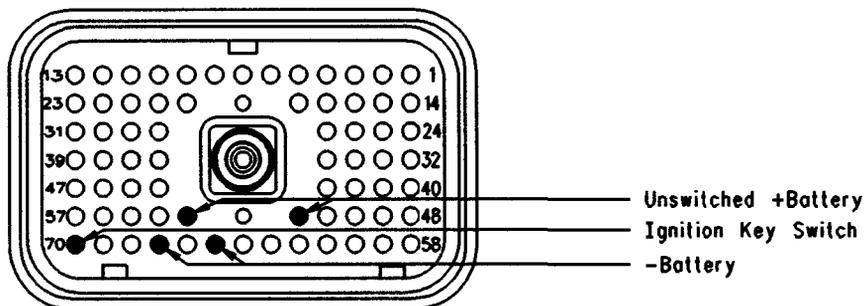
STOP.

- Not OK – Proceed to Test Step 3.

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

**Perform Steps A, B, and C if the following diagnostic code is active or logged:**

- 168-02 ECM Battery Power Intermittent
- Insert a 140-2266 Cable (Seventy-Pin Breakout) between the J1 and P1 ECM connector.
  - Measure the voltage between P1:52 (Unswitched +Battery) and P1:65 (-Battery).



- C.** Measure the voltage between P1:53 (Unswitched +Battery) and P1:67 (-Battery).

Refer to Illustration 128.

**Perform Steps D, E, and F if the following diagnostic code is active or logged:**

- 43-02 Key Switch Fault

- D.** Insert a 140-2266 Cable (Seventy-Pin Breakout) between the J1 and P1 ECM connector.

- E.** Turn the key switch to the ON position.

- F.** Measure the voltage between P1:70 (Ignition Key Switch) and P1:65 (-Battery).

Refer to Illustration 128.

**Expected Result:**

For 12 Volt Systems, the measured voltage is a constant 11.0 to 13.5 VDC with no suspected intermittent problems at this time.

For 24 Volt Systems, the measured voltage is a constant 22.0 to 27.0 VDC with no suspected intermittent problems at this time.

**Results:**

- **OK** – The ECM is receiving the correct voltage.

**Repair:** If an intermittent condition is suspected, refer to Troubleshooting, "Electrical Connectors - Inspect".

STOP.

- **Battery Voltage is out of range** – Proceed to Test Step 4.
- **Intermittent Or No Voltage** – Proceed to Test Step 5.
- **Key Switch Voltage Out Of Range**

**Repair:** Trace the wiring for the key switch from the ECM through the key switch circuit to the batteries. Find the problem and repair the problem. Check the circuit protection for the circuit and the wiring. Refer to the vehicle service manual for instructions on troubleshooting the circuit for the key switch.

Verify that the repairs eliminate the problem.

STOP.

## Test Step 4. Check the Batteries

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

**Expected Result:**

The batteries pass the load test. For 12 Volt systems, the measured voltage is at least 11.0. For 24 Volt systems, the measured voltage is at least 22.0.

**Results:**

- **OK**

**Repair:** Refer to the vehicle service manual for instructions on troubleshooting the vehicle wiring harness. Troubleshoot the vehicle wiring harness and repair the vehicle wiring harness, as required. Verify that the repairs eliminate the problem.

STOP.

- **Not OK**

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

STOP.

## Test Step 5. Bypass the Vehicle Harness

 **WARNING**

**Batteries give off flammable fumes which can explode.**

**To avoid injury or death, do not strike a match, cause a spark, or smoke in the vicinity of a battery.**

**NOTICE**

Do Not connect the bypass harness to the battery until the 20 Amp in-line fuse has been removed from the +Battery line. If the fuse is not removed before connection to the battery, a spark may result.

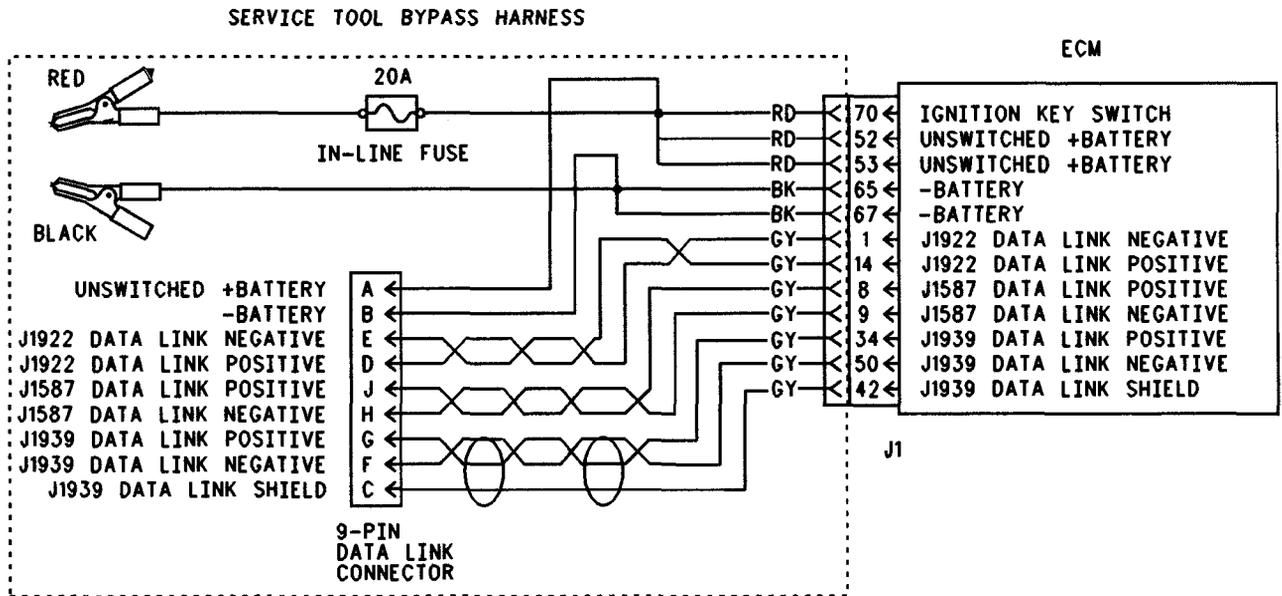


Illustration 129

g00732318

## Bypass harness

**Note:** This bypass harness is only for test applications. This bypass harness may be left only temporarily on the vehicle. The bypass harness can be used in order to determine if the cause of the intermittent problem is interruptions in battery power to the ECM or the key switch circuit.

- A.** Turn the key switch to the OFF position.
- B.** Disconnect the J1/P1 ECM connector.
- C.** Connect a bypass harness to the J1 ECM connector.
- D.** Remove the 20 Amp in-line fuse from the +Battery line of the Bypass Harness and connect the Unswitched +Battery and - BATTERY LINES directly to the battery posts.

**Note:** This bypass directly connects the circuit for the key switch to the ECM. The ECM will remain powered until the connection to the Unswitched battery line "+" is disconnected. Remove the 20 Amp fuse from the in-line fuse holder to power down the ECM. Do Not connect the bypass to the battery posts without first removing the 20 Amp in-line fuse or do not remove the bypass from the battery posts without first removing the 20 Amp in-line fuse.

**E.** Connect Cat ET to the data link connector of the bypass harness and verify that communication is established.

**F.** Restore all wiring to the original condition after testing.

**Expected Result:**

Installing the bypass eliminates the problem.

**Note:** The status for "Ignition Key Switch" will always indicate "On" while the bypass harness is installed.

**Results:**

- **OK** – The symptoms disappear when the bypass harness is installed. Also, the symptoms return when the bypass harness is removed. The problem is in the vehicle wiring that supplies power to the ECM. Check for aftermarket engine protection switches that interrupt power. Send the vehicle to the OEM dealer to repair. **STOP.**

- **Not OK**

**Repair:** Connect the bypass to another battery and verify if the problem is resolved. If the problem is resolved, the problem is with the vehicle batteries.

If the problem still exists, temporarily connect a test ECM. Remove all jumpers and replace all connectors. Recheck the system for active diagnostic codes and repeat the Test Step. If the problem is resolved with the test ECM, reconnect the suspect ECM. If the problem returns with the suspect ECM, replace the ECM.

Verify that the repair eliminates the problem.

STOP.

i01632317

## Ignore Brake/Clutch Switch Circuit - Test

**SMCS Code:** 7332-038-CL

### System Operation Description:

#### Use this procedure under the following situation:

The circuit for the Ignore Brake/Clutch Switch is suspected of incorrect operation.

#### The following background information is related to this procedure:

The ECM can use various inputs in a number of ways. The inputs depend on the parameter programming. Certain features are available on several different inputs. The configuration for the switch must match the actual switch installation in order for the switch to function properly.

### Ignore Brake/Clutch Switch

The ignore brake/clutch switch is typically used with a "Cab Switches PTO Configuration" which requires mobile use of the vehicle during PTO operation. When the ignore brake/clutch switch is on, depressing the brake or the clutch will not disengage PTO operation or a set engine speed. If the "Ignore/Brake Clutch Switch" parameter is programmed to "None" (default), this feature is not used. If the "Ignore/Brake Clutch Switch" parameter is programmed to J1/P1:47, then the feature is available and the switch circuit should be connected to terminal 47 of the J1/P1 ECM vehicle harness connector.

**Note:** The wiring for your particular application may be slightly different. The circuits for the sensor common are used interchangeably by the OEM of the vehicle. The following circuits are common within the ECM:

- The "Input Sensor Common 1" is terminal 18.
- The "Input Sensor Common 2" is terminal 3.

- The "AP Sensor/Switch Sensor Common" is terminal 5.

Ignore Brake/Clutch Switch

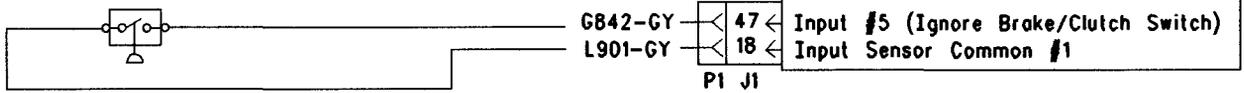


Illustration 130  
 Schematic for ignore brake/clutch switch

g00682286

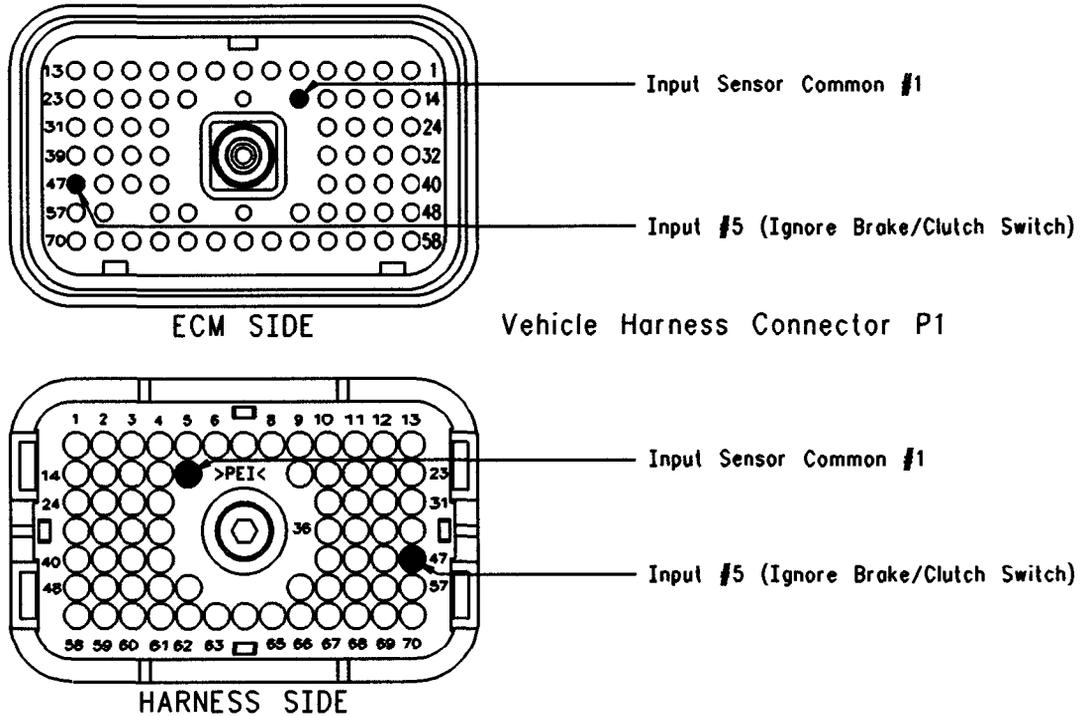


Illustration 131  
 Terminal Locations for ECM

g00682292

**Test Step 1. Check the Electrical Connectors and the Wiring**

- A. Thoroughly inspect the ECM vehicle harness connector J1/P1, the connectors, and the firewall bulkhead connectors. Refer to Troubleshooting, "Electrical Connectors - Inspect" for details.
- B. Perform a 45 N (10 lb) pull test on each of the wires in the ECM connector that are associated with the circuit for the "Ignore Brake/Clutch Switch".
- C. Check the ECM connector (allen head screw) for the proper torque of 6.0 N·m (55 lb in).
- D. Check the harness and the wiring for abrasion and pinch points from the ignore brake/clutch switch to the ECM.

Refer to Illustration 131 for terminal locations for the ECM.

**Expected Result:**

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

**Results:**

- OK – Proceed to Test Step 2.
- Not OK – Repair the wiring and connectors or replace the wiring or the connectors. Ensure that all of the seals are properly connected. Verify that the repair eliminates the problem. STOP.

### Test Step 2. Check the Status of the Ignore Brake/Clutch Switch on ET

- A. Connect the Caterpillar Electronic Technician (ET) at the cab data link connector.
- B. Turn the ignition key switch to the ON position.
- C. Operate the switch in the ON and OFF positions.
- D. View the "Ignore Brake/Clutch Switch" status on ET.
- E. If the "Ignore Brake/Clutch Switch" status indicates "Not Installed", then the "Ignore Brake/Clutch Switch" parameter has not been programmed.

#### Expected Result:

The "Status" screen should indicate "On" if the switch is turned on. The "Status" screen should indicate "Off" if the switch is turned off.

#### Results:

- OK – The switch is operating normally. Continue troubleshooting if the original condition is not resolved. STOP.
- Not OK – The ECM is not reading the change in switch status. Proceed to Test Step 3.

### Test Step 3. Check the Switch Circuit at the ECM

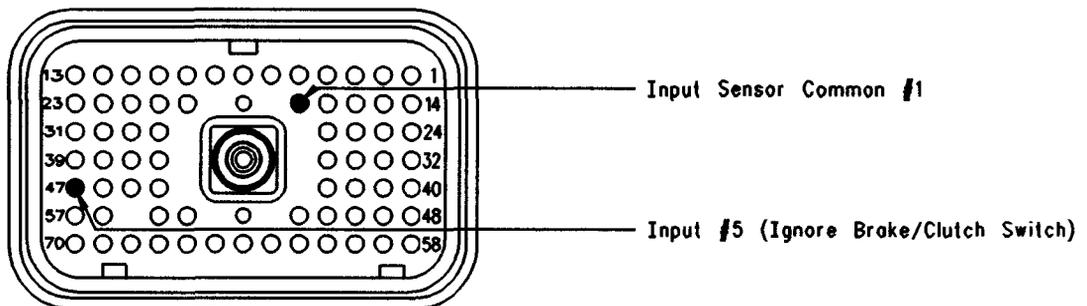


Illustration 132

g00682301

Connector for Breakout T

- A. Turn the ignition key switch to the OFF position.
- B. Install a 70 terminal breakout T to the ECM vehicle harness connector J1/P1.
- C. Fabricate a jumper wire 100 mm (4 inch) long. Crimp a Deutsch pin to both ends of the wire.
- D. Insert the jumper wire into terminal 18 (Input Sensor Common #1) of the breakout T. Insert the other end of the jumper wire into terminal 47 (Ignore Brake/Clutch Switch) of the breakout T.
- E. Connect ET to the cab data link connector.
- F. Turn the ignition key switch to the ON position.

- G.** Alternately remove the jumper wire and insert the jumper wire at terminal 18 while you monitor the status screen on ET.

**Expected Result:**

The switch status changes from "ON" with the jumper wire in place to "OFF" when the jumper wire is removed.

**Results:**

- **OK** – The ECM is functioning properly at this time. Proceed to Test Step 4.
- **Not OK** – The ECM is not functioning properly.

**Repair:** Perform the following repair:

1. Temporarily connect a test ECM.
2. Remove all jumpers and replace all connectors.
3. Recheck the system for active diagnostic codes.
4. Repeat the Test Step.
5. If the problem is resolved with the test ECM, reconnect the suspect ECM.
6. If the problem returns with the suspect ECM, replace the ECM.
7. Verify that the repair eliminates the problem.

STOP.

**Test Step 4. Insert a Jumper Wire at the Switch**

- A.** Turn the ignition key switch to the OFF position.
- B.** Reconnect the ECM vehicle harness connector J1/P1.
- C.** Fabricate a jumper wire 100 mm (4 inch) long. Crimp a Deutsch pin to both ends of the wire.
- D.** Insert the jumper wire between the two terminals of the ignore brake/clutch switch.
- E.** Turn the ignition key switch to the ON position.
- F.** Alternately remove the jumper wire and then insert the jumper wire at the switch terminals. At the same time, watch the status screen on ET.

**Expected Result:**

The switch status changes to "ON" with the jumper wire in place to "OFF" when the jumper wire is removed.

**Results:**

- **OK**

**Repair:** Replace the ignore brake/clutch switch.

Verify that the repair eliminates the problem.

STOP.

- **Not OK** – There is a problem in the wire harness between the Ignore Brake/Clutch Switch and the ECM. Proceed to Test Step 5.

**Test Step 5. Insert a Jumper Wire at the Bulkhead Connector**

- A.** Turn the ignition key switch to the OFF position.
- B.** Fabricate a jumper wire 100 mm (4 inch) long. Crimp a Deutsch pin to both ends of the wire.
- C.** Insert the jumper wire between the two terminals for the ignore brake/clutch switch on the engine side of the ECM bulkhead connector.
- D.** Turn the ignition key switch to the ON position.
- E.** Alternately connect and then disconnect the jumper wire. At the same time, monitor the status screen on ET.

**Expected Result:**

The switch status changes from "ON" with the jumper wire in place to "OFF" when the jumper wire is removed.

**Results:**

- **OK** – The problem is in the vehicle wiring between the bulkhead connector and the switch.

**Repair:** Inspect the vehicle wiring and then repair the vehicle wiring. Otherwise, send the vehicle to the OEM dealer for repair.

Verify that the original condition is resolved.

STOP.

- **Not OK** – The problem is in the vehicle wiring between the bulkhead connector and the ECM.

**Repair:** Inspect the vehicle wiring and then repair the vehicle wiring. Otherwise, send the vehicle to the OEM dealer for repair.

Verify that the original condition is resolved.

STOP.

i01907627

## Injector Solenoid Circuit - Test

**SMCS Code:** 1290-038

### System Operation Description:

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).

### The following background information is related to this procedure:

These engines have Electronic Unit Injectors that are mechanically actuated and electronically energized. The engine control module 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. The 105 volt pulse can be individually cut out to aid in troubleshooting misfire problems.

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

Some personality modules require the injector codes to be programmed. Injector codes allow each individual injector to be fine tuned for optimum performance. The ECM will generate the following diagnostic code if the injector codes are not programmed:

- 253-02 Check Customer or System Parameters

When an injector is replaced, program the injector code that is etched on the injector. The injector code is a four digit number. If the ECM is replaced, all six injector codes must be programmed into the new ECM. Refer to Troubleshooting, "Injector Code - Calibrate".

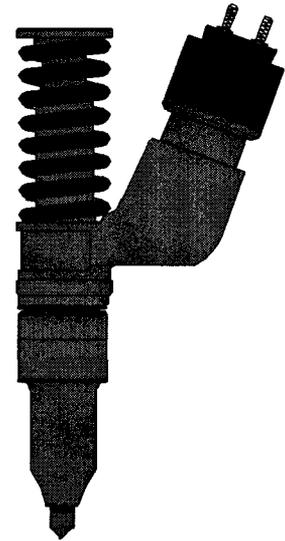


Illustration 133  
Electronic Unit Injector

g00735975

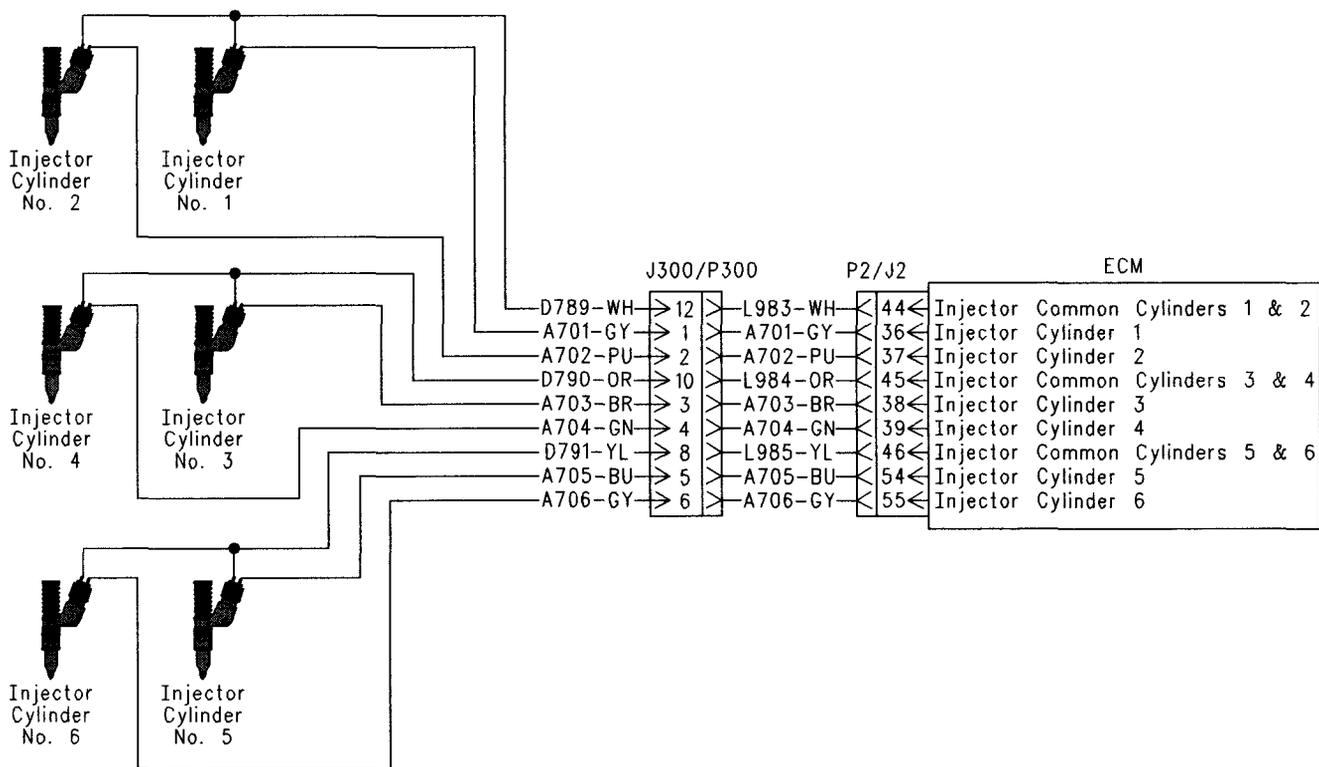


Illustration 134  
 Schematic for electronic unit injector

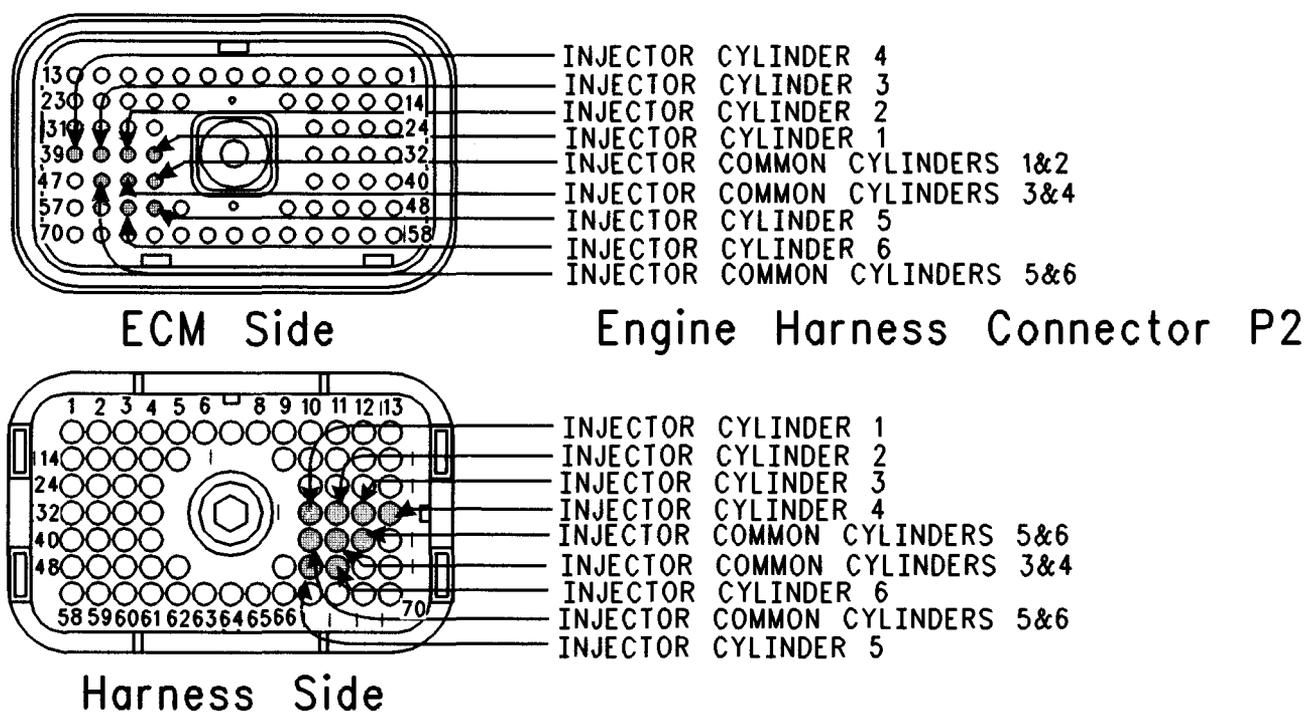


Illustration 135  
P2 ECM connector

g00663571

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

**WARNING**

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

- A.** Turn the key switch to the OFF position. A strong electrical shock hazard is present if the key switch is not turned off.
- B.** Thoroughly inspect the ECM engine harness connector J2/P2 and the solenoid connector for the Injector J300/P300. Refer to Troubleshooting, "Electrical Connectors - Inspect" for details.
- C.** Perform a 45 N (10 lb) pull test on each of the wires in the J2/P2 ECM connector and the J300/P300 valve cover connector that are associated with injector solenoids.

Refer to Illustration 135.

- D.** Check the ECM connector (allen head screw) for the proper torque of 6.0 N·m (55 lb in).
- E.** Check the J300/P300 valve cover connector in order to ensure the proper mating of the connector.

- F.** Check the harness and wiring for abrasion and pinch points from the injectors to the ECM.

**Expected Result:**

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

**Results:**

- OK – Proceed to Test Step 2.
- Not OK

**Repair:** Perform the following repair:

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

Verify that the repair eliminates the problem.

**STOP.**

### Test Step 2. Check for Logged Diagnostic Codes Regarding Injector Solenoids

- A.** Connect the Caterpillar Electronic Technician (ET) to the data link connector.

- B.** Turn the key switch to the ON position.
- C.** Monitor the logged diagnostic code screen on Cat ET.

**Expected Result:**

One or more diagnostic codes for the injectors have been logged:

**Results:**

- OK – Proceed to Test Step 4.
- Not OK – Proceed to Test Step 3.

**Test Step 3. Check the Variation of the Injectors from a Cylinder to a Cylinder**

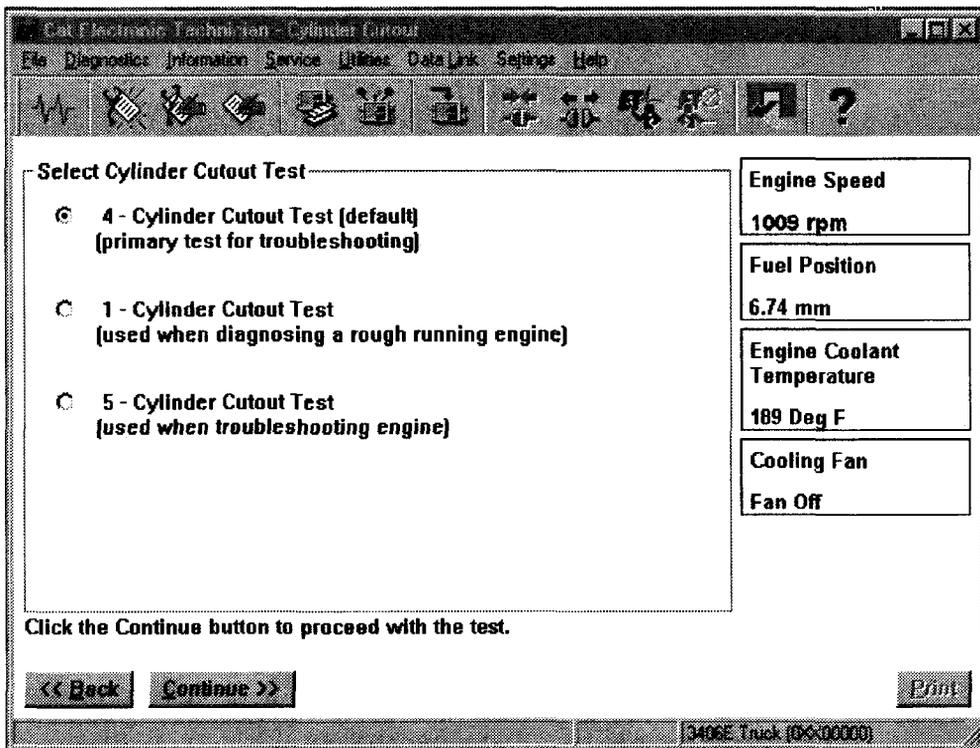


Illustration 136

g00663575

“Automated Cylinder Cutout Test” screen in Caterpillar Electronic Technician (Cat ET)

- A.** Connect Cat ET to the data link connector.
- B.** When possible, put the truck on a dynamometer.
- C.** Start the engine.
- D.** Allow the engine to warm up to normal operating temperature 77 °C (171 °F).
- E.** After the engine is warmed to operating temperature, access the “Cylinder Cutout Test” by accessing the following display screens in order:
- “Diagnostics”
  - “Diagnostic Tests”
  - “Cylinder Cutout Test”

- F. Enable the cooling fan, if the fan is not controlled by the ECM. If the ECM controls the cooling fan, the cooling fan will start automatically when the test begins.
- G. Shut off all parasitic loads such as the air conditioning and the air compressors which could affect the results of the test.
- H. Set the engine speed to  $1000 \pm 20$  rpm.
- I. Select the start button at the bottom of the screen for the "Cylinder Cutout Test".
- J. Select the "4 Cylinder Cutout Test" which is the default test.
- K. Follow the instructions that are provided in the Cylinder Cutout Test. The Cylinder Cutout Test is interactive so the procedure is guided to the finish.

**Note:** The "Manual Cylinder Cutout Test" is also available. Access the manual test by selecting the "Change" button on the Cat ET screen for the Cylinder Cutout Test. The "4 Cylinder Cutout Test" is the recommended starting procedure. The automated tests run twice collecting data. The two sets of data are analyzed and an "OK" or "NOT OK" result is displayed.

**Expected Result:**

All cylinders indicate "OK" on Cat ET.

**Results:**

- OK

**Repair:** If the engine is misfiring or if the engine has low power, refer to Troubleshooting, "Engine Misfires, Runs Rough or Is Unstable" and Troubleshooting, "Low Power/Poor or No Response to Throttle".

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

- Not OK – Proceed to Test Step 4.

## Test Step 4. Use the Injector Solenoid Test to Test the Injector Solenoids

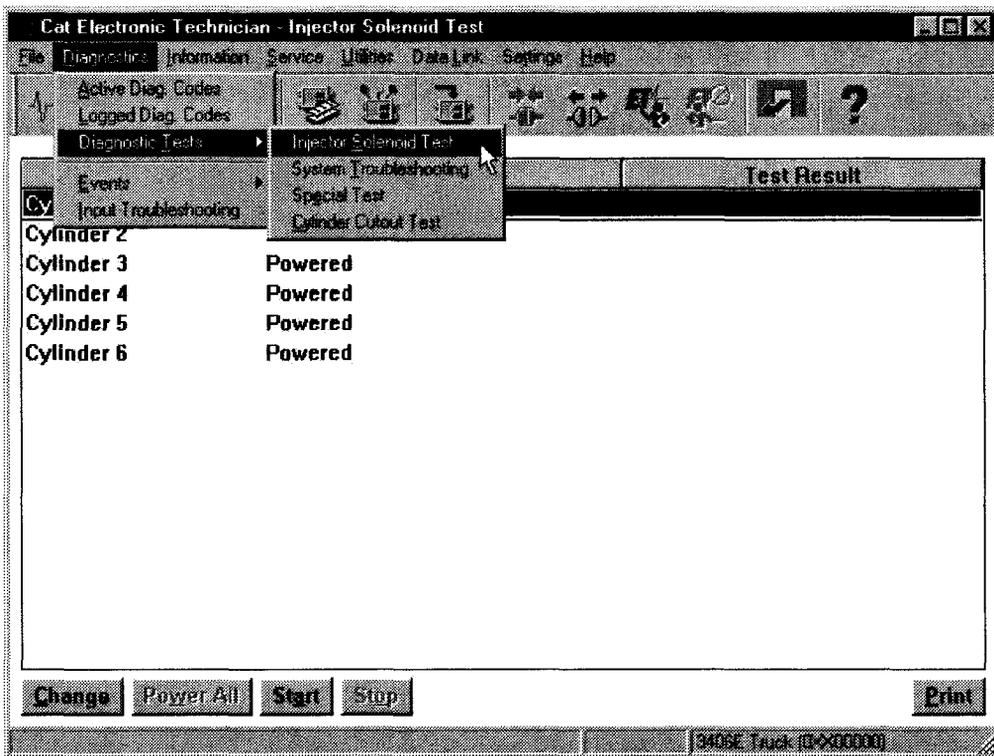


Illustration 137

g00663576

"Injector Solenoid Test" screen in Caterpillar Electronic Technician (Cat ET)

- A. Start the engine.
- B. Allow the engine to warm up to 77 °C (171 °F) which is the normal operating temperature.
- C. Turn the key switch to the OFF position.
- D. Connect Cat ET to the data link connector.
- E. Turn the key switch to the ON position.
- F. After the engine is warmed to operating temperature, access the "Injector Solenoid Test" by accessing the following display screens in order:
  - "Diagnostics"
  - "Diagnostic Tests"
  - "Injector Solenoid Test"
- G. Activate the test.

**Note:** Do not confuse the Injector Solenoid Test with the Cylinder Cutout Test. The Cylinder Cutout Test is used to shut off fuel to a specific cylinder while the engine is running. The Injector Solenoid Test is used in order to actuate the injector solenoids. This allows the click of the injector solenoids to be heard when the engine is not running in order to determine that the circuit is functioning properly.

- H. As each solenoid is energized by the ECM an audible click can be heard at the valve cover. Listen for a click at each valve cover. A black square will appear over the cylinder number when the cylinder is being fired.
- I. Perform the Injector Solenoid Test at least two times.

### Expected Result:

All cylinders indicate "OK".

### Results:

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

**Repair:** If the Cylinder Cutout Test returned a "NOT OK" for any injector, refer to Troubleshooting, "Engine Misfires, Runs Rough or Is Unstable".

STOP.

- Not OK – Note the cylinders that indicate "OPEN" and/or "SHORT". Proceed to Test Step 5.

### **Test Step 5. Use the Injector Solenoid Test to Check the Engine Harness from P2 to P300 for Short Circuits**

 **WARNING**

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

- A. Turn the key switch to the OFF position. A strong electrical shock hazard is present if the key switch is not turned off.
- B. Disconnect the J300/P300 injector connector.
- C. Turn the key switch to the ON position.
- D. Perform the Injector Solenoid Test at least two times.

#### **Expected Result:**

All cylinders indicate "OPEN".

#### **Results:**

- OK – Proceed to Test Step 6.
- Not OK – Note the cylinders that indicate a short circuit. Proceed to Test Step 7.

## Test Step 6. Use the Injector Solenoid Test to Check the Engine Harness from P2 to P300 for an Open Circuit

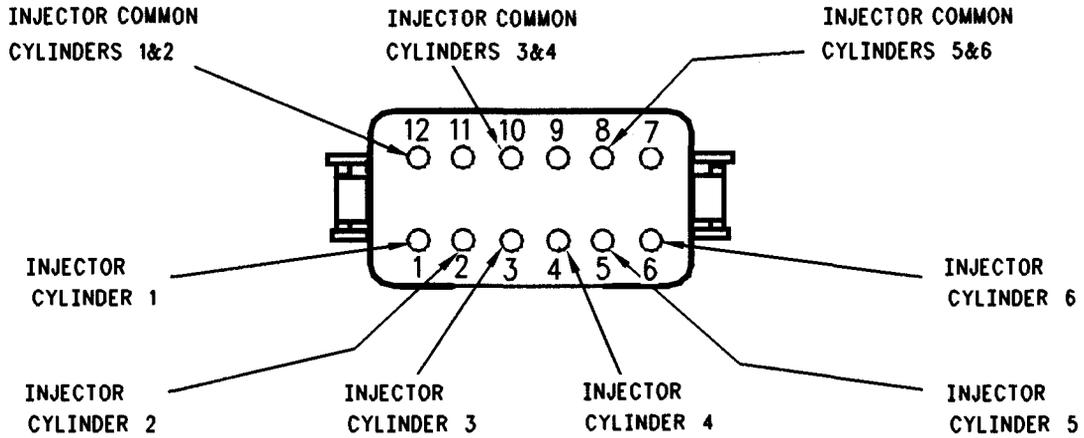


Illustration 138  
Injector connector for Engine harness

g00663572

### **WARNING**

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

- A. Turn the key switch to the OFF position. A strong electrical shock hazard is present if the key switch is not turned off.
- B. Disconnect injector connector J300/P300.
- C. Turn the key switch to the ON position.
- D. Fabricate a jumper wire 100 mm (4 inch) long. Crimp a Deutsch pin to both ends of the wire.
- E. Insert one end of the jumper wire into the "Injector Common" socket of the problem injector. Insert the other end of the jumper wire into the socket of injector connector P300 that goes to the problem injector. For example, if Injector 5 is the problem injector, insert the jumper from terminal 5 of the injector connector P300 to terminal 8 of the injector connector P300.
- F. Perform the Injector Solenoid Test at least two times.
- G. Repeat this test for each suspect Injector. Ensure that the Injector Solenoid Test is disabled before handling the jumper wires.

### **Expected Result:**

Cat ET displays "SHORT" for the cylinder with the jumper wire.

### **Results:**

- OK – Proceed to Test Step 8.
- Not OK – Proceed to Test Step 9.

## Test Step 7. Use the Injector Solenoid Test to Check the ECM for Short Circuits

### **WARNING**

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

- A. Turn the key switch to the OFF position. A strong electrical shock hazard is present if the key switch is not turned off.
- B. Disconnect the J2/P2 ECM connector from the ECM and check for evidence of moisture entry.
- C. Turn the key switch to the ON position.
- D. Perform the Injector Solenoid Test at least two times.

**Expected Result:**

All cylinders indicate "OPEN" when the P2 ECM connector is disconnected from the ECM.

**Note:** When the engine harness is disconnected all of the diagnostic codes for supply voltage to the sensors will be active. This is normal. Clear all of these diagnostic codes after completing this test step.

**Results:**

- OK – The short circuit is in the engine harness.

**Repair:** Perform the following repair:

Repair the engine harness or replace the engine harness, as required. Clear all diagnostic codes after completing this test step.

Verify that the repair eliminates the problem.

STOP.

- Not OK

**Repair:** Perform the following repair:

1. Temporarily connect a test ECM.
2. Remove all jumpers and replace all connectors.
3. Recheck the system for active diagnostic codes.
4. Repeat the Test Step.
5. If the problem is resolved with the test ECM, reconnect the suspect ECM.
6. If the problem returns with the suspect ECM, replace the ECM.
7. Verify that the repair eliminates the problem.

STOP.

**Test Step 8. Evaluate the Symptoms****Expected Result:**

Choose from these possible results:

**Result 1** Test Step 6 indicated that only one injector had an "OPEN" or "SHORT", or that one injector had an "OPEN" but the other injector on the injector common line had a "SHORT".

**Result 2** Test Step 6 indicated that two injectors that share an injector common line are open.

**Result 3** Test Step 6 indicated that two injectors that share an injector common line are shorted.

**Results:**

- Result 1 – Proceed to Test Step 10.
- Result 2 – Proceed to Test Step 11.
- Result 3 – Proceed to Test Step 12.

**Test Step 9. Check the ECM for an Open Circuit**

**WARNING**

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

- A. Turn the key switch to the OFF position. A strong electrical shock hazard is present if the key switch is not turned off.
- B. Disconnect the J2/P2 ECM connector. Connect a 140-2266 Cable (Seventy-Pin Breakout) to the ECM. Do not connect the engine harness to the breakout T.
- C. Use a jumper wire to short between the socket of the injector and the common socket of the suspect injector.
- D. Turn the key switch to the ON position.
- E. Perform the Injector Solenoid Test at least two times.

**Expected Result:**

ET displays "SHORT" for the cylinder with the jumper wire.

**Note:** When the engine harness is disconnected all of the diagnostic codes for supply voltage to the sensors will be active. This is normal. Clear all of these diagnostic codes after completing this test step.

**Results:**

- OK – The ECM is OK.

**Repair:** Perform the following repair:

Replace the engine harness or repair the engine harness, as required.

Verify that the repair eliminates the problem.

STOP.

- Not OK

**Repair:** Perform the following repair:

1. Temporarily connect a test ECM.
2. Remove all jumpers and replace all connectors.
3. Recheck the system for active diagnostic codes.
4. Repeat the Test Step.
5. If the problem is resolved with the test ECM, reconnect the suspect ECM.
6. If the problem returns with the suspect ECM, replace the ECM.
7. Verify that the repair eliminates the problem.

STOP.

### **Test Step 10. Check the Injector Harness Under the Valve Cover**



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

---

- A. Turn the key switch to the OFF position. A strong electrical shock hazard is present if the key switch is not turned off.
- B. Remove the valve cover.
- C. Disconnect the harness from the problem injector. Disconnect the harness from the other injector that has the same injector common line.
- D. Thoroughly clean the terminals of both injectors and the harness.
- E. Exchange the harness between the two injectors that share the common line.
- F. Turn the key switch to the ON position.
- G. Perform the Injector Solenoid Test at least two times.

#### **Expected Result:**

Exchanging the harness between the two injectors caused the problem to move to the other injector on Cat ET.

#### **Results:**

- OK

**Repair:** Perform the following repair:

Replace the faulty injector. Restore the wiring to the proper injectors.

Verify that the repair eliminates the problem.

STOP.

- Not OK –

**Repair:** Perform the following repair:

Replace the injector harness under the valve cover.

Verify that the repair eliminates the problem.

STOP.

**Test Step 11. Check the Engine Harness Under the Valve Cover for an Open Circuit in the Common Line**

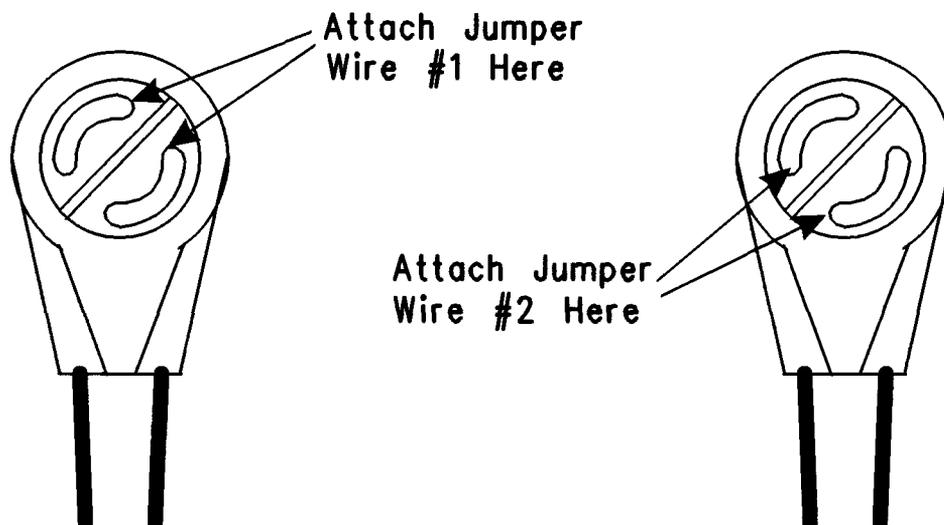


Illustration 139

g00663574

Harness terminals of Electronic Unit Injector

**⚠ WARNING**

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

- A.** Turn the key switch to the OFF position. A strong electrical shock hazard is present if the key switch is not turned off.
- B.** Remove the valve cover.
- C.** Disconnect each of the injectors that indicate an "OPEN" from the wiring harness. Ensure that each of the connectors from the disconnected injector harness does not touch other components and short to ground.
- D.** Attach a jumper wire to both terminals of the injector harness for the two injectors that share an injector common line.
- E.** Turn the key switch to the ON position.
- F.** Perform the Injector Solenoid Test at least two times.

**Expected Result:**

The cylinders with the short in place indicate an "OPEN".

**Results:**

- OK

Repair: Perform the following repair:

1. Replace the engine harness under the valve cover.
2. Use the Injector Solenoid Test to check the installation of the new harness before installing the valve covers.
3. Verify that the repair eliminates the problem.

STOP.

- Not OK – Both injectors indicate "SHORT".

Repair: Perform the following repair:

Both injectors indicate "SHORT". Replace Both injectors.

Verify that the repair eliminates the problem.

STOP.

**Test Step 12. Check the Engine Harness Under the Valve Cover for Short Circuits in the Injector Wires**

**⚠ WARNING**

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

- A. Turn the key switch to the OFF position. A strong electrical shock hazard is present if the key switch is not turned off.
- B. Remove the valve cover.
- C. Disconnect each of the injectors that indicate a "SHORT" from the wiring harness. Ensure that each of the connectors from the disconnected injector harness does not touch other components and short to ground.
- D. Turn the key switch to the ON position.
- E. Perform the Injector Solenoid Test at least two times.

**Expected Result:**

Both cylinders indicate an "OPEN".

**Results:**

- OK – Leave the injector wires disconnected. Neither of the injector wires are shorted to the engine. Proceed to Test Step 13.
- Not OK

Repair: Perform the following repair:

Replace the injector harness under the valve cover.

Verify that the repair eliminates the problem.

STOP.

**Test Step 13. Check for a Short Circuit in the Injector Common Line to the Engine****WARNING**

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

- A. Turn the key switch to the OFF position. A strong electrical shock hazard is present if the key switch is not turned off.
- B. Disconnect the J2/P2 ECM connector.
- C. Locate the common line for the problem injector in the P2 connector. Measure the resistance from the terminal to the engine ground stud connection.

**Expected Result:**

The multimeter indicates that the resistance is greater than 10 Ohms.

**Results:**

- OK – Reconnect the engine harness to the ECM. Proceed to Test Step 14.
- Not OK

Repair: Perform the following repair:

Replace the injector harness under the valve cover.

Verify that the repair eliminates the problem.

STOP.

**Test Step 14. Check for a Short Circuit in the Injector****WARNING**

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

- A. Turn the key switch to the OFF position. A strong electrical shock hazard is present if the key switch is not turned off.
- B. Reconnect one of the two disconnected injectors.
- C. Turn the key switch to the ON position.
- D. Perform the Injector Solenoid Test at least two times.

**Expected Result:**

The reconnected injector indicates a "SHORT".

**Results:**

- OK

Repair: Perform the following repair:

Replace the Injector.

Verify that the repair eliminates the problem.

STOP.

- Not OK – The injector is OK. Proceed to Test Step 15.

**Test Step 15. Check for a Short Circuit in the Other Injector****WARNING**

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

- A.** Turn the key switch to the OFF position. A strong electrical shock hazard is present if the key switch is not turned off.
- B.** Reconnect the other disconnected injector.
- C.** Turn the key switch to the ON position.
- D.** Perform the Injector Solenoid Test at least two times.

**Expected Result:**

The reconnected injector indicates a "SHORT".

**Results:**

- OK –

Repair: Perform the following repair:

Replace the faulty injector. Restore the wiring to the proper injectors.

Verify that the repair eliminates the problem.

STOP.

- Not OK – This injector is OK. STOP.

i01815762

**Multi-Torque - Test**

**SMCS Code:** 1901-038

**System Operation Description:****Use this procedure under the following situation:**

The multitorque software is suspected of operating incorrectly. Access the Instantaneous Screen if the vehicle is equipped with the (CAT ID) Driver Information Display. This screen will show the status of the multitorque feature in order to determine if the multitorque feature is activating.

Background of the multitorque feature

The multitorque feature is an optional feature. This feature requires unique software. The multitorque feature provides an otherwise standard engine with two different torque curves. The torque curve for the lower gears functions as a standard engine. The torque curve for the top gears provides additional torque. The transmission ratio determines the top gears. In the top gears, the engine provides additional torque. This additional torque is typically 136 N·m (100 lb ft).

The ECM determines when the vehicle is in the top gears by sensing the ratio of engine speed to vehicle speed. The engine will operate with the higher torque curve if the ratio of engine speed to vehicle speed is within the specified range.

The engine ratings are based on the trip point. Additional torque is made available at the trip points. The three options are listed below.

- **MT-4** ratio is 71.5 rpm/mph & below (Top 4 Gears)
- **MT-2** ratio is 37.6 rpm/mph & below (Top 2 Gears)
- **MT-1** ratio is 27.9 rpm/mph & below (Top 1 Gear)

With OCT99 and newer software, the "Multitorque Ratio" parameter was added. This allows the selection of the desired ratio turn on trip point (MT-1, MT-2, or MT-4). "Multitorque Ratio" is used rather than requiring three different ratings that are based only on the different ratio trip points. With older software, the engine rating determined the specific ratio that was used for the vehicle application.

The multitorque feature differs from the PTO torque limit. The PTO torque limit requires a torque limit switch. Multitorque software provides a second torque curve. The engine will not exceed the PTO torque limit. The ECM essentially removes the top of the torque curve at the programmed PTO torque limit. The PTO torque limit is used only for temporary protection of equipment.

**Test Step 1. Repair all Diagnostic Codes and Other Problems**

- A.** Make sure that there are no active diagnostic codes and make sure that there are no logged diagnostic codes that affect engine performance.
- B.** Refer to the procedure that best describes the symptom if there are any other complaints or symptoms. Refer to Troubleshooting for troubleshooting information on specific symptoms, or the relationship between diagnostic codes and possible performance related complaints.

**Expected Result:**

No other detectable problems exist.

**Results:**

- OK – Proceed to Test Step 2.
- Not OK – Repair any other problems, as required. Proceed to Test Step 2.

**Test Step 2. Verify that the Software is Installed**

- Connect the Caterpillar Electronic Technician (ET) to the cab data link connector.
- Turn the ignition key switch to the ON position.

**Expected Result:**

The rating type in the customer specified parameters indicates "Multitorque".

**Results:**

- OK – Proceed to Test Step 3.
- Not OK – The engine is not equipped with the multitorque feature. STOP.

**Test Step 3. Verify a Change in the Rated Fuel Limit**

- Put the vehicle on a dynamometer or take the vehicle for a road test.
- Operate the vehicle in the lower gears at an approximate engine speed of 1200 rpm. A load on the engine is not required.
- Read the "Rated Fuel Limit" and record the "Rated Fuel Limit" from the status screen on ET.
- Operate the vehicle in the top gear at 1200 rpm. Read the "Rated Fuel Limit" and record the "Rated Fuel Limit".

**Expected Result:**

The "Rated Fuel Limit" in the top gear is greater than the "Rated Fuel Limit" in the lower gears.

**Results:**

- OK – The multitorque feature is operating correctly. STOP.
- Not OK

**Repair:** Verify that the vehicle specifications are compatible with the multitorque feature. The ratio of engine speed to vehicle speed should be less than 71.5 in top gear. The ratio of engine speed to vehicle speed should be less than 44.7 when metric vehicle speed is used.

With OCT99 and newer software, verify that the "Multitorque Ratio" parameter is programmed to the correct setting.

Verify that the repair eliminates the problem.

STOP.

i01859775

**Neutral Switch Circuit - Test**

**SMCS Code:** 1435-038

**System Operation Description:**

Use this procedure to determine if the neutral switch is preventing normal operation of cruise control, idle set speed, or PTO operation:

The following switch circuits can also prevent the correct operation of the cruise control, idle set speed or PTO operation:

- Service Brake Pedal Position (Switch 1)
- Service Brake Pedal Position (Switch 2)
- Cruise Control Set/Resume Switch
- Cruise Control On/Off Switch
- PTO On/Off Switch

The switches are described in the respective circuit tests in Troubleshooting.

All of the following customer programmable parameters can affect cruise control, idle set speed, and PTO operation:

- "Low Cruise Control Speed Set Limit"
- "High Cruise Control Speed Set Limit"
- "Idle Vehicle Speed Limit"
- "Cruise/Idle/PTO Switch Configuration"
- "Idle/PTO Bump rpm"
- "Idle/PTO rpm Ramp Rate"

- “PTO Vehicle Speed Limit”

The vehicle speed calibration can also affect the cruise control, the idle set speed, and the PTO if the vehicle speed calibration is incorrectly programmed. Refer to Troubleshooting, “Customer Specified Parameters”.

A service brake pedal position (Switch 1) is required for all configurations. The service brake pedal position (Switch 1) connects to the ECM through connector P1:45. The service brake pedal position (Switch 2) connects to the ECM through connector P1:64. The neutral switch connects to the ECM through connector P1:62.

### Transmission Neutral Switch

The transmission neutral switch is required when the “Transmission Style” parameter is programmed to “Automatic Option 3” or “Automatic Option 4”. This switch is used to indicate when the automatic transmission is in neutral.

The transmission neutral switch is an open circuit when the transmission is in gear. Shifting the transmission to the neutral position should close the circuit, which connects the input to the battery voltage. Many other switches in the system connect the input to ground when the circuit is closed.

### Usage of Transmission Style Switches

The “Transmission Style” parameter determines the switches that will be used. The following switches can be used with being dependent on the parameter setting:

- Clutch Pedal Position
- Neutral
- Service Brake Pedal Position (Switch 1)
- Service Brake Pedal Position (Switch 2)

Refer to Table 150 for additional information.

Table 150

Setting For Transmission Style Parameter	Switch Usage.			
	Service Brake Switch 1	Service Brake Switch 2	Clutch	Neutral
Manual Option 1	X		X	
Automatic Option 1	X			
Automatic Option 2	X	X		
Automatic Option 3	X	X		X
Automatic Option 4	X			X
Eaton Top 2	X		X	

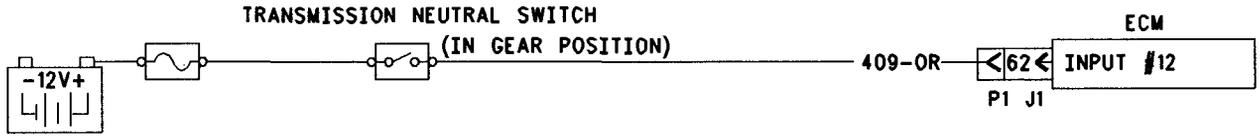


Illustration 140

g00646460

Schematic for transmission neutral switch

### Test Step 1. Determine the Type of Problem

- A. Connect the electronic service tool to the data link connector.
- B. Turn the key switch to the ON position.
- C. If the vehicle will not allow setting a cruise speed, an idle speed or a PTO speed, check the following customer parameters:

#### Cruise Control Parameters

- "Low Cruise Control Speed Set Limit"
- "High Cruise Control Speed Set Limit"

#### Idle Parameters

- "Idle Vehicle Speed Limit"
- "Idle RPM Limit"
- "Top Engine Limit" (TEL)

#### PTO Parameters

- "PTO Configuration"
- "PTO Vehicle Speed Limit"

- D. Ensure that the vehicle is not experiencing a problem due to one of these parameters. Refer to Troubleshooting, "Customer Specified Parameters" for a description of the parameters, if necessary.
- E. Check the status screen on the electronic service tool that indicates the last cause of a kickout for one of the following modes:
  - Cruise Kickout
  - Idle Kickout
  - PTO Kickout

#### Expected Result:

The problem is due to a parameter setting or the problem is due to a normal kickout.

#### Results:

- OK – Explain the proper operation of system to the driver. STOP.
- Not OK

Repair: If a problem is still suspected with the neutral switch circuit perform the following procedure:

Proceed to Test Step 2.

## Test Step 2. Inspect Electrical Connectors and Wiring

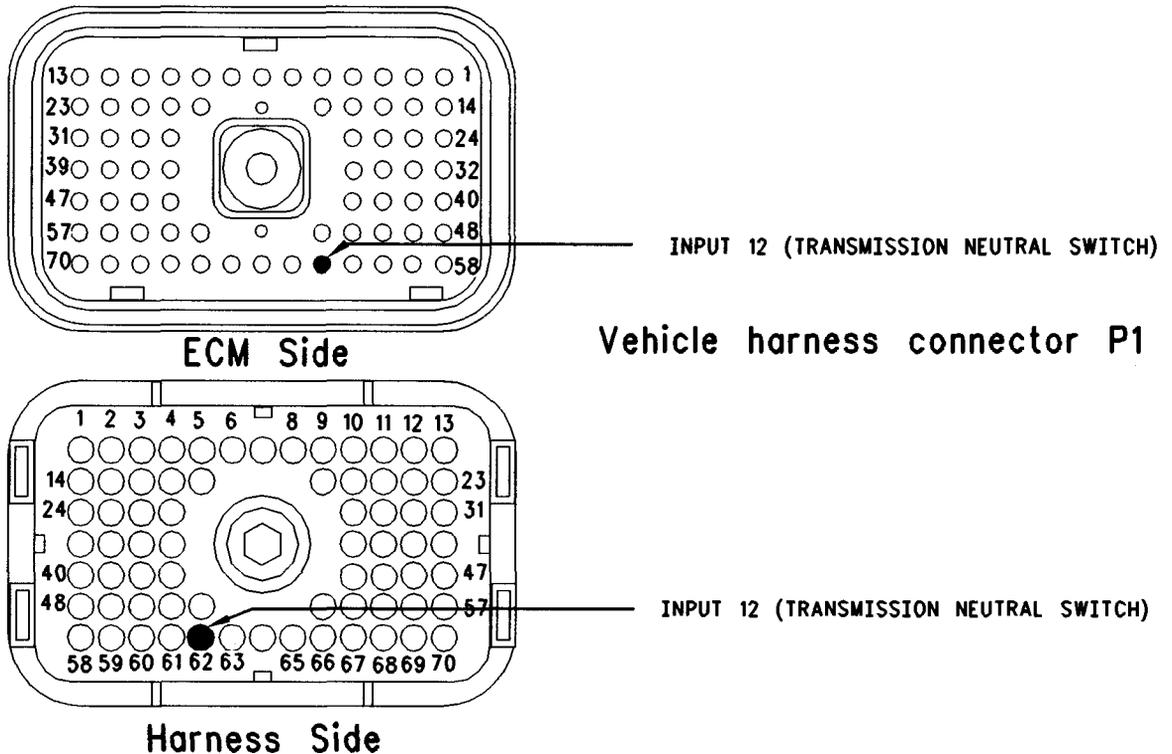


Illustration 141

g00705233

**A.** Thoroughly inspect the J1/P1 ECM connector, the firewall bulkhead connector and the terminals for the following switches in the connectors:

- J1/P1:62 (Neutral Switch)

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

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

Refer to Illustration 141.

**C.** Check the ECM connector (allen head screw) for the proper torque of 6.0 N·m (55 lb in).

**D.** Check the harness and wiring for abrasion and pinch points from the sensor to the ECM.

### Expected Result:

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

### Results:

- OK – Proceed to Test Step 3.

- 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 3. Check the Status of the “Transmission Neutral Switch”

Table 151

“Transmission Neutral Switch” Status		
Switch Position	Switch Status	Circuit
The Transmission is in Neutral.	ON	Closed
The Transmission is in Gear.	OFF	Open

**A.** Access the status screen on the electronic service tool.

**B.** Turn the key switch to the ON position.

**C.** Shift the transmission into the Neutral position while the status for the “Transmission Neutral Switch” is being observed. Also, shift out of neutral while the status for the “Transmission Neutral Switch” is being observed.

**Note:** If the status indicates “Not Installed”, check the programming of the “Transmission Style” parameter. The “Transmission Style” must be programmed to “Automatic Option 3” or “Automatic Option 4”.

**Expected Result:**

The switch status changes per the information in Table 151.

**Results:**

- OK – The switch is operating normally. STOP.
- Intermittent Problem Suspected – Proceed to Test Step 4.
- Not OK – The ECM is not reading the switch status change. Proceed to Test Step 5.

### Test Step 4. Operate the Vehicle and Check the Kickout Status Parameter

**A.** For an intermittent cruise control kickout, talk to the driver in order to determine the conditions when the kickout occurs. Topics of examination could be the following examples:

- Specific Speed
- Road Conditions
- Weather Conditions

Take the vehicle for a road test in order to duplicate these conditions and set the cruise control. Operate the vehicle in cruise control until the problem reoccurs.

**B.** For an intermittent idle kickout, talk to the driver in order to determine the conditions when the kickout occurs. A topic of examination could be the following example:

- Specific engine rpm

Start the engine. Duplicate these conditions and set the idle rpm. Operate the vehicle in idle until the problem reoccurs.

**Note:** The status screen on the electronic service tool will only indicate the last kickout. The status screen on the electronic service tool will lose this information if the key switch is turned OFF.

**C.** Connect the electronic service tool and check the status screen for the last cause of the kickout.

**D.** If the status screen on the electronic service tool is blank, then either there was no kickout of the cruise control, or the power to the ECM was turned off before the information could be read. Repeat this test step.

**Note:** A status screen that is blank indicates No Occurrence.

**Expected Result:**

**RESULT 1** The status for the kickout displays the following result:

- “Neutral”

**RESULT 2** The status for the kickout displays the following result:

- “Switch Turned Off”

**RESULT 3** The status for the kickout displays the following result:

- “Brake”

**RESULT 4** The status for the kickout displays the following result:

- “Vehicle Speed < Limit”

- “Bad Vehicle Speed”
- “Vehicle Speed  $\geq$  Limit”

**RESULT 5** The status for the kickout displays the following result:

- “PTO Switch ON”

**RESULT 6** The status for the kickout displays the following result:

- “Clutch”

**RESULT 7** The status for the kickout displays the following result:

- “No Engine Speed”

**Results:**

- **Result 1** – Proceed to Test Step 5.
- **Result 2**

**Repair:** Perform the following diagnostic procedure:

Troubleshooting, “Cruise Control Switch Circuit - Test”

**STOP.**

- **Result 3**

**Repair:** Perform the following diagnostic procedure:

Troubleshooting, “Service Brake Pedal Position (Switch 1) Circuit - Test”

**STOP.**

- **Result 4**

**Repair:** Perform the following diagnostic procedure:

Troubleshooting, “Vehicle Speed Circuit - Test”

**STOP.**

- **Result 5**

**Repair:** Perform the following diagnostic procedure:

Troubleshooting, “PTO Switch Circuit - Test”

**STOP.**

- **Result 6**

**Repair:** Perform the following diagnostic procedure:

Troubleshooting, “Clutch Pedal Position Switch Circuit - Test”

**STOP.**

- **Result 7**

**Repair:** Perform the following diagnostic procedure:

Troubleshooting, “Engine Speed/Timing Circuit - Test”

**STOP.**

**Test Step 5. Check the Switch Circuit for the ECM**

- Turn the key switch to the OFF position.
- Fabricate a jumper wire 100 mm (4 inch) long. Crimp a Deutsch pin to both ends of the wires.
- Disconnect the P1 ECM connector from the ECM.
- Connect a 140-2266 Cable (Seventy-Pin Breakout) between the P1 ECM connector and the ECM.
- Install the jumper into terminal 62 (Neutral Switch) of the breakout T. Connect the other end of the jumper to terminal 52 (Unswitched +Battery) of the breakout T.
- Turn the key switch to the ON position.
- Connect the electronic service tool to the data link connector.
- Access the status screen on the electronic service tool.
- While the status for the “Transmission Neutral Switch” is being monitored on the status screen slowly remove the jumper from terminal 52 (Unswitched +Battery). Now, slowly insert the jumper into terminal 52 (Unswitched +Battery).

**Expected Result:**

When the jumper wire is installed, the status for the “Transmission Neutral Switch” is “On”. When the jumper wire is removed, the status for the “Transmission Neutral Switch” is “Off”.

**Results:**

- **OK** – The ECM is functioning properly. Proceed to Test Step 6.

- **Not OK** – The ECM is not functioning properly.

**Repair:** Perform the following repair:

1. Temporarily connect a test ECM.
2. Remove all jumpers and replace all connectors.
3. Recheck the system for active diagnostic codes.
4. Repeat the Test Step.
5. If the problem is resolved with the test ECM, reconnect the suspect ECM.
6. If the problem returns with the suspect ECM, replace the ECM.
7. Verify that the repair eliminates the problem.

**STOP.**

### **Test Step 6. Insert a Jumper at the Neutral Switch**

- A. Turn the key switch to the OFF position.
- B. Ensure that the J1/P1 ECM connector is connected.
- C. Find the neutral switch in the vehicle.
- D. Disconnect the wires from the neutral switch terminals.
- E. Turn the key switch to the ON position.
- F. Connect the electronic service tool to the data link connector.
- G. Access the status screen on the electronic service tool.
- H. While the status for the "Transmission Neutral Switch" is being monitored, connect the switch wires and disconnect the switch wires.

#### **Expected Result:**

When the switch wires are connected, the status for the "Transmission Neutral Switch" is "On". When the switch wires are disconnected, the status for the "Transmission Neutral Switch" is "Off".

#### **Results:**

- **OK** – The switch is not functioning properly.

**Repair:** Perform the following repair:

Replace the faulty switch.

Verify that the repair eliminates the problem.

**STOP.**

- **Not OK** – There is a problem in the harness between the switch and the ECM. Proceed to Test Step 7.

### **Test Step 7. Insert a Jumper at the Bulkhead Connector**

- A. Turn the key switch to the OFF position.
- B. Fabricate a jumper wire 100 mm (4 inch) long. Crimp a Deutsch pin to each end of the wires.
- C. Find the neutral switch terminal and the +Battery connection in the engine side of the bulkhead connector for the vehicle harness.
- D. Insert the jumper wire between the two terminals in the engine side of the bulkhead connector.
- E. Turn the key switch to the ON position.
- F. Connect the electronic service tool to the data link connector.
- G. Access the status screen on the electronic service tool.
- H. While the switch status is being monitored, alternately remove the jumper wire between the two terminals, and alternately insert the jumper wire between the two terminals.

#### **Expected Result:**

When the jumper wire is installed, the status for the "Transmission Neutral Switch" is "On". When the jumper wire is removed, the status for the "Transmission Neutral Switch" is "Off".

#### **Results:**

- **OK** – The problem is in the vehicle wiring between the bulkhead connector and the switch.

**Repair:** Perform the following repair:

Inspect the vehicle wiring and repair the vehicle wiring, as required. If the problem still exists with the wiring, send the vehicle to the OEM dealer.

**STOP.**

- **Not OK** – The problem is in the vehicle wiring between the bulkhead connector and the ECM.

**Repair:** Perform the following repair:

Inspect the vehicle wiring and repair the vehicle wiring, as required. If the problem still exists with the wiring, send the vehicle to the OEM dealer.

STOP.

i01909566

## Powertrain Data Link Circuit - Test

**SMCS Code:** 1901-038

### System Operation Description:

#### Power train Data Links

Power train data links are designed to facilitate communication and control between electronically controlled Anti-Lock Brakes (ABS), traction control systems, transmissions, and engines. Typical control would include a momentary reduction of engine rpm and/or engine torque, that is triggered by a signal from an off-engine control module such as the ABS, the traction control, or the transmission. An off-engine control module is a control module that is not part of the Caterpillar engine control system.

Any combination of the following systems may be installed together on a vehicle:

- Traction Control
- Transmission Control
- ABS

The required components are installed at the OEM when the vehicle is built.

Powertrain data link wiring, off-engine control modules, and wiring are installed by the vehicle OEM. Questions that are related to the hardware configuration, software, and installation should be directed to the vehicle OEM.

The following two power train data links are available:

- SAE J1922
- SAE J1939

The J1922 and J1939 refers to the standard for data link communications of the Society of Automotive Engineers Inc.. The ECM has a customer programmable parameter that is called "Powertrain Data Link" which can be programmed to any one of the following options:

- J1922
- J1939
- J1922 and J1939
- None

### Anti-Lock Brake Systems (ABS)

The "Powertrain Data Link" may be used by an anti-lock brake system (ABS) in order to disable the engine retarder when the anti-lock brake control determines that the engine retarder should be disabled. This is usually achieved when the ABS system is active.

### Traction Control Systems

Loss of traction is determined by sensors on the vehicle that are mounted near the wheels. These sensors are also used by the ABS system. Typically, a system with traction control includes Anti-Lock brakes.

### Transmission Control

The following characteristics are determined by a vehicle speed sensor in the transmission:

- Transmission shift points
- Engine rpm
- Load

The sensors for power train control provide signals to the vehicle control module of the "Powertrain Data Link". The vehicle control module of the "Powertrain Data Link" then communicates with the engine ECM. The engine ECM receives a request from the "Powertrain Data Link". The engine ECM responds by momentarily limiting the following characteristics:

- Engine rpm
- Torque
- Both Engine rpm and Torque

The presence of an active J1922 data link circuit can be determined by observing the "Powertrain Status" screen on the Caterpillar Electronic Technician (Cat ET). The status screen will display "Installed" if the proper software is installed in the ECM, and there is no action that is being requested at that time by any of the control modules on the data link.

If an action is being requested by one of the vehicle control modules, the display will indicate the control that is making the request (Traction Control or Transmission Control) or a combination of the two (Traction Control and Transmission Control). Power train control is also displayed in the upper right hand corner of the display status screen. This space is replaced by the low oil pressure indicator, when a condition of low oil pressure exists.

**J1922 Data Link**

SAE J1922 is standard with all software.

**Note:** The J1922 data link wires are a twisted pair. The twisted pair is used to reduce electromagnetic interference. If a section of wiring must be replaced, the new wires should also be a twisted pair. Use care to maintain the polarity of the original wire when the pins and the sockets are being installed into the connectors.

**J1939 Data Link**

SAE J1939 is standard with all software.

**Note:** The wiring for the J1939 data link is a shielded twisted pair cable and the wiring is not serviceable. The wiring must be replaced when the wiring is damaged.

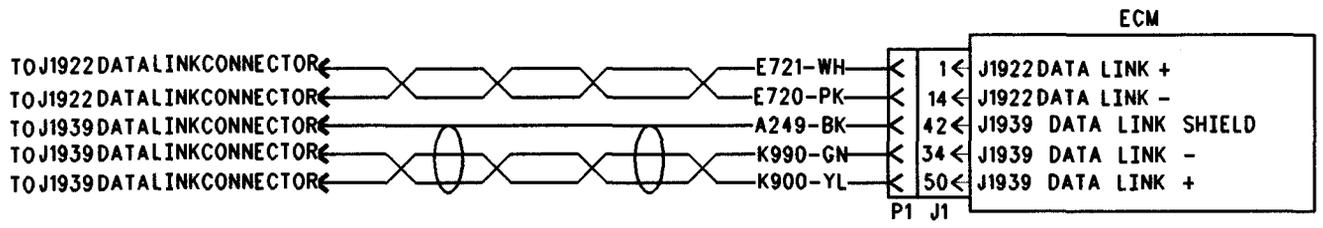
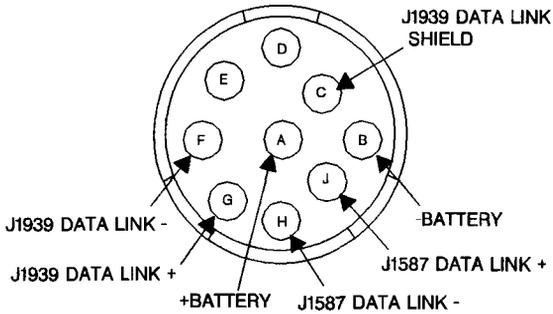
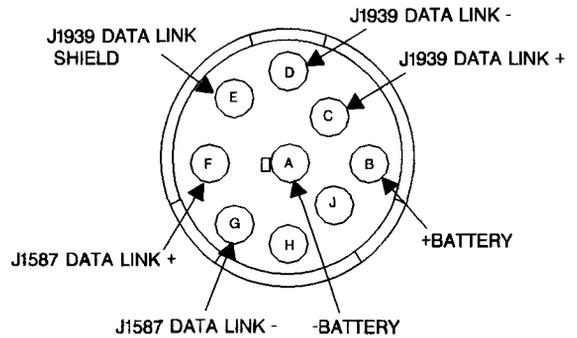


Illustration 142  
 Schematic for Power train data link



**DEUTSCH 9-TERMINAL CONNECTOR**  
 Does not require an Adapter Harness for connection to the Service Tool Cable



**DEUTSCH J1939 CAB CONNECTOR**  
 Requires 157-4829 Adapter Harness for connection to the Service Tool Cable

Illustration 143  
 ECM pin locations

g00714306

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

**A.** Thoroughly inspect the J1/P1 ECM connector, the firewall bulkhead connector, the connectors for the power train control module, and the connector terminals for the SAE J1922 data link or the connector terminals for the J1939 data link. Refer to Troubleshooting, “Electrical Connectors - Inspect” for details.

**B.** Perform a 45 N (10 lb) pull test on each of the wires in the ECM connector that are associated with the SAE J1922 data link or the J1939 data link.

Refer to Illustration 145.

**C.** Check the ECM connector (allen head screw) for the proper torque of 6.0 N·m (55 lb in).

**D.** Check the harness and wiring for abrasion and pinch points from the data link connectors back to the ECM.

**Expected Result:**

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

**Results:**

- OK – Proceed to Test Step 2.
- Not OK

Repair: Perform the following repair:

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

Verify that the repair eliminates the problem.

STOP.

**Test Step 2. Check for Active Diagnostic Codes**

**A.** Connect Cat ET to the data link connector.

**B.** Turn the key switch to the ON position.

**C.** Monitor the active diagnostic code screen on Cat ET. Check and record active diagnostic codes.

**Expected Result:**

There is an active diagnostic code for the SAE J1922 data link or the SAE J1939 data link.

**Note:** The “Powertrain Data Link” parameter is a customer parameter that must not be programmed to J1939, or J1922 and J1939, unless the J1939 data link is being used.

**Results:**

- J1939 – Proceed to Test Step 3.
- J1922 – Proceed to Test Step 5.
- Not OK – Proceed to Test Step 4.

**Test Step 3. Check the Devices on the J1939 Data Link.**

**A.** Connect Cat ET to the data link connector.

**B.** Access the special test “J1939 Receive Communication Status”. The special tests are located under the Diagnostic menu.

**C.** Cat ET will display the J1939 sources that have transmitted at least one good message that has been successfully received by the ECM. If the ECM has not received any messages from a source, that source will not be displayed. Examples of devices that can use the J1939 data link include the following switches:

- Switches that are programmed to “Instrument Cluster”
- Switches that are programmed to “Body Controller”
- Switches that are programmed to “Cab Controller”

**D.** Cat ET will display the J1939 source in the “Description” column. The “Status” column displays the status of the device.

**E.** If an expected message is not received from a device, Cat ET will display “Not Receiving”.

**F.** The status screen on Cat ET can be set to display the status of a device that is not working. The status screen will display “No Comm” if a message is not received from the device.

**Expected Result:**

Cat ET displays the devices that are used on the vehicle and the ECM is receiving messages from the devices.

**Results:**

- **Yes** – The ECM is receiving messages from the devices that are installed on the vehicle. **STOP.**

- **No** – The ECM is not receiving messages from the devices that are installed on the vehicle.

*Repair:* The devices that can be programmed to use the J1939 data link can be circuits with two wires or circuits with three wires. Bad connections are the most frequent problem. Repair the suspect component or replace the suspect component. This may include the connectors, the wiring, and/or the device. Ensure that the connectors are free of corrosion.

**STOP.**

**Test Step 4. Check the Power Train Status Screen**

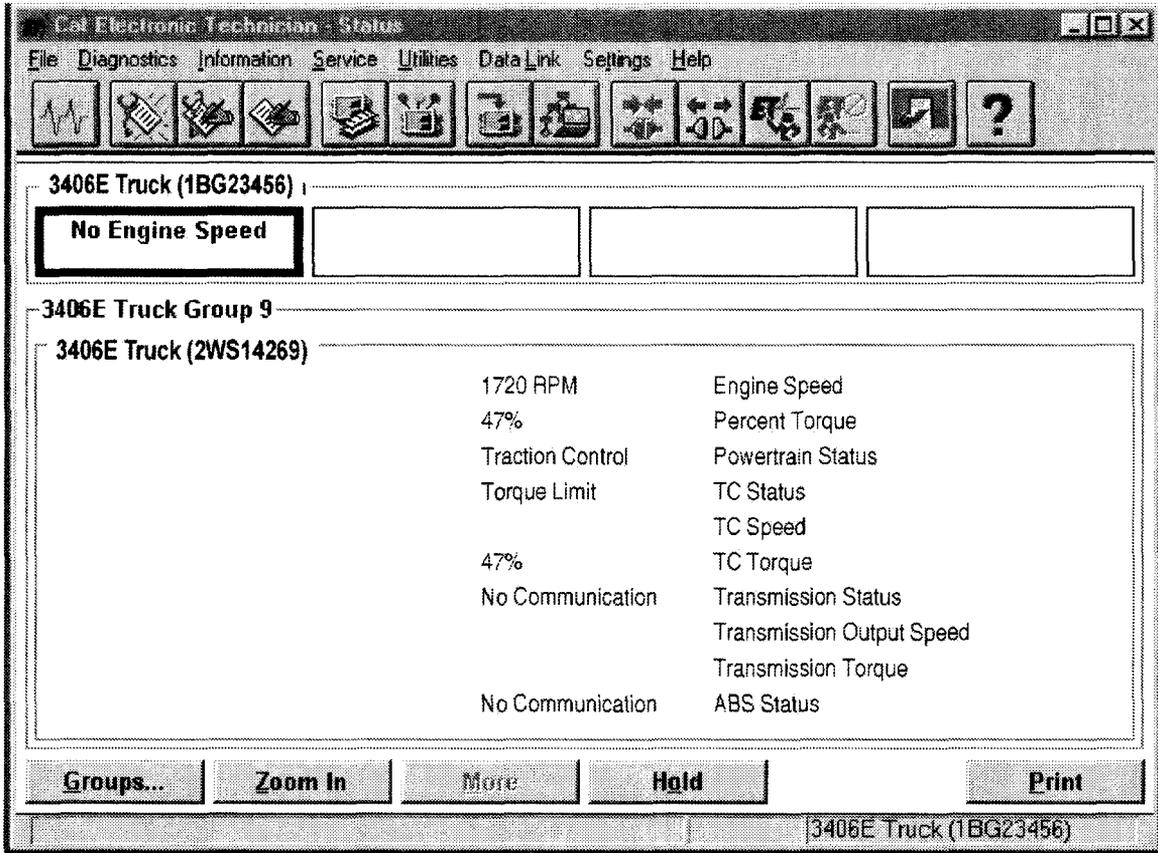


Illustration 144

g00714416

Table 152

Powertrain Status Group Definition Table		
Heading On Status Screen	Displayed Message	Definition of Message
Engine Speed		Actual Engine rpm of the engine
Percent Torque		Current engine torque during operation that is expressed as a percent of peak torque
Powertrain Status	“Not Installed”, “ABS Control”, “Traction Control”, “Traction and ABS Control”, “Trans Control”, “Trans and ABS Control”, “Trans and Traction Control”, “Trans and Traction and ABS”	Communication of the Power Train control module

(continued)

(Table 152, contd)

Powertrain Status Group Definition Table		
Heading On Status Screen	Displayed Message	Definition of Message
<b>TC Status or Transmission Status</b>	"No Communication"	Communication from the vehicle control is not being received by the ECM. One of the following conditions exists: The vehicle does not support this feature. The vehicle control is not currently powered, or the wiring is damaged or disconnected.
	"Not Active"	No requests from the Vehicle Power Train ECU (Electronic Control Unit)
	"Speed Command"	Engine rpm is being controlled by a Vehicle ECU.
	"Torque Command"	Engine torque is being controlled by a Vehicle ECU.
	"Speed and Torque Limit"	Engine rpm and torque is being determined by a Vehicle ECU.
	"Torque Limit"	The Torque limit is being determined by a Vehicle ECU.
	"Speed Limit"	The rpm limit is being determined by a Vehicle ECU.
<b>TC Speed</b>		The TC Speed is the desired engine rpm setpoint or the engine rpm limit that is being requested by the Vehicle's Traction Control ECU.
<b>TC Torque</b>		The TC Torque is the desired percent of torque or the desired percent of torque limit that is being requested by the Vehicle's Traction Control ECU.
<b>Transmission Output Speed</b>		The Transmission Output Speed is the desired engine rpm setpoint or the engine rpm limit that is being requested by the Vehicle's Traction Control ECU.
<b>Transmission Torque</b>		The Transmission Torque is the desired percent of torque or the percent of torque limit that is being requested by the Vehicle's Traction Control ECU.
<b>ABS Status</b>	"No Communication"	The ECM is not receiving communication from the vehicle's ABS/Traction Control System. One of the following conditions exists: The vehicle does not support this feature. The vehicle's ABS/Traction Control System is not currently powered. The wiring is damaged or disconnected.
	"Not Active"	There are no requests from the ABS/Traction Control ECU .
	"Disable Retarder"	This is a request from the ABS/Traction Control ECU to the ECM. The ABS/Traction Control System requests the disabling of the Engine Retarder operation.

**A.** Connect Cat ET to the data link connector.

**B.** While the vehicle is being driven by someone else, monitor Cat ET. Use the following procedure:

- a. Access the status screen on Cat ET. Select the "Powertrain Status" screen. The "Powertrain Status" screen relates to the J1922 data link and J1939 data link.
- b. While the vehicle is being operated, monitor the "Powertrain Status" screen.

Refer to Table 152 for an explanation of the headings that are displayed in the "Powertrain Status" screen on Cat ET.

**Note:** Transmission shifts and/or a momentary loss of traction should trigger the appropriate action by the ECM when the correct sensors, controls and wiring are installed on the vehicle.

**Expected Result:**

The status screen indicates that the ECM is responding to a power train control.

**Note:** Some power train control modules have test modes that are available by activating diagnostic switches. Ensure that the Caterpillar ECM is not reacting to a test by the power train control module if the problem is related to power train control operation and you believe that the system should not be active.

**Results:**

- OK – If the response is abnormal, send the vehicle to the OEM dealer for repairs. **STOP.**
- Not OK

**Repair:** Perform the following diagnostic procedure:

Troubleshooting, "Troubleshooting without a Diagnostic Code"

**STOP.**

**Test Step 5. Disconnect the Data Link Lines from the ECM Connector**

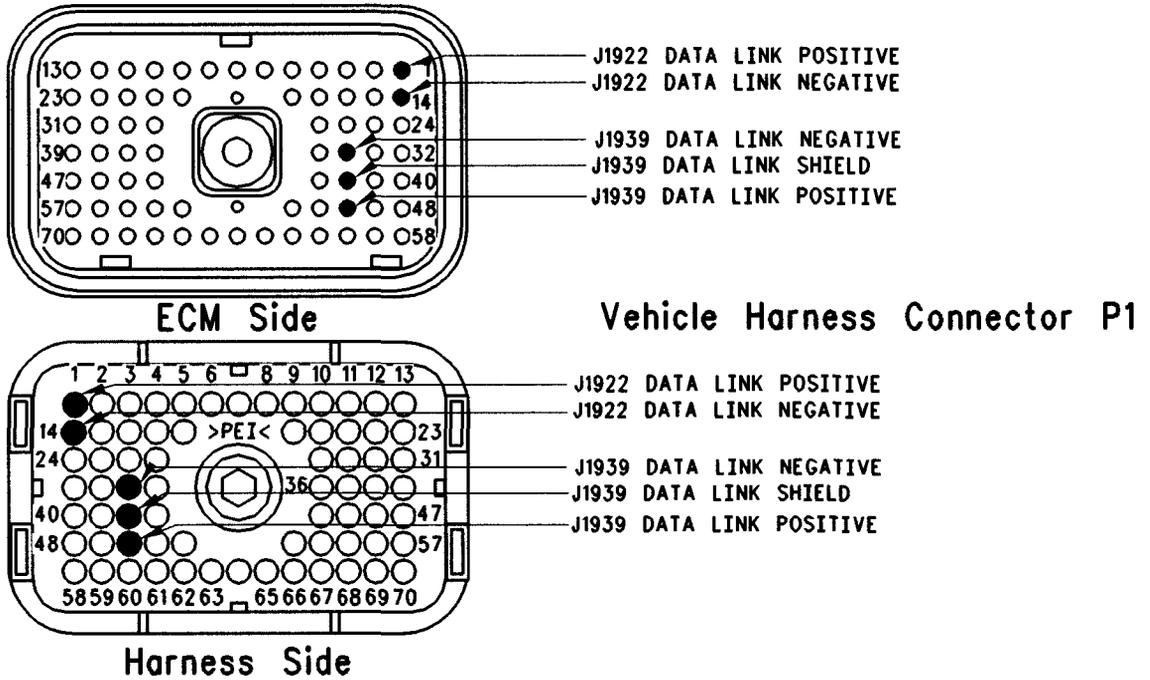


Illustration 145

g00652192

Terminal locations for ECM

- A. Turn the key switch to the OFF position.
- B. Remove the wires from J1/P1:14 (J1922 Data Link Negative) and J1/P1:1 (J1922 Data Link Positive). This may require disconnection of J1/P1 from the ECM.
- C. Reconnect vehicle harness connector P1 to the ECM when the wires are disconnected.
- D. Turn the key switch to the ON position.
- E. Monitor the active diagnostic code screen on Cat ET. Check and record active diagnostic codes.

**Expected Result:**

The following diagnostic code is active:

- 249-11 J1922 Data Link Fault (58)

**Note:** If the J1922 data link is not being used for the vehicle's power train control, program the "Powertrain Data Link" parameter to "None". After the "Powertrain Data Link" parameter is programmed to "None", the following active diagnostic code should be repaired:

- 249-11 J1922 Data Link Fault (58)

**Results:**

- OK

**Repair:** Perform the following diagnostic procedure:

1. Use the following procedure if the vehicle is not using the J1922 data link for power train control:
  - a. Leave the pins for the data link disconnected from the ECM.
  - b. Fill the unused cavities of connector P1 with Deutsch plugs.
  - c. Program the parameter for the "Powertrain Data Link" to "None".
2. Use the following procedure if the vehicle is using the J1922 data link for power train control:
  - a. Temporarily connect a test ECM.

- b. Repeat the Test Step.
- c. If the problem is resolved with the test ECM, reconnect the suspect ECM.
- d. If the problem returns with the suspect ECM, replace the ECM.

STOP.

- Not OK – The ECM is OK.

**Repair:** Perform the following diagnostic procedure:

1. Use the following procedure if the vehicle is not using the J1922 data link for power train control:
  - a. Leave the pins of the data link disconnected from the ECM.
  - b. Fill the unused cavities of connector P1 with Deutsch plugs.
  - c. Program the parameter for the “Powertrain Data Link” to “OFF”.
  - d. Verify that the repair eliminates the problem.
2. Use the following procedure if the vehicle is using the J1922 data link for power train control:
  - a. Send the vehicle to the OEM dealer for repair.
  - b. Verify that the repair eliminates the problem.

STOP.

i01625471

## PTO Engine RPM Set Speed (Input A and Input B) Circuit - Test

**SMCS Code:** 1901-038

### System Operation Description:

#### Use this procedure under the following situation:

Use this procedure to determine if the circuit for the PTO Engine RPM Set Speed “Input A” and “Input B” is operating correctly. This feature is available on NOV99 and newer software.

**The following background information is related to this procedure:**

The ECM can use various inputs in a number of ways. The inputs depend on the parameter programming. Certain features are available on several different inputs. The configuration for the switch must match the actual switch installation in order for the switch to function properly.

### Switch for “PTO Engine RPM Set Speed Input A”

The switch for the “PTO Engine RPM Set Speed Input A” is used to control engine RPM during PTO operation. The “PTO Engine RPM Set Speed A” parameter requires an engine RPM to be programmed. The “PTO Engine RPM Set Speed A” parameter is located in the “Dedicated PTO Parameter Group”. The “PTO Engine RPM Set Speed Input A” status is located in the “Input Selections Parameter Group”. The engine will ramp up to the engine rpm that is programmed under the following conditions:

- The switch for the “PTO Engine RPM Set Speed Input A” is in the ON position and the PTO On/Off switch is then turned on.
- The switch for the “PTO Engine RPM Set Speed Input A” is turned to the ON position when the PTO On/Off switch is on.

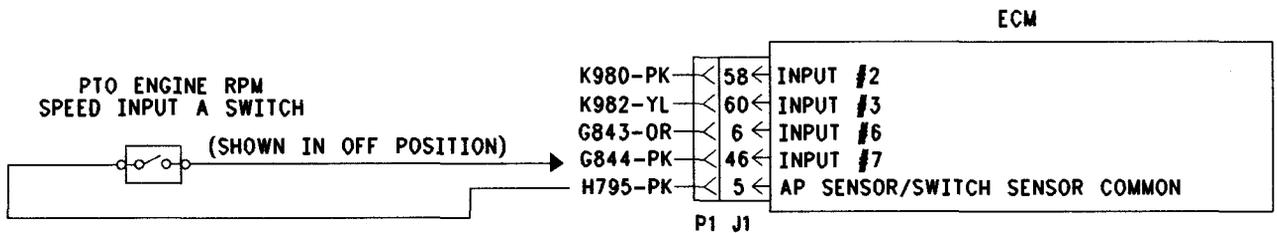
The “PTO Configuration” must be programmed to “Cab Switches”, “Remote Switches”, or “Remote Throttle” for this feature to function. The PTO On/Off switch or the switch for the “PTO Engine RPM Set Speed Input A” must be cycled from the OFF position to the ON position in order to return to the programmed engine rpm if the PTO operation is disabled. If the “PTO Engine RPM Set Speed Input A” parameter is programmed to None (default), this feature is not used. If the “PTO Engine RPM Set Speed Input A” parameter is programmed to one of the available inputs (J1/P1:6, J1/P1:46, J1/P1:58, J1/P1:60), the feature is available. Also, the switch circuit should be connected to the same input.

### Switch for the “PTO Engine RPM Set Speed Input B”

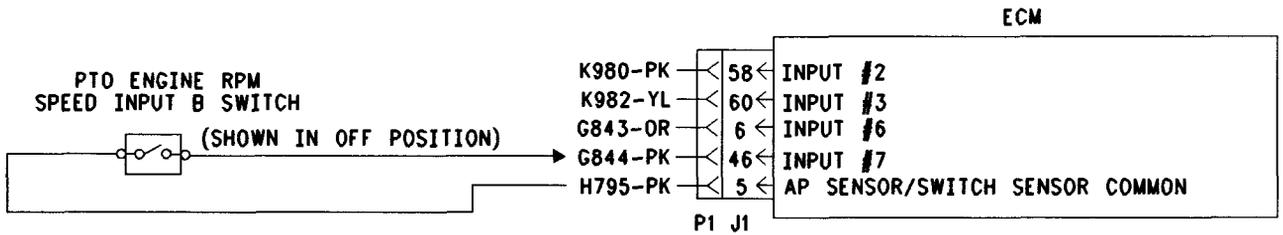
The switch for the "PTO Engine RPM Set Speed Input B" is used to control engine RPM during PTO operation. The "PTO Engine RPM Set Speed B" parameter requires an engine RPM to be programmed. The "PTO Engine RPM Set Speed B" parameter is located in the "Dedicated PTO Parameter Group". The "PTO Engine RPM Set Speed Input B" status is located in the "Input Selections Parameter Group". The function of the switch for the "PTO Engine RPM Set Speed Input B" is similar to the function of the switch for the "PTO Engine RPM Set Speed Input A". The engine will operate at set speed "A" when both of the switches are on. If the "PTO Engine RPM Set Speed Input B" parameter is programmed to "None" (default), this feature is not used. If the "PTO Engine RPM Set Speed Input B" parameter is programmed to one of the available inputs (J1/P1:6, J1/P1:46, J1/P1:58, J1/P1:60), then the feature is available. Also, the switch circuit should be connected to the same input option.

**Note:** The wiring for your particular application may be slightly different. The sensor common circuits are used interchangeably by the OEM of the vehicle. The following circuits are common within the ECM:

- The "Input Sensor Common 1" is terminal 18.
- The "Input Sensor Common 2" is terminal 3.
- The "A/P Sensor/Switch Sensor Common" is terminal 5.



**NOTE:** INPUT #2, #3, #6 OR #7 MAY BE USED. THE PTO ENGINE RPM SET SPEED INPUT A PARAMETER MUST BE PROGRAMMED TO THE INPUT SELECTION.



NOTE: INPUT #2, #3, #6 OR #7 MAY BE USED. THE PTO ENGINE RPM SET SPEED INPUT B PARAMETER MUST BE PROGRAMMED TO THE INPUT SELECTION.

Illustration 147

g00683021

This illustration represents the schematic for the "PTO Engine RPM Set Speed Input B" switch circuit.

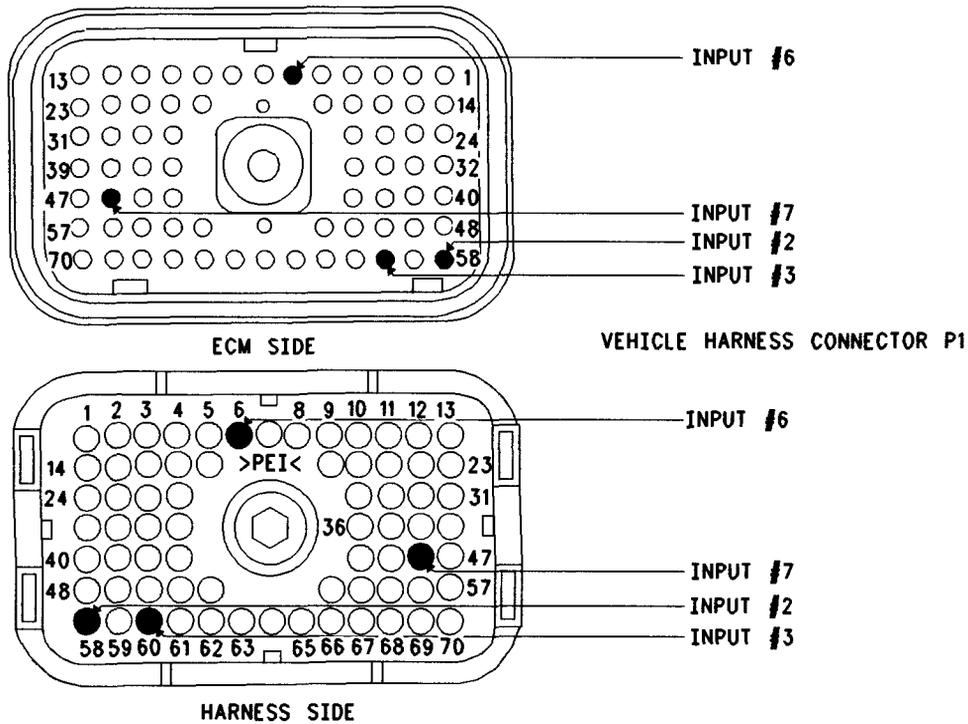


Illustration 148

g00683028

Terminal Locations for ECM

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

- A. Thoroughly inspect the ECM vehicle harness connector J1/P1, the connectors, and the firewall bulkhead connectors. Refer to Troubleshooting, "Electrical Connectors - Inspect" for details.
- B. Perform a 45 N (10 lb) pull test on each of the wires in the ECM connector that are associated with the suspect switch circuit.
- C. Check the ECM connector (allen head screw) for the proper torque of 6.0 N·m (55 lb in).

- D. Check the harness and the wiring for abrasion and pinch points from the battery to the ECM. Then, check from the ignition key switch to the ECM.

Refer to Illustration 148 for terminal locations for the ECM.

#### Expected Result:

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

**Results:**

- OK – Proceed to Test Step 2.
- Not OK

**Repair:** Repair the wiring and connectors or replace the wiring or the connectors. Ensure that all of the seals are properly connected.

Verify that the repair eliminates the problem.

STOP.

**Test Step 2. Check the Status of the “PTO Engine RPM Set Speed Input A” and “PTO Engine RPM Set Speed Input B” on ET**

- Connect the Caterpillar Electronic Technician (ET) to the cab data link connector.
- Turn the ignition key switch to the ON position.
- Operate the switch in the ON and OFF positions.
- View the switch status on ET.
- If the “PTO Engine RPM Set Speed Input A” status indicates “Not Installed”, then the parameter has not been programmed. If the “PTO Engine RPM Set Speed Input B” status indicates “Not Installed”, then the parameter has not been programmed.

**Expected Result:**

The status screen should indicate “ON” if the switch is turned on. The status screen should indicate “OFF” if the switch is off.

**Results:**

- OK – The switch is operating normally. Continue troubleshooting if the original condition is not resolved. STOP.
- Not OK – The ECM is not reading the switch status change. Proceed to Test Step 3.

### Test Step 3. Check the Switch Circuit for the ECM

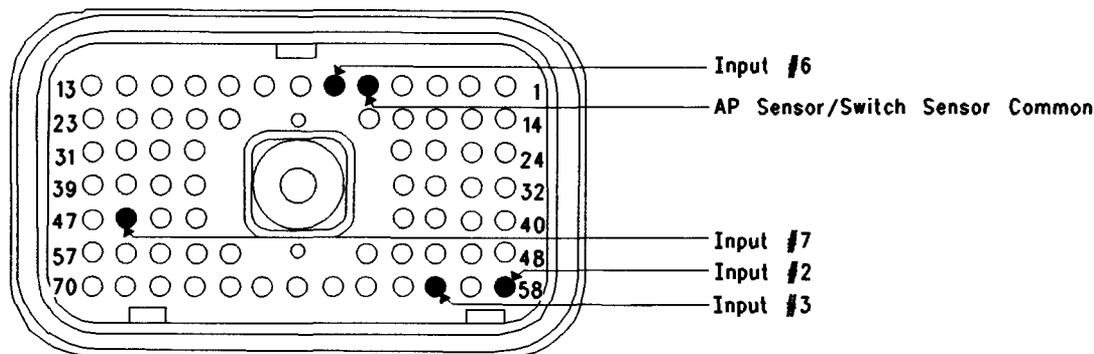


Illustration 149

g00683037

#### Connector for Breakout T

- A. Turn the ignition key switch to the OFF position.
- B. Install a 70 terminal breakout T to the ECM vehicle harness connector J1/P1.
- C. Fabricate a jumper wire 100 mm (4 inch) long. Crimp a Deutsch pin to both ends of the wire.
- D. Insert the jumper wire into the suspect switch socket of the breakout T. Connect the other end of the jumper wire to terminal 5 (AP Sensor/Switch Common) in the breakout T.
- E. Connect ET to the cab data link connector.
- F. Turn the ignition key switch to the ON position.
- G. Alternately remove the jumper wire and then insert the jumper wire from terminal 5. At the same time, monitor the status screen on ET.

#### Expected Result:

The switch status changes to "ON" with the jumper wire in place. The switch status changes to "OFF" when the jumper wire is removed.

#### Results:

- OK – The ECM is functioning properly at this time. Proceed to Test Step 4.
- Not OK – The ECM is not functioning properly.

Repair: Perform the following repair:

1. Temporarily connect a test ECM. Only connect ECM harness J1/P1.
2. Recheck for an +5 V diagnostic code when the engine harness is disconnected.

3. If the problem is resolved with the test ECM, reconnect the suspect ECM.
4. If the problem returns with the suspect ECM, replace the ECM.

STOP.

### Test Step 4. Insert a Jumper Wire at the Switch

- A. Turn the ignition key switch to the OFF position.
- B. Reconnect the ECM vehicle harness connector J1/P1.
- C. Fabricate a jumper wire 100 mm (4 inch) long. Crimp a Deutsch pin to both ends of the wire.
- D. Insert the jumper wire between the two switch terminals.
- E. Turn the ignition key switch to the ON position.
- F. Alternately remove the jumper wire and then insert the jumper wire at the switch terminals. At the same time, watch the status screen on ET.

#### Expected Result:

The switch status changes to "ON" with the jumper wire in place. The switch status changes to "OFF" when the jumper wire is removed.

#### Results:

- OK

Repair: Perform the following diagnostic procedure:

Replace the switch. Verify that the repair eliminates the problem.

STOP.

- **Not OK** – There is a problem in the wire harness between the switch and the ECM. Proceed to Test Step 5.

### Test Step 5. Insert a Jumper Wire at the Bulkhead Connector

- Turn the ignition key switch to the OFF position.
- Fabricate a jumper wire 100 mm (4 inch) long. Crimp a Deutsch pin to both ends of the wire.
- Locate the suspect switch socket in the engine side of the ECM bulkhead connector.
- Insert the wire jumper pin between the switch socket and the sensor common connection. Install the jumper wire on the engine side of the ECM bulkhead connector.
- Turn the ignition key switch to the ON position.
- Alternately connect and then disconnect the jumper wire. At the same time, monitor the status screen on ET.

#### Expected Result:

The switch status changes from "ON" with the jumper wire in place. The switch status changes to "OFF" when the jumper wire is removed.

#### Results:

- **OK** – The problem is in the vehicle wiring between the bulkhead connector and the switch. Inspect the vehicle wiring and then repair the vehicle wiring. Otherwise, send the vehicle to the OEM dealer for repair. Verify that the original condition is resolved. **STOP.**
- **Not OK** – The problem is in the vehicle wiring between the bulkhead connector and the ECM. Inspect the vehicle wiring and then repair the vehicle wiring. Otherwise, send the vehicle to the OEM dealer for repair. Verify that the original condition is resolved. **STOP.**

## PTO Shutdown Timer - Test

**SMCS Code:** 1901-038

### System Operation Description:

#### Use this procedure under the following situation:

Use this procedure to determine if the PTO Shutdown is operating correctly.

#### The following background information is related to this procedure:

### PTO Shutdown Timer

A programmable parameter for the PTO Shutdown Timer is provided. This timer will shut down the engine when all of the following conditions are met:

- The PTO shutdown time that is programmed has expired.
- The ECM is programmed to use "Dedicated PTO" parameters.
- The PTO on/off switch is ON and the ECM is in the dedicated PTO mode.
- The engine is not in the Cold Mode.

During the last 90 seconds of the PTO Shutdown Timer, the check engine lamp will begin flashing. If the vehicle is equipped with a PTO switch on lamp, the PTO switch on lamp will begin flashing during the last 90 seconds.

If the PTO shutdown timer is activated and the timer stops the engine, the following event code will be generated.

- 71-14 PTO Shutdown (47)

**Note:** Fuel rates are not monitored while the PTO shutdown timer is active. Shutdown will occur regardless of load. Unlike the idle shutdown timer, the PTO shutdown timer cannot be overridden by using the clutch pedal or the brake pedal.

### Test Step 1. Verify Activation of the PTO Shutdown Timer

- Connect the electronic service tool to the data link connector.
- Access the Customer Parameters on the electronic service tool. Access the following display screens in order:

- “Service”
  - “Configuration”
- a. Record the programmed PTO shutdown time. The PTO shutdown Time must be between 3 and 1440 minutes. If the PTO shutdown time is programmed to 0, the timer is disabled.
- C.** Start the engine. Allow the engine to warm up until the coolant temperature is 38 °C (100 °F). Allow the engine to operate at the programmed low idle and turn off any unnecessary accessory devices.
- D.** Ensure that all unnecessary loads are turned off.
- E.** Use the following procedure in order to check the operation of the PTO shutdown:
- a. Park the vehicle.
  - b. Ensure that the PTO configuration is programmed to “Cab Switches”, “Remote Switches” or “Remote Throttle”.
  - c. Ensure that the status of the PTO on/off switch is on.
  - d. Observe the status of the “PTO Shutdown”.

**Expected Result:**

**Result 1** The status of the parameter for “PTO Shutdown” indicates “COUNTING”.

**Result 2** The ECM is not reading the proper conditions for activation of the timer.

**Results:**

- **Result 1** – The ECM is reading the proper conditions for the activation of the PTO shutdown timer. Proceed to Test Step 2.
- **Result 2** – Proceed to Test Step 3.

**Test Step 2. Use the Electronic Service Tool to Verify the Driver Alert Function of the PTO Shutdown**

- A.** Connect the electronic service tool to the data link connector.
- B.** Use the following procedure in order to activate the PTO shutdown timer:
  - a. Access the “Customer Parameters” on the electronic service tool. Access the following display screens in order:
    - “Service”

- “Configuration”

- b. Record the programmed PTO shutdown time. The PTO shutdown time must be between 3 and 1440 minutes. If the PTO shutdown time is programmed to 0, the timer is disabled.

- c. Reprogram the PTO shutdown time to 3 minutes for this test.

- C.** Observe the following items during the 90 second period before the programmed shutdown time:

- Check engine lamp
- Status of the PTO shutdown timer
- PTO switch on lamp

During the 90 second period before the scheduled shutdown, the status should change from “COUNTING” to “DRIVER ALERT”. The check engine lamp and the PTO switch on lamp should flash rapidly.

**Note:** A PTO switch on lamp is an optional feature and the PTO switch on lamp may not be installed.

- D.** Reprogram the PTO shutdown timer to the value that was recorded earlier for this test.

**Expected Result:**

**Result 1** The driver alert function of the PTO shutdown operates in the manner that is described above.

**Result 2** The PTO switch on lamp did not flash.

**Result 3** The check engine lamp did not flash.

**Results:**

- **Result 1** – The PTO shutdown timer is operating properly. Clear all diagnostic codes. **STOP.**
- **Result 2** – The PTO switch on lamp did not flash during the driver alert.

**Repair:** Perform the following diagnostic procedure: Troubleshooting, “PTO Switch ON Lamp Circuit - Test”

**STOP.**

- **Result 3** – The check engine lamp did not flash during the driver alert.

**Repair:** Perform the following diagnostic procedure:

Troubleshooting, "Check Engine Lamp Circuit - Test"

STOP.

### Test Step 3. Check the State of the Related Conditions when the Vehicle is Parked

**A.** Check the state of the following related conditions when the vehicle is parked:

- a. Ensure that the vehicle speed is 0 km/h (0 mph) on the electronic service tool or the dash display.
- b. Ensure that the engine is not in cold mode.

**Note:** The electronic service tool status screen will indicate if the cold mode is active.

- c. Ensure that the PTO on/off switch is on.

#### Expected Result:

**Result 1** Vehicle speed is not indicated as 0 km/h (0 mph).

**Result 2** The electronic service tool status screen indicates that the engine is in the cold mode.

**Result 3** The PTO on/off switch is not on.

#### Results:

- **Result 1** – Continue by testing the vehicle speed circuit.

**Repair:** Perform the following diagnostic procedure: Troubleshooting, "Vehicle Speed Circuit - Test"

STOP.

- **Result 2** – The engine must not be in cold mode operation while this test procedure is being performed. Allow the engine to run until the coolant temperature exceeds 38 °C (100 °F). Troubleshoot and repair any related conditions.  
STOP.

- **Result 3** – Continue by testing the circuit for the PTO on/off switch.

**Repair:** Perform the following diagnostic procedure: Troubleshooting, "PTO Switch Circuit - Test"

STOP.

## PTO Switch Circuit - Test

**SMCS Code:** 7332-038

### System Operation Description:

**Use this procedure under the following situation:**

Use this procedure to determine that the vehicle wiring and the ECM are functioning properly for the features of Dedicated PTO.

**The following background information is related to this procedure:**

#### INPUT 1

J1/P1:56 Input 1 is used for the circuit for the PTO on/off switch when the PTO Configuration is programmed to "Cab Switches", "Remote Switches", or "Remote Throttle".

When the PTO on/off switch is on, the ECM will be in Dedicated PTO mode.

When the ECM is in the Dedicated PTO mode the PTO Top Engine Limit (TEL) is activated. The engine may proceed directly to the PTO engine rpm set speed if the parameter is programmed. If a PTO switch on lamp is connected to the J1/P1:30 Output 1, the PTO switch on lamp will turn on whenever the PTO on/off circuit is on.

**If the problem is with undetermined PTO kickouts, use the following procedure:**

Operate the vehicle in PTO mode.

After the kickout, review the status parameter on the electronic service tool. The status parameter indicates the cause of the kickout. This must be performed before the ignition key switch is turned off. It is important to remember that the parameter will only indicate the last kickout since the ECM has been powered by the ignition key switch.

This parameter is blank when the ECM is first powered up. If this parameter is blank "Not Kicked Out" is indicated. This parameter remains blank until the ECM detects the use of the PTO mode. Also, this parameter remains blank until the ECM detects the disengagement of PTO mode. Refer to Table 153 in order to interpret the status parameter.

The following kickout status parameter is available:

- PTO kickout

PTO interlocks may also be connected in series with the PTO on/off switch. The interlocks are intended to prevent the PTO on/off circuit from activating unless certain conditions are met.

## INPUT 2

J1/P1:58 Input 2 is used for the PTO set switch when the "PTO Configuration" is programmed to "Remote Switches" or "Remote Throttle". The PTO set switch can also be used to increase engine rpm.

## INPUT 3

J1/P1:60 Input 3 is used for the PTO resume switch when the "PTO Configuration" is programmed to "Remote Switches" or "Remote Throttle". The PTO resume switch can also be used to decrease engine rpm.

### The PTO Configuration Is Set To Cab Switches.

When the "PTO Configuration" is programmed to "Cab Switches" and the PTO on/off switch is on, the following circuits can be used to interrupt a set rpm:

- Cruise control set/resume switch
- Service brake pedal position switch 1
- Service brake pedal position switch 2
- Clutch pedal position switch
- Neutral switch
- Cruise Control Pause Switch

When the "PTO Configuration" is programmed to "Cab Switches" and the PTO on/off switch is on, the accelerator pedal position sensor that is located in the cab can be limited to one of the following settings by using the "PTO Cab Throttle RPM Limit" parameter:

- Low idle
- PTO Top Engine Limit
- Top engine limit

### The "PTO Configuration" Is Programmed To "Remote Switches" or "Remote Throttle".

When the "PTO Configuration" is programmed to "Remote Switches" or "Remote Throttle" and the PTO on/off switch is on, the following circuits are ignored:

- Service brake pedal position switch 1
- Service brake pedal position switch 2

- Clutch pedal position switch
- Neutral switch
- Accelerator pedal position sensor
- Cruise control set/resume switch that is located in the cab

A remote accelerator pedal position sensor is connected to J1/P1:68 Input 8 when the "PTO Configuration" is programmed to "Remote Throttle".

**Note:** The wiring for your particular application may be slightly different. The circuits for the sensor common are used interchangeably by the OEM of the vehicle. The following circuits are common within the ECM:

- J1/P1:18 (sensor common 1)
- J1/P1:3 (sensor common 2)
- J1/P1:5 (AP sensor/switch sensor common)

Table 153

Table For The PTO Kickout Status Screen On The Electronic Service Tool		
Cat ET	Meaning or Possible Cause	Troubleshooting
"No Engine Speed"	Intermittent engine speed signal or lost engine speed signal.	Refer to Troubleshooting, "Speed/Timing Circuit - Test".
"Switch Turned Off"	The PTO On/Off switch is turned OFF or the switch circuit has an open circuit condition.	Proceed with this test procedure.
"Cruise Control PAUSE Switch"	The cruise control pause switch is depressed or there is an illegal message on the J1939 data link.	Refer to Troubleshooting, "Powertrain Data Link Circuit - Test".
"Brake Pedal Depressed"	The service brake pedal is depressed or the circuit for the service brake switch has an open circuit condition.	Refer to Troubleshooting, "Service Brake Pedal Position Switch 1 Circuit - Test".
"Clutch Pedal Depressed"	The clutch pedal is depressed or the circuit for the clutch pedal switch has an open circuit condition. Also, the switch could be incorrectly adjusted.	Refer to Troubleshooting, "Clutch Pedal Position Switch Circuit - Test".
"Vehicle Speed $\geq$ Limit"	The vehicle speed has exceeded the speed that is programmed into the "PTO Vehicle Speed Limit" parameter or the vehicle speed signal is erratic or intermittent.	Refer to Troubleshooting, "Vehicle Speed Circuit - Test" if a problem with the signal exists.
"Neutral"	The transmission is not in neutral or the transmission neutral switch circuit has an open circuit condition.	Refer to Troubleshooting, "Neutral Switch Circuit - Test".
"Not Kicked Out"	The PTO has not been enabled since the ECM has been powered up.	Operate the vehicle in the PTO mode in order to create the problem again.

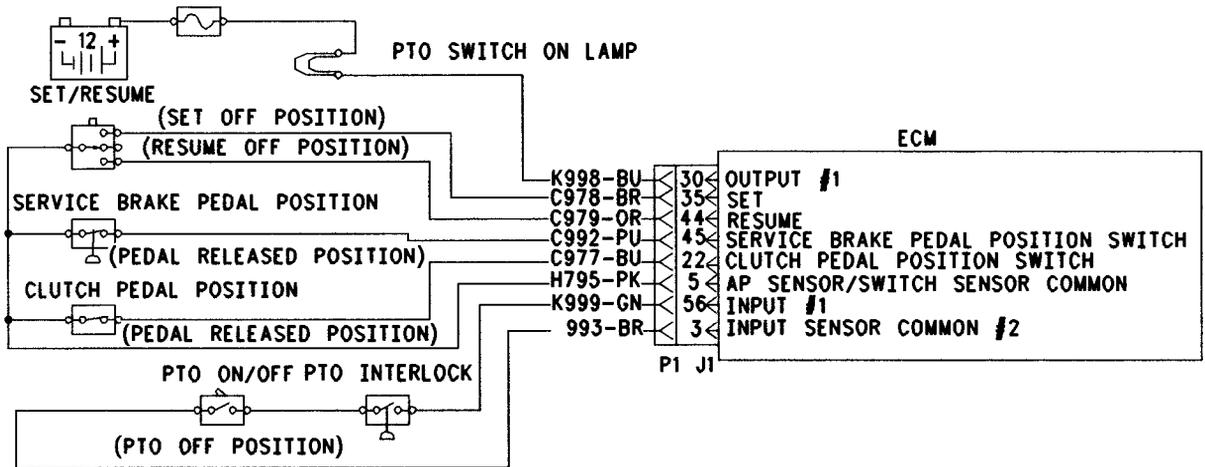


Illustration 150  
Circuit schematic for "Cab Switches" configuration

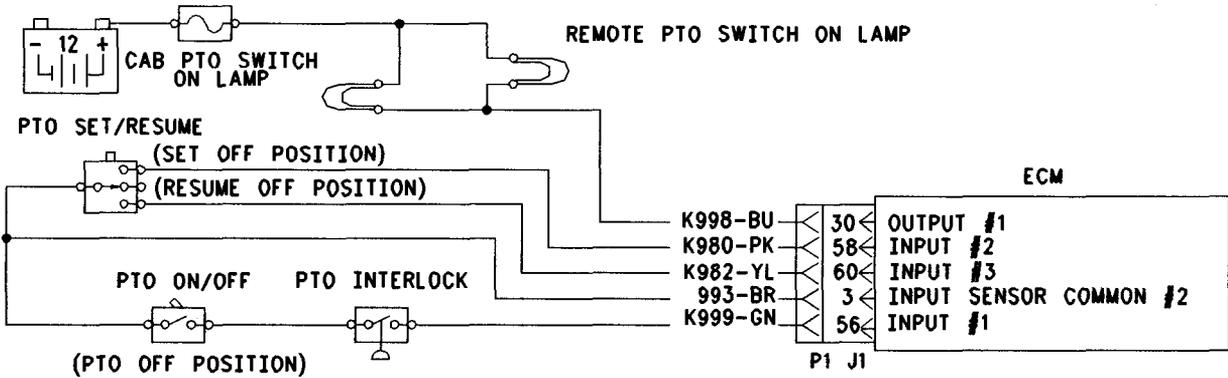


Illustration 151  
Circuit schematic for "Remote Switches" configuration

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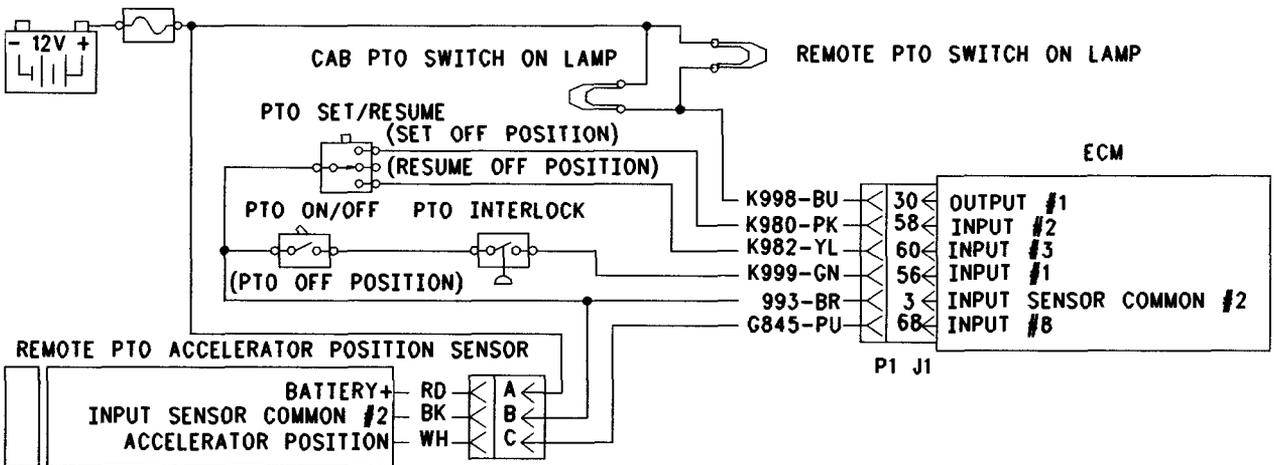


Illustration 152  
Circuit schematic for "Remote Throttle" configuration

g00644448

### Test Step 1. Use the Electronic Service Tool to Check the Programming of the Parameter "Dedicated PTO Parameters"

- A. Connect the electronic service tool to the data link connector.
- B. Turn the ignition key switch to the ON position.
- C. Access the "Dedicated PTO Parameters" on the electronic service tool. Note the programming of the parameter "PTO Configuration".

#### Expected Result:

The "PTO Configuration" is programmed to "Cab Switches", "Remote Switches", or "Remote Throttle".

#### Results:

- Yes – Proceed to Test Step 2.
- No – The Dedicated PTO features are not programmed for this engine. If PTO operation is desired, the "PTO Configuration" must be programmed to "Cab Switches", "Remote Switches", or "Remote Throttle". STOP.

## **Test Step 2. Determine the Truck OEM Wiring Installation of the PTO**

- A.** From the programming of the parameter for the "PTO Configuration", review the truck wiring in order to determine the method of installation of the wiring. Talk to the driver about the use of the PTO.
- B.** Check the cab glove box for any information regarding the installation of the PTO. It is important to understand the location and the function of the interlock switches for the PTO.
- C.** Contact the installer of the components that are used for the PTO, if necessary.
- D.** Determine the schematic that most closely matches the installation. Review the schematics in this procedure for each of the options for the specific "PTO Configuration" of the truck.
- E.** Record the "PTO Configuration".

### **Expected Result:**

The requirements for the installation and the application have been reviewed.

### **Results:**

- OK – Proceed to Test Step 3.

### Test Step 3. Inspect Electrical Connectors and Wiring

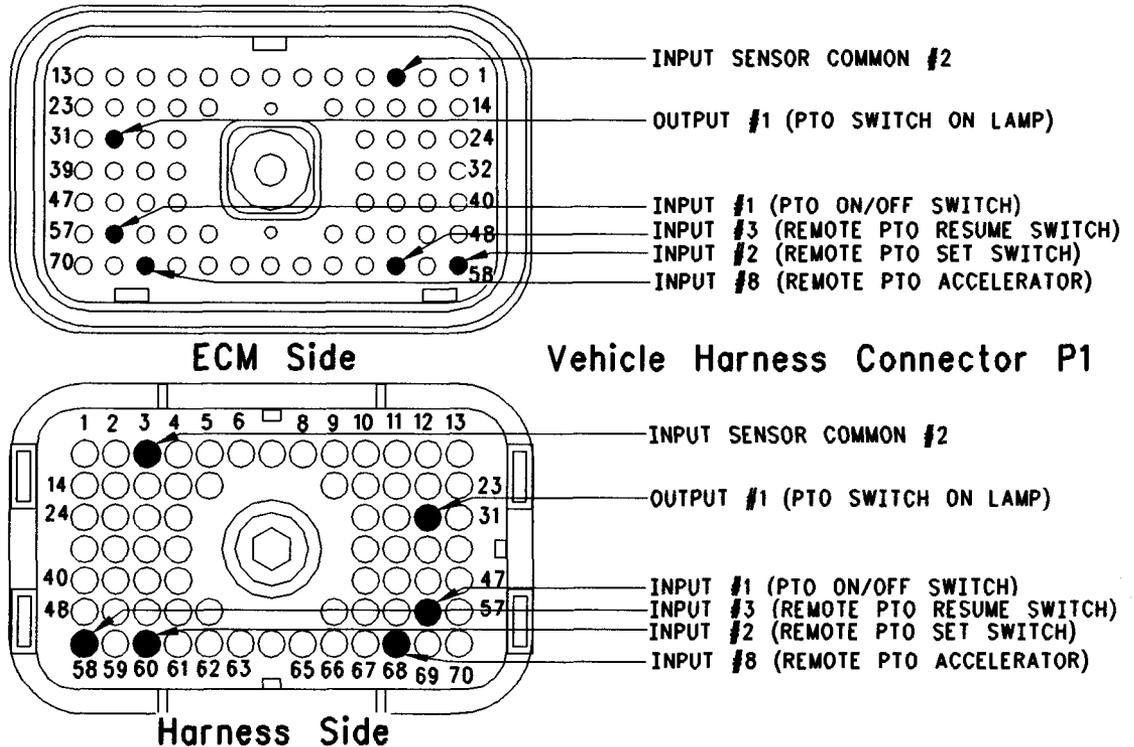


Illustration 153

g00713728

#### Terminal locations for ECM

**A.** Thoroughly inspect ECM connector J1/P1, the firewall bulkhead connectors, and any connectors that are used by the PTO.

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

**B.** Perform a 45 N (10 lb) pull test on each of the wires in the ECM connector that are associated with the connections for the PTO. The following connections should be tested if the connections are used:

- P1/J1:3
- P1/J1:5
- P1/J1:30
- P1/J1:35
- P1/J1:44
- P1/J1:56
- P1/J1:58
- P1/J1:60
- P1/J1:68

Refer to Illustration 153.

**C.** Check the ECM connector (allen head screw) for the proper torque of 6.0 n·m (55 lb in).

**D.** Check the harness and wiring for abrasion and pinch points from the sensor to the ECM.

#### Expected Result:

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

#### Results:

- OK – Proceed to Test Step 4.
- Not OK

**Repair:** Perform the following diagnostic procedure:

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

Verify that the repair eliminates the problem.

STOP.

#### **Test Step 4. Use the Electronic Service Tool to Check the Circuit for the PTO On/Off Switch**

- A.** Turn the ignition key switch to the ON position.
- B.** For the input 1 (PTO on/off switch), access the electronic service tool status screens that display the following status parameters:
  - "PTO Config"
  - "PTO On/Off Switch"
- C.** Verify that each of the interlocks for the PTO are set. Then, while the electronic service tool status screen is being monitored move the PTO on/off switch to the ON position and move the PTO on/off switch to the OFF position.

An example of an interlock for the PTO would be a parking brake that is intended to allow the PTO to control the engine under specific conditions.

#### **Expected Result:**

**Result 1** The status of the PTO on/off switch on the electronic service tool changes from "OFF" to "ON" when the PTO on/off switch is turned to the OFF position and the ON position, but the set/resume switch is not operating correctly.

**Result 2** The status of the PTO on/off switch on the electronic service tool changes from "OFF" to "ON" when the PTO on/off switch is turned to the OFF position and the ON position. However, the remote accelerator is not operating correctly.

**Result 3** The status of the PTO on/off switch on the electronic service tool does not change from "OFF" to "ON" when the PTO on/off switch is turned to the OFF position and the ON position.

#### **Results:**

- **Result 1** – Proceed to Test Step 5.
- **Result 2**

**Repair:** Perform the following diagnostic procedure: Troubleshooting, "Remote PTO Accelerator Position Sensor Circuit - Test"

STOP.

- **Result 3** – Proceed to Test Step 6.

#### **Test Step 5. Use the electronic service tool to Check the Status of the Set/Resume Input**

**Note:** The set/resume input increases the engine rpm and the set/resume input decreases the engine rpm.

- A.** Find the PTO set switch. If the "PTO Configuration" is programmed to "Cab Switches", the cruise control set/resume switch will be used. If the "PTO Configuration" is programmed to "Remote Switches" or "Remote Throttle", a dedicated PTO set switch will be used.

#### **The "PTO Configuration" is programmed to "Cab Switches".**

Look at the status for the "Cruise Control Set/Resume Switch" parameter on the electronic service tool. The parameter is located on the same status screen as the idle switch.

- B.** Monitor the status screen of the electronic service tool. Perform the following procedure in order:
  - Put the cruise control set/resume switch in the Set position.
  - Release the cruise control set/resume switch from the Set position.
  - Put the cruise control set/resume switch in the Resume position.
  - Release the cruise control set/resume switch from the Resume position.

#### **The "PTO Configuration" is programmed to "Remote Switches" or "Remote Throttle".**

View the status parameter on the electronic service tool for the "Remote PTO Set Switch" and the "Remote PTO Resume Switch".

- C.** While the status screen of the electronic service tool for the switch is being monitored, perform the following procedure in order:
  - Put the remote PTO set/resume switch in the Set position.
  - Release the remote PTO set/resume switch from the Set position.
  - Put the remote PTO set/resume switch in the Resume position.
  - Release the remote PTO set/resume switch from the Resume position.



- The switch status changes from “OFF” to “ON” when the jumper is in place.
- The switch status is “OFF” when the jumper is removed.

**Results:**

- **Yes** – The input 1 (PTO on/off switch) of the ECM is functioning correctly. The problem is in the switches of the vehicle or the problem is in the wiring of the vehicle.

**Repair:** Inspect the wiring. Select one of the following options:

- Repair the wiring or replace the wiring.
- Send the vehicle to the OEM dealer for repair.

Verify that the repair eliminates the problem.

**STOP.**

- **No** – The ECM is not reading the switch status change.

**Repair:** Perform the following diagnostic procedure:

1. Temporarily connect a test ECM.
2. Ensure that the “PTO Configuration” of the test ECM matches the “PTO Configuration” of the suspect ECM.
3. Remove all jumpers and replace all connectors.
4. Recheck the system for active diagnostic codes.
5. Repeat the test step.
6. If the problem is resolved with the test ECM, reconnect the suspect ECM.
7. If the problem returns with the suspect ECM, replace the ECM.
8. Verify that the repair eliminates the problem.

**STOP.**

### Test Step 7. Use the Electronic Service Tool to Check the Status of the Cruise Control Set/Resume Switch

AP Sensor/Switch Sensor Common

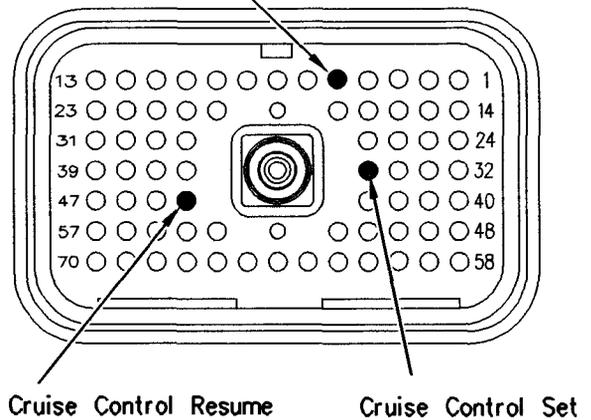


Illustration 155

g00768798

ECM breakout T-connector

- A. Turn the ignition key switch to the OFF position.
- B. Fabricate a jumper wire 100 mm (4 inch) long. Crimp a Deutsch pin to both ends of the wire.
- C. Disconnect vehicle harness connector P1 from the ECM.
- D. Connect a breakout T to ECM connector J1 and connect P1 to the breakout T.
- E. Connect the electronic service tool to the data link connector.
- F. Turn the ignition key switch to the ON position, while the engine is off.
- G. Access the status of the cruise control set/resume switch on the electronic service tool.
- H. While the switch status is being observed on the electronic service tool, install the jumper into the breakout T in order to connect P1/J1:35 (Set) to P1/J1:5 (AP sensor/switch sensor common). Also, while the switch status is being observed on the electronic service tool remove the jumper from the breakout T in order to disconnect P1/J1:35 (Set) from P1/J1:5 (AP sensor/switch sensor common).

- I. While the switch status is being observed on the electronic service tool, install the jumper into the breakout T. This connects P1/J1:44 (resume) to P1/J1:5 (AP sensor/switch sensor common). Also, while the switch status is being observed on the electronic service tool, remove the jumper from the breakout T. This will disconnect P1/J1:44 (resume) from P1/J1:5 (AP sensor/switch sensor common).

Refer to Illustration 155.

**Expected Result:**

The switch status of the cruise control set/resume switch on the electronic service tool behaves in the following manner:

- The switch status of the cruise control set/resume switch changes from "OFF" to set switch "ON" when the jumper is connected from P1/J1:35 (Set) to P1/J1:5 (AP sensor/switch sensor common).
- The switch status of the cruise control set/resume switch is "OFF" when the jumper is removed.
- The switch status of the cruise control set/resume switch changes from "OFF" to resume switch "ON" when the jumper is connected from P1/J1:44 (switch resume terminal) to J1/P1:5 (AP sensor/switch sensor common).

**Results:**

- **Yes** – The input for the set switch and the input for the resume switch of the ECM are functioning correctly. The problem is in the switches of the vehicle or the problem is in the wiring of the vehicle.

**Repair:** Inspect the wiring. Select one of the following options:

- Repair the wiring or replace the wiring.
- Send the vehicle to the OEM dealer for repair.

Verify that the repair eliminates the problem.

**STOP.**

- **No** – The ECM is not reading the switch status change.

**Repair:** Perform the following diagnostic procedure:

1. Temporarily connect a test ECM.
2. Ensure that the "PTO Configuration" of the test ECM matches the "PTO Configuration" of the suspect ECM.

3. Remove all jumpers and replace all connectors.
4. Recheck the system for active diagnostic codes.
5. Repeat the test step.
6. If the problem is resolved with the test ECM, reconnect the suspect ECM.
7. If the problem returns with the suspect ECM, replace the ECM.
8. Verify that the repair eliminates the problem.

**STOP.**

**Test Step 8. Use the Electronic Service Tool to Check the Status of the Remote PTO Set Switch and the Remote PTO Resume Switch**

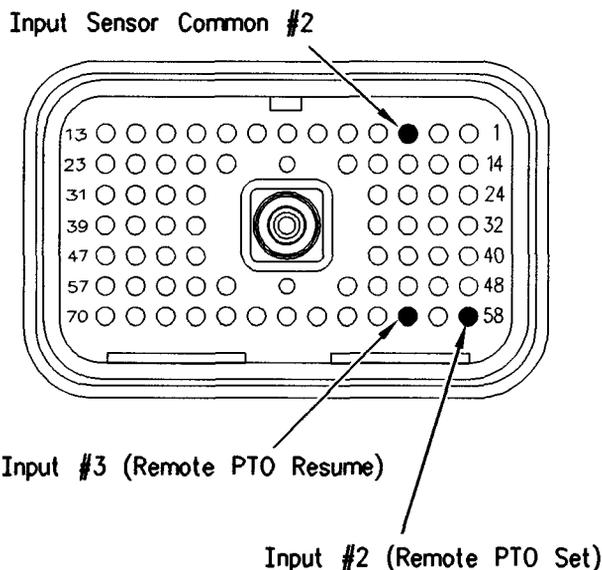


Illustration 156  
ECM breakout T-connector g00768769

- A. Turn the ignition key switch to the OFF position.
- B. Fabricate a jumper wire 100 mm (4 inch) long. Crimp a Deutsch pin to both ends of the wire.
- C. Disconnect vehicle harness connector P1 from the ECM.
- D. Connect a breakout T to ECM connector J1 and connect P1 to the breakout T.
- E. Connect the electronic service tool to the data link connector.
- F. Turn the ignition key switch to the ON position.

- G.** Access the “Remote PTO Set Switch” and “Remote PTO Resume Switch” status on the electronic service tool.
- H.** While the status of the “Remote PTO Set Switch” is being observed on the electronic service tool, install the jumper into the breakout T in order to connect J1/P1:58 (Input 2) to J1/P1:3 (Input sensor common 2). Also, while the switch status is being observed on the electronic service tool remove the jumper from the breakout T in order to disconnect J1/P1:58 (Input 2) from J1/P1:3 (Input sensor common 2).
- I.** While the status of the “Remote PTO Resume Switch” is being observed on the electronic service tool, install the jumper into the breakout T in order to connect J1/P1:60 (Input 3) to J1/P1:3 (Input sensor common 2). Also, while the switch status is being observed on the electronic service tool remove the jumper from the breakout T in order to disconnect J1/P1:60 (Input 3) from J1/P1:3 (Input sensor common 2).

The J1/P1:58 Input 2 is the set switch for the PTO and the J1/P1:60 Input 3 is the resume switch for the PTO.

Refer to Illustration 156.

### Expected Result:

The switch status of the “Remote PTO Set Switch” on the electronic service tool behaves in the following manner:

- The switch status of the “Remote PTO Set Switch” is “OFF” when the jumper is removed.
- The switch status of the “Remote PTO Set Switch” changes from “OFF” to set switch “ON” when the jumper is connected from J1/P1:58 (Input 2) to J1/P1:3 (Input Sensor Common 2).

The switch status of the “Remote PTO Resume Switch” on the electronic service tool behaves in the following manner:

- The switch status of the “Remote PTO Resume Switch” is “OFF” when the jumper is removed.
- The switch status of the “Remote PTO Resume Switch” changes from “OFF” to resume switch “ON” when the jumper is connected from J1/P1:60 (Input 3) to J1/P1:3 (Input sensor common 2).

### Results:

- **Yes** – Input 2 (“Remote PTO Set Switch”) and input 3 (“Remote PTO Resume Switch”) of the ECM are functioning correctly. The problem is in the switches of the vehicle or the problem is in the wiring of the vehicle.

**Repair:** Inspect the wiring. Select one of the following options:

- Repair the wiring or replace the wiring.
- Send the vehicle to the OEM dealer for repair.

Verify that the repair eliminates the problem.

### STOP.

- **No** – The ECM is not reading the switch status change.

**Repair:** Perform the following diagnostic procedure:

1. Temporarily connect a test ECM.
2. Ensure that the “PTO Configuration” of the test ECM matches the “PTO Configuration” of the suspect ECM.
3. Remove all jumpers and replace all connectors.
4. Recheck the system for Active diagnostic codes.
5. Repeat the test step.
6. If the problem is resolved with the test ECM, reconnect the suspect ECM.
7. If the problem returns with the suspect ECM, replace the ECM.
8. Verify that the repair eliminates the problem.

### STOP.

i01864922

## PTO Switch ON Lamp Circuit - Test

**SMCS Code:** 7431-038

### System Operation Description:

**Use this procedure under the following situation:**

Use the following information in order to determine if the PTO Switch On Lamp is operating incorrectly.

**Terminal 30 (Output 1)**

With software that is older than OCT99, J1:30 (Output 1) is dedicated for use as a PTO Switch ON Lamp Output. If the "PTO Configuration" is programmed to Cab switches, Remote Switches, or Remote Throttle, the Output will turn the lamp ON whenever the PTO Switch Circuit is turned ON.

With OCT99 and newer software, J1:30 (Output 1) can be used as an output for the PTO Switch ON Lamp or as an output for the Low Coolant Level Warning Lamp. The parameters should be programmed to match the desired usage of the terminal. If the "Engine Monitoring Lamps" parameter is programmed to Warning Lamp, then output 1 is used for the PTO Switch ON Lamp. If the "Engine Monitoring Lamps" parameter is programmed to Option 1 and the "Coolant Level Lamp" parameter is programmed to "4-Pin" or "2 wire Float Sensor", then output 1 is used for the low coolant level warning.

**Note:** The "PTO Configuration" must be programmed to Cab Switches, Remote Switches, or Remote Throttle to utilize the PTO Switch ON Lamp. Option 1 is not available for the GM truck manufacturer.

**Electrical Connection of Lamps**

One terminal of the lamp must be connected to battery voltage through the vehicle wiring. The other terminal is connected to the ECM at terminal J1/P1:30.

The ECM provides a path to ground in order to turn on the lamp.

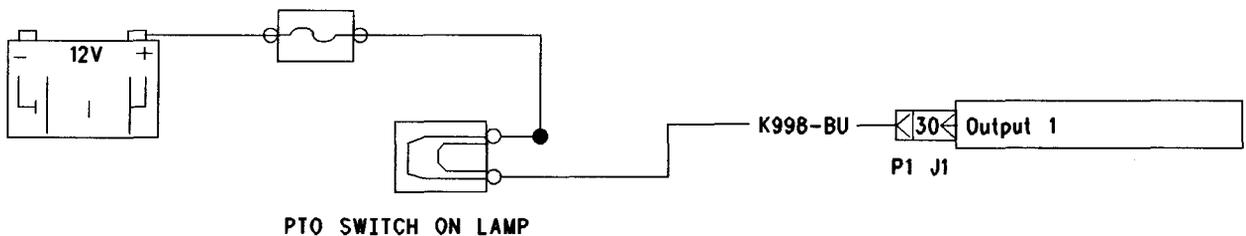


Illustration 157

g00703413

Circuit schematic for PTO Switch On Lamp

If terminal 30 is used for another function, a lamp may be wired to a multiple pole PTO On/Off switch.

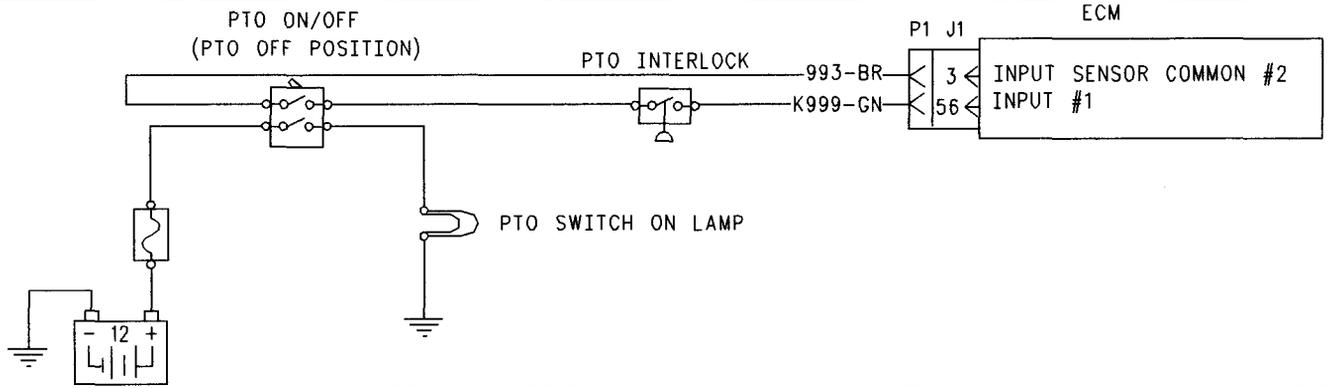


Illustration 158  
 Optional circuit for PTO Switch On Lamp

g00834964

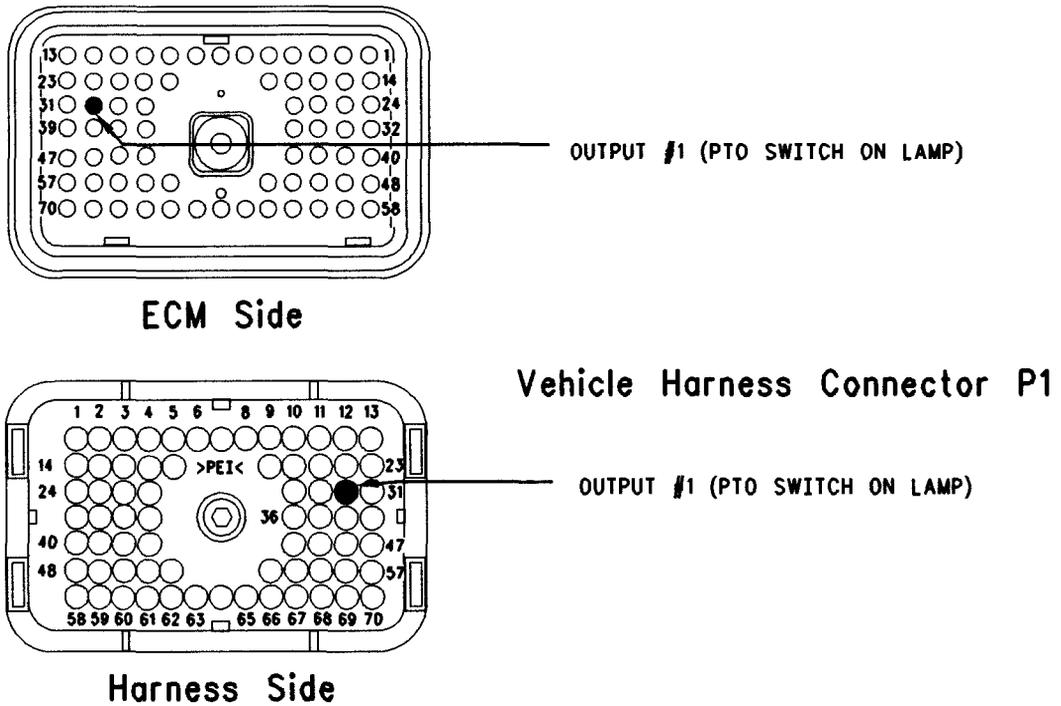


Illustration 159  
 Terminal locations for ECM

g00668646

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

- A. Thoroughly inspect ECM connector J1/P1, the firewall bulkhead connector, or the PTO Switch On Lamp. Refer to Troubleshooting, "Electrical Connectors - Inspect" for details.
- B. Perform a 45 N (10 lb) pull test on each of the wires in the ECM Connector that are associated with the PTO Switch On Lamp.

Refer to Illustration 159.

- C. Check the ECM connector (allen head screw) for the proper torque of 6.0 N·m (55 lb in).

- D. Check the harness and wiring for abrasion and pinch points from the battery to the ECM.

**Expected Result:**

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

**Results:**

- OK – Proceed to Test Step 2.
- 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.

STOP.

**Test Step 2. Check for Normal Operation of the PTO Switch On Lamp**

- A.** Use the following procedure for the output 1 (PTO Switch On Lamp).

Connect the electronic service tool to the data link connector. Access the status screen that displays the "PTO Configuration" and the PTO On/Off Switch. The "PTO Configuration" must indicate "Cab Switches", "Remote Switches", or "Remote Throttle". The "PTO Configuration" is not programmed to turn on the PTO Switch On Lamp if the "PTO Configuration" parameter is programmed to "OFF".

While the PTO Switch On Lamp and the status of PTO On/Off Switch is being monitored on the electronic service tool, turn the PTO On/Off Switch to the ON position and the OFF position. The PTO Switch On Lamp should turn on when the PTO On/Off Switch is in the ON position. Also, the PTO Switch On Lamp should turn off when the PTO On/Off switch is in the OFF position.

**Expected Result:**

The lamp turns on and the lamp turns off per the above description.

**Results:**

- Yes – The lamp appears to operating correctly at this time. STOP.
- No – Proceed to Test Step 3.

### Test Step 3. Test the Circuit for the PTO Switch On Lamp

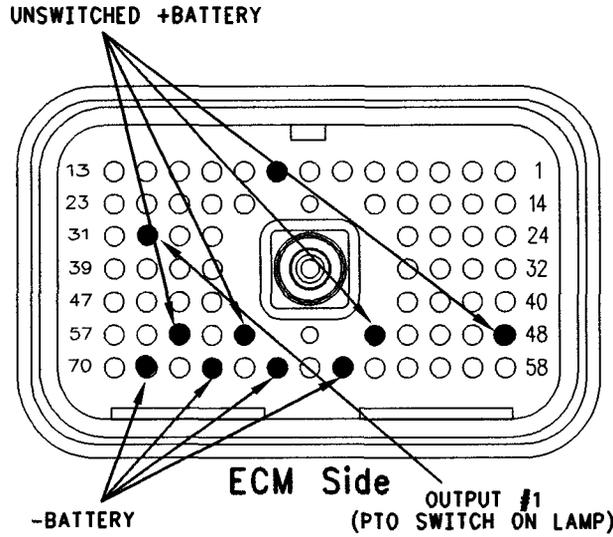


Illustration 160  
ECM connector P1

g00945932

- A. Disconnect ECM connector J1/P1.
- B. Fabricate a jumper wire 100 mm (4 inch) long. Crimp a Deutsch pin to both ends of the wire.
- C. Insert the jumper into P1:30 output 1.
- D. Connect the other end of the jumper wire to one of the following terminal connections:
  - P1:63 -battery
  - P1:65 -battery
  - P1:67 -battery
  - P1:69 -battery
- E. Turn the ignition key switch to the ON position.
- F. While the lamp is being watched, insert the jumper wire and remove the jumper wire.

Refer to Illustration 160.

#### Expected Result:

**Result 1** The PTO Switch On Lamp turns on while the jumper is connected to both sockets. Also, the PTO Switch On Lamp turns off when the jumper is removed from one of the sockets.

**Result 2** The suspect lamp does not turn on while the jumper is connected to both sockets.

**Result 3** The lamp will stay on while the ECM connector is disconnected.

#### Results:

- **Result 1** – The circuit for the PTO Switch On Lamp is functioning properly. Proceed to Test Step 4.
- **Result 2** – The lamp did not turn on. The vehicle's lamp circuit is *not* functioning properly. The lamp is probably burned out or there is a problem in the wiring from the cab to either the ECM or the +Battery connection. Repair the lamp circuit or send the vehicle to the OEM dealer for repairs. STOP.
- **Result 3**

**Repair:** Perform the following diagnostic procedure:

The circuit between the ECM and the lamp is shorted to chassis ground. Repair the circuit or send the vehicle to the OEM dealer for repairs.

STOP.

### Test Step 4. Use the Special Test “PTO Switch On Lamp” on the Electronic

## Service Tool to Check the Operation of the ECM

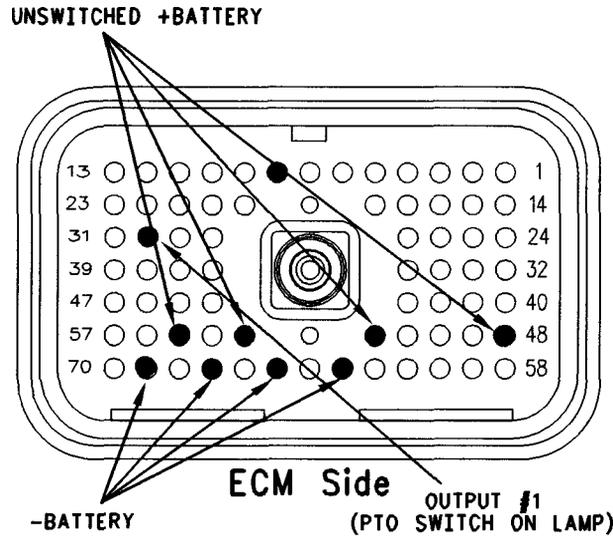


Illustration 161

g00945932

### ECM breakout T-connector

- A.** Disconnect ECM connector J1/P1.
- B.** Insert a breakout T between ECM connector J1 and ECM connector P1.
- C.** Connect one probe of the voltage test lamp to terminal 63 (-battery). Connect the other probe of the voltage test lamp to terminal 48 (unswitched +battery) of the breakout T.
- D.** The test lamp should turn on. If the test lamp does not turn on, either the test lamp is faulty or the wiring to the ECM is faulty. Continue with this step if the lamp turns ON.

**Note:** Use the same procedure to check the following:

- P1:65 and P1:52
- P1:67 and P1:53
- P1:69 and P1:55

- E.** Leave the probe of the test lamp connected to terminal 48 (unswitched +battery).
- F.** Connect the other probe of the test lamp to terminal 30 (Output 1) of the breakout T.

Refer to Illustration 161.

- G.** Connect the electronic service tool. Access the following display screens in order:

- "Diagnostics"

- "Diagnostic Test"
- "Special Test"

- H.** Activate the special test for the PTO Switch On Lamp. Observe the voltage test lamp. The lamp should turn on when the test is active. Also, the lamp should turn off when the test is inactive.

**Note:** Perform the same test procedure with terminals P1:52, P1:53, and P1:55 unswitched +batt.

### Expected Result:

The test lamp turns on and the test lamp turns off per the above description.

### Results:

- **Yes** – The ECM is operating correctly. There is a problem in the vehicle wiring or the lamp. **STOP.**
- **No**

**Repair:** Temporarily connect a test ECM. Ensure that the "PTO Configuration" of the test ECM matches the "PTO Configuration" of the suspect ECM. Check the ECM output for the PTO Switch On Lamp when the test ECM is installed. If the problem is resolved with the test ECM, reconnect the suspect ECM. If the problem returns with the suspect ECM, replace the ECM. Refer to Troubleshooting, "Replacing the ECM".

**STOP.**

i01901604

## Remote PTO Accelerator Position Sensor Circuit - Test

**SMCS Code:** 1913-038

### System Operation Description:

#### Use this procedure under the following situation:

Use this procedure if any of the following diagnostic codes are indicated:

- 30-08 PTO Throttle Signal Invalid (29)
- 30-13 PTO Throttle Out Of Calibration (29)

Also, use this procedure if the remote accelerator position sensor is suspected of improper operation.

### Remote Accelerator Position Sensor

A remote accelerator position sensor may be used for PTO purposes. The remote accelerator position sensor should be connected to J1/P1:68. Before the ECM will respond to the remote accelerator position sensor, the ECM "PTO Configuration" must be programmed to "Remote Throttle", and the "PTO On/Off Switch" must be in the ON position. Also, Caterpillar offers the following recommendation:

- The remote accelerator position sensor must be powered from the vehicle battery (+12 V).

Therefore, the +12 V version of the accelerator position sensor must be used for the remote accelerator position sensor, and the +8 V version for the accelerator pedal position sensor in the cab.

The ECM will not respond to the remote accelerator position sensor if 253-02 Check Customer or System Parameters (56) is active under some conditions. Refer to Troubleshooting, "ECM Memory - Test" if 253-02 Check Customer or System Parameters (56) is active.

The remote accelerator position sensor is used to provide a throttle position signal to the ECM. Sensor output is a constant frequency signal with a pulse width that varies with the pedal position. This output signal is referred to as either a duty cycle or a pulse width modulated signal (PWM) and this output signal is expressed as a percentage between 3 and 100 percent.

The accelerator position sensor in the cab is attached directly to the accelerator pedal assembly and the sensor requires no adjustment.

The accelerator position sensor will produce a duty cycle of 10 to 22 percent at low idle and 75 to 90 percent when the accelerator pedal is fully depressed. The percent of duty cycle is translated in the ECM into an accelerator pedal position of 3 to 100 percent.

The accelerator position sensor can be replaced separately from the pedal assembly. An incorrectly calibrated pedal assembly can not be adjusted. The entire pedal assembly must be replaced.

If the vehicle is using the ECM dedicated PTO functions, the accelerator position sensor will be ignored while the engine is in "PTO Mode" and the "PTO Configuration" is programmed to the following setting:

- "Remote Throttle"

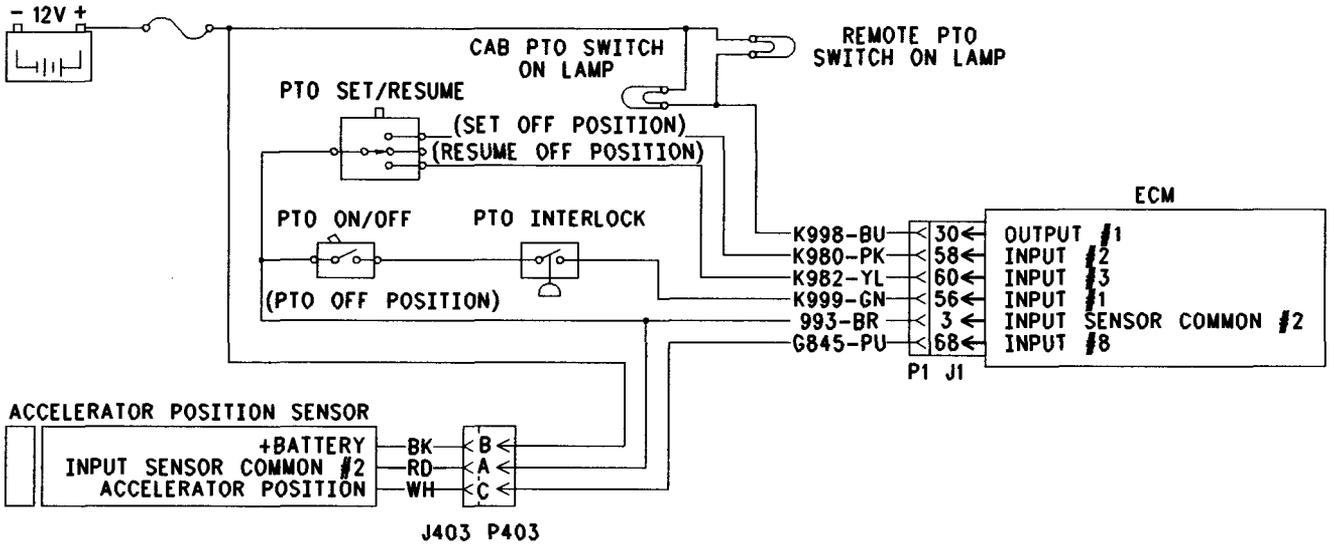
The ECM is in "PTO Mode" if the PTO On/Off Switch is on. This can be checked through the status screen on the electronic service tool.

The ECM will not respond to the remote accelerator position sensor when both of the following conditions are met:

- The PTO On/Off circuit is switched from the OFF position to the ON position.
- The ECM reads the remote accelerator position sensor above low idle.

This prevents the engine from experiencing unexpected acceleration or sudden acceleration when the PTO On/Off circuit is turned on. The remote accelerator position sensor must return to low idle before the ECM will respond. The ECM must also see a transition from the OFF position to the ON position in the PTO On/Off Switch in order to allow the other PTO speed control functions to operate. If the engine is started with the PTO On/Off Switch in the ON position, the accelerator will respond. The response will occur only if the accelerator pedal is first returned to the low idle position. The other speed control functions will not respond.

REMOTE ACCELERATOR POSITION SENSOR WITH SET AND RESUME



REMOTE ACCELERATOR POSITION SENSOR WITHOUT SET AND RESUME

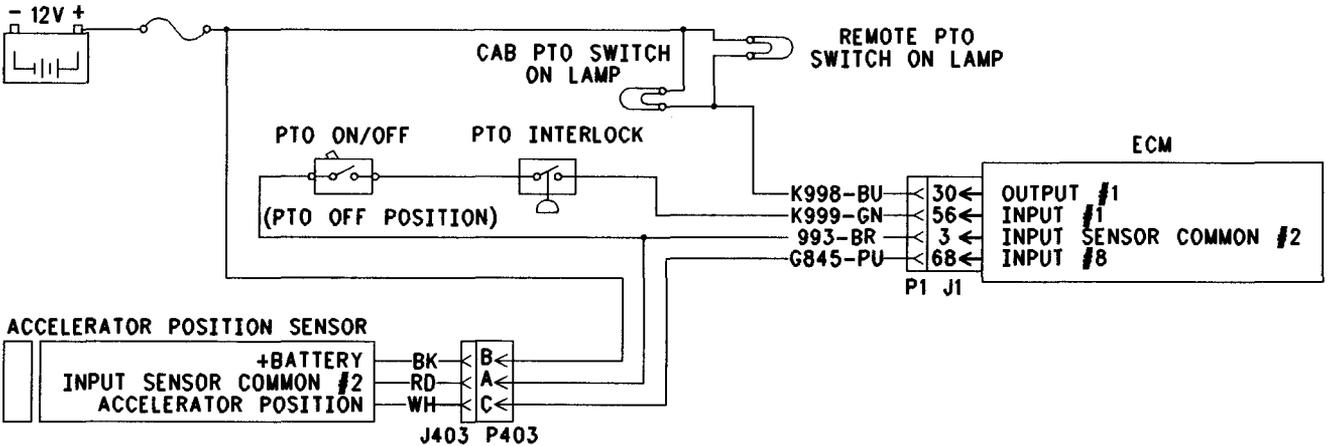
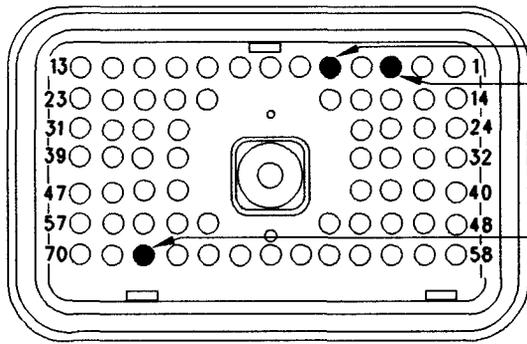


Illustration 162

g00925843

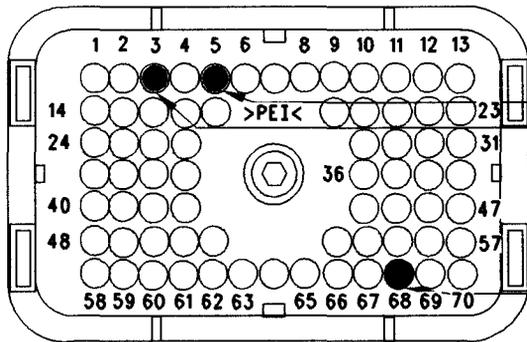
Schematic for remote accelerator pedal position sensor



ECM Side

Vehicle Harness Connector P1

AP SENSOR/SWITCH SENSOR COMMON  
 INPUT SENSOR COMMON #2  
  
 INPUT #8 (PTO ACCELERATOR)



Harness Side

AP SENSOR/SWITCH SENSOR COMMON  
 INPUT SENSOR COMMON #2  
  
 INPUT #8 (PTO ACCELERATOR)

Illustration 163

g00642018

Terminal locations for ECM

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

- A. Connect the electronic service tool to the data link connector. Verify that the parameter for the PTO Configuration is programmed to the "Remote Throttle".
- B. Thoroughly inspect ECM vehicle harness connector J1/P1, the firewall bulkhead connector and the connector for the remote accelerator position sensor. Refer to Troubleshooting, "Electrical Connectors - Inspect" for details.
- C. Perform a 45 N (10 lb) pull test on each of the wires in the ECM connector that are associated with the remote accelerator position sensor:
  - J1/P1:68
- D. Check the ECM connector (Allen Head Screw) for the proper torque of 6.0 N·m (55 lb in).

- E. Check the harness and wiring for abrasion and pinch points from the remote accelerator position sensor to the ECM.

**Expected Result:**

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

**Results:**

- OK – Proceed to Test Step 2.
- Not OK

**Repair:** Perform the following diagnostic procedure:

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 the electronic service tool to the data link connector.
- B. Turn the ignition key switch to the ON position.
- C. Monitor the active diagnostic code screen on the electronic service tool. Check and record active diagnostic codes.

**Note:** When the ECM automatically calibrates new duty cycle values for the low idle throttle position and the high idle throttle position the ECM assumes 22 percent duty cycle at low idle and 75 percent duty cycle at high idle. As a result, you may notice that the PTO throttle position status reaches 100 percent well before the remote PTO accelerator pedal is fully depressed. This is normal. After some cycling of the accelerator pedal to the high idle position, the ECM will adjust the calibration automatically. The ECM will adjust the calibration automatically provided that the high idle stop position is within the 75 to 90 percent duty cycle range, and the low idle is in the 10 to 22 percent duty cycle range. During normal operation, you may notice that more movement of the remote PTO accelerator pedal is required for the PTO throttle position status to increase above 3 percent. You may also observe that the status reaches the 100 percent value prior to the limit of the high idle position. This is done in order to ensure that the accelerator reaches these two critical points for engine operation.

### Expected Result:

**Result 1** 30-08 or 30-13 are active.

**Result 2** There are no active diagnostic codes that are related to the accelerator position sensor circuit at this time, but a problem is suspected with operation of the remote PTO accelerator position sensor circuit.

### Results:

- **Result 1** – Proceed to Test Step 3.
- **Result 2** – Proceed to Test Step 3.

## Test Step 3. Check the Supply Voltage for the Remote Accelerator Position Sensor

- A. Turn the ignition key switch to the ON position.
- B. Measure the voltage at terminal “A” (+12 V) with reference to terminal “B” (sensor common) at J406. This connector is for the remote accelerator position sensor.

### Expected Result:

The measured voltage is between 11.0 VDC and 13.5 VDC.

### Results:

- **OK** – The voltage is OK. Proceed to Test Step 4.
- **Not OK** – The vehicle wiring or the battery is causing the problem. Repair the wiring or the battery. Replace the wiring or the battery. Perform the repair that is necessary. Verify that the repair has fixed the problem. **STOP.**

## Test Step 4. Check the Duty Cycle of the Remote Accelerator Pedal Position Sensor

- A. Turn the ignition key switch to the ON position.
- B. Monitor the duty cycle of the PTO throttle sensor on the electronic service tool. Access the following display screen in order:
  - “Service”
  - “Calibrations”
  - “Monitor Throttle Position Sensor”

### Expected Result:

The duty cycle is between 10 and 22 percent with the accelerator pedal assembly in the low idle position, and the duty cycle is between 75 and 90 percent with the accelerator pedal assembly in the high idle position.

### Results:

- **OK** – The remote accelerator position sensor is operating correctly. Proceed to Test Step 5.
- **Not OK** – The remote accelerator position sensor circuit is not operating correctly. Proceed to Test Step 6.

### Test Step 5. Check the Status of the Power Train Data Link on the Electronic Service Tool

- A. Start the engine. While the status of the PTO throttle position is being monitored on the electronic service tool, depress the remote PTO accelerator pedal and release the remote PTO accelerator pedal. The throttle position status and the engine should respond to the change in the accelerator pedal position.
- B. Go to the "System Troubleshooting Settings" section of the electronic service tool and turn off the power train data link.
- C. While the status of the PTO throttle position is being monitored on the electronic service tool, depress the accelerator pedal and release the accelerator pedal. Also depress the accelerator pedal and release the accelerator pedal while the engine response is being monitored.

#### Expected Result:

The status of the PTO throttle position and the engine should respond to the change in the accelerator pedal position.

**Result 1** The PTO accelerator is functioning properly.

**Result 2** The throttle response is limited by a power train data link message.

#### Results:

- **Result 1** – The remote accelerator position sensor is operating correctly. Continue troubleshooting until the original condition is resolved. STOP.
- **Result 2** – If the engine responds with the power train data link in the OFF position, but not with the power train data link in the ON position, a component of the power train data link is causing the response problem of the remote accelerator position sensor. Send the truck to the vehicle manufacturer in order to repair the faulty component of the power train data link. STOP.

### Test Step 6. Check the Duty Cycle of the Remote Accelerator Position Sensor at the Sensor

**Note:** Performing certain steps within this procedure requires the use of a multimeter that is capable of measuring a PWM duty cycle.

- A. Turn the ignition key switch to the OFF position.

- B. Remove the signal wire for the remote accelerator position sensor (terminal "C") from J406. This is the vehicle harness side of the connector for the accelerator position sensor.
- C. Install a breakout T with 3 terminals at the connector J406/P406 for the remote accelerator position sensor.
- D. Connect the multimeter probes to terminal "C" (Accelerator Pedal Position) and terminal "B" (Accelerator/Switch Sensor Common) of the breakout T.
- E. While the duty cycle is being monitored on the multimeter, depress the accelerator pedal and release the accelerator pedal.

#### Expected Result:

The duty cycle is between 10 and 22 percent with the accelerator pedal assembly in the low idle position, and the duty cycle is between 75 and 90 percent with the accelerator pedal assembly in the high idle position.

#### Results:

- **OK** – Reinsert the wire (terminal "C") into the connector for the remote accelerator position sensor. The sensor is working correctly. Proceed to Test Step 7.
- **Not OK** – Leave the PWM probe connected to the breakout T. Insert wire C into the connector for the remote accelerator position sensor. The sensor or the accelerator pedal assembly is faulty. Proceed to Test Step 8.

### Test Step 7. Check the Duty Cycle of the Remote Accelerator Position Sensor at the ECM

**Note:** Performing certain steps within this procedure requires the use of a multimeter that is capable of measuring a PWM duty cycle.

- A. Turn the ignition key switch to the OFF position.
- B. Remove the wire from P1:68 Remote Accelerator Position Sensor from ECM connector P1/J1.
- C. Connect the multimeter probes between the removed wire and the ECM sensor common or ground.
- D. Turn the ignition key switch to the ON position.

- E. Use the multimeter in order to display the duty cycle output of the accelerator position sensor. While the duty cycle output of the remote accelerator position sensor is being monitored on the multimeter, move the accelerator assembly from the low idle position to the high idle position. Record the results.
- F. Turn the ignition key switch to the OFF position.
- G. Insert terminal 68 into the ECM vehicle connector P1/J1 terminal 70.

**Expected Result:**

The duty cycle is between 10 and 22 percent with the accelerator pedal assembly in the low idle position, and the duty cycle is between 75 and 90 percent with the accelerator pedal assembly in the high idle position.

**Results:**

- **OK** – A good signal from the remote accelerator position sensor is reaching the ECM. Verify that the ECM is receiving the proper battery voltage. If the ECM is receiving the proper battery voltage, temporarily connect a test ECM and verify that the problem is resolved. If the problem disappears with the test ECM, reconnect the suspect ECM. If the problem returns with the suspect ECM, replace the ECM. **STOP**.
- **Not OK** – There is a problem with signal wire for the remote accelerator position sensor in the vehicle wiring harness. Proceed to Test Step 9.

**Test Step 8. Remove the Remote Accelerator Position Sensor From the Accelerator Pedal Assembly**

- A. Turn the ignition key switch to the OFF position.
- B. Remove the remote accelerator position sensor from the accelerator pedal assembly. Note sensor orientation in the accelerator pedal assembly, and the sensor pigtail routing prior to sensor removal. Thoroughly inspect the pigtail for signs of abrasion.
- C. Connect the multimeter that is capable of measuring a PWM duty cycle to terminal "C" of the breakout T.
- D. Turn the ignition key switch to the ON position.
- E. Display the duty cycle output of the remote accelerator position sensor while the sensor slot is released. Use a screwdriver to advance the sensor slot to the maximum position. Refer to Illustration 164.

When the sensor is removed from the accelerator pedal assembly the following diagnostic codes may be generated:

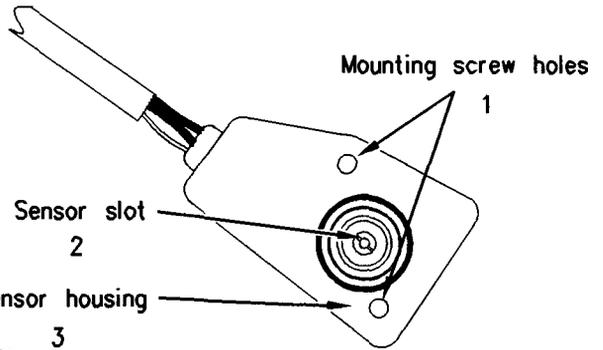
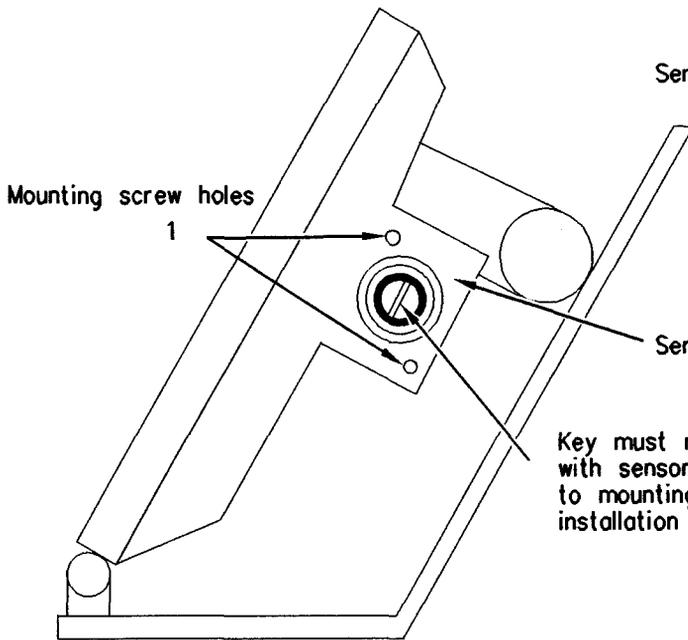
- 30-13 PTO Throttle Out Of Calibration (29)

The diagnostic code should disappear when the sensor is properly assembled back into the accelerator pedal assembly.

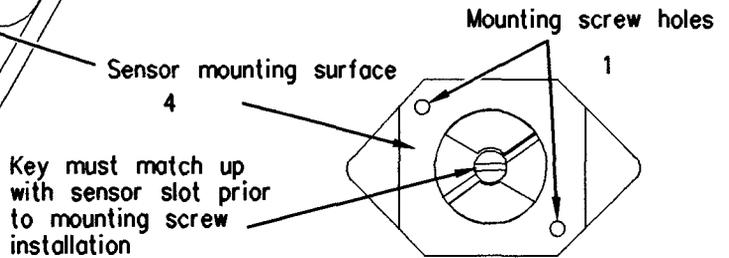
- A Mate sensor to accelerator pedal assembly. Key must match up with the sensor slot. Check the sensor housing for a flush fit to the pedal assembly mounting surface (This ensures slot on sensor has mated correctly with the pedal assembly key.)
- B Ensure the sensor is oriented the same as it was prior to removal to ensure sensor harness pigtail is routed correctly.
- C Line up screw holes and install mounting screws.

**NOTE:** Procedure is identical for the suspended accelerator pedal assembly.

### (5) Accelerator Pedal Assembly



### Accelerator Block Assembly



### (6) Accelerator Block Assembly

Illustration 164

g00642019

(1) Mounting screw holes  
 (2) Sensor slot

(3) Sensor housing  
 (4) Mounting surface for sensor

(5) Accelerator pedal assembly  
 (6) Accelerator block assembly

**Expected Result:**

When the sensor is removed from the accelerator pedal assembly and the sensor slot is released, the duty cycle is 10 percent or less. When the sensor slot is moved to the maximum position, the duty cycle increases to 90 percent or more.

**Results:**

- OK – The remote accelerator position sensor is working correctly. Clear any diagnostic codes that were caused by performing this test procedure. Refer to the OEM dealer for correct replacement of the accelerator pedal assembly. STOP.

- Not OK – The remote accelerator position sensor is faulty. Check the accelerator pedal assembly in order to ensure that the accelerator pedal assembly is not causing damage to the sensor. If the accelerator pedal assembly is causing damage to the sensor, refer to the OEM dealer for correct replacement of the accelerator pedal assembly. STOP.

**Test Step 9. Route the Supply Bypass Wires to the Remote Accelerator Pedal Position Sensor**

- A. Turn the ignition key switch to the OFF position.

- B. Remove P1:66 remote accelerator position sensor from P1 ECM connector.
- C. Remove terminal "C" (Accelerator Pedal Position) from the connector for the remote accelerator position sensor.
- D. Route new wiring from the ECM to the remote accelerator position sensor.
- E. Turn the ignition key switch to the ON position.
- F. Check the duty cycle of the remote accelerator position sensor with the electronic service tool while the accelerator pedal assembly is being moved over the full range.

**Expected Result:**

The duty cycle is between 10 and 22 percent with the accelerator pedal assembly in the low idle position, and the duty cycle is between 75 and 90 percent with the accelerator pedal assembly in the high idle position.

**Results:**

- **OK** – The wiring from the ECM to the accelerator position sensor appears faulty. Permanently install new wiring. Verify that the repair eliminates the problem. **STOP**.
- **Not OK** – Double check the wiring, the ECM vehicle harness connector J1/P1 and the sensor connector. If a problem still exists, restart the test procedure. **STOP**.

i01906648

## Retarder (Compression Brake) Solenoid Circuit - Test

**SMCS Code:** 1129-038

**System Operation Description:**

The engine retarder solenoids are usually factory installed at Caterpillar and the switches are installed by the vehicle OEM. The ECM directly drives the retarder solenoids, eliminating OEM installed relays and circuit protection. The ECM reads the status of the OEM installed engine retarder switches in order to determine the following modes of operation:

- OFF
- Low
- Medium
- High

Operation of the retarder solenoids is inhibited during undesirable engine operating conditions.

All of the following conditions must be met in order to ensure the proper retarder operation regardless of the settings of the customer specified parameters:

- Engine speed is above 800 rpm.
- The "Accelerator Pedal Position" is less than 8 percent.
- The clutch pedal is released.

Additional factors may affect retarder operation. The additional factors are based on the programming of certain customer specified parameters. The following parameters may affect retarder operation:

- "Engine Retarder Mode"
- "Auto Retarder In Cruise"
- "Auto Retarder In Cruise Increment"
- "Engine Retarder Minimum Vehicle Speed"
- "Engine Retarder Minimum Vehicle Speed Type"
- "Engine Retarder Delay"

**Note:** If the "PTO Configuration" is programmed to Cab Switches, Remote Switches, or Remote Throttle, the engine retarder is disabled whenever the PTO On/Off circuit is on.

**When the Cruise Control On/Off Switch is in the ON position, the following conditions exist:**

**"Engine Retarder Mode"**

When the cruise control On/Off switch is on, this parameter provides two special options that allow the engine retarder to be operated only after the driver has depressed the service brake pedal. The two modes of operation that follow are customer programmable:

- The "Coast" mode engages the engine retarder when the driver depresses the service brake pedal. The retarder disengages when the driver releases the service brake pedal.
- The "Latch" mode engages the retarder when the driver depresses the service brake pedal. The retarder remains engaged until the control detects a change in a control input. The following actions are examples of a change in a control input:
  - The throttle is depressed.
  - The clutch pedal is depressed.

- The engine speed drops below 800 rpm.

The third option for the engine retarder parameter is “Manual”. The Manual mode operates in the same manner regardless of the position of the cruise control On/Off switch. The driver is not required to depress the service brake pedal in order to initiate the engine retarder. This is required in the Latch mode and the Coast mode.

**Note:** The Latch mode and the Coast mode are customer programmable options. The Latch mode and the Coast mode determine engine retarder operation only when the cruise control switch is in the ON position. The Latch mode and the Coast mode do not determine engine retarder operation when the engine is active in cruise control. Latch mode and Coast mode require the initiation of the service brake before acting. The action of the service brake disengages the cruise control.

### “Auto Retarder In Cruise”

This parameter allows the engine retarder to activate while the engine is in cruise control in order to maintain the cruise set speed. The “Auto Retarder in Cruise” option still requires the engine retarder switches to be in the ON position. The “Auto Retarder in Cruise” option will only activate the engine retarder to the level of braking that is determined by the switch setting. The “Auto Retarder in Cruise” parameter is a vehicle speed above the cruise set speed. When the vehicle speed that is above the cruise set speed is met, the ECM will send a signal in order to begin engaging the engine retarder.

At this vehicle speed, the engine retarder will activate at the low level. The Medium and High braking levels will be activated at the programmed “Auto Retarder in Cruise Increment”. This assumes that the engine retarder switches are set at the high level. The “Auto Retarder in Cruise” affects the engine retarder solenoids that are driven directly from the ECM engine harness connector P2 terminal 9, terminal 10 and terminal 11.

### “Auto Retarder In Cruise Increment”

The “Auto Retarder in Cruise Increment” parameter determines the increment in kilometers per hour (km/h) or miles per hour (mph) when the higher levels of engine retarder will activate. This feature requires the “Auto Retarder in Cruise ” parameter to be programmed above 0 mph.

### “Engine Retarder Minimum Vehicle Speed”

This parameter determines the minimum vehicle speed limit for the engine retarders to turn ON. When this parameter is programmed to “0” the retarder will operate at all vehicle speeds.

### “Engine Retarder Minimum VSL Type”

The “Engine Retarder Minimum VSL Type” defines the use of the “Engine Retarder Minimum Vehicle Speed” parameter. The “Engine Retarder Minimum VSL Type” provides the following two options:

- Hard Limit
- Soft Limit

If the “Engine Retarder Minimum VSL Type” is programmed to the Hard Limit, the engine retarder will turn off when the value that is programmed into the “Engine Retarder Minimum Vehicle Speed” is reached.

If the “Engine Retarder Minimum VSL Type” is programmed to the Soft Limit, the engine retarder will remain in the ON position below the value that is programmed in the “Engine Retarder Minimum Vehicle Speed”. The engine retarder will remain in the ON position until the parameters that would normally turn off the engine retarder are met. The retarder cannot be activated when the vehicle speed is below the “Engine Retarder Minimum Vehicle Speed”.

This parameter requires the “Engine Retarder Minimum Vehicle Speed” parameter to be programmed above 0 mph.

### “Engine Retarder Delay”

The “Engine Retarder Delay” parameter provides a programmable delay after all basic conditions that are required to turn on the retarder are met. Once the conditions are met, the ECM will delay the activation of the retarder by the programmed additional time. The programmable range is 0.0 to 3.0 seconds in 0.1 second increments.

### Other Control Systems

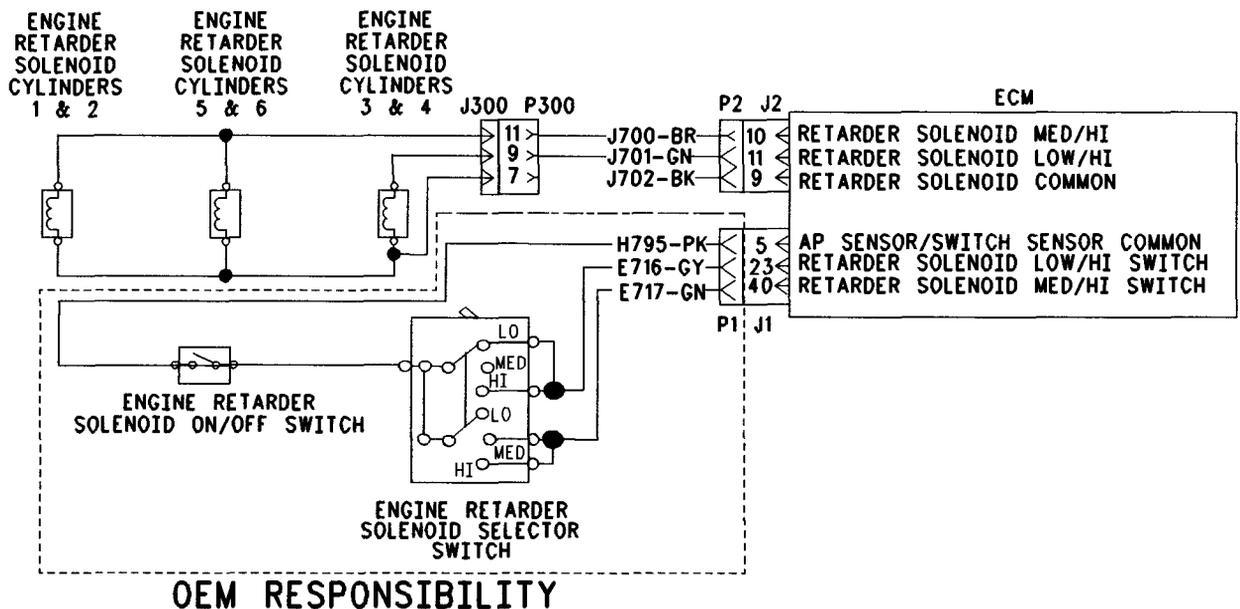
Trucks that are equipped with SAE J1922 systems may also control the engine retarder. For ABS systems that do not use SAE J1922 with the engine retarder solenoids, a relay may be connected into the retarder switch circuit in order to disable the engine retarder or a relay may be connected into the clutch switch circuit in order to disable the engine retarder.

**Note:** If the vehicle is equipped with an Anti-Lock Brake System (ABS), the vehicle may have an additional relay in the switch circuit for the engine retarder switches or the clutch switch. This is installed so the ABS system can turn off the engine retarder, if necessary. The relay should have normally closed contacts. The ABS system can not turn on the engine retarder. The Caterpillar ECM must still activate the retarder.

**Note:** If the "Transmission Style" parameter is programmed to Eaton Top 2, normal engine retarder operation can be inhibited by the ECM. Normal engine retarder operation can be inhibited by the ECM when the driver is attempting to make a shift in Top 2 mode in order to provide better control of torque during the process of shifting.

**"Retarder Brake Test"**

The "Retarder Brake Test" should be used to assist in troubleshooting problems in the circuit for the engine retarder. The ECM will only detect shorts in the circuit for the engine retarder when the test is active. "Current high" diagnostic codes (short circuits) will be logged once the test has been deactivated. The ECM will only detect opens in the circuit for the engine retarder when the test is not active. The test must be activated and then deactivated before the ECM will detect an open circuit. "Current low" diagnostic codes (open circuits) will be active once the test has been deactivated.



**OEM RESPONSIBILITY**

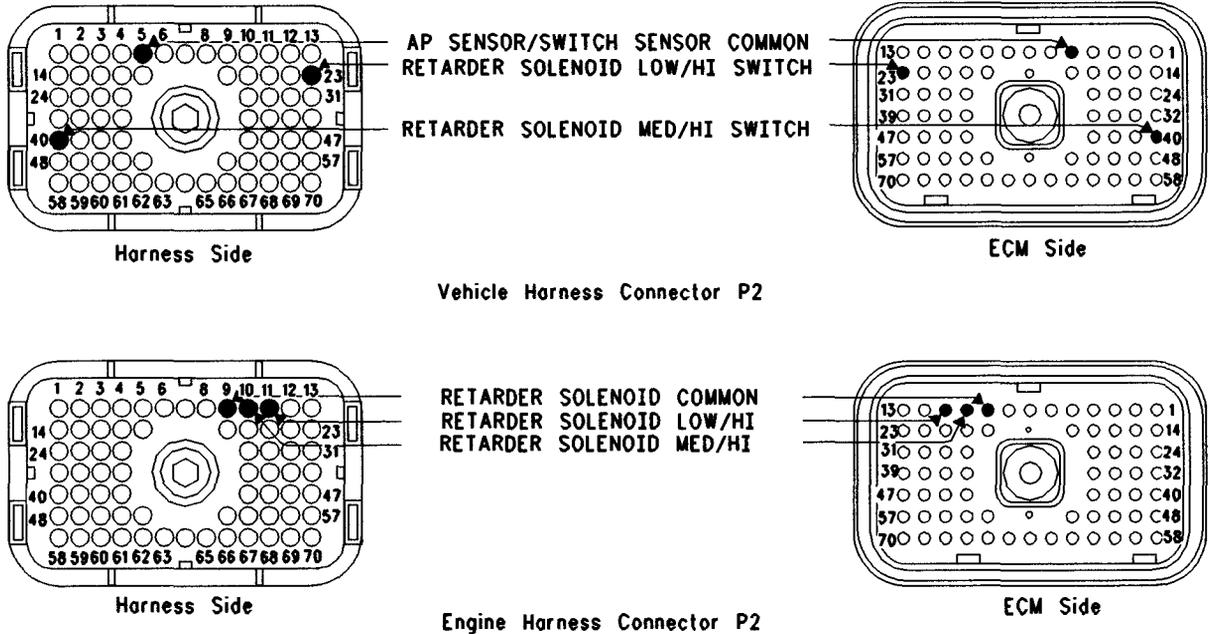


Illustration 166  
 Terminal locations for ECM

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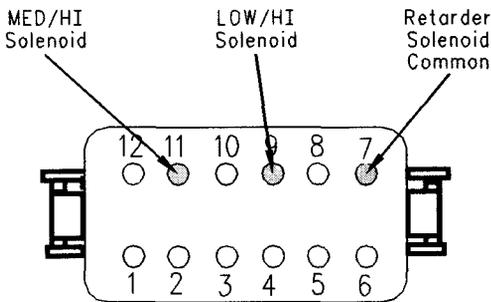


Illustration 167  
 g00999340

**Test Step 1. Check Electrical Connectors and Wiring**

- A.** Thoroughly inspect the J1/P1 and J2/P2 ECM connectors, the injector connector for the valve cover J300/P300 and the firewall bulkhead connector. Refer to Troubleshooting, "Electrical Connectors - Inspect" for details.
- B.** Perform a 45 N (10 lb) pull test on each of the wires in the ECM connector that are associated with the connections for the engine retarder solenoids and the engine retarder switch:

- C.** Check the ECM connector (allen head screw) for the proper torque of 6.0 N·m (55 lb in).
- D.** Check the harness and wiring for abrasion and pinch points from the accelerator pedal position sensor to the ECM.

**Expected Result:**

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

**Results:**

- OK – Proceed to Test Step 2.
- Not OK

**Repair:** Perform the following repair:

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

Verify that the repair eliminates the problem.

**STOP.**

**Test Step 2. Check for Diagnostic Codes**

- A. Connect the Caterpillar Electronic Technician (Cat ET) to the data link connector.
- B. Place the engine retarder switch in the High position.
- C. Turn the key switch to the ON position.
- D. Check for active diagnostic codes and logged diagnostic codes that are related to the engine retarder. Clear any logged diagnostic codes that are related to the engine retarder.
- E. Access the "Retarder Brake Test" in the "Special Tests" under the "Diagnostics" menu.
- F. Start the test. Allow the test to be active for five seconds.
- G. Check for active diagnostic codes that are related to the engine retarder.
- H. Stop the test.
- I. Check for active diagnostic codes that are related to the engine retarder.

**Expected Result:**

There is an active "current low" diagnostic code (open circuit) or an active "current high" diagnostic code (short circuit).

**Results:**

- **Current Low (Open)** – There is an open in the circuit for the engine retarder. Proceed to Test Step 3.
- **Current High (Short)** – There is a short in the circuit for the engine retarder. Proceed to Test Step 6.
- **No Codes** – There are no diagnostic codes that are related to the engine retarder. Proceed to Test Step 9.

**Test Step 3. Create a Short Circuit at the Valve Cover**

- A. Turn the key switch to the OFF position.
- B. Disconnect the J300/P300 Injector connector on the valve cover base.
- C. Connect a jumper wire between the terminal for the suspect circuit and P300:7 (Retarder Solenoid Common).
  - P300:9 (LOW/HI Retarder Solenoid)

- P300:11 (MED/HI Retarder Solenoid)

- D. If the diagnostic code is related to the "LOW/HI" circuit, place the engine retarder switch in the Low position.

If the diagnostic code is related to the "MED/HI" circuit, place the engine retarder switch in the Medium position.

If the diagnostic code is related to both circuits, place the engine retarder switch in the High position.

- E. Turn the key switch to the ON position.
- F. Access the "Retarder Brake Test" in the "Special Tests" under the "Diagnostics" menu.
- G. Start the test.
- H. Check for active diagnostic codes that are related to the engine retarder.
- I. Stop the test.
- J. Check for active diagnostic codes that are related to the engine retarder.

**Expected Result:**

A "current high" diagnostic code (short circuit) is active when the jumper wire is in place and the "Retarder Brake Test" is active.

**Note:** A "current low" diagnostic code (open circuit) will be active when the jumper wire is removed and the test is not active.

**Results:**

- **OK** – The harness between the ECM and the valve cover base is OK. Proceed to Test Step 4.
- **Not OK** – A "current high" diagnostic code (short circuit) was not active. There is a problem between the ECM and the valve cover base. Proceed to Test Step 5.

**Test Step 4. Create a Short Circuit at the Engine Retarder Solenoid**

- A. Turn the key switch to the OFF position.
- B. Remove the valve cover(s).
- C. Disconnect the wires for the suspect solenoid. Insert a jumper wire between the two wires for the suspect solenoid.
- D. Turn the key switch to the ON position.

- E. Access the "Retarder Brake Test" in the "Special Tests" under the "Diagnostics" menu.
- F. Start the test.
- G. Check for active diagnostic codes that are related to the engine retarder.
- H. Stop the test.
- I. Check for active diagnostic codes that are related to the engine retarder.

**Expected Result:**

A "current high" diagnostic code (short circuit) is active when the jumper wire is in place and the "Retarder Brake Test" is active.

**Note:** A "current low" diagnostic code (open circuit) will be active when the jumper wire is removed and the test is not active.

**Results:**

- **OK** – There may be a problem with the engine retarder solenoid.

**Repair:** Temporarily connect a new engine retarder solenoid.

If the new solenoid fixes the problem, reconnect the suspect solenoid.

If the problem returns, permanently replace the solenoid.

Verify that the repair eliminates the problem.

**STOP.**

- **Not OK** – There is a problem in the harness under the valve cover.

**Repair:** Inspect the wiring between the valve cover base and the engine retarder solenoids.

Insert a jumper wire between the supply wire for the suspect solenoid and chassis ground.

Repeat this Test Step.

If there is still a "current low" diagnostic code (open circuit), the problem is the supply wire.

If there is a "current high" diagnostic code (short circuit), the problem is the common wire.

Repair the wiring or replace the wiring.

Verify that the repair eliminates the problem.

**STOP.**

**Test Step 5. Create a Short Circuit at the ECM**

- A. Turn the key switch to the OFF position.
- B. Disconnect the J2/P2 ECM connector.
- C. Connect a 140-2266 Cable (Seventy-Pin Breakout) to the J2 ECM connector. Do not connect the P2 ECM connector.
- D. Connect a jumper wire between the terminal for the suspect circuit on the breakout T and Terminal 9 (Retarder Solenoid Common).
  - Terminal 11 (LOW/HI Retarder Solenoid)
  - Terminal 10 (MED/HI Retarder Solenoid)
- E. Turn the key switch to the ON position.
- F. Access the "Retarder Brake Test" in the "Special Tests" under the "Diagnostics" menu.
- G. Start the test.
- H. Check for active diagnostic codes that are related to the engine retarder.
- I. Stop the test.
- J. Check for active diagnostic codes that are related to the engine retarder.

**Expected Result:**

A "current high" diagnostic code (short circuit) is active when the jumper wire is in place and the "Retarder Brake Test" is active.

**Note:** A "current low" diagnostic code (open circuit) will be active when the jumper wire is removed and the test is not active.

**Results:**

- **OK** – There is a problem in the harness between the ECM and the valve cover base.

**Repair:** Remove the breakout T and reconnect the J1/P1 ECM connector.

Inspect the wiring between the ECM and the valve cover base.

Disconnect the P300 connector.

Insert a jumper wire between the terminal on the P300 connector for the suspect solenoid and chassis ground.

Repeat this Test Step.

If there is still a “current low” diagnostic code (open circuit), the problem is the supply wire.

If there is a “current high” diagnostic code (short circuit), the problem is the common wire.

Repair the wiring or replace the wiring.

Verify that the repair eliminates the problem.

STOP.

- **Not OK** – There may be a problem with the ECM.

**Repair:** Temporarily connect a test ECM.

If the test ECM fixes the problem, reconnect the suspect ECM.

If the problem returns, permanently replace the ECM.

Verify that the repair eliminates the problem.

STOP.

### Test Step 6. Create an Open Circuit at the Valve Cover

- Disconnect the J300/P300 Injector connector on the valve cover base.
- If the diagnostic code is related to the “LOW/HI” circuit, place the engine retarder switch in the Low position.

If the diagnostic code is related to the “MED/HI” circuit, place the engine retarder switch in the Medium position.

If the diagnostic code is related to both circuits, place the engine retarder switch in the High position.

- Access the “Retarder Brake Test” in the “Special Tests” under the “Diagnostics” menu.
- Start the test.
- Check for active diagnostic codes that are related to the engine retarder.
- Stop the test.
- Check for active diagnostic codes that are related to the engine retarder.

#### Expected Result:

A “current low” diagnostic code (open circuit) is active.

#### Results:

- **OK** – The harness between the ECM and the valve cover base is OK. Proceed to Test Step 7.
- **Not OK** – There is a problem between the valve cover base and the ECM. Proceed to Test Step 8.

### Test Step 7. Create an Open Circuit at the Retarder Solenoids

- Turn the key switch to the OFF position.
- Remove the valve cover(s).
- Disconnect the wires from each engine retarder solenoid. Ensure that the wires are not touching any metal parts.
- Turn the key switch to the ON position.
- Access the “Retarder Brake Test” in the “Special Tests” under the “Diagnostics” menu.
- Start the test.
- Check for active diagnostic codes that are related to the engine retarder.
- Stop the test.
- Check for active diagnostic codes that are related to the engine retarder.

#### Expected Result:

A “current low” diagnostic code (open circuit) is active.

#### Results:

- **OK** – There may be a problem with the engine retarder solenoid.

**Repair:** Inspect the common wire for shorts. Repair any faulty wiring or replace any faulty wiring.

Temporarily connect a new engine retarder solenoid.

If the new solenoid fixes the problem, reconnect the suspect solenoid.

If the problem returns, permanently replace the solenoid.

Verify that the repair eliminates the problem.

STOP.

- **Not OK** – There is a problem in the harness under the valve cover.

**Repair:** Inspect the wiring between the valve cover base and the engine retarder solenoids.

Repair the wiring or replace the wiring.

Verify that the repair eliminates the problem.

STOP.

### **Test Step 8. Create an Open Circuit at the ECM**

- A.** Turn the key switch to the OFF position.
- B.** Disconnect the J2/P2 ECM connector.
- C.** Turn the key switch to the ON position.
- D.** Access the “Retarder Brake Test” in the “Special Tests” under the “Diagnostics” menu.
- E.** Start the test.
- F.** Check for active diagnostic codes that are related to the engine retarder.
- G.** Stop the test.
- H.** Check for active diagnostic codes that are related to the engine retarder.

#### **Expected Result:**

A “current low” diagnostic code (open circuit) is active.

#### **Results:**

- **OK** – There is a problem in the harness between the ECM and the valve cover base.

**Repair:** Inspect the wiring between the ECM and the valve cover base.

Repair the wiring or replace the wiring.

Verify that the repair eliminates the problem.

STOP.

- **Not OK** – There may be a problem with the ECM.

**Repair:** Temporarily connect a test ECM.

If the test ECM fixes the problem, reconnect the suspect ECM.

If the problem returns, permanently replace the ECM.

Verify that the repair eliminates the problem.

STOP.

### **Test Step 9. Check the Status of the Engine Retarder Switch**

- A.** Turn the key switch to the ON position.
- B.** Monitor the status for “Retarder Off/Low/Med/High Switch” on Cat ET.
- C.** Operate the engine retarder switch in the ON position and the OFF position. Also, operate the engine retarder switch in the Low, Medium, and High positions.

#### **Expected Result:**

The status for “Retarder Off/Low/Med/High Switch” correlates to the position of the engine retarder switch.

#### **Results:**

- **OK** – The engine retarder switch is operating correctly. Proceed to Test Step 10.
- **Not OK** – There is a problem in the circuit for the engine retarder switch. STOP.

### **Test Step 10. Check the Operating Parameters of the Engine Retarder**

- A.** Turn the key switch to the ON position.
- B.** Access the “Configuration” screen on Cat ET. Review the programming of the following parameters:
  - “Engine Retarder Mode”
  - “Engine Retarder Minimum VSL Type”
  - “Engine Retarder Minimum Vehicle Speed”
  - “Engine Retarder Delay”
- C.** Use the following information when the parameter for the “Engine Retarder Mode” is being reviewed:

a. If the parameter is programmed to Latch mode or Coast mode, the engine retarder will not turn on unless the following conditions are met:

- The Cruise Control On/Off Switch is on.
- The service brake pedal has been depressed.

D. Use the following information when the parameter for the "Engine Retarder Minimum VSL Type" is being reviewed:

- a. This parameter has no effect on engine retarder operation when the "Engine Retarder Minimum Vehicle Speed" is programmed to 0 mph.
- b. When this parameter is programmed to the Hard Limit and the vehicle speed drops below the Engine Retarder Minimum Vehicle Speed, the engine retarder turns off.

c. When this parameter is programmed to the Soft Limit and the vehicle speed drops below the Engine Retarder Minimum Vehicle Speed, the engine retarder remains in the ON position.

E. Use the following information when the parameter for the "Engine Retarder Minimum Vehicle Speed" is being reviewed:

- a. When the programmed value is more than 0 mph, the engine retarder will not turn on below the programmed value.

**Note:** The retarder will not turn on if the vehicle speed is already below the "Engine Retarder Minimum Vehicle Speed".

F. Use the following information when the parameter for the "Engine Retarder Delay" is being reviewed:

- a. This parameter provides a programmable delay once the conditions are met in order to turn the engine retarder.

#### **Expected Result:**

The problem is due to the programming of any of the listed parameters.

#### **Results:**

- OK

**Repair:** Perform the following diagnostic procedure:

Program parameters for desired operation.

Refer to Troubleshooting, "Customer Specified Parameters" for additional information on the listed parameters.

**STOP.**

- **Not OK** – The parameters are programmed correctly. Proceed to Test Step 11.

### **Test Step 11. Check the Accelerator Pedal**

**A.** Turn the key switch to the ON position.

**B.** Monitor the status for "Accelerator Pedal Position" on Cat ET while the accelerator pedal is fully released.

**C.** While the status is monitored, depress the accelerator pedal.

#### **Expected Result:**

The status for "Accelerator Pedal Position" is less than 8% when the accelerator pedal is fully released. The status changes as the accelerator is depressed.

#### **Results:**

- **OK** – The accelerator pedal is operating correctly. Proceed to Test Step 12.
- **Not OK** – The accelerator pedal position sensor is not operating correctly.

**Repair:** Refer to Troubleshooting, "Accelerator Pedal (Throttle) Position Sensor Circuit - Test".

**STOP.**

### **Test Step 12. Check the Clutch Switch**

**A.** Turn the key switch to the ON position.

**B.** Monitor the status for "Clutch Pedal Position Switch" while the clutch pedal is fully released.

**C.** While the status is monitored, depress the clutch pedal.

#### **Expected Result:**

The status for "Clutch Pedal Position Switch" is "Off" when the clutch pedal is fully released. The status is "On" when the clutch pedal is depressed.

**Note:** If a clutch pedal is not installed, select "OK".

#### **Results:**

- **OK** – The clutch pedal position switch is operating correctly. There may be a mechanical problem with the engine retarder.

**Repair:** Refer to Testing and Adjusting, "Compression Brake".

STOP.

- **Not OK** – The clutch pedal position switch is not operating correctly.

**Repair:** Refer to Troubleshooting, "Clutch Pedal Position Switch Circuit - Test".

STOP.

i01870469

## Service Brake Pedal Position (Switch 1) Circuit - Test

**SMCS Code:** 1435-038-BRK

### System Operation Description:

#### Use this procedure under the following situation:

Use this procedure to determine if the Service Brake Pedal Position (Switch 1) is preventing normal operation of cruise control, idle set speed, or PTO operation:

The following switch circuits can also prevent the correct operation of the cruise control, idle set speed or PTO operation:

- Service Brake Pedal Position (Switch 1)
- Service Brake Pedal Position (Switch 2)
- Neutral Switch
- Cruise Control Set/Resume Switch
- Cruise Control On/Off Switch
- PTO On/Off Switch

The switches are described in the respective circuit tests in Troubleshooting.

All of the following customer programmable parameters can affect cruise control, idle set speed, and PTO operation:

- "Low Cruise Control Speed Set Limit"
- "High Cruise Control Speed Set Limit"
- "Idle Vehicle Speed Limit"
- "Cruise/Idle/PTO Switch Configuration"

- "Idle/PTO Bump rpm"
- "Idle/PTO rpm Ramp Rate"
- "PTO Vehicle Speed Limit"

The vehicle speed calibration can also affect the cruise control, the idle set speed, and the PTO if the vehicle speed calibration is incorrectly programmed. Refer to Troubleshooting, "Customer Specified Parameters".

### Service Brake Pedal Position (Switch 1)

The switch for the Service Brake Pedal Position (Switch 1) is normally closed when the respective pedal is released. Depressing the brake pedal should open the individual circuit. This switch is OEM supplied. The Service Brake Pedal Position (Switch 1) is typically a pressure switch.

### Kickout Switches

The service brake pedal position switches, the neutral switch and the clutch switch are used in the cruise control mode, the PTO mode and the Idle mode in order to discontinue the cruise operation, the PTO operation, or the idle operation. The capability to override the idle shutdown timer is determined by the "Allow Idle Shutdown Override" parameter setting. The "Allow Idle Shutdown Override" is a customer parameter.

### Usage of Transmission Style Switches

The "Transmission Style" parameter determines the switches that will be used. The following switches can be used with being dependent on the parameter setting:

- Clutch Pedal Position
- Neutral
- Service Brake Pedal Position (Switch 1)
- Service Brake Pedal Position (Switch 2)

Refer to Table 154 for additional information.

Table 154

Setting For Transmission Style Parameter	Switch Usage.			
	Service Brake 1	Service Brake 2	Clutch	Neutral
Manual Option 1	X		X	
Automatic Option 1	X			
Automatic Option 2	X	X		
Automatic Option 3	X	X		X
Automatic Option 4	X			X
Eaton Top 2	X		X	

A Service Brake Pedal Position (Switch 1) is required for all configurations. The Service Brake Pedal Position (Switch 1) connects to the ECM through connector P1:45. The Service Brake Pedal Position (Switch 2) connects to the ECM through Connector P1:64. The Clutch Pedal Position Switch connects to the ECM through Connector P1:22. The Neutral Switch connects to the ECM through Connector P1:62.

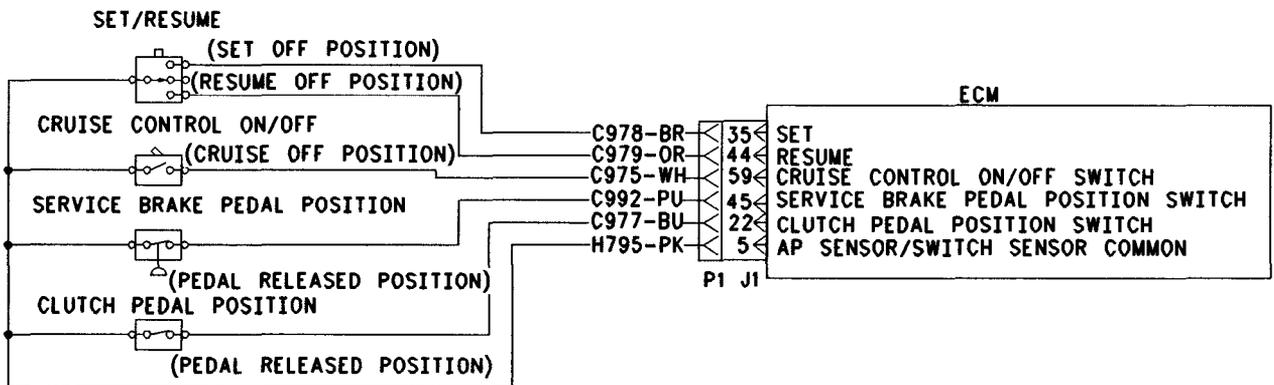


Illustration 168

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Schematic for cruise control switch, service brake pedal position (switch 1) and clutch pedal position switch

**Test Step 1. Check the Status for the "Service Brake Pedal Position Switch #1"**

- A.** Connect the electronic service tool to the data link connector.
- B.** Turn the key switch to the ON position.
- C.** Access the status for the "Service Brake Pedal Position Switch #1" on the electronic service tool.
- D.** While the status for the "Service Brake Pedal Position Switch #1" is monitored, depress the brake and release the brake.

**Expected Result:**

The status for the "Service Brake Pedal Position Switch #1" is "Off" when the brake is released. The status for the "Service Brake Pedal Position Switch #1" is "On" when the brake is depressed.

**Results:**

- **OK** – The service brake pedal position (Switch 1) is working correctly. **STOP**.
- **Not OK** – The service brake pedal position (Switch 1) is not working correctly. Proceed to Test Step 2.

**Test Step 2. Determine the Configuration of the Switch**

- A. Determine if the wiring for the service brake pedal position (Switch 1) is wired directly to the ECM or through the J1939 data link.
- B. Verify that the "Service Brake Pedal Position Switch #1" parameter is programmed to reflect the proper wiring.

**Expected Result:**

The service brake pedal position (Switch 1) is wired directly to the ECM.

**Results:**

- **OK** – The service brake pedal position (Switch 1) is wired directly to the ECM.

**Repair:** Verify that the "Service Brake Pedal Position Switch #1" parameter is programmed to "J1/P1:45".

Proceed to Test Step 3.

- **Not OK** – The service brake pedal position (Switch 1) is wired through the J1939 data link.

**Repair:** Verify that the "Service Brake Pedal Position Switch #1" parameter is programmed to "J1939 - Body Controller", "J1939 - Cab Controller", or "J1939 - Instrument Cluster".

Refer to Troubleshooting, "Powertrain Data Link Circuit - Test".

**STOP.**

### Test Step 3. Inspect Electrical Connectors And Wiring

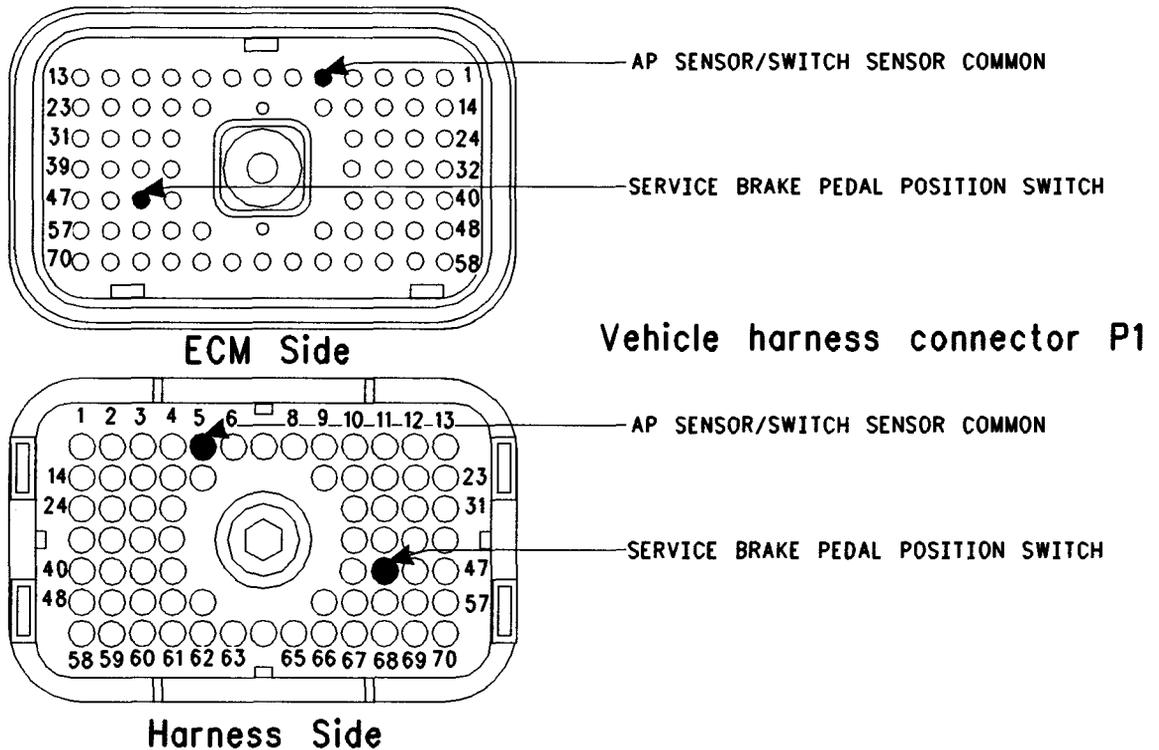


Illustration 169

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**A.** Thoroughly inspect the J1/P1 ECM connector, the firewall bulkhead connector and the terminals for the following switches in the connectors:

- J1/P1:5 (AP Sensor/Switch Sensor Common)
- J1/P1:45 (Service Brake Pedal Position (Switch 1))

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

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

Refer to Illustration 169.

**C.** Check the ECM connector (allen head screw) for the proper torque of 6.0 N·m (55 lb in).

**D.** Check the harness and wiring for abrasion and pinch points from the sensor to the ECM.

**Expected Result:**

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

**Results:**

- OK – Proceed to Test Step 4.
- Not OK

**Repair:** Perform the following repair:

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

Verify that the repair eliminates the problem.

**STOP.**

**Test Step 4. Check the Switch Circuit at the ECM**

- A.** Turn the key switch to the OFF position.
- B.** Fabricate a jumper wire 100 mm (4 inch) long. Crimp a Deutsch pin to both ends of the wires.
- C.** Connect a 140-2266 Cable (Seventy-Pin Breakout) between the J1 and P1 ECM connectors.

- D. Install the jumper into terminal 45 (Service Brake Pedal Position Switch) of the breakout T. Connect the other end of the jumper to terminal 5 (AP Sensor/Switch Sensor Common) of the breakout T.
- E. Turn the key switch to the ON position.
- F. Access the status for the "Service Brake Pedal Position Switch #1".
- G. While the status for the "Service Brake Pedal Position Switch #1" is monitored, remove the jumper from terminal 5 and insert the jumper into terminal 5 (AP Sensor/Switch Sensor Common).

**Expected Result:**

The status for the "Service Brake Pedal Position Switch #1" is "Off" when the jumper wire is removed. The status for the "Service Brake Pedal Position Switch #1" is "On" when the jumper wire is installed.

**Results:**

- OK – The ECM is functioning properly.

**Repair:** Remove the breakout T and reconnect the J1 and P1 ECM connectors.

Proceed to Test Step 5.

- Not OK – The ECM is not functioning properly.

**Repair:** Perform the following repair:

1. Temporarily connect a test ECM.
2. Remove the breakout T and reconnect the J1 and P1 ECM connectors.
3. If the problem is resolved with the test ECM, reconnect the suspect ECM.
4. If the problem returns with the suspect ECM, replace the ECM.
5. Verify that the repair eliminates the problem.

STOP.

**Test Step 5. Insert a Jumper at the Service Brake Pedal Position (Switch 1)**

- A. Turn the key switch to the OFF position.
- B. Find the switch for the Service Brake Pedal Position (Switch 1) in the vehicle.
- C. Disconnect the wires from the switch terminals.

- D. Turn the key switch to the ON position.
- E. Access the status for the "Service Brake Pedal Position Switch #1".
- F. While the status for the "Service Brake Pedal Position Switch #1" is monitored, connect the wires for the service brake pedal position (Switch 1) and disconnect the wires for the service brake pedal position (Switch 1).

**Expected Result:**

The status for the "Service Brake Pedal Position Switch #1" is "Off" when the wires are disconnected. The status for the "Service Brake Pedal Position Switch #1" is "On" when the wires are connected.

**Results:**

- OK

**Repair:** Replace the faulty switch.

Verify that the repair eliminates the problem.

STOP.

- Not OK – There is a problem in the harness between the switch and the ECM. Proceed to Test Step 6.

**Test Step 6. Insert a Jumper at the Bulkhead Connector**

- A. Turn the key switch to the OFF position.
- B. Fabricate a jumper wire 100 mm (4 inch) long. Crimp a Deutsch pin to each end of the wire.
- C. Locate the terminal for the "Service Brake Pedal Position (Switch 1)" and the "AP Sensor/Switch Sensor Common" on the engine side of the bulkhead connector.
- D. Insert the jumper wire between the two terminals in the engine side of the bulkhead connector.
- E. Turn the key switch to the ON position.
- F. Access the status for the "Service Brake Pedal Position Switch #1".
- G. While the status for the "Service Brake Pedal Position Switch #1" is monitored, remove the jumper from one of the terminals and insert the jumper wire into the terminal.

**Expected Result:**

The status for the “Service Brake Pedal Position Switch #1” is “Off” when the jumper wire is removed. The status for the “Service Brake Pedal Position Switch #1” is “On” when the jumper wire is installed.

**Results:**

- OK – The problem is in the vehicle wiring between the bulkhead connector and the switch.

**Repair:** Inspect the vehicle wiring and repair the vehicle wiring, as required. If the problem still exists with the wiring, send the vehicle to the OEM dealer.

STOP.

- Not OK – The problem is in the vehicle wiring between the bulkhead connector and the ECM.

**Repair:** Inspect the vehicle wiring and repair the vehicle wiring, as required. If the problem still exists with the wiring, send the vehicle to the OEM dealer.

STOP.

- “Allow Idle Shutdown Override”

Refer to Troubleshooting, “Service Brake Pedal Position (Switch 1) Circuit - Test” for more details on the operation of the brake pedal position switches.

Table 155

Setting For Transmission Style Parameter	Switch Usage.			
	Service Brake 1	Service Brake 2	Clutch	Neutral
Manual Option 1	X		X	
Automatic Option 1	X			
Automatic Option 2	X	X		
Automatic Option 3	X	X		X
Automatic Option 4	X			X
Eaton Top 2	X		X	

i01626422

## Service Brake Pedal Position (Switch 2) Circuit - Test

**SMCS Code:** 1435-038-BRK

**System Operation Description:**

**Use this procedure under the following situation:**

Use this procedure to determine if the “Service Brake Pedal Position (Switch 2)” is preventing normal operation of the cruise control, the idle set speed or the PTO.

**“Service Brake Pedal Position (Switch 2)”**

The “Service Brake Pedal Position (Switch 2)” is required when the “Transmission Style” parameter is programmed to Automatic Option 2 or Automatic Option 3. This switch has an identical function as “Service Brake Pedal Position (Switch 1)”. This switch is used only when a redundant system is required. Unlike the “Service Brake Pedal Position (Switch 1)”, this switch connects to + Battery. This provides a fully redundant system. A logged fault will be present if the status of the two brake switches do not agree. This switch is used to exit cruise control, Cab Switch PTO mode or idle. The switch may also be used to override the idle shutdown timer during the last 90 seconds. This capability is determined by the following customer parameter:

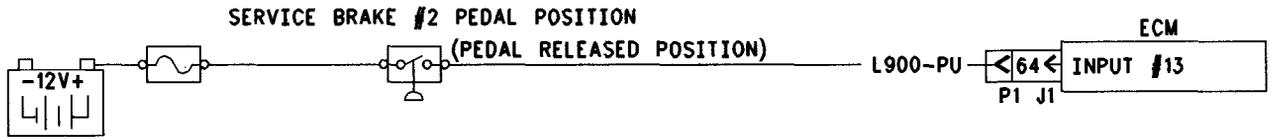


Illustration 170  
 Schematic for service brake pedal position (switch 2) g00646450

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

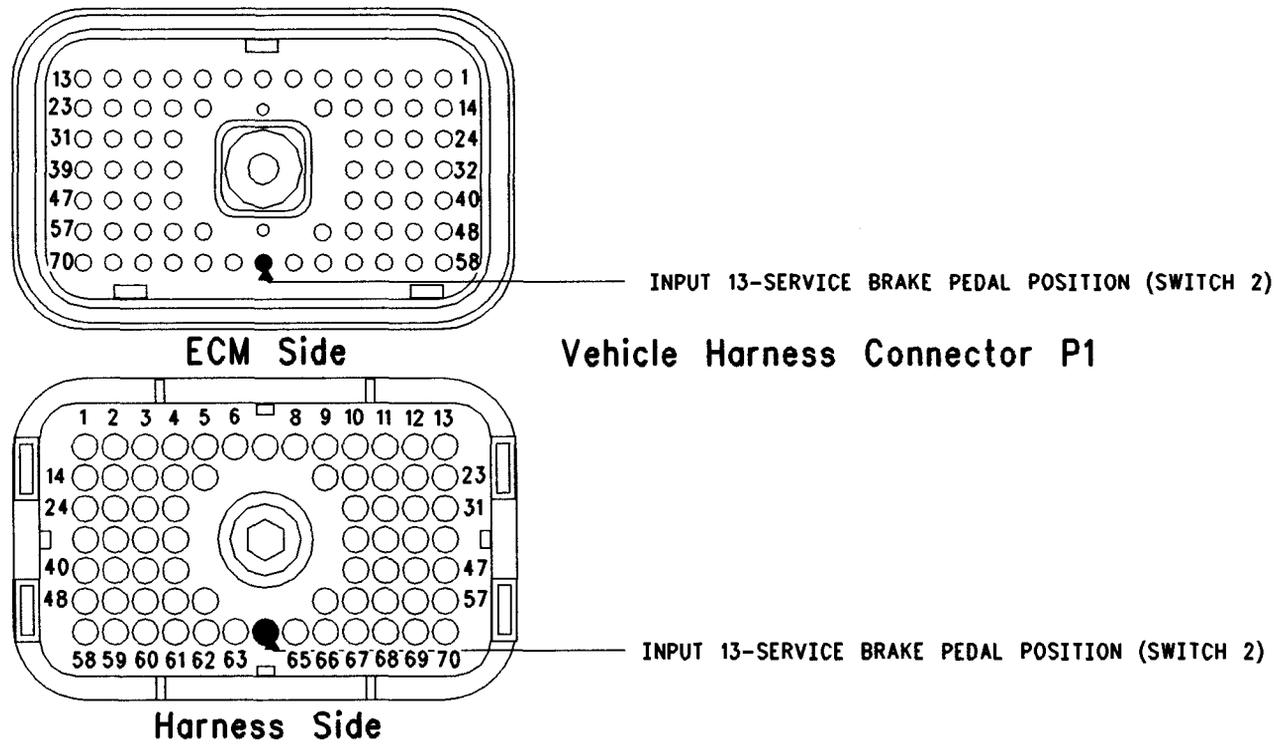


Illustration 171  
 Terminal locations for ECM g00704926

- A.** Thoroughly inspect ECM vehicle harness connector J1/P1 and the firewall bulkhead connector.  
  
Refer to Troubleshooting, “ Electrical Connectors - Inspect” for details.
- B.** Perform a 45 N (10 lb) pull test on each of the wires in the ECM connector that are associated with the switches.  
  
Refer to Illustration 171.
- C.** Check the ECM connector (allen head screw) for the proper torque of 6.0 N·m (55 lb in).

- D.** Check the harness and wiring for abrasion and pinch points from the sensor to the ECM.

**Expected Result:**

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

**Results:**

- OK – Proceed to Test Step 2.
- Not OK

**Repair:** Perform the following repair:

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

Verify that the repair eliminates the problem.

**STOP.**

## Test Step 2. Check the Switch Status on ET

Table 156

**Table for Status of the Service Brake Pedal Position (Switch 2)**

Switch Position or Pedal Position	Switch Status	Circuit
The Service Brake is Depressed.	ON	Shorted
The Service Brake is Released.	OFF	Open

- A.** Access the status screen on the Caterpillar Electronic Technician (ET).
- B.** Turn the ignition key switch to the ON position.
- C.** Start the engine or ensure that the air system is charged if the vehicle is equipped with air brakes.
- D.** Depress the Service Brake while the status of both brake switches is being observed on ET.
- E.** Release the service brake while the status of both brake switches is being observed on ET.

**Note:** If the Service Brake Pedal Position (Switch 2) status indicates "Not Installed", check the programming of the "Transmission Style" parameter. The "Transmission Style" must be programmed to Automatic Option 2 or Automatic Option 3 if a second switch is used.

### Expected Result:

The switch status changes per the information in table 156

### Results:

- **OK** – The switch is operating normally.

**Repair:** Perform the following diagnostic procedure:

Troubleshooting, "Service Brake Pedal Position (Switch 1) Circuit - Test".

**STOP.**

- **Not OK** – The ECM is not reading the switch status change. Proceed to Test Step 3.

### Test Step 3. Check the Switch Circuit of the ECM

Table 157

Table for Status of the Service Brake Pedal Position (Switch 2)		
Condition of Switch Circuit	Switch Status	Circuit
Terminal 64 is Open.	OFF	Open
Terminal 64 is connected to + Battery.	ON	Shorted

- A. Turn the ignition key switch to the OFF position.
  - B. Fabricate a jumper wire 100 mm (4 inch) long. Crimp a Deutsch pin to both ends of the wire.
  - C. Disconnect vehicle harness connector P1 from the ECM.
  - D. Connect a 70-Termial Breakout T to ECM connector J1 and connect P1 to the breakout T.
  - E. Install the jumper wire into terminal 52 (unswitched +Battery) of the breakout T. Connect the other end of the jumper wire to (terminal 64) which is the Service Brake Pedal Position (Switch 2) of the breakout T.
  - F. Turn the ignition key switch to the ON position.
  - G. Connect ET to the cab data link connector.
  - H. Access the status screen on ET.
  - I. While the status of the Service Brake Pedal Position (Switch 2) is being monitored on the status screen, slowly remove the jumper from terminal 52 and slowly insert the jumper from terminal 52.
- 4. Repeat the Test Step.
  - 5. If the problem is resolved with the test ECM, reconnect the suspect ECM.
  - 6. If the problem returns with the suspect ECM, replace the ECM.
  - 7. Verify that the repair eliminates the problem.

STOP.

#### Expected Result:

The switch status changes per the information in table 157

#### Results:

- OK – The ECM is functioning properly. Proceed to Test Step 4.
- Not OK – The ECM is not functioning properly.

Repair: Perform the following repair:

1. Temporarily connect a test ECM.
2. Remove all jumpers and replace all connectors.
3. Recheck the system for active diagnostic codes.

### Test Step 4. Insert a Jumper at the Service Brake Pedal Position (Switch 2)

Table 158

Table for Input Status of the Service Brake Pedal Position (Switch 2)		
Switch Position or Pedal Position	Switch Status	Circuit
Switch wires are disconnected.	OFF	Open
Switch wires are connected.	ON	Shorted

- A. Turn the ignition key switch to the OFF position.
- B. Ensure that ECM vehicle harness connector J1/P1 is connected.
- C. Find the switch in the vehicle.
- D. Disconnect the wires from the switch terminals.
- E. Turn the ignition key switch to the ON position.
- F. Connect ET to the cab data link connector.
- G. Access the status screen on ET.
- H. While the switch status is being monitored on the status screen slowly connect the suspect switch wires and slowly disconnect the suspect switch wires.

**Expected Result:**

Refer to table 158.

**Results:**

- OK

Repair: Perform the following repair:

Replace the faulty switch. Verify that the repair eliminates the problem.

STOP.

- Not OK – There is a problem in the harness between the switch and the ECM. Proceed to Test Step 5.

### Test Step 5. Insert a Jumper at the Bulkhead Connector

Table 159

Table for Input Status of the Service Brake Pedal Position (Switch 2)		
Switch Position or Pedal Position	Switch Status	Circuit
Switch wires are disconnected.	OFF	Open
Switch wires are connected.	ON	Shorted

- A. Turn the ignition key switch to the OFF position.

- B.** Fabricate a jumper wire 100 mm (4 inch) long. Crimp a Deutsch pin to both ends of the wires.
- C.** Find the switch terminal in the engine side of the bulkhead connector for the vehicle harness. Also, find a convenient location for + Battery voltage.
- D.** Insert the jumper wire between the two terminals in the engine side of the bulkhead connector.
- E.** Turn the ignition key switch to the ON position.
- F.** Connect ET to the cab data link connector.
- G.** Access the status screen on ET.
- H.** While the switch status is being monitored on the status screen alternately remove the jumper wire from the + Battery connection, and alternately install the jumper wire at the + Battery connection.

**Expected Result:**

Refer to table 159.

**Results:**

- **OK** – The problem is in the vehicle wiring between the bulkhead connector and the switch.

**Repair:** Perform the following repair:

Inspect the vehicle wiring and repair the vehicle wiring, as required. If the problem still exists with the wiring, send the vehicle to the OEM dealer.

**STOP.**

- **Not OK** – The problem is in the vehicle wiring between the bulkhead connector and the ECM.

**Repair:** Perform the following repair:

Inspect the vehicle wiring and repair the vehicle wiring, as required. If the problem still exists with the wiring, send the vehicle to the OEM dealer.

**STOP.**

Use this procedure to determine if the Starting Aid Output circuit is operating properly.

**The following background information is related to this procedure:**

The "Starting Aid Output" can be programmed to J1/P1:10, J1/P1:12, or J1/P1:13.

The "Starting Aid Output" will function on the following corresponding output that is selected:

- ECM Connector J1/P1 terminal 10
- ECM Connector J1/P1 terminal 12
- ECM Connector J1/P1 terminal 13

This "Starting Aid Output" is used to connect to a relay and/or a solenoid in order to control a starting aid system. Typical starting aid systems inject ether into the inlet manifold in order to aid starting of the engine during cold weather operation. The output can be automatically controlled by the ECM, or an additional switch can be added to the system. This switch allows the operator to disable the system if the operator desires. The On/Off switch for the starting aid can be programmed to use J1/P1:6, J1/P1:7, J1/P1:46, or J1/P1:47. The reading of the coolant temperature sensor is used to determine if conditions require the use of the starting aid. If a fault condition exists with the circuit for the coolant temperature sensor, the reading for the inlet manifold temperature sensor will be used. The "Starting Aid Output" will be enabled for a maximum of 30 seconds while the engine is cranking and the temperature reading is below 0 °C (32 °F). The "Starting Aid Output" will be disabled if the engine starts. The "Starting Aid Output" will also be disabled if a condition that prevents fuel injection occurs.

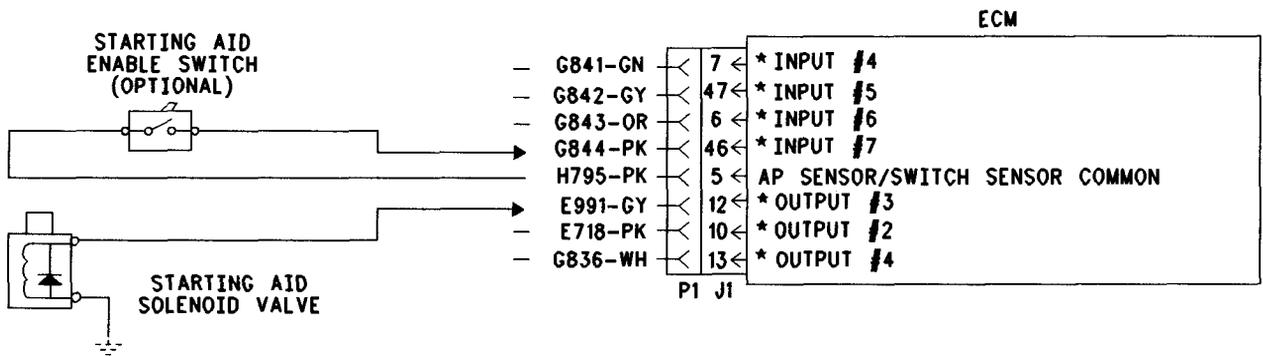
i01626360

## Starting Aid Output Circuit - Test

**SMCS Code:** 1456-038

**System Operation Description:**

**Use this procedure under the following situation:**



NOTE: STARTING AID OUTPUT PARAMETER MUST BE PROGRAMMED TO THE OUTPUT SELECTION. OUTPUT 2, 3, OR 4 MAY BE USED.

NOTE: STARTING AID ON/OFF SWITCH PARAMETER MUST BE PROGRAMMED TO INPUT SELECTION. INPUT 4, 5, 6, OR 7 MAY BE USED.

Illustration 172  
Starting Aid Output Circuit

g00681335

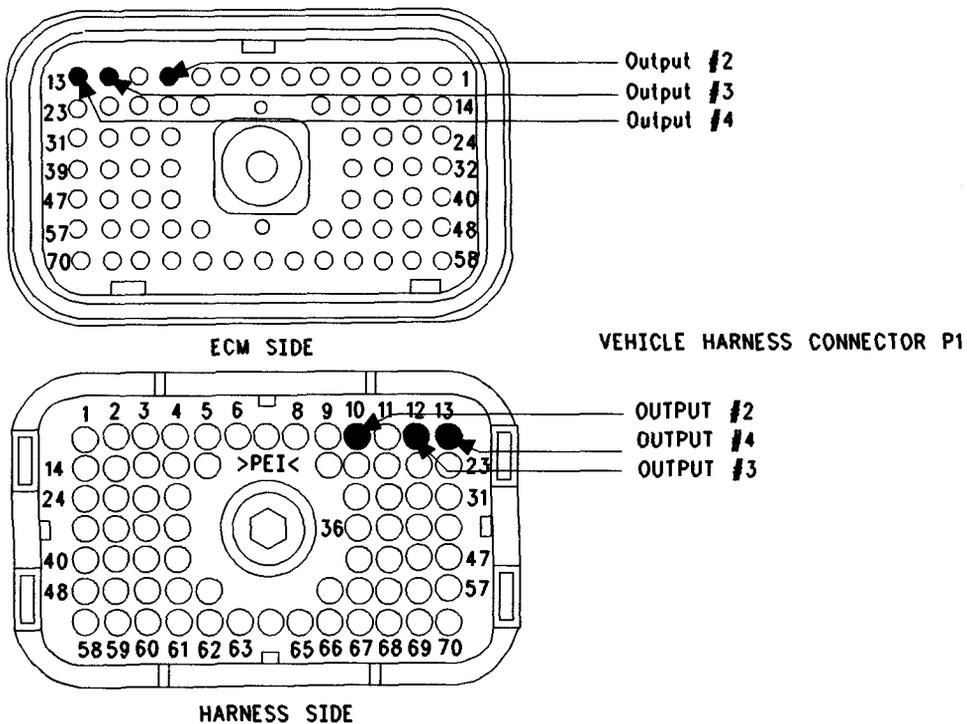


Illustration 173  
Terminal locations for the ECM

g00681396

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

**A.** Thoroughly inspect the ECM Vehicle Harness Connector J1/P1, and the firewall bulkhead connectors. Refer to Troubleshooting, "Electrical Connectors - Inspect" for details.

**B.** Perform a 45 N (10 lb) pull test on terminal 10, terminal 12, or terminal 13 in the ECM connector.

**C.** Check the ECM connector (allen head screw) for the proper torque of 6.0 N·m (55 lb in).

**D.** Check the harness and the wiring for abrasion and pinch points from the relays to the ECM.

### Expected Result:

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

### Results:

- OK – Proceed to Test Step 2.
- Not OK – Repair the wiring or replace the wiring, if necessary. Repair the connectors or replace the connectors, if necessary. Ensure that all of the seals are in the proper place. Ensure that all of the connectors are connected properly. Verify that the repair eliminates the problem. STOP.

### Test Step 2. Ensure Correct Parameter Programming

- Connect the Caterpillar Electronic Technician (ET) to the cab data link connector.
- Turn the ignition key switch to the ON position.
- Access the Customer Specified Parameter Screen in order to make sure that the ECM is programmed to use the starting aid output.
- Ensure that the starting aid circuit is connected to the programmed output.

### Expected Result:

The circuit is connected to the correct ECM terminal that is selected for the "Starting Aid Output".

### Results:

- OK – Proceed to Test Step 3.
- Not OK – Update the customer specified parameter in order to match the correct output terminal. Proceed to Test Step 3.

### Test Step 3. Check the Relay on ET

- Turn the ignition key switch to the ON position.



**Personal injury or death can result from not following the proper procedures.**

**To avoid the possibility of injury or death, follow the established procedure.**

---

- Access the "Starting Aid Output Special Test" on ET. The "Starting Aid Output Special Test" will enable the "Starting Aid Output" when the test is active.

**Disconnect the starting aid canister in order to prevent accidental discharge.**

- Begin the "Starting Aid Output Special Test" and listen for the solenoid or the relay to "click". You may need to be near the engine in order to hear the "click".

### Expected Result:

The solenoid or the relay activates when the special test is enabled.

### Results:

- OK – The ECM and vehicle components are operating correctly. Ensure that the ether canister is not empty. STOP.
- Not OK – Proceed to Test Step 4.

### Test Step 4. Check the ECM on ET

- Connect ET to the cab data link connector.
- Turn the ignition key switch to the OFF position.
- Disconnect the ECM vehicle harness connector J1/P1.
- Install a 70 Terminal breakout T between connectors J1 and P1.
- If the "Starting Aid Output" is programmed to J1/P1:10, connect a voltage test lamp to terminal 10 (Output 2) and terminal 65 (-Battery) of the breakout T.
- If the "Starting Aid Output" is programmed to J1/P1:12, connect a voltage test lamp to terminal 12 (Output 3) and terminal 65 (-Battery) of the breakout T.
- If the "Starting Aid Output" is programmed to J1/P1:13, connect a voltage test lamp to terminal 13 (Output 4) and terminal 65 (-Battery) of the breakout T.
- Turn the ignition key switch to the ON position.
- Access the "Starting Aid Output Special Test" on ET.
- Cycle the corresponding "Starting Aid Output Special Test" to the ON position and to the OFF position and watch the voltage test lamp.

**K. Stop the “Starting Aid Output Special Test”.**

**Note:** A multimeter can not be used in place of the voltage test lamp when the ECM outputs are being tested.

**Note:** The “Starting Aid Output Special Test” will only remain active for one second in order to prevent accidental discharge. The test lamp will turn off when the “Starting Aid Output Special Test” is disabled.

**Expected Result:**

The voltage test Lamp will turn ON when the “Starting Aid Output Special Test” is active. The voltage test lamp will turn off when the “Starting Aid Output Special Test” is disabled.

**Results:**

- **OK** – The ECM is OK. The problem is in the vehicle wiring. Inspect the vehicle wiring and then repair the vehicle wiring. Otherwise, send the vehicle to the OEM dealer for repair. Verify that the original condition is resolved. **STOP.**
- **Not OK** – Temporarily connect a test ECM. Use the “Starting Aid Output Special Test” on ET to check the ECM. If the problem is resolved with the test ECM, install the suspect ECM. If the problem returns with the suspect ECM, replace the ECM. Verify that the repair eliminates the problem. **STOP.**

i01627841

## Starting Aid Switch Circuit - Test

**SMCS Code:** 7332-038

**System Operation Description:****Use this procedure under the following situation:**

Use this procedure to determine if the circuit for the starting aid switch is operating correctly.

**The following background information is related to this procedure:**

The ECM can use various inputs in a number of ways. The inputs depend on the parameter programming. Certain features are available on several different inputs. The configuration for the switch must match the actual switch installation in order for the switch to function properly.

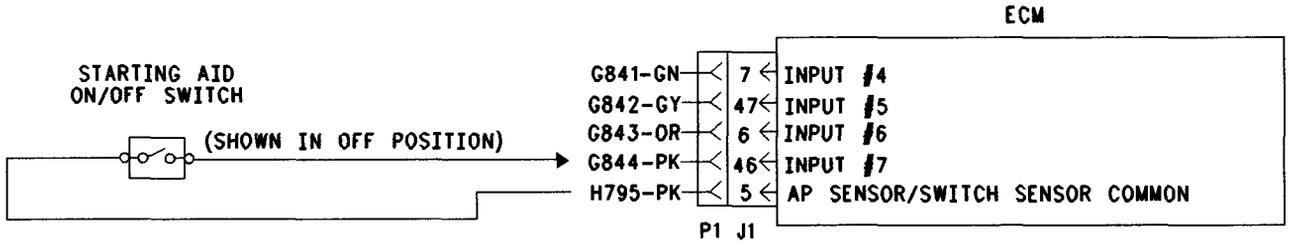
**“Starting Aid On/Off Switch”**

A starting aid feature that is controlled by the ECM is available with NOV99 and newer software.

The starting aid system does not require a switch for automatic operation. A switch can be installed in order to allow the operator to override the automatic starting aid. If a switch is installed and the “starting aid On/Off switch” parameter is programmed to the corresponding switch input, the switch will control the starting aid system. The starting aid system will automatically enable the starting aid output when the switch is in the ON position. However, the conditions must require the use of a starting aid. When the switch is in the OFF position, the starting aid system will not function. If the “Starting Aid On/Off Switch” parameter is programmed to “None” (default), this feature is not used. The “Starting Aid On/Off Switch” parameter should be programmed to one of the inputs (J1/P1:7, J1/P1:47, J1/P1:6, J1/P1:46). Also, the switch circuit should be connected to the same input option.

**Note:** The wiring for your particular application may be slightly different. The sensor common circuits are used interchangeably by the OEM of the vehicle. The following circuits are common within the ECM:

- The “Input Sensor Common 1” is terminal 18.
- The “Input Sensor Common 2” is terminal 3.
- The “AP Sensor/Switch Sensor Common” is terminal 5.



NOTE: INPUT #4, #5, #6 OR #7 MAY BE USED. THE STARTING AID ON/OFF SWITCH PARAMETER MUST BE PROGRAMMED TO THE INPUT SELECTION.

Illustration 174  
Schematic for the Starting Aid Switch

g00682699

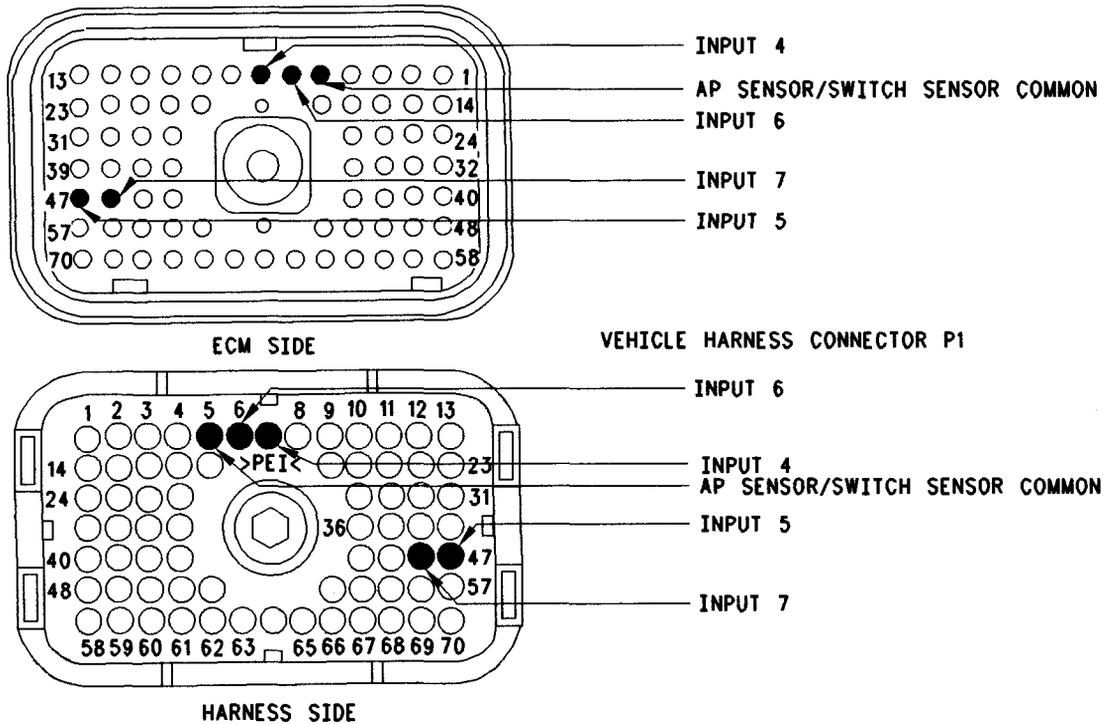


Illustration 175  
Terminal Locations for the ECM

g00682618

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

- A. Thoroughly inspect the ECM vehicle harness connector J1/P1, the connectors, and the firewall bulkhead connectors. Refer to Troubleshooting, "Electrical Connectors - Inspect" for details.
- B. Perform a 45 N (10 lb) pull test on each of the wires in the ECM connector that are associated with the circuit for the starting aid switch.

- C. Check the ECM connector (allen head screw) for the proper torque of 6.0 N·m (55 lb in).
- D. Check the harness and the wiring for abrasion and pinch points from the battery to the ECM. Then, check from the ignition key switch to the ECM.

Refer to Illustration 175 for terminal locations for the ECM.

**Expected Result:**

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

**Results:**

- OK – Proceed to Test Step 2.
- Not OK – Repair the wiring and connectors or replace the wiring or the connectors. Ensure that all of the seals are properly connected. Verify that the repair eliminates the problem. STOP.

**Test Step 2. Check the “Starting Aid On/Off Switch” Status on ET**

- A. Connect the Caterpillar Electronic Technician (ET) to the cab data link connector.
- B. Turn the ignition key switch to the ON position.
- C. Operate the switch in the ON and OFF positions.
- D. View the “Starting Aid On/Off Switch” status on ET.
- E. If the “Starting Aid On/Off Switch” status indicates “Not Installed”, then the “Starting Aid On/Off Switch” parameter has not been programmed.

**Expected Result:**

The status screen should indicate ON if the switch is turned on. The status screen should indicate OFF if the switch is off.

**Results:**

- OK – The switch is operating normally. Continue troubleshooting if the original condition is not resolved. STOP.
- Not OK – The ECM is not reading the “Switch Status” change. Proceed to Test Step 3.

### Test Step 3. Check the Switch Circuit for the ECM

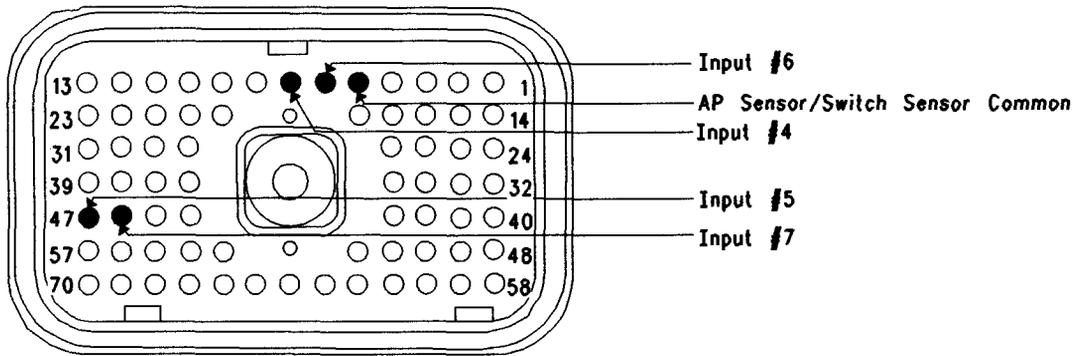


Illustration 176

g00682624

Connector for the Breakout T

- A. Turn the ignition key switch to the OFF position.
- B. Install a 70 terminal breakout T to the ECM vehicle harness connector J1/P1.
- C. Fabricate a jumper wire 100 mm (4 inch) long. Crimp a Deutsch pin to both ends of the wire.
- D. Insert the jumper wire into the input terminal for the starting aid switch of the breakout T. Connect the other end of the jumper wire to terminal 5 in the breakout T. Terminal 5 is AP Sensor/Switch Common.

**Note:** Refer to the programmed selection of the “starting aid On/Off switch” parameter. This reference will display the appropriate input.

- E. Connect ET to the cab data link connector.
- F. Turn the ignition key switch to the ON position.
- G. Alternately remove the jumper wire and then insert the jumper wire from terminal 5. At the same time, monitor the status screen on ET.

#### Expected Result:

The switch status changes to “ON” with the jumper wire in place. The switch status changes to “OFF” when the jumper wire is removed.

#### Results:

- OK – The ECM is functioning properly at this time. Proceed to Test Step 4.
- Not OK – The ECM is not functioning properly.

**Repair:** Perform the following diagnostic procedure:

1. Temporarily connect a test ECM. Only connect ECM harness J1/P1.
2. Recheck for an +5 V diagnostic code when the engine harness is disconnected.
3. If the problem is resolved with the test ECM, reconnect the suspect ECM.
4. If the problem returns with the suspect ECM, replace the ECM.

STOP.

### Test Step 4. Insert a Jumper Wire at the Switch

- A. Turn the ignition key switch to the OFF position.
- B. Reconnect the ECM vehicle harness connector J1/P1.
- C. Fabricate a jumper wire 100 mm (4 inch) long. Crimp a Deutsch pin to both ends of the wire.
- D. Insert the jumper wire between the two switch terminals of the starting aid switch.
- E. Turn the ignition key switch to the ON position.
- F. Alternately remove the jumper wire and then insert the jumper wire at the switch terminals. At the same time, watch the status screen on ET.

#### Expected Result:

The switch status changes to “ON” with the jumper wire in place. The switch status changes to “OFF” when the jumper wire is removed.

**Results:**

## • OK

**Repair:** Perform the following diagnostic procedure:

Replace the switch.

Verify that the repair eliminates the problem.

**STOP.**

- **Not OK** – There is a problem in the wire harness between the starting aid switch and the ECM. Proceed to Test Step 5.

**Test Step 5. Insert a Jumper Wire at the Bulkhead Connector**

- A.** Turn the ignition key switch to the OFF position.
- B.** Fabricate a jumper wire 100 mm (4 inch) long. Crimp a Deutsch pin to both ends of the wire.
- C.** Locate the socket for the starting aid switch that is suspect in the engine side of the ECM bulkhead connector.
- D.** Insert the wire jumper pin between the switch socket and the sensor common connection. Install the jumper wire on the engine side of the ECM bulkhead connector.
- E.** Turn the ignition key switch to the ON position.
- F.** Alternately connect and then disconnect the jumper wire. At the same time, monitor the status screen on ET.

**Expected Result:**

The switch status changes from “ON” with the jumper wire in place. The switch status changes to “OFF” when the jumper wire is removed.

**Results:**

- **OK** – The problem is in the vehicle wiring between the bulkhead connector and the switch. Inspect the vehicle wiring and then repair the vehicle wiring. Otherwise, send the vehicle to the OEM dealer for repair. Verify that the original condition is resolved. **STOP.**
- **Not OK** – The problem is in the vehicle wiring between the bulkhead connector and the ECM. Inspect the vehicle wiring and then repair the vehicle wiring. Otherwise, send the vehicle to the OEM dealer for repair. Verify that the original condition is resolved. **STOP.**

**Tachometer Circuit - Test**

**SMCS Code:** 7462-038

**System Operation Description:**

If the vehicle tachometer is driven by the ECM the vehicle tachometer will be connected to the ECM through connector J1/P1:38 and/or J1/P1:39. Some tachometers require only one of the ECM tachometer signal lines to operate while other tachometers may require both of the ECM tachometer signal lines to operate.

**The following background information is related to this procedure:**

The tachometer circuit consists of the tachometer that is connected to the ECM through connector J1/P1 and associated wiring. The ECM engine speed signal is provided by the primary engine speed/timing sensor. The ECM converts the signal from the primary engine speed/timing sensor into engine rpm in pulses per revolution before the ECM sends a signal to the tachometer. The selection of the pulses per revolution for the tachometer is done through the “Tachometer Calibration” parameter.

The ECM tachometer signal is programmable from 12.0 to 500.0 pulses per revolution in 0.1 increments. The tachometer must be calibrated identically to this value for proper operation.

The most likely source of a tachometer circuit problem is the vehicle wiring. The second most likely source of a tachometer circuit problem is the tachometer and the least likely source of a tachometer circuit problem is the ECM.

**Note:** A tachometer may also be driven by the SAE J1587 data link or the J1939 data link. If the engine ECM communicates with the electronic service tool and the instrument cluster uses the signal from a data link, the problem is in one of two locations. Either the problem is in the wiring from the ECM to the dash, or the problem is in the dash.

**Note:** Do not disturb the secondary engine speed/timing sensor and the primary engine speed/timing sensor in order to troubleshoot a tachometer circuit problem. If there is a problem that is associated with the sensors, refer to Troubleshooting, “Engine Speed/Timing Sensor Circuit - Test”. Any problem that is associated with the secondary engine speed/timing sensor and the primary engine speed/timing sensor will be apparent because of engine operation with a diagnostic code that is present. There are no diagnostic codes that are associated with the tachometer circuit.

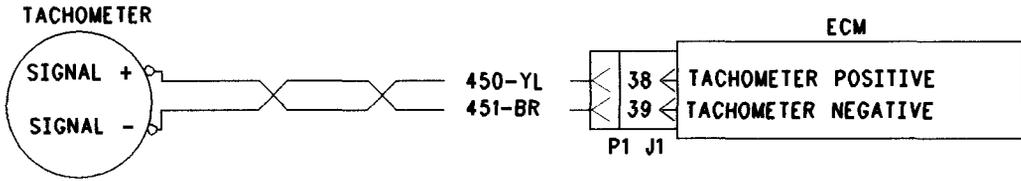


Illustration 177  
 Schematic No. 1 for tachometer

g00649121

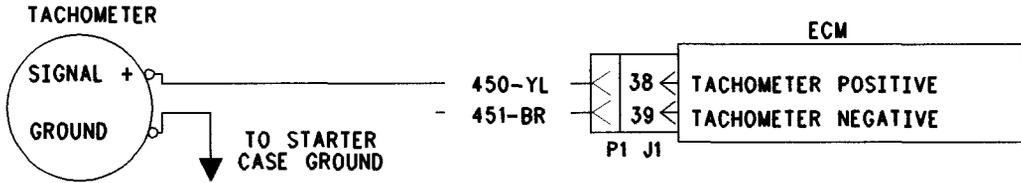


Illustration 178  
 Schematic No. 2 for tachometer

g00649123

### Test Step 1. Use an Electronic Service Tool to Check the ECM Tachometer Signal

- A. Connect the electronic service tool at the data link connector.
- B. Turn the key switch to the ON position.
- C. Access the "Tachometer Circuit Test". Access the following display screens in order:
  - "Diagnostics"
  - "Diagnostic Tests"
  - "Special Test"
- D. While the dash tachometer is being monitored, begin the test.

#### Expected Result:

**RESULT 1** The dash tachometer indicates approximately 1500 ± 150 rpm and the dash tachometer is stable.

**RESULT 2** The tachometer does not indicate an engine rpm or the tachometer is erratic.

**RESULT 3** The tachometer rpm is stable but the tachometer rpm is not within 50 rpm of 1500 rpm.

#### Results:

- **Result 1** – The ECM and the tachometer are OK.  
 STOP.

- **Result 2** – The engine rpm is not indicated or the engine rpm is erratic. Proceed to Test Step 2.
- **Result 3** – The engine rpm is not within 50 rpm of 1500 rpm. Proceed to Test Step 6.

### Test Step 2. Determine the Type of Connection

- A. Determine if the wiring for the tachometer is wired directly to the ECM or through the J1939 or J1587 data link.

#### Expected Result:

The tachometer is wired directly to the ECM.

#### Results:

- **OK** – The tachometer is wired directly to the ECM. Proceed to Test Step 3.
- **J1939 data link** – The tachometer is wired through the J1939 data link.

**Repair:** Refer to Troubleshooting, "Powertrain Data Link Circuit - Test".

STOP.

- **J1587 data link** – The tachometer is wired through the J1587 data link.

**Repair:** Refer to Troubleshooting, "ATA (SAE J1587 / J1708) Data Link Circuit - Test".

STOP.

### Test Step 3. Inspect Electrical Connectors and Wiring

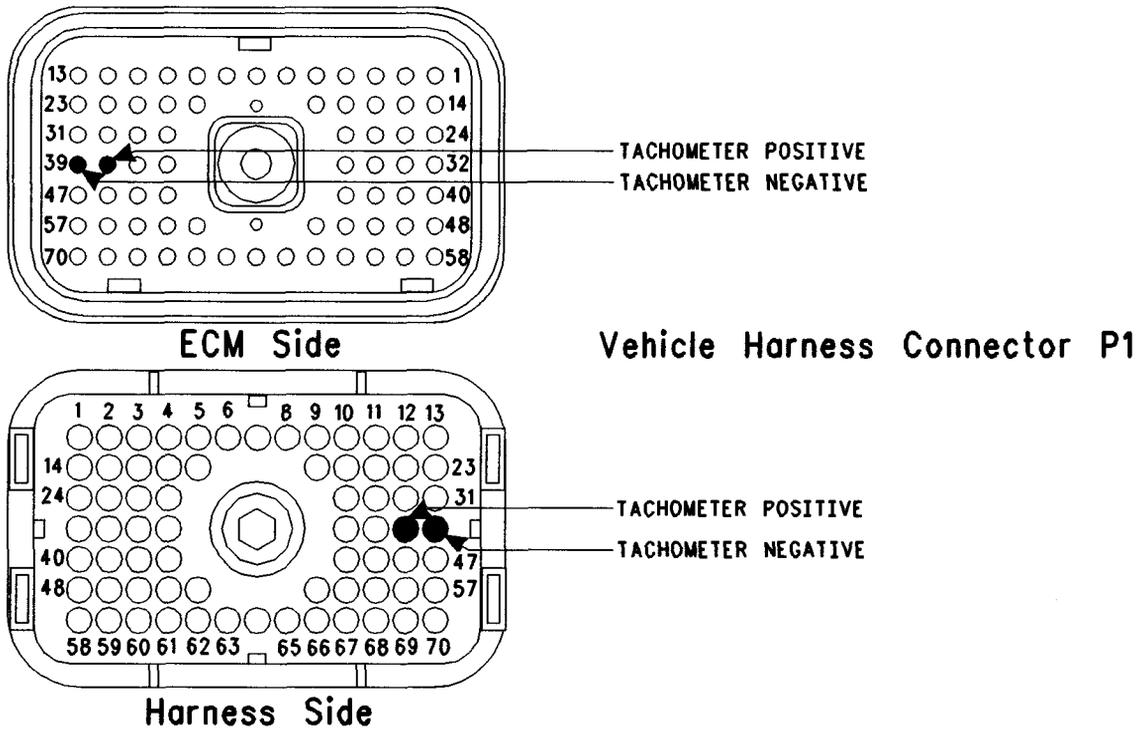


Illustration 179

g00649124

Terminal locations for ECM

**A.** Thoroughly inspect the J1/P1 ECM connector, the firewall bulkhead connector, and the terminals for the tachometer in the connectors. Refer to Troubleshooting, "Electrical Connectors - Inspect" for details.

**B.** Perform a 45 N (10 lb) pull test on each of the wires in the ECM connector that are associated with the terminals for the tachometer:

- P1:38
- P1:39

Refer to Illustration 179.

**C.** Check the ECM connector (allen head screw) for the proper torque of 6.0 N·m (55 lb in).

**D.** Check the harness and wiring for abrasion and pinch points from the battery to the ECM.

**Expected Result:**

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

**Results:**

- OK – Proceed to Test Step 4.
- Not OK

Repair: Perform the following repair:

1. 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.
2. Verify that the repair eliminates the problem.

STOP.

**Test Step 4. Check the ECM Connection to the Tachometer**

**A.** Inspect the J1/P1 ECM connector. Verify that the connections are present at P1:39 Tachometer- and/or P1:38 Tachometer+.

**Note:** Some of the tachometers require only one signal line to be connected. Either of the ECM terminals can be used for this type of tachometer. The other wire should be left disconnected. If both wires are connected, and one indicates an open circuit, repair this line.

**Expected Result:**

Wires are connected to the ECM terminals for the tachometer, P1:39 (Tachometer-) and/or P1: 38 (Tachometer+).

**Results:**

- **OK** – The ECM is providing the signal for the tachometer. Proceed to Test Step 5.
- **Not OK** – The ECM is not connected in order to supply the signal to the tachometer.

**Repair:** Send the vehicle to the OEM dealer in order to repair the tachometer circuit.

STOP.

**Test Step 5. Check the ECM Tachometer Signal**

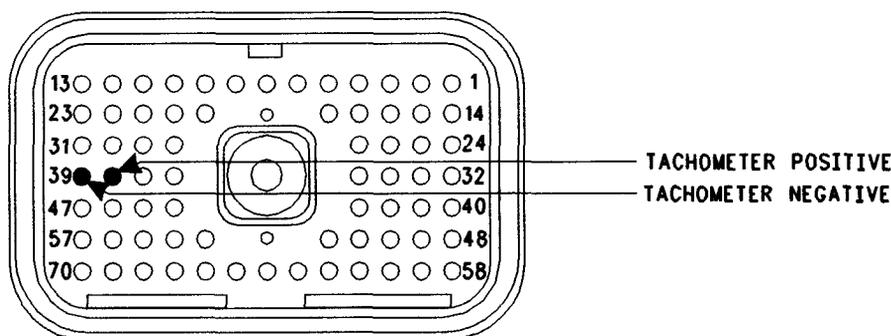


Illustration 180  
ECM Breakout T-connector

g00649125

**Note:** Performing certain steps within this procedure requires the use of a multimeter that is capable of measuring a PWM Duty Cycle.

- A.** Disconnect the J1/P1 ECM connector.
- B.** Connect a 140-2266 Cable (Seventy-Pin Breakout) between the J1 and P1 ECM connector
- C.** Fabricate two jumper wires 100 mm (4 inch) long. Crimp a Deutsch Pin to one end of each wire.
- D.** Insert one of the jumper wires into P1:39 (Tachometer-) of the breakout T and insert the other jumper wire into P1:38 (Tachometer+) of the breakout T.

Refer to Illustration 180.

- E.** Access the "Tachometer Circuit Test". Access the following display screens in order:

- "Diagnostics"
- "Diagnostic Tests"
- "Special Test"

- F.** Attach one of the multimeter leads to the jumper wire from P1:38.
- G.** Attach the other multimeter lead to the jumper wire from P1:39.
- H.** While the "Tachometer Circuit Test" is being run, observe the reading on the multimeter.

**Expected Result:**

The multimeter indicates a duty cycle from 30 to 70 percent from each of the terminals for the tachometer while the engine is running.

**Results:**

- OK – The ECM tachometer output is OK.

**Repair:** Remove the breakout T and reconnect the J1/P1 ECM connector.

Proceed to Test Step 7.

- Not OK – The duty cycle is out of the range.

**Repair:** Perform the following repair:

1. Temporarily connect a test ECM.
2. Remove all jumpers and replace all connectors.
3. Recheck the system for active diagnostic codes.
4. Repeat the test step.
5. If the problem is resolved with the test ECM, reconnect the suspect ECM.
6. If the problem returns with the suspect ECM, replace the ECM.
7. Verify that the repair eliminates the problem.

STOP.

**Test Step 6. Inspect the Tachometer Calibration**

- A. Determine the tachometer engine speed calibration setting in pulses per revolution. You may be required to contact the OEM dealer or you may be required to send the vehicle to the OEM dealer for this information.
- B. Connect the electronic service tool to the data link connector.
- C. Check the "Tachometer Calibration" parameter on the "Configuration" screen.

**Expected Result:**

The "Tachometer Calibration" matches the ECM tachometer calibration.

**Results:**

- OK – The tachometer is correctly calibrated.

**Repair:** Perform the following repair:

1. If the tachometer is correctly calibrated but the tachometer does not work, replace the tachometer or send the tachometer to the OEM dealer for repair.

2. Verify that the repair eliminates the problem.

STOP.

- Not OK – The tachometer is not correctly calibrated.

**Repair:** Perform the following repair:

1. Calibrate the tachometer in order to match the ECM.
  - a. If the tachometer calibration is known and the tachometer calibration is within 12.0 to 500.0 pulses per revolution, change the Customer Programmable Parameter of the ECM "Tachometer Calibration" in order to match the tachometer.
2. Verify that the repair eliminates the problem.

STOP.

**Test Step 7. Check the ECM Connection to the Tachometer**

- A. Find the tachometer signal connections to the tachometer.
- B. Disconnect the wires from the ECM to the tachometer at the ECM connector and at the tachometer.
 

Refer to Illustration 180.
- C. Check for continuity through the wires to the ECM connector P1:39 (Tachometer-) and P1:38 (Tachometer+).

**Note:** Some of the tachometers require only one signal line to be connected. Either of the ECM terminals can be used for this type of tachometer. The other wire should be left disconnected. If both wires are connected, and one indicates an open circuit, repair this line.

**Expected Result:**

The wires from the ECM to the tachometer are undamaged.

**Results:**

- OK – The wiring is OK. Proceed to Test Step 8.
- Not OK – The wiring is damaged.

**Repair:** Perform the following repair:

Either repair the wiring or send the vehicle to the OEM dealer. Verify that the repair eliminates the problem.

STOP.

### Test Step 8. Check the Supply Voltage to the Tachometer

- A. Connect the tachometer lines to the ECM and the tachometer.
- B. Check the positive battery connections and the negative battery connections to the tachometer. Include the fuses and the circuit protection.

#### Expected Result:

The tachometer is receiving the correct battery supply voltage.

#### Results:

- OK – The battery supply voltage is OK.

Repair: Perform the following repair:

If the tachometer is receiving the correct battery supply voltage but the tachometer does not work, replace the tachometer or send the tachometer to the OEM dealer for repair.

STOP.

- Not OK – The battery supply voltage is incorrect.

Repair: Perform the following repair:

1. Repair the wiring for the battery connection.
2. Verify that the repair eliminates the problem.

STOP.

The ECM can use various inputs in a number of ways. The inputs depend on the parameter programming. Certain features are available on several different inputs. The configuration for the switch must match the actual switch installation in order for the switch to function properly.

### Torque Limit Switch

The torque limit switch provides a way to temporarily protect equipment from damage that is caused by applying too much torque. Torque limiting is typically used during PTO operation. Torque limiting can also be used when the PTO On/Off switch is in the OFF position.

In order to use torque limiting, a "Torque Limit" must be programmed. The "Torque Limit" parameter is located under the "Dedicated PTO Parameters". The default setting is 3400 N·m (2500 lb ft). The "Torque Limit Switch" input selection must also be programmed. If the "Torque Limit Switch" parameter is programmed to "None" (default), this feature is not used. If the "Torque Limit Switch" is programmed to J1/P1:7, then the feature is available and the switch circuit should be connected to terminal 7 of the J1/P1 ECM vehicle harness connector.

**Note:** The wiring for your particular application may be slightly different. The circuits for the sensor common are used interchangeably by the OEM of the vehicle. The following circuits are common within the ECM:

- The "Input Sensor Common 1" is terminal 18.
- The "Input Sensor Common 2" is terminal 3.
- The "AP Sensor/Switch Sensor Common" is terminal 5.

i01625987

## Torque Limit Switch Circuit - Test

**SMCS Code:** 1435-038

### System Operation Description:

#### Use this procedure under the following situation:

Use this procedure to determine if the circuit for the torque limit switch is operating correctly.

**The following background information is related to this procedure:**

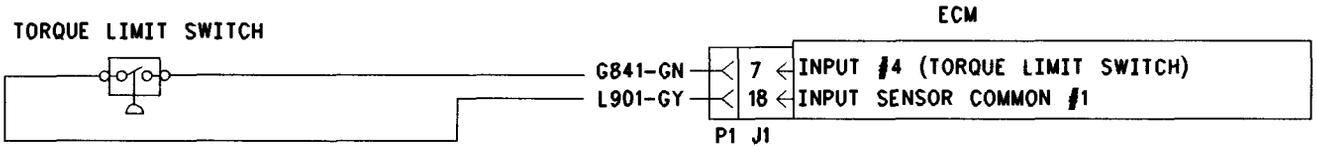


Illustration 181  
Schematic for Torque Limit Switch

g00682363

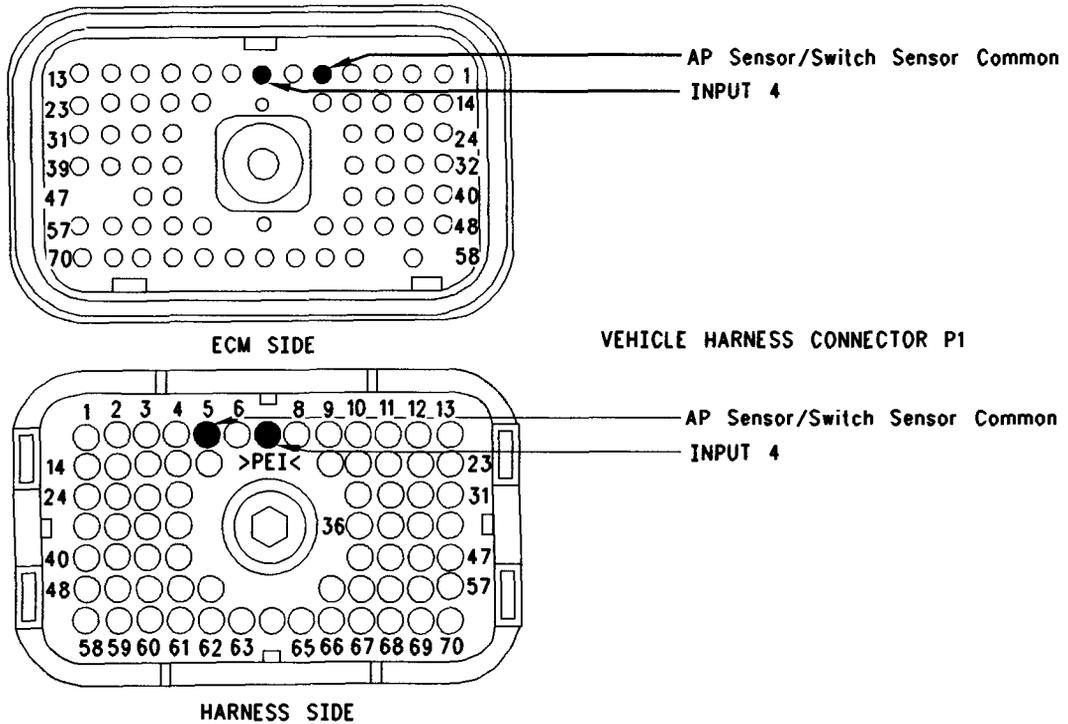


Illustration 182  
Terminal Locations for ECM

g00682368

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

**A.** Thoroughly inspect the ECM vehicle harness connector J1/P1, the connectors, and the firewall bulkhead connectors. Refer to Troubleshooting, "Electrical Connectors - Inspect" for details.

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

The wires are on the following terminals:

- terminal 7
- terminal 5

**C.** Check the ECM connector (allen head screw) for the proper torque of 6.0 N·m (55 lb in).

**D.** Check the harness and the wiring for abrasion and pinch points from the battery to the ECM. Then, check from the ignition key switch to the ECM.

Refer to Illustration 182 for terminal locations for the ECM.

#### Expected Result:

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

#### Results:

- OK – Proceed to Test Step 2.

- **Not OK** – Repair the wiring and connectors or replace the wiring or the connectors. Ensure that all of the seals are properly connected. Verify that the repair eliminates the problem. **STOP**.

### Test Step 2. Check the Status of the Torque Limit Switch on ET

- Connect the Caterpillar Electronic Technician (ET) to the cab data link connector.
- Turn the ignition key switch to the ON position.
- Operate the switch in the ON position and the OFF position.
- View the "Torque Limit Switch" status on ET.
- If the "Torque Limit Switch" status indicates "Not Installed", then the "Torque Limit Switch" parameter has not been programmed.

#### Expected Result:

The status screen should indicate "ON" if the switch is turned on. The status screen should indicate "OFF" if the switch is off.

#### Results:

- **OK** – The switch is operating normally. Continue troubleshooting if the original condition is not resolved. **STOP**.
- **Not OK** – The ECM is not reading the "Switch Status" change. Proceed to Test Step 3.

### Test Step 3. Check the Switch Circuit for the ECM

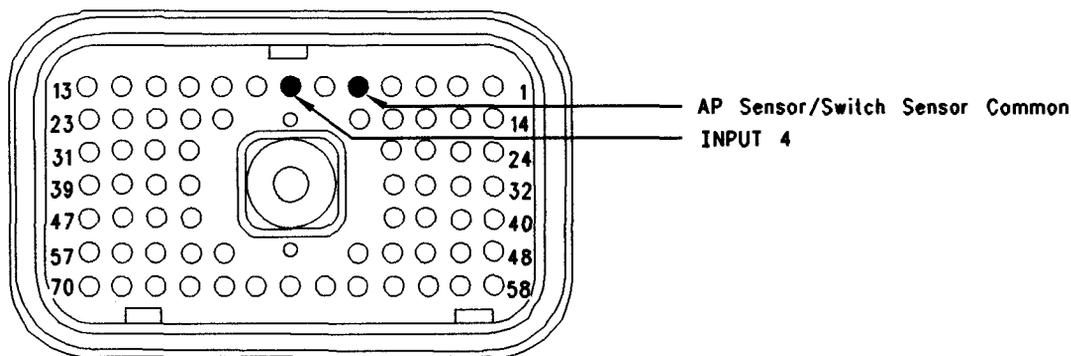


Illustration 183

Connector for Breakout T

g00682375

- Turn the ignition key switch to the OFF position.
- Install a 70 terminal breakout T to the ECM vehicle harness connector J1/P1.
- Fabricate a jumper wire 100 mm (4 inch) long. Crimp a Deutsch pin to both ends of the wire.

**D.** Insert the jumper wire into terminal 7 of the breakout T. Connect the other end of the jumper wire to terminal 5 in the breakout T. Terminal 5 is AP Sensor/Switch Common.

**E.** Connect ET to the cab data link connector.

**F.** Turn the ignition key switch to the ON position.

**G.** Alternately remove the jumper wire and then insert the jumper wire from terminal 5. At the same time, monitor the status screen on ET.

#### **Expected Result:**

The switch status changes to "ON" with the jumper wire in place. The switch status changes to "OFF" when the jumper wire is removed.

#### **Results:**

- **OK** – The ECM is functioning properly at this time. Proceed to Test Step 4.
- **Not OK** – The ECM is not functioning properly.

**Repair:** Perform the following repair:

1. Temporarily connect a test ECM.
2. Remove all jumpers and replace all connectors.
3. Recheck the system for active diagnostic codes.
4. Repeat the Test Step.
5. If the problem is resolved with the test ECM, reconnect the suspect ECM.
6. If the problem returns with the suspect ECM, replace the ECM.
7. Verify that the repair eliminates the problem.

**STOP.**

#### **Test Step 4. Insert a Jumper Wire at the Switch**

- A.** Turn the ignition key switch to the OFF position.
- B.** Reconnect the ECM vehicle harness connector J1/P1.
- C.** Fabricate a jumper wire 100 mm (4 inch) long. Crimp a Deutsch pin to both ends of the wire.
- D.** Insert the jumper wire between the two switch terminals of the torque limit switch.
- E.** Turn the ignition key switch to the ON position.

**F.** Alternately remove the jumper wire and then insert the jumper wire at the switch terminals. At the same time, watch the status screen on ET.

#### **Expected Result:**

The switch status changes to "ON" with the jumper wire in place. The switch status changes to "OFF" when the jumper wire is removed.

#### **Results:**

- **OK**

**Repair:** Perform the following diagnostic procedure:

Replace the torque limit switch.

Verify that the repair eliminates the problem.

**STOP.**

- **Not OK** – There is a problem in the wire harness between the torque limit switch and the ECM. Proceed to Test Step 5.

#### **Test Step 5. Insert a Jumper Wire at the Bulkhead Connector**

- A.** Turn the ignition key switch to the OFF position.
- B.** Fabricate a jumper wire 100 mm (4 inch) long. Crimp a Deutsch pin to both ends of the wire.
- C.** Locate the torque limit switch socket in the engine side of the ECM bulkhead connector.
- D.** Insert the wire jumper pin between the switch socket and the sensor common connection. Install the jumper wire on the Engine side of the ECM bulkhead connector.
- E.** Turn the ignition key switch to the ON position.
- F.** Alternately connect and then disconnect the jumper wire. At the same time, monitor the status screen on ET.

#### **Expected Result:**

The switch status changes from "ON" with the jumper wire in place. The switch status changes to "OFF" when the jumper wire is removed.

#### **Results:**

- **OK** – The problem is in the vehicle wiring between the Bulkhead connector and the switch. Inspect the vehicle wiring and then repair the vehicle wiring. Otherwise, send the vehicle to the OEM dealer for repair. Verify that the original condition is resolved. **STOP.**

- **Not OK** – The problem is in the vehicle wiring between the bulkhead connector and the ECM. Inspect the vehicle wiring and then repair the vehicle wiring. Otherwise, send the vehicle to the OEM dealer for repair. Verify that the original condition is resolved. **STOP**.

i01871027

## **Two Speed Axle Switch Circuit - Test**

**SMCS Code:** 7332-038-ZX

### **System Operation Description:**

#### **Use this procedure under the following situation:**

The "Two Speed Axle Switch" is suspected of incorrect operation.

### **Two Speed Axle Switch**

If a two-speed axle is used, the change in gear ratios alters the calibration of the vehicle speed signal. When the Two-Speed Axle Switch is in the ON position, the ECM will automatically adjust the vehicle speed calibration. This will ensure that the ECM driven speedometer and the stored information in the ECM correctly reflect the actual vehicle speed. In order for this feature to function properly, the "Low Speed Range Axle Ratio" and "High Speed Range Axle Ratio" parameters must be programmed. If the "Two Speed Axle Switch" parameter is programmed to "None" (default), this feature is not used. If the "Two Speed Axle Switch" parameter is programmed to J1/P1:6, the feature is available and the switch circuit should be connected to terminal 6 of the J1/P1 ECM connector. The switch can also be connected through the J1939 data link.

**Note:** The wiring for your particular application may be slightly different. The sensor common circuits are used interchangeably by the OEM of the vehicle. The following circuits are common within the ECM:

- The "Input Sensor Common 1" is terminal 18.
- The "Input Sensor Common 2" is terminal 3.
- The "AP Sensor/Switch Sensor Common" is terminal 5.

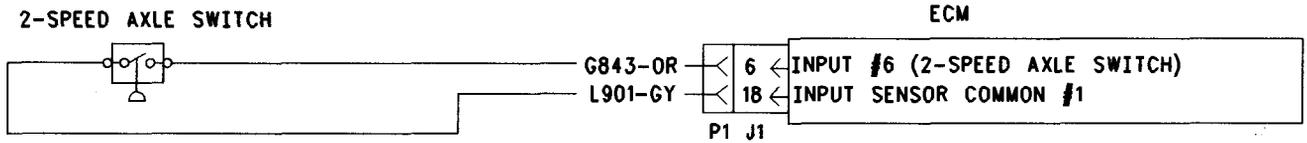


Illustration 184

g00682705

Schematic for Two Speed Axle Switch Circuit

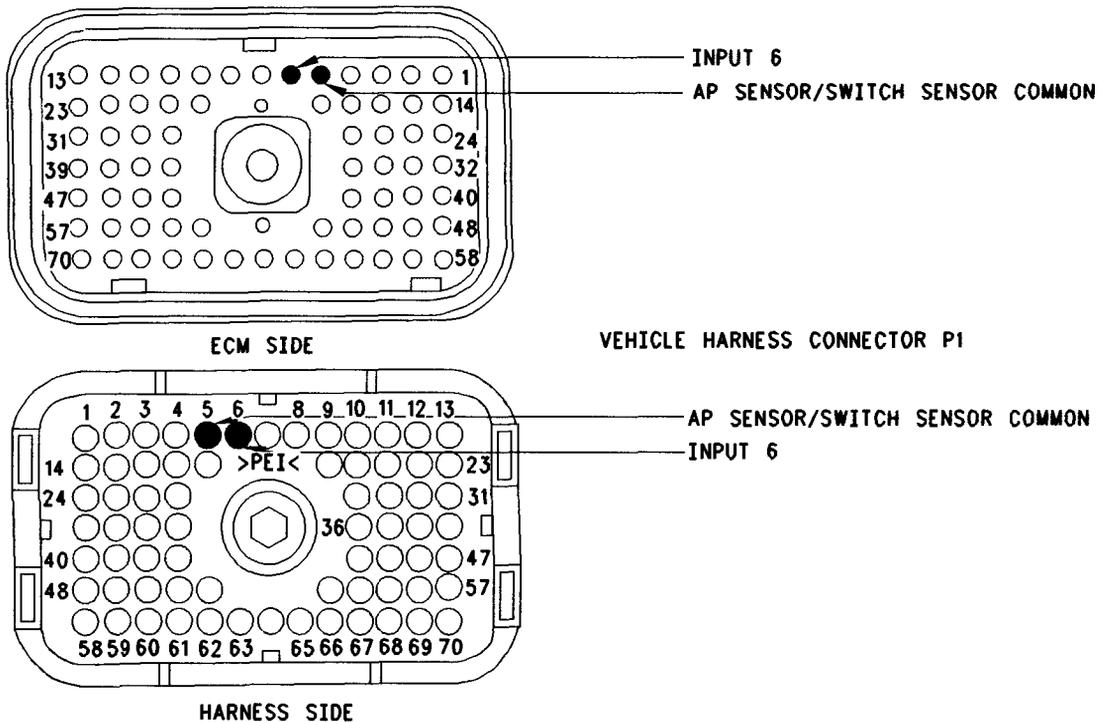


Illustration 185

g00682684

Terminal Locations for the ECM

**Test Step 1. Check the Status of the “Two Speed Axle Switch”**

- A. Connect the electronic service tool to the data link connector.
- B. Turn the key switch to the ON position.
- C. Monitor the status for the “Two Speed Axle Switch” while the switch is operated in the ON and OFF positions.
- D. If the “Two Speed Axle Switch” status indicates “Not Installed”, then the “Two Speed Axle Switch” parameter has not been programmed.

**Expected Result:**

The status screen should indicate “ON” if the switch is turned on. The status screen should indicate “OFF” if the switch is off.

**Results:**

- OK – The switch is operating normally. Continue troubleshooting if the original condition is not resolved. STOP.
- Not OK – The ECM is not reading the “Switch Status” change. Proceed to Test Step 2.

**Test Step 2. Determine the Configuration of the Switch**

- A. Determine if the wiring for the switch is wired directly to the ECM or through the J1939 data link.
- B. Verify that the “Two-Speed Axle Switch” parameter is programmed to reflect the proper wiring.

**Expected Result:**

The switch is wired directly to the ECM.

**Results:**

- OK – The switch is wired directly to the ECM.

**Repair:** Verify that the “Two-Speed Axle Switch” parameter is programmed to “J1/P1:6”.

Proceed to Test Step 3.

- Not OK – The switch is wired through the J1939 data link.

**Repair:** Verify that the “Two-Speed Axle Switch” parameter is programmed to “J1939 - Body Controller”, “J1939 - Cab Controller”, or “J1939 - Instrument Cluster”.

STOP.

**Test Step 3. Check the Electrical Connectors and the Wiring**

- A.** Thoroughly inspect the J1/P1 ECM connector, the connectors, and the firewall bulkhead connectors. Refer to Troubleshooting, “Electrical Connectors - Inspect” for details.
- B.** Perform a 45 N (10 lb) pull test on each of the wires in the ECM connector that are associated with the two speed axle switch circuit:
  - terminal 6
  - terminal 5
- C.** Check the ECM connector (allen head screw) for the proper torque of 6.0 N·m (55 lb in).
- D.** Check the harness and the wiring for abrasion and pinch points from the battery to the ECM. Then, check from the key switch to the ECM.

Refer to Illustration 185 for terminal locations for the ECM.

**Expected Result:**

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

**Results:**

- OK – Proceed to Test Step 4.

- Not OK – Repair the wiring and connectors or replace the wiring or the connectors. Ensure that all of the seals are properly connected. Verify that the repair eliminates the problem. STOP.

### Test Step 4. Check the Switch Circuit for the ECM.

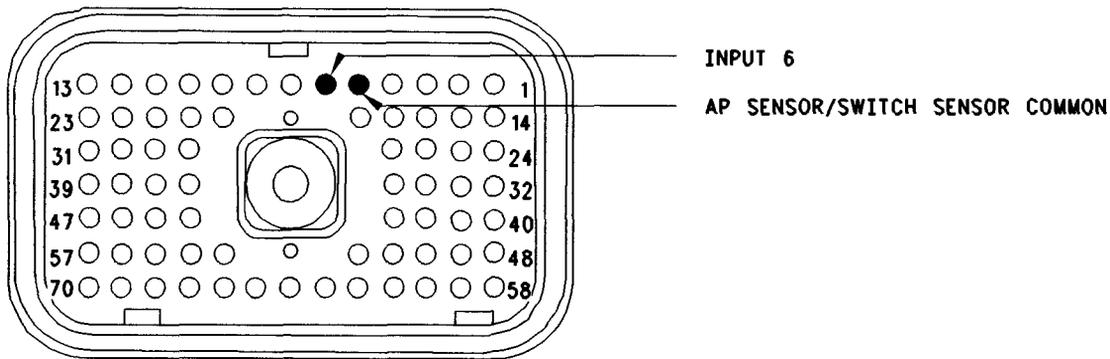


Illustration 186

g00682687

Connector for Breakout T

- A. Turn the key switch to the OFF position.
- B. Install a 140-2266 Cable (Seventy-Pin Breakout) between the J1 and P1 ECM connector.
- C. Fabricate a jumper wire 100 mm (4 inch) long. Crimp a Deutsch pin to each end of the wire.
- D. Insert the jumper wire into terminal 6 of the breakout T. Connect the other end of the jumper wire to terminal 5 (AP Sensor/Switch Common) of the breakout T.
- E. Connect the electronic service tool to the data link connector.
- F. Turn the key switch to the ON position.
- G. Alternately remove the jumper wire and then insert the jumper wire from terminal 5. At the same time, monitor the status screen on the electronic service tool.

#### Expected Result:

The switch status changes to "ON" with the jumper wire in place. The switch status changes to "OFF" when the jumper wire is removed.

#### Results:

- OK – The ECM is functioning properly at this time.

**Repair:** Remove the breakout T and reconnect the J1 and P1 ECM connectors.

Proceed to Test Step 5.

- Not OK – The ECM is not functioning properly.

**Repair:** Perform the following repair:

1. Temporarily connect a test ECM.

2. Remove the breakout T and reconnect the J1 and P1 ECM connectors.
  3. If the problem is resolved with the test ECM, reconnect the suspect ECM.
  4. If the problem returns with the suspect ECM, replace the ECM.
  5. Verify that the repair eliminates the problem.
- STOP.

### Test Step 5. Insert a Jumper Wire at the Switch

- A. Turn the key switch to the OFF position.
- B. Fabricate a jumper wire 100 mm (4 inch) long. Crimp a Deutsch pin to both ends of the wire.
- C. Locate the switch for the Two-Speed Axle. Insert the jumper wire between the two switch terminals.
- D. Turn the key switch to the ON position.
- E. Alternately remove the jumper wire and then insert the jumper wire at the switch terminals. At the same time, watch the status screen on the electronic service tool.

#### Expected Result:

The switch status changes to "ON" with the jumper wire in place. The switch status changes to "OFF" when the jumper wire is removed.

#### Results:

- OK – Replace the switch. Verify that the repair solves the problem. STOP.

- **Not OK** – There is a problem in the wire harness between the switch for the two-speed axle and the ECM. Proceed to Test Step 6.

### Test Step 6. Insert a Jumper Wire at the Bulkhead Connector

- Turn the key switch to the OFF position.
- Fabricate a jumper wire 100 mm (4 inch) long. Crimp a Deutsch pin to both ends of the wire.
- Locate the two speed axle switch socket in the engine side of the ECM bulkhead connector.
- Insert the wire jumper pin between the switch socket and the sensor common connection. Install the jumper wire on the engine side of the ECM bulkhead connector.
- Turn the key switch to the ON position.
- Alternately connect and then disconnect the jumper wire. At the same time, monitor the status screen on the electronic service tool.

#### Expected Result:

The switch status changes from “ON” with the jumper wire in place. The switch status changes to “OFF” when the jumper wire is removed.

#### Results:

- **OK** – The problem is in the vehicle wiring between the bulkhead connector and the switch. Inspect the vehicle wiring and then repair the vehicle wiring. Otherwise, send the vehicle to the OEM dealer for repair. Verify that the original condition is resolved. **STOP**.
- **Not OK** – The problem is in the vehicle wiring between the bulkhead connector and the ECM. Inspect the vehicle wiring and then repair the vehicle wiring. Otherwise, send the vehicle to the OEM dealer for repair. Verify that the original condition is resolved. **STOP**.

i01871031

## Vehicle Speed and Speedometer Circuit - Test

**SMCS Code:** 7463-038

#### System Operation Description:

#### Use this procedure under the following situation:

- There is an active diagnostic code.

- There is an easily repeated diagnostic code that is associated with the vehicle speed circuit.

Refer to Troubleshooting, “Vehicle Speed Circuit - Calibrate” if the vehicle speed is being calibrated in ppm (pulses per mile) or PPKM (pulses per kilometer).

#### The following background information is related to this procedure:

The vehicle speed circuit consists of the vehicle speed source and associated wiring. The vehicle speed source is installed by the vehicle OEM. Usually, a sensor reads movement of the transmission output shaft from the teeth on a chopper wheel. The ECM converts the signal from the vehicle speed source into vehicle speed for the following functions:

- Cruise Control
- Idle Speed Control
- Progressive Shift
- Driver Reward
- Speedometer
- Battery Monitor Engine Speed Control
- PTO Operation
- Vehicle Speed Limiting
- Engine Retarding
- Idle Shutdown
- Secure Idle Theft Deterrent
- Trip Data
- Maintenance Data

To begin troubleshooting a vehicle speed problem, the following information must be determined:

The problem is electrical or the problem is a calibration problem.

Electrical problems would be an erratic speed signal or no speed signal. A calibration problem would be a stable ECM speed, but an inaccurate ECM speed. Another calibration problem would be a stable speedometer speed, but an inaccurate speedometer speed.

If the problem is related to vehicle speed calibration, refer to Troubleshooting, "Vehicle Speed Circuit - Calibration" for calibrating the vehicle speed in PPKM (pulses per kilometer) or ppm (pulses per mile). The ECM Speedometer output signal is set to 18,600 PPKM (30,000 ppm) and the ECM speedometer output signal cannot be changed. All speedometers that are driven by the ECM output (J1/P1:36 & 37) must match the ECM (30,000 ppm) in order to operate properly.

The type of vehicle speed sensor that is installed on the vehicle must be determined.

Both single coil magnetic sensors and dual coil magnetic sensors are commonly used. Caterpillar recommends single coil magnetic sensors. Some of the vehicles may provide the vehicle speed through the transmission ECM.

You must determine if the vehicle speedometer is driven from the ECM.

The ECM can drive the speedometer through the connection to J1:36 (Speedometer Positive) and/or J1:37 (Speedometer Negative).

**Note:** The ECM may also drive the speedometer by a connection to the J1587 ATA data link or the J1939 data link, if the instrument cluster is capable of interpreting the signal.

### Vehicle Speed Circuit Wiring

The vehicle speed signal is connected to the ECM at J1/P1:32 (Vehicle Speed In Positive) and J1/P1:33 (Vehicle Speed In Negative).

### Speedometer Connection

If the speedometer is driven by the ECM output, the speedometer is connected to the following terminals:

- J1/P1:36 (Speedometer Positive)
- J1/P1:37 (Speedometer Negative)

**Note:** Some speedometers require only one of the ECM signal lines to operate. Other speedometers may require both of the ECM signal lines to operate.

### Speedometer Special Test

If the vehicle speedometer is driven by ECM output, the speedometer circuit can be checked by using the electronic service tool. The "55 mph VSP/Speedometer Test" will drive the speedometer to approximately 55 mph under the following conditions:

- The "55 mph VSP/Speedometer Test" is activated.

- The circuit is operating properly.
- The speedometer is operating properly.

**Note:** While the test is active, the odometer will increment mileage.

### Magnetic Sensors

A magnetic pickup will have only two wires if the magnetic pickup is a single coil magnetic sensor. Also, a magnetic pickup will have four wires if the magnetic pickup is a dual coil magnetic sensor. The magnetic pickup sensor does not require a power connection or a ground connection.

### Vehicles with Electronic Vehicle Speed Sources

For these vehicles, the vehicle speed signal is provided by an electronic source. The signal is received over a single wire that is connected to J1/P1:32 (Vehicle Speed In Positive). No other connection should be made to this line. A speedometer is an example of a connection that should not be made to this line. For this type of signal, the J1/P1:33 (Vehicle Speed In Negative) should not be connected to the ECM in order to prevent introducing electrical noise into the circuit.

For vehicle speed problems on trucks that are equipped with either of these vehicle speed sources, first inspect the wiring from the electronic source to the engine ECM for open circuits or short circuits.

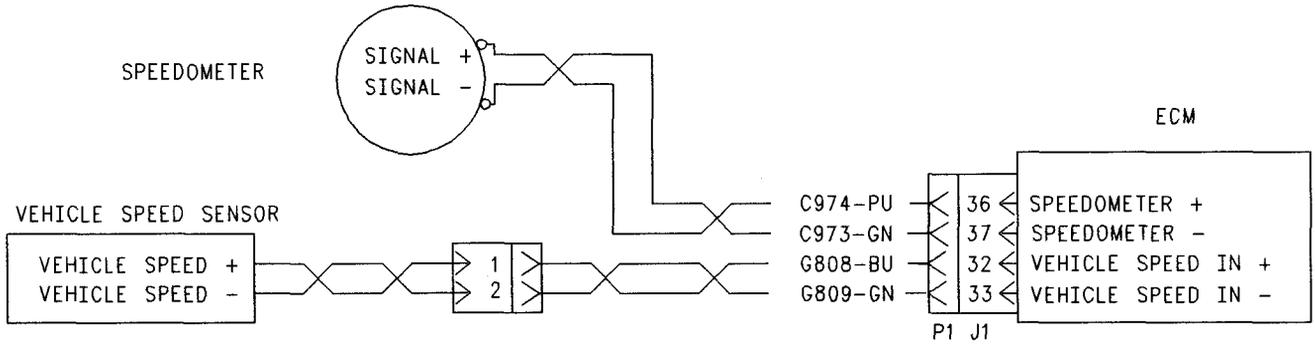


Illustration 187  
 Schematic for a single coil speed sensor and an ECM driven speedometer

g00643046

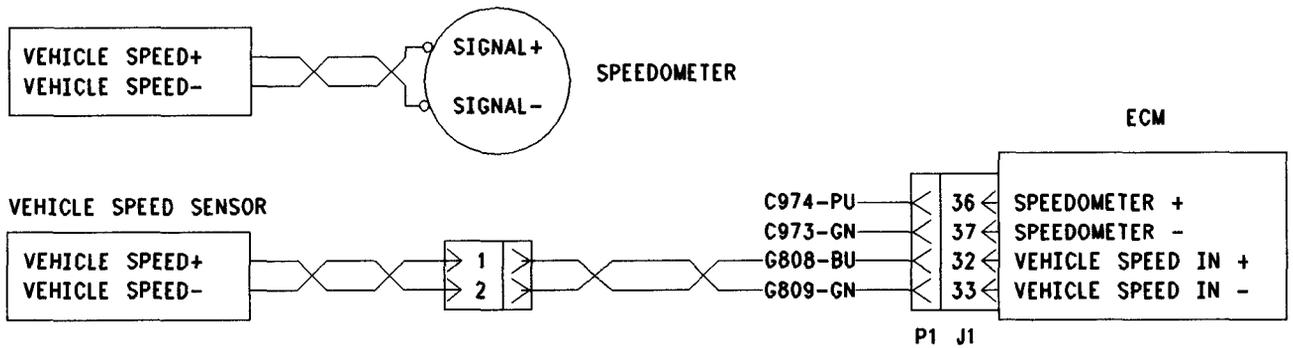


Illustration 188  
 Schematic for a single coil speed sensor and a second single coil sensor for a speedometer

g00643048

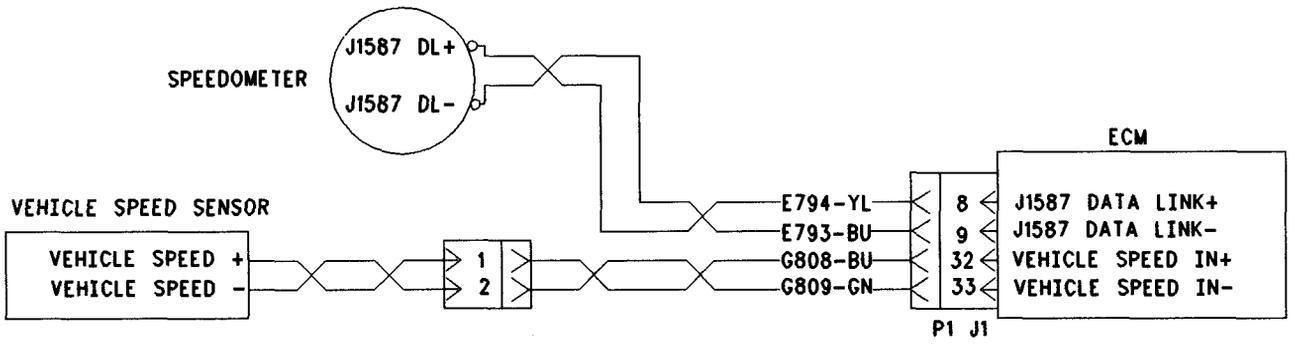


Illustration 189  
 Schematic for a single coil speed sensor and a data link driven speedometer

g00643050

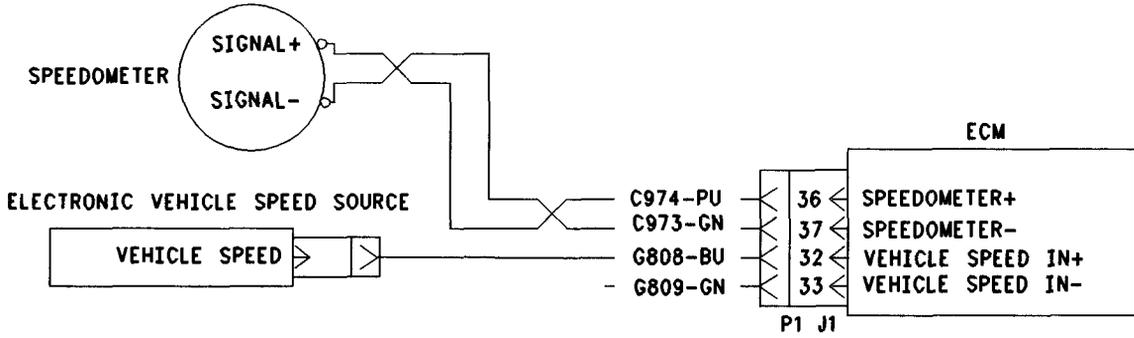


Illustration 190  
 Schematic for an electronic vehicle speed source and an ECM driven speedometer

g00643051

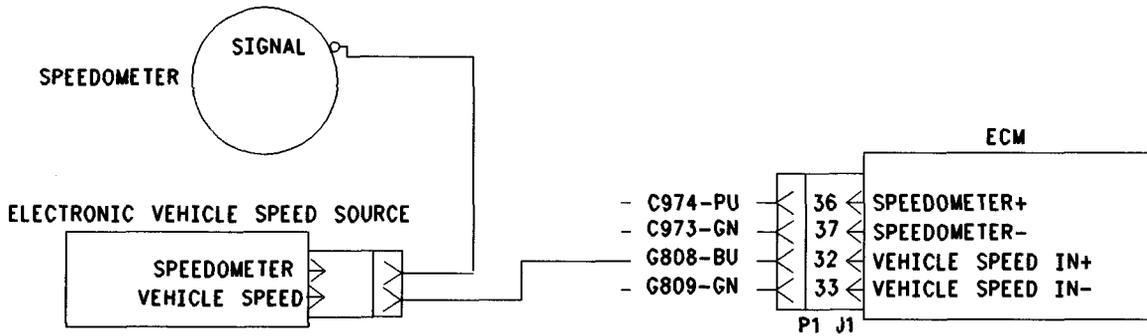


Illustration 191  
 Schematic for an electronic vehicle speed source and a speedometer

g00643052

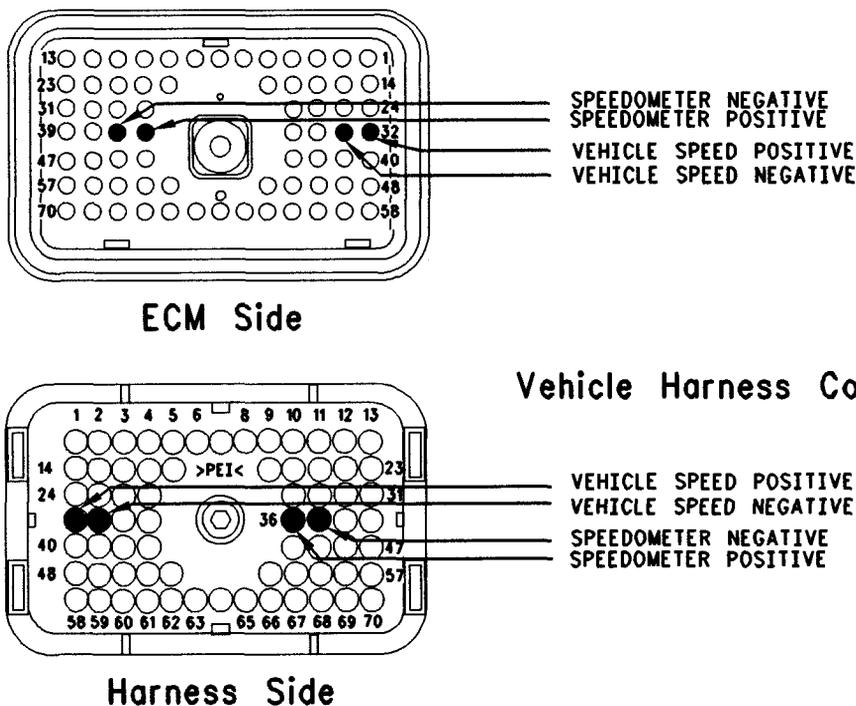


Illustration 192  
 Terminal locations for ECM

g00643054

**Test Step 1. Determine the Type of Connection**

- A. Determine if the wiring for the circuit is wired directly to the ECM or through the J1939 or J1587 data link.
- B. Verify that the "Vehicle Speed Input" parameter is programmed to reflect the proper wiring.

**Expected Result:**

The suspect input is wired directly to the ECM.

**Results:**

- OK – The suspect input is wired directly to the ECM. Proceed to Test Step 2.
- J1939 data link – The suspect input is wired through the J1939 data link.

Repair: Refer to Troubleshooting, "Powertrain Data Link Circuit - Test".

STOP.

- J1587 data link –

Repair: Refer to Troubleshooting, "ATA (SAE J1587 / J1708) Data Link Circuit - Test".

STOP.

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

- A. Thoroughly inspect the J1/P1 ECM connector, the firewall bulkhead connector and the terminals for vehicle speed (terminals 32 and 33) in the connectors. Refer to Troubleshooting, "Electrical Connectors - Inspect" for details.

- B. Perform a 45 N (10 lb) pull test on each of the wires in the ECM connector that are associated with the vehicle speed sensor.

Refer to Illustration 192.

- C. Check the ECM connector (allen head screw) for the proper torque of 6.0 N·m (55 lb in).
- D. Check the harness and wiring for abrasion and pinch points from the sensor to the ECM.

**Expected Result:**

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

**Results:**

- OK – Proceed to Test Step 3.
- Not OK

**Repair:** Perform the following repair:

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

Verify that the repair eliminates the problem.

STOP.

**Test Step 3. Determine the Type of Vehicle Speed Problem**

- Perform a dynamometer test on the vehicle or perform a road test on the vehicle. Compare the vehicle speed on the status screen on ET against the speedometer. Also, compare the vehicle speed on the status screen against the actual vehicle speed. The actual vehicle speed can be measured on a dynamometer or the actual vehicle speed can be measured by a stopwatch.
- Monitor the vehicle speed status on the electronic service tool while the vehicle is parked and the engine is running.
- Operate various electrical devices in the vehicle while the vehicle speed is being monitored. In order to operate the various electrical devices, cycle the electrical devices to the ON position and the OFF position.
- Increase the engine rpm a few times and decrease the engine rpm a few times.

**Note:** If the operation of a specific electrical device is producing a vehicle speed problem, the electrical device may be the source of an electrical noise problem. An electrical noise problem is also a possibility if increasing the engine rpm on a stationary vehicle produces a vehicle speed problem.

**Expected Result:**

**Result 1** The speed that is displayed on the status screen and the speed of the ECM driven speedometer are stable and both speeds agree with the actual speed.

**Result 2** The status screen and speed is stable, but incorrect.

**Result 3** The status screen agrees with the actual speed, but the ECM driven speedometer is incorrect or inoperable.

**Result 4** The speed that is displayed on the status screen is not present, unstable, or erratic.

**Results:**

- **Result 1** – There is not a vehicle speed problem at this time. If a problem still exists, continue troubleshooting until the condition is resolved. STOP.
- **Result 2** – Proceed with vehicle speed calibration and adjustment.

**Repair:** Perform the following diagnostic procedure:

Troubleshooting, "Vehicle Speed Circuit - Calibrate"

STOP.

- **Result 3** – Proceed to Test Step 4.
- **Result 4** – Proceed to Test Step 5.

## Test Step 4. Use the Special Test to Check the Speedometer

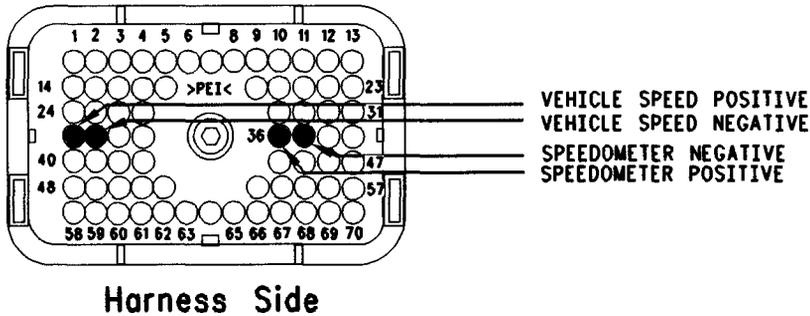


Illustration 193

g00723985

**A.** Inspect the P1 ECM connector. Observe whether connections are present at either of the following terminals:

- P1:36 (Speedometer Positive)
- P1:37 (Speedometer Negative)

If there is a connection to either of the speedometer terminals continue with the procedure.

**B.** Connect the electronic service tool to the data link connector.

**C.** Access the “55 mph VSP/Speedometer Test” by accessing the following display screens in order:

- “Diagnostics”
- “Diagnostic Tests”
- “Special Test menu”

**D.** Activate the test and observe the speedometer.

**Note:** Some types of speedometers only require one ECM signal line to be connected to the speedometer. Either of the ECM terminals can be used for these speedometers.

Refer to Illustration 193.

### Expected Result:

The speedometer indicates 80 to 96 km/h (50 to 60 mph).

### Results:

- **OK** – The ECM is providing the signal for the speedometer and the wiring and the speed are OK. Send the vehicle to the OEM dealer for repair of the speedometer. **STOP.**
- **Not OK** – The ECM is not connected to the speedometer.

**Repair:** Perform the following repair:

If the ECM is not connected to the OEM speedometer, send the vehicle to the OEM dealer for repair of the speedometer.

**STOP.**

- **Not OK** – The speedometer does not show any vehicle speed.

**Repair:** If OEM truck wiring diagrams are available, trace the wiring to the speedometer and repair the speedometer, as required.

**STOP.**

- **Not OK** – The vehicle speed is not within the proper range.

**Repair:** Perform the following diagnostic procedure:

Troubleshooting, “Vehicle Speed Circuit - Calibrate”

**STOP.**

## Test Step 5. Determine the Type of Vehicle Speed Circuit

- A.** Inspect the vehicle wiring for the type of vehicle speed circuit that is being used.

Compare the vehicle speed circuit with the detailed circuit schematics:

**Schematic 1** Refer to Illustration 187.

**Schematic 2** Refer to Illustration 188.

**Schematic 3** Refer to Illustration 189.

**Schematic 4** Refer to Illustration 190.

**Schematic 5** Refer to Illustration 191.

Select the schematic that is similar to the circuit that is being repaired.

### Expected Result:

The vehicle speed circuit is similar to Schematic 1, 2, or 3.

### Results:

- OK – Proceed to Test Step 6.
- Not OK – The vehicle speed circuit is similar to Schematic 4 or 5. Proceed to Test Step 8.

## Test Step 6. Measure Vehicle Speed Sensor Resistance at the Sensor

- A.** Disconnect the vehicle speed sensor from the vehicle harness.
- B.** Thoroughly inspect the connector. Ensure that the connector terminals are free of corrosion and ensure that the connector terminals are fully seated into the housing of the connector. Repair the connector terminals or replace the connector terminals, as required.
- C.** Measure the resistance between the two terminals of the sensor connector. The sensor resistance measurement should be 100 to 4500 Ohms.
- D.** Reverse the meter leads and measure the resistance. Switching the probes should not change the resistance measurement by more than 10 Ohms.

### Expected Result:

The sensor resistance that is measured is between 100 and 4500 Ohms and the sensor resistance that is measured is within 10 Ohms with the meter probes in either position.

### Results:

- OK – Reconnect the sensor to the vehicle harness. Proceed to Test Step 7.
- Not OK

**Repair:** Perform the following repair:

If the sensor is damaged, replace the damaged sensor or send the vehicle to the OEM dealer for repairs.

Verify that any repair eliminates the problem.

**STOP.**

## Test Step 7. Inspect the Passive Magnetic Speed Sensor for Vehicle Speed.

- A.** Remove the vehicle speed sensor from the transmission and inspect the vehicle speed sensor for steel shavings, debris, or damage.

**Note:** Shavings and debris on the sensor may occur unless the transmission fluid is drained and replaced according to the maintenance schedule.

- B.** Wipe off the sensor until the sensor is clean. Test the sensor according to the manufacturer's instructions. The sensor is OEM supplied.

**Note:** If the gap between the vehicle speed sensor and the chopper wheel is too small, the sensor may be damaged. Also if the gap between the vehicle speed sensor and the chopper wheel is too small, the sensor may create a signal due to the vibration of the chopper wheel. This will cause a vehicle speed signal when the vehicle is parked. If the vehicle is parked and a vehicle speed signal is produced, back out the sensor from the wheel until the signal disappears. Use caution. backing out the sensor too far may cause a loss of the vehicle speed signal. Back out the sensor no more than one turn to one and one quarter turns.

### Expected Result:

The vehicle speed sensor is correctly installed and undamaged.

### Results:

- OK – Proceed to Test Step 8.
- Not OK

**Repair:** Perform the following repair:

If the sensor is damaged, replace the damaged sensor or send the vehicle to the OEM dealer for repairs.

Verify that any repair eliminates the problem.

STOP.

### Test Step 8. Test ECM Vehicle Speed Inputs by Using the Speedometer Special Test.

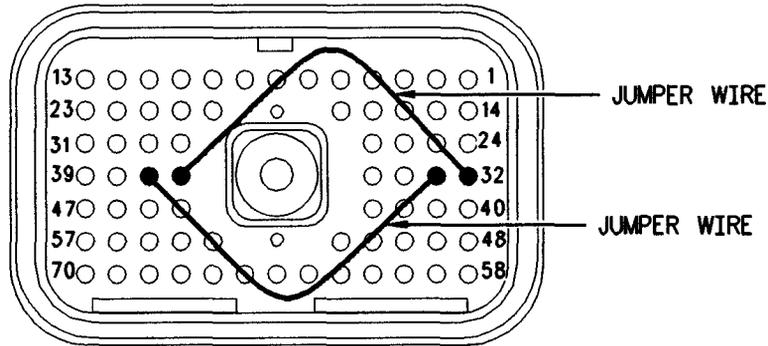


Illustration 194

g00643436

Jumper wire locations for breakout T

- A. Turn the key switch to the OFF position.
- B. Fabricate two jumper wires 100 mm (4 inch) long. Crimp a Deutsch pin to each end of the wires.
- C. Connect a 140-2266 Cable (Seventy-Pin Breakout) between the J1 and P1 ECM connectors.
- D. Install one jumper into the breakout T in order to connect terminal 36 (Speedometer Positive) to terminal 32 (Vehicle Speed In Positive). Install the other jumper into the breakout T in order to connect terminal 37 (Speedometer Negative) to terminal 33 (Vehicle Speed In Negative).

Refer to Illustration 194.

- E. Turn the key switch to the ON position.
- F. Connect the electronic service tool to the data link connector.
- G. Access the "55 mph VSP/Speedometer Test" by accessing the following display screens in order:
  - "Diagnostics"
  - "Diagnostic Tests"
  - "Special Test menu"
- H. Activate the test and observe the vehicle speed on the vehicle speed status screen.

#### Expected Result:

The electronic service tool indicates a constant vehicle speed between 80 to 96 km/h (50 to 60 mph) when the jumper wires from the speedometer circuit are connected.

#### Results:

- **OK** – The ECM is operating correctly. The source of the problem is either the wiring or the source of the problem is the vehicle speed sensor.

**Repair:** Perform the following repair:

If the sensor is damaged, replace the damaged sensor or send the vehicle to the OEM dealer for repairs.

Verify that any repair eliminates the problem.

STOP.

- **Not OK** – Recheck the connections of the jumper wires. Leave the jumper wires installed in the breakout T. Disconnect the breakout T. Proceed to Test Step 9.

### Test Step 9. Test the ECM Vehicle Speed Inputs When the Test ECM is Installed

- A. Connect a test ECM and reconnect the breakout T.

- B.** Install one jumper into the breakout T in order to connect terminal 36 (Speedometer Positive) to terminal 32 (Vehicle Speed In Positive). Install the other jumper into the breakout T in order to connect terminal 37 (Speedometer Negative) to terminal 33 (Vehicle Speed In Negative).

Refer to Illustration 194.

- C.** Turn the key switch to the ON position.
- D.** Access the "55 mph VSP/Speedometer Test" by accessing the following display screens in order:
- "Diagnostics"
  - "Diagnostic Tests"
  - "Special Test menu"
- E.** Activate the test and observe the vehicle speed on the vehicle speed status screen.

**Expected Result:**

The electronic service tool indicates a constant vehicle speed between 80 to 96 km/h (50 to 60 mph) when the jumper wires from the speedometer circuit are connected.

**Results:**

- OK

**Repair:** Perform the following repair:

Reconnect the suspect ECM. If the problem returns with the suspect ECM, replace the ECM.

**STOP.**

- **Not OK** – Recheck the connectors. Continue troubleshooting until original condition is resolved.  
**STOP.**

i01624592

## Warning Lamp Circuit - Test

**SMCS Code:** 7431-038

**System Operation Description:**

**Use this procedure under the following situation:**

A problem is suspected with the operation of the warning lamp.

**The following background information is related to the following procedure:**

**Warning Lamp Operation**

A warning lamp is required if the "Engine Monitoring" feature is used. The warning lamp indicates an active problem with one of the monitored conditions such as high coolant temperature. A flashing warning lamp indicates that the engine is derating power. The warning lamp will turn on for a minimum of two seconds after the engine has started.

With OCT99 and newer software, a new parameter is available to provide the option of using a single warning lamp or multiple warning lamps. The programmable "Engine Monitoring Lamps" parameter provides the option of using a single warning lamp for all monitored conditions, or discrete lamps for each monitored condition. If the "Engine Monitoring Lamps" parameter is programmed to "Warning Lamp", then J1/P1:29 is used for the connection of a single warning lamp. If the "Engine Monitoring Lamps" parameter is programmed to "Option 1", then J1/P1:29 is used to connect a lamp for Low Oil Pressure Warning and J1/P1:31 is used to connect a lamp for High Coolant Temperature Warning. If an optional Coolant Level Sensor is also installed then J1/P1:30 is used to connect a Low Coolant Level Warning Lamp. The "Coolant Level Sensor" parameter must be programmed to "4-pin".

If a Coolant Level Sensor is not installed or the "Engine Monitoring Lamps" parameter is programmed to "Warning Lamp", then J1/P1:30 will function as a PTO Switch On Lamp output. The parameter for the "Coolant Level Sensor" must be programmed to "NO" if the sensor is not installed.

**Operation of Engine Monitoring**

When the ECM has detected an engine condition that exceeds the acceptable limits, the warning lamp will turn on. The activation of the lamp depends on the existing conditions and the programming of the parameter for "Engine Monitoring". The lamp will activate in one of the following modes:

- The lamp not only turns on, but the lamp stays on.
- The lamp will flash on and off.

If the lamp turns on continuously, the engine is in warning mode. If the lamp begins to flash, the ECM has begun to derate engine speed, vehicle speed, or power.

If the parameter for engine monitoring is programmed to "Warning", the lamp will not flash. The lamp only flashes when the engine is programmed to "Derate" or "Shutdown".

If the Customer Parameter for Engine Monitoring is programmed to "Warning", "Derate", or "Shutdown" the lamp will turn on when a warning condition exists. The lamp will be turned on continuously while a warning condition exists.

If the customer parameter for engine monitoring is programmed to "Derate" or "Shutdown", the lamp flashes whenever engine monitoring is derating engine speed, vehicle speed, and power.

If the customer parameter for engine monitoring is programmed to "Shutdown", the warning lamp will continue flashing after the derate mode until the engine is shut down. Refer to Troubleshooting, "System Overview".

### **Output 1 (PTO Switch On Lamp)**

Output 1 is used for the PTO Switch ON Lamp when OCT99 or older software is used. However, the "PTO configuration" must be programmed to "Cab Switches", "Remote Switches", or "Remote Throttle". The PTO Switch ON Lamp should turn on when the circuit for the PTO On/Off Switch is turned on.

With OCT99 and newer software, "Output 1" can be used as a PTO Switch On Lamp output or a Low Coolant Level Warning Lamp output. The customer parameters determine the desired usage. If the "Engine Monitoring Lamps" parameter is programmed to "Option 1" and the "Coolant Level Sensor" parameter is programmed to "4-pin", then "Output 1" is used as a Low Coolant Level Warning Lamp output. Otherwise, "Output 1" can be used as a PTO Switch On Lamp output. With OCT99 and older Software, "Output 1" was the PTO Switch On Lamp.

### **"Output 9"**

With OCT99 and newer Software, the "Output 9" can be used for a High Coolant Temperature Lamp output if the "Engine Monitoring Lamps" parameter is programmed to "Option 1". If the "Engine Monitoring Lamps" parameter is programmed to the "Warning Lamp" option, then "Output 9" is not used.

### **Electrical Connection of Lamps**

One terminal of each lamp must be connected to battery voltage through the vehicle wiring. The other terminal is connected to the ECM at the ECM vehicle harness connector J1/P1 at the following terminals:

- J1/P1:29 (Warning Lamp or Low Oil Pressure Lamp)
- J1/P1:30 (PTO Switch On Lamp or Low Coolant Level Lamp)
- J1/P1:31 (High Coolant Temperature Lamp)

The ECM illuminates the lamp by providing a path to ground.

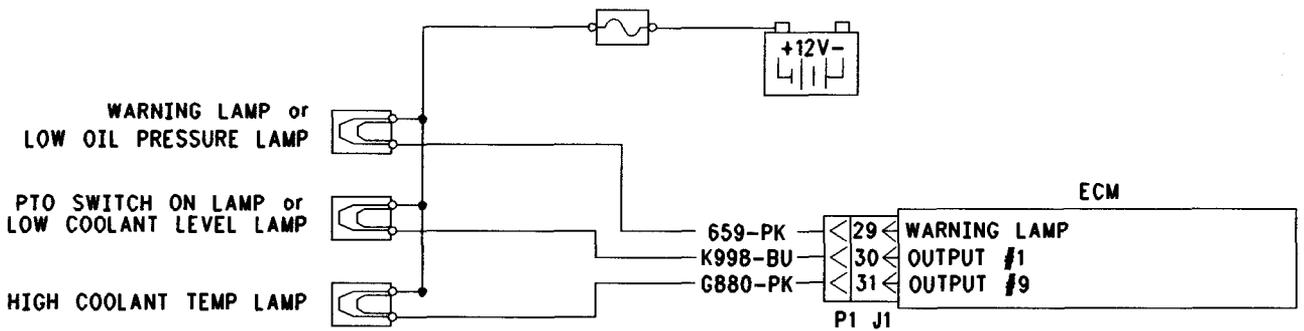


Illustration 195

g00676476

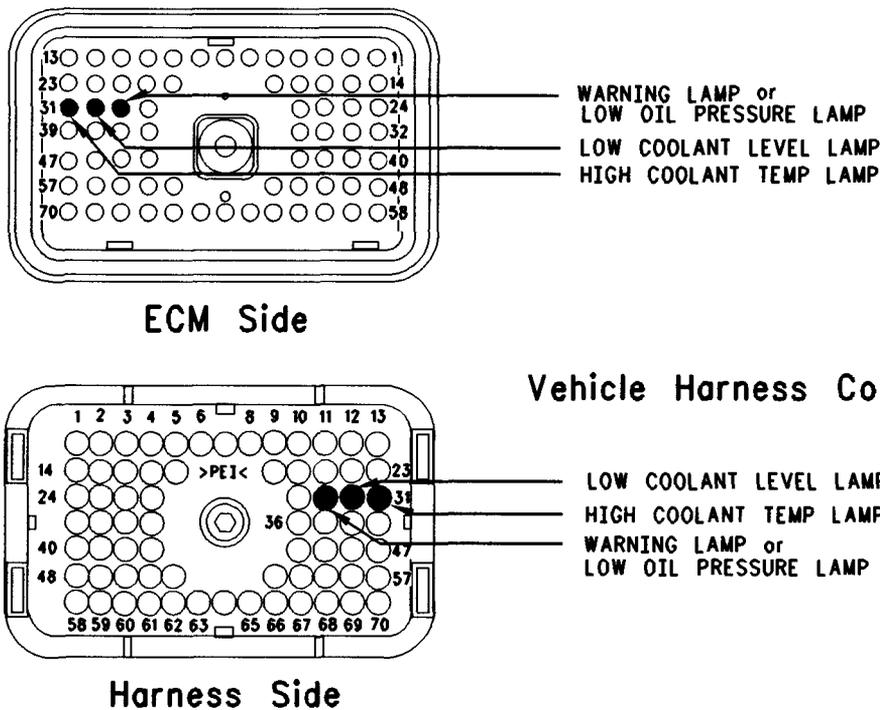


Illustration 196

g00676565

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

**A.** Thoroughly inspect ECM vehicle harness connector J1/P1, the firewall bulkhead connector, and the suspect terminal for the lamp. Refer to Illustration 196. Refer to Troubleshooting, "Electrical Connectors - Inspect" for details.

**B.** Perform a 45 N (10 lb) pull test on each of the wires in the ECM connector that is associated with the suspect terminal for the lamp.

Refer to Illustration 196.

**C.** Check the ECM connector (allen head screw) for the proper torque of 6.0 N·m (55 lb in).

**D.** Check the harness and wiring for abrasion and pinch points from the battery to the ECM.

**Expected Result:**

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

**Results:**

- OK – Proceed to Test Step 2.
- 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.

STOP.

**Test Step 2. Check for Normal Operation of the Warning Lamp(s)**

- A.** Monitor the check engine lamp. Turn the ignition key switch to the ON position, while the engine is off. The lamp should turn on for five seconds. Then, the lamp should turn off.

The lamp will continue flashing if there is an active diagnostic code. If there is an active diagnostic code, connect the Caterpillar Electronic Technician (ET) in order to read the active diagnostic code. Troubleshoot the problem.

**Note:** The warning lamp will not turn on until the engine is cranked.

- B.** Connect ET in order to verify that the "Engine Monitoring" has been programmed to "Warning", "Derate", or "Shutdown". If "Engine Monitoring" is programmed to "Off", the warning lamp is not used and the ECM will not turn on the lamp.

The "Engine Monitoring Lamps" parameter must be programmed to "Option 1" in order for the following lamps to function.

- Low Oil Pressure
- High Coolant Temperature
- Low Coolant Level Warning

The lamp for the low coolant level also requires the "Coolant Level Sensor" parameter to be programmed to the "4-pin" option.

While the warning lamp is being observed, start the engine. The warning lamp should turn on for a minimum of two seconds after the engine starts. Then, the warning lamp should turn off. If the lamp remains on, immediately shut down the engine.

**Expected Result:**

The warning lamp turns on and the Warning Lamp turns off per the above description.

**Results:**

- OK – The lamp appears to operating correctly at this time. STOP.
- Not OK – The lamp is not operating correctly.

**Repair:** Perform the following diagnostic procedure:

Use ET to determine if an "Engine Monitoring" condition is causing the lamp to turn on. If an "Engine Monitoring" condition is not present, perform the following diagnostic procedure.

Proceed to Test Step 3.

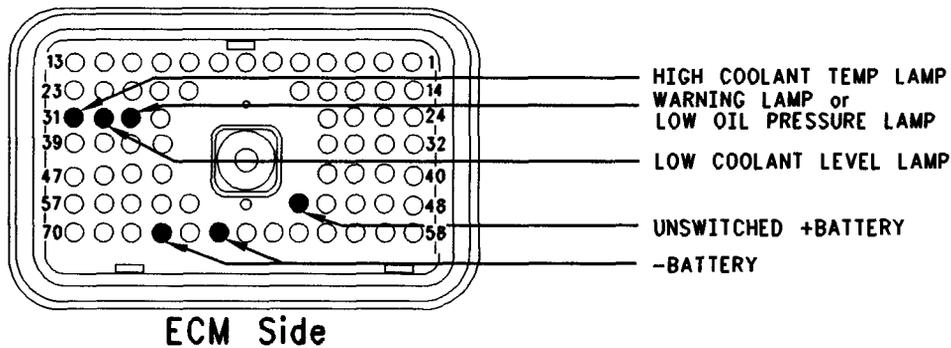
**Test Step 3. Test the Lamp Circuit**

Illustration 197

g00676787

Vehicle harness connector P1

- A.** Disconnect ECM vehicle harness connector J1/P1.
- B.** Fabricate a jumper wire 100 mm (4 inch) long. Crimp a Deutsch pin to both ends of the wire.
- C.** Insert the jumper into the terminal of the suspect lamp of connector P1. The jumper can be inserted into the following terminals in order to test the appropriate lamp circuit:
  - P1:31 (High Coolant Temperature Lamp)
  - P1:29 (Warning Lamp or Low Oil Pressure Lamp)
  - P1:30 (PTO Switch On Lamp or Low Coolant Level Lamp)
- D.** Connect the other side of the jumper wire to P1:65 (-Battery).
- E.** Turn the ignition key switch to the ON position.
- F.** While the lamp is being watched, insert the jumper wire and remove the jumper wire.

Refer to Illustration 197.

**Expected Result:**

**Result 1** The lamp turns on while the jumper is connected to both sockets. Also, the warning lamp turns off when the jumper is removed from one of the sockets.

**Result 2** The lamp does not turn on while the jumper is connected to both sockets.

**Result 3** The lamp will stay on while the ECM vehicle harness connector is disconnected.

**Results:**

- **Result 1** – The warning lamp circuit is functioning properly. Proceed to Test Step 4.
- **Result 2** – The lamp did not turn on. The vehicle's lamp circuit is not functioning properly. The lamp is probably burned out or there is a problem in the wiring from the cab to either the ECM or the +Battery connection. Repair the lamp circuit or send the vehicle to the OEM dealer for repairs. **STOP.**

• **Result 3**

**Repair:** Perform the following diagnostic procedure:

The circuit between the ECM and the lamp is shorted to chassis ground. Repair the circuit or send the vehicle to the OEM dealer for repairs.

**STOP.**

### Test Step 4. Check ECM Operation of the Warning Lamp

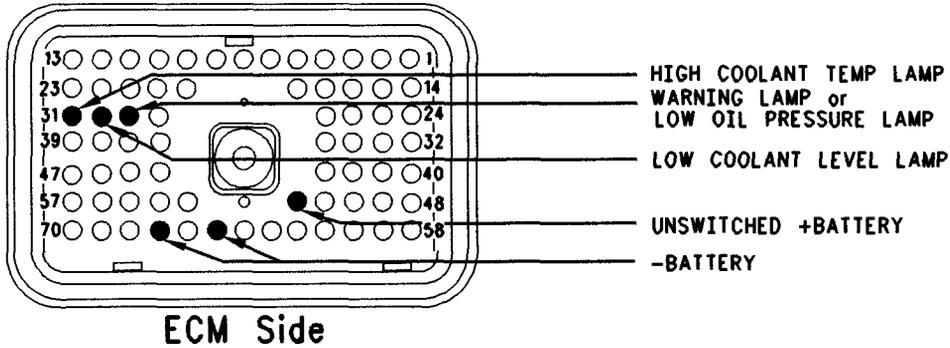


Illustration 198  
ECM Breakout T-connector

g00676787

- A.** Disconnect ECM vehicle harness connector J1/P1.
- B.** Insert a 70-Terminal breakout T between the ECM vehicle harness connectors J1 and P1.
- C.** Connect a voltage test lamp probe to terminal 65 (-Battery) and connect the other probe to terminal 52 (Unswitched +Battery) of the breakout T.
- D.** The test lamp should turn on. If the test lamp does not turn on, either the test lamp is faulty or the wiring to the ECM is faulty. Continue with this step if the lamp turns on.
- E.** Leave the voltage test lamp probe connected to terminal 52 (Unswitched +Battery).
- F.** Connect the other probe of the test lamp to the suspect lamp terminal on the breakout T.

- **Not OK** – Temporarily connect a test ECM. Ensure that the “Engine Monitoring” of the test ECM matches the “Engine Monitoring” of the suspect ECM. Check the ECM operation of the Lamp when the test ECM is installed. If the problem is resolved with the test ECM, reconnect the suspect ECM. If the problem returns with the suspect ECM, replace the ECM. **STOP.**

Refer to Illustration 198.

- G.** Watch the voltage test lamp. Start the engine. The lamp should turn on for a minimum of two seconds after the engine starts. Then, the lamp should turn off. Immediately turn the engine off if the lamp continues to stay in the ON position. Connect ET in order to determine the cause of the problem.

**Expected Result:**

The lamp turns on and the warning lamp turns off per the above description.

**Results:**

- **OK** – The ECM is operating correctly. There is a problem in the vehicle wiring or the lamp. Repair the vehicle wiring or the lamp, as required. **STOP.**

**CATERPILLAR**  
**3406E, C-10, C-12, C-15, C-16 AND C-18 TRUCK ENGINE**  
**CALIBRATION PROCEDURES**  
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# Calibration Procedures

i01907628

## Engine Speed/Timing Sensor - Calibrate

**SMCS Code:** 1912-524

### System Operation Description:

### Use this procedure under the following situation:

Use this procedure if any of the following conditions exist:

- The ECM has been replaced and the old ECM will not communicate with the Caterpillar Electronic Technician (Cat ET).
- 22-13 Check Timing Sensor Calibration is active.
- Work has been done to the front gear group.

The primary engine speed/timing sensor provides an engine speed signal (rpm) to the ECM. The signal is created as the crankshaft gear rotates past the pickup of the primary engine speed/timing sensor. The secondary engine speed/timing sensor provides the timing signal to the ECM. The signal is created as the camshaft gear rotates past the pickup of the secondary engine speed/timing sensor. A unique pattern on the gear allows the ECM to determine the crankshaft position. This unique pattern on the gear allows the ECM to determine the top center position of the piston in the No. 1 cylinder. If the signal is lost from one of the sensors, a diagnostic code is generated. If the signal is lost from one of the sensors, the ECM will use a special type of logic that will allow the engine to start on only one sensor and this special type of logic will allow the engine to run on only one sensor.

Timing calibration is accomplished by installing a special magnetic transducer into the side of the engine block. The magnetic transducer senses a special slot on the crankshaft counterweight. The magnetic transducer is connected to the ECM through the P400 Speed/Timing Calibration Connector that is on the engine wiring harness.

When the engine rpm is from 1000 to 1200 rpm, the ECM is placed in timing calibration mode with Cat ET.

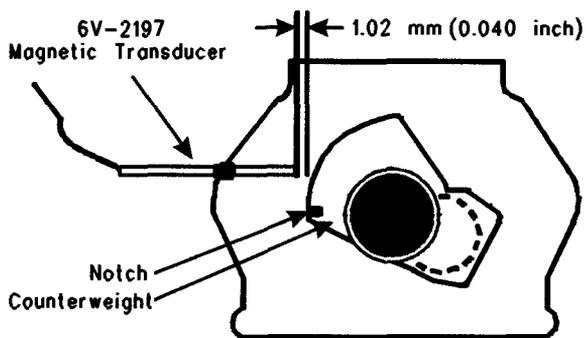


Illustration 199

g00660979

**Note:** The Timing Calibration will not increase the available engine power or the Timing Calibration will not decrease the available engine power. Do not expect an increase in power due to the performance of the timing calibration.

### Replacement ECM

If a replacement ECM is required, the ECM parameters and the timing calibration can be transferred from the suspect ECM to the replacement ECM. Timing calibration will NOT be necessary. This feature requires Cat ET and this feature is only possible if the existing ECM can communicate with Cat ET.

Table 160

Required Special Tools	
Part Number	Description
6V-2197	Magnetic Transducer
7X-1695	Cable
7X-1171	Transducer Adapter
9S-9082	Engine Turning Tool

### Test Step 1. Install the 7X-1171 Transducer Adapter

- Turn the key switch to the OFF position.
- Use the 9S-9082 Engine Turning Tool to put either the No. 1 piston or the No. 6 piston at top center. Rotate the engine in the opposite direction of the correct engine rotation by the following amount:
  - 60 Degrees
- Use the following procedure for a C-10 or C-12 engine:

- a. Remove the timing calibration plug from the right side of the cylinder block as the engine is viewed from the flywheel. The timing calibration plug is located on the No. 4 cylinder rod pocket.
  - b. Install the 7X-1171 Transducer Adapter into the hole for the plug.
- D.** Use the following procedure for a 3406E, C-15, C-16 or C-18 Engine:
- a. Remove the timing calibration plug from the left side of the cylinder block as the engine is viewed from the flywheel.
  - b. Install the 7X-1171 Transducer Adapter into the hole for the plug.

**Results:**

- OK – Proceed to Test Step 2.

**Test Step 2. Install the 6V-2197 Magnetic Transducer on the Engine****NOTICE**

If the crankshaft is not in the correct position when the 6V-2197 Magnetic Transducer is installed, the Magnetic Transducer will be damaged when the engine is started.

- A.** Put a 2D-6392 O-Ring Seal on the end of the magnetic transducer.

**Note:** A small amount of clean engine oil will allow the seal to slide onto the transducer more easily.

- B.** Push the magnetic transducer through the adapter until the magnetic transducer comes in contact with the outermost portion of the crankshaft counterweight. Move the O-ring seal downward against the adapter.
- C.** Withdraw the magnetic transducer 1.0 mm (0.04 inch) and hand tighten the nut on the adapter sleeve in order to secure the magnetic transducer in place.
- D.** Connect the 6V-2197 Magnetic Transducer to the 7X-1695 Cable.

**Results:**

- OK – Proceed to Test Step 3.

**Test Step 3. Start the Engine and Allow the Coolant to Reach Operating Temperature**

- A.** Start the engine and run at low idle until the engine has warmed up enough to exit cold mode operation. The status screen on Cat ET will display "COLD MODE" in the upper corner when cold mode operation exists. The engine will adjust idle rpm from cold mode idle to the programmed low idle rpm when cold mode operation is complete.
- B.** Check for active diagnostic codes. Use the procedures in this manual to troubleshoot and repair any active diagnostic codes before attempting a calibration check. The engine must not have any diagnostic fault conditions that are present during the timing calibration except the following condition:
- 22-13 Engine Speed Signal Calibration Not Performed
- C.** After the engine has warmed up, set the engine speed to 1100 rpm by the use of the cruise control switches or the accelerator pedal.

**Note:** The engine rpm must be steady within the 1000 to 1200 rpm range in order to perform a timing calibration.

**Results:**

- OK – Proceed to Test Step 4.

**Test Step 4. Connect Cat ET**

- A.** Connect Cat ET to the data link connector.
- B.** After the engine has exited cold mode operation, access the "Timing Calibration Screen" on Cat ET. Access the following display screens in order:
- "Service"
  - "Calibrations"
  - "Timing Calibration"

**Note:** To perform a timing calibration, the engine rpm must remain as steady as possible at approximately 1100 rpm. This can be performed by the use of the cruise control switches or a steady foot on the accelerator pedal. Any changes to engine rpm that are more than 100 rpm will slow down the procedure. These changes will also reduce the accuracy of the procedure.

**C.** Connect the 7X-1695 Cable for the 6V-2197 Magnetic Transducer to the P400 Speed/Timing Calibration Connector.

**D.** Ensure that all of the connections are made correctly.

**Results:**

- OK – Proceed to Test Step 5.

**Test Step 5. Calibrate the Speed/Timing Sensor**

**A.** To calibrate the timing to the correct setting, select “Continue” on Cat ET. Wait until Cat ET indicates that the timing is “CALIBRATED”.

**Note:** If Cat ET displays “CALIBRATION UNSUCCESSFUL”, the electronic injection timing has not been set. Recheck the tool installation and tool operation and try again to calibrate electronic injection timing. If the crankshaft and camshaft gears have been reassembled incorrectly, the engine will not calibrate.

If the timing calibration has been successfully completed, do not exit the timing calibration screen on Cat ET until you have disconnected the 7X-1695 Cable for the 6V-2197 Magnetic Transducer from the P400 Speed/Timing Calibration Connector.

**Expected Result:**

The timing calibration procedure was completed successfully.

**Results:**

- OK – The timing calibration procedure was completed successfully. Proceed to Test Step 6.
- Not OK

**Repair:** Perform the following procedure:

1. Verify that the engine rpm was stable during the testing ( $\pm 50$  rpm). If the engine rpm was unstable or the engine rpm could not be controlled within  $\pm 50$  rpm because of mechanical factors or electrical factors, refer to Troubleshooting, “Engine Misfires, Runs Rough or Is Unstable”.

2. If all of the problems have been corrected but the timing can not be calibrated, check the cable of the 6V-2197 Magnetic Transducer and check the 6V-2197 Magnetic Transducer in order to verify that the Magnetic Transducer is not bent. If the 6V-2197 Magnetic Transducer is not bent, restart this procedure.

STOP.

**Test Step 6. Disconnect the 6V-2197 Magnetic Transducer Before Exiting the “Monitor/Calibrate Timing” Screen**

**A.** Disconnect the 6V-2197 Magnetic Transducer from the P400 Speed/Timing Calibration Connector.

**B.** Exit the timing calibration screen on Cat ET.

**Note:** Exiting the timing calibration screen on Cat ET will drop the engine rpm to the programmed low idle if the cruise control switches were used to maintain engine rpm during calibration. This is normal.

**Expected Result:**

The magnetic transducer was disconnected before exiting the timing calibration screen on Cat ET.

**Results:**

- OK – STOP.
- Not OK – If the magnetic transducer is still installed after exiting the timing calibration screen on Cat ET, vehicle speed diagnostic codes may be generated.

**Repair:** If vehicle speed diagnostic codes are generated, the vehicle speed diagnostic codes should be cleared.

STOP.

i01741189

**Injector Code - Calibrate**

**SMCS Code:** 1290-524

**System Operation Description:**

If any of the following conditions have occurred, the injector trim codes should be calibrated:

- Replacement of the ECM
- Replacement of any of the unit injectors

A special code is stamped on the top of each unit injector. The injector trim code allows the ECM to compensate for variances in manufacturing.

**Note:** Changing the injector trim codes will not increase the power that is available to the engine.

### Test Step 1. Record Injector Trim Codes

- A.** Record the injector trim code and the corresponding cylinder number for each unit injector that will be replaced.

Table 161

Injector Trim Code		
Cylinder	Old	New
1		
2		
3		
4		
5		
6		

**Note:** If the ECM is replaced, all injector trim codes must be recorded. The injector trim codes can be found in "Calibrations" under the "Service" menu on the Caterpillar Electronic Technician (Cat ET).

#### Expected Result:

All injector trim codes were obtained.

#### Results:

- **OK** – All injector trim codes were obtained. Proceed to Test Step 2.
- **Not OK** – The injector trim codes were not obtained.

**Repair:** Remove the valve cover and record the injector trim code and the corresponding cylinder number for each unit injector.

Proceed to Test Step 2.

### Test Step 2. Replace Hardware

- A.** Replace the suspect unit injectors and/or the ECM.
- B.** Record the injector trim code and the corresponding cylinder number for each unit injector.

#### Expected Result:

All hardware was successfully replaced and the new injector trim codes were recorded.

#### Results:

- **OK** – The hardware was successfully replaced. Proceed to Test Step 3.

### Test Step 3. Enter Injector Trim Codes into the ECM

- A.** Connect Cat ET to the service tool connector.
- B.** Turn the keyswitch to the ON position.
- C.** Open the "Injector Codes Calibration" in "Calibrations" under the "Service" menu on Cat ET.
- D.** Enter the new injector trim code for each cylinder.

#### Results:

- **OK** – STOP.

i01810925

## Vehicle Speed Circuit - Calibrate

**SMCS Code:** 7463-524

#### System Operation Description:

The ECM uses vehicle speed information for the following features:

- Cruise control
- Fast idle control
- Idle speed control
- PTO operation
- Vehicle speed limiting
- Speedometer
- Progressive shift
- Idle shutdown
- Operation of the air inlet heater
- Secure idle theft deterrent
- Trip data
- Maintenance data

There are three different methods that can be used to obtain the information for the ECM to use for calculating vehicle speed. The ECM can calculate vehicle speed by either of the following means:

- The ECM monitors the signal from a vehicle speed sensor in pulses per kilometer (mile). The vehicle speed sensor is connected to the vehicle speed input circuit (terminals 32 and 33 of the ECM). This is the “Vehicle Speed Calibration” option.
- The ECM receives a message over the J1939 data link from the Transmission ECU that indicates revolutions per kilometer (mile) of the transmission output shaft. This is the “Vehicle Speed Cal (J1939-Trans)” option.
- The ECM receives a message over the J1939 data link from the Anti-lock Brake System (ABS) that contains information about the wheel speed. This is the “Vehicle Speed Cal (J1939-ABS)” option.

Each of these methods require a specific calibration number to be programmed into the ECM to calculate vehicle speed.

For the “Vehicle Speed Calibration” option that uses the vehicle speed sensor, the ECM must know the number of pulses that are produced by the vehicle speed sensor during each kilometer (mile) of travel by the vehicle. In order to find the number of pulses that are produced by the sensor, multiply the tire size by the axle ratio. Multiply the number that was obtained in the previous calculation by the number of teeth on the output shaft that is used by the sensor to obtain the pulses.

For the “Vehicle Speed Cal (J1939-Trans)” option, the ECM must know the number of times that the output shaft revolves per kilometer (mile) of travel by the vehicle. This can be calculated by one of the following methods:

- Divide the pulses per kilometer (mile) of the sensor on the transmission output shaft by the number of teeth on the transmission output shaft.
- Multiply the axle ratio by the number of revolutions per kilometer (mile) of the tire.

For the “Vehicle Speed Cal (J1939-ABS)” option, the ECM must know a calibration number. The number is calculated by dividing the actual tire revolutions per kilometer (mile) by the tire revolutions per kilometer (mile) that is programmed into the ABS.

The ECM calculates vehicle speed by converting the vehicle speed signal to kilometers per hour (km/h) or miles per hour (mph). The conversion factor is customer programmable and the conversion factor is stored in pulses per km (PPKM) or pulses per mile (PPM).

The variable for the tire revolution could be affected by changing from bias ply tires to radial tires and vice versa. Also, changing to radial tires that have a low profile could affect the variable for the tire revolution. This result may change the actual vehicle speed which could result in performance complaints or complaints about fuel consumption. If the tire configuration has been changed, determine the new variable for the tire revolution. Enter the new value in pulses per km (PPKM) or pulses per mile (PPM). The preferred method is obtaining the data from the individual tire manufacturers for the specific tire that is being used.

**Note:** The ECM speedometer signal is set to 18,600 pulses per km (PPKM) or 30,000 pulses per mile (PPM). This setting cannot be changed. All speedometers that are driven by the ECM output (J1/P1 terminal 36 and terminal 37) must match the fixed output of the ECM for proper operation.

### **Test Step 1. Use the Electronic Service Tool to Determine the Configuration for the Vehicle Speed Input to the ECM**

- Connect the electronic service tool to the cab data link connector.
- Access the “Configuration Parameter List”. View the “Vehicle Speed Parameters”. Determine if the vehicle is configured to use the “Vehicle Speed Calibration” option, the “Vehicle Speed Cal (J1939-Trans)” option, or the “Vehicle Speed Cal (J1939-ABS)” option.

#### **Expected Result:**

**RESULT 1** The ECM is configured for the “Vehicle Speed Calibration” option.

**RESULT 2** The ECM is configured to use the “Vehicle Speed Cal (J1939-Trans)” option.

**RESULT 3** The ECM is configured to use the “Vehicle Speed Cal (J1939-ABS)” option.

#### **Results:**

- RESULT 1 – Proceed to Test Step 2.
- RESULT 2 – Proceed to Test Step 3.
- RESULT 3 – Proceed to Test Step 4.

### **Test Step 2. Calculating Pulses Per Kilometer (Mile) When all the Variables are Known.**

- Calculate pulses per kilometer (PPKM) or pulses per mile (PPM).

$$\text{PPKM} = K \times \text{Ra} \times N.$$

$$\text{PPM} = \text{M} \times \text{Ra} \times \text{N}$$

**K** – This symbol represents the tire revolutions per kilometer. This is a constant that is divided by the tire static loaded radius.

**M** – This symbol represents the tire revolutions per mile. This is a constant that is divided by the tire static loaded radius.

**Ra** – This symbol represents the rear axle ratio. The rear axle ratio can typically be found on the housing of the rear axle, or the rear axle ratio can typically be found on the specification sheet for the vehicle.

**N** – This symbol represents the number of chopper teeth on the transmission drive shaft. The magnetic pickup sensor is mounted here. The number of chopper teeth is usually 16. Some transmissions have 11 tooth chopper wheels.

- B.** Use the electronic service tool to enter pulses per km (PPKM) or pulses per mile (PPM) into the ECM.

#### **Expected Result:**

This value is within the valid range of the ECM.

#### **Results:**

- **OK** – Once the value is entered, verify that the ECM is accurately measuring vehicle speed. Proceed to Test Step 5.
- **Not OK** – Recalculate the value and re-enter the correct value into the ECM. STOP.

### **Test Step 3. Calculate the Revolutions Per Kilometer (Mile) of the Transmission Output Shaft**

- A.** The correct revolutions per kilometer (mile) of the transmission output shaft must be entered for the “Vehicle Speed Cal J1939-Trans” setting. If this value is unknown, either of the following calculations can be used to obtain the correct setting:
- Divide the pulses per kilometer (mile) of the sensor on the transmission output shaft by the number of teeth on the transmission output shaft.
  - Multiply the axle ratio by the number of revolutions per kilometer (mile) of the tire.

- B.** Use the electronic service tool to enter the calculated value into the ECM.

#### **Expected Result:**

The value is within the valid range of the ECM.

#### **Results:**

- **Yes** – Once the value is entered, verify that the ECM is accurately measuring vehicle speed. Proceed to Test Step 5.
- **No** – Recalculate the value and re-enter the correct value into the ECM. STOP.

### **Test Step 4. Calculate Tire Revolutions Per Kilometer (Mile) When all the Variables are Known**

- A.** The correct calibration number must be entered for the “Vehicle Speed Cal J1939-ABS” setting. If this value is unknown, the following calculation can be used to obtain the correct setting.

Divide the actual tire revolutions per kilometer (mile) by the tire revolutions per kilometer (mile) that is broadcast by the ABS.

For example, the actual tire revolutions per kilometer (mile) could equal 400 revolutions per kilometer (mile). The tire revolutions per kilometer (mile) that is broadcast by the ABS could equal 500 revolutions per kilometer (mile).

The formula would be  $400 / 500 = 0.800$ .

Therefore, 0.800 would be the value that would be entered into the ECM.

- B.** Use the electronic service tool to enter the calculated value into the ECM.

#### **Expected Result:**

This value is within the valid range of the ECM.

#### **Results:**

- **OK** – Once the value is entered, verify that the ECM is accurately measuring vehicle speed. Proceed to Test Step 5.
- **Not OK** – Recalculate the value and re-enter the correct value into the ECM. STOP.

### **Test Step 5. Inspect the Speedometer Calibration.**

Determine the speedometer’s vehicle speed calibration setting.

**Expected Result:**

The speedometer must be calibrated to 18,600 pulses per kilometer (30,000 pulses per mile).

The ECM can only provide the signal that is listed above.

**Results:**

- OK – The speedometer is correctly calibrated.  
STOP.
- Not OK

**Repair:** Perform the following diagnostic procedure:

Reprogram the speedometer to the correct setting for the pulses per kilometer (mile).

STOP.

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# Troubleshooting

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## **3406E, C-10, C-12, C-15, C-16 and C-18 On-highway Engines**

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W1A1-Up (Engine)  
CPD1-Up (Engine)  
1MM1-Up (Engine)  
CJP1-Up (Engine)  
MDP1-Up (Engine)  
MEP1-Up (Engine)  
2KS1-Up (Engine)  
2WS1-Up (Engine)  
3CS1-Up (Engine)  
6NZ1-Up (Engine)  
7CZ1-Up (Engine)