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September 2022

Perkins®

THE HEART OF EVERY GREAT MACHINE

Troubleshooting

403J-E17T, 404J-E22T, and 404J-E22TA Engines

i07966018

Important Safety Information

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

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

Do not operate or perform any lubrication, maintenance or repair on this product, until you verify that you are authorized to perform this work, and have read and understood the operation, lubrication, maintenance and repair information.

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

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

⚠ WARNING

The meaning of this safety alert symbol is as follows:

Attention! Become Alert! Your Safety is Involved.

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

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

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

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

NOTICE

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

Other parts may not meet certain original equipment specifications.

When replacement parts are installed, the machine owner/user should ensure that the machine remains in compliance with all applicable requirements.

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

Table of Contents

Troubleshooting Section

Index Section

Troubleshooting Section

Introduction

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General Information

Important Safety Information

Do not perform any procedures in this Troubleshooting Guide until you have read the Operation and Maintenance Manual and you understand this information. Use only proper tools and observe all precautions that pertain to the use of those tools. Failure to follow these procedures can result in personal injury. The following procedures should also be observed.

Work safely. 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.

Safety precautions and warnings are provided in this publication and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to you or to other persons. Perkins cannot anticipate every possible circumstance that might involve a potential hazard.

Therefore, the warnings in this publication and the warnings that are on the product are not all inclusive.

Overview

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

- Control of the engine
- Control of particulate emissions via the Clean Emission Module (CEM)
- Applications control system interface
- Fault detection and reporting

Electronic Control System

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

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

- Horsepower
- Torque curves
- Engine speed (rpm)

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

Application Interface

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

The application control system provides inputs to the electrical connector on the ECM to indicate the status of switches. Correctly configure the ECM to interpret the inputs.

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

Clean Emissions Module (CEM)

The CEM contains these components:

Diesel Particulate Filter (DPF) – A DPF is installed in the exhaust system. The DPF collects soot and ash from the engine exhaust.

Diesel Oxidation Catalyst (DOC) – A DOC is installed in the exhaust system. The DOC oxidizes hydrocarbons (HC), carbon monoxide (CO), odor causing compounds, and soluble organic fractions (SOF).

Software – Software in the ECM monitors the DPF.

Fault Detection and Reporting

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

The ECM broadcasts the codes on a CAN data link. If a fault is suspected with the CAN data link, refer to Troubleshooting, “CAN Data Link - Test”.

The codes can be displayed on the electronic service tool and optional operator interfaces. Refer to Troubleshooting, “Diagnostic Trouble Codes” for additional information on diagnostic trouble codes and a complete list of codes.

Troubleshooting

During troubleshooting, refer to the Electrical System Schematic for the application.

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

Failure of an electrical component may cause the failure of other components. Always attempt to correct the cause of an electrical failure before you replace a component. If wire insulation is punctured, repair the damage.

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Welding Precaution

Correct welding procedures are necessary to avoid damage to the Electronic Control Module (ECM), to sensors, and to associated components. Components for the driven equipment should also be considered. When possible, remove the component that requires welding. When welding on an application that is equipped with an electronically controlled engine and removal of the component is not possible, the following procedure must be followed. This procedure minimizes the risk to the electronic components.

1. Stop the engine. Remove the electrical power from the ECM.

2. Ensure that the fuel supply to the engine is turned off.

3. Disconnect the negative battery cable from the battery. If a battery disconnect switch is installed, open the switch.

4. Disconnect all electronic components from the wiring harnesses. Include the following components:

- Electronic components for the driven equipment
- ECM
- Sensors
- Electronically controlled valves
- Relays
- Electronic control units

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

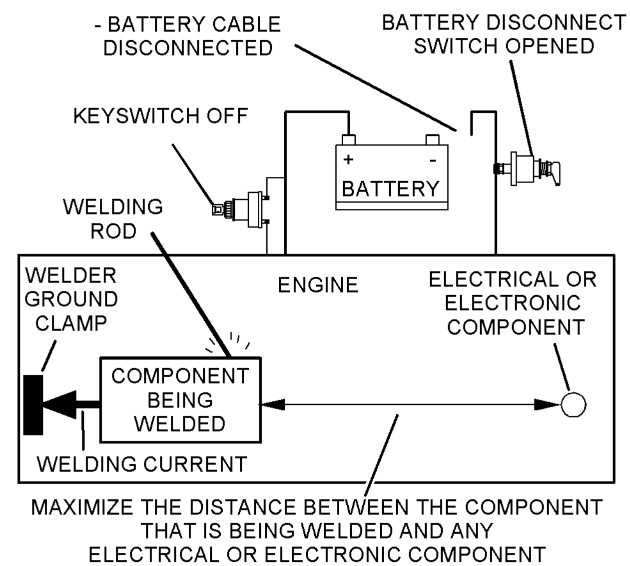

Illustration 1 g01143634

Service welding guide (typical diagram)

5. When possible, connect the ground clamp for the welding equipment directly to the engine component that will be welded. Place the clamp as close as possible to the weld. Close positioning reduces the risk of welding current damage to the engine bearings, to the electrical components, and to other components.

6. Protect the wiring harnesses from welding debris and/or from welding spatter.

7. Use standard welding procedures to weld the materials together.

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Electronic Service Tools

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

- Information access
- System diagnostics

- System calibrations
- System configurations
- Data link communications

Required Service Tools

Table 1

Required Service Tools	
Part Number	**Description**
CH11155	Crimp Tool (12−AWG TO 18−AWG)
2900A019	Wire Removal Tool
27610285	Removal Tool
-	Suitable Digital Multimeter

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

Optional Service Tools

Table 2 lists the optional service tools that can be used when the engine is serviced.

Table 2

Part Number	Description
U5MK1092	Spoon Probe Kit (MULTIMETER)
- or -	Suitable Digital Pressure Indicator or Engine Pressure Group
-	Suitable Battery Load Tester
-	Suitable Temperature Adapter (MULTIMETER)
2900A038	Bypass Harness As
2900A036	Stub as

Perkins Electronic Service Tool

The Perkins Electronic Service Tool can display the following information:

- Status of all pressure sensors and temperature sensors
- Programmable parameter settings
- Active diagnostic codes and logged diagnostic codes
- Logged events
- Histograms

The Electronic Service Tool can also be used to perform the following functions:

- Diagnostic tests
- Sensor calibrations
- Programming of flash files and injector trim codes
- Parameter programming
- Copy configuration function for ECM replacement
- Data logging
- Graphs (real time)

Table 3 lists the service tools that are required in order to use the Electronic Service Tool.

Table 3

Service Tools for the Use of the Electronic Service Tool	
Part Number	**Description**
-(1)	Single Use Program License
-(1)	Data Subscription for All Engines
27610164 27610401	TIPSS Adapter Kit (Electronic Service Tool to the ECM interface) or Perkins CA3 Kit

(1) Refer to Perkins Engine Company Limited.

Note: For more information on the Electronic Service Tool and the PC requirements, refer to the documentation that accompanies the software for the Electronic Service Tool.

Connecting the Electronic Service Tool and the TIPSS Adapter

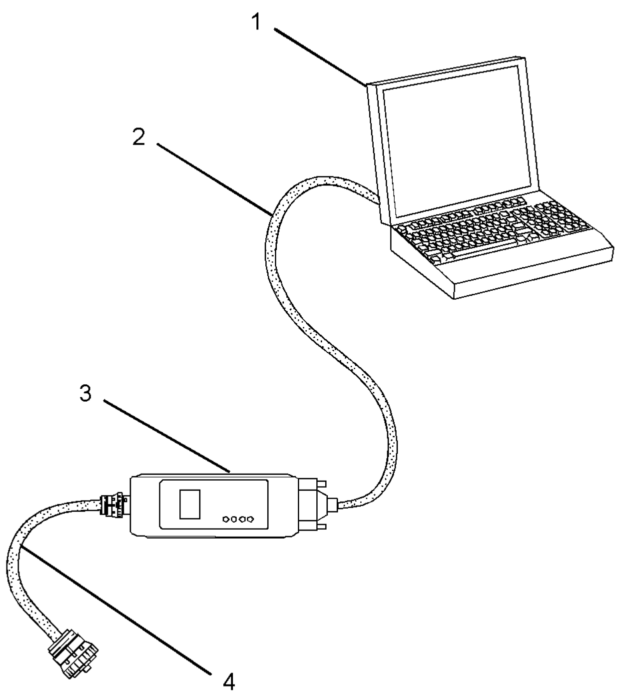

Illustration 2 g01121866

(1) Personal Computer (PC)
(2) Adapter Cable (Computer Serial Port)
(3) TIPSS adapter
(4) Adapter Cable Assembly

Note: Items (2), (3) and (4) are part of the TIPSS adapter kit.

Use the following procedure in order to connect the Electronic Service Tool and the TIPSS Adapter.

1. Turn the keyswitch to the OFF position.

2. Connect cable (2) between the “COMPUTER” end of TIPSS adapter (3) and the RS232 serial port of PC (1).

Note: The Adapter Cable Assembly (4) is required to connect to the USB port on computers that are not equipped with an RS232 serial port.

3. Connect cable (4) between the “DATA LINK” end of TIPSS adapter (3) and the service tool connector.

4. Place the keyswitch in the ON position. If the Electronic Service Tool and the TIPSS adapter do not communicate with the Electronic Control Module (ECM), refer to the diagnostic procedure Troubleshooting, “Electronic Service Tool Does Not Communicate”.

Connecting the Electronic Service Tool and the CA3 Kit

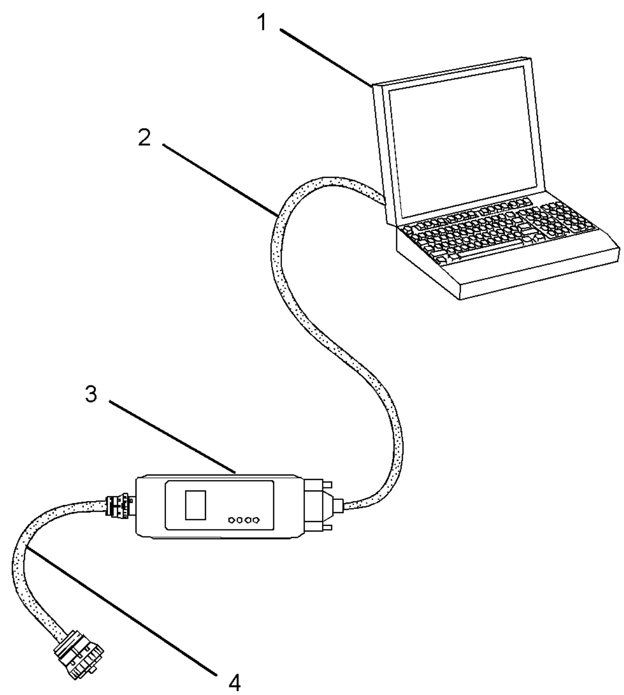

Illustration 3 g01121866

(1) Personal Computer (PC)
(2) Adapter Cable (Computer Serial Port)
(3) CA3 adapter
(4) Adapter Cable Assembly

Note: Items (2), (3) and (4) are part of the CA3 kit.

Use the following procedure in order to connect the Electronic Service Tool and the CA3 Adapter.

1. Turn the keyswitch to the OFF position.

2. Connect cable (2) between the “COMPUTER” end of CA3 adapter (3) and a USB port of PC (1).

3. Connect cable (4) between the “DATA LINK” end of CA3 adapter (3) and the service tool connector.

4. Place the keyswitch in the ON position. If the Electronic Service Tool and the CA3 adapter do not communicate with the Electronic Control Module (ECM), refer to the diagnostic procedure Troubleshooting, “Electronic Service Tool Does Not Communicate”.

Electronic System Overview

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System Overview

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

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

System Operation

Engine Governor

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

For variable speed engines, the ECM uses the throttle position sensor to determine the desired engine speed. The ECM compares the desired engine speed to the actual engine speed. The actual engine speed is determined through interpretation of the signals that are received by the ECM from the engine speed/timing sensors. If the desired engine speed is greater than the actual engine speed, the ECM allows more fuel to be injected, increasing engine speed.

Timing Considerations

Once the ECM has determined the amount of fuel that is required, the ECM must determine the timing of the fuel injection.

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

Fuel Injection

The common rail fuel system is controlled by the ECM. The ECM gathers data from several sensors on the engine. The ECM then uses this data to adjust the quantity of fuel being delivered as well as the timing of the injection event. The injection event begins when the ECM sends a signal to the injector solenoid to actuate the valve inside the injector. As the valve opens, the fuel flows from the fuel rail, through the fuel line, and into the injector. As the valve opening pressure is reached, the valve is lifted and the fuel is delivered at high pressure into the combustion chamber.

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

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

Other ECM Functions for Performance

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

Programmable Parameters

Certain parameters that affect engine operation may be changed with the electronic service tool. 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. Factory passwords must be obtained and factory passwords must be used to change the system configuration parameters.

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

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

Customer passwords may be required to change customer specified parameters.

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

Passwords

System configuration parameters are protected by factory passwords. Factory passwords are calculated on a computer system that is available only to Perkins dealers and distributors. Since factory passwords contain alphabetic characters, only the electronic service tool can be used to change system configuration parameters.

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

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

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Component Location

Electronic Control Circuit Diagram

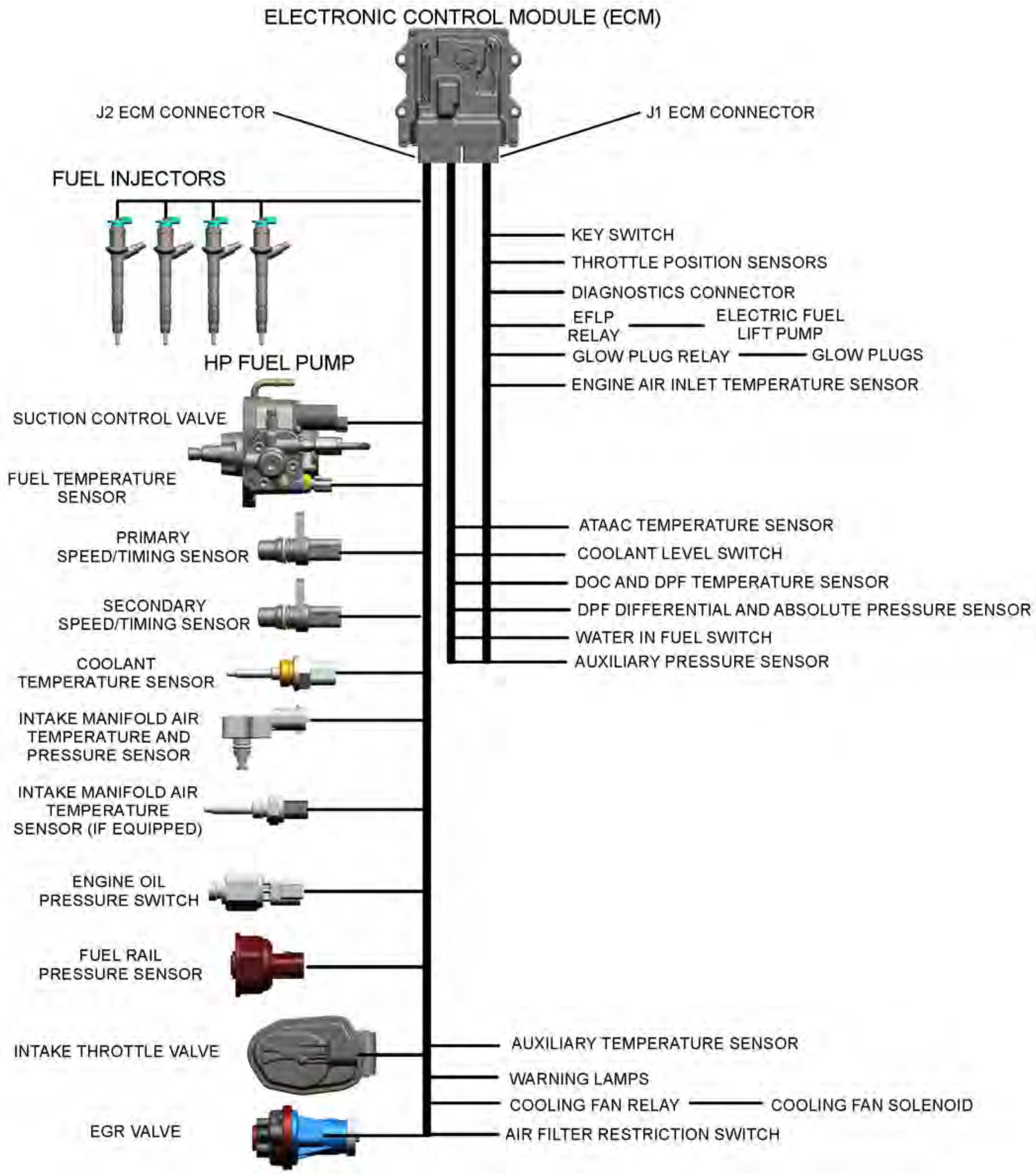

Illustration 4 g06452553

Sensor Locations

Note: In the following illustrations, some components have been removed to improve visibility.

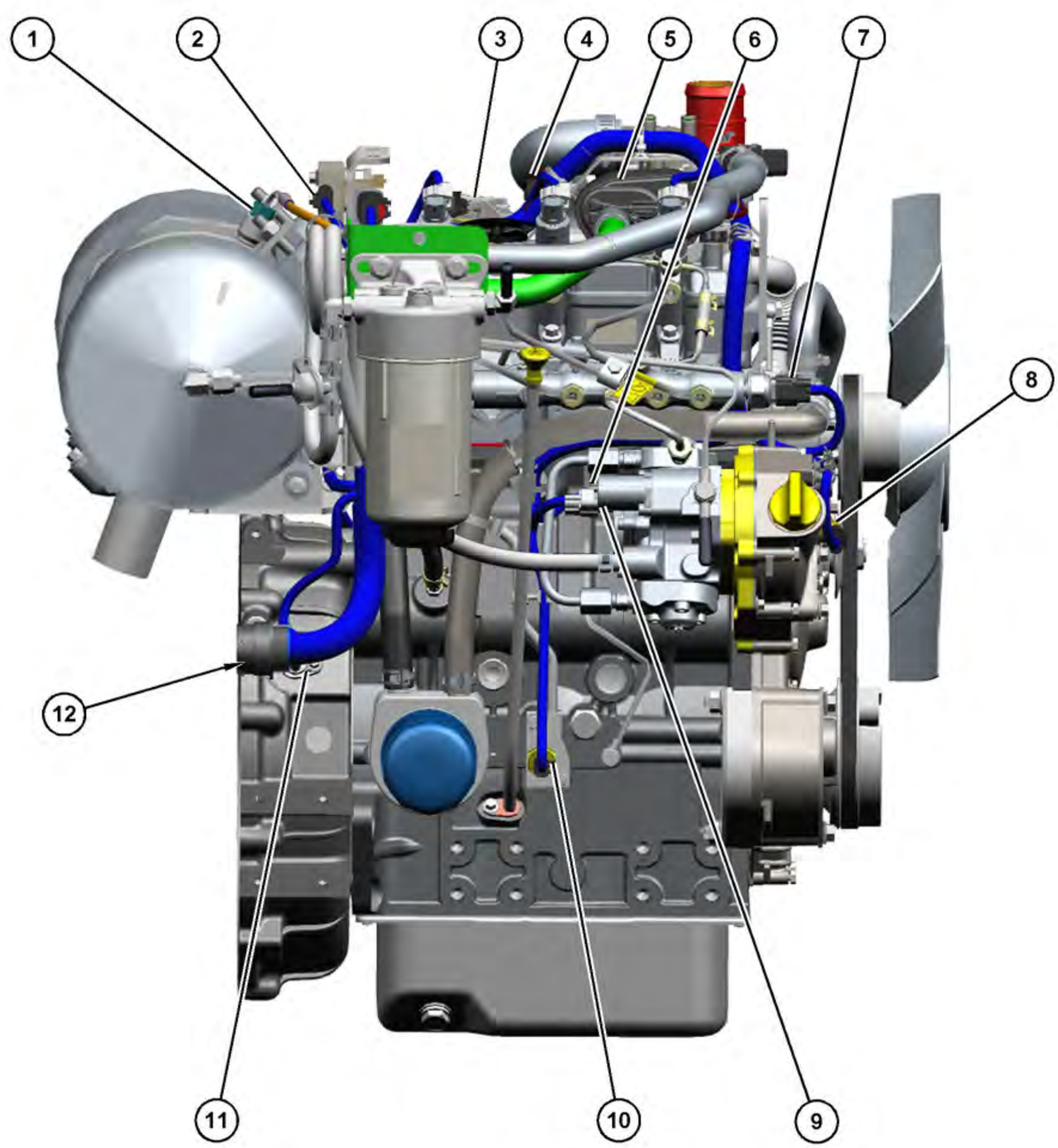

Illustration 5 g06452641

Sensor locations on the right side of the engine (typical example)

(1) DPF inlet temperature sensor
(2) DPF differential and absolute pressure sensor
(3) Intake manifold air pressure/temperature sensor
(4) Intake manifold air temperature sensor
(5) Engine intake throttle valve
(6) Fuel temperature sensor
(7) Fuel rail pressure sensor
(8) Secondary speed/timing sensor
(9) Flow control valve for high-pressure fuel pump
(10) Oil pressure switch
(11) Primary speed/timing sensor
(12) Engine interface connector

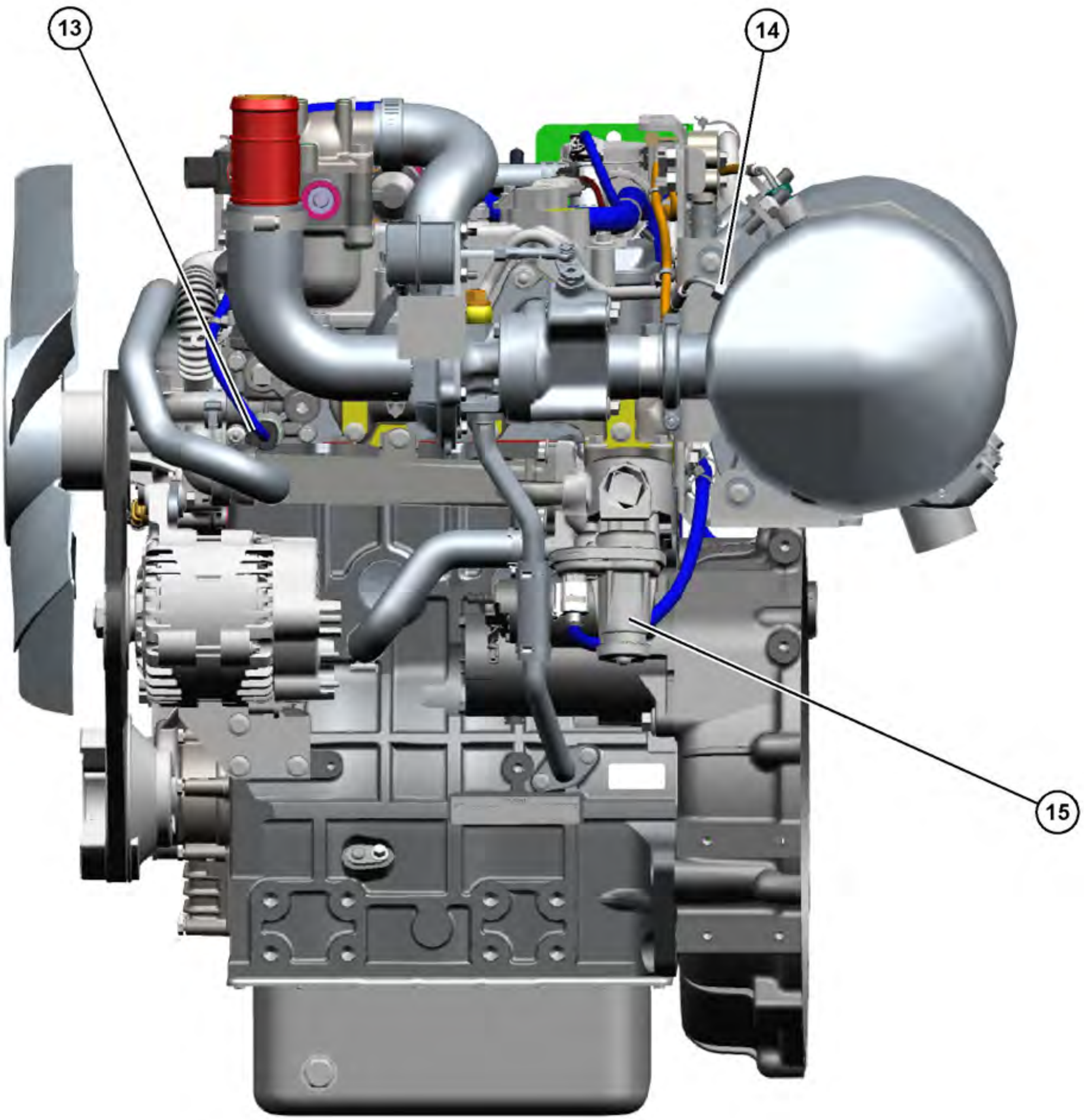

Illustration 6 g06452669

Sensor locations on the left side of the engine (typical example)

(13) Coolant temperature sensor

(14) DOC inlet temperature sensor

(15) NOx Reduction System (NRS) Valve

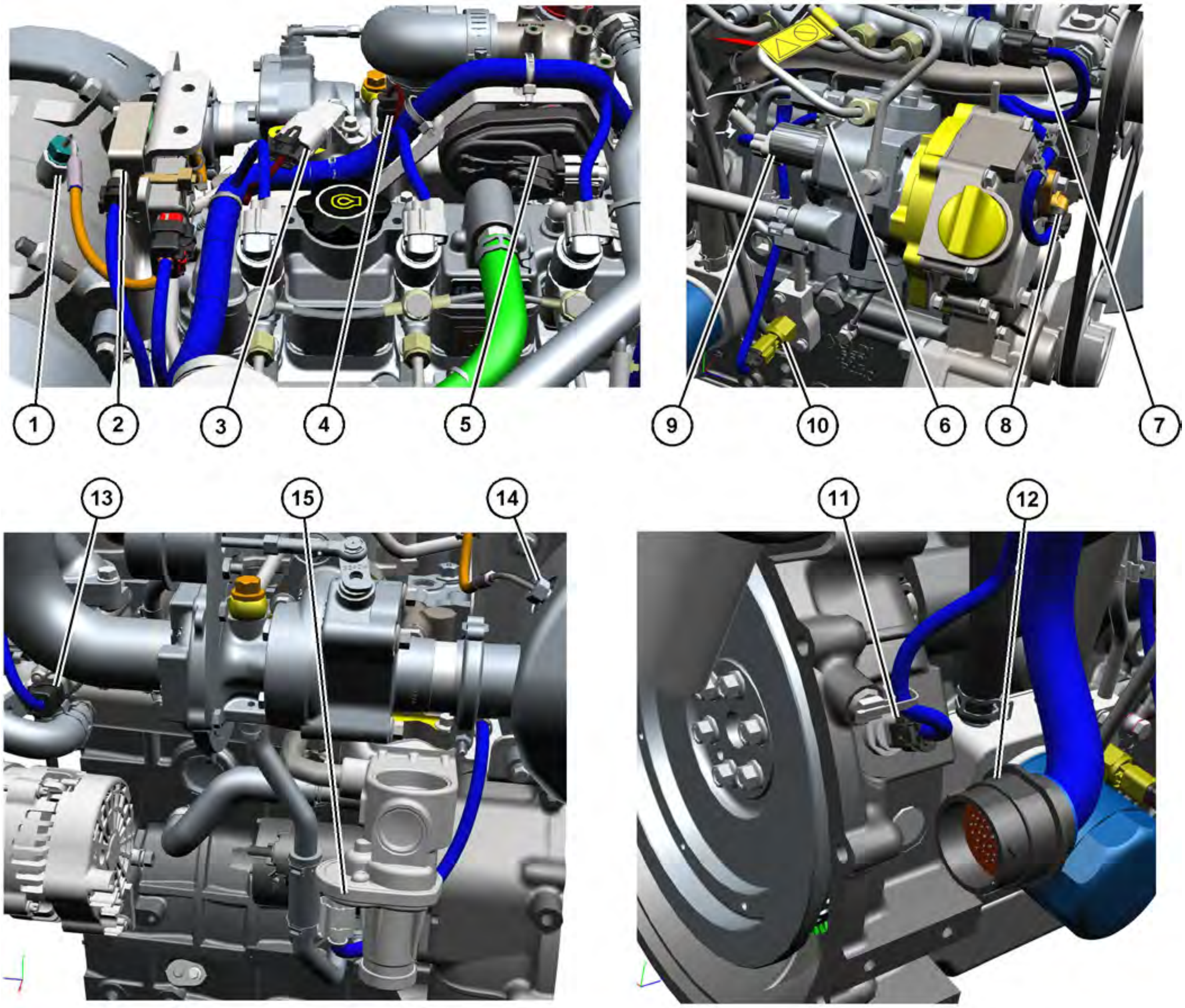

Illustration 7 g06453013

Close up views of sensor locations on the engine (typical example)

(1) DPF inlet temperature sensor
(2) DPF differential and absolute pressure sensor
(3) Intake manifold air pressure/temperature sensor
(4) Intake manifold air temperature sensor
(5) Engine intake throttle valve
(6) Fuel temperature sensor
(7) Fuel rail pressure sensor
(8) Secondary speed/timing sensor
(9) Flow control valve for high-pressure fuel pump
(10) Oil pressure switch
(11) Primary speed/timing sensor
(12) Engine interface connector
(13) Coolant temperature sensor
(14) DOC inlet temperature sensor
(15) NOx Reduction System (NRS) Valve

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Diesel Particulate Filter Regeneration

Regeneration

The Diesel Particulate Filter (DPF) traps both soot and ash. Regeneration is the removal of soot from the DPF.

For additional information on the regeneration of the DPF, refer to Systems Operation, Testing and Adjusting.

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Engine Monitoring System

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

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

- Illumination of a warning lamp or warning alarm
- Engine derate
- Engine shutdown

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

Use the electronic service tool to perform the following activities for the monitoring system:

- Viewing parameters
- Parameter programming
- Set delay times

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

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

Viewing or Changing the Settings of the Monitoring System

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

1. Select the “Service/Monitoring System” screen on the electronic service tool.

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

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

The “Change Monitor System” screen will appear.

3. Change the “State” of the parameter.

4. Set the “Trip Point” and the “Delay Time” according to the “Allowed Values” that are displayed in the lower half of the screen.

5. Click the “OK” button.

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

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

The new settings will be effective immediately.

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

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Diagnostic Capabilities

Diagnostic Codes

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

There are two categories of codes:

- Diagnostic code
- Event code

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

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

Codes can have two different states:

- Active
- Logged

Active Codes

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

- Troubleshooting, “Diagnostic Trouble Codes”
- Troubleshooting, “Event Codes”

Logged Codes

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

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

Configuration Parameters

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Configuration Parameters

Use this procedure if the diagnostic code in Table 4 is active.

Table 4

J1939 Code	Description	Comments
630-2	Calibration Memory : Erratic, Intermittent, or Incorrect	The Electronic Control Module (ECM) detects that one or more of the programmable parameters have not been programmed. The ECM may use a default torque map or the ECM may limit the engine to low idle. The code is active only.

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

The parameters are divided into two different types:

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

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

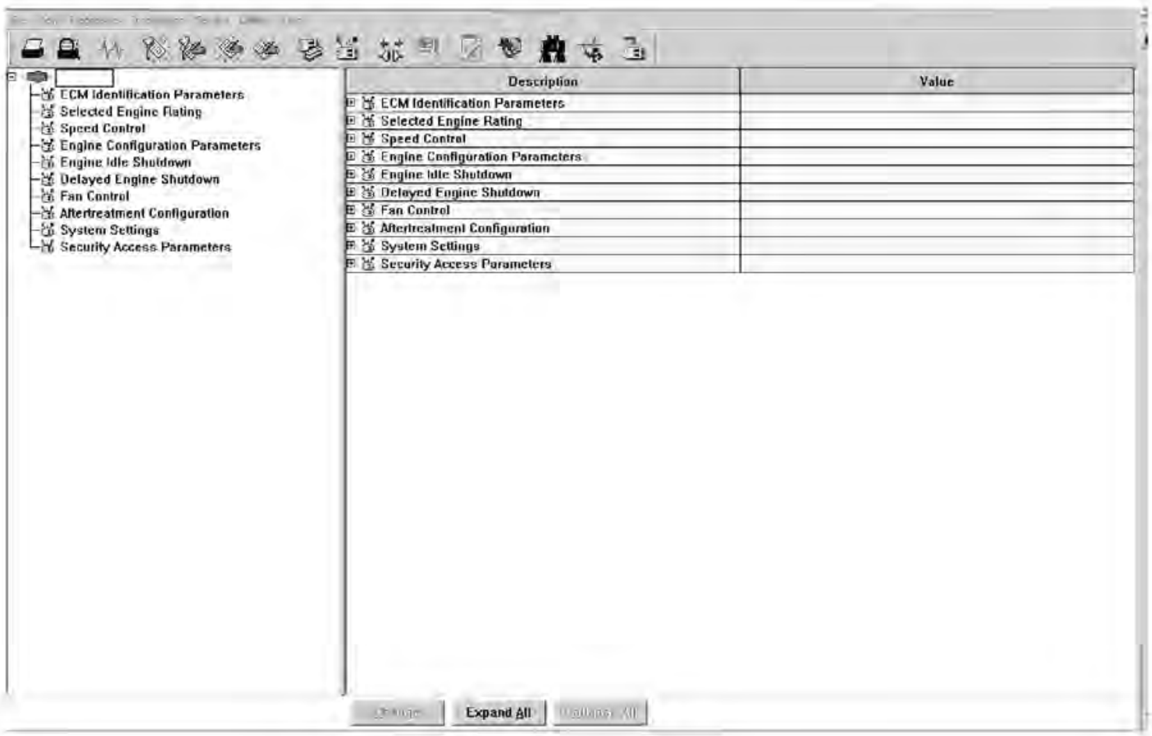

Illustration 8 g03869427

Typical configuration screen

1. Connect to the electronic service tool.

2. Select the Service tab.

3. Select the Configuration tab to view the configuration parameters.

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

NOTICE

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

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

Check Programmable Parameters (630–2)

If a programmable parameter has not been programmed, the ECM will generate a 630-2 diagnostic code. The programmable parameter that is not programmed will be listed under the code. The unprogrammed parameters will be set to default. Certain aspects of the engines performance and engine monitoring may be affected.

Diagnostic Trouble Codes

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Diagnostic Trouble Codes

Diagnostic Trouble Codes in J1939 Order

Table 5 lists the diagnostic trouble codes that apply to the engines that are covered in this manual. The codes are listed in J1939 order. Use the electronic service tool to determine the codes that are active or logged. Then refer to the appropriate troubleshooting procedure for more information.

Table 5

List of Diagnostic Trouble Codes	
J1939 Code and Description	**Troubleshooting Procedure**
27–3 EGR #1 Valve Position : Voltage Above Normal	Troubleshooting, “Valve Position - Test”
27–4 EGR #1 Valve Position : Voltage Below Normal	Troubleshooting, “Valve Position - Test”
29–2 Accelerator Pedal Position #2 : Erratic, Intermittent, or Incorrect	Troubleshooting, “Switch Circuits - Test (Multiposition Throttle Switch)”
29–3 Accelerator Pedal Position 2: Voltage Above Normal	Troubleshooting, “Speed Control (Analog) - Test” or Troubleshooting, “Speed Control (PWM) - Test”
29–4 Accelerator Pedal Position 2: Voltage Below Normal	Troubleshooting, “Speed Control (Analog) - Test” or Troubleshooting, “Speed Control (PWM) - Test”
29–8 Accelerator Pedal Position 2 : Abnormal Frequency, Pulse Width, or Period	Troubleshooting, “Speed Control (PWM) - Test”
51–3 Engine Throttle Position : Voltage Above Normal	Troubleshooting, “Valve Position - Test”
51–4 Engine Throttle Position : Voltage Below Normal	Troubleshooting, “Valve Position - Test”
91–2 Accelerator Pedal Position #1 : Erratic, Intermittent, or Incorrect	Troubleshooting, “Switch Circuits - Test (Multiposition Throttle Switch)”
91–3 Accelerator Pedal Position 1 : Voltage Above Normal	Troubleshooting, “Speed Control (Analog) - Test” or Troubleshooting, “Speed Control (PWM) - Test”
91–4 Accelerator Pedal Position 1 : Voltage Below Normal	Troubleshooting, “Speed Control (Analog) - Test” or Troubleshooting, “Speed Control (PWM) - Test”

(continued)

(Table 5, contd)

91–8 Accelerator Pedal Position 1 : Abnormal Frequency, Pulse Width, or Period	Troubleshooting, “Speed Control (PWM) - Test”
97–3 Water In Fuel Indicator : Voltage Above Normal	Troubleshooting, “Water in Fuel - Test”
97–15 Water In Fuel Indicator : High - least severe (1)	Troubleshooting, “Fuel Contains Water”
97–16 Water In Fuel Indicator : High - moderate severity (2)	Troubleshooting, “Fuel Contains Water”
98–1 Engine Oil Level : Low - most severe (3)	Troubleshooting, “Oil Level Is Low”
98–17 Engine Oil Level : Low - least severe (1)	Troubleshooting, “Oil Level Is Low”
98–18 Engine Oil Level : Low - moderate severity (2)	Troubleshooting, “Oil Level Is Low”
100–1 Engine Oil Pressure : Low - most severe (3)	Troubleshooting, “Oil Pressure Is Low”
100–2 Engine Oil Pressure : Erratic, Intermittent, or Incorrect	Troubleshooting, “Switch Circuits - Test (Engine Oil Pressure Switch)”
102–16 Engine Intake Manifold #1 Pressure : High - moderate severity (2)	Troubleshooting, “Intake Manifold Air Pressure Is High”
102–18 Engine Intake Manifold #1 Pressure : Low - moderate severity (2)	Troubleshooting, “Intake Manifold Air Pressure Is Low”
105–0 Engine Intake Manifold #1 Temperature : High - most severe (3)	Troubleshooting, “Intake Manifold Air Temperature Is High”
105–3 Engine Intake Manifold #1 Temperature : Voltage Above Normal	Troubleshooting, “Sensor Signal (Analog, Passive) - Test”
105–4 Engine Intake Manifold #1 Temperature : Voltage Below Normal	Troubleshooting, “Sensor Signal (Analog, Passive) - Test”
105–15 Engine Intake Manifold #1 Temperature : High - least severe (1)	Troubleshooting, “Intake Manifold Air Temperature Is High”
105–16 Engine Intake Manifold #1 Temperature : High - moderate severity (2)	Troubleshooting, “Intake Manifold Air Temperature Is High”
107–3 Air Filter Differential Pressure Switch : Voltage Above Normal	Troubleshooting, “Switch Circuits - Test (Air Filter Restriction Switch)”
107–4 Air Filter Differential Pressure Switch : Voltage Below Normal	Troubleshooting, “Switch Circuits - Test (Air Filter Restriction Switch)”
107–15 Engine Air Filter 1 Differential Pressure high - least severe (1)	Troubleshooting, “Inlet Air Is Restricted”

(continued)

(Table 5, contd)

107–16 Engine Air Filter 1 Differential Pressure high - moderate severity (2)	Troubleshooting, “Inlet Air Is Restricted”
108–12 Barometric Pressure : Failure	Troubleshooting, “Sensor Signal (Analog, Active) - Test”
110–0 Engine Coolant Temperature : High - most severe (3)	Troubleshooting, “Coolant Temperature Is High”
110–3 Engine Coolant Temperature : Voltage Above Normal	Troubleshooting, “Sensor Signal (Analog, Passive) - Test”
110–4 Engine Coolant Temperature : Voltage Below Normal	Troubleshooting, “Sensor Signal (Analog, Passive) - Test”
110–15 Engine Coolant Temperature : High - least severe (1)	Troubleshooting, “Coolant Temperature Is High”
110–16 Engine Coolant Temperature : High - moderate severity (2)	Troubleshooting, “Coolant Temperature Is High”
111–1 Engine Coolant Level : Low - most severe (3)	Troubleshooting, “Coolant Level Is Low”
111–17 Engine Coolant Level : Low - least severe (1)	Troubleshooting, “Coolant Level Is Low”
111–18 Engine Coolant Level : Low - moderate severity (2)	Troubleshooting, “Coolant Level Is Low”
157–3 Engine Injector Metering Rail #1 Pressure : Voltage Above Normal	Troubleshooting, “Sensor Signal (Analog, Active) - Test”
157–4 Engine Injector Metering Rail #1 Pressure : Voltage Below Normal	Troubleshooting, “Sensor Signal (Analog, Active) - Test”
157–12 Engine Injector Metering Rail #1 Pressure : Failure	Troubleshooting, “Sensor Signal (Analog, Active) - Test”
157–16 Engine Injector Metering Rail #1 Pressure : High - moderate severity (2)	Troubleshooting, “Fuel Rail Pressure Problem”
157–18 Engine Injector Metering Rail #1 Pressure : Low - moderate severity (2)	Troubleshooting, “Fuel Rail Pressure Problem”
168–15 Battery Potential / Power Input #1 : High - least severe (1)	Troubleshooting, “Electrical Power Supply - Test”
168–17 Battery Potential / Power Input #1 : Low - least severe (1)	Troubleshooting, “Electrical Power Supply - Test”
168–31 Battery Potential / Power Input #1	Troubleshooting, “Configuration Parameters”
172–3 Engine Air Inlet Temperature : Voltage Above Normal	Troubleshooting, “Sensor Signal (Analog, Passive) - Test”
172–4 Engine Air Inlet Temperature : Voltage Below Normal	Troubleshooting, “Sensor Signal (Analog, Passive) - Test”

(continued)

(Table 5, contd)

174–3 Engine Fuel Temperature 1 : Voltage Above Normal	Troubleshooting, “Sensor Signal (Analog, Passive) - Test”
174–4 Engine Fuel Temperature 1 : Voltage Below Normal	Troubleshooting, “Sensor Signal (Analog, Passive) - Test”
174–16 Engine Fuel Temperature 1 : High - moderate severity (2)	Troubleshooting, “Fuel Temperature Is High”
190–0 Engine Speed : High - most severe (3)	Troubleshooting, “Engine Overspeeds”
190–8 Engine Speed : Abnormal Frequency, Pulse Width, or Period	Troubleshooting, “Speed/Timing - Test”
190–10 Engine Speed : Abnormal Rate of Change	Troubleshooting, “Engine Speed - Test”
190–15 Engine Speed : High - least severe (1)	Troubleshooting, “Engine Overspeeds”
441–0 Auxiliary Temperature #1 : High - most severe (3)	Troubleshooting depends on the function of the auxiliary temperature sensor which is defined by the OEM of the application.
441–3 Auxiliary Temperature #1 : Voltage Above Normal	Troubleshooting, “Sensor Signal (Analog, Passive) - Test”
441–4 Auxiliary Temperature #1 : Voltage Below Normal	Troubleshooting, “Sensor Signal (Analog, Passive) - Test”
441–15 Auxiliary Temperature #1 : High - least severe (1)	Troubleshooting depends on the function of the auxiliary temperature sensor which is defined by the OEM for the application.
441–16 Auxiliary Temperature #1 : High - moderate severity (2)	Troubleshooting depends on the function of the auxiliary temperature sensor which is defined by the OEM for the application.
515–2 Engine's Desired Operating Speed : Erratic, Intermittent, or Incorrect	The ECM has detected a higher than expected speed request. The engine will be derated. Fully power-down the application. If the fault persists after the application has been restarted, contact the Dealer Solutions Network (DSN).
558–2 Accelerator Pedal #1 Low Idle Switch : Erratic, Intermittent, or Incorrect	Troubleshooting, “Idle Validation - Test”
630-2 Calibration Memory : Erratic, Intermittent, or Incorrect	Troubleshooting, “Configuration Parameters”
631–2 Personality Module : Erratic, Intermittent, or Incorrect	Troubleshooting, “ECM Software - Install”
637–11 Engine Timing Sensor : Other Failure Mode	Troubleshooting, “Speed/Timing - Test”
639–9 J1939 Network #1 : Abnormal Update Rate	Troubleshooting, “CAN Data Link - Test”
639–14 J1939 Network #1 : Special Instruction	Troubleshooting, “Data Link Configuration Status - Test”
651–2 Engine Injector Cylinder #01 : Erratic, Intermittent, or Incorrect	Troubleshooting, “Injector Data Incorrect - Test”

(continued)

(Table 5, contd)

651–5 Engine Injector Cylinder #01 : Current Below Normal	Troubleshooting, “Injector Solenoid - Test”
651–6 Engine Injector Cylinder #01 : Current Above Normal	Troubleshooting, “Injector Solenoid - Test”
652–2 Engine Injector Cylinder #02 : Erratic, Intermittent, or Incorrect	Troubleshooting, “Injector Data Incorrect - Test”
652–5 Engine Injector Cylinder #02 : Current Below Normal	Troubleshooting, “Injector Solenoid - Test”
652–6 Engine Injector Cylinder #02 : Current Above Normal	Troubleshooting, “Injector Solenoid - Test”
653–2 Engine Injector Cylinder #03 : Erratic, Intermittent, or Incorrect	Troubleshooting, “Injector Data Incorrect - Test”
653–5 Engine Injector Cylinder #03 : Current Below Normal	Troubleshooting, “Injector Solenoid - Test”
653–6 Engine Injector Cylinder #03 : Current Above Normal	Troubleshooting, “Injector Solenoid - Test”
654–2 Engine Injector Cylinder #04 : Erratic, Intermittent, or Incorrect	Troubleshooting, “Injector Data Incorrect - Test”
654–5 Engine Injector Cylinder #04 : Voltage Above Normal	Troubleshooting, “Injector Solenoid - Test”
654–6 Engine Injector Cylinder #04 : Voltage Below Normal	Troubleshooting, “Injector Solenoid - Test”
676–5 Engine Glow Plug Relay : Current Below Normal	Troubleshooting, “Glow Plug Starting Aid - Test”
676–6 Engine Glow Plug Relay : Current Above Normal	Troubleshooting, “Glow Plug Starting Aid - Test”
677–5 Engine Starter Motor Relay : Current Above Normal	Troubleshooting, “Relay - Test (Start Relay)”
677–6 Engine Starter Motor Relay : Current Below Normal	Troubleshooting, “Relay - Test (Start Relay)”
723–8 Engine Speed Sensor #2 : Abnormal Frequency, Pulse Width, or Period	Troubleshooting, “Speed/Timing - Test”
1075–5 Engine Electric Lift Pump for Engine Fuel Supply : Current Below Normal	Troubleshooting, “Fuel Transfer Pump - Test”
1075–6 Engine Electric Lift Pump for Engine Fuel Supply : Current Above Normal	Troubleshooting, “Fuel Transfer Pump - Test”
1076–5 Engine Fuel Injection Pump Fuel Control Valve : Current Below Normal	Troubleshooting, “Fuel Control - Test”
1076–6 Engine Fuel Injection Pump Fuel Control Valve : Current Above Normal	Troubleshooting, “Fuel Control - Test”

(continued)

(Table 5, contd)

1231–9 J1939 Network #2 : Abnormal Update Rate	Troubleshooting, “CAN Data Link - Test”
1231–14 J1939 Network 2: Special Instruction	Troubleshooting, “Data Link Configuration Status - Test”
1387–0 Auxiliary Pressure #1 : High - most severe (3)	Troubleshooting depends on the function of the auxiliary pressure sensor which is defined by the OEM for the application.
1387–1 Auxiliary Pressure #1 : Low - most severe (3)	Troubleshooting depends on the function of the auxiliary pressure sensor which is defined by the OEM for the application.
1387–3 Auxiliary Pressure #1 : Voltage Above Normal	Troubleshooting, “Sensor Signal (Analog, Active) - Test”
1387–4 Auxiliary Pressure #1 : Voltage Below Normal	Troubleshooting, “Sensor Signal (Analog, Active) - Test”
1387–15 Auxiliary Pressure #1 : High - least severe (1)	Troubleshooting depends on the function of the auxiliary pressure sensor which is defined by the OEM for the application.
1387–16 Auxiliary Pressure #1 : High - moderate severity (2)	Troubleshooting depends on the function of the auxiliary pressure sensor which is defined by the OEM for the application.
1387–17 Auxiliary Pressure #1 : Low - least severe (1)	Troubleshooting depends on the function of the auxiliary pressure sensor which is defined by the OEM for the application.
1387–18 Auxiliary Pressure #1 : Low - moderate severity (2)	Troubleshooting depends on the function of the auxiliary pressure sensor which is defined by the OEM for the application.
2630–3 Engine Charge Air Cooler Outlet Temperature : Voltage Above Normal	Troubleshooting, “Sensor Signal (Analog, Passive) - Test”
2630–4 Engine Charge Air Cooler Outlet Temperature : Voltage Below Normal	Troubleshooting, “Sensor Signal (Analog, Passive) - Test”
2791–6 EGR Valve Control : Current Above Normal	Troubleshooting, “Motorized Valve - Test”
2791–7 EGR Valve Control : Not Responding Properly	Troubleshooting, “Motorized Valve - Test”
2882–2 Engine Alternate Select : Erratic, Intermittent, or Incorrect	Troubleshooting, “Mode Selection - Test”
2970–2 Accelerator Pedal #2 Low Idle Switch : Erratic, Intermittent, or Incorrect	Troubleshooting, “Idle Validation - Test”
3242–18 Aftertreatment #1 DPF Intake Temperature : Low - moderate severity (2)	Troubleshooting, “Diesel Particulate Filter Temperature Is Low”
3251–1 Aftertreatment #1 DPF Differential Pressure : Low - Most Severe (3)	Troubleshooting, “Diesel Particulate Filter Has Low Inlet Pressure”
3251–3 Aftertreatment #1 DPF Differential Pressure : Voltage Above Normal	Troubleshooting, “Sensor Signal (Analog, Active) - Test”
3251–4 Aftertreatment #1 DPF Differential Pressure : Voltage Below Normal	Troubleshooting, “Sensor Signal (Analog, Active) - Test”

(continued)

(Table 5, contd)

3251–13 Aftertreatment #1 DPF Differential Pressure : Out of Calibration	Troubleshooting, “Sensor Calibration Required - Test”
3251–16 Aftertreatment #1 DPF Differential Pressure : High - moderate severity (2)	Troubleshooting, “Diesel Particulate Filter Collects Excessive Soot”
3251–18 Aftertreatment #1 DPF Differential Pressure : Low - moderate severity (2)	Troubleshooting, “Diesel Particulate Filter Has Low Inlet Pressure”
3464–6 Engine Throttle Actuator 1 Control Command : Current Above Normal	Troubleshooting, “Motorized Valve - Test”
3464–7 Engine Throttle Actuator 1 Control Command : Not Responding Properly	Troubleshooting, “Motorized Valve - Test”
3509–3 Sensor Supply Voltage 1 : Voltage Above Normal	Troubleshooting, “Sensor Supply - Test”
3509–4 Sensor Supply Voltage 1 : Voltage Below Normal	Troubleshooting, “Sensor Supply - Test”
3510–3 Sensor Supply Voltage 2 : Voltage Above Normal	Troubleshooting, “Sensor Supply - Test”
3510–4 Sensor Supply Voltage 2 : Voltage Below Normal	Troubleshooting, “Sensor Supply - Test”
3563–3 Engine Intake Manifold #1 Absolute Pressure : Voltage Above Normal	Troubleshooting, “Sensor Signal (Analog, Active) - Test”
3563–4 Engine Intake Manifold #1 Absolute Pressure : Voltage Below Normal	Troubleshooting, “Sensor Signal (Analog, Active) - Test”
3563–13 Engine Intake Manifold #1 Absolute Pressure : Out of Calibration	Troubleshooting, “Sensor Calibration Required - Test”
3609–3 DPF #1 Intake Pressure : Voltage Above Normal	Troubleshooting, “Sensor Signal (Analog, Active) - Test”
3609–4 DPF #1 Intake Pressure : Voltage Below Normal	Troubleshooting, “Sensor Signal (Analog, Active) - Test”
3609–13 DPF #1 Intake Pressure : Out of Calibration	Troubleshooting, “Sensor Calibration Required - Test”
3719–0 DPF #1 Soot Loading Percent : High - most severe (3)	Troubleshooting, “Diesel Particulate Filter Collects Excessive Soot”
3714–31 DPF Active Regeneration Inhibited Due to Temporary System Lockout	Troubleshooting, “Diesel Particulate Filter Collects Excessive Soot”
3715–31 DPF Active Regeneration Inhibited Due to Permanent System Lockout	Troubleshooting, “Diesel Particulate Filter Collects Excessive Soot”
3719–0 DPF #1 Soot Loading Percent : High - most severe (3)	Troubleshooting, “Diesel Particulate Filter Collects Excessive Soot”

(continued)

(Table 5, contd)

3719–16 DPF #1 Soot Loading Percent : High - moderate severity (2)	Troubleshooting, “Diesel Particulate Filter Collects Excessive Soot”
4206–9 TSC1 Message Counter : Incorrect	The ECM has detected an incorrect counter value from the application over TSC1. The engine will be derated. Fully power-down the application. If the fault persists after the application has been restarted, contact the Dealer Solutions Network (DSN).
4207–9 TSC1 Message Checksum : Incorrect	The ECM has detected an incorrect checksum value from the application over TSC1 The engine will be derated. Fully power-down the application. If the fault persists after the application has been restarted, contact the Dealer Solutions Network (DSN).
4765–17 Aftertreatment #1 Diesel Oxidation Catalyst Intake Gas Temperature : Low - least severe (1)	Troubleshooting, “Diesel Oxidation Catalyst Has Incorrect Inlet Temperature”
5246–0 Aftertreatment SCR Operator Inducement Severity : High - most severe (3)	Troubleshooting, “SCR Warning System Problem”
5246–15 Aftertreatment SCR Operator Inducement Severity : High - least severe (1)	Troubleshooting, “SCR Warning System Problem”
5246–16 Aftertreatment SCR Operator Inducement Severity : High - moderate severity (2)	Troubleshooting, “SCR Warning System Problem”
5298–17 Aftertreatment 1 Diesel Oxidation Catalyst Conversion Efficiency : Low - least severe (1)	Troubleshooting, “Diesel Oxidation Catalyst Has Low Conversion Efficiency”
5571–0 High Pressure Common Rail Fuel Pressure Relief Valve : High - most severe (3)	Troubleshooting, “Fuel Rail Pressure Problem”
5742–12 Aftertreatment Diesel Particulate Filter Temperature Sensor Module : Failure	Troubleshooting, “Sensor (Data Link Type) - Test”
7032–31 Aftertreatment System Has Shutdown Engine	Troubleshooting, “Diesel Particulate Filter Collects Excessive Soot”

Symptom Troubleshooting

i07945631

Acceleration Is Poor or Throttle Response Is Poor

Check the electronic service tool for any associated codes that are listed in Table 6 . Troubleshoot any active codes before continuing with this procedure.

Table 6

Associated Diagnostic Trouble Codes
J1939 Code
107–15
107–16

Probable Causes

- Diagnostic codes
- Parameters in the Electronic Control Module (ECM)
- Oil pressure
- Throttle Signal
- Air Inlet and Exhaust System
- Intake Throttle Valve stuck in incorrect position
- Turbocharger
- Fuel System
- Engine Load
- Valve Lash
- Low compression (cylinder pressure)
- Electronic unit injectors
- Individual malfunctioning cylinder

Recommended Actions

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

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

Table 7

Troubleshooting Test Steps	Values	Results
1. Engine Derate or Active Codes **A.** Certain diagnostic codes and/or event codes may cause poor performance. Refer to the histogram information for engine derates in the electronic service tool. Check for the following histograms: **1.** High Exhaust Temperature Prevention Derate Time Histogram **2.** High Turbo Speed Prevention Derate Time Histogram **B.** If the histograms contain derates and no diagnostic codes are present, then the engine is operating normally. The following list contains conditions that can cause derates: **1.** Elevated altitude **2.** Elevated inlet air temperature **3.** Elevated ambient temperature	Engine Derate or Active Codes	**Result:** A diagnostic code is present. **Repair:** Troubleshoot the code and then reset the histogram. **Result:** A diagnostic code is not present. Proceed to Test Step 2.
2. Incorrect Parameters **A.** Use the electronic service tool to verify that the correct parameters are being used. Refer to Troubleshooting, “Configuration Parameters” for additional information.	Parameters	**Result:** The parameters are correct. Proceed to Test Step 3. **Result:** The parameters are not correct. **Repair:** Input the correct parameters. Refer to Troubleshooting, “Configuration Parameters” for additional information.
3. Oil Pressure **Note:** When the engine is started, the turbocharger protection strategy will lock the engine speed at low idle until the oil pressure builds or the engine has been running for 60 seconds. **A.** Ensure that the engine oil pressure is sufficient. Refer to Troubleshooting, Oil Pressure Is Low.	Oil pressure	**Result:** The oil pressure is not OK. **Repair:** Make any necessary repairs. Refer to Troubleshooting, Oil Pressure Is Low. **Result:** The oil pressure is OK. Proceed to Test Step 4.
4. Throttle Signal **A.** Monitor the status for “Throttle Position” on the electronic service tool. Verify that the status for “Throttle Position” is stable and that the engine is able to reach high idle speed.	Throttle Signal	**Result:** The throttle signal is stable. Proceed to Test Step 5. **Result:** The throttle signal is not stable. **Repair:** Make the necessary repairs, Refer to the appropriate circuit test.

(continued)

(Table 7, contd)

5. Restriction in the Air Inlet and Exhaust System **A.** Observe the check engine lamp. **B.** Check for an air filter restriction indicator, if equipped. **C.** Check for ECM codes for inlet air restriction: 107-15: Engine Air Filter 1 Differential Pressure high - least severe (1) 107-16: Engine Air Filter 1 Differential Pressure high - moderate severity (2) **D.** Replace any plugged air filters. Refer to the Operation and Maintenance Manual. **E.** Check the air inlet and exhaust system for restrictions and/or leaks.	Restrictions	**Result:** There are no restrictions in the air inlet or exhaust system. Proceed to Test Step 6. **Result:** There are restrictions in the air inlet or exhaust system. **Repair:** Make the necessary repairs, Refer to Systems Operation, Testing and Adjusting, “Air Inlet and Exhaust System - Inspect” for additional information. **Result:** A 107-15 or 107-16 code is active **Repair:** Refer to Troubleshooting, Inlet Air is Restricted.
6. Check the Intake Throttle Valve **A.** Use the electronic service tool to perform the “Air System Motor Valve Verification Test” .	Intake Throttle Valve	**Result:** The “Air System Motor Valve Verification Test” failed. **Repair:** Troubleshoot any diagnostic codes that were generated. Refer to Troubleshooting, Diagnostic Trouble Codes. **Result:** The turbocharger is OK. The “Air System Motor Valve Verification Test” passed. Proceed to Test Step 7.
7. Turbocharger **Note:** The turbocharger that is installed on the engine is a non-serviceable item. If any mechanical fault exists, then the faulty turbocharger must be replaced. **A.** Ensure that the mounting bolts for the turbocharger are tight. **B.** Check that the compressor blades rotate freely in the turbocharger. **C.** Check that the oil drain for the turbocharger is not blocked or restricted. **D.** Check that the compressor housing for the turbocharger is free of dirt and debris. Make sure that the housing is not damaged. **E.** Check that the turbine housing for the turbocharger is free of dirt and debris. Make sure that the housing is not damaged. **F.** Inspect the wastegate for damage and ensure that it is operating correctly. Refer to Systems Operation Testing and Adjusting, Turbocharger - Inspect.	Turbocharger	**Note:** Some oil residue/pooling may be seen, but this is not an indication that the turbo has failed. If the compressor and turbine blades are undamaged and rotate freely, it is likely the turbocharger is fault free. **Result:** There is a fault on the turbocharger. **Repair:** Replace the turbocharger. Refer to Disassembly and Assembly, “Turbocharger - Remove” and Disassembly and Assembly, “Turbocharger - Install”. **Result:** There are no faults on the turbocharger. Proceed to Test Step 8.

(continued)

(Table 7, contd)

8. Check the Fuel System Refer to Systems Operation, Testing and Adjusting, "Fuel System" for additional information. **A.** Visually check the fuel level in the fuel tank. Do not rely on the fuel gauge only. **B.** Ensure that the vent in the fuel cap is not filled with debris. **C.** Ensure that the fuel supply valve (if equipped) is in the full OPEN position. **D.** Inspect the fuel system. Refer to Systems Operation, Testing and Adjusting, "Fuel System - Inspect" for additional information. **E.** Cold weather adversely affects the characteristics of the fuel. Refer to the engines Operation and Maintenance Manual for information on improving the characteristics of the fuel during cold-weather operation. Cold mode (if applicable) is activated whenever the engine coolant temperature falls below a predetermined value. Monitor the status screen on the electronic service tool to verify that the engine has exited cold mode. Observe the reading for coolant temperature on the electronic service tool. Refer to **"Cold Mode Operation"** within Systems Operation, Testing and Adjusting, "General Information". **F.** Check the fuel quality. Refer to Systems Operation, Testing and Adjusting, "Fuel Quality - Test" for the proper procedure. Check the fuel tank for debris or foreign objects which may block the fuel supply. **G.** Check for the proper operation of the fuel transfer pump. Refer to Systems Operation/Testing and Adjusting, "Fuel System" for test information.	Fuel system	**Result:** The fuel pressure is OK. Proceed to Test Step 9. **Result:** The fuel pressure is not OK. **Repair:** Replace the fuel filters. Clean the primary filter/water separator of debris. Refer to the Operation and Maintenance Manual for details.
9. Clean the Fuel System **A.** Following the instructions on the bottle, add Perkins Fuel System Cleaner T400012 to the fuel tank.	Electronic Unit Injectors	**Result:** Performance should be restored within 2-3 hours. Return the unit to service, the fuel system will be cleaned during operation. **Result:** Performance is not restored within 2-3 hours. Proceed to Test Step 10.
10. Engine Load **A.** Check accessories and parasitic loads on the engine.	Engine loads	**Result:** There is not a parasitic load. Proceed to Test Step 11. **Result:** There is a parasitic load. **Repair:** Remove the parasitic load.

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(Table 7, contd)

11. Valve Lash **Note:** The valve lash can affect the performance of the engine. **A.** Check the valve lash.	Valve lash	**Result:** The valve lash is not correct. **Repair:** Check the valve lash. Refer to Systems Operation, Testing, and Adjusting, “Engine Valve Lash - Inspect” for the correct procedure. **Result:** The valve lash is correct. Proceed to Test Step 12.
12. Low Compression (Cylinder Pressure) **A.** Perform a compression test. Refer to Systems Operation, Testing, and Adjusting, “Compression - Test”.	Cylinder compression	**Result:** The results of the compression test are outside the specifications. **Repair:** Investigate the cause and rectify any faults. **Note:** Possible causes of low compression are shown in the following list: · Loose glow plugs · Faulty piston · Faulty piston rings · Worn cylinder bores · Worn valves · Faulty cylinder head gasket · Damaged cylinder head **Result:** The results of the compression test are OK. Proceed to Test Step 13.

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(Table 7, contd)

13. Electronic Unit Injectors **A.** Use the electronic service tool to perform the automatic “Cylinder Cutout Test” . Refer to Troubleshooting, Service Tool Features for more information on understanding the results of the “Cylinder Cutout Test” . **Note:** If the compression test that was performed in Test Step 9 was satisfactory, the “Cylinder Cutout Test” will identify any faulty injectors.	Electronic Unit Injectors	**Result:** A faulty injector is indicated. **Repair:** Remove any faulty electronic unit injectors. Refer to Disassembly and Assembly, “Electronic Unit Injector - Remove”. Install new electronic unit injectors. Refer to Disassembly and Assembly, “Electronic Unit Injector - Install”. Repeat the automatic “Cylinder Cutout Test” . If the fault is still apparent, remove the replacement electronic unit injector and install the original electronic unit injector. Refer to Disassembly and Assembly, “Electronic Unit Injector - Remove” and Disassembly and Assembly, “Electronic Unit Injector - Install”. **Result:** All injectors are OK. Proceed to Test Step 14.
14. Individual Malfunctioning Cylinders **A.** With the engine speed at a fast idle, use the electronic service tool to perform the manual “Cylinder Cutout Test” . As each cylinder is cut out, listen for a change in the sound from the engine. When a cylinder is cut out, there should be a noticeable change in the sound of the engine. If a change in the sound of the engine is not noted, the isolated cylinder is not operating under normal conditions. If the isolation of a cylinder results in a change in the sound that is less noticeable, the cylinder may be operating below normal performance.	Cylinders	**Result:** The test indicates a faulty cylinder. **Repair:** Investigate the cause of the fault on any cylinder that is not operating. Investigate the cause of the fault on any cylinder that is operating below normal performance. **Result:** The test indicates that all cylinders are OK. Contact the Dealer Solutions Network (DSN).

i07839212

Alternator Problem
(Charging Problem and/or Noisy Operation)

Probable Causes

- Alternator drive belt and tensioner
- Alternator mounting bracket
- Alternator drive pulley
- Alternator bearings
- Alternator
- Charging circuit

Recommended Actions

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

Note: If the engine is left at low idle for long periods of time, ensure that the operator is following the correct starting procedure. Refer to Operation and Maintenance Manual, Starting the Engine.

Table 8

Troubleshooting Test Steps	Values	Results
1. Condition of the Alternator Drive Belts **A.** Inspect the condition of the alternator drive belts. **B.** Check the belt tension. If the engine is equipped with an automatic belt tensioner, check the automatic belt tensioner. Excessive belt tension can result in damage to the alternator.	Drive Belt	**Result:** The alternator drive belts are in good condition and the belt tension is correct. Proceed to Test Step 2. **Result:** The alternator drive belts are not in good condition or the belt tension is incorrect. **Repair:** If the alternator drive belts are worn or damaged, replace the belts. Refer to Disassembly and Assembly for the correct procedure. If necessary, replace the automatic belt tensioner. Refer to Disassembly and Assembly for the correct procedure.
2. Alternator Mounting Bracket **A.** Inspect the alternator mounting bracket for cracks and distortion.	Alternator Mounting Bracket	**Result:** The alternator mounting bracket is cracked and distorted. Repair the mounting bracket or replace the mounting bracket. **Note:** The repair/replacement will ensure that the alternator drive belt and the alternator drive pulley are in alignment. **Result:** The alternator mounting bracket is OK. Proceed to Test Step 3.
3. Condition of the Alternator Drive Pulley **A.** Check the condition of the alternator drive pulley. Look for deep grooves that have been worn into the pulley by the belt. Check that the nut for the pulley has not become loose.	Alternator Drive Pulley	**Result:** There is excessive wear on the alternator drive pulley. **Repair:** Replace the pulley. **Result:** The alternator drive pulley nut was loose. **Repair:** Tighten the nut. **Result:** There is not excessive wear on the alternator drive pulley. Proceed to Test Step 4.
4. Wear of the Alternator Bearings **A.** Check the alternator bearings for signs of wear.	Alternator Bearings	**Result:** The alternator bearings are OK. Proceed to Test Step 5. **Result:** The alternator bearings are not OK. **Repair:** Repair the alternator or replace the alternator, as needed. Refer to Disassembly and Assembly for the correct procedure.

(continued)

(Table 8, contd)

Troubleshooting Test Steps	Values	Results
5. Operation of the Alternator or Regulator **A.** Verify that the alternator or the regulator is operating correctly. Refer to Systems Operation, Testing and Adjusting, "Charging System - Test" for the proper testing procedures.	Regulator and Alternator	**Result:** The regulator and alternator are operating correctly. Proceed to Test Step 6. **Result:** The regulator and alternator are not operating correctly. **Repair:** Repair the alternator and regulator or replace the alternator and regulator, as needed. Refer to Disassembly and Assembly for the correct procedure.
6. Inspection of the Charging Circuit **A.** Inspect the battery cables, wiring, and connections in the charging circuit.	Charging Circuit	**Result:** The charging circuit is not working correctly. **Repair:** Clean all connections and tighten all connections. Replace any faulty parts. **Result:** The charging circuit is working correctly. Contact the Dealer Solutions Network (DSN).

i07708815

Battery Problem

This procedure covers the following diagnostic code:

Table 9

Diagnostic Trouble Code for Battery Problem		
J1939 Code	**Description**	**Notes**
168-31	Battery Potential / Power Input #1	The engine idle has been elevated to increase battery voltage. This diagnostic code does not necessarily indicate a fault. This feature is used to increase an excessively low battery voltage while the engine is at idle.

Probable Causes

- Charging circuit
- Batteries
- Auxiliary device

Recommended Actions

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

Table 10

Troubleshooting Test Steps	Values	Results
1. Charging Circuit **A.** Check that the battery charging circuit is operating correctly. Refer to Troubleshooting, “Alternator Problem”.	Charging circuit	**Result:** The charging circuit is not OK. **Repair:** Repair the charging circuit, as necessary. **Result:** The charging circuit is OK. Proceed to Test Step 2.
2. Batteries **A.** Verify that the battery or batteries are no longer able to hold a charge. Refer to Systems Operation/Testing and Adjusting, “Battery - Test”.	Battery	**Result:** One of the batteries is not OK. **Repair:** Replace the faulty battery. Refer to the Operation and Maintenance Manual. **Result:** The battery or batteries are OK. Proceed to Test Step 3.
3. Auxiliary Device **A.** Check if an auxiliary device has drained the battery or batteries by being left in the ON position.	Auxiliary Device	**Result:** The battery or batteries have been drained by an auxiliary device being left in the ON position. **Repair:** Charge the battery or batteries. Verify that the battery or batteries are able to maintain a charge. Refer to Systems Operation/Testing and Adjusting for the correct procedure. **Result:** The battery or batteries have not been drained by an auxiliary device being left in the ON position. Contact the Dealer Solutions Network (DSN).

i08473211

Belt Tensioner Noise

Probable Causes

- Belt condition and assembly alignment
- Belt tensioner

Recommended Actions

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

Table 11

Troubleshooting Test Steps	Values	Results
1. Check the Condition of the Belt and the Assembly Alignment **A.** Check for debris or rust in all pulleys and grooves. **B.** Check the belt for worn patches, contamination, paint, or debris. **C.** Visibly check the alignment between the following components: • Refrigerant Compressor • Belt Tensioner • Alternator • Idler Pulley • Crank Pulley	Auxiliary assembly	**Result:** There is rust or debris present. **Repair:** Remove the rust or debris from the pulley grooves. **Result:** The alternator drive belts are worn, damaged, or contaminated. **Repair:** Replace the belts. Refer to Disassembly and Assembly, Alternator Belt - Remove and Install. **Result:** There is visible misalignment between the components **Repair:** Remove the belt. Refer to Disassembly and Assembly, Alternator Belt - Remove and Install. Loosen the fixtures for the driven components and adjust the position as required. Tighten the fixtures. Refer to Disassembly and Assembly for the correct procedure. Reinstall the belt. Refer to Disassembly and Assembly for the correct procedure. Run the engine to test the system. **Result:** The alignment is visibly correct. Proceed to Test Step 2.

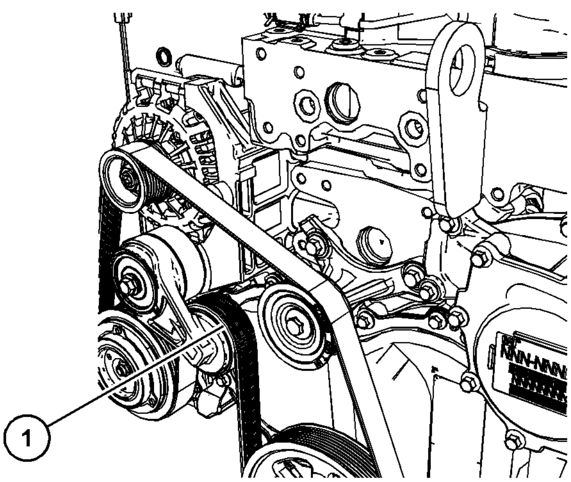


Illustration 9 g06276401

(1) Belt tensioner wheel (typical example)

Table 12

Troubleshooting Test Steps	Values	Results
2. Spray Water on the Belt **Note:** Best results are achieved when the engine is running. Only perform this step with the engine running if the conditions are safe. If necessary, stop the engine. **A.** Spray water on the belt in the area around the tensioner. This will reduce the friction between the pulleys and the belt. **B.** Run the engine and check for noise.	Noise	**Result:** The noise is reduced or eliminated and returns when the belt dries. There may be an issue with the alignment of the system. Proceed to Test Step 3. **Result:** The noise is worse or louder. The belt may be slipping. There maybe an issue with the tension of the system. Proceed to Test Step 4.

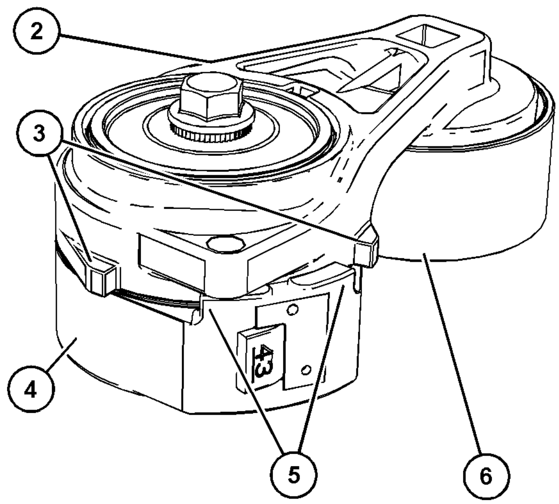


Illustration 10 g06276469

Typical view of the tensioner

(2) Arm
(3) Arm case stops
(4) Spring case
(5) Spring case stops
(6) Pulley

Table 13

Troubleshooting Test Steps	Values	Results
3. On-Engine Inspection of the Belt Tensioner **A.** Determine if the belt is tracking toward either side of pulley (6). **B.** Check the alignment between the following components: • Refrigerant Compressor • Belt Tensioner • Alternator • Idler Pulley • Crank Pulley	Inspection	**Result:** The witness mark created by the belt on the pulley is considerably wider than the belt or the belt is tracking away from the pulley center. **Repair:** Remove and reinstall the components. Refer to Disassembly and Assembly for the correct procedure. **Result:** There is visible misalignment between the components. **Repair:** Remove the belt. Refer to Disassembly and Assembly, Alternator Belt - Remove and Install. Loosen the fixtures for the driven components and adjust the position as required. Tighten the fixtures. Refer to Disassembly and Assembly for the correct procedure. Reinstall the belt. Refer to Disassembly and Assembly for the correct procedure. Run the engine to test the system.
4. On-Engine Inspection of the Belt Tensioner **A.** Leave the belt and tensioner installed. Determine if arm case stops (3) are contacting or very close to spring case stops (5).	Inspection	**Result:** The arm case stops (3) are contacting or very close to spring case stops (5). **Repair:** Check that the correct belt is installed. If necessary, replace the belt. Refer to Disassembly and Assembly, Alternator Belt - Remove and Install. The arm case stops (3) are not contacting or very close to spring case stops (5). Proceed to Test Step 5.

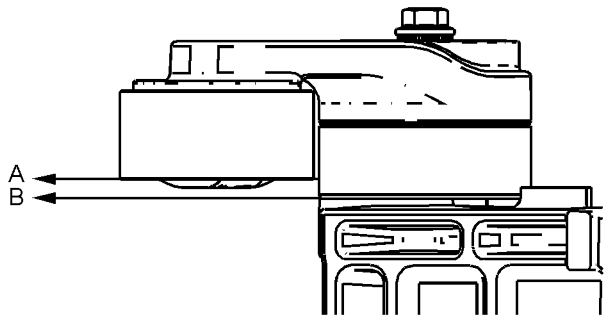


Illustration 11 g06276750

Table 14

Troubleshooting Test Steps	Values	Results
5. Remove the Belt and Tensioner for Inspection **A.** Remove the belt. Refer to Disassembly and Assembly, Alternator Belt - Remove and Install . **B.** Use a suitable tool to move the tensioner arm over the full range of movement between stops (3) and (5). **C.** Turn pulley (6). Check that the pulley turns smoothly and quietly. **Note:** New bearings may not turn as freely as used bearings. **D.** Ensure that the pulley surface (A) is parallel to the tensioner mounting surface (B). Refer to Illustration 11 (typical example). **E.** Remove the belt tensioner. Refer to Disassembly and Assembly, Belt Tensioner - Remove and Install. **F.** Check for evidence of metal-to-metal contact between arm (2) and spring case (4). **G.** Inspect arm (2) and spring case (4) for cracks and damage. **H.** Inspect arm case stops (3), spring case stops (5), and locator pin (7) for damage. **I.** Inspect the tensioner for excessive bearing wear.		**Result:** The tensioner does not move smoothly over the full range. **Repair:** Replace the belt tensioner. Refer to Disassembly and Assembly, Belt Tensioner - Remove and Install. **Result:** Pulley (6) does not spin smoothly or the pulley makes a noise when spinning. **Repair:** Replace the belt tensioner. Refer to Disassembly and Assembly, Belt Tensioner - Remove and Install. **Result:** The pulley surface is not parallel to the mounting surface. **Repair:** Replace the belt tensioner. Refer to Disassembly and Assembly, Belt Tensioner - Remove and Install. **Result:** There is evidence of metal-to-metal contact between (2) and spring case (4). **Repair:** Replace the belt tensioner. Refer to Disassembly and Assembly, Belt Tensioner - Remove and Install. **Result:** There is evidence of damage to any part of the belt tensioner. **Repair:** Replace the belt tensioner. Refer to Disassembly and Assembly, Belt Tensioner - Remove and Install.

i07704970

Coolant Contains Oil

Probable Causes

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

Recommended Actions

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

Table 15

Troubleshooting Test Steps	Values	Results
1. Engine Oil Cooler **A.** Drain the coolant from the cooling system. Drain the lubricating oil from the engine. Refer to the Operation and Maintenance Manual for more information. **B.** Check for leaks in the engine oil cooler. Refer to Systems Operation, Testing, and Adjusting, “Cooling System” for the correct procedure.	Oil Cooler	**Result:** A leak is found in the engine oil cooler. **Repair:** Install a new oil cooler. Refer to Disassembly and Assembly, “Engine Oil Cooler - Remove” and Disassembly and Assembly, “Engine Oil Cooler - Install” for the correct procedure. Flush the cooling system. Refer to the Operation and Maintenance Manual for the correct procedure. Refill the cooling system with the correct coolant. Refer to the Operation and Maintenance Manual for the recommended coolant and capacities. After the leak has been repaired, refill the engine with oil of the correct specification . Refer to the Operation and Maintenance Manual for the correct oil capacity and viscosity. **Result:** A leak was not found in the engine oil cooler. Proceed to Test Step 2.
2. Cylinder Head Gasket **A.** Remove the cylinder head. Refer to Disassembly and Assembly, “Cylinder Head - Remove”. **B.** Inspect the cylinder head gasket for faults and any signs of leakage.	Cylinder head gasket	**Result:** The cylinder head gasket shows signs of damage or leakage. **Repair:** Install a new cylinder head gasket and install the cylinder head. Refer to Disassembly and Assembly, “Cylinder Head - Install” . **Result:** The cylinder head gasket does not show signs of damage or leakage. Proceed to Test Step 3.

(continued)

(Table 15, contd)

Troubleshooting Test Steps	Values	Results
3. Cylinder Head **A.** Check for cracks in the cylinder head. Perform a leak test on the cylinder head. Refer to System Operation, Testing and Adjusting, “Cylinder Head - Inspect” for the correct procedure.	Cylinder head	**Result:** A fault was found in the cylinder head. **Repair:** Repair the cylinder head or replace the cylinder head. Install the cylinder head. Refer to Disassembly and Assembly, “Cylinder Head - Install”. Refill the engine with oil of the correct specification . Refer to the Operation and Maintenance Manual for the correct oil capacity and viscosity. **Result:** A fault was not found in the cylinder head. Proceed to Test Step 4.
4. Cylinder Block **A.** Inspect the top face of the cylinder block for faults and signs of leakage. Refer to Systems Operation, Testing, and Adjusting, “Cylinder Block - Inspect” for the correct procedure.	Cylinder block	**Result:** A fault was found in the cylinder block. **Repair:** Repair the cylinder block or replace the cylinder block. Inspect the top deck. Refer to the Reuse and Salvage Guidelines for the proper inspection procedure. Refill the engine with oil of the correct specification . Refer to the Operation and Maintenance Manual for the correct oil capacity and viscosity. **Result:** No fault was found in the cylinder block. Install the cylinder head. Refer to Disassembly and Assembly, “Cylinder Head - Install”. Contact the Dealer Solutions Network (DSN).

i07708862

Coolant Level Is Low

This procedure is only applicable to engines that have a coolant level sensor.

This procedure covers the following diagnostic code:

Table 16

Diagnostic Trouble Codes for Low Coolant Level		
J1939 Code	**Code Description**	**Comments**
111-1	Engine Coolant Level : Low - most severe (3)	The engine has been running for 60 seconds. The engine coolant level has fallen below the coolant level sensor for the specified delay time. Engine power is derated. The code is logged.
111–17	Engine Coolant Level : Low - least severe (1)	The engine has been running for 60 seconds. The engine coolant level has fallen below the coolant level sensor for the specified delay time. Engine power is derated. The code is logged.
111-18	Engine Coolant Level : Low - moderate severity (2)	The engine has been running for 60 seconds. The engine coolant level has fallen below the coolant level sensor for the specified delay time. Engine power is derated. The code is logged.

Probable Causes

- Low Coolant Level and/or Coolant Leakage
- Coolant level sensor

Recommended Actions

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

Table 17

Troubleshooting Test Steps	Values	Results
1. Low Coolant Level and/or Coolant Leakage **A.** Inspect the coolant level.	Coolant level	**Result:** The engine coolant level is OK. Proceed to Test Step 2. **Result:** The engine coolant level is not OK. **Repair:** Troubleshoot the cause of the incorrect coolant level. Check for the correct mixture of antifreeze and water. Refer to Operation and Maintenance Manual. Check the cooling system for leaks. Refer to Systems Operation, Testing and Adjusting, “Cooling System - Test” for the correct procedure. Repair any leaks immediately. Check the NRS cooler for leaks. Refer to Systems Operation, Testing and Adjusting, “Exhaust Cooler (NRS) - Test”. Check for air in the cooling system. Refer to Systems Operation, Testing and Adjusting, “Testing the Cooling System” for the correct procedure.
2. Faulty Sensor **A.** If an electrical fault with the coolant level sensor is suspected, refer to Troubleshooting, “Coolant Level - Test” for information on troubleshooting the coolant level sensor.	Coolant level sensor	**Result:** The coolant level sensor is not operating correctly. **Repair:** Replace the coolant level sensor. **Result:** The coolant level sensor is operating correctly. Contact the Dealer Solutions Network (DSN).

i07482968

Coolant Temperature Is High

Use this procedure to troubleshoot high coolant temperature or use this procedure if one of the following event codes is active. Refer to Troubleshooting, “Event Codes” for information about event codes. Use the electronic service tool to view the current trip points for these codes.

Table 18

Diagnostic Trouble Codes for High Coolant Temperature		
J1939 Code	**Code Description**	**Comments**
110-15	Engine Coolant Temperature : High - least severe (1)	The engine coolant temperature has exceeded the trip point and the delay time has expired. The code is logged.
110-16	Engine Coolant Temperature : High - moderate severity (2)	The engine coolant temperature has exceeded the trip point and the delay time has expired. The code is logged.
110-0	Engine Coolant Temperature : High - most severe (3)	The engine coolant temperature has exceeded the trip point and the delay time has expired. The code is logged.

Probable Causes

- Diagnostic codes
- Coolant level
- Belt and belt tensioner
- Coolant temperature sensor
- Radiator and hoses
- Radiator cap and pressure relief valve
- Water temperature regulator
- Engine cooling fan
- Quality of coolant
- Coolant pump
- NRS cooler
- Cylinder head gasket

Recommended Actions

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

Table 19

Troubleshooting Test Steps	Values	Results
1. Diagnostic Codes **A.** Use the electronic service tool to check for diagnostic codes that relate to the temperature in the cooling system.	Diagnostic Codes	**Result:** Diagnostic codes are not present. Return the unit to service. **Result:** Diagnostic codes are present. Proceed to Test Step 2.
2. Coolant Level **A.** Check the coolant level.	Engine coolant level	**Result:** The engine coolant level is low. **Repair:** Check the cooling system for leaks. Refer to Systems Operation, Testing and Adjusting, "Cooling System" for additional information. Repair any leaks immediately. **Result:** The engine coolant level is OK. Proceed to Test Step 3.
3. Condition of the Alternator Drive Belts **A.** Inspect the condition of the belts. **B.** Check the belt tension. If the engine is equipped with an automatic belt tensioner, check the automatic belt tensioner.	Drive Belt	**Result:** The belts are in good condition and the belt tension is correct. Proceed to Test Step 4. **Result:** The belts are not in good condition or the belt tension is incorrect. **Repair:** If the belts are worn or damaged, replace the belts. Refer to Disassembly and Assembly for the correct procedure. If necessary, replace the automatic belt tensioner. Refer to Disassembly and Assembly for the correct procedure.
4. Coolant Temperature Sensor **A.** Compare the reading for the coolant temperature on the electronic service tool to the reading for the coolant temperature on a calibrated test gauge.	Coolant temperature sensor	**Result:** The temperature sensor is not accurate. **Repair:** Troubleshoot the circuit and the coolant temperature sensor. Refer to Troubleshooting, "Sensor Signal (Analog, Passive) - Test". **Result:** The temperature sensor is reading accurately. Proceed to Test Step 5.

(continued)

(Table 19, contd)

Troubleshooting Test Steps	Values	Results
5. Radiator and Hoses **A.** Check the radiator fins for dirt, debris, and/or damage. **B.** Check for collapsed hoses and/or other restrictions. **C.** Check the radiator for internal blockage. Ensure that the radiator size is sufficient. An undersized radiator does not have enough area for the effective release of heat. An undersized radiator may cause the engine to run at a temperature that is higher than normal. The normal temperature depends on the ambient temperature.	Radiator and hoses	**Result:** The radiator fins are blocked or damaged. **Repair:** Remove any dirt and/or debris and straighten any bent fins. **Result:** The radiator has internal blockage. **Repair:** Remove the blockage. **Result:** The radiator fins are not damaged and the radiator does not have an internal blockage. Proceed to Test Step 6.
6. Radiator Cap and Pressure Relief Valve **A.** Pressure-test the cooling system. Refer to Systems Operation, Testing, and Adjusting, “Cooling System” for the correct procedure. **B.** Check that the seating surfaces of the pressure relief valve and the radiator cap are clean and undamaged. **C.** Check operation of the pressure relief valve and/or the water temperature regulator.	Radiator cap	**Result:** The pressure relief valve and/or the water temperature regulator are not operating correctly. **Repair:** Clean the components or replace the components. **Result:** The pressure relief valve and/or the water temperature regulator are operating correctly. Proceed to Test Step 7.
7. Water Temperature Regulator **A.** Check the water temperature regulator for correct operation. Refer to Systems Operation, Testing, and Adjusting, “Cooling System” for the proper procedure.	Water Temperature Regulator	**Result:** The water temperature regulator is not operating correctly. **Repair:** Replace the water temperature regulator. Refer to Disassembly and Assembly, “Water Temperature Regulator - Remove and Install”. **Result:** The water temperature regulator is operating correctly. Proceed to Test Step 8.
8. Engine Cooling Fan **A.** Check that the cooling fan is operating correctly. **B.** Check the engine cooling fan for damage.	Fan	**Result:** The cooling fan is not operating correctly. **Repair:** Make sure that the cooling fan is being driven correctly. Make sure that the belt tensioner is operating correctly **Result:** The fan is damaged. **Repair:** Repair the fan or replace the fan, as necessary. Refer to Disassembly and Assembly, “Fan - Remove and Install”. **Result:** The fan is OK. Proceed to Test Step 9.

(continued)

(Table 19, contd)

Troubleshooting Test Steps	Values	Results
9. Quality of Coolant **A.** Check the quality of the coolant. Refer to the Operation and Maintenance Manual, “Refill Capacities and Recommendations - Coolant”.	Coolant	**Result:** The coolant is not of an acceptable quality. **Repair:** Drain and refill the coolant system with coolant of the correct quality. Refer to the Operation and Maintenance Manual, “Refill Capacities and Recommendations - Coolant”. **Result:** The coolant is of an acceptable quality. Proceed to Test Step 10.
10. Inspection of the Coolant Pump **A.** Inspect the impeller of the coolant pump for damage and/or erosion. **B.** Make sure that the fan belt is not loose on the drive pulley of the coolant pump.	Coolant pump	**Result** The coolant pump is damaged or not operating correctly. **Repair:** If necessary, replace the coolant pump. Refer to Disassembly and Assembly, “Water Pump - Remove” and Disassembly and Assembly, “Water Pump - Install”. **Result** The coolant pump is not damaged and the pump is operating correctly. Proceed to Test Step 11.
11. NRS Cooler **A.** Switch off the engine and allow the engine to cool to below normal working temperature. Remove the pressure cap for the coolant system. Perform a leak test on the cooling system and the NRS cooler. Refer to Systems Operation, Testing, and Adjusting, “Cooling System - Test”. Refer to the subsection “Testing The Radiator And Cooling System For Leaks” .	NRS cooler	**Result:** The leak test fails. **Repair:** Check the NRS cooler. Perform a leak test on the NRS cooler. Refer to Systems Operation, Testing, and Adjusting, “Exhaust Cooler (NRS) - Test”. If necessary, install a replacement NRS cooler. Confirm that the fault has been eliminated. **Result:** The leak test is passed. Proceed to Test Step 12.
12. Cylinder Head Gasket **A.** Switch off the engine and allow the engine to cool to below normal working temperature. Remove the pressure cap for the coolant system. Perform a leak test on the cooling system and the NRS cooler. Refer to Systems Operation, Testing, and Adjusting, “Cooling System - Test”. Refer to the subsection “Testing The Radiator And Cooling System For Leaks” .	Cylinder Head gasket	**Result:** The leak test fails. **Repair:** Check the cylinder head gasket. Refer to the recommended action for the cylinder head gasket within Troubleshooting, “Oil Contains Coolant”. Check the cylinder head for flatness. Refer to the recommended action for checking flatness of the cylinder head within Systems Operation, Testing, and Adjusting, “Cylinder Head - Inspect”. **Result:** The leak test is passed. Contact the Dealer Solutions Network (DSN).

i07486429

Coolant Temperature Is Low

Use this procedure to troubleshoot a low coolant temperature.

Probable Causes

- Extreme ambient temperatures
- Cooling system fault
- Coolant temperature sensor
- Water temperature regulator

Recommended Actions

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

WARNING

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

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

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

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

Table 20

Troubleshooting Test Steps	Values	Results
1. Make Sure the Engine is Correctly Equipped for Ambient Conditions **A.** Ensure that the engine is correctly equipped for the ambient conditions.	Engine operation	**Result:** The engine is equipped for the ambient conditions. Proceed to Test Step 2. **Result:** The engine is not equipped for ambient conditions. **Repair:** Refer to the Operation and Maintenance Manual for more information regarding equipment required for cold-weather operation.

(continued)

(Table 20, contd)

2. Inspect the Cooling System **A.** Check the coolant level. **B.** Check for signs of a coolant leak. **Note:** If the coolant temperature sensor is not immersed in coolant, a false reading can occur.	Engine coolant level	**Result:** The engine coolant level is OK. Proceed to Test Step 3. **Result:** The engine coolant level is not OK. **Repair:** Check the cooling system for leaks. Refer to Troubleshooting, “Coolant Level is Low” for additional information. Repair any leaks.
3. Faulty Coolant Temperature Sensor **A.** Check the reading of the coolant temperature on the electronic service tool. The temperature should rise steadily as the engine is warmed. Ensure that the temperature is as expected.	Faulty coolant temperature sensor	**Result** The coolant temperature is as expected. **Repair:** A failed coolant temperature sensor has been detected. Replace the temperature sensor. **Result** The coolant temperature is as expected. Proceed to Test Step 4.
4. Check the Engine Coolant System **A.** Turn the keyswitch to the OFF position. **B.** Connect to the electronic service tool. **C.** Start the engine. **D.** Monitor the “Engine Coolant Temperature” in the status screen	Coolant temperature	**Result:** The coolant temperature comes up to operational temperature. Return the unit to service. **Result** The coolant temperature does not come up to operational levels. **Repair:** Test the water temperature regulator. Refer to Systems Operation, Testing, and Adjusting, “Water Temperature Regulator - Test”. If the test fails, replace the water temperature regulator. Refer to Disassembly and Assembly, “Water Temperature Regulator - Remove and Install”. If the fault is still present, contact the Dealer Solutions Network (DSN).

i07945572

Cylinder Is Noisy

Probable Causes

- Diagnostic codes
- Fuel quality
- Valve train components
- Low compression (cylinder pressure)
- Injectors
- Pistons and connecting rods

Recommended Actions

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

Table 21

Troubleshooting Test Steps	Values	Results
1. Diagnostic Codes **A.** Establish communication between the electronic service tool and the Electronic Control Module (ECM). **B.** Use the electronic service tool to check for active or logged codes.	Codes	**Result:** A diagnostic trouble code is active or logged. **Repair:** Troubleshoot the active or logged codes. **Result:** A diagnostic trouble code is not active or logged. Proceed to Test Step 2.
2. Fuel Quality **A.** Check the fuel quality. Refer to Systems Operation, Testing, and Adjusting, “Fuel Quality - Test”. **B.** Refer to Operation and Maintenance Manual for information on the correct characteristics of the fuel for the engine.	Fuel	**Result:** The fuel quality is not OK. **Repair:** Drain the fuel system and replace the fuel filters. Refer to Operation and Maintenance Manual, “Fuel System Primary Filter (Water Separator) Element - Replace” and Operation and Maintenance Manual, “Fuel System Filter - Replace”. Fill the fuel system with fuel that meets the standard in the Operation and Maintenance Manual, “Fluid Recommendations”. Prime the fuel system. Refer to the Operation and Maintenance Manual, “Fuel System - Prime”. Verify that the procedure has eliminated the noise. **Result:** The fuel quality is OK. Proceed to Test Step 3.
3. Valve Train Components **A.** Check the valve lash. Refer to Troubleshooting, “Valve Lash Is Excessive”. **B.** Check for damage to valve train components. Remove the valve cover from the engine. Check the following items for damage: · Valve springs · Rocker shaft · Bridges · Pushrods · Camshaft followers Refer to Disassembly and Assembly for additional information.	Valve train	**Result:** Valve train components are damaged. **Repair:** Make the necessary repairs, Verify that the repair has eliminated the noise. **Result:** The valve train components are not damaged. Proceed to Test Step 4.

(continued)

(Table 21, contd)

Troubleshooting Test Steps	Values	Results
4. Low Compression (Cylinder Pressure) **A.** Perform a compression test. Refer to Systems Operation, Testing, and Adjusting, “Compression - Test”.	Cylinder compression	**Result:** The results of the compression test are outside the specifications. **Repair:** Investigate the cause and rectify any faults. **Note:** Possible causes of low compression are shown in the following list: · Loose glow plugs · Faulty piston · Faulty piston rings · Worn cylinder bores · Worn valves · Faulty cylinder head gasket · Damaged cylinder head **Note:** Any work completed to rectify any of the above faults where injectors are reused must include the use of Perkins Fuel system cleaner T400012 upon engine recommission. **Result:** The results of the compression test are OK. Proceed to Test Step 5.
5. Electronic Unit Injectors **A.** Use the electronic service tool to perform the automatic “Cylinder Cutout Test” . Refer to Troubleshooting, Service Tool Features for more information on understanding the results of the “Cylinder Cutout Test” . **Note:** If the compression test that was performed in Test Step 4 was satisfactory, the “Cylinder Cutout Test” will identify any faulty injectors.	Electronic Unit Injectors	**Result:** A faulty injector is indicated. **Repair:** Remove any faulty electronic unit injectors. Refer to Disassembly and Assembly, “Electronic Unit Injector - Remove”. Install new electronic unit injectors. Refer to Disassembly and Assembly, “Electronic Unit Injector - Install”. Repeat the automatic “Cylinder Cutout Test” . If the fault is still apparent, remove the replacement electronic unit injector and install the original electronic unit injector. Refer to Disassembly and Assembly, “Electronic Unit Injector - Remove” and Disassembly and Assembly, “Electronic Unit Injector - Install”. **Result:** All injectors are OK. Proceed to Test Step 6.
6. Pistons and Connecting Rods **A.** Inspect the pistons for damage and wear. **B.** Inspect the connecting rod bearings for damage and wear.	Pistons	**Result:** One or more components are worn or damaged. **Repair:** Replace any worn or damaged parts. Verify that the repair has eliminated the noise. **Result:** All components are OK. If the fault is still present, contact the Dealer Solutions Network (DSN).

i07901321

Diesel Oxidation Catalyst Has Incorrect Inlet Temperature

Table 22

Diagnostic Trouble Code for DOC Has Incorrect Inlet Temperature		
J1939 Code	Code Description	Comments
4765-17	Aftertreatment #1 Diesel Oxidation Catalyst Intake Gas Temperature : Low - least severe (1)	ECM detects that the DOC inlet temperature is below the acceptable range during HC dosing. The code is logged.
Follow the troubleshooting procedure to identify the root cause of the fault.		

Table 23

Associated Codes
J1939 Codes
51–3
51–4
3464–5
3464–6
3464–7

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

Table 24

Troubleshooting Test Steps	Values	Results
1. Check for Diagnostic Trouble Codes **A.** Turn the keyswitch to the ON position. Do not start the engine. **B.** Connect to the electronic service tool. **C.** Check for associated diagnostic trouble codes.	Diagnostic trouble codes	**Result:** A 4765-17 code is active or recently logged. Proceed to Test Step 2. **Result:** An associated code is active or recently logged. Troubleshoot the logged or active code. Refer to Troubleshooting, “Diagnostic Trouble Codes”. **Result:** No associated diagnostic codes are active or recently logged. Proceed to Test Step 3.
2. Check the Exhaust System **A.** Check the exhaust system for gas leaks between the turbocharger and the Clean Emissions Module (CEM). **B.** Check for missing or damaged exhaust system insulation. **C.** Ensure that the length of the exhaust piping between the turbocharger and the CEM is within specifications.	Exhaust system	**Result:** The exhaust system has a gas leak. **Repair:** Make the necessary repairs. Proceed to Test Step 3. **Result:** The exhaust system insulation is damaged or missing. **Repair:** Make the necessary repairs. Proceed to Test Step 3. **Result:** The length of exhaust piping between the turbocharger and the CEM is not within the specification. **Repair:** Contact the Dealer Solutions Network (DSN). Proceed to Test Step 3.
3. Check the Exhaust System Temperature **A.** Connect to the electronic service tool. **B.** Run the engine. **C.** Perform the “Manual Hydrocarbon Dosing Capability Test” .	Test	**Result:** The “Manual Hydrocarbon Dosing Capability Test” completed successfully. Return the unit to service. **Result:** The “Manual Hydrocarbon Dosing Capability Test” failed. Associated diagnostic trouble codes are active. Troubleshoot the logged or active code. Refer to Troubleshooting, “Diagnostic Trouble Codes”. **Result:** The “Manual Hydrocarbon Dosing Capability Test” failed. An error code is generated by the electronic service tool. Troubleshoot the error code. Refer to Troubleshooting, “Service Tool Error Identifiers”. **Result:** The “Manual Hydrocarbon Dosing Capability Test” failed. No associated diagnostic trouble codes are active. Contact the Dealer Solutions Network (DSN).

i08769025

Diesel Oxidation Catalyst Has Low Conversion Efficiency

Table 25

Diagnostic Trouble Code for DOC Has Low Conversion Efficiency		
J1939 Code	**Code Description**	**Comments**
5298-17	Aftertreatment 1 Diesel Oxidation Catalyst Conversion Efficiency : Low - least severe (1)	ECM detects that the DOC outlet temperature is below the acceptable range during HC dosing. The code is logged.
Follow the troubleshooting procedure to identify the root cause of the fault.		

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

Table 26

Troubleshooting Test Steps	Values	Results
1. Check for Diagnostic Trouble Codes **A.** Turn the keyswitch to the ON position. Do not start the engine. **B.** Connect to the electronic service tool. **C.** Check for diagnostic trouble codes.	Diagnostic trouble codes	**Result:** A 5298-17 code is active or recently logged. Proceed to Test Step 2. **Result:** A recurrence of 5298-17 code is active or recently logged. The code has previously been rectified. Proceed to Test Step 4. **Result:** An associated code other than 5298-17 is active or recently logged. **Repair:** Troubleshoot the logged or active code. Refer to Troubleshooting, “Diagnostic Trouble Codes”. **Result:** No codes are active or recently logged. Proceed to Test Step 3.
2. Check the Exhaust System **A.** Check the exhaust system for evidence of oil between the turbocharger and the Clean Emissions Module (CEM). Refer to Special Instruction, M0134553 for additional troubleshooting for the turbocharger.	Exhaust System	**Result:** Oil is present in the exhaust system. **Repair:** Refer to Troubleshooting, “Exhaust System Contains Oil”. **Result:** There is no oil in the exhaust system. **Repair:** Use the electronic service tool to perform the “Manual Hydrocarbon Dosing Capability Test” . Proceed to Test Step 3.

(continued)

(Table 26, contd)

Troubleshooting Test Steps	Values	Results
3. Check for High Sulfur Fuel **A.** Ensure that the correct specification of fuel is being used. Refer to the Operation and Maintenance Manual for the correct specification. **Note:** If fuel with a high sulfur content is used, this fault will reoccur and a replacement CEM may be required.	Test	**Result:** High sulfur fuel is in use. Drain the fuel tank, flush the fuel lines, and replace the fuel filters. Refill the fuel system with fuel of the correct specification. Proceed to Test Step 4. **Result:** High Sulfur fuel is not in use. Proceed to Test Step 4.
4. Recover the Aftertreatment System **A.** Connect to the electronic service tool. **B.** Run the engine. **C.** Perform the “Aftertreatment Recovery Procedure” .	Test	**Result:** The “Aftertreatment Recovery Procedure” completed successfully. Return the unit to service. **Result:** The “Aftertreatment Recovery Procedure” failed. An error code is generated by the electronic service tool. **Repair:** Troubleshoot the error code. Refer to Troubleshooting, “Service Tool Error Identifiers”. **Result:** The “Aftertreatment Recovery Procedure” failed. No error codes are generated. A replacement CEM may be required. Contact the Dealer Solutions Network (DSN).

i09607869

Diesel Particulate Filter Collects Excessive Soot

The Electronic Control Module (ECM) uses the differential pressure sensors to monitor the soot load in the Diesel Particulate Filter (DPF). If the soot load becomes excessive, the ECM activates the applicable code.

Table 27

Diagnostic Trouble Codes for Excessive Soot Load		
J1939 Code	**Code Description**	**Comments**
3251–16	Aftertreatment #1 DPF Differential Pressure High : Moderate Severity (2)	The ECM detects that the face of the DPF is blocked.
3714–31	Diesel Particulate Filter Active Regeneration Inhibited Due to Temporary System Lockout	Automatic regeneration is disabled. The electronic service tool must be used to recover the aftertreatment system.
3715–31	Diesel Particulate Filter Active Regeneration Inhibited Due to Permanent System Lockout	The estimated soot load is too high for safe recovery of the aftertreatment.

(continued)

(Table 27, contd)

Diagnostic Trouble Codes for Excessive Soot Load		
J1939 Code	Code Description	Comments
3719-16	DPF #1 Soot Loading Percent : High - moderate severity (2)	The estimated soot load is high. Engine power is gradually derated as the soot load increases.
3719-0	DPF #1 Soot Loading Percent : High - most severe (3)	The estimated soot load is high. Engine operation is limited to 60 second intervals when the electronic service tool is not communicating with the ECM.
7032–31	Aftertreatment System Has Shutdown Engine	This code is associated with the Hydrocarbon Dosing (HCD) escalation logic and an aspect of that logic known as the Quick Restart feature. The Quick Restart feature allows an operator that is experiencing restricted speed operation due to the HCD escalation level being high to quickly stop and restart the engine. This action enables a short period of normal machine operation so that the machine could be moved. After this time period has expired, a progressively large derate will be ramped in until the engine eventually stalls. At this point, the diagnostic code is logged.

An excessive accumulation of soot in the DPF can be caused by the following faults:

- Diagnostic codes
- Oil in the exhaust system
- Low compression (cylinder pressure)
- Faulty injectors
- Faulty Intake Throttle Valve
- A fault in the NOx Reduction System (NRS)
- Fuel with a high sulfur content

Engine operation must be kept to a minimum to minimize the amount of soot that is created. Follow the troubleshooting procedure to minimize the amount of engine operation.

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

Table 28

Troubleshooting Test Steps	Values	Results
1. Check for Active Diagnostic Trouble Codes **A.** Turn the keyswitch to the ON position. **B.** Connect the electronic service tool. **C.** Check for active diagnostic trouble codes.	Diagnostic trouble codes	**Result:** A 3719-xx, 3714-31, or 3251-16, or 7032-31 code is active. Proceed to Test Step 2. **Result:** A 3715–31 code is active. Contact the Dealer Solutions Network (DSN). **Result:** A code other than 3719-xx, 3714–31, 3715–31 or 3251–16 is active. Diagnose and rectify the fault before continuing with this procedure. Refer to Troubleshooting, “Diagnostic Trouble Codes”.
2. Check for Oil in the Exhaust System **A.** Remove the exhaust elbow. Refer to Disassembly and Assembly, “Exhaust Elbow - Remove and Install”. **B.** Inspect the exhaust system and Clean Emissions Module (CEM) inlet for oil deposits. Refer to Special Instruction, M0134553 for additional troubleshooting for the turbocharger.	Exhaust system	**Result:** Oil deposits are present in the exhaust system. Refer to Troubleshooting, “Exhaust System Contains Oil”. **Result:** No oil deposits are found in the exhaust system. Proceed to Test Step 3.
3. Low Compression (Cylinder Pressure) **A.** Perform a compression test. Refer to Systems Operation, Testing, and Adjusting, “Compression - Test”.	Cylinder compression	**Result:** The results of the compression test are outside the specifications. **Repair:** Investigate the cause and rectify any faults. **Note:** Possible causes of low compression are shown in the following list: · Loose glow plugs · Faulty piston · Faulty piston rings · Worn cylinder bores · Worn valves · Faulty cylinder head gasket · Damaged cylinder head **Result:** The results of the compression test are OK. Proceed to Test Step 4.
4. Clean the Fuel System **A.** Following the instructions on the bottle, add Perkins Fuel System Cleaner T400012 to the fuel tank.	Electronic Unit Injectors	**Result:** Performance should be restored within 2-3 hours. Return the unit to service, the fuel system will be cleaned during operation. **Result:** Performance is not restored within 2-3 hours. Proceed to Test Step 5.

(continued)

(Table 28, contd)

Troubleshooting Test Steps	Values	Results
5. Electronic Unit Injectors **A.** Use the electronic service tool to perform the automatic “Cylinder Cutout Test” . Refer to Troubleshooting, Service Tool Features for more information on understanding the results of the “Cylinder Cutout Test” . **Note:** If the compression test that was performed in Test Step 4 was satisfactory, the “Cylinder Cutout Test” will identify any faulty injectors.	Electronic Unit Injectors	**Result:** A faulty injector is indicated. **Repair:** Remove any faulty electronic unit injectors. Refer to Disassembly and Assembly, “Electronic Unit Injector - Remove”. Install new electronic unit injectors. Refer to Disassembly and Assembly, “Electronic Unit Injector - Install”. Repeat the automatic “Cylinder Cutout Test” . If the fault is still apparent, remove the replacement electronic unit injector and install the original electronic unit injector. Refer to Disassembly and Assembly, “Electronic Unit Injector - Remove” and Disassembly and Assembly, “Electronic Unit Injector - Install”. **Result:** All injectors are OK. Proceed to Test Step 6.
6. Check the Engine Intake Throttle Valve and the NRS system **A.** Use the Electronic service tool to perform the “Air System Motor Valve Verification Test” .	Diagnostic codes	**Result:** The “Air System Motor Valve Verification Test” failed. A diagnostic code is present that is associated with the engine intake throttle valve or the NRS system. Refer to Troubleshooting, “Diagnostic Trouble Codes” for information on troubleshooting the code. **Result:** The “Air System Motor Valve Verification Test” passed. There are no diagnostic codes present for the engine intake throttle valve or the NRS system. Proceed to Test Step 7.
7. Check for High Sulfur Fuel **A.** Ensure that the correct specification of fuel is being used. Refer to the Operation and Maintenance Manual for the correct specification. **Note:** If fuel with a high sulfur content is used, this fault will reoccur and a replacement CEM may be required.	Fuel	**Result:** High sulfur fuel is in use. **Repair:** Drain the fuel tank, flush the fuel lines, and replace the fuel filters. Refill the fuel system with fuel of the correct specification. Proceed to Test Step 8. **Result:** The fuel is the correct specification. Contact the Dealer Solutions Network (DSN).
8. Recover the Aftertreatment System **A.** Start the engine and use the electronic service tool to perform a “Aftertreatment Recovery Procedure” .	DPF	**Result:** The soot content of the DPF returns to normal. Use the electronic service tool to clear all related diagnostic codes. Operate the engine to ensure that the fault has been eliminated. Return the unit to service. **Result:** The soot content of the DPF remains high. Contact the Dealer Solutions Network (DSN).

i08251928

Diesel Particulate Filter Has Low Inlet Pressure

Use this procedure if the following event code is active.

Table 29

J1939 Code and Description	Description	Comments
3251–1	Aftertreatment #1 DPF Differential Pressure : Low - most severe (3)	The code detects an implausibly low DPF differential pressure which indicates reverse installation of the DPF differential pressure sensor. The shutdown lamp will illuminate. The warning lamp will flash fast. The Emissions Systems Malfunction Lamp will flash fast.
3251-18	Aftertreatment #1 DPF Differential Pressure : Low - moderate severity (2)	The code indicates the detection of the removal of the DPF substrate. The warning lamp will flash slowly.

Table 30

Troubleshooting Test Steps	Values	Results
1. Inspect the Exhaust System for Leaks **A.** Inspect the exhaust system for leaks between the exhaust manifold and the Clean Emissions Module (CEM). **B.** Check the exhaust system for loose connections or open ports.	Exhaust Leaks	**Result:** The exhaust system has leaks. **Repair:** Repair the exhaust. Return the engine to service. **Result:** The exhaust system does not have leaks. Proceed to Test Step 2.
2. Inspect Electrical Connections **A.** Inspect the electrical connections between the sensor and ECM for loose wires, breaks, or dirt ingress.	Electrical Connections	**Result:** A connection point has damaged wires or pins. **Repair:** Repair the damaged wires or pins. **Result:** A wire is loose. **Repair:** Resecure wire into correct port. **Result:** A connection point has excessive dirt/dust. **Repair:** Thoroughly clean the connection point and wire ports in the back of the connector with an air gun or similar. Ensure they are free of dirt and/or dust. **Result:** Electrical connections have no loose wires, breaks, or dirt ingress. Proceed to Test Step 3.
3. Inspect the Diesel Particulate Filter **A.** Inspect the inlet of the DPF. Inspect the DPF for a missing or damaged DPF brick.	Damaged DPF Brick	**Result:** The DPF has a damaged or missing DPF brick. **Repair:** Replace the damaged DPF or missing DPF brick. Return the engine to service.

If the procedure did not correct the issue, contact the Dealer Solutions Network (DSN).

i07528505

Diesel Particulate Filter Temperature Is Low

The Electronic Control Module (ECM) monitors the temperature at the intake of the Diesel Particulate Filter (DPF). The ECM activates the following diagnostic code when the conditions are met.

Table 31

Diagnostic Trouble Codes for Diesel Particulate Filter Temperature Is Low		
J1939 Codes	**Code Description**	**Comments**
3242-18	Aftertreatment #1 DPF Intake Gas Temperature : Low - moderate severity (2)	The temperature sensor is not correctly installed. Engine power is derated 30%. The code is logged. The code remains active until electrical power to the ECM is cycled.

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

Table 32

Troubleshooting Test Steps	Values	Results
1. Check for Active Diagnostic Trouble Codes **A.** Turn the keyswitch to the ON position. **B.** Connect the electronic service tool. **C.** Check for active diagnostic trouble codes.	Diagnostic trouble codes	**Result:** A 3242-18 code is active. Proceed to Test Step 2. **Result:** A code other than 3242-18 is active. **Repair:** Diagnose and rectify the fault before continuing with this procedure. Refer to Troubleshooting, “Diagnostic Trouble Codes”.
2. Check the Sensor Installation **A.** Check that the temperature sensor is correctly installed and is not loose.	Sensor installation	**Result:** The temperature sensor is not correctly installed or is loose. **Repair:** Install the temperature sensor and tighten to the recommended torque. Refer to Disassembly and Assembly, “Temperature Sensor (DPF) - Remove and Install”. Proceed to Test Step 3. **Result:** The temperature sensor is correctly installed and is not loose. Proceed to Test Step 3.
3. Check if the Fault has Been Eliminated **A.** Start the engine. **B.** Use the electronic service tool to check that the fault has been eliminated.	Diagnostic	**Result:** The fault has been eliminated. Return the unit to service. **Result:** The fault is still present. Contact the Dealer Solutions Network (DSN).

i07836664

Engine Cranks but Does Not Start

Probable Causes

- Diagnostic codes
- Visible faults
- Air intake and exhaust system
- Speed/timing sensor
- Starting aids
- Low-pressure fuel system
- Return fuel lines
- High-pressure fuel system
- Low compression (cylinder pressure)

Recommended Actions

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

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

Table 33

Troubleshooting Test Steps	Values	Results
1. Diagnostic Codes **A.** Download the Histograms before performing any troubleshooting or clearing any diagnostic codes. **Note:** The downloaded information will be required by the Dealer Solutions Network (DSN) if troubleshooting assistance is needed. **B.** Use the electronic service tool to check for active or logged codes.	Diagnostic codes	**Result:** A diagnostic code is present. **Repair:** Troubleshoot the code and then reset the histogram. Refer to Troubleshooting, Diagnostic Trouble Codes or Troubleshooting, Event Codes. **Result:** A diagnostic code is not present. Proceed to Test Step 2.
2. Visible Faults **A.** Check that the fuel supply valve (if equipped) is in the OPEN position. **B.** Check for the correct level of fuel, oil, and coolant. **C.** Check for water in the primary fuel filter/water separator. **D.** If the ambient temperature is below 0 °C (32 °F), check the specification of engine oil and oil for the machine. **E.** Visually inspect the engine for the following faults: · Missing components · Damaged components · Damaged electrical cables or loose electrical cables · Oil leaks · Fuel leaks · All fuel filters are correctly installed. **F.** Check that the battery voltage is correct. **G.** Use the electronic service tool to check the average cranking speed of the engine.	Visible faults	**Result:** The fuel supply valve (if equipped) is not in the OPEN position. **Repair:** Move the fuel supply valve to the OPEN position. **Result:** The level of fuel, oil, or coolant is not correct. **Repair:** Replenish any fluids with an incorrect level. **Result:** Water is present in the primary fuel filter/water separator. **Repair:** Drain any water from the primary fuel filter/water separator. **Result:** The correct specification of engine oil and oil for the machine is not in use. **Repair:** Replenish the system with oil of the correct specification for the ambient conditions. **Result:** Battery voltage is low. **Repair:** Check the batteries. Refer to Troubleshooting, "Battery Problem". **Result:** The cranking speed is less than 150 rpm. **Repair:** Investigate the cause of the low cranking speed and rectify, as necessary. Proceed to Test Step 3.

(continued)

(Table 33, contd)

Troubleshooting Test Steps	Values	Results
3. Check the “Engine Starting” Screen on the Electronic Service Tool **A.** Use the electronic service tool to check the “Engine Starting” screen while cranking the engine. **B.** Check that the battery voltage is greater than 9 V for a 12 V system or 18 V for a 24 V system. **C.** Check that the engine speed is greater than 150 rpm. **D.** Check that the “Injector Disable” parameter is set to “Off” . **E.** Check that the “Fuel Rail Pressure” is greater than 25 MPa (3625 psi). **F.** Check that the “Primary Engine Speed Sensor Timing Pattern Status” and “Secondary Engine Speed Sensor Timing Pattern Status” indicate “Detected” .	“Engine Starting” screen	**Result:** The battery voltage is low. **Repair:** Refer to Troubleshooting, Electrical Power Supply - Test. **Result:** The engine cranking speed is less than 150 rpm. **Repair:** Refer to Troubleshooting, Engine Does not Crank. **Result:** The “Injector Disable” parameter is not set to “Off” . **Repair:** Proceed to Test Step 11. **Result:** The “Fuel Rail Pressure” is less than 25 MPa (3625 psi). Proceed to Test Step 6. **Result:** The “Primary Engine Speed Sensor Timing Pattern Status” or “Secondary Engine Speed Sensor Timing Pattern Status” does not indicate “Detected” . Proceed to Test Step 5. **Result:** All parameters on the “Engine Starting” screen are OK. Proceed to Test Step 4.
4. Air Intake and Exhaust System **A.** Check the air filter restriction indicator, if equipped. **B.** Check the air intake and the exhaust system for the following defects: · Signs of dirt ingress · Blockages · Restrictions · Damage to the air intake and exhaust lines and hose **C.** Check for ECM codes for inlet air restriction: 107-15: Engine Air Filter 1 Differential Pressure high - least severe (1) 107-16: Engine Air Filter 1 Differential Pressure high - moderate severity (2) **D.** Check the engine has not exceeded the service interval for the air cleaner element. Refer to Operation and Maintenance Manual.	Air intake and exhaust system	**Result:** The air filter restriction indicator has operated or the air filter is blocked. **Repair:** Make sure that the air filter is clean and serviceable. If necessary, replace the air filter. **Result:** The air intake or the exhaust system is blocked, restricted, or damaged. **Repair:** Repair the air intake or the exhaust system, as required. **Result:** A 107-15 or 107-16 code is active **Repair:** Refer to Troubleshooting, Inlet Air is Restricted. **Result:** The service interval for the air cleaner element has been exceeded. **Repair:** Replace the air cleaner element. Refer to Operation and Maintenance Manual, Engine Air Cleaner Element - Replace. **Result:** The air intake or the exhaust system is OK. Proceed to Test Step 5.

(continued)

(Table 33, contd)

Troubleshooting Test Steps	Values	Results
5. Speed/Timing Sensors **A.** Crank the engine and observe the engine speed on the electronic service tool status screen. **Note:** Upon initial cranking, the status for engine speed may indicate that the engine speed signal is abnormal. This message will be replaced with an engine speed once the ECM is able to calculate a speed from the signal.	Speed/timing sensor	**Result:** The speed/timing sensors are not operating correctly. **Repair:** Test the speed/timing sensors. Refer to Troubleshooting, “Speed/Timing - Test”. **Result:** The speed/timing sensors are operating correctly. Proceed to Test Step 6.
6. Starting Aids **A.** Check the operation of the glow plugs. Refer to Troubleshooting, “Glow Plug Starting Aid - Test”.	Starting aids	**Result:** One or more of the glow plugs are faulty. **Repair:** Replace any faulty glow plugs. Refer to Disassembly and Assembly, “Glow Plug - Remove and Install”. Check that the engine starts normally. If the engine will not start, proceed to Test Step 7.

(continued)

(Table 33, contd)

Troubleshooting Test Steps	Values	Results
7. Low-Pressure Fuel System **A.** Visually check the fuel tank for fuel. **Note:** The fuel gauge may be faulty. **B.** If the temperature is below 0 °C (32 °F), check for solidified fuel (wax). **C.** Check the primary filter/water separator for water in the fuel. **D.** Check for fuel supply lines that are restricted or not correctly installed. **E.** Check that the electric fuel priming pump is operating correctly. **F.** Check for air in the fuel system and that the fuel system is primed. **G.** Check the diesel fuel for contamination. Refer to Systems Operation, Testing, and Adjusting, “Fuel Quality - Test”.	Low-pressure fuel system	**Result:** The fuel tank level is low. **Repair:** Fill the fuel tank. **Result:** The fuel contains solidified wax. **Repair:** Replace the fuel with fuel of the correct specification for the ambient conditions. Replace the primary fuel filter and the secondary fuel filters. Refer to the Operation and Maintenance Manual for further information. **Result:** There are fuel supply lines that are restricted or not correctly installed. **Repair:** Install the fuel lines correctly. Replace any damaged or restricted fuel lines. **Result:** The electric fuel priming pump is not operating correctly. Investigate the fault with the EFLP. Refer to Troubleshooting, “Fuel Transfer Pump - Test”. **Result:** There is air in the fuel system. **Repair:** Prime the fuel system. Refer to Systems Operation, Testing, and Adjusting, “Fuel System - Prime”. **Result:** The diesel fuel is contaminated. **Repair:** Drain the fuel tank and the fuel system. Replace the primary fuel filter and the secondary fuel filters. Refer to the Operation and Maintenance Manual for further information. Fill and prime the fuel system with fuel of the correct specification. Refer to Systems Operation, Testing, and Adjusting, “Fuel System - Prime”. **Result:** The low-pressure fuel system is OK. Proceed to Test Step 8.
8. Check the Return Fuel Lines **A.** Make sure that the fuel return lines are not blocked or kinked.	Return lines	**Result:** The fuel return lines are blocked or kinked. **Repair:** Clear or replace the blocked line. **Result:** The fuel return lines are clear. Proceed to Test Step 9.

WARNING

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

NOTICE

Contact with high-pressure fuel may cause personal injury or death. Wait 10 minutes after the engine has stopped to allow fuel pressure to purge before any service or repair is performed on the engine fuel lines.

Table 34

Troubleshooting Test Steps	Values	Results
9. High-Pressure Fuel System **A.** Use the electronic service tool to check the absolute fuel rail pressure while the engine is cranking at a minimum speed of 150 rpm.	High-pressure fuel system	**Result:** The absolute fuel rail pressure is less than 25 MPa (3625 psi). **Repair:** Check for fuel leaks in the high-pressure fuel system. Rectify any fuel leaks and then recheck the pressure in the fuel rail. Use the electronic service tool to perform a solenoid test on the fuel injection pump. Refer to Troubleshooting, “Fuel Control - Test”. Check the Pressure Limiting Valve (PLV) in the fuel rail for leakage. If the valve is leaking, replace the valve and recheck the pressure in the fuel rail. Check for fuel in the engine oil system. If fuel is suspected in the oil system, take an engine oil sample for analysis. Refer to the Operation and Maintenance Manual, “Engine Oil Sample - Obtain”. If the analysis confirms that there is fuel in the engine oil system, investigate the cause. **Result:** The absolute fuel rail pressure is greater than 25 MPa (3625 psi). Use the electronic service tool to make sure that the status of the electronic unit injectors is not “Disabled” . If the injectors are disabled but the injectors have not been intentionally disabled, proceed to Test Step 11. Use the electronic service tool to perform an injector solenoid test. Refer to Troubleshooting, “Injector Solenoid - Test”. If the engine will not start, proceed to Test Step 10.
10. Electronic Control Module (ECM) **A.** Make sure that the latest flash file for the application is installed in the ECM.	ECM	**Result:** Installation of the latest flash file does not eliminate the fault. **Repair:** Contact the Dealer Solutions Network (DSN). **Note:** This consultation can greatly reduce the repair time. If the DSN recommends the use of a test ECM, install a test ECM. Refer to Troubleshooting, “ECM - Replace”. Attempt to start the engine. If the engine will not start, install the original ECM and then proceed to Test Step 11. If the engine starts normally, reconnect the suspect ECM and then verify that the fault returns when the suspect ECM is installed. If the engine will not start with the suspect ECM, replace the ECM and then check that the engine starts normally.

(continued)

(Table 34, contd)

Troubleshooting Test Steps	Values	Results
11. High-Pressure Fuel Pump **A.** Check the timing of the high-pressure fuel pump. Refer to Systems Operation, Testing, and Adjusting, “Fuel Injection Timing - Check”.	HP fuel pump	**Result:** The timing of the high-pressure fuel pump is incorrect. **Repair:** Correct the timing of the high-pressure fuel pump. Refer to Disassembly and Assembly, “Fuel Injection Pump - Remove” and Disassembly and Assembly, “Fuel Injection Pump - Install”. With the high-pressure fuel pump correctly timed, check that the engine starts normally. If the engine will not start, proceed to Test Step 12. **Result:** The timing of the high-pressure fuel pump is correct. **Repair:** Replace the high-pressure fuel pump. Refer to Disassembly and Assembly, “Fuel Injection Pump - Remove” and Disassembly and Assembly, “Fuel Injection Pump - Install”. Check that the engine starts normally. If the engine will not start, proceed to Test Step 12.
12. Low Compression (Cylinder Pressure) **A.** Perform a compression test. Refer to Systems Operation, Testing, and Adjusting, “Compression - Test”.	Cylinder compression	**Result:** The results of the compression test are outside the specifications. **Repair:** Investigate the cause and rectify any faults. **Note:** Possible causes of low compression are shown in the following list: · Loose glow plugs · Faulty piston · Faulty piston rings · Worn cylinder bores · Worn valves · Faulty cylinder head gasket · Damaged cylinder head **Result:** The results of the compression test are OK. Contact the Dealer Solutions Network (DSN).

i08062903

Engine Does Not Crank

Use this procedure to troubleshoot an engine that will not crank.

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

Table 35

Troubleshooting Test Steps	Values	Results
1. Inspection of the Batteries and Battery Cables **A.** Inspect the main power switch, battery posts, and battery cables for loose connections and for corrosion. If the battery cables are corroded, remove the battery cables and clean the battery cables. Tighten any loose connections. **B.** Inspect the batteries. **C.** Charge the batteries. Refer to Systems Operation, Testing and Adjusting, “Battery - Test”.	Batteries	**Result** The batteries and cables are OK. Proceed to Test Step 2. **Result** The batteries and cables are not OK. **Repair:** Make the necessary repairs.
2. Switches and/or Circuit Breakers (if applicable) **A.** Check any switches and/or circuit breakers that may prevent engine cranking. For additional information, refer to the electrical schematic for the application.	Switches and/or circuit breakers	**Result** The switches and/or circuit breakers are OK. Proceed to Test Step 3. **Result** The switches and/or circuit breakers are not OK. **Repair:** Make the necessary repairs.
3. Starting Motor Solenoid and Starting Circuit **A.** Test the operation of the starting motor circuit. Refer to Systems Operation, Testing, and Adjusting, “Electrical System” for additional information.	Starting motor solenoid and circuit	**Result** The starting motor solenoid and circuit are OK. Proceed to Test Step 4. **Result** The starting motor solenoid and circuit are not OK. **Repair:** Make the necessary repairs.
4. Inspect the Starter Pinion and Flywheel Ring Gear **A.** Test the operation of the starting motor. **B.** Check the pinion clearance. Inspect the pinion and the flywheel ring gear for damage. Refer to Systems Operation, Testing, and Adjusting, “Electrical System” for additional information.	Starter pinion and flywheel ring gear	**Result** The starter pinion and flywheel ring gear are OK. Proceed to Test Step 5. **Result** The starter pinion and flywheel ring gear are not OK. **Repair:** Make the necessary repairs.

(continued)

(Table 35, contd)

Troubleshooting Test Steps	Values	Results
5. Inspect Engine Accessories and the Transmission (if applicable) **A.** Ensure free movement of the driveline. **B.** Remove and inspect any engine accessories that may lock up the engine. The following list identifies engine accessories that may lock up the engine: · Hydraulic pump that is driven from the PTO · Air compressor · Engine oil pump · Other components that are driven by the engine	Engine accessories and transmission	**Result** The engine accessories and transmission are OK. Proceed to Test Step 6. **Result** The engine accessories and transmission are not OK. **Repair:** Make the necessary repairs.
6. Hydraulic Cylinder Lock **A.** If the engine will not start, check for fluid in the cylinders (hydraulic cylinder lock) by removing the individual unit injectors. Check for damaged seals. Determine the type of fluid that locked up the cylinder. **C.** If there was a coolant leak, determine the cause of the leak. Check the exhaust (NRS) cooler for leaks. Refer to Systems Operation, Testing and Adjusting, “Exhaust Cooler (NRS) - Test”. **D.** If there was excessive fuel in the cylinder, replace the seals and reinstall the injector. Drain any excess fuel from the cylinder head. **E.** If a mechanical problem is suspected, disassemble the engine. Refer to the Disassembly and Assembly manual. Inspect the internal components for the following conditions: · Seizure · Broken components · Bent components	Hydraulic cylinder lock	**Result** The engine has a hydraulic cylinder lock. **Repair:** Make the necessary repairs. **Result** The engine does not have a hydraulic cylinder lock. Contact the Dealer Solutions Network (DSN).

i06010812

Engine Has Early Wear

Probable Causes

- Incorrect maintenance intervals and/or incorrect oil
- Contaminated engine oil
- Leaks in air intake system
- Dirt in fuel
- Low oil pressure

Recommended Actions

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

Table 36

Troubleshooting Test Steps	Values	Results
1. Incorrect Maintenance Intervals and/or Incorrect Oil **A.** Use engine oil that is recommended and change the engine oil at the interval that is recommended by the engines Operation and Maintenance Manual.	Maintenance intervals	**Result:** The engine oil was not changed at the interval that is recommended by the Operation and Maintenance Manual. **Repair:** Use the recommended grade of oil. Change the engine oil at the interval that is recommended. Repair or replace any damaged parts. **Result:** The engine oil was changed at the interval that is recommended by the engines Operation and Maintenance Manual. Proceed to Test Step 2.
2. Contaminated Engine Oil **A.** Obtain an oil analysis. The analysis will identify oil contamination. **B.** Check the oil filter bypass valve. **Note:** If the oil filter bypass valve is open, the oil will not be filtered.	Contamination	**Result:** The oil is contaminated. **Repair:** Determine the reason for any contamination of the engine oil and make the necessary repairs. Drain the crankcase and refill the crankcase with clean engine oil. Install new engine oil filters. Refer to the engines Operation and Maintenance Manual. **Result:** The oil filter bypass valve is open. **Repair:** Replace the oil filter element. Refer to the Operation and Maintenance Manual. Check the oil filter bypass valve for a weak spring or for a broken spring. If the spring is broken, replace the spring. Verify that the oil bypass valve is operating correctly. **Result:** The oil is not contaminated. Proceed to Test Step 3.
3. Leaks in Air Intake System **Note:** A leak in the air intake system may allow unfiltered air into the engine. **A.** Inspect the air intake system for streaks which may indicate a leakage of unfiltered air. Inspect all of the gaskets and the connections. Refer to Systems Operation, Testing, and Adjusting, “Air Inlet and Exhaust System” for more information.	Air leak	**Result:** There are air leaks. **Repair:** Repair any leaks. **Result:** There are no air leaks. Proceed to Test Step 4.

(continued)

(Table 36, contd)

Troubleshooting Test Steps	Values	Results
4. Dirt in Fuel **A.** Remove the fuel filters. Inspect the fuel filters for contamination. **Note:** Contaminants in the fuel such as hydrogen sulfide and sulfur can lead to the formation of acids in the crankcase. **B.** Obtain a fuel analysis.	Fuel and fuel filters	**Result:** The fuel has contamination. **Repair:** Determine the cause of any contamination and make the necessary repairs. Install new fuel filters. Refer to the Operation and Maintenance Manual. **Result:** The fuel is not contaminated. Proceed to Test Step 5.
5. Low Oil Pressure **Note:** Engine oil that is contaminated with another liquid can cause low engine oil pressure. High engine oil level can be an indication of contamination. **A.** Obtain an analysis of the engine oil. **B.** Check the inlet screen on the suction tube and remove any material that may be restricting engine oil flow. **Note:** The inlet screen of the suction tube for the engine oil pump can have a restriction. This restriction will cause cavitation and a loss of engine oil pressure. **Note:** When some components of the engine show wear in a short time, the cause can be a restriction in a passage for engine oil. An indicator for the engine oil pressure may indicate sufficient pressure, but a component is worn due to a lack of lubrication. In such a case, look at the passage for the engine oil supply to the component. Refer to Systems Operation/Testing and Adjusting, “Lubrication System” for additional information.	Oil pressure	**Result:** Analysis indicates that the oil is contaminated. **Repair:** Replace the oil and the oil filter. Refer to the Operation and Maintenance Manual. **Result:** The inlet tube has a restriction. **Repair:** Clear the obstruction. Verify the repair. **Result:** The oil pressure is low. Refer to Troubleshooting, “Oil Pressure Is Low” for the testing procedure. Repair any identified faults. **Result:** The oil pressure is normal. Contact the Dealer Solutions Network (DSN).

i07945581

Engine Has Mechanical Noise (Knock)

Probable Causes

- Active codes and logged codes
- Electrical connections
- Fuel injection
- Fuel quality
- Lubrication
- Engine accessory
- Valve train components
- Pistons and connecting rods
- Crankshaft

Recommended Actions

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

Table 37

Troubleshooting Test Steps	Values	Results
1. Active Codes and Logged Codes **A.** Establish communication between the electronic service tool and the Electronic Control Module (ECM). Refer to Troubleshooting, "Electronic Service Tools", if necessary.	Codes	**Result:** There are active codes. **Repair:** Troubleshoot any active codes before continuing with this procedure. **Result:** There are no active codes. Proceed to Test Step 2.
2. Electrical Connections **A.** Check for the correct installation of the ECM J1/P1 and the J2/P2 connectors. Check for correct installation of the fuel injector connectors.	Connectors	**Result:** There are suspect connectors. **Repair:** Repair connectors that are suspect or replace connectors that are suspect. Perform the "Wiggle Test" on the electronic service tool. **Result:** There are no suspect connectors. Proceed to Test Step 3.
3. Low Compression (Cylinder Pressure) **A.** Perform a compression test. Refer to Systems Operation, Testing, and Adjusting, "Compression - Test".	Cylinder compression	**Result:** The results of the compression test are outside the specifications. **Repair:** Investigate the cause and rectify any faults. **Note:** Possible causes of low compression are shown in the following list: · Loose glow plugs · Faulty piston · Faulty piston rings · Worn cylinder bores · Worn valves · Faulty cylinder head gasket · Damaged cylinder head **Result:** The results of the compression test are OK. Proceed to Test Step 4.
4. Clean the Fuel System **A.** Following the instructions on the bottle, add Perkins Fuel System Cleaner T400012 to the fuel tank.	Electronic Unit Injectors	**Result:** Performance should be restored within 2-3 hours. Return the unit to service, the fuel system will be cleaned during operation. **Result:** Performance is not restored within 2-3 hours. Proceed to Test Step 5.

(continued)

(Table 37, contd)

Troubleshooting Test Steps	Values	Results
5. Electronic Unit Injectors **A.** Use the electronic service tool to perform the automatic “Cylinder Cutout Test” . Refer to Troubleshooting, Service Tool Features for more information. **Note:** If the compression test that was performed in Test Step 3 was satisfactory, the “Cylinder Cutout Test” will identify any faulty injectors.	Electronic Unit Injectors	**Result:** A faulty injector is indicated. **Repair:** Remove any faulty electronic unit injectors. Refer to Disassembly and Assembly, “Electronic Unit Injector - Remove”. Install new electronic unit injectors. Refer to Disassembly and Assembly, “Electronic Unit Injector - Install”. Repeat the automatic “Cylinder Cutout Test” . If the fault is still apparent, remove the replacement electronic unit injector and install the original electronic unit injector. Refer to Disassembly and Assembly, “Electronic Unit Injector - Remove” and Disassembly and Assembly, “Electronic Unit Injector - Install”. **Result:** All injectors are OK. Proceed to Test Step 6.
6. Fuel Quality **A.** Refer to Operation and Maintenance Manual for information on the correct characteristics of the fuel for the engine. If necessary, obtain a fuel analysis to confirm that the correct fuel is being used for the engine. Refer to Systems Operation, Testing and Adjusting, “Fuel Quality - Test” for the correct procedure.	Fuel	**Result:** The fuel quality is OK. Proceed to Test Step 7. **Result:** The fuel quality is not OK. **Repair:** Replace the fuel. Verify that the repair eliminated the fault.
7. Lubrication **A.** Check for sufficient lubrication of the valve components. **B.** Check for blocked oil passages. Oil passages must be clean. Clean any oil passages that are suspect. Refer to the Disassembly and Assembly for additional information. **C.** Inspect the engine oil filters for ferrous material. **D.** Obtain an oil analysis. **Note:** The analysis will contribute to a better understanding of oil contamination and the origin of the contamination.	Lubrication	**Result:** The oil passages are not blocked and the engine has sufficient lubrication. Proceed to Test Step 8. **Result:** The oil passages are blocked or the engine does not have sufficient lubrication. **Repair:** Make the necessary repairs, Verify that the repair eliminated the fault.
8. Engine Accessory **A.** If the source of the noise is an engine accessory, remove and inspect the suspect item.	Engine accessory	**Result** An engine accessory is the source of the noise. **Repair:** Repair and/or replace the engine accessory, if necessary. **Result** An engine accessory is not the source of the noise. Proceed to Test Step 9.

(continued)

(Table 37, contd)

Troubleshooting Test Steps	Values	Results
9. Valve Train Components **A.** Check the valve lash. Refer to Troubleshooting, “Valve Lash Is Excessive”. **B.** Check for damage to valve train components. Remove the valve cover from the suspect cylinders. Check the following items for damage: · Camshaft · Valve springs · Camshaft followers · Rocker shaft · Valve bridges · Pushrods · Injectors Refer to Disassembly and Assembly for additional information. **C.** Check for valves that do not move freely. Remove the cylinder head and inspect the valves. Refer to Disassembly and Assembly for additional information.	Valve train	**Result:** The valve train components are not damaged. Proceed to Test Step 10. **Result:** The valve train components are damaged. **Repair:** Make the necessary repairs, Verify that the repair eliminated the fault.
10. Pistons and Connecting Rods **A.** Inspect the pistons for damage and wear. **B.** Inspect the connecting rod bearings for damage and wear.	Pistons and connecting rods	**Result:** One or more components are worn or damaged. Replace any worn or damaged parts. Verify that the repair has eliminated the noise. **Result:** All components are OK. Proceed to Test Step 11.
11. Crankshaft **A.** Inspect the crankshaft and the related components. Look for worn thrust plates and wear on the crankshaft. **B.** Inspect the connecting rod bearings and the bearing surfaces on the crankshaft. Make sure that the bearings are in the correct position.	Crankshaft	**Result:** The crankshaft or the related components are damaged or worn. **Repair:** Repair or replace any damaged parts. Verify that the repair eliminated the fault. **Result:** All components are OK. Contact the Dealer Solutions Network (DSN).

i09623584

Engine Misfires, Runs Rough or Is Unstable

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

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

Probable Causes

- Diagnostic codes
- ECM Software
- Fuel supply
- Throttle position sensor
- CAN data link
- NRS valve or intake throttle valve
- High-pressure fuel pump
- Low compression (cylinder pressure)
- Electronic unit injectors
- Aftertreatment contains oil or fuel

Recommended Actions

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

Table 38

Troubleshooting Test Steps	Values	Results
1. Diagnostic Codes **A.** Establish communication between the electronic service tool and the Electronic Control Module (ECM). Refer to Troubleshooting, “Electronic Service Tools”, if necessary. **B.** Download the Histograms before performing any troubleshooting or clearing any diagnostic codes. **Note:** The downloaded information will be required by the Dealer Solutions Network (DSN) if troubleshooting assistance is needed. **C.** Use the electronic service tool to check for active or logged codes.	Codes	**Result:** There are active codes. **Repair:** Troubleshoot any active codes before continuing with this procedure. **Result:** There are no active codes. Proceed to Test Step 2.
2. ECM Software **A.** Verify that the latest engine software is installed in the ECM.	Engine software	**Result:** The latest engine software is not installed. **Repair:** Install the latest engine software. refer to Troubleshooting, ECM Software - Install for the correct procedure. Run the engine and check if the fault is eliminated. If the fault is eliminated, return the engine to service. If the fault is eliminated, return the engine to service. If the fault is still present, proceed to Test Step 3. **Result:** The latest engine software is installed. Proceed to Test Step 3.
3. Fuel Supply **A.** Visually check the fuel tank for fuel. The fuel gauge may be faulty. **B.** Ensure that the vent in the fuel cap is not filled with debris. **C.** Ensure that the fuel supply valve (if equipped) is in the full OPEN position. **D.** Check the primary filter/water separator for water in the fuel. **E.** Check for fuel supply or return lines that are restricted. Aged or perished fuel lines may collapse when in service and cause temporary restrictions. **F.** Check that the Electric Priming Pump (EPP) is operating. If the EFLP is suspect, refer to Troubleshooting, “Fuel Transfer Pump - Test”. **G.** Check for air in the fuel system. Refer to Systems Operation, Testing and Adjusting, “Air in Fuel - Test”. **H.** Obtain a fuel analysis to confirm that the correct fuel is being used. Refer to Systems Operation, Testing and Adjusting, “Fuel Quality - Test” for the correct procedure.	Fuel supply	**Result:** There is air in the fuel system. **Repair:** Prime the fuel system. Refer to Systems Operation, Testing, and Adjusting, “Fuel System - Prime”. **Result:** The fuel quality is not OK. **Repair:** Replace the fuel. Replace the in line fuel filter that is upstream of the EPP. Replace the primary and secondary fuel filters. Verify that the repair eliminated the fault. Proceed to Test Step 11. **Result:** The fuel quality is OK. Proceed to Test Step 4.

(continued)

(Table 38, contd)

Troubleshooting Test Steps	Values	Results
4. Clean the Fuel System **A.** Following the instructions on the bottle, add T400012 Perkins Fuel System Cleaner to the fuel tank.	Electronic Unit Injectors	**Result:** Performance should be restored within 2-3 hours. Return the unit to service, the fuel system will be cleaned during operation. **Result:** Performance is not restored within 2-3 hours. Proceed to Test Step 5.
5. Throttle Position Sensor **Note:** This Test Step is only applicable if the machine has a hand or foot throttle. **A.** Use the electronic service tool and observe the signal for the throttle position sensor. Make sure that the throttle response is smooth and progressive.	Throttle	**Result:** The throttle position sensor response is erratic. **Repair:** Test the throttle position sensor. Refer to Troubleshooting, “Speed Control (Analog) - Test” or Troubleshooting, “Speed Control (PWM) - Test”. Proceed to Test Step 11. **Result:** The throttle position sensor response is OK. Proceed to Test Step 6.
6. Check the CAN Data Link **Note:** This Test Step is only applicable if the desired engine speed signal is sent through the CAN data link. **A.** Use the electronic service tool to check for diagnostic codes that are related to the CAN data link.	Throttle	**Result:** The CAN data link is suspect. **Repair:** Test the CAN data link. Refer to Troubleshooting, “CAN Data Link - Test”. Proceed to Test Step 11. **Result:** The CAN data link is OK. Proceed to Test Step 7.
7. NRS Valve or Engine Intake Throttle Valve **A.** Use the electronic service tool to perform the “Air System Motor Valve Verification Test” .	Pass	**Result:** The “Air System Motor Valve Verification Test” failed. **Repair:** Troubleshoot active diagnostic codes generated as a result of the test. **Result:** The “Air System Motor Valve Verification Test” passed. Proceed to Test Step 8.

(continued)

(Table 38, contd)

Troubleshooting Test Steps	Values	Results
8. High-Pressure Fuel Pump SCV **A.** Use the electronic service tool to perform a solenoid test on the fuel injection pump. Refer to Troubleshooting, "Solenoid Valve - Test".	HP fuel pump	**Result:** The solenoid valve test fails. **Repair:** Replace the HP fuel pump SCV and solenoid assembly. Proceed to Test Step 11. **Result:** The solenoid valve test passes successfully. Proceed to Test Step 9.
9. Low Compression (Cylinder Pressure) **A.** Perform a compression test. Refer to Systems Operation, Testing and Adjusting, "Compression - Test".	Cylinder compression	**Result:** The results of the compression test are outside the specifications. **Repair:** Investigate the cause and rectify any faults. **Note:** Possible causes of low compression are shown in the following list: · Loose glow plugs · Faulty piston · Faulty piston rings · Worn cylinder bores · Worn valves · Faulty cylinder head gasket · Damaged cylinder head Proceed to Test Step 11. **Result:** The results of the compression test are OK. Proceed to Test Step 10.

WARNING

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

NOTICE

Contact with high-pressure fuel may cause personal injury or death. Wait 10 minutes after the engine has stopped to allow fuel pressure to purge before any service or repair is performed on the engine fuel lines.

Table 39

Troubleshooting Test Steps	Values	Results
10. Electronic Unit Injectors **A.** Use the electronic service tool to perform the automatic "Cylinder Cutout Test" . **Note:** If the compression test that was performed in Test Step 7 was satisfactory, the "Cylinder Cutout Test" will identify any faulty injectors.	Electronic Unit Injectors	**Result:** A faulty injector is indicated. **Repair:** Remove any faulty electronic unit injectors. Refer to Disassembly and Assembly, "Electronic Unit Injector - Remove". Install new electronic unit injectors. Refer to Disassembly and Assembly, "Electronic Unit Injector - Install". Repeat the automatic "Cylinder Cutout Test" . If the fault is still apparent, remove the replacement electronic unit injector and install the original electronic unit injector. Refer to Disassembly and Assembly, "Electronic Unit Injector - Remove" and Disassembly and Assembly, "Electronic Unit Injector - Install". Proceed to Test Step 12. **Result:** All injectors are OK. Proceed to Test Step 11.
11. Check the Aftertreatment System for Oil or Fuel **A.** Remove excess oil or fuel from the piping with a clean cloth. **B.** Remove the Clean Emissions Module (CEM). Refer to Disassembly and Assembly, "Clean Emissions Module - Remove and Install". **C.** Support the CEM over a suitable container with the exhaust inlet downwards. Leave the CEM to drain for 8 hours. **D.** Check the quantity of drained oil or fuel in the container.	CEM	**Result** The volume of drained oil or fuel is greater than 0.3 L (0.31701 qt). **Repair:** Install a replacement CEM. Refer to Disassembly and Assembly, "Clean Emissions Module - Remove and Install". Return the unit to service. **Result** The volume of drained oil or fuel is less than 0.3 L (0.31701 qt). Proceed to Test Step 12.
12. Recover the Aftertreatment System **A.** Clean any remaining oil or fuel from the piping and the CEM inlet with a clean cloth. **B.** Install the Clean Emissions Module (CEM). Refer to Disassembly and Assembly, "Clean Emissions Module - Remove and Install". **C.** Run the engine at high idle with no load for a minimum of 20 minutes. **D.** Use the electronic service tool to perform the "Aftertreatment Recovery Procedure" . While the procedure is progressing, check for smoke from the exhaust. Some smoke will be evident during the procedure. The smoke must dissipate before the procedure is completed.	CEM	**Result:** The "Aftertreatment Recovery Procedure" completes with a soot load of less than 80% and no smoke from the exhaust. Return the unit to service. **Result** The "Aftertreatment Recovery Procedure" completes with a soot load of more than 80% or smoke from the exhaust. Contact the Dealer Solutions Network (DSN).

i07839170

Engine Overspeeds

This procedure covers the following diagnostic trouble codes:

Table 40

Diagnostic Trouble Codes for Engine Overspeed		
J1939 Code	**Code Description**	**Comments**
190-15	Engine Speed : High - least severe (1)	The engine has exceeded the value that is programmed into the Electronic Control Module (ECM) for 0.6 seconds. There are no diagnostic trouble codes for the speed/timing sensors. The engine has been running for at least 3 seconds.
190-0	Engine Speed : High - most severe (3)	The engine has exceeded the value that is programmed into the Electronic Control Module (ECM) for 0.6 seconds. There are no diagnostic trouble codes for the speed/timing sensors. The engine has been running for at least 3 seconds. The engine may shut down.

The ECM limits the flow of fuel to prevent the engine speed from exceeding the value that is programmed into the ECM. When the engine speed has dropped to less than the value that is programmed into the ECM, the 190-x code will be reset.

If the engine speed exceeds the value that is programmed into the ECM, the ECM illuminates the warning lamp and a 190-x code is logged. Factory passwords are required to clear the code. No troubleshooting is required.

The history of engine overspeeds can be viewed on the electronic service tool.

Probable Causes

- Proceeding down steep grades (if applicable)
- Diagnostic codes
- Turbocharger
- Combustible gases or liquid in the Intake air
- Aftertreatment system contains oil

Recommended Actions

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

Table 41

Troubleshooting Test Steps	Values	Results
1. Proceeding Down Steep Grades (If Applicable) Engaging the engine brakes on a steep grade may be necessary. Not all applications have engine brakes. **A.** Make sure that the operator understands the correct operation of the machine while using the engine brakes.	Steep grades	**Result:** Steep grades are the cause of the overspeed. **Repair:** Control the engine speed during steep grades. Running in this operating mode or rolling of the machine can cause the crankcase breather to fill with oil. This leads to oil leaking into the turbocharger. Proceed to Test Step 2. **Result:** Steep grades are not the cause of the overspeed. Proceed to Test Step 2.
2. Extended Idle Times **A.**Engines spending excessive time at idle with little load can lead to oil carryover. This could lead to overspeed. Refer to Operation and Maintenance Manual, Operation Section.	Idle times	**Result** The idle times are extensive. Reduce the idle times. Proceed to Test Step 6. **Result** The idle times are not extensive. Proceed to Test Step 3.
3. Diagnostic Codes **A.** Download the Product Status Report with Histograms before performing any troubleshooting or clearing any diagnostic codes. **Note:** The downloaded information will be required by the Dealer Solutions Network (DSN) if troubleshooting assistance is needed. **B.** Use the electronic service tool to check for active or logged codes.	Diagnostic codes	**Result:** A diagnostic code is not active or logged. Return the unit to service. **Result:** At least one of the diagnostic codes listed in Table 40 is active or recently logged. Proceed to Test Step 4.
4. Turbocharger **Note:** The turbocharger that is installed on the engine is a nonserviceable item. If any mechanical fault exists, then the faulty turbocharger must be replaced. **A.** Check for any oil that may be leaking into the intake air.	Turbocharger	**Note:** Some oil residue/pooling may be seen, but this is not an indication that the turbo has failed. If the compressor and turbine blades are undamaged and rotate freely, it is likely the turbocharger is fault free. **Result:** The turbocharger is leaking oil into the intake air. **Repair:** Replace the faulty turbocharger. Proceed to Test Step 6. **Result:** A turbocharger is not leaking oil into the intake air. Proceed to Test Step 5.

(continued)

(Table 41, contd)

Troubleshooting Test Steps	Values	Results
5. Combustible Gases or Liquid in the Intake Air **A.** Check for combustible gases in the surrounding atmosphere. **B.** Check for combustible liquid in the air intake.	Air quality	**Result:** The atmosphere has combustible gases. **Repair:** Do not operate the engine in an environment with combustible gases. **Result:** There is combustible liquid in the air intake. **Repair:** Remove the liquid. Investigate and rectify the cause of liquid ingestion **Result:** The intake air does not contain combustible gases. Proceed to Test Step 6.
6. Check the Aftertreatment System for Oil **A.** Remove excess oil from the piping with a clean cloth. **B.** Remove the Clean Emissions Module (CEM). Refer to Disassembly and Assembly, “Clean Emissions Module - Remove and Install”. **C.** Support the CEM over a suitable container with the exhaust inlet downwards. Leave the CEM to drain for 8 hours. **D.** Check the quantity of drained oil in the container.	CEM	**Result** The volume of drained oil is greater than 0.3 L (0.31701 qt). **Repair:** Install a replacement CEM. Refer to Disassembly and Assembly, “Clean Emissions Module - Remove and Install”. Return the unit to service. **Result** The volume of drained oil is less than 0.3 L (0.31701 qt). Proceed to Test Step 7.
7. Recover the Aftertreatment System **A.** Clean any remaining oil from the piping and the CEM inlet with a clean cloth. **B.** Install the Clean Emissions Module (CEM). Refer to Disassembly and Assembly, “Clean Emissions Module - Remove and Install”. **C.** Run the engine at high idle with no load for a minimum of 20 minutes. **Note:** During the following step, there are two versions of the “Aftertreatment Recovery Procedure” . One version is for engines with a DPF. The other version is for engines without a DPF. Ensure that the correct procedure is used. **D.** Use the electronic service tool to perform the “Aftertreatment Recovery Procedure” . While the procedure is progressing, check for smoke from the exhaust. Some smoke will be evident during the procedure. The smoke must dissipate before the procedure is completed.	CEM	**Result:** The “Aftertreatment Recovery Procedure” completes with a soot load of less than 80% and no smoke from the exhaust. Return the unit to service. **Result** The “Aftertreatment Recovery Procedure” completes with a soot load of more than 80% or smoke from the exhaust. Contact the Dealer Solutions Network (DSN).

i07580334

Engine Shutdown Occurs Intermittently

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

Probable Causes

- Active codes and logged codes
- Electrical connections
- Unstable fuel supply
- Switches
- Circuit protection
- Engine speed/timing

Table 42

Associated Diagnostic Trouble Codes
J1939 Code
3719-0
3719-16

Recommended Actions

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

Table 43

Troubleshooting Test Steps	Values	Results
1. Active Codes and Logged Codes **A.** Certain diagnostic codes and/or event codes may cause an engine shutdown. Connect the electronic service tool and check for active codes and for logged codes. **B.** Use the electronic service tool to check for associated diagnostic trouble codes. Refer to Table 42	Codes	**Result:** There are associated diagnostic trouble codes active or logged. **Repair:** Troubleshoot any active or logged associated diagnostic trouble codes before continuing with this procedure. **Result:** There are no associated diagnostic trouble codes active or logged. Proceed to Test Step 2.
2. Electrical Connections **A.** Check for the correct installation of the ECM J1/P1 and the J2/P2 connectors. Check for correct installation of the fuel injector connectors.	Connectors	**Result:** There are suspect connectors. **Repair:** Perform the “Wiggle Test” on the electronic service tool. Repair or replace connectors that are suspect. **Result:** There are no suspect connectors. Proceed to Test Step 3.
3. Electrical Connections **A.** Check the power and ground connections to the ECM. Refer to Troubleshooting, “Electrical Power Supply - Test”.	Electrical Connectors	**Result:** The electrical connections are OK. Proceed to Test Step 4. **Result:** The electrical connections are not OK. **Repair:** Repair or replace the damaged connectors. Verify that the repair eliminated the fault.
4. Unstable Fuel Supply **A.** Inspect the fuel system. Refer to Systems Operation, Testing and Adjusting, “Fuel System - Inspect” for additional information. Cold weather adversely affects the characteristics of the fuel. Refer to the engine Operation and Maintenance Manual, “Cold Weather Operation” for further information. **B.** Check fuel quality. Check the fuel tank for debris or foreign objects which may block the fuel supply. **C.** Check for air in the fuel system. Refer to Systems Operation, Testing and Adjusting, Air in Fuel - Test.	Fuel	**Result:** The fuel quality is OK. Proceed to Test Step 5. **Result:** The fuel quality is not OK. **Repair:** Replace the fuel. Verify that the repair eliminated the fault.

(continued)

(Table 43, contd)

Troubleshooting Test Steps	Values	Results
5. Switches **A.** Check the keyswitch input to the ECM. **B.** Check any engine shutdown switches and associated wiring.	Switches	**Result:** The shutdown switches and wiring are OK. Proceed to Test Step 6. **Result:** The shutdown switches and wiring are not OK. **Repair:** Make the necessary repairs, Verify that the repair eliminated the fault.
6. Circuit Protection **A.** Inspect the wires and connectors to all circuit protection for the engine. **B.** Check the device for circuit protection.	Circuit protection	**Result** The circuit protection device is tripped. **Repair:** Reset the circuit breakers if the circuit breakers are tripped. If necessary, replace blown fuses. Prior to returning the engine to service, determine the condition that caused the circuit breaker to trip or the fuse to blow. Make the necessary repairs. **Result** The circuit protection device is OK. Proceed to Test Step 7.
7. Engine Speed/Timing Sensors **A.** Inspect the connectors for the engine speed/timing sensors. **B.** Crank the engine. If the engine starts and no speed timing codes are logged, the speed timing circuit is operating correctly.	Speed/Timing	**Result:** The Speed/Timing sensor circuit is not operating correctly. **Repair:** Test the speed/timing circuit. Refer to Troubleshooting, “Speed/Timing `- Test”. Verify that the repair eliminated the fault. If the fault is still present, contact the Dealer Solutions Network (DSN).

i08166720

Engine Stalls at Low RPM

Probable Causes

- Diagnostic codes
- Accessory equipment
- Power mode control (if equipped)
- Fuel supply
- Low compression (cylinder pressure)
- Electronic unit injectors

Recommended Actions

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

Table 44

Troubleshooting Test Steps	Values	Results
1. Diagnostic Codes **A.** Establish communication between the electronic service tool and the Electronic Control Module (ECM) . If necessary, refer to Troubleshooting, "Electronic Service Tools". **B.** Check if any codes are active or logged.	Diagnostic code	**Result:** A code is active or logged. **Repair:** Troubleshoot any codes before continuing with this procedure. **Result:** A code is not active or logged. Proceed to Test Step 2.
2. Accessory Equipment **A.** Check all accessory equipment for faults that may create excessive load on the engine.	Accessories	**Result:** An engine accessory is creating an excessive load. **Repair:** Repair or replace the engine accessory. **Result:** An engine accessory is not creating an excessive load. Proceed to Test Step 3.
3. Power Mode Control (If Equipped) **A.** Refer to Troubleshooting, "CAN Data Link - Test". **B.** Check the engine wiring harness for defects. Refer to Troubleshooting, "Electrical Connectors - Inspect".	Power mode control	**Result:** There is a fault in the data link. **Repair:** Repair the data link, as necessary. **Result:** There is a wiring fault. **Repair:** Repair or replace the wiring, as necessary. **Result:** The data link and the wiring are OK. Proceed to Test Step 4.

(continued)

(Table 44, contd)

Troubleshooting Test Steps	Values	Results
4. Fuel Supply **A.** Ensure that the vent in the fuel cap is not filled with debris. **B.** Ensure that the fuel supply valve (if equipped) is in the full OPEN position. **C.** If the temperature is below 0 °C (32 °F), check for solidified fuel (wax). **D.** Check the primary filter/water separator for water in the fuel. **E.** Check for fuel supply lines that are restricted. **F.** Replace the in-line fuel filter that is installed upstream of the Electric Priming Pump (EPP). **G.** Check that the EPP is operating correctly. **H.**Replace any filters and/or screens in the fuel system. Refer to Operation and Maintenance Manual for further information. **I.** Check the diesel fuel for contamination. Refer to Systems Operation, Testing, and Adjusting, “Fuel Quality - Test”. **J.** Check for air in the fuel system. Refer to Systems Operation, Testing, and Adjusting, “Air in Fuel - Test”.	Fuel system	**Result:** The vent in the fuel cap is blocked. **Repair:** Install a replacement fuel cap. **Result:** The fuel contains solidified wax. **Repair:** Replace the fuel with fuel of the correct specification for the ambient conditions. **Result:** There are fuel supply lines that are restricted. **Repair:** Replace any damaged or restricted fuel lines. The EFLP is suspect. Refer to Troubleshooting, “Fuel Transfer Pump - Test”. Replace any filters and/or screens in the fuel system. Refer to Operation and Maintenance Manual for further information. **Result:** There is air in the fuel system. **Repair:** Prime the fuel system. Refer to Systems Operation, Testing, and Adjusting, “Fuel System - Prime”. **Result:** The diesel fuel is contaminated. **Repair:** Drain the fuel tank and the fuel system. Replace any filters and/or screens in the fuel system. Refer to Operation and Maintenance Manual for further information. Fill and prime the fuel system with fuel of the correct specification. Refer to Systems Operation, Testing, and Adjusting, “Fuel System - Prime”. **Result:** The fuel supply is OK. Proceed to Test Step 5.
5. Low Compression (Cylinder Pressure) **A.** Perform a compression test. Refer to Systems Operation, Testing, and Adjusting, “Compression - Test”.	Cylinder compression	**Result:** The results of the compression test are outside the specifications. Investigate the cause and rectify any faults. **Note:** Possible causes of low compression are shown in the following list: · Loose glow plugs · Faulty piston · Faulty piston rings · Worn cylinder bores · Worn valves · Faulty cylinder head gasket · Damaged cylinder head

(continued)

(Table 44, contd)

Troubleshooting Test Steps	Values	Results
		Result: The results of the compression test are OK. Proceed to Test Step 6.
6. Electronic Unit Injectors **A.** Use the electronic service tool to perform the automatic “Cylinder Cutout Test” . **Note:** If the compression test that was performed in Test Step 5 was satisfactory, the “Cylinder Cutout Test” will identify any faulty injectors.	Electronic Unit Injectors	**Result:** A faulty injector is indicated. **Repair:** Remove any faulty electronic unit injectors. Refer to Disassembly and Assembly, “Electronic Unit Injector - Remove”. Install new electronic unit injectors. Refer to Disassembly and Assembly, “Electronic Unit Injector - Install”. Repeat the automatic “Cylinder Cutout Test” . If the fault is still apparent, remove the replacement electronic unit injector and install the original electronic unit injector. Refer to Disassembly and Assembly, “Electronic Unit Injector - Remove” and Disassembly and Assembly, “Electronic Unit Injector - Install”. **Result:** All injectors are OK. Contact the Dealer Solutions Network (DSN).

i07945590

Engine Top Speed Is Not Obtained

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

Probable Causes

- Diagnostic codes
- ECM parameters
- Accessory and/or parasitic loads
- Flash file
- Throttle signal
- Air intake and exhaust system
- Turbocharger
- Fuel supply
- Return fuel lines
- Low compression (cylinder pressure)
- Electronic unit injectors
- Individual malfunctioning cylinders

Table 45

Associated Diagnostic Trouble Codes
J1939 Code
157-18

Recommended Actions

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

Table 46

Troubleshooting Test Steps	Values	Results
1. Diagnostic Codes **A.** Establish communication between the electronic service tool and the Electronic Control Module (ECM). Refer to Troubleshooting, “Electronic Service Tools”, if necessary. **B.** Use the electronic service tool to check for active or logged codes.	Diagnostic codes	**Result:** There are active or logged codes. **Repair:** Troubleshoot any codes before continuing with this procedure. **Result:** There are no active or logged codes. Proceed to Test Step 2.
2. ECM Parameters **A.** Use the electronic service tool to verify that the correct engine parameters are being used. Refer to Troubleshooting, “Configuration Parameters” for additional information. **B.** If applicable, verify that all parameters for any parasitic loads are correct.	Parameters	**Result:** The parameters are not configured correctly. **Repair:** Correctly configure the parameters. Verify that the configuration change eliminated the fault. **Result:** The parameters are configured correctly. Proceed to Test Step 3.
3. Accessory and/or Parasitic Loads **A.** Check all accessory equipment for problems that may create excessive load on the engine. **B.** Check for any excess parasitic load on the engine.	Parasitic loads	**Result:** There is an excessive load on the engine. **Repair:** Diagnose and repair the fault. Verify that the repair eliminated the fault. **Result:** There is not an excessive load on the engine. Proceed to Test Step 4.
4. Flash File **A.** Verify that the latest flash file is installed in the Electronic Control Module (ECM). Refer to Troubleshooting, “ECM Software - Install” for the correct procedure.	Flash file	**Result:** The latest flash file is not installed in the ECM. **Repair:** Install the latest flash file. Verify that the repair eliminated the fault. **Result:** The latest flash file is installed in the ECM. Proceed to Test Step 5.
5. Throttle Signal **A.** Use the electronic service tool and observe the throttle signal. Make sure that the throttle reaches the 100% raw position and the calibrated position.	CAN data link	**Result:** The throttle signal is erratic or does not reach the 100% raw position or the calibrated position. **Repair:** Refer to the appropriate circuit test for the type of throttle that is installed. **Result:** The throttle signal is OK. Proceed to Test Step 6.

(continued)

(Table 46, contd)

Troubleshooting Test Steps	Values	Results
6. Air Intake and Exhaust System **A.** Check the air filter restriction indicator, if equipped. **B.** Check the air intake and the exhaust system for the following defects: · Signs of dirt ingress · Blockages · Restrictions · Damage to the air intake and exhaust lines and hose **C.** Check for ECM codes for inlet air restriction: 107-15: Engine Air Filter 1 Differential Pressure high - least severe (1) 107-16: Engine Air Filter 1 Differential Pressure high - moderate severity (2) **D.** Check the engine has not exceeded the service interval for the air cleaner element. Refer to Operation and Maintenance Manual.	Air intake and exhaust system	**Result:** The air filter restriction indicator has operated or the air filter is blocked. **Repair:** Make sure that the air filter is clean and serviceable. If necessary, replace the air filter. **Result:** The air intake or the exhaust system is blocked, restricted, or damaged. **Repair:** Repair the air intake or the exhaust system, as required. **Result:** A 107-15 or 107-16 code is active **Repair:** Refer to Troubleshooting, Inlet Air is Restricted. **Result:** The service interval for the air cleaner element has been exceeded. **Repair:** Replace the air cleaner element. Refer to Operation and Maintenance Manual, Engine Air Cleaner Element - Replace. **Result:** The air intake or the exhaust system is OK. Proceed to Test Step 7.
7. Turbocharger **Note:** The turbocharger that is installed on the engine is a non-serviceable item. If any mechanical fault exists, then the faulty turbocharger must be replaced. **A.** Ensure that the mounting bolts for the turbocharger are tight. **B.** Check that the oil drain for the turbocharger is not blocked or restricted. **C.** Check that the compressor housing for the turbocharger is free of dirt and debris. Make sure that the housing is not damaged. **D.** Check that the turbine housing for the turbocharger is free of dirt and debris. Make sure that the housing is not damaged. **E.** Check that the turbine blades rotate freely in the turbocharger.	Turbocharger	**Note:** Some oil residue/pooling may be seen, but this is not an indication that the turbo has failed. If the compressor and turbine blades are undamaged and rotate freely, it is likely the turbocharger is fault free. **Result:** There is a fault in the turbocharger. **Repair:** Replace the turbocharger. Refer to Disassembly and Assembly, "Turbocharger - Remove" and Disassembly and Assembly, "Turbocharger - Install". **Result:** The turbocharger is OK. Proceed to Test Step 8.

⚠ WARNING

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

NOTICE

Contact with high-pressure fuel may cause personal injury or death. Wait 10 minutes after the engine has stopped to allow fuel pressure to purge before any service or repair is performed on the engine fuel lines.

Table 47

Troubleshooting Test Steps	Values	Results
8. Fuel Supply **A.** Check for leaks from the high-pressure fuel lines. **B.** Ensure that the vent in the fuel cap is not filled with debris. **C.** Ensure that the fuel supply valve (if equipped) is in the full OPEN position. **D.** If the temperature is below 0 °C (32 °F), check for solidified fuel (wax). **E.** Check the primary filter/water separator for water in the fuel. **F.** Check for fuel supply lines that are restricted. **G.** Replace the in-line fuel filter that is installed upstream of the Electric Priming Pump (EPP). **H.** Replace the primary fuel filter. Replace the secondary fuel filter (if equipped). **I.** Check the diesel fuel for contamination. Refer to Systems Operation, Testing, and Adjusting, “Fuel Quality - Test”. **J.** Check for air in the fuel system. Refer to Systems Operation, Testing, and Adjusting, “Air in Fuel - Test”.	Fuel system	**Result:** There is a leak from a high-pressure fuel line. **Repair:** Replace the high-pressure fuel line. Refer to Disassembly and Assembly, “Fuel injection lines - Remove” and Disassembly and Assembly, “Fuel injection lines - Install”. **Result:** The vent in the fuel cap is blocked. **Repair:** Install a replacement fuel cap. **Result:** The fuel contains solidified wax. **Repair:** Replace the fuel with fuel of the correct specification for the ambient conditions. **Result:** There are fuel supply lines that are restricted. **Repair:** Replace any damaged or restricted fuel lines. Replace the primary fuel filter. Replace the secondary fuel filter (if equipped). Refer to the Operation and Maintenance Manual for further information. **Result:** There is air in the fuel system. **Repair:** Prime the fuel system. Refer to Systems Operation, Testing, and Adjusting, “Fuel System - Prime”. **Result:** The diesel fuel is contaminated. **Repair:** Drain the fuel tank and the fuel system. Replace the primary fuel filter. Replace the secondary fuel filter (if equipped). Refer to the Operation and Maintenance Manual for further information. Fill and prime the fuel system with fuel of the correct specification. Refer to Systems Operation, Testing, and Adjusting, “Fuel System - Prime”. **Result:** The fuel supply is OK. Proceed to Test Step 9.
9. Check the Return Fuel Lines **A.** Make sure that the fuel return lines are not blocked or kinked.	Return lines	**Result:** The fuel return lines are blocked or kinked. **Repair:** Clear or replace the blocked line. **Result:** The fuel return lines are clear. **Repair:** Proceed to Test Step 10.

(continued)

(Table 47, contd)

Troubleshooting Test Steps	Values	Results
10. Clean the Fuel System **A.** Following the instructions on the bottle, add Perkins Fuel System Cleaner T400012 to the fuel tank.	Electronic Unit Injectors	**Result:** Performance should be restored within 2-3 hours. Return the unit to service, the fuel system will be cleaned during operation. **Result:** Performance is not restored within 2-3 hours. Proceed to Test Step 11.
11. Low Compression (Cylinder Pressure) **A.** Perform a compression test. Refer to Systems Operation, Testing, and Adjusting, “Compression - Test”.	Cylinder compression	**Result:** The results of the compression test are outside the specifications. **Repair:** Investigate the cause and rectify any faults. **Note:** Possible causes of low compression are shown in the following list: · Loose glow plugs · Faulty piston · Faulty piston rings · Worn cylinder bores · Worn valves · Faulty cylinder head gasket · Damaged cylinder head **Result:** The results of the compression test are OK. Proceed to Test Step 12.

(continued)

(Table 47, contd)

Troubleshooting Test Steps	Values	Results
12. Electronic Unit Injectors **A.** Use the electronic service tool to perform the automatic “Cylinder Cutout Test” . **Note:** If the compression test that was performed in Test Step 10 was satisfactory, the “Cylinder Cutout Test” will identify any faulty injectors.	Electronic Unit Injectors	**Result:** A faulty injector is indicated. **Repair:** Remove any faulty electronic unit injectors. Refer to Disassembly and Assembly, “Electronic Unit Injector - Remove”. Install new electronic unit injectors. Refer to Disassembly and Assembly, “Electronic Unit Injector - Install”. Repeat the automatic “Cylinder Cutout Test” . If the fault is still apparent, remove the replacement electronic unit injector and install the original electronic unit injector. Refer to Disassembly and Assembly, “Electronic Unit Injector - Remove” and Disassembly and Assembly, “Electronic Unit Injector - Install”. **Result:** All injectors are OK. Proceed to Test Step 13.
13. Individual Malfunctioning Cylinders **A.** With the engine speed at a fast idle, use the electronic service tool to perform the manual “Cylinder Cutout Test” . As each cylinder is cut out, listen for a change in the sound from the engine. When a cylinder is cut out, there should be a noticeable change in the sound of the engine. **Note:** If a change in the sound of the engine is not noted, the isolated cylinder is not operating under normal conditions. If the isolation of a cylinder results in a change in the sound that is less noticeable, the cylinder may be operating below normal performance.	Cylinders	**Result:** The test indicates a faulty cylinder. **Repair:** Investigate the cause of the fault on any cylinder that is not operating. Investigate the cause of the fault on any cylinder that is operating below normal performance. **Result:** The test indicates that all cylinders are OK. Contact the Dealer Solutions Network (DSN).

i07945592

Engine Vibration Is Excessive

Refer to Systems Operation, Testing and Adjusting for additional information on determining the cause of this condition.

Probable Causes

- Driven equipment
- Engine supports
- Low compression (cylinder pressure)
- Electronic unit injectors
- Individual malfunctioning cylinder

Recommended Actions

Note: When performing the following procedure, do not stand near the engine. The vibration may indicate an imminent component failure.

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

Table 48

Troubleshooting Test Steps	Values	Results
1. Driven Equipment **A.** Inspect the mounting bolts for the driven equipment. Inspect the alignment and the balance of the driven equipment. **B.** Inspect the coupling.	Driven equipment	**Result** The driven equipment and the alignment are not OK. **Repair:** Repair or replace the driven equipment. **Result:** The driven equipment and the alignment are OK. Proceed to Test Step 2.
2. Engine Supports **A.** Inspect the mounts and the brackets while you run the engine through the speed range. Look for mounts and brackets that are loose and/or broken. **B.** Check the alignment of the following before operating the engine under load for any length of time: · Mounts · Coupling	Engine supports	**Result:** The mounts and brackets are loose and/or broken. Replace the mounts and brackets that are loose and/or broken. **Result:** The mounts and brackets are not loose and/or broken. Proceed to Test Step 3.
3. Clean the Fuel System **A.** Following the instructions on the bottle, add Perkins Fuel System Cleaner T400012 to the fuel tank.	Electronic Unit Injectors	**Result:** Performance should be restored within 2-3 hours. Return the unit to service, the fuel system will be cleaned during operation. **Result:** Performance is not restored within 2-3 hours. Proceed to Test Step 4.
4. Low Compression (Cylinder Pressure) **A.** Perform a compression test. Refer to Systems Operation, Testing, and Adjusting, "Compression - Test".	Cylinder compression	**Result:** The results of the compression test are outside the specifications. **Repair:** Investigate the cause and rectify any faults. **Note:** Possible causes of low compression are shown in the following list: · Loose glow plugs · Faulty piston · Faulty piston rings · Worn cylinder bores · Worn valves · Faulty cylinder head gasket · Damaged cylinder head **Result:** The results of the compression test are OK. Proceed to Test Step 5.

(continued)

(Table 48, contd)

Troubleshooting Test Steps	Values	Results
5. Electronic Unit Injectors **A.** Use the electronic service tool to perform the automatic “Cylinder Cutout Test” . **Note:** If the compression test that was performed in Test Step 3 was satisfactory, the “Cylinder Cutout Test” will identify any faulty injectors.	Electronic Unit Injectors	**Result:** A faulty injector is indicated. **Repair:** Remove any faulty electronic unit injectors. Refer to Disassembly and Assembly, “Electronic Unit Injector - Remove”. Install new electronic unit injectors. Refer to Disassembly and Assembly, “Electronic Unit Injector - Install”. Repeat the automatic “Cylinder Cutout Test” . If the fault is still apparent, remove the replacement electronic unit injector and install the original electronic unit injector. Refer to Disassembly and Assembly, “Electronic Unit Injector - Remove” and Disassembly and Assembly, “Electronic Unit Injector - Install”. **Result:** All injectors are OK. Proceed to Test Step 6.
6. Individual Malfunctioning Cylinders **A.** With the engine speed at a fast idle, use the electronic service tool to perform the manual “Cylinder Cutout Test” . As each cylinder is cut out, listen for a change in the sound from the engine. When a cylinder is cut out, there should be a noticeable change in the sound of the engine. **Note:** If a change in the sound of the engine is not noted, the isolated cylinder is not operating under normal conditions. If the isolation of a cylinder results in a change in the sound that is less noticeable, the cylinder may be operating below normal performance.	Cylinders	**Result:** The test indicates a faulty cylinder. **Repair:** Investigate the cause of the fault on any cylinder that is not operating. Investigate the cause of the fault on any cylinder that is operating below normal performance. **Result:** The test indicates that all cylinders are OK. Contact the Dealer Solutions Network (DSN).

i07945593

Exhaust Has Excessive Black Smoke

If excessive black smoke is caused by an engine fault, the smoke will only be visible when the Diesel Particulate Filter (DPF) has also failed. Perform the following procedure to diagnose the cause of the black smoke and then investigate the failure of the DPF.

Note: A faulty DPF will allow some smoke to be visible. In this situation, there may not be a fault in the engine.

Probable Causes

- Diagnostic codes
- Parameters in the Electronic Control Module (ECM)
- Air intake system or exhaust system
- NRS Valve
- Valve lash
- Low compression (cylinder pressure)
- Electronic unit injectors
- Turbocharger
- Individual malfunctioning cylinder

Recommended Actions

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

Table 49

Troubleshooting Test Steps	Values	Results
1. Diagnostic Codes **A.** Download Histograms before performing any troubleshooting or clearing any diagnostic codes. **Note:** The downloaded information will be required by the Dealer Solutions Network (DSN) if troubleshooting assistance is needed. **B.** Use the electronic service tool to check for active or logged codes.	Diagnostic codes	**Result:** A diagnostic code is present. **Repair:** Troubleshoot the code. **Result:** A diagnostic code is not present. Proceed to Test Step 2.
2. Parameters in the Electronic Control Module (ECM) **A.** Use the electronic service tool to verify that the correct parameters are being used. Refer to Troubleshooting, “Configuration Parameters” for additional information.	Parameters	**Result:** The parameters are not correct. **Repair:** Input the correct parameters. Refer to Troubleshooting, “Configuration Parameters” for additional information. **Result:** The parameters are correct. Proceed to Test Step 3.
3. Air Intake and Exhaust System **A.** Check the air filter restriction indicator, if equipped. **B.** Check the air intake and the exhaust system for the following defects: · Signs of dirt ingress · Blockages · Restrictions · Damage to the air intake and exhaust lines and hose **C.** Check for ECM codes for inlet air restriction: 107-15: Engine Air Filter 1 Differential Pressure high - least severe (1) 107-16: Engine Air Filter 1 Differential Pressure high - moderate severity (2) **D.** Check the engine has not exceeded the service interval for the air cleaner element. Refer to Operation and Maintenance Manual.	Air intake and exhaust system	**Result:** The air filter restriction indicator has operated or the air filter is blocked. **Repair:** Make sure that the air filter is clean and serviceable. If necessary, replace the air filter. **Result:** The air intake or the exhaust system is blocked, restricted, or damaged. **Repair:** Repair the air intake or the exhaust system, as required. **Result:** A 107-15 or 107-16 code is active **Repair:** Refer to Troubleshooting, Inlet Air is Restricted. **Result:** The service interval for the air cleaner element has been exceeded. **Repair:** Replace the air cleaner element. Refer to Operation and Maintenance Manual, Engine Air Cleaner Element - Replace. **Result:** The air intake or the exhaust system is OK. Proceed to Test Step 4.

(continued)

(Table 49, contd)

Troubleshooting Test Steps	Values	Results
4. NRS Valve **A.** Use the electronic service tool to perform the "Air System Motor Valve Verification Test" .	Pass	**Result:** The "Air System Motor Valve Verification Test" failed. **Repair:** Troubleshoot active diagnostic codes generated as a result of the test. **Result:** The "Air System Motor Valve Verification Test" passed. Proceed to Test Step 5.
5. Clean the Fuel System **A.** Following the instructions on the bottle, add Perkins Fuel System Cleaner T400012 to the fuel tank.	Electronic Unit Injectors	**Result:** Performance should be restored within 2-3 hours. Return the unit to service, the fuel system will be cleaned during operation. **Result:** Performance is not restored within 2-3 hours. Proceed to Test Step 6.
6. Valve Lash **A.** Check the valve lash.	Valve lash	**Result:** The valve lash is incorrect. **Repair:** Check the valve lash. Refer to Systems Operation, Testing, and Adjusting, "Engine Valve Lash - Inspect" for the correct procedure. **Result:** The valve lash is correct. Proceed to Test Step 7.
7. Low Compression (Cylinder Pressure) **A.** Perform a compression test. Refer to Systems Operation, Testing, and Adjusting, "Compression - Test".	Cylinder compression	**Result:** The results of the compression test are outside the specifications. **Repair:** Investigate the cause and rectify any faults. **Note:** Possible causes of low compression are shown in the following list: · Loose glow plugs · Faulty piston · Faulty piston rings · Worn cylinder bores · Worn valves · Faulty cylinder head gasket · Damaged cylinder head **Result:** The results of the compression test are OK. Proceed to Test Step 8.

⚠ WARNING

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

NOTICE

Contact with high-pressure fuel may cause personal injury or death. Wait 10 minutes after the engine has stopped to allow fuel pressure to purge before any service or repair is performed on the engine fuel lines.

Table 50

Troubleshooting Test Steps	Values	Results
8. Electronic Unit Injectors **A.** Use the electronic service tool to perform the automatic "Cylinder Cut Out Test" . **Note:** If the compression test that was performed in Test Step 7 was satisfactory, the "Cylinder Cut Out Test" will identify any faulty injectors.	Electronic Unit Injectors	**Result:** A faulty injector is indicated. **Repair:** Remove any faulty electronic unit injectors. Refer to Disassembly and Assembly, "Electronic Unit Injector - Remove". Install new electronic unit injectors. Refer to Disassembly and Assembly, "Electronic Unit Injector - Install". Repeat the automatic "Cylinder Cut Out Test" . If the fault is still apparent, remove the replacement electronic unit injector and install the original electronic unit injector. Refer to Disassembly and Assembly, "Electronic Unit Injector - Remove" and Disassembly and Assembly, "Electronic Unit Injector - Install". **Result:** All injectors are OK. Proceed to Test Step 9.
9. Turbocharger **Note:** The turbocharger that is installed on the engine is a non-serviceable item. If any mechanical fault exists, then the faulty turbocharger must be replaced. **A.** Ensure that the mounting bolts for the turbocharger are tight. **B.** Check that the oil drain for the turbocharger is not blocked or restricted. **C.** Check that the compressor housing for the turbocharger is free of dirt and debris. Make sure that the housing is not damaged. **D.** Check that the turbine housing for the turbocharger is free of dirt and debris. Make sure that the housing is not damaged. **E.** Check that the turbine blades rotate freely in the turbocharger.	Turbocharger	**Note:** Some oil residue/pooling may be seen, but this is not an indication that the turbo has failed. If the compressor and turbine blades are undamaged and rotate freely, it is likely the turbocharger is fault free. **Result:** There is a fault in the turbocharger. **Repair:** Replace the turbocharger. Refer to Disassembly and Assembly, "Turbocharger - Remove" and Disassembly and Assembly, "Turbocharger - Install". **Result:** The turbocharger is OK. Proceed to Test Step 10.
10. Individual Malfunctioning Cylinders **A.** With the engine speed at a fast idle, use the electronic service tool to perform the manual "Cylinder Cut Out Test" . As each cylinder is cut out, listen for a change in the sound from the engine. When a cylinder is cut out, there should be a noticeable change in the sound of the engine. If a change in the sound of the engine is not noted, the isolated cylinder is not operating under normal conditions. If the isolation of a cylinder results in a change in the sound that is less noticeable, the cylinder may be operating below normal performance.	Cylinders	**Result:** The test indicates a faulty cylinder. **Repair:** Investigate the cause of the fault on any cylinder that is not operating. Investigate the cause of the fault on any cylinder that is operating below normal performance. **Result:** The test indicates that all cylinders are OK. Contact the Dealer Solutions Network (DSN).

i07945595

Exhaust Has Excessive White Smoke

Note: Some white smoke may be present during cold start-up conditions and during acceleration after a prolonged period at low idle. If the white smoke persists, there may be a fault.

Probable Causes

- Diagnostic codes
- ECM Flash file
- Glow plugs
- Coolant temperature
- Cooling system
- Fuel quality
- Valve lash
- Low compression (cylinder pressure)
- Electronic unit injectors
- Individual malfunctioning cylinder
- Aftertreatment system contains oil or fuel

Recommended Actions

Diagnostic Codes

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

Table 51

Troubleshooting Test Steps	Values	Results
1. Diagnostic Codes **A.** Establish communication between the electronic service tool and the Electronic Control Module (ECM). Refer to Troubleshooting, "Electronic Service Tools", if necessary. **B.** Download the Histograms before performing any troubleshooting or clearing any diagnostic codes. **Note:** The downloaded information will be required by the Dealer Solutions Network (DSN) if troubleshooting assistance is needed. **C.** Determine if a code is active or logged.	Diagnostic codes	**Result:** A code is active or logged. **Repair:** Troubleshoot any active codes before continuing with this procedure. **Result:** A code is not active or logged. Proceed to Test Step 2.
2. ECM Flash File **A.** Verify that the latest flash file is installed in the ECM.	Flash file	**Result:** The latest flash file is not installed. **Repair:** Install the latest flash file. Refer to Troubleshooting, "ECM Software - Install" for the correct procedure. Verify that the repair eliminates the fault. **Result:** The latest flash file is installed. Proceed to Test Step 3.
3. Glow Plugs **Note:** Faulty glow plugs will only affect the production of white smoke when the ambient temperature is below 5° C (41° F). **A.** Check operation of glow plugs. Verify that the glow plugs are operating correctly. Refer to Troubleshooting, "Glow Plug Starting Aid - Test".	Glow plugs	**Result:** The glow plugs are not operating correctly. **Repair:** Make the necessary repairs. Verify that the repair corrected the fault. **Result:** The glow plugs are operating correctly. Proceed to Test Step 4.
4. Coolant Temperature **A.** Check that the water temperature regulator is operating correctly. Refer to Systems Operation, Testing and Adjusting, "Water Temperature Regulator - Test".	Coolant temperature	**Result:** The water temperature regulator is not operating correctly. **Repair:** Replace the water temperature regulator. Verify that the repair corrected the fault. **Result:** The water temperature regulator is operating correctly. Proceed to Test Step 5.
5. Cooling System **A.** Check for an internal coolant leak into the cylinder and/or the exhaust. Refer to Systems Operation, Testing and Adjusting, "Cooling System".	Internal coolant leak	**Result:** There is an internal coolant leak. **Repair:** Make the necessary repairs. Verify that the repair eliminated the fault. **Result:** There is not an internal coolant leak. Proceed to Test Step 6.

(continued)

(Table 51, contd)

Troubleshooting Test Steps	Values	Results
6. Fuel Quality **A.** Check the fuel quality. Refer to Systems Operation, Testing and Adjusting, “Fuel Quality - Test”. **B.** Refer to Operation and Maintenance Manual for information on the proper characteristics of the fuel for the engine.	Fuel	**Result:** The fuel quality is not OK. **Repair:** Drain the fuel system and replace the fuel filters. Refer to the Operation and Maintenance Manual, “Fuel System Primary Filter (Water Separator) Element - Replace” and Operation and Maintenance Manual, “Fuel System Filter - Replace”. Fill the fuel system with fuel that meets the standard in the Operation and Maintenance Manual, “Fluid Recommendations”. Prime the fuel system. Refer to the Operation and Maintenance Manual, “Fuel System - Prime”. Proceed to Test Step 12. **Result:** The fuel quality is OK. Proceed to Test Step 7.
7. Valve Lash **Note:** The valve lash can affect the performance of the engine. **A.** Check the valve lash.	Valve lash	**Result:** The valve lash is not set correctly. **Repair:** Check the valve lash. Refer to Systems Operation, Testing and Adjusting, “Engine Valve Lash - Inspect” for the correct procedure. Proceed to Test Step 11. **Result:** The valve lash is correct. Proceed to Test Step 8.
8. Low Compression (Cylinder Pressure) **A.** Perform a compression test. Refer to Systems Operation, Testing and Adjusting, “Compression - Test”.	Cylinder compression	**Result:** The results of the compression test are outside the specifications. **Repair:** Investigate the cause and rectify any faults. **Note:** Possible causes of low compression are shown in the following list: · Loose glow plugs · Faulty piston · Faulty piston rings · Worn cylinder bores · Worn valves · Faulty cylinder head gasket · Damaged cylinder head Proceed to Test Step 12. **Result:** The results of the compression test are OK. Proceed to Test Step 9.

(continued)

(Table 51, contd)

Troubleshooting Test Steps	Values	Results
9. Electronic Unit Injectors **A.** Use the electronic service tool to perform the automatic “Cylinder Cutout Test” . **Note:** If the compression test that was performed in Test Step 8 was satisfactory, the “Cylinder Cutout Test” will identify any faulty injectors.	Electronic Unit Injectors	**Result:** A faulty injector is indicated. **Repair:** Remove any faulty electronic unit injectors. Refer to Disassembly and Assembly, “Electronic Unit Injector - Remove”. Install new electronic unit injectors. Refer to Disassembly and Assembly, “Electronic Unit Injector - Install”. Repeat the automatic “Cylinder Cutout Test” . If the fault is still apparent, remove the replacement electronic unit injector and install the original electronic unit injector. Refer to Disassembly and Assembly, “Electronic Unit Injector - Remove” and Disassembly and Assembly, “Electronic Unit Injector - Install”. Proceed to Test Step 12. **Result:** All injectors are OK. Proceed to Test Step 10.
10. Clean the Fuel System **A.** Following the instructions on the bottle, add Perkins Fuel System Cleaner T400012 to the fuel tank.	Electronic Unit Injectors	**Result:** Performance should be restored within 2-3 hours. Return the unit to service, the fuel system will be cleaned during operation. **Note:** The engine should be run in a manner to protect the hardware - at idle or low speed and load. **Result:** Performance is not restored within 2-3 hours. Proceed to Test Step 11.
11. Individual Malfunctioning Cylinders **A.** With the engine speed at a fast idle, use the electronic service tool to perform the manual “Cylinder Cutout Test” . As each cylinder is cut out, listen for a change in the sound from the engine. When a cylinder is cut out, there should be a noticeable change in the sound of the engine. If a change in the sound of the engine is not noted, the isolated cylinder is not operating under normal conditions. If the isolation of a cylinder results in a change in the sound that is less noticeable, the cylinder may be operating below normal performance.	Cylinders	**Result:** The test indicates a faulty cylinder. **Repair:** Investigate the cause of the fault on any cylinder that is not operating. Investigate the cause of the fault on any cylinder that is operating below normal performance. Proceed to Test Step 12. **Result:** The test indicates that all cylinders are OK. Contact the Dealer Solutions Network (DSN).

(continued)

(Table 51, contd)

Troubleshooting Test Steps	Values	Results
12. Check the Aftertreatment System for Oil or Fuel **A.** Remove excess oil or fuel from the piping with a clean cloth. **B.** Remove the Clean Emissions Module (CEM). Refer to Disassembly and Assembly, “Clean Emissions Module - Remove and Install”. **C.** Support the CEM over a suitable container with the exhaust inlet downwards. Leave the CEM to drain for 8 hours. **D.** Check the quantity of drained oil or fuel in the container.	CEM	**Result** The volume of drained oil or fuel is greater than 0.3 L (0.31701 qt). **Repair:** Install a replacement CEM. Refer to Disassembly and Assembly, “Clean Emissions Module - Remove and Install”. Return the unit to service. **Result** The volume of drained oil or fuel is less than 0.3 L (0.31701 qt). Proceed to Test Step 13.
13. Recover the Aftertreatment System **A.** Clean any remaining oil or fuel from the piping and the CEM inlet with a clean cloth. **B.** Install the Clean Emissions Module (CEM). Refer to Disassembly and Assembly, “Clean Emissions Module - Remove and Install”. **C.** Run the engine at high idle with no load for a minimum of 20 minutes. **D.** Use the electronic service tool to perform the “Aftertreatment Recovery Procedure” . While the procedure is progressing, check for smoke from the exhaust. Some smoke will be evident during the procedure. The smoke must dissipate before the procedure is completed.	CEM	**Result:** The “Aftertreatment Recovery Procedure” completes with a soot load of less than 80% and no smoke from the exhaust. Return the unit to service. **Result** The “Aftertreatment Recovery Procedure” completes with a soot load of more than 80% or smoke from the exhaust. Contact the Dealer Solutions Network (DSN).

i07945605

Exhaust System Contains Coolant

Use the following procedure to troubleshoot a problem with coolant in the exhaust system.

Probable Causes

- NOx Reduction System (NRS) cooler
- Cylinder head gasket
- Cylinder head
- Cylinder block

Recommended Actions

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

Note: After the repair has been made, the electronic service tool must be used to perform an “Aftertreatment System Functional Test” . The test will verify the correct functionality of both NOx sensors and the catalysts.

Table 52

Troubleshooting Test Steps	Values	Results
1. NRS cooler **A.** Check the NRS cooler for leaks. Refer to Systems Operation, Testing, and Adjusting, "Exhaust Cooler (NRS) - Test".	NRS cooler	**Result :** The NRS cooler has a leak. **Repair:** Replace the NRS cooler. Refer to the Disassembly and Assembly manual for the correct procedure. Proceed to Step 5. **Result :** The NRS cooler does not have a leak. Proceed to Test Step 2.
2. Cylinder head gasket leak **A.** Check the cylinder head gasket for leaks.	Cylinder head gasket	**Result :** The cylinder head gasket is leaking. Proceed to Test Step 3. **Result :** The cylinder head gasket is not leaking. Proceed to Test Step 3.
3. Cylinder head **A.** Check for cracks in the cylinder head. Perform a leak test on the cylinder head. Refer to the Systems Operation, Testing, and Adjusting, "Cylinder Head - Inspect" for the correct procedure.	Cylinder head	**Result :** A crack is found in the cylinder head. **Repair:** Repair the cylinder head or replace the cylinder head. Refer to the Disassembly and Assembly manual. Proceed to Test Step 4. **Result :** The cylinder head is OK. Proceed to Test Step 4.
4. Cylinder Block **A.** Check for cracks in top face of the cylinder block. Refer to the Systems Operation, Testing, and Adjusting, "Cylinder Block - Inspect" for the correct procedure.	Cylinder head	**Result :** A crack is found in the cylinder block. **Repair:** Repair the cylinder block or replace the cylinder block. Refer to the Disassembly and Assembly manual. **Repair:** Assemble the cylinder head with a new cylinder head gasket. Refer to the Disassembly and Assembly manual. Proceed to Test Step 5. **Result :** The cylinder block is OK. **Repair:** Assemble the cylinder head with a new cylinder head gasket. Refer to the Disassembly and Assembly manual. Proceed to Test Step 5.

(continued)

(Table 52, contd)

Troubleshooting Test Steps	Values	Results
5. Perform an “Aftertreatment System Functional Test” **A.** Start the engine. **B.** Connect the electronic service tool to the diagnostic connector. **C.** Navigate to “Diagnostics Tests” . **D.** Perform the “Aftertreatment System Functional Test” .	System test	**Result :** The test is successful. Return the engine to service. **Result :** The test is not successful. There are diagnostic codes. **Repair:** Troubleshoot the additional codes. Refer to Troubleshooting, “Diagnostic Trouble Codes” manual for the correct procedure. Proceed to Test Step 6.
6. Clean the Fuel System **A.** Following the instructions on the bottle, add Perkins Fuel System Cleaner T400012 to the fuel tank.	Electronic Unit Injectors	Return the unit to service, the fuel system will be cleaned during operation.

i08768442

Exhaust System Contains Oil

Probable Causes

- Extended idle times
- Air intake system or exhaust system
- Turbocharger
- Worn valve guide seals or faulty valve guide seals
- Worn valve guides
- Worn piston rings
- Aftertreatment system contains oil

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

Refer to Special Instruction, M0134553 for additional troubleshooting for the turbocharger.

Table 53

Troubleshooting Test Steps	Values	Results
1. Extended Idle Times **A.** Extended idle times will allow oil to pass into the exhaust system. Refer to Operation and Maintenance Manual, Operation Section.	Idle times	**Result** The idle times are extensive. Reduce the idle times. Proceed to Test Step 6. **Result** The idle times are not extensive. Proceed to Test Step 2.
2. Air Intake and Exhaust System **A.** Check the air filter restriction indicator, if equipped. **B.** Check the air intake and the exhaust system for the following defects: · Signs of dirt ingress · Blockages · Restrictions · Damage to the air intake and exhaust lines and hose **C.** Check for ECM codes for inlet air restriction: 107-15: Engine Air Filter 1 Differential Pressure high - least severe (1) 107-16: Engine Air Filter 1 Differential Pressure high - moderate severity (2) **D.** Check that the engine has not exceeded the service interval for the air cleaner element. Refer to Operation and Maintenance Manual.	Air intake and exhaust system	**Result:** The air filter restriction indicator has operated or the air filter is blocked. **Repair:** Make sure that the air filter is clean and serviceable. If necessary, replace the air filter. **Result:** The air intake or the exhaust system is blocked, restricted, or damaged. **Repair:** Repair the air intake or the exhaust system, as required. **Result:** A 107-15 or 107-16 code is active **Repair:** Refer to Troubleshooting, Inlet Air is Restricted. **Result:** The service interval for the air cleaner element has been exceeded. **Repair:** Replace the air cleaner element. Refer to Operation and Maintenance Manual, Engine Air Cleaner Element - Replace. **Result:** The air intake or the exhaust system is OK. Proceed to Test Step 3.
3. Worn Valve Guide Seals or Faulty Valve Guide Seals **A.** Inspect the valve guide seals for wear and for damage.	Valve guide seals	**Result:** The valve guide seals are damaged. **Repair:** Replace the valve guide seals. Verify the repair. Proceed to Test Step 6. **Result:** The valve guide seals are not damaged. Proceed to Test Step 4.

(continued)

(Table 53, contd)

Troubleshooting Test Steps	Values	Results
4. Worn Valve Guides **A.** Inspect the valve guides for wear. Refer to the Specification manual for the maximum permissible wear of the valve guides.	Valve guides	**Result:** The valve guides are worn. **Repair:** If necessary, recondition the cylinder head. Verify the repair. Proceed to Test Step 6. **Result:** The valve guides are not worn. Proceed to Test Step 5.
5. Worn Piston Rings **Note:** This step does not apply to engines equipped with an open crankcase breather. **A.** Remove the pistons. Refer to Disassembly and Assembly, “Pistons and Connecting Rods - Remove”. **B.** Remove the piston rings from the pistons. Refer to Disassembly and Assembly, “Pistons and Connecting Rods - Disassemble” **C.** Inspect the pistons and piston rings for wear or damage. Refer to the “Specifications” manual for further information.	Piston rings	**Result** The piston rings are worn. **Repair:** Replace the piston rings. Verify the repair. Proceed to Test Step 6. **Result** The piston rings are not worn. Contact the Dealer Solutions Network (DSN).
6. Check the Aftertreatment System for Oil **A.** Remove excess oil from piping with a clean cloth. **B.** Remove the Clean Emissions Module (CEM). Refer to Disassembly and Assembly, “Clean Emissions Module - Remove and Install”. **C.** Support the CEM over a suitable container with the exhaust inlet downwards. Leave the CEM to drain for 8 hours. **D.** Check the quantity of drained oil in the container.	CEM	**Result** The volume of drained oil is greater than 0.3 L (0.31701 qt). **Repair:** Install a replacement CEM. Refer to Disassembly and Assembly, “Clean Emissions Module - Remove and Install”. Return the unit to service. **Result** The volume of drained oil is less than 0.3 L (0.31701 qt). Proceed to Test Step 7.

(continued)

(Table 53, contd)

Troubleshooting Test Steps	Values	Results
7. Recover the Aftertreatment System **A.** Clean any remaining oil from the piping and the CEM inlet with a clean cloth. **B.** Install the Clean Emissions Module (CEM). Refer to Disassembly and Assembly, "Clean Emissions Module - Remove and Install". **C.** Run the engine at high idle with no load for a minimum of 20 minutes. **D.** Use the electronic service tool to perform the "Aftertreatment Recovery Procedure" . While the procedure is progressing, check for smoke from the exhaust. Some smoke will be evident during the procedure. The smoke must dissipate before the procedure is completed.	CEM	**Result:** The "Aftertreatment Recovery Procedure" completes with a soot load of less than 80% and no smoke from the exhaust. Proceed to Test Step 8 **Result** The "Aftertreatment Recovery Procedure" completes with a soot load of more than 80% or smoke from the exhaust. Contact the Dealer Solutions Network (DSN).
8. Clean the Fuel System **A.** Following the instructions on the bottle, add Perkins Fuel System CleanerT400012 to the fuel tank.	Electronic Unit Injectors	Return the unit to service, the fuel system will be cleaned during operation.

i07901371

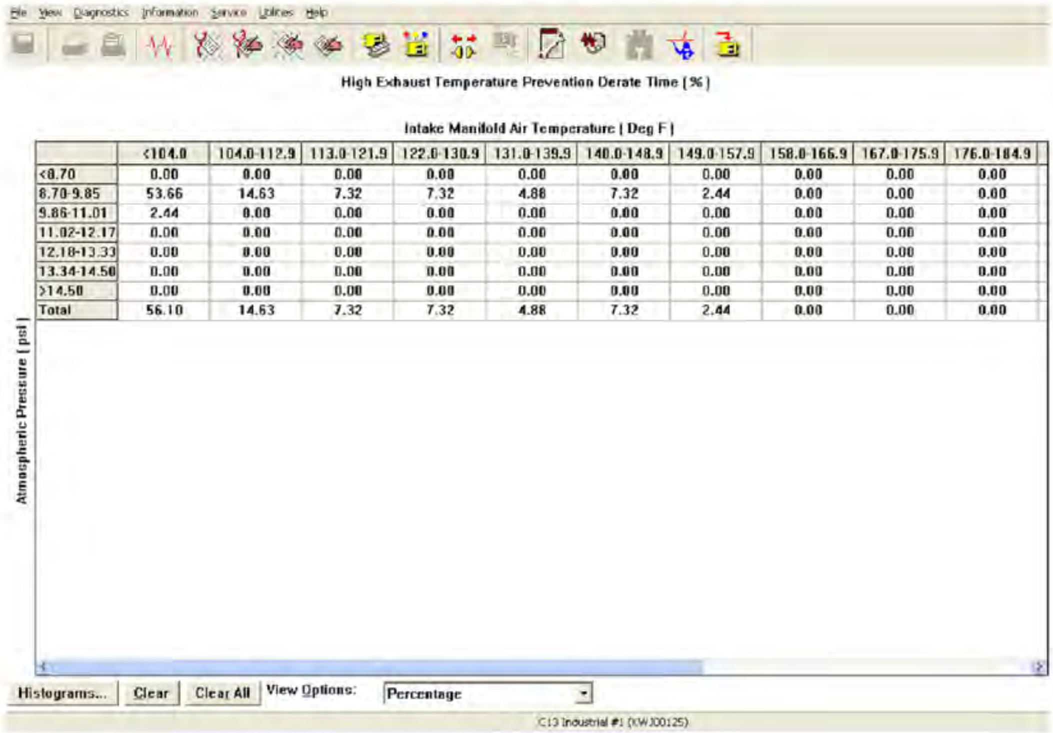
Exhaust Temperature Is High

The Electronic Control Module (ECM) monitors the temperature sensor in the outlet from the turbocharger.

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

Probable Causes

- Inlet system leak/restriction
- Engine operating conditions
- Failed engine intake throttle valve
- High altitude
- Obstructed Air-to-Air Aftercooler (ATAAC)



	<104.0	104.0-112.9	113.0-121.9	122.0-130.9	131.0-139.9	140.0-148.9	149.0-157.9	158.0-166.9	167.0-175.9	176.0-184.9
<8.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.70-9.85	53.66	14.63	7.32	7.32	4.88	7.32	2.44	0.00	0.00	0.00
9.86-11.01	2.44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11.02-12.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12.18-13.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
13.34-14.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
>14.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	56.10	14.63	7.32	7.32	4.88	7.32	2.44	0.00	0.00	0.00

Illustration 12 g03844797

Example of an electronic service tool screenshot of the histogram. This histogram is populated when the engine system has calculated a condition in which high exhaust temperatures are present. A diagnostic code will not be logged when the system calculates a high exhaust temperature condition. The engine will be derated to protect the engine system. This situation is normal under most circumstances and no additional troubleshooting is necessary.

Note: Information from this histogram is to be used with active and logged diagnostic trouble codes. This histogram is for information only.

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

Table 54

Troubleshooting Test Steps	Values	Results
1. Check for Inlet System Leakage/Restrictions **A.** Apply a light load to the engine and check for leakage from the inlet system downstream of the turbocharger. **B.** Check the air inlet system for restrictions. Check for ECM codes for inlet air restriction: 107-15: Engine Air Filter 1 Differential Pressure high - least severe (1) 107-16: Engine Air Filter 1 Differential Pressure high - moderate severity (2) **C.** Replace any plugged air filters. Refer to the Operation and Maintenance Manual.	Boost leaks	**Result:** Leakage was found. **Repair:** Repair the leaks. Return the unit to service. **Result:** A 107-15 or 107-16 code is active **Repair:** Refer to Troubleshooting, Inlet Air is Restricted. **Result:** There are restrictions in the air inlet or exhaust system. **Repair:** Make the necessary repairs, Refer to Systems Operation, Testing and Adjusting, “Air Inlet and Exhaust System - Inspect” for additional information. **Result:** No leaks or restrictions are found. Proceed to Test Step 2.
2. Check the Engine Operating Conditions **A.** Use the electronic service tool to check the histograms. Use the histograms to determine if the high exhaust temperature was due to normal operation. If possible, interview the operator. Determine if the engine is being operated under heavy load. Ensure that the engine is being operated at an acceptable engine speed. If derates are suspected, reset the histogram and return the unit to service. If the histogram repopulates without fault codes, the derating of the engine was under normal engine operation.	Normal operation	**Result:** The code was logged during a heavy load. **Repair:** Reduce the load on the engine. Return the unit to service. **Result:** The code was not logged during a heavy load. Proceed to Test Step 3.
3. Check the Engine Intake Throttle Valve **A.** Check the engine intake throttle valve for correct operation. Use the electronic service tool to perform the “Air System Motor Valves Verification Test” . If the “Air System Motor Valves Verification Test” indicates a fault, refer to Troubleshooting, “Motorized Valve - Test” for the correct troubleshooting procedure.	Failed engine intake throttle valve	**Result:** The engine intake throttle valve has failed. **Repair:** Repair or replace the valve. Refer to Disassembly and Assembly, Throttle Valve (Intake Air) - Remove and Install. If a new valve is fitted, use the electronic service tool to run the “Engine Throttle Valve Replacement Reset” and then use the electronic service tool to run the “Air System Motor Valves Verification Test” . If the valve is repaired, use the electronic service tool to perform the “Air System Motor Valves Verification Test” and verify that the repair eliminates the fault. **Result:** The engine intake throttle valve has not failed. Proceed to Test Step 4.

(continued)

(Table 54, contd)

Troubleshooting Test Steps	Values	Results
4. Check the Engine Operating Altitude **A.** Check the engine operating altitude. **Note:** High altitudes can cause high exhaust temperatures, consider the operational altitude when troubleshooting a high exhaust temperature. High exhaust temperatures are associated with high operational altitudes. When operating below 5500ft and the ambient temperature is below 30° C (85° F), altitude should not cause a high exhaust temperature derate.	High operational altitudes	**Result:** The engine was operating at high altitudes. The high exhaust temperature was due to high altitudes. Return the unit to service. **Result:** The engine was not operating at high altitudes. Proceed to Test Step 5.
5. Check for an Obstructed Air-to-Air Aftercooler (ATAAC) **A.** The intake manifold air temperature can increase if the flow through the ATAAC is obstructed. Check the ATAAC for obstructions or debris. Ensure that the flow of air or coolant through the ATAAC is adequate.	Obstructed aftercooler	**Result:** The engine ATAAC was obstructed. **Repair:** Clear any obstructions. Return the unit to service. If the procedure did not correct the issue, contact the Dealer Solutions Network (DSN).

i07945626

Fuel Consumption Is Excessive

Probable Causes

- Diagnostic codes
- Misreading of fuel level
- Fuel leakage
- Fuel quality
- Quality of oil
- Coolant temperature
- Prolonged operation at idle speed
- Air intake and exhaust system
- Cooling fan
- Reduced pressure of intake air
- Excessive valve lash
- Failure of the primary speed/timing sensor

Recommended Actions

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

Table 55

Troubleshooting Test Steps	Values	Results
1. Diagnostic Codes **Note:** Certain diagnostic codes and/or event codes may cause high fuel consumption. **A.** Use the electronic service tool to check for active or logged codes.	Diagnostic codes	**Result:** A diagnostic code is present. **Repair:** Troubleshoot the code and then verify that the fuel consumption is normal. **Result:** A diagnostic code is not present. Proceed to Test Step 2.
2. Misreading of Fuel Level **Note:** Misreading of the fuel gauge can give a false indication of fuel consumption. **A.** Monitor the fuel consumption over a period of 50 engine hours.	Fuel level	**Result:** Fuel consumption is normal for the operating conditions. Return the unit to service. **Result:** Fuel consumption is high for the operating conditions. Proceed to Test Step 3.
3. Fuel Leakage **A.** Check the engine for signs of fuel leakage.	Fuel leaks	**Result:** Evidence of a fuel leak is found. **Repair:** Repair or replace the component that is leaking fuel. **Result:** No evidence of a fuel leak is found. Proceed to Test Step 4.
4. Fuel Quality **Note:** The grade of the fuel affects the rate of fuel consumption. Refer to the engines Operation and Maintenance Manual for additional information. Cold weather adversely affects the characteristics of the fuel. Refer to the Operation and Maintenance Manual for information on improving the characteristics of the fuel during cold-weather operation. **A.** Check the fuel quality. Refer to Systems Operation, Testing and Adjusting, “Fuel Quality - Test”. **B.** Refer to Operation and Maintenance Manual for information on the proper characteristics of the fuel for the engine.	Fuel quality	**Result:** The fuel quality does not meet specifications. **Repair:** Drain the fuel system and replace the fuel filters. Refer to the Operation and Maintenance Manual, “Fuel System Primary Filter (Water Separator) Element - Replace” and Operation and Maintenance Manual, “Fuel System Filter - Replace”. Fill the fuel system with fuel that meets the standard in the Operation and Maintenance Manual, “Fluid Recommendations”. Prime the fuel system. Refer to the Operation and Maintenance Manual, “Fuel System - Prime”. Proceed to Test Step 5. **Result:** The fuel quality meets specifications. Proceed to Test Step 5.

(continued)

(Table 55, contd)

Troubleshooting Test Steps	Values	Results
5. Clean the Fuel System **A.** Following the instructions on the bottle, add Perkins Fuel System Cleaner T400012 to the fuel tank.	Electronic Unit Injectors	**Result:** Performance should be restored within 2-3 hours. Return the unit to service, the fuel system will be cleaned during operation. **Result:** Performance is not restored within 2-3 hours. Proceed to Test Step 6.
6. Quality of Oil **Note:** The nominal viscosity of the lubricating oil that is used in the engine will affect the rate of fuel consumption. The viscosity of lubricating oil is defined by the SAE grade of the lubricating oil. The grade of the lubricating oil must be correct for the ambient conditions. Lubricating oil for high ambient temperatures will affect fuel consumption in cold ambient temperatures. **A.** Check that the engine oil meets the required specification. Refer to “Engine Oil” in the Operation and Maintenance Manual, “Refill Capacities”.	Engine oil quality	**Result:** The engine oil does not meet the required specification. **Repair:** Drain and fill the oil system with oil of an acceptable quality. Refer to the applicable sections in the Operation and Maintenance Manual. **Result:** The engine oil meets the required specification. Proceed to Test Step 7.
7. Coolant Temperature **Note:** The operating temperature of the engine will affect the rate of fuel consumption. Operation of the engine below the correct temperature will increase fuel consumption. Failure of the water temperature regulator can prevent the engine from operating at the correct temperature. **A.** Check that the water temperature regulator is operating correctly. Refer to Systems Operation, Testing and Adjusting, “Water Temperature Regulator - Test”.	Coolant temperature	**Result:** The water temperature regulator is not operating correctly. **Repair:** Replace the water temperature regulator. Verify that the repair corrected the fault. **Result:** The water temperature regulator is operating correctly. Proceed to Test Step 8.
8. Prolonged Operation at Idle Speed **Note:** Prolonged operation of the engine at idle speed increases fuel consumption. **A.** Check for extended periods of engine operation at idle speed.	Extended idle operation	**Result:** The engine is operating at idle speed for extended periods. When possible, stop the engine to conserve fuel. **Result:** The engine is not operating at idle speed for extended periods. Proceed to Test Step 9.

(continued)

(Table 55, contd)

Troubleshooting Test Steps	Values	Results
9. Air Intake and Exhaust System **A.** Check the air filter restriction indicator, if equipped. **B.** Check the air intake and the exhaust system for the following defects: · Signs of dirt ingress · Blockages · Restrictions · Damage to the air intake and exhaust lines and hose **C.** Check for ECM codes for inlet air restriction: 107-15: Engine Air Filter 1 Differential Pressure high - least severe (1) 107-16: Engine Air Filter 1 Differential Pressure high - moderate severity (2) **D.** Check the engine has not exceeded the service interval for the air cleaner element. Refer to Operation and Maintenance Manual.	Air intake and exhaust system	**Result:** The air filter restriction indicator has operated or the air filter is blocked. **Repair:** Make sure that the air filter is clean and serviceable. If necessary, replace the air filter. **Result:** The air intake or the exhaust system is blocked, restricted, or damaged. **Repair:** Repair the air intake or the exhaust system, as required. **Result:** A 107-15 or 107-16 code is active **Repair:** Refer to Troubleshooting, Inlet Air is Restricted. **Result:** The service interval for the air cleaner element has been exceeded. **Repair:** Replace the air cleaner element. Refer to Operation and Maintenance Manual, Engine Air Cleaner Element - Replace. **Result:** The air intake or the exhaust system is OK. Proceed to Test Step 10.
10. Cooling Fan **Note:** Excessive operation of the cooling fan or damage to the cooling fan will increase fuel consumption. **A.** Check the operation and condition of the cooling fan.	Cooling fan	**Result:** The cooling fan is operating excessively. **Repair:** Repair or replace the faulty cooling fan components. **Result:** The cooling fan is damaged excessively. **Repair:** Repair or replace the faulty cooling fan components. **Result:** The cooling fan is not operating excessively and is not damaged. Proceed to Test Step 11.
11. Reduced Pressure of Intake Air **Note:** If the air pressure is lower than normal, the same power can only be achieved by the following: · Higher engine speed · Injection of more fuel Either of these conditions will increase the fuel consumption. **A.** Check all pipes from the outlets of the turbocharger compressor to the inlet manifold for leaks. **B.** Check for the correct operation of the wastegate in the turbocharger.	Intake air	**Result:** There is a leak in the intake air system. **Repair:** Repair the leak or replace the component that is causing the leak. **Result:** The turbocharger wastegate is not operating correctly. **Repair:** Replace the turbocharger. **Result:** The air intake system and the wastegate are OK. Proceed to Test Step 12.

(continued)

(Table 55, contd)

Troubleshooting Test Steps	Values	Results
12. Excessive Valve Lash **A.** Check for excessive valve lash.	Valve lash	**Result:** The valve lash is incorrect. **Repair:** Check the valve lash. Refer to Systems Operation, Testing and Adjusting, “Engine Valve Lash - Inspect” for the correct procedure. **Result:** The valve lash is correct. Proceed to Test Step 13.
13. Failure of the Primary Speed/Timing Sensor **A.** Crank the engine and observe the engine speed on the electronic service tool status screen. Upon initial cranking, the status for engine speed may indicate that the engine speed signal is abnormal. This message will be replaced with an engine speed once the ECM is able to calculate a speed from the signal.	Primary Speed/ Timing Sensor	**Result:** The primary speed/timing sensor is not operating correctly. **Repair:** Test the primary speed/timing sensor. Refer to Troubleshooting, “Speed/Timing - Test”. **Result:** The primary speed/timing sensor is operating correctly. Contact the Dealer Solutions Network (DSN).

i07710968

Fuel Contains Water

This procedure covers the following diagnostic code:

Table 56

Diagnostic Trouble Code for Water in Fuel		
J1939 Code	**Code Description**	**Comments**
97-15	Water In Fuel Indicator : High - least severe (1)	Water has been detected in the fuel that is contained in the fuel/water separator bowl. The water has been present for at least 5 seconds. The warning lamp will come on.
97-16	Water In Fuel Indicator : High - moderate severity (2)	Water has been detected in the fuel that is contained in the fuel/water separator bowl. The water has been present for at least 60 minutes. The warning lamp will come on. The engine will be derated at 10% per second up to a maximum of 100%.

Note: Visual identification of water in the bowl may be impossible. Water may turn dark yellow in the fuel system. The similarity in color would prevent the ability to differentiate the water from the fuel.

Recommended Actions

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

Table 57

Troubleshooting Test Steps	Values	Results
1. Drain the Fuel/Water Separator Bowl **A.** Turn the ignition key to the OFF position. **B.** Drain the fuel/water separator bowl. Refer to the Operation and Maintenance Manual, "Fuel System Primary Filter/Water Separator - Drain". **C.** If necessary, prime the fuel system. Refer to the Operation and Maintenance Manual, "Fuel System - Prime". **D.** Turn the ignition key to the ON position. Do not start the engine. Wait for 1 minute.	Fuel/water separator	**Result:** The "Water-In-Fuel" warning disappears within 1 minute. Proceed to Test Step 2. **Result:** The "Water-In-Fuel" warning remains on. Proceed to Test Step 3.
2. Confirm that there is no Water in the Fuel **A.** Run the engine for 5 minutes.	Water in fuel	**Result:** The "Water-In-Fuel" warning does not reappear within the 5 minutes. Return the unit to service. **Result:** The "Water-In-Fuel" warning reappears within the 5 minutes. **Repair:** The fuel supply is contaminated with water. Drain the fuel tank and then fill the fuel tank with clean fuel. Repeat the procedure from Test Step 1. If the fault is still present, contact the Dealer Solutions Network (DSN).
3. Water-In-Fuel Switch **A.** Check the operation of the Water-In-Fuel switch. Refer to Troubleshooting, "Water In Fuel - Test".	Water in fuel switch	**Result:** The Water-In-Fuel switch circuit required a repair. Repeat the procedure from Test Step 1. **Result** The Water-In-Fuel switch is OK. **Repair:** The fuel supply is contaminated with water. Drain the fuel tank and then fill the fuel tank with clean fuel. Repeat the procedure from Test Step 1. If the fault is still present, contact the Dealer Solutions Network (DSN).

i08481139

Fuel Rail Pressure Problem

Use this procedure to troubleshoot abnormal fuel rail pressure or use this procedure if any of the following diagnostic trouble codes are active. Refer to Troubleshooting, "Diagnostic Trouble Codes" for information about the codes.

Table 58

Diagnostic Trouble Codes for Fuel Rail Pressure Problem		
J1939 Code	**Code Description**	**Comments**
157-16	Engine Injector Metering Rail #1 Pressure: High - moderate severity (2)	No other 157-XX codes are active. 3509-XX codes are not active. 3510-XX codes are not active. No codes for the high-pressure fuel pump or the injectors are active. The fuel rail pressure is above an acceptable level. The code is logged. Engine power is derated.
157-18	Engine Injector Metering Rail #1 Pressure: Low - moderate severity (2)	No other 157-XX codes are active. 3509-XX codes are not active. 3510-XX codes are not active. No codes for the high-pressure fuel pump or the injectors are active. The fuel rail pressure is below an acceptable level. The code is logged. Engine power is derated.
5571-0	High Pressure Common Rail Fuel Pressure Relief Valve : Active	3509-XX codes are not active. 3510-XX codes are not active. The pressure limiting valve in the fuel rail is open. This code is a calculated parameter. The code is logged.

Probable Causes

- Diagnostic codes
- Electrical connectors
- Fuel filters
- Fuel rail pressure sensor
- High-pressure fuel pump calibration
- Fuel system

Recommended Actions

⚠ WARNING

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

Table 59

Troubleshooting Test Steps	Values	Results
1. Download Information Using the Electronic Service Tool **A.** Use the electronic service tool to download the "Product Status Report" (PSR) with histograms before performing any trouble-shooting or clearing any diagnostic codes. **Note:** The downloaded information will be required by the Dealer Solutions Network (DSN) if troubleshooting assistance is required.	Downloaded information	**Result:** The information was successfully saved. Proceed to Test Step 2. **Result:** The electronic service tool information was not successfully saved. Contact the Dealer Solutions Network (DSN) for guidance.
2. Create an Electronic Service Tool Snapshot **A.** Select "Snapshot Viewer" on the electronic service tool, using menus: Information -> Snapshot -> Viewer **B.** Select the event code and then click "View Graph" . **C.** Select the following parameter and then click OK. · Engine Speed **D.** Select Save to "File to save" a Snapshot File (*.xml). This file will contain all the data in the snapshot and not only the data shown on the graph. **Note:** The downloaded information will be required by the DSN if troubleshooting assistance is required.	Snapshot saved	**Result:** The electronic service tool snapshot was suc-cessfully saved. Proceed to Test Step 3. **Result:** The electronic service tool snapshot was not successfully saved. Contact the DSN for guidance.
3. Diagnostic Codes **A.** Connect the electronic service tool to the diagnostic connector. Refer to Troubleshooting, "Electronic Service Tools", if necessary. **B.** Determine if a diagnostic is active or recently logged.	Diagnostic codes	**Result:** One of the codes in Table 58 is present. Proceed to Test Step 4. **Result:** A code other than the codes in Table 58 is present. **Repair:** Troubleshoot the code. Refer to the applicable troubleshooting procedure.
4. Fuel Rail Pressure Sensor **A.** Make sure that the engine has been shut down for at least 10 minutes. Use the electronic service tool to check the status of the "Fuel Rail Pressure" .	Pressure sensor	**Result:** The "Fuel Rail Pressure (absolute)" is more than 5,000 kPa (725 psi). **Repair:** Test the fuel rail pressure sensor. Refer to Trou-bleshooting, "Sensor Signal (analog, Active) - Test". Use the electronic service tool to perform the "Fuel Rail Pressure Test". If the test fails, replace the fuel pressure sensor. Refer to Disassembly and Assembly, "Fuel Pressure Sensor - Remove and Install". Confirm that the fault has been eliminated. **Result:** The "Fuel Rail Pressure (absolute)" is less than 5,000 kPa (725 psi). Proceed to Test Step 5.

(continued)

(Table 59, contd)

Troubleshooting Test Steps	Values	Results
5. Electrical Connectors **A.** Check for the correct installation of the ECM J1/P1 and the J2/P2 connectors. Check for correct installation of the connector on the fuel rail pressure sensor. Check for correct installation of the connector for the flow control valve on the high-pressure fuel pump.	Connectors	**Result:** There are suspect connectors. **Repair:** Use the electronic service tool to perform the “Wiggle Test” . Repair or replace connectors that are suspect. **Result:** There are no suspect connectors. Proceed to Test Step 6.
6. High-Pressure Fuel Pump Calibration **A.** Use the electronic service tool to perform the “High Pressure Fuel Pump Calibration” .	Fuel system	**Result:** Fuel rail pressure is normal after performing the “High Pressure Fuel Pump Calibration” . Return the unit to service. **Result:** Fuel rail pressure is still high after performing the “High Pressure Fuel Pump Calibration” . Run the engine for a minimum of 30 minutes. Proceed to Test Step 7.
7. Fuel System **A.** Visually check the fuel tank for fuel. **Note:** The fuel gauge may be faulty. **B.** Check the primary filter/water separator for water in the fuel or debris. **C.** If the temperature is below 0 °C (32 °F), check for solidified fuel (wax). **D.** Check that the EPP is operating correctly. **E.** Check for fuel supply lines that are restricted or not correctly installed. **F.** Check for air in the fuel system and that the fuel system is primed. **G.** Use the electronic service tool to perform the “Fuel Rail Pressure Relief Valve Test” . **H.** Inspect the high-pressure fuel system for leaks. **I.** Replace the in-line fuel filter that is installed upstream of the Electric Priming Pump (EPP). **J.** Replace any filters and/or screens in the fuel system. Refer to Operation and Maintenance Manual for further information. **K.** Check the diesel fuel for contamination. Refer to Systems Operation, Testing, and Adjusting, “Fuel Quality - Test”.	Fuel system	**Result:** There is a leak from the high-pressure fuel system. **Repair:** Rectify any fuel leaks. **Result:** The fuel contains solidified wax. **Repair:** Replace the fuel with fuel of the correct specification for the ambient conditions. Replace any filters and/or screens in the fuel system. Refer to Operation and Maintenance Manual for further information. **Result:** There are fuel supply lines that are restricted or not correctly installed. **Repair:** Install the fuel lines correctly. Replace any damaged or restricted fuel lines. **Result:** The EPP is not operating correctly. **Repair:** Investigate the fault with the EPP. Refer to Troubleshooting, “Fuel Transfer Pump - Test”. **Result:** There is air in the fuel system. **Repair:** Prime the fuel system. Refer to Systems Operation, Testing, and Adjusting, “Fuel System - Prime”. **Result:** The diesel fuel is contaminated. **Repair:** Drain the fuel tank and the fuel system.

(continued)

(Table 59, contd)

Troubleshooting Test Steps	Values	Results
Note: This test will identify excessive leakage through the Pressure Limiting Valve (PLV) in the fuel rail.		Replace any filters and/or screens in the fuel system. Refer to Operation and Maintenance Manual for further information. Fill and prime the fuel system with fuel of the correct specification. Refer to Systems Operation, Testing, and Adjusting, “Fuel System - Prime”. **Result:** The low-pressure fuel system is OK. If the fault is still present, contact the DSN and provide the following information from Test Step 1 and Test Step 2: • PSR and Histograms • Snapshot data

i07581514

Fuel Temperature Is High

If either of the following diagnostic trouble codes are active, perform the procedure that follows:

Table 60

Diagnostic Trouble Codes for Fuel Temperature Is High		
J1939 Code	**Code Description**	**Comments**
174-16	Engine Fuel Temperature 1 : High - moderate severity (2)	The temperature of the low-pressure fuel in the high-pressure fuel pump is high. The ECM has been powered for at least 2 seconds. The engine has been operating for at least 185 seconds. There are no other faults in the electrical system. The warning lamp will come on. The engine may be derated by up to 100%. The warning lamp will go off when the temperature drops below the trip point for 15 seconds.

Probable causes

- Incorrect position of fuel shut-off valves
- Fuel level in tank
- Return fuel cooler
- Return fuel lines
- Location of the fuel tank

Note: The procedures have been listed in order of probability. Complete the procedure in the order in which the steps are listed.

Table 61

Troubleshooting Test Steps	Values	Results
1. Download Information Using the Electronic Service Tool **A.** Use the electronic service tool to download the “Product Status Report” (PSR) with histograms before performing any troubleshooting or clearing any diagnostic codes. **Note:** The downloaded information will be required by the Dealer Solutions Network (DSN) if troubleshooting assistance is required.	Downloaded information	**Result:** The information was successfully saved. Proceed to Test Step 2. **Result:** The electronic service tool information was not successfully saved. Contact the Dealer Solutions Network (DSN) for guidance.
2. Create an Electronic Service Tool Snapshot **A.** Select “Snapshot Viewer” on the electronic service tool, using menus: Information -> Snapshot -> Viewer **B.** Select the event code and then click “View Graph” . **C.** Select the following parameter and then click OK. · Engine Speed **D.** Select Save to "File to save" a Snapshot File (*.xml). This file will contain all the data in the snapshot and not only the data shown on the graph. **Note:** The downloaded information will be required by the DSN if troubleshooting assistance is required.	Snapshot saved	**Result:** The electronic service tool snapshot was successfully saved. Proceed to Test Step 3. **Result:** The electronic service tool snapshot was not successfully saved. Contact the DSN for guidance.
3. Check for Diagnostic Codes Active or Logged Diagnostic codes. **A.** Establish communication between the electronic service tool and the Electronic Control Module (ECM). Refer to Troubleshooting, “Electronic Service Tools”, if necessary. **B.** Use the electronic service tool to check for active or logged codes.	Diagnostic Active or Logged codes	**Result:** A diagnostic code is active or logged other than a 174-16 code. **Repair:** Troubleshoot the active or logged code. **Result:** A 174-16 diagnostic code is active or logged. Proceed to Test Step 4.
4. Fuel Shut-off Valves **A.** Check the position of any fuel shut-off valves in the feed lines between the fuel tank and the engine. **B.** Check the position of any fuel shut-off valves in the return lines between the engine and the fuel tank.	Fuel valves	**Result:** A fuel shut-off valve is not fully open. **Repair:** Move all shut-off valves to the fully open position. **Result:** All shut-off valves are in the fully open position. Proceed to Test Step 5.
5. Fuel Level in Tank **Note:** If the level in the fuel tank is low, the hot return fuel can raise the temperature in the fuel tank. **A.** Check the fuel level in the tank.	Fuel level	**Result:** The fuel level in the tank is low. **Repair:** Replenish the fuel tank at the earliest opportunity. **Result:** The fuel level in the tank is OK. Proceed to Test Step 6.

(continued)

(Table 61, contd)

6. Return Fuel Cooler **A.** Check that the fins on the return fuel cooler are not blocked with dirt or debris. Make sure that the fins are not bent or missing.	Return fuel cooler	**Result:** The fins on the return fuel cooler are blocked with dirt or debris. **Repair:** Clean the return fuel cooler. **Result:** The fins on the return fuel cooler are bent or missing. **Repair:** Install a replacement return fuel cooler. **Result:** The return fuel cooler is OK. Proceed to Test Step 7.
7. Return Fuel Lines **A.** Check the return fuel lines for blockages or restrictions.	Return fuel lines	**Result:** A return fuel line is blocked or restricted. **Repair:** Clear the fuel line or replace the line. **Result:** The return fuel lines are OK. Proceed to Test Step 8.
8. Location of the Fuel Tank **A.** Make sure that the fuel tank is not close to a heat source.	Fuel tank location	**Result:** The fuel tank is close to a heat source. **Repair:** Shield the fuel tank from the heat source. **Result:** The fuel tank is not close to a heat source. If the fault is still present, contact the DSN and provide the following information from Test Step 1 and Test Step 2: • PSR and Histograms • Snapshot data

i07928862

Inlet Air Is Restricted

Use this procedure to troubleshoot a high differential pressure for the air inlet system. Use this procedure if one of the following event codes are active. For information on the engine monitoring system, refer to Troubleshooting, “Engine Monitoring System”.

Table 62

Diagnostic Trouble Codes for Inlet Air Is Restricted		
J1939 Code	**Code Description**	**Comments**
107-15	Engine Air Filter 1 Differential Pressure : High - least severe (1)	The air filter differential pressure is above the trip point pressure for the delay time. The code is logged.
107-16	Engine Air Filter 1 Differential Pressure : High - moderate severity (2)	The air filter differential pressure is above the trip point pressure for the delay time. The code is logged. The engine power is derated.

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

Table 63

Troubleshooting Test Steps	Values	Results
1. Check the Air Filter Element **A.** Check the air intake system for plugged air filters or for damaged air filters. If the engine is equipped with an air intake precleaner, verify the proper operation of the air intake precleaner.	Plugged air filter	**Result:** The air filter is clogged. **Repair:** Clean or replace the air filter. Verify that the problem is resolved. **Result:** The air filter is not clogged. Proceed to Test Step 2.
2. Check the Air Inlet Piping **A.** Check the air inlet piping for damage or restrictions.	Damaged air inlet piping	**Result:** The air inlet piping is damaged or has restrictions. **Repair:** Repair the piping or replace the piping. Verify that the problem is resolved. **Result:** The air inlet piping does not have damage or restrictions. Proceed to Test Step 3.
3. Check the Enclosure Ventilation **A.** Check that the engine has been installed in an enclosure that is sufficiently ventilated.	Enclosure ventilation	**Result:** The engine does not have sufficient ventilation. **Repair:** Repair the ventilation for the enclosure. Verify that the fault is resolved. **Result:** The engine has sufficient ventilation. Contact the Dealer Solutions Network (DSN).

i08252014

Intake Manifold Air Pressure Is High

The Electronic Control Module (ECM) monitors the intake manifold air pressure. The following event is associated with high intake manifold air pressure:

Table 64

Diagnostic Trouble Code for Intake Manifold Air Pressure Is High		
J1939 Code	**Code Description**	**Comments**
102-16	Engine Intake Manifold #1 Pressure : High - moderate severity (2)	This pressure is a variable value that is calculated by the ECM. The resulting value depends on the operating conditions of the engine.

Probable Causes

- Engine intake throttle valve
- Turbocharger wastegate

Recommended Actions

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

Table 65

Troubleshooting Test Steps	Values	Results
1. Download Information Using the Electronic Service Tool **A.** Use the electronic service tool to download the “Product Status Report” (PSR) with histograms before performing any troubleshooting or clearing any diagnostic codes. **Note:** The downloaded information will be required by the Dealer Solutions Network (DSN) if troubleshooting assistance is required.	Downloaded information	**Result:** The information was successfully saved. Proceed to Test Step 2. **Result:** The electronic service tool information was not successfully saved. Contact the Dealer Solutions Network (DSN) for guidance.
2. Create an Electronic Service Tool Snapshot **A.** Select “Snapshot Viewer” on the electronic service tool, using menus: Information -> Snapshot -> Viewer **B.** Select the event code and then click “View Graph” . **C.** Select the following parameter and then click OK. · Engine Speed **D.** Select Save to "File to save" a Snapshot File (*.xml). This file will contain all the data in the snapshot and not only the data shown on the graph. **Note:** The downloaded information will be required by the DSN if troubleshooting assistance is required.	Snapshot saved	**Result:** The electronic service tool snapshot was successfully saved. Proceed to Test Step 3. **Result:** The electronic service tool snapshot was not successfully saved. Contact the DSN for guidance.
3. Engine Intake Throttle Valve **A.** Use the electronic service tool to perform the “Air System Motor Valve Verification Test” to check that the engine intake throttle valve is operating correctly.	Diagnostic codes	**Result:** Diagnostic codes became active during the “Air System Motor Valve Verification Test” . **Repair:** Troubleshoot the diagnostic codes. Refer to Troubleshooting, Diagnostic Trouble Codes. **Result:** The “Air System Motor Valve Verification Test” passed. No diagnostic codes became active during the test. Proceed to Test Step 4.

(continued)

(Table 65, contd)

Troubleshooting Test Steps	Values	Results
4. Turbocharger Wastegate **A.** Check the operation of the wastegate on the turbocharger. **B.** Check the operation of the wastegate actuator on the turbocharger. Refer to Systems Operation, Testing, and Adjusting, “Turbocharger - Inspect” .	Turbocharger wastegate	**Result:** Operation of the turbocharger wastegate is suspect. **Repair:** Remove the circlip. Remove the wastegate arm. **Note:** Ensure that the wastegate arm is not lifted more than 5 degrees from the horizontal. Release the wastegate and rotate back and forwards until the wastegate becomes free and loose. If the wastegate does not become free and loose, replace the turbocharger. Refer to Disassembly and Assembly, “Turbocharger - Remove” and Disassembly and Assembly, “Turbocharger - Install”. **Result:** Operation of the turbocharger wastegate is OK. Proceed to Test Step 5.
5. Inspect Electrical Connections **A.** Inspect the electrical connections between the sensor and ECM for loose wires, breaks, or dirt ingress.	Electrical Connections	**Result:** A connection point has damaged wires or pins. **Repair:** Repair the damaged wires or pins. **Result:** A wire is loose. **Repair:** Resecure wire into correct port. **Result:** A connection point has excessive dirt/dust. **Repair:** Thoroughly clean the connection point and wire ports in the back of the connector with an air gun or similar. Ensure they are free of dirt and/or dust. **Result:** Electrical connections have no loose wires, breaks, or dirt ingress. Contact the Dealer Solutions Network (DSN).

i08253384

Intake Manifold Air Pressure Is Low

The Electronic Control Module (ECM) monitors the intake manifold air pressure. The following event is associated with low intake manifold air pressure:

Table 66

Diagnostic Trouble Code for Low Intake Manifold Air Pressure		
J1939 Code	**Code Description**	**Notes**
102-18	Engine Intake Manifold #1 Pressure : Low - moderate severity (2)	This pressure is a variable value that is calculated by the ECM. The resulting value depends on the operating conditions of the engine.

Probable Causes

- Boost leaks between Compressor outlet and Inlet Manifold
- Intake air filter
- Air intake system
- Engine intake throttle valve
- Turbocharger
- ATAAC/pipes leaks
- Inlet manifold to head joint leaks

Recommended Actions

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

Table 67

Troubleshooting Test Steps	Values	Results
1. Download Information Using the Electronic Service Tool **A.** Use the electronic service tool to download the “Product Status Report” (PSR) with histograms before performing any troubleshooting or clearing any diagnostic codes. **Note:** The downloaded information will be required by the Dealer Solutions Network (DSN) if troubleshooting assistance is required.	Downloaded information	**Result:** The information was successfully saved. Proceed to Test Step 2. **Result:** The electronic service tool information was not successfully saved. Contact the Dealer Solutions Network (DSN) for guidance.
2. Create an Electronic Service Tool Snapshot **A.** Select “Snapshot Viewer” on the electronic service tool, using menus: Information -> Snapshot -> Viewer **B.** Select the event code and then click “View Graph” . **C.** Select the following parameter and then click OK. · Engine Speed **D.** Select Save to "File to save" a Snapshot File (*.xml). This file will contain all the data in the snapshot and not only the data shown on the graph. **Note:** The downloaded information will be required by the DSN if troubleshooting assistance is required.	Snapshot saved	**Result:** The electronic service tool snapshot was successfully saved. Proceed to Test Step 3. **Result:** The electronic service tool snapshot was not successfully saved. Contact the DSN for guidance.
3. Boost Leaks **A.** Check all clamps and pipes from the outlet of the turbocharger compressor to the inlet manifold for damage/leaks.	Intake air	**Result:** There is a leak in the intake air system. **Repair:** Repair the leak. **Result:** No leak is found in the intake air system. Proceed to Test Step 4.
4. Intake Air Filter **A.** Check the air filter restriction indicator, if equipped. **B.** Check for ECM codes for inlet air restriction: 107-15: Engine Air Filter 1 Differential Pressure high - least severe (1) 107-16: Engine Air Filter 1 Differential Pressure high - moderate severity (2) **C.** Ensure that the air filter is clean and serviceable.	Air filter	**Result:** The air filter is blocked. **Repair:** Replace the air filter element. Refer to the Operation and Maintenance Manual, “Engine Air Cleaner Element - Replace”. **Result:** A 107-15 or 107-16 code is active **Repair:** Refer to Troubleshooting, Inlet Air is Restricted. **Result:** The air filter is OK. Proceed to Test Step 5.

(continued)

(Table 67, contd)

Troubleshooting Test Steps	Values	Results
5. Air Intake System **A.** Check the air intake system for the following defects: · Blockages · Restrictions · Damage to the air intake ducts and hoses · Loose connections and air leaks	Air intake	**Result:** The air intake system is blocked, restricted, damaged, or loose. **Repair:** Make all necessary repairs to the air intake system. **Result:** The air intake system is OK. Proceed to Test Step 6.
6. Check the Engine Intake Throttle Valve **A.** Check the engine intake throttle valve for correct operation. Use the electronic service tool to perform the “Air System Motor Valves Verification Test” . If the “Air System Motor Valves Verification Test” indicates a fault, refer to Troubleshooting, “Motorized Valve - Test” for the correct troubleshooting procedure.	Engine intake throttle valve	**Result:** The engine intake throttle valve has failed. **Repair:** Repair or replace the valve. Refer to Disassembly and Assembly, Throttle Valve (Intake Air) - Remove and Install. If a new valve is fitted, use the electronic service tool to run the “Engine Throttle Valve Replacement Reset” and then use the electronic service tool to run the “Air System Motor Valves Verification Test” . If the valve is repaired, use the electronic service tool to perform the “Air System Motor Valves Verification Test” and verify that the repair eliminates the fault. **Result:** The engine intake throttle valve has not failed. Proceed to Test Step 7.
7. Inspect Electrical Connections **A.** Inspect the electrical connections between the sensor and ECM for loose wires, breaks, or dirt ingress.	Electrical Connections	**Result:** A connection point has damaged wires or pins. **Repair:** Repair the damaged wires or pins. **Result:** A wire is loose. **Repair:** Resecure wire into correct port. **Result:** A connection point has excessive dirt/dust. **Repair:** Thoroughly clean the connection point and wire ports in the back of the connector with an air gun or similar. Ensure they are free of dirt and/or dust. **Result:** Electrical connections have no loose wires, breaks, or dirt ingress. Proceed to Test Step 8.

(continued)

(Table 67, contd)

Troubleshooting Test Steps	Values	Results
8. Turbocharger **Note:** The turbocharger that is installed on the engine is a nonserviceable item. If any mechanical fault exists, then the faulty turbocharger must be replaced. **A.** Check that the compressor housing for the turbocharger is free of dirt and debris. **B.** Check that the turbine housing for the turbocharger is free of dirt and debris. **C.** Check that the turbine blades rotate freely in the turbocharger.	Turbocharger	**Result:** There is a fault in the turbocharger. **Repair:** Replace the turbocharger. Refer to Disassembly and Assembly, “Turbocharger - Remove” and Disassembly and Assembly, “Turbocharger - Install”. **Result:** The turbocharger is OK. Proceed to Test Step 9.
9. Check the Aftercooler and Aftercooler Hoses for Leaks **A.** Check the Air to Air Aftercooler (ATAAC) for leaks or damage. **B.** Check the Air to Air Aftercooler (ATAAC) hoses for leaks or damage.	ATAAC	**Result:** The ATAAC and hoses are OK. Proceed to Test Step 9. **Result:** The ATAAC and/or hoses are leaking or damaged. **Repair:** Repair or replace the damaged ATAAC and/or piping. If the problem is not resolved, proceed to Test Step 10.
10. Check Joints between Intake Manifold and Head for Leaks **A.** Check for signs of leaks between the intake manifold and the cylinder head.		**Result:** The joints between the intake manifold and the cylinder head are leaking. **Repair:** Repair the leaks and verify that the issue is resolved. If the issue is not resolved, contact the Dealer Solutions Network (DSN). **Result:** The joints between the intake manifold and the cylinder head are OK. Contact the Dealer Solutions Network (DSN).

i07956445

Intake Manifold Air Temperature Is High

The Electronic Control Module (ECM) monitors the intake manifold air for excessive temperature. The following event codes are associated with high intake manifold air temperature:

Table 68

Diagnostic Trouble Codes for High Intake Manifold Air Temperature		
J1939 Code	Code Description	Comments
105-15	Engine Intake Manifold #1 Temperature : High - least severe (1)	The engine has been running for 3 minutes. No other 105 codes are active. 168 codes are not active. Code 412-16 is not active. The intake manifold air temperature exceeds the value that is programmed into the ECM for 8 seconds. The code is logged. This code will be reset when the temperature is less than 122° C (252° F) for 4 seconds.
105-16	Engine Intake Manifold #1 Temperature : High - Moderate Severity (2)	The engine has been running for 3 minutes. No other 105 codes are active. 168 codes are not active. Code 412-16 is not active. The intake manifold air temperature exceeds the value that is programmed into the ECM for 8 seconds. The engine will be derated. The code is logged. This code will be reset when the temperature is 2° C (35.6° F) less than the configured trip threshold for a period of 20 seconds.
105-0	Engine Intake Manifold #1 Temperature : High - most severe (3)	The engine has been running for 3 minutes. No other 105 codes are active. 168 codes are not active. Code 412-16 is not active. The intake manifold air temperature exceeds the value that is programmed into the ECM for 8 seconds. The engine will be shut down. The code is logged. This code will be reset when the temperature is 2° C (35.6° F) less than the configured trip threshold for a period of 20 seconds.

Probable Causes

- Coolant level
- Air-to-air aftercooler (ATAAC)
- Cooling fan
- Air inlet and exhaust system
- NRS valve and engine intake throttle valve
- Turbocharger
- Ambient temperature
- Altitude
- Running condition

Recommended Actions

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

Table 69

Troubleshooting Test Steps	Values	Results
1. Coolant Level **A.** Check that the coolant is filled to the correct level. **Note:** If the coolant level is too low, air will get into the cooling system. Air in the cooling system will cause a reduction in coolant flow.	Coolant	**Result:** The coolant level is low. **Repair:** Fill the coolant system to the correct level. Refer to the Operation and Maintenance Manual, “Coolant Level - Check”. **Result:** The coolant level is OK. Proceed to Test Step 2.
2. Air-to-Air Aftercooler (ATAAC) **A.** Check the ATAAC for debris or damage. **Note:** Debris between the fins of the ATAAC core restricts air flow through the core.	ATAAC	**Result:** The ATAAC has excessive debris or is damaged. **Repair:** Clear the debris from the ATAAC or replace the ATAAC. **Result:** The ATAAC is OK. Proceed to Test Step 3.
3. Cooling Fan **A.** Check the operation of the cooling fan. **Note:** A fan that is not turning at the correct speed can result in insufficient airflow through the aftercooler core.	Cooling fan	**Result:** The cooling fan is not operating correctly. **Repair:** Investigate the cause of the incorrect fan operation **Result:** The cooling fan is operating correctly. Proceed to Test Step 4.
4. Air Intake and Exhaust System **A.** Check the air filter restriction indicator, if equipped. **B.** Check the air intake and the exhaust system for the following defects: · Signs of dirt ingress · Blockages · Restrictions · Damage to the air intake and exhaust lines and hose **C.** Check for ECM codes for inlet air restriction: 107-15: Engine Air Filter 1 Differential Pressure high - least severe (1) 107-16: Engine Air Filter 1 Differential Pressure high - moderate severity (2) **D.** Check the engine has not exceeded the service interval for the air cleaner element. Refer to Operation and Maintenance Manual.	Air intake and exhaust system	**Result:** The air filter restriction indicator has operated or the air filter is blocked. **Repair:** Make sure that the air filter is clean and serviceable. If necessary, replace the air filter. **Result:** The air intake or the exhaust system is blocked, restricted, or damaged. **Repair:** Repair the air intake or the exhaust system, as required. **Result:** A 107-15 or 107-16 code is active **Repair:** Refer to Troubleshooting, Inlet Air is Restricted. **Result:** The service interval for the air cleaner element has been exceeded. **Repair:** Replace the air cleaner element. Refer to Operation and Maintenance Manual, Engine Air Cleaner Element - Replace. **Result:** The air intake or the exhaust system is OK. Proceed to Test Step 5.

(continued)

(Table 69, contd)

Troubleshooting Test Steps	Values	Results
5. NRS Valve or Intake Throttle Valve **A.** Use the electronic service tool to perform the “Air System Motor Valves Verification Test” . Check for active diagnostic codes that relate to the engine intake throttle valve.	Engine intake throttle valve	**Result:** There are active diagnostic codes that relate to the NRS valve or engine intake throttle valve. **Repair:** Troubleshoot the active diagnostic codes. Refer to Troubleshooting, “Diagnostic Trouble Codes”. **Result:** The NRS valve and engine intake throttle valve are OK. Proceed to Test Step 6.
6. Turbocharger **Note:** The turbocharger that is installed on the engine is a nonserviceable item. If any mechanical fault exists, then the faulty turbocharger must be replaced. **A.** Ensure that the mounting bolts for the turbocharger are tight. **B.** Check that the compressor blades rotate freely in the turbocharger. **C.** Check that the oil drain for the turbocharger is not blocked or restricted. **D.** Check that the compressor housing for the turbocharger is free of dirt and debris. Make sure that the housing is not damaged. **E.** Check that the turbine housing for the turbocharger is free of dirt and debris. Make sure that the housing is not damaged. **F.** Inspect the wastegate for damage and ensure that it is operating correctly. Refer to Systems Operation Testing and Adjusting, Turbocharger - Inspect.	Turbocharger	**Note:** Some oil residue/pooling may be seen, but this is not an indication that the turbo has failed. If the compressor and turbine blades are undamaged and rotate freely, it is likely the turbocharger is fault free. **Result:** There is a fault on the turbocharger. **Repair:** Replace the turbocharger. Refer to Disassembly and Assembly, “Turbocharger - Remove” and Disassembly and Assembly, “Turbocharger - Install”. **Result:** There are no faults on the turbocharger. Proceed to Test Step 7.
7. Ambient Temperature **A.** Check for a high ambient temperature. **Note:** When outside temperatures are too high, there is insufficient temperature difference between the outside air and the intake air.	Ambient Temperature	**Result:** The ambient air temperature is high. **Repair:** Operate the engine at reduced speed or reduced power. **Result:** The ambient air temperature is OK. Proceed to Test Step 8.

(continued)

(Table 69, contd)

Troubleshooting Test Steps	Values	Results
8. Altitude **A.** Check for operation at high altitude. **Note:** The cooling capacity of the ATAAC is reduced as the engine is operated at higher altitudes.	Altitude	**Result:** The engine is being operated at high altitude. **Repair:** Operate the engine at reduced speed or reduced power. **Result:** The engine is not being operated at high altitude. Proceed to Test Step 9.
9. Running Condition **A.** Check that the engine is not operating in the lug condition. **Note:** When the load that is applied to the engine is too large, the engine will run in the lug condition. When the engine is running in the lug condition, engine rpm does not increase with an increase of fuel. This lower engine rpm causes a reduction in coolant flow through the system.	Running condition	**Result:** The engine is operating in the lug condition. **Repair:** Reduce the load on the engine or, if possible, increase the power rating of the engine. **Result:** The engine is not operating in the lug condition. Contact the Dealer Solutions Network (DSN).

i09615680

Oil Consumption Is Excessive

Probable Causes

- Misreading oil level
- High oil level
- Oil leaks
- Engine crankcase breather
- Air intake and exhaust system
- Turbocharger
- Low compression (cylinder pressure)

Recommended Actions

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

Table 70

Troubleshooting Test Steps	Values	Results
1. Misreading Oil Level **A.** Accurately measure the consumption of oil and fuel over a period of 50 engine hours.	Oil level	**Result:** The oil consumption is less than 0.08% of the fuel consumption. Oil consumption is within specification. Return the unit to service **Result:** The oil consumption is greater than 0.08% of the fuel consumption. Proceed to Test Step 2.
2. Oil Level **A.** Check for a high oil level in the engine.	Oil level	**Result:** The oil level in the engine is high. **Repair:** Make sure that the oil is not contaminated with fuel. Refer to Troubleshooting, “Oil Contains Fuel”. Make sure that the oil is not contaminated with coolant. Refer to Troubleshooting, “Oil Contains Coolant”. Remove the excess oil. Proceed to Test Step 8. **Result:** The oil level is OK. Proceed to Test Step 3.
3. Oil Leaks **A.** Check for evidence of oil leaks on the engine. **B.** Check for evidence of oil in the coolant.	Oil leaks	**Result:** An oil leak is identified. **Repair:** Rectify the cause of the oil leak. **Result:** Oil is present in the coolant. **Repair:** Refer to Troubleshooting, “Coolant Contains Oil”. No oil leaks are identified Proceed to Test Step 4.

(continued)

(Table 70, contd)

Troubleshooting Test Steps	Values	Results
4. Engine Crankcase Breather **A.** Check the engine crankcase breather for blockage or restrictions. **B.** Check for excessive oil from the outlet of the breather. **C.** Check that the application has not been operated above the recommended gradient. **D.** Check if the Oil Mist Separator drain hose is fitted using correct orientation (white mark facing OMS drain spigot). **Note:** Only applicable to engines equipped with a closed circuit crankcase breather. **E.** Check to see whether an OMS filter is fitted.	Breather	**Result:** The engine crankcase breather is blocked or restricted. **Repair:** Clear the blockage or restriction. **Result:** Excessive oil is ejected from the outlet of the breather. **Repair:** Investigate the cause of the excessive oil content in the breather flow. Check that the engine has been serviced in line with the recommended maintenance intervals. Refer to Operation and Maintenance Manual, if above 1500 hours, change the crankcase breather filter. Refer to Operation and Maintenance Manual, Crankcase Breather (Canister) - Replace. **Note:** Some oil presence from the breather is normal. Proceed to Test Step 8 **Result:** Little or no oil is ejected through the breather. **Repair:** Clean oil from hoses and retest. Proceed to Test Step 5.
5. Air Intake and Exhaust System **A.** Check the air filter restriction indicator, if equipped. **B.** Check the air intake and the exhaust system for the following defects: · Signs of dirt ingress · Blockages · Restrictions · Damage to the air intake and exhaust lines and hose **C.** Check for ECM codes for inlet air restriction: 107-15: Engine Air Filter 1 Differential Pressure high - least severe (1) 107-16: Engine Air Filter 1 Differential Pressure high - moderate severity (2) **D.** Check that the engine has not exceeded the service interval for the air cleaner element. Refer to Operation and Maintenance Manual.	Air intake and exhaust system	**Result:** The air filter restriction indicator has operated or the air filter is blocked. **Repair:** Make sure that the air filter is clean and serviceable. If necessary, replace the air filter. **Result:** The air intake or the exhaust system is blocked, restricted, or damaged. **Repair:** Repair the air intake or the exhaust system, as required. **Result:** A 107-15 or 107-16 code is active **Repair:** Refer to Troubleshooting, Inlet Air is Restricted. **Result:** The service interval for the air cleaner element has been exceeded. **Repair:** Replace the air cleaner element. Refer to Operation and Maintenance Manual, Engine Air Cleaner Element - Replace. **Result:** The air intake or the exhaust system is OK. Proceed to Test Step 6.

(continued)

(Table 70, contd)

Troubleshooting Test Steps	Values	Results
6. Turbocharger **Note:** The turbocharger that is installed on this engine is a non-serviceable item. If any mechanical fault exists, then the turbocharger must be replaced. **A.** Check that the oil drain for the turbocharger is not blocked or restricted. **Note:** Wetted walls are considered to be a normal level of oil. Pooled oil is considered excessive.	Turbocharger	**Result:** The oil drain for the turbocharger is blocked or restricted. **Repair:** Remove the blockage or restriction. If necessary, replace the oil drain line. Check that the repairs have eliminated the faults. Proceed to Test Step 8. **Result:** The turbocharger is OK. Proceed to Test Step 7.
7. Low Compression (Cylinder Pressure) **A.** Perform a compression test. Refer to Systems Operation, Testing and Adjusting, “Compression - Test”.	Cylinder compression	**Result:** The results of the compression test are outside the specifications. **Repair:** Investigate the cause and rectify any faults. **Note:** Possible causes of low compression are shown in the following list: · Loose glow plugs · Worn piston · Worn piston rings · Worn cylinder bores · Worn valves · Worn seals · Faulty cylinder head gasket · Damaged cylinder head **Result:** The results of the compression test are OK. Contact the Dealer Solutions Network (DSN).
8. Clean the Fuel System **A.** Following the instructions on the bottle, add T40 - 0012 Fuel System Cleaner to the fuel tank.	Electronic Unit Injectors	Return the unit to service, the fuel system will be cleaned during operation.

i07590766

Oil Contains Coolant

Probable Causes

- Engine oil cooler
- Cylinder head and gasket
- Cylinder block

Recommended Actions

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

Table 71

Troubleshooting Test Steps	Values	Results
1. Engine Oil Cooler **A.** Drain the engine lubricating oil and coolant from the engine. Check for leaks in the oil cooler assembly.	Oil cooler	**Result:** Evidence of coolant in the oil system is identified. **Repair:** Install a new oil cooler. Refer to Disassembly and Assembly, “Engine Oil Cooler - Remove” and Disassembly and Assembly, “Engine Oil Cooler - Install” for the correct procedure. **Result:** There is no evidence of coolant in the oil system. Proceed to Test Step 2.
2. Cylinder Head and Gasket **A.** Remove the cylinder head. Refer to Disassembly and Assembly, “Cylinder Head - Remove” for the correct procedure. Inspect the cylinder head gasket for faults and any signs of leakage. **B.** Check the cylinder head for flatness. Refer to Systems Operation, Testing and Adjusting, “Cylinder Head - Inspect” for the correct procedure. **C.** Check the mating face of the cylinder head for faults and signs of leakage. If a fault is found, replace the cylinder head. If signs of leakage are found, determine the cause of the leakage. Refer to Systems Operation, Testing and Adjusting, “Cylinder Head - Inspect” for the correct procedure. **D.** Check the internal core plugs in the cylinder head for signs of leakage.	Cylinder head and gasket	**Result:** The cylinder head gasket is faulty or shows signs of leakage. **Repair:** Check for faults in the corresponding areas of the cylinder head and cylinder block. **Result:** The cylinder head is not within specification for flatness. **Repair:** Install a new cylinder head. Refer to Disassembly and Assembly, “Cylinder Head - Install” for the correct procedure. **Result:** The cylinder head shows signs of a fault or leakage. **Repair:** Install a new cylinder head. Refer to Disassembly and Assembly, “Cylinder Head - Install” for the correct procedure. **Result:** An internal core plug in the cylinder head shows signs of leakage. **Repair:** Replace the faulty core plug. **Result:** The cylinder head is OK. Proceed to Test Step 3.
3. Cylinder Block **A.** Inspect the top face of the cylinder block for faults and signs of leakage.	Cylinder block	**Result:** The top face of the cylinder block has a fault. **Repair:** Replace the cylinder block. **Result:** The top face of the cylinder block shows signs of leakage. **Repair:** Determine the cause of the leakage. Refer to Systems Operation, Testing and Adjusting, “Cylinder Block - Inspect” for the correct procedure. **Result:** The cylinder block is OK. **Repair:** Install the cylinder head. Refer to Disassembly and Assembly, “Cylinder Head - Install”.

(continued)

(Table 71, contd)

Troubleshooting Test Steps	Values	Results
		Remove the oil filter element. Install a new engine oil filter element. Fill the engine with clean engine oil to the correct level. Refer to the Operation and Maintenance Manual, “Engine Oil and Filter - Change” for more information. Fill the cooling system. Refer to the Operation and Maintenance Manual for more information. If coolant is found in the oil again, contact the Dealer Solutions Network (DSN).

i08166738

Oil Contains Fuel

Measuring Fuel Dilution

Diesel fuel is chemically similar to the lubricants that are used in diesel engines. A slow fuel leak will blend the fuel into the oil. Normal operating temperatures may cause volatile parts of the fuel to vaporize. The fuel that remains in the oil is less volatile.

A closed cup flash test can be performed to detect fuel dilution. The flash test is designed to measure the volatile parts of the fuel that are remaining in the oil. Detecting less volatile fuel is difficult. The lack of volatility reduces the accuracy of the flash test.

Since the flash test does not accurately detect fuel dilution, do not use the flash test as the only measure of fuel dilution. Instead, verify the dilution by the following methods:

- Gas chromatograph fuel dilution test
- Oil viscosity

The test that uses a gas chromatograph is designed to measure fuel dilution in crankcase oils. The gas chromatograph can identify the small chemical differences between diesel fuel and lubricating oil. Even though the gas chromatograph provides a more accurate measure of fuel dilution, always verify the results with the viscosity test.

A significant level of fuel dilution reduces oil viscosity. If an unacceptable level of fuel dilution is suspected, the kinematic viscosity of the oil must be measured.

Fuel dilution that is greater than 4 percent will usually cause viscosity that is less than the specified viscosity grade. If the oil is still within the specified viscosity grade, fuel dilution is unlikely to have reached an unacceptable level. Use the following chart to determine if viscosity has reached the minimum acceptable level. The guidelines of viscosity in the chart are slightly less than the limits of the SAE viscosity grades. However, these guidelines still provide adequate engine protection.

Table 72

Viscosity Grade	Minimum Oil Viscosity at 100 °C with Fuel Dilution Greater Than 4% as Measured by a Gas Chromatograph	Action
0W-40 5W-40 10W-40 15W-40	12.0 cSt	Investigate the cause of fuel dilution or reduce the engine oil change interval.
0W-30 5W-30 10W-30	9.0 cSt	

Verifying Fuel Dilution

Always verify fuel dilution by the combination of a viscosity test and a gas chromatograph test that gives a result more than 4 percent.

Probable Causes

- Fuel injector seals
- Fuel injector tip
- Shaft seal for the high-pressure fuel pump

Recommended Actions

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

⚠ WARNING

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

NOTICE

Contact with high-pressure fuel may cause personal injury or death. Wait 10 minutes after the engine has stopped to allow fuel pressure to purge before any service or repair is performed on the engine fuel lines.

Table 73

Troubleshooting Test Steps	Values	Results
1. Fuel Injector Seals **A.** Check for signs of damage to the seals for the fuel injectors.	Fuel injector seals	**Result:** Injector seals are damaged. **Repair:** Replace any damaged injector seals. Drain and refill the engine oil. Refer to the Operation and Maintenance Manual, “Engine Oil and Filter - Change”. **Result:** All injector seals are OK. Proceed to Test Step 2.
2. Fuel Injector Tip **A.** Check for signs of damage to the fuel injectors. Check the fuel injector tip for cracks or breakage.	Fuel injector tip	**Result:** A fuel injector is damaged. **Repair:** Replace the fuel injector. Refer to Disassembly and Assembly, “Electronic Unit Injector - Remove” and Disassembly and Assembly, “Electronic Unit Injector - Install”. Drain and refill the engine oil. Refer to the Operation and Maintenance Manual, “Engine Oil and Filter - Change”. **Result:** All fuel injectors are OK. Proceed to Test Step 3.
3. Shaft Seal for the High-Pressure Fuel Pump **A.** Check for fuel leakage around the shaft seal for the high-pressure fuel pump.	HP fuel pump shaft seal	**Result:** Fuel is leaking past the shaft seal for the high-pressure fuel pump. **Repair:** There is a restriction in the return line to the fuel tank. Investigate the cause of the restriction and then repair the fuel line. Replace the high-pressure fuel pump. Refer to Disassembly and Assembly, “Fuel Injection Pump - Remove” and Disassembly and Assembly, “Fuel Injection Pump - Install”. Replace any filters and/or screens in the fuel system. Refer to Operation and Maintenance Manual for further information. Inspect the return pipe from the high-pressure fuel pump to the fuel tank. replace any pipes that have been damaged or distorted by hot fuel. Drain and refill the engine oil. Refer to the Operation and Maintenance Manual, “Engine Oil and Filter - Change”. **Result:** The shaft seal for the high-pressure fuel pump is OK. If the fault is still present, contact the Dealer Solutions Network (DSN).

i07951879

Oil Level Is Low

This procedure is only applicable to engines with an oil level switch.

Use this procedure if one of the following event codes is active.

Table 74

Diagnostic Trouble Codes for Oil Level Is Low		
J1939 Code	**Code Description**	**Comments**
98–17	Engine Oil Level : Low - least severe (1)	The engine oil level has dropped below the level of the switch for the time specified in the ECM. The code is logged. The engine is derated.
98-18	Engine Oil Level : Low - moderate severity (2)	The engine oil level has dropped below the level of the switch for the time specified in the ECM. The code is logged. The engine is derated.
98-1	Engine Oil Level : Low - most severe (3)	The engine oil level has dropped below the level of the switch for the time specified in the ECM. The code is logged. The engine is derated and may stop.

Probable Causes

- Low engine oil level
- Problem with an electrical connection or with the wiring
- Faulty oil level switch

Recommended Actions

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

Table 75

Troubleshooting Test Steps	Values	Results
1. Low Engine Oil Level **A.** Check the engine oil level. Refer to the Operation and Maintenance Manual, "Engine Oil Level - Check".	Engine oil level	**Result:** The engine oil level is low. **Repair:** Add engine oil, as necessary. If engine oil consumption is considered excessive, refer to Troubleshooting, "Oil Consumption Is Excessive". Proceed to Test Step 2.
2. Electrical Connections or Wiring **A.** Inspect the electrical connectors and all the wiring for the switch. Refer to Troubleshooting, "Electrical Connectors - Inspect" and refer to the electrical Schematic.	Electrical connectors and wiring	**Result:** There is a fault in an electrical connection or the wiring. **Repair:** Repair or replace the faulty item. **Result:** The electrical connections and wiring are OK. Proceed to Test Step 3.
3. Test the Oil Level Switch **Note:** The engine oil level switch must be closed in order for the engine to operate. The switch is normally open. The switch must be submerged in fluid to become closed. **A.** Disconnect the switch and remove the switch. **B.** Connect an ohmmeter to the switch terminals and measure the continuity. The correct continuity for the normally open switch is greater than 2k Ohms. **C.** Continue to monitor the ohmmeter and submerge the switch in water. The correct continuity for the closed switch is less than 5 Ohms.	Oil level switch	**Result:** The correct results are not obtained or if the switch does not close. **Repair:** Replace the switch. **Result:** The correct results are obtained and the switch closes correctly. Contact the Dealer Solutions Network (DSN).

i08062947

Oil Pressure Is Low

NOTICE

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

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

Table 76

Diagnostic Code for Low Engine Oil Pressure		
J1939 Code	Code Description	Comments
100-1	Engine Oil Pressure : Low - most severe (3)	The Electronic Control Module (ECM) detects that the oil pressure is low. The engine is running. If equipped, the warning lamp will come on and the oil pressure lamp will come on.

Probable Causes

- Engine oil level
- Oil specification
- Aerated oil
- Engine oil pressure
- Engine oil filter
- Engine oil cooler
- Fuel in the engine oil
- Engine oil suction tube
- Engine oil pump pressure relief valve
- Engine oil pump
- Bearing clearance

Recommended Actions

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

Table 77

Troubleshooting Test Steps	Values	Results
1. Engine Oil Level **A.** Check the engine oil level.	Oil level	**Result:** The engine oil level is low. **Repair:** Fill the oil system to the full mark on the dipstick. **Result:** The engine oil level is OK. Proceed to Test Step 2.
2. Oil Specification **A.** Check that engine oil of the correct specification is being used. Refer to the Operation and Maintenance Manual, “Refill Capacities and Recommendations”.	Oil specification	**Result:** An incorrect specification of engine oil is being used. **Repair:** Drain the oil system and refill the oil system with engine oil of the correct specification. Refer to Operation and Maintenance Manual, “Engine Oil and Filter - Change”. **Result:** The engine contains oil of the correct specification. Proceed to Test Step 3.
3. Aerated Oil **A.** Sample the engine oil for aeration. **Note:** Foamy oil on the dipstick is a good indication of aeration.	Aeration	**Result:** The oil is aerated. Proceed to Test Step 9. **Result:** The oil is not aerated. Proceed to Test Step 4.
4. Engine Oil Pressure **A.** Check the actual engine oil pressure with a calibrated test gauge. The oil pressure switch should not close unless the pressure drops below 72 ± 17 kPa (10.4 ± 2.5 psi).	Oil pressure	**Result:** The oil pressure reading from the test gauge is greater than the closing pressure for the oil pressure switch. **Repair:** Install a new oil pressure switch. Refer to Disassembly and Assembly, “Engine Oil Pressure Sensor - Remove and Install”. **Result:** The oil pressure reading from the test gauge is less than the closing pressure for the oil pressure switch. Proceed to Test Step 5.
5. Engine Oil Filter **A.** Remove the engine oil filter. Refer to the Operation and Maintenance Manual, “Engine Oil and Filter - Change”. **B.** Inspect the engine oil filter for evidence of blockage.	Oil filter	**Result:** The oil filter is blocked. **Repair:** Investigate the cause of the filter blockage. Install a new oil filter. Refer to the Operation and Maintenance Manual, “Engine Oil and Filter - Change” for further information. **Result:** The oil filter is OK. **Repair:** Install a new oil filter. Refer to the Operation and Maintenance Manual, “Engine Oil and Filter - Change” for further information. Proceed to Test Step 6.

(continued)

(Table 77, contd)

Troubleshooting Test Steps	Values	Results
6. Engine Oil Cooler **A.** Check the oil cooler for signs of damage or restrictions.	Oil cooler	**Result:** The oil cooler has signs of damage or restriction. **Repair:** Install a new oil cooler. Refer to Disassembly and Assembly, “Engine Oil Cooler - Remove” and Disassembly and Assembly, “Engine Oil Cooler - Install”. **Result:** The oil cooler is OK. Proceed to Test Step 7.
7. Fuel in the Engine Oil **A.** Check fuel contamination of the engine oil. Refer to Troubleshooting, “Oil Contains Fuel”.	Oil contamination	**Result:** The oil contains fuel. **Repair:** Refer to Troubleshooting, “Oil Contains Fuel”. **Result:** The oil is not contaminated. Proceed to Test Step 8.
8. Engine Oil Suction Tube **A.** Check the inlet screen on the oil suction tube and remove any material that may be restricting oil flow. **B.** Check the joints of the oil suction tube for cracks or a damaged joint. **Note:** Cracks or damage may allow air leakage into the supply to the oil pump.	Oil suction tube	**Result:** The inlet screen on the oil suction tube is blocked with debris. **Repair:** Remove the debris from the inlet screen. Attempt to identify the source of the debris. **Result:** The oil suction tube is cracked. **Repair:** Install a new oil suction tube. **Result:** The oil suction tube is OK. Proceed to Test Step 9.
9. Engine Oil Pump Pressure Relief Valve **A.** Inspect the components of the pressure relief valve for excessive wear or damage.	Oil pump PRV	**Result:** A component in the pressure relief valve is not within specification. **Repair:** Repair or replace the pressure relief valve, as necessary. Refer to Disassembly and Assembly, “Engine Oil Relief Valve - Remove and Install”. **Result:** The pressure relief valve is OK. Proceed to Test Step 10.

(continued)

(Table 77, contd)

Troubleshooting Test Steps	Values	Results
10. Engine Oil Pump **A.** Inspect the components of the engine oil pump for excessive wear.	Oil pump	**Result:** A component in the oil pump is not within specification. **Repair:** Repair the oil pump or replace the oil pump, if necessary. Refer to Disassembly and Assembly, “Engine Oil Pump - Remove” and Disassembly and Assembly, “Engine Oil Pump - Install”. **Result:** The oil pump is OK. Proceed to Test Step 11.
11. Bearing Clearance **A.** Inspect the engine components for excessive bearing clearance or damaged bearings. Inspect the following components for excessive bearing clearance: · Crankshaft main bearings · Connecting rod bearings · Camshaft front bearing · Idler gear bearing	Bearing clearance	**Result:** An engine bearing is not within specification. **Repair:** Install a new bearing. Refer to Disassembly and Assembly. **Result:** All engine bearings are within specification. Contact the Dealer Solutions Network (DSN).

i08166748

Power Is Intermittently Low or Power Cutout Is Intermittent

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

Probable Causes

- Diagnostic codes
- Electrical connectors
- ECM connection
- Intake manifold pressure
- Fuel supply

Recommended Actions

NOTICE

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

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

Table 78

Troubleshooting Test Steps	Values	Results
1. Diagnostic Codes **A.** Establish communication between the electronic service tool and the Electronic Control Module (ECM). Refer to Troubleshooting, “Electronic Service Tools”, if necessary. **B.** Download the Product Status Report (PSR) with Histograms before performing any troubleshooting or clearing any diagnostic codes. **Note:** The downloaded information will be required by the Dealer Solutions Network (DSN) if troubleshooting assistance is needed. **C.** Use the electronic service tool to check for active or logged codes.	Diagnostic codes	**Result:** There are active or logged codes. **Repair:** Troubleshoot any codes before continuing with this procedure. **Result:** There are no active or logged codes. Proceed to Test Step 2.
2. Electrical Connectors **A.** Check all electrical connectors for damage. Refer to Troubleshooting, “Electrical Connectors - Inspect”. **B.** Make sure that all the connector seals are in place and that the connectors have been correctly installed.	Electrical connectors	**Result:** An electrical connector is damaged. **Repair:** Repair the electrical connector or replace the electrical connector. **Result:** A connector seal is displaced or missing or an electrical connector is not correctly installed. **Repair:** Repair the electrical connector or replace the electrical connector. **Result:** All electrical connectors are OK. Proceed to Test Step 3.
3. ECM Connection **A.** Check that the P2/J2 and P1/J1 connectors are correctly installed. **Note:** If a fault is suspected with the ECM power or ground connections, refer to Troubleshooting, “Electrical Power Supply - Test”.	ECM connection	**Result:** An ECM connector is not correctly installed. **Repair:** Repair the electrical connector or replace the electrical connector. **Result:** Both ECM connectors are correctly installed. Proceed to Test Step 4.

(continued)

(Table 78, contd)

Troubleshooting Test Steps	Values	Results
4. Intake Manifold Pressure **A.** Use the electronic service tool to verify the intake manifold pressure. Turn the start switch to the ON position. The intake manifold pressure must read 0 ± 0.5 kPa (0 ± 0.07 psi).	Intake manifold	**Result:** The intake manifold pressure does not read 0 ± 0.5 kPa (0 ± 0.07 psi). **Repair:** Refer to Troubleshooting, “Intake Manifold Air Pressure Is Low”. **Result:** The intake manifold pressure reads 0 ± 0.5 kPa (0 ± 0.07 psi). Proceed to Test Step 5.
5. Fuel Supply **A.** Visually check the fuel level in the fuel tank. Do not rely on the fuel gauge only. **B.** Ensure that the vent in the fuel cap is not filled with debris. **C.** Ensure that the fuel supply valve (if equipped) is in the full OPEN position. **D.** If the temperature is below 0 °C (32 °F), check for solidified fuel (wax). **E.** Check the primary filter/water separator for water in the fuel. **F.** Check for fuel supply lines that are restricted. **G.** Check that the low-pressure fuel lines are tight and secured properly. **H.** Check that the Electric Priming Pump (EPP) is operating correctly. **I.** Replace any filters and/or screens in the fuel system. Refer to Operation and Maintenance Manual for further information. **J.** Check the diesel fuel for contamination. Refer to Systems Operation, Testing and Adjusting, “Fuel Quality - Test”. **K.** Check for air in the fuel system. Refer to Systems Operation, Testing and Adjusting, “Air in Fuel - Test”. **L.** Ensure that the fuel system has been primed. Refer to Systems Operation, Testing and Adjusting, “Fuel System - Prime”.	Fuel system	**Result:** The fuel supply is not OK. **Repair:** Repair the fuel system or replace the fuel system components, as necessary. **Result:** The fuel supply is OK. Proceed to Test Step 6.

i07848390

SCR Warning System Problem

Operator Level Inducement

Inducements are engine derates or other actions intended to prompt the operator to repair or maintain the emission control system.

Inducement strategies are control actions required by EPA/ARB Tier 4 and EU Stage IV regulations. An inducement strategy ensures prompt correction of various failures in the engine NOx emission control system. The strategy requires actions to limit engine performance and defines required the following indications when the control actions are imposed:

- Lamps
- Messages

- Audible alarms

Table 79

Diagnostic Trouble Codes for SCR Warning System Problem		
J1939 Code	Description	Notes
5246-15	Aftertreatment SCR Operator Inducement Severity : High - least severe (1)	This code is a Level 1 inducement associated with an emission activated fault. The Emissions System Malfunction Lamp is on.
5246-16	Aftertreatment SCR Operator Inducement Severity : High - moderate severity (2)	This code is a Level 2 inducement associated with an emission activated fault. The Emissions System Malfunction Lamp is on and the Action Lamp is flashing. The engine is derated.
5246-0	Aftertreatment SCR Operator Inducement Severity : High - most severe (3)	This code is a Level 3 inducement associated with an emission activated fault. The Emissions System Malfunction lamp is on, the Action lamp is flashing, and the warning horn may sound. The engine is derated. The engine may stop.

Associated Codes

Troubleshoot any associated diagnostic codes listed in Table 80 that are present. Refer to “Inducement Type” in Table 80 for the correct Inducement table.

Table 80

Associated Codes		
J1939 Code	Code Description	Inducement Type
27–3	EGR Control Actuator Position Sensor: Voltage Above Normal	NRS Inducement
27–4	EGR Control Actuator Position Sensor: Voltage Below Normal	NRS Inducement
2791-6	Engine Exhaust Gas Recirculation (EGR) Valve Control : Current Above Normal	NRS Inducement
2791-7	Engine Exhaust Gas Recirculation (EGR) Valve Control : Not Responding Properly	NRS Inducement

Table 81

Troubleshooting Test Steps	Values	Results
1. Check for Associated Codes **A.** Use the electronic service tool to check for active diagnostic codes.	Associated Codes	**Result:** Associated codes are logged or active. **Repair:** Troubleshoot the associated codes. Refer to Troubleshooting, “Diagnostic Trouble Codes” for the proper procedure. Proceed to Test Step 2.
2. “Air System Motor Valve Verification Test” **A.** Use the electronic service tool to perform the “Air System Motor Valve Verification Test” .	Diagnostic codes	**Result:**There are active diagnostic codes as a result of the “Air System Motor Valve Verification Test” . **Repair:** Troubleshoot the codes. Refer to Troubleshooting, Diagnostic Trouble Codes. Once the fault has been repaired, operate the engine for at least 2 minutes. If no more faults are present, the inducement code will be cleared. **Result:** The inducements have not cleared. Contact the Dealer Solutions Network (DSN).

World-Wide Reduced Performance Setting

Table 82

<table>
<tr><th colspan="6">World-Wide Reduced Performance Setting</th></tr>
<tr><th colspan="6">Category 3 Fault (Non-Tampering NOx Control Monitoring and Impeded EGR)</th></tr>
<tr><td>-</td><td>Normal operation</td><td>Level 1</td><td>Level 2</td><td>Level 3</td><td>Override</td></tr>
<tr><td>Inducement Time
First Occurrence</td><td>None</td><td>36 Hours</td><td>64 Hours</td><td>50 Percent torque
Shut down or idle
Until fault heals</td><td>Cycling the keyswitch will give 20 minutes of full power</td></tr>
<tr><td colspan="6">The system must be fault free for 40 hours before the system will reset to zero. If the fault is intermittent, and returns within the 40 hours, then the repeat occurrence inducement time will be triggered.
The override can only be used once</td></tr>
<tr><td>Inducement Time
Repeat Occurrence</td><td>None</td><td>None</td><td>5 Hours</td><td rowspan="2">50 Percent torque
Shut down or idle
Until fault heals</td><td rowspan="2">Cycling the keyswitch will give 20 minutes of full power</td></tr>
<tr><td>Inducement</td><td>None</td><td>None</td><td>75 Percent of torque</td></tr>
<tr><td>Notification</td><td>None</td><td>Emission malfunction lamp will be on solid</td><td>Emission malfunction lamp will flash</td><td>Emission malfunction lamp will flash
The stop lamp will be on solid</td><td>Emission malfunction lamp will flash</td></tr>
<tr><td colspan="6">Contact your Perkins dealer or your Perkins Distributor at level 1 warning, do not let the fault develop.</td></tr>
</table>

World-Wide Reduce Time Setting

Table 83

World-Wide Reduced Time Setting					
Category 3 Fault (Non-Tampering NOx Control Monitoring and Impeded EGR)					
-	Normal operation	Level 1	Level 2	Level 3	Override
Inducement Time First Occurrence	None	18 Hours	18 Hours	50 Percent torque **Shut down or idle Until fault heals**	Cycling the keyswitch will give 20 minutes of full power
The system must be fault free for 40 hours before the system will reset to zero. If the fault is intermittent, and returns within the 40 hours, then the repeat inducement time will be triggered. The override can only be used once.					
Inducement Time Repeat Occurrence	None	None	108 Minutes	50 Percent torque **Shut down or idle Until fault heals**	Cycling the keyswitch will give 20 minutes of full power
Inducement	None	None	None		
Notification	None	Emission malfunction lamp will be on solid	Emission malfunction lamp will flash	Emission malfunction lamp will flash The stop lamp will activate	Emission malfunction lamp will flash
Contact your Perkins dealer or your Perkins Distributor at level 1 warning, do not let the fault develop.					

i08062901

Valve Lash Is Excessive

Probable Causes

- Lubrication
- Valve train components

Recommended Actions

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

Table 84

Troubleshooting Test Steps	Values	Results
1. Lubrication **A.** Remove the valve mechanism cover. Refer to Disassembly and Assembly, "Valve Mechanism Cover - Remove and Install" for the correct procedure. **B.** Crank the engine and check the lubrication in the valve compartment. Ensure that there is adequate engine oil flow in the valve compartment. The passages for the engine oil must be clean. **Note:** Do not run the engine with the valve mechanism cover removed.	Lubrication	**Result:** The oil flow to the valve mechanism is insufficient. **Repair:** Make sure that the passages for the engine oil are clear. **Result:** The oil flow to the valve mechanism is OK. Proceed to Test Step 2.
2. Valve Train Components **A.** Inspect the following components of the valve train for abnormal or excessive wear, straightness, and cleanliness: · Rocker arms · Valve bridges · Pushrods · Camshaft · Valve stems · Rocker shafts	Valve train components	**Result:** A valve train component is worn, bent, or not clean. **Repair:** Repair or replace the component. Refer to Disassembly and Assembly. **Note:** If the camshaft is replaced, new valve lifters must also be installed. **Result:** All the valve train components are OK. Contact the Dealer Solutions Network (DSN).

Circuit Tests

i08785831

CAN Data Link - Test

Use this procedure if a fault is suspected in the CAN data links. Also, use this procedure if one of the following diagnostic codes is active:

Table 85

Diagnostic Trouble Codes for the CAN Data Link Circuit		
J1939 Code	Code Description	Comments
639-9	J1939 Network #1 : Abnormal Update Rate	Another controller has incorrectly stopped transmitting an expected J1939 message or another controller has incorrectly started transmitting a conflicting J1939 message. This diagnostic code applies to the CAN A datalink. The ECM will log the diagnostic code. The engine will not start.
1231-9	J1939 Network #2 : Abnormal Update Rate	One of the following components has incorrectly stopped or started transmitting a data request: • Diesel Oxidation Catalyst (DOC) or Diesel Particulate Filter (DPF) inlet temperature sensor This diagnostic code applies to the CAN C datalink. The ECM will log the diagnostic code.

The following background information is related to this procedure:

The CAN data links are also known as J1939 data links. A data link is an industry standard for sending data between different devices in the same application.

High-speed data is transferred via the data links. The data links cannot be accurately tested without complicated equipment. The data links require a resistance of 60 Ohms between the two wires to transmit the data correctly. This resistance is made up of two 120 Ohm resistors. The two resistors are known as “Terminating Resistors” . The terminating resistors should be at opposite ends of a data link circuit. If this resistance is not present, then the data will be intermittent or unreadable.

Note: The wiring for a J1939 data link is a shielded twisted-pair cable. If the wiring is damaged, the replacement type must be shielded twisted-pair cable.

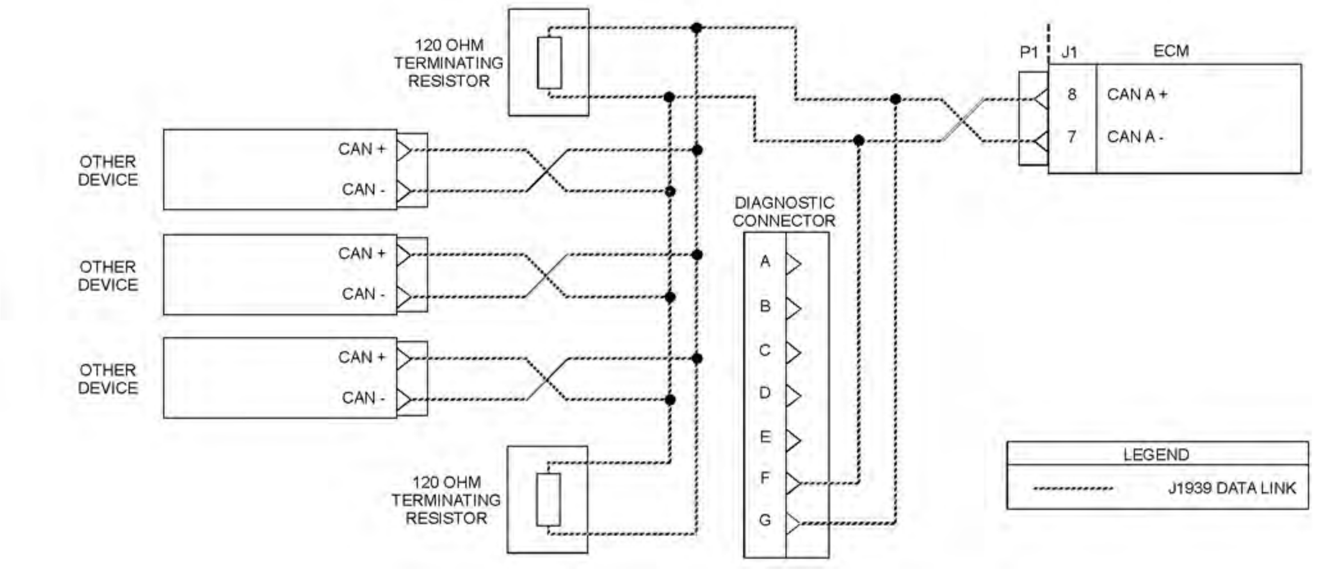


Illustration 13 g06364768

Typical example of the schematic for the CAN A data link

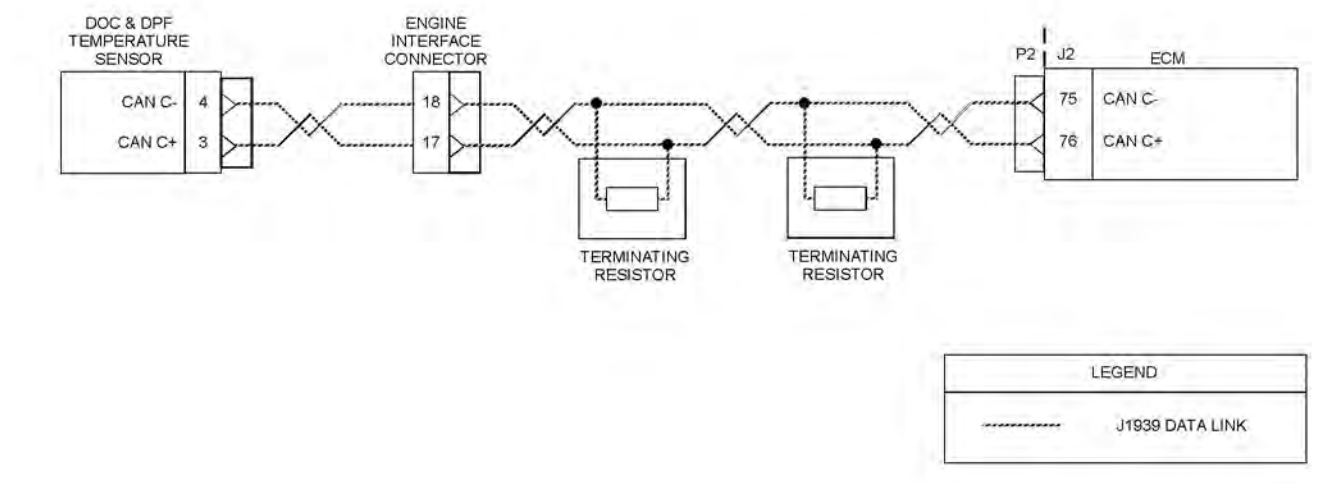


Illustration 14 g06456141

Typical example of the schematic for the CAN C data link

Table 86

Troubleshooting Test Steps	Values	Results
1. Use the “System Communication Status to Check the Status of the Other Devices on the Suspect CAN Data Link” **A.** In the electronic service tool, click the “Diagnostics” tab on the tool bar. **B.** Select the “System Communication Status” option from the drop-down list.	Component Identified	**Result:** A 639-9 diagnostic code is active or logged. **Repair:** Perform a full power-down of the application. Once the application is fully powered down, reapply power to the application. The 639-9 code will be reset. **Result:** One or more of the devices on the suspect data link is not visible on the electronic service tool. **Repair:** Thoroughly inspect the electrical connectors for the suspect devices Refer to Troubleshooting, “Electrical Connectors - Inspect”. Check the power supply to the suspect devices. If the suspect device is the DOC and DPF temperature sensor, check that the sensor supply voltage is 5 V between pin 1 and pin 2 on the sensor connector. If necessary, refer to Troubleshooting, “Electrical Power Supply - Test”. If the fault has been resolved, return the engine to service. If the fault is still present, proceed to Test Step 2. **Result:** All devices are visible on the electronic service tool. Proceed to Test Step 2.
2. Check the Data Link Terminating Resistance **A.** Disconnect the P1 connector and the P2 connector from the ECM. **B.** Measure the resistance between P1:8 and P1:7. Measure the resistance between P2:75 and P2:76.	Between 50 Ohms and 70 Ohms	**Result:** The resistance is less than 50 Ohms - there is a short circuit in the harness. **Repair:** Repair the connectors or the harness and/or replace the connectors or the harness. Ensure that all the seals are correctly in place and ensure that the connectors are correctly connected. Use the electronic service tool to clear all logged diagnostic codes and then verify that the repair eliminates the fault. **Result:** The resistance is between 110 and 130 Ohms - one of the terminating resistors may have failed. **Repair:** Locate the two terminating resistors and remove the two terminating resistors from the harness. Depending on the application, one or both of the terminating resistors may be located in other ECMs on the data link. Measure the resistance of the two terminating resistors. If one of the terminating resistors is incorrect, replace the faulty terminating resistor. If the two terminating resistors are between 110 and 130 Ohms, proceed to Test Step 4. **Result:** The resistance is greater than 150 Ohms. Proceed to Test Step 3. **Result:** The resistance is between 50 and 70 Ohms The resistance is correct. The fault may be in the connection to other devices on the data link.

(continued)

(Table 86, contd)

Troubleshooting Test Steps	Values	Results
		Proceed to Test Step 3.
3. Check the Data Link Wiring **A.** Disconnect each of the connectors that connect other devices on the data link. **B.** Use a multimeter to measure the resistance between P1:8 and each of the CAN+ pins on other devices on the CAN A data link. **C.** Use a multimeter to measure the resistance between P1:8 and pin (G) on the diagnostic connector. **D.** Use a multimeter to measure the resistance between P1:7 and each of the CAN- pins on other devices on the CAN A data link. **E.** Use a multimeter to measure the resistance between P1:7 and pin (F) on the diagnostic connector. **F.** Use a multimeter to measure the resistance between P2:76 to each of the CAN+ pins on other devices on the CAN C data link. **G.** Use a multimeter to measure the resistance between P2:75 to each of the CAN- pins on other devices on the CAN C data link.	Less than 2 Ohms	**Result:** At least one of the resistance measurements is greater than 2 Ohms - there is an open circuit or high resistance in the wiring. **Repair:** Repair the connectors or the harness and/or replace the connectors or the harness. Ensure that all seals are correctly in place and ensure that the connectors are correctly connected. Use the electronic service tool to clear all logged diagnostic codes and then verify that the repair has eliminated the fault. **Result:** All measured resistances are less than 2 Ohms. Proceed to Test Step 4.
4. Check the Other Devices on the CAN Data Link **A.** Use the appropriate service tools to diagnose other devices on the data link.	Other devices are OK	**Result:** At least one of the other devices is not operating correctly. **Repair:** Use the appropriate service tools to repair other devices on the data link. Use the electronic service tool to clear all logged diagnostic codes and then verify that the repair eliminates the fault. **Result:** The other devices are operating correctly. Contact the Dealer Solutions Network (DSN).

i09602774

Data Link Configuration Status - Test

Use this procedure if one of the following diagnostic codes are active.

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

Table 87

Diagnostic Trouble Codes for the Data Link Configuration Status		
J1939 Code	**Code Description**	**Comments**
639-14	J1939 Network #1 : Special Instruction	The data received from the CAN A data bus is not in the correct format. The code is logged.
1235-14	J1939 Network 2: Special Instruction	The data received from the CAN C data bus is not in the correct format. The code is logged.

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

Table 88

Troubleshooting Test Steps	Values	Results
1. Check for an Associated -9 Code **A.** Establish communication between the electronic service tool and the Electronic Control Module (ECM) for the engine. **B.** Check for active diagnostic codes.	Associated Trouble code	**Result:** An associated -9 code is logged. **Repair:** Repair all associated -9 codes before continuing with this procedure. Refer to Troubleshooting, “CAN Data Link - Test”. If a -14 code is still present after resolving the -9 code, proceed to Test Step 2. **Result:** An associated -9 code is not logged. Proceed to Test Step 2.
2. Check the Personality Module Code for Compatibility with the Application **A.** Connect to the electronic service tool. **B.** Select the ECM connection that is related to the logged code. **C.** Check if the personality module code is valid for the application.	Compatible personality module	**Result:** The code is valid for the application. Proceed to Test Step 3. **Result:** The code is not valid for the application. **Repair:** Obtain the correct flash file and update the ECM. Reset all active codes and clear all logged codes. Return the unit to service.
3. Check that the Latest Available Software is Installed **A.** Ensure that the latest software is installed on the engine ECM . Ensure that the software installed is for the correct system voltage (12 V or 24 V). If necessary, refer to Troubleshooting, “ECM Software - Install” for the correct procedure.	Software	**Result:** The latest software is not installed. **Repair:** Install the latest software. If necessary, refer to Troubleshooting, “ECM Software - Install” for the correct procedure. Turn the keyswitch to the on position. If the fault is cleared, return the engine to service. If the fault is still present, proceed to Test Step 4. **Result:** The latest software is installed. The software is for the correct system voltage. Proceed to Test Step 4.

(continued)

(Table 88, contd)

Troubleshooting Test Steps	Values	Results
4. Check the Configuration Parameters **A.** Check the configuration parameters to ensure that the parameters are programmed correctly. Refer to Troubleshooting, “Configuration Parameters”. **B.** Select the ECM connection that is related to the logged code.	Correct configuration parameters	**Result:** The configuration parameters are programmed correctly. Proceed to Test Step 5. **Result:** The configuration parameters are not programmed correctly. **Repair:** Program the parameters to function with the other modules on the data link. Reset all active codes and clear all logged codes. Return the unit to service.
5. Check for Compatibility with Any Other ECM on the Data Link **A.** Determine if any other ECM or display on the data link are incompatible. **B.** Select the ECM connection that is related to the logged code.	Compatible ECM	**Result:** The ECMs are not compatible. **Repair:**Replace the incompatible ECM with the correct module. Reset all active codes and clear all logged codes. Return the unit to service. If the procedure did not correct the fault, contact the Dealer Solutions Network (DSN).

i07901200

Electrical Power Supply - Test

Use this procedure to troubleshoot the electrical system if a problem is suspected with the power to the engines Electronic Control Module (ECM). Use this procedure if any of the diagnostic codes in Table 89 are active or easily repeated.

Table 89

Diagnostic Trouble Codes for the Electrical Power Supply		
J1939 Code	**Code Description**	**Comments**
168-15	Battery Potential / Power Input #1 : High - least severe (1)	The ECM detects voltage that is above 16 V.
168-17	Battery Potential / Power Input #1 : Low - least severe (1)	The ECM detects voltage that is below 9 V.

The engine ECM requires the keyswitch to be in the ON position to maintain communications with the electronic service tool.

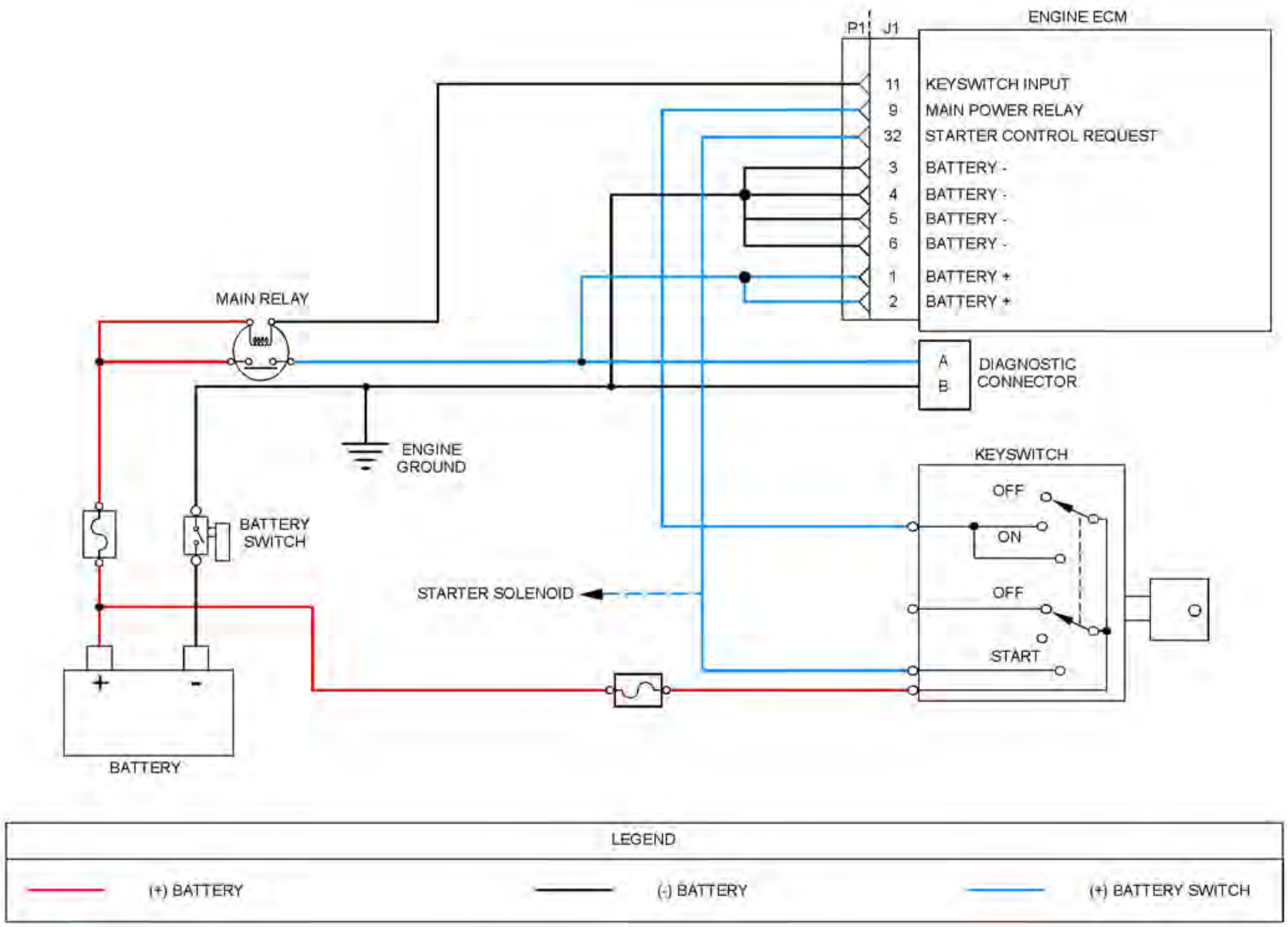


Illustration 15 g06365119

Schematic diagram for the engine electrical power supply circuit

Not all connectors are shown. Refer to the appropriate electrical schematic

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

Table 90

Troubleshooting Test Steps	Value	Results
1. Determine the Diagnostic Code **A.** Establish communication between the electronic service tool and the ECM . Refer to Troubleshooting, “Electronic Service Tools”, if necessary. **B.** Start the engine. Run the engine until the engine is at normal operating temperature. **C.** Observe the “Active Diagnostic” screen on the electronic service tool. Wait at least 30 seconds so that any codes may become active.	Diagnostic code	**Result:** One of the diagnostic codes listed in Table 89 is active. Proceed to Test Step 2. **Result:** The electronic service tool will not communicate with the ECM. **Repair:** Refer to Troubleshooting, “Electronic Service Tool Does Not Communicate”.

(continued)

(Table 90, contd)

2. Inspect Electrical Connectors and Wiring **A.** Ensure that the battery disconnect switch is in the CLOSED position. **B.** Thoroughly inspect all connectors associated with the electrical power supplies. **C.** Check all fuses. **D.** Perform a 30 N (6.7 lb) pull test on each of the wires in the connectors associated with the electrical power supplies. **E.** Check all the wiring associated with the electrical power supplies for abrasions and pinch points. **F.** Verify that the “System Operating Voltage Configuration” is correctly configured in the Engine ECM configuration parameters.	Damaged wire or connector. Blown fuse.	**Result:** A damaged wire or damaged connector was found. A blown fuse was found. **Repair:** Repair the damaged wire or the damaged connector. Replace all blown fuses. Use the electronic service tool to clear all logged diagnostic codes. Verify that the repair eliminates the fault. **Result:** The “System Operating Voltage Configuration” is configured incorrectly. **Repair:** Program the parameter with the correct system voltage. **Result:** A damaged wire or damaged connector was not found. The fuses are OK. Proceed to Test Step 3.
3. Load Test the Batteries **A.** Use a suitable battery load tester to test the batteries. Refer to Systems Operation, Testing and Adjusting, “Battery - Test” for the correct procedure.	Load test	**Result:** The batteries pass the load test. Proceed to Test Step 4. **Result:** The batteries do not pass the load test. **Repair:** Recharge or replace the faulty batteries. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.
4. Check the Charging Circuit **A.** Check the charging circuit. Refer to Systems Operation, Testing and Adjusting, “Charging System - Test”.	Charging circuit	**Result:** The charging system is OK. Contact the Dealer Solutions Network (DSN). **Result:** The charging system is not OK. **Repair:** There is a fault in the charging system. Make the necessary repairs. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.

i07816297

Engine Speed - Test

This procedure covers the following diagnostic trouble code:

Table 91

Diagnostic Trouble Codes for Engine Speed		
J1939 Code	Code Description	Comments
190-10	Engine Speed : Abnormal Rate of Change	The ECM has detected an unintended injector current command causing engine speed to exceed a threshold above desired engine speed for a longer than allowable time. The engine will usually shut down. Factory passwords are required to clear a 190–10 diagnostic code.

Probable Causes

- Wiring to the electronic unit injectors
- Electronic unit injectors
- Engine software and ECM

Recommended Actions

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

WARNING

Electrical Shock Hazard. The electronic unit injectors use DC voltage. The ECM sends this voltage to the electronic unit injectors. Do not come in contact with the harness connector for the electronic unit injectors while the engine is operating. Failure to follow this instruction could result in personal injury or death.

Table 92

Troubleshooting Test Steps	Values	Results
1. Diagnostic Codes **A.** Download the Product Status Report (PSR) with Histograms before performing any troubleshooting or clearing any diagnostic codes. **Note:** The downloaded information will be required by the Dealer Solutions Network (DSN) if troubleshooting assistance is needed. **B.** Use the electronic service tool to check for active or logged diagnostic codes.	Diagnostic codes	**Result:** A diagnostic code is not active or logged. Return the unit to service. **Result:** A 190–10 diagnostic code is active or logged. Proceed to Test Step 2.
2. Inspect Electrical Connectors and Wiring **A.** Turn the keyswitch to the OFF position. A strong electrical shock hazard is present if the keyswitch is not turned OFF. **B:** Thoroughly inspect the connectors at the cylinder head. Refer to Troubleshooting, Electrical Connectors - Inspect for details. **C.** Perform a 30 N (6.7 lb) pull test on each of the wires in the ECM connector that are associated with the injector solenoids. **D.** Check the harness and wiring for abrasions and for pinch points from the injectors to the ECM.	Loose connection or damaged wire	**Result:** There is a fault in the connector or the wiring. **Repair:** Repair any faulty connectors or replace the wiring harness. Ensure that all the seals are properly in place and ensure that the connectors are correctly coupled. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault. **Result:** All connectors, pins, and sockets are correctly coupled and/or inserted. The harness is free of corrosion, abrasion, and pinch points. Proceed to Test Step 3.
3. Use the “Injector Solenoid Test” **A.** Start the engine. **B.** Allow the engine to warm up to the normal operating temperature. **C.** Stop the engine. **D.** Turn the keyswitch to the ON position. **E.** Access the “Injector Solenoid Test” in the electronic service tool by accessing the following screens: • Diagnostics • Diagnostic Tests • Injector Solenoid Test **F.** 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 to actuate the injector solenoids while the engine is not running.	“OK” , “OPEN” , or “SHORT”	**Result:** All cylinders indicate “OK” . There is not an electrical fault with the injectors. Proceed to Test Step 4. **Result:** “OPEN” or “SHORT” is indicated on any injector. Note the cylinders that indicate “OPEN” or “SHORT” . Refer to Troubleshooting, Injector Solenoid - Test to diagnose the cause of the injector circuit fault.

(continued)

(Table 92, contd)

Troubleshooting Test Steps	Values	Results
4. Electronic Unit Injectors **A.** Use the electronic service tool to perform the automatic “Cylinder Cutout Test” . Refer to Troubleshooting, Service Tool Features for more information on the “Cylinder Cutout Test” .	Electronic unit injectors	**Result:** A faulty cylinder is indicated. **Repair:** Remove any faulty electronic unit injectors. Refer to Disassembly and Assembly, Electronic Unit Injector - Remove. Install new electronic unit injectors. Refer to Disassembly and Assembly, Electronic Unit Injector - Install. Repeat the automatic “Cylinder Cutout Test” . If the fault is still present, remove the replacement electronic unit injector and install the original electronic unit injector. Refer to Disassembly and Assembly, Electronic Unit Injector - Remove and Disassembly and Assembly, Electronic Unit Injector - Install. Proceed to Test Step 5. If the fault is cleared, return the unit to service. **Result:** All injectors are OK. Proceed to Test Step 5.
5. Engine Software and Electronic Control Module (ECM) **A.** Make sure that the latest flash file for the application is installed in the engine ECM. **B.** Ensure that the ECM has been powered down after the ECM flash file has been updated.	Software updated	**Result** The 190–10 does not recur after the software has been updated. Return the unit to service. **Result** The 190–10 code is still present after the software has been updated. Proceed to Test Step 6.
6. Create an Electronic Service Tool Snapshot **A.** Select “Snapshot Viewer” on the electronic service tool, using menus: Information -> Snapshot -> Viewer **B.** Select the diagnostic code and then click “View Graph” . **C.** Select the following parameter and then click OK. · Engine Speed **D.** Select Save to "File to save" a Snapshot File (*.xml). This file will contain all the data in the snapshot and not only the data shown on the graph. **Note:** The downloaded information will be required by the Dealer Solutions Network (DSN) if diagnostic assistance is needed.	Snapshot saved	**Result:** The electronic service tool snapshot was successfully saved. Contact the DSN. **Result:** The electronic service tool snapshot was not successfully saved. Contact the DSN for guidance.

i07592910

Fuel Control - Test

This procedure covers the following diagnostic codes:

Table 93

Diagnostic Codes for the Fuel Control Valve		
J1939 Code	Code Description	Comments
1076–5	Engine Fuel Injection Pump Fuel Control Valve : Current Below Normal	The Electronic Control Module (ECM) detects the following conditions: Low current in the output from the ECM to the fuel pump solenoid for 0.6 seconds. There are no active 168 diagnostic codes. The warning lamp will come on. The diagnostic code will be logged.
1076–6	Engine Fuel Injection Pump Fuel Control Valve : Current Above Normal	The ECM detects the following conditions: High current in the output from the ECM to the fuel pump solenoid for 0.6 seconds. There are no active 168 diagnostic codes. The warning lamp will come on. The diagnostic code will be logged.
Follow the troubleshooting procedure to identify the root cause of the fault.		

The following background information is related to this procedure:

Fuel Control Valve for the High-Pressure Fuel Pump

The high-pressure fuel pump is equipped with a fuel control valve. The fuel control valve precisely controls the amount of fuel that enters the high-pressure fuel pump.

The amount of fuel that is required is calculated by the software that is contained in the ECM. The solenoid in the suction control valve is controlled by a PWM signal from the ECM.

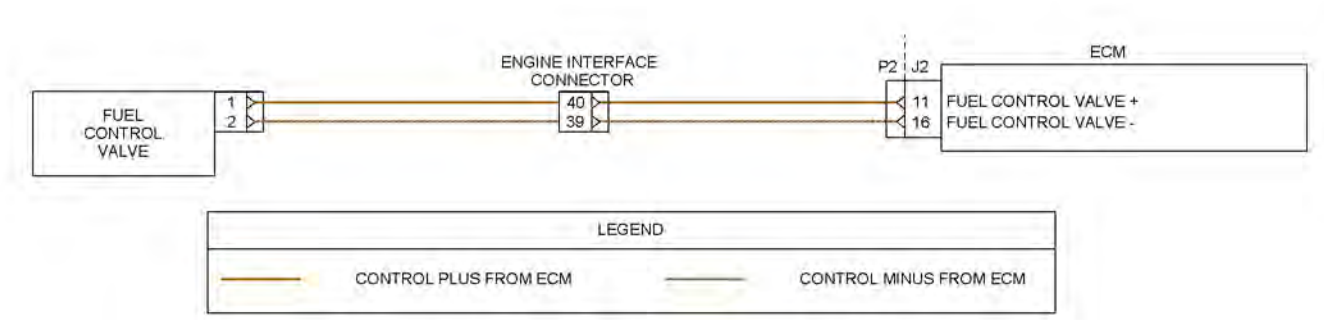


Illustration 16 g06373781

Schematic diagram for the fuel control valve

Table 94

Troubleshooting Test Steps	Values	Results
1. Inspect Electrical Connectors and Wiring **A.** Thoroughly inspect the connector for the fuel control valve. Refer to Troubleshooting, "Electrical Connectors - Inspect" for details. **B.** Thoroughly inspect the engine interface connector. Refer to Troubleshooting, "Electrical Connectors - Inspect" for details. **C.** Check the harness for corrosion, abrasion, and pinch points from the fuel control valve to the ECM. **Note:** Do not disconnect the ECM connector at this stage. The ECM can only be disconnected and reconnected 10 times before damage to the harness connector may occur.	Loose connection or damaged wire	**Result:** There is a fault in a connector or the wiring. **Repair:** Repair any faulty connectors or replace the wiring harness. Ensure that all the seals are properly in place and ensure that the connectors are correctly coupled. Use the electronic service tool to clear all logged diagnostic codes. Use the electronic service tool to verify that the repair eliminates the fault. **Result:** All connectors, pins, and sockets are correctly coupled and/or inserted. The harness is free of corrosion, abrasion, and pinch points. Proceed to Test Step 2.
2. Check for Active Diagnostic Codes **A.** Turn the keyswitch to the OFF position. **B.** Connect the electronic service tool to the diagnostic connector. **C.** Turn the keyswitch to the ON position. **E.** Verify if any of the diagnostic codes that are listed in Table 93 are active. **F.** Turn the keyswitch to the OFF position.	Diagnostic codes	**Result:** A 1076-5 diagnostic code is active. Proceed to Test Step 3. **Result:** A 1076–6 diagnostic code is active. Proceed to Test Step 6. **Result:** No diagnostic codes are active. There may be an intermittent fault. **Repair:** Use the electronic service tool to perform a Wiggle Test. If no faults are found, return the unit to service. If the Wiggle Test identifies a fault, investigate the cause.
3. Create a Short Circuit at the Harness Connector for the Fuel Control Valve **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the connector for the fuel control valve. **C.** Fabricate a jumper wire that is 150 mm (6 inch) long. **D.** Install the wire between the terminal 1 and terminal 2 on the harness connector for the fuel control valve to create a short circuit. **E.** Turn the keyswitch to the ON position. **F.** Check for active diagnostic codes. **G.** Remove the jumper wire from the connector for the fuel control valve.	Short circuit	**Result:** A 1076–5 diagnostic code was active before installing the jumper. A 1076–6 diagnostic code is active when the jumper is installed - There is a fault in the fuel control valve. **Repair:** Install a replacement fuel control valve. Refer to Disassembly and Assembly, Flow Control Valve - Remove and Install. Use the electronic service tool to check that the repair eliminates the fault. **Result:** A 1076–5 diagnostic code is still active with the jumper installed. Remove the jumper. Reconnect all connectors. Proceed to Test Step 4.

(continued)

(Table 94, contd)

Troubleshooting Test Steps	Values	Results
4. Create a Short Circuit at the Engine Interface Connector **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the engine interface connector. **C.** Fabricate a jumper wire that is 150 mm (6 inch) long. **D.** Install the wire between terminal 39 and terminal 40 on the engine interface connector (ECM side). **E.** Turn the keyswitch to the ON position. **F.** Use the electronic service tool to check for an active 1076 diagnostic code. **Note:** Diagnostic codes for all the engine sensors will be active with the engine interface connector disconnected. Disregard the other active diagnostic codes. Only look for an active 1076 code.	Short circuit	**Result:** A 1076–5 diagnostic code was active before installing the jumper. A 1076–6 diagnostic code is active when the jumper is installed - There is a fault in the engine wiring harness. **Repair:** Repair the faulty wiring or replace the faulty wiring. Use the electronic service tool to check that the repair eliminates the fault. **Result:** A 1076–5 diagnostic code is still active with the jumper installed. Remove the jumper. Reconnect all connectors. Proceed to Test Step 5.
5. Check the Wiring to the ECM for an Open Circuit **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the P2 connector. Disconnect the connector for the fuel control valve. **C.** Inspect the P2/J2 connectors for damage or corrosion. Refer to Troubleshooting, Electrical Connectors - Inspect for more information. **D.** Perform a 30 N (6.7 lb) pull test on P2:16 and P2:11. **E.** Use a suitable multimeter to measure the resistance between terminal 1 on the harness connector for the fuel control valve and P2:11. Use a suitable multimeter to measure the resistance between terminal 2 on the harness connector for the fuel control valve and P2:16.	Less than 2 Ohms	**Result:** At least one of the measured resistances is greater than 2 Ohms. The fault is in the wiring connected to the ECM connector. **Repair:** Repair the faulty wiring or replace the faulty wiring. **Result:** The resistance is less than 2 Ohms. Contact the Dealer Solutions Network (DSN).
6. Create an Open Circuit at the Fuel Control Valve **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the connector for the fuel control valve. **C.** Turn the keyswitch to the ON position. **D.** Check for active diagnostic codes.	Open circuit	**Result:** A 1076–6 diagnostic code was active before disconnecting the fuel control valve. A 1076–5 diagnostic code is active with the fuel control valve disconnected. The fault is in the fuel control valve. **Repair:** Install a replacement fuel control valve. Refer to Disassembly and Assembly, Flow Control Valve - Remove and Install. Use the electronic service tool to check that the repair eliminates the fault. **Result:** A 1076–6 diagnostic code is still active with the fuel control valve disconnected. Proceed to Test Step 7.

(continued)

(Table 94, contd)

Troubleshooting Test Steps	Values	Results
7. Create an Open Circuit at the Engine Interface Connector **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the engine interface connector. **C.** Turn the keyswitch to the ON position. **D.** Use the electronic service tool to check for an active 1076 diagnostic code. **Note:** Diagnostic codes for all the engine sensors will be active with the engine interface connector disconnected. Disregard the other active diagnostic codes. Only look for an active 1076 code.	Open circuit	**Result:** A 1076–6 diagnostic code was active before disconnecting the engine interface connector. A 1076–5 diagnostic code is active with the fuel control valve disconnected. The fault is in the engine wiring harness. **Repair:** Repair the faulty wiring or replace the faulty wiring. Use the electronic service tool to check that the repair eliminates the fault. **Result:** A 1076–6 diagnostic code is still active with the engine interface connector disconnected. Proceed to Test Step 7.
8. Check the Wiring to the ECM for a Short Circuit **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the P2 connector. Disconnect the connector for the fuel control valve. **C.** Inspect the P2/J2 connectors for damage or corrosion. Refer to Troubleshooting, Electrical Connectors - Inspect for more information. **D.** Perform a 30 N (6.7 lb) pull test on the wire in P2:16 and P2:11. **E.** Use a suitable multimeter to measure the resistance between terminal 39 on the engine interface connector (ECM side) and all other terminals on the engine interface connector. Use a suitable multimeter to measure the resistance between terminal 40 on the engine interface connector (ECM side) and all other terminals on the engine interface connector.	Greater than 1 k Ohm	**Result:** At least one of the resistance measurements is less than 1 k Ohm. The fault is in the wiring connected to the ECM connector. **Repair:** Repair the faulty wiring or replace the faulty wiring. **Result:** All resistance measurements are greater than 1 k Ohm. Contact the Dealer Solutions Network (DSN).

i07851871

Fuel Transfer Pump - Test

Use this procedure to troubleshoot the relay for the Electric Priming Pump (EPP). Use this procedure if there is a suspected electrical fault with the EPP.

This procedure covers the following diagnostic codes:

Table 95

Diagnostic Codes for the EPP Relay		
J1939 Code	Code Description	Comments
1075-5	Engine Electric Lift Pump for Engine Fuel Supply : Current Below Normal	The Electronic Control Module (ECM) detects a low current condition in the EPP relay circuit. The warning light will come on. The diagnostic code will be logged. The ECM is unable to activate the relay for the EPP. The EPP will not operate or the EPP will operate all the time. The engine will not operate.
1075-6	Engine Electric Lift Pump for Engine Fuel Supply : Current Above Normal	The ECM detects a high current condition in the EPP relay circuit. There is a high current condition in the EPP relay circuit for more than 2 seconds. The warning light will come on. The diagnostic code will be logged. The ECM is unable to activate the relay for the EPP. The EPP will not operate or the EPP will operate all the time. The engine will not operate.

The following background information is related to this procedure:

The EPP is used to provide positive fuel pressure to the high-pressure fuel pump. When the keyswitch is turned to the ON position, the ECM will activate the EPP. If the engine is not running, the ECM will deactivate the EPP after 2 minutes.

Not all engines are equipped with an EPP. Ensure that the ECM parameters for the EPP are correctly configured for the hardware equipped.

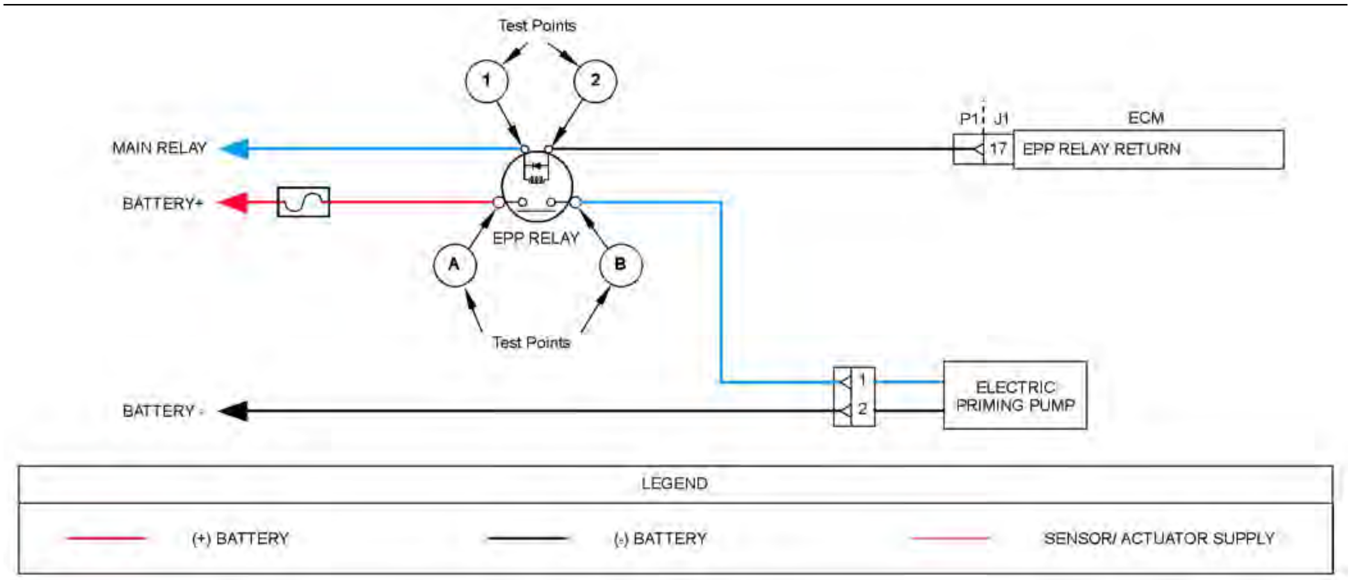


Illustration 17 g06366341

Schematic for the Electric Priming Pump (EPP) relay

During the following procedure, refer to the electrical schematic for the application.

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

Table 96

Troubleshooting Test Steps	Values	Results
1. Inspect Electrical Connectors and Wiring **A.** Turn the keyswitch to the OFF position. **B.** Check the fuses. **C.** Thoroughly inspect the connectors between the EPP relay and the engine ECM. Refer to Troubleshooting, "Electrical Connectors - Inspect" for details. **D.** Check the harness and wiring for abrasion and for pinch points from the EPP to the ECM and from the EPP relay to the battery. **Note:** Do not disconnect the ECM connector at this stage. The ECM can only be disconnected and reconnected 10 times before damage to the harness connector may occur.	Loose connection or damaged wire	**Result:** There is a fault in a connector or the wiring. A fuse is blown. **Repair:** Repair any faulty connectors or replace the wiring harness. Ensure that all the seals are properly in place and ensure that the connectors are correctly coupled. Replace blown fuses. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault. **Result:** All connectors, pins, and sockets are correctly coupled and/or inserted. The harness is free of corrosion, abrasion, and pinch points. Proceed to Test Step 2.
2. Check for Active Diagnostic Codes **A.** Connect the electronic service tool to the diagnostic connector. **B.** Turn the keyswitch to the ON position. Do not start the engine. **C.** Make a note of any active diagnostic codes. **D.** Wait for at least 2 minutes for the Electric Fuel Lift Pump (EPP) to deactivate. Make a note of any active diagnostic codes.	Diagnostic codes	**Result:** Diagnostic code 1075-5 is active or recently logged. Proceed to Test Step 3. **Result:** Diagnostic code 1075-6 is active or recently logged. Proceed to Test Step 5.
3. Create a Short Circuit at the EPP Relay **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the harness connector for the EPP relay. **C.** Fabricate a jumper wire that is 150 mm (6 inch) long. **D.** Use the jumper wire to connect Test Point 1 to Test Point 2 on the harness connector for the EPP relay. Refer to Illustration 17 . **E.** Turn the keyswitch to the ON position. Do not start the engine. **F.** Use the electronic service tool to check for an active 1075-6 diagnostic code. **G.** Wait for at least 2 minutes for the EPP to deactivate. Check for an active 1075-5 diagnostic code. **H.** Turn the keyswitch to the OFF position. **I.** Remove the jumper. Leave the connector for the EPP disconnected.	Open circuit	**Result:** A 1075-6 diagnostic code was active with the jumper installed. **Repair:** Install a replacement EPP relay. Reconnect the connector for the EPP relay. Turn the keyswitch to the ON position. Do not start the engine. Check for active diagnostic codes. Wait for at least 2 minutes for the EPP to deactivate. Check for active diagnostic codes. Confirm that the fault has been eliminated. **Result:** A 1075-5 diagnostic code is still active with the jumper installed. There is a fault in the wiring or the ECM. Proceed to Test Step 4.

(continued)

(Table 96, contd)

Troubleshooting Test Steps	Values	Results
4. Check the Wiring Between the ECM and the EPP Relay for an Open Circuit **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the EPP relay. Disconnect the J1 connector from the ECM. **C.** Inspect the P1/J1 connectors for damage or corrosion. Refer to Troubleshooting, Electrical Connectors - Inspect for more information. **D.** Perform a 30 N (6.7 lb) pull test on P1:17. **E.** Measure the resistance between P1:17 and Test Point 1 on the harness connector for the relay.	Less than 2 Ohms	**Result:** The resistance measurement is greater than 2 Ohms. **Repair:** The fault is in the wiring between the EPP relay and the ECM. Repair the faulty wiring or replace the faulty wiring. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault. **Result:** The resistance measurement is less than 2 Ohms. Contact the Dealer Solutions Network (DSN).
5. Create an Open Circuit at the Relay **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the harness connector for the EPP relay. **C.** Turn the keyswitch to the ON position. Do not start the engine. Wait for at least 2 minutes for the EPP to deactivate. **D.** Use the electronic service tool to check for an active 1075-6 diagnostic code. **E.** Turn the keyswitch to the OFF position.	Short circuit	**Result:** A 1075-5 diagnostic code is active. There are no faults in the wiring for the EPP. **Repair:** Install a replacement relay. Turn the keyswitch to the ON position. Do not start the engine. Wait for at least 2 minutes for the EPP to deactivate. Check for active diagnostic codes. Confirm that the fault has been eliminated. **Result:** A 1075-6 diagnostic code is still active. There is a fault in the wiring or the ECM. Proceed to Test Step 6.
6. Check the Wiring Between the Relay and the ECM for a Short Circuit **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the P1 connector. **C.** Inspect the P1/J1 connector. Refer to Troubleshooting, “Electrical Connectors - Inspect”. **D.** Perform a 30 N (6.7 lb) pull test on P1:17. **E.** Disconnect the connector for the Electric Priming Pump (EPP) relay. **F.** Measure the resistance between P1:17 and all other pins on the P1 connector.	Greater than 1k Ohm	**Result:** At least one of the resistance measurements is less than 1k Ohm. The fault is in the wiring between the EPP relay and the ECM. **Repair:** Repair the faulty wiring or replace the faulty harness. Turn the keyswitch to the ON position. Do not start the engine. Check for active diagnostic codes. Wait for at least 2 minutes for the EPP to deactivate. Check for active diagnostic codes. Confirm that the fault has been eliminated. **Result:** All resistance measurements are greater than 1k Ohm. Contact the Dealer Solutions Network (DSN).

i07575166

Glow Plug Starting Aid - Test

This procedure covers the following diagnostic codes:

Use this procedure if there is a suspected fault in the glow plug start aid circuit or the glow plugs.

Table 97

Diagnostic Trouble Codes For The Glow Plug Starting Aid		
J1939 Code	Code Description	Comments
676-5	Engine Glow Plug Relay : Current Below Normal	The Electronic Control Module (ECM) detects a low current condition in the glow plug start aid relay circuit. The ECM is unable to activate the relay for the glow plug starting aid. The glow plugs will not operate. The engine may be difficult to start in cold temperatures and the exhaust may emit white smoke.
676-6	Engine Glow Plug Relay : Current Above Normal	The Electronic Control Module (ECM) detects a high current condition in the glow plug start aid relay circuit The ECM is unable to activate the relay for the glow plug starting aid. The glow plugs will not operate or the glow plugs will operate all the time. The engine may be difficult to start in cold temperatures and the exhaust may emit white smoke.
Follow the troubleshooting procedure to identify the root cause of the fault.		

The following background information is related to this procedure:

The starting aid is used to improve the engine starting when the engine is cold. With the keyswitch in the ON position, the ECM monitors the following parameters to decide if the glow plugs need to be switched ON:

- Coolant temperature
- Intake manifold air temperature
- Air inlet temperature

If the glow plugs are required, then the ECM will activate the starting aid relay for a controlled period. While the glow plug start aid relay is activated, the glow plug start aid relay will supply power to the glow plugs. If a “Wait To Start” lamp is installed, then this lamp will be illuminated to indicate the “Wait To Start” period.

“Wait to Start Lamp”

This feature may be included as an option.

When glow plugs need to be activated prior to starting, a lamp will indicate that the operator needs to “Wait to Start” . Starting aids may be used during the cranking of the engine. Starting aids may be used if the engine has previously been started. The “Wait to Start” lamp will not be active in these conditions.

Electronic Service Tool Test Aid

The electronic service tool includes the test “Glow Plug Start Aid Override Test” . This test will assist the analysis of the cold starting aid.

Overview of the Glow Plug Start Aid Override Test

This glow plug start aid override test switches on the cold starting aid when the engine is not running. The glow plug start aid override test aids the analysis of the circuit for the glow plug start aid relay.

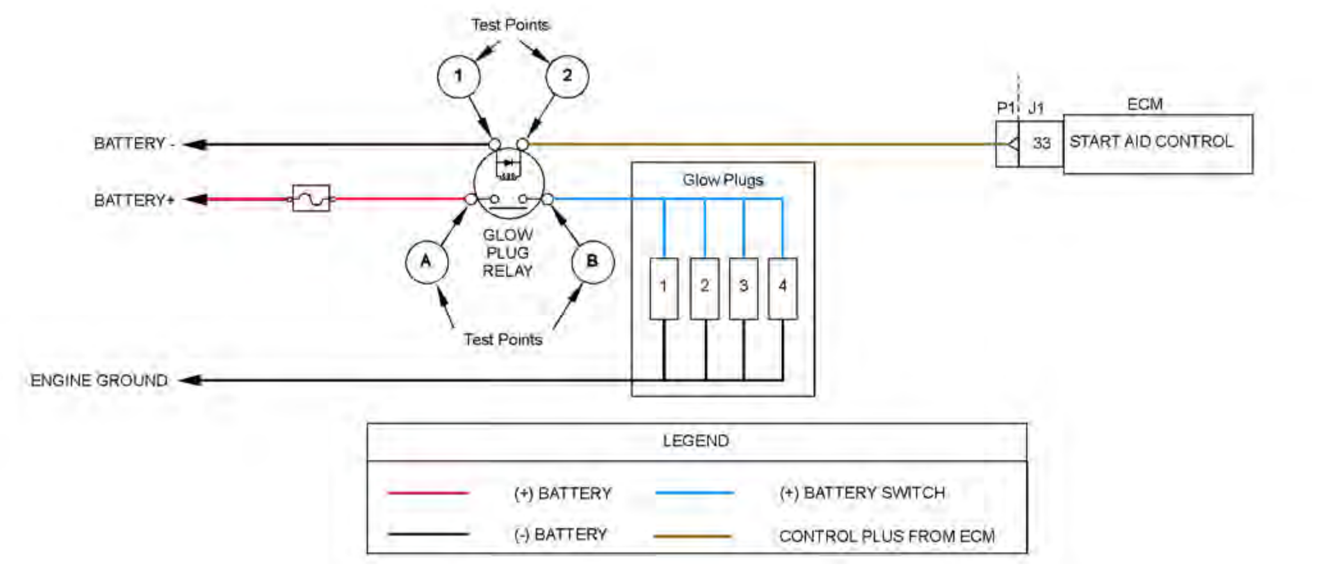


Illustration 18 g06366278

Schematic for the glow plug starting aid circuit

Not all connectors are shown. Refer to the appropriate Electrical Schematic.

Table 98

Troubleshooting Test Steps	Values	Results
1. Inspect Electrical Connectors and Wiring **A.** Check that the fuses are not blown. **B.** Inspect the terminals on the glow plug start aid relay and then inspect the connector on the flying lead from the relay. Refer to Troubleshooting, “Electrical Connectors - Inspect” for details. **C.** Inspect the bus bar for the glow plugs. Ensure that the nuts that secure the bus bar to each glow plug are tightened to a torque of 2 N·m (17 lb in). Ensure that the bus bar is not shorted to the engine. **D.** Check the harness for abrasion and pinch points from the glow plugs back to the ECM. **Note:** Do not disconnect the ECM connector at this stage. The ECM can only be disconnected and reconnected 10 times before damage to the harness connector may occur.	Loose connection or damaged wire	**Result:** There is a fault in a connector or the wiring. **Repair:** Repair any faulty connectors or replace the wiring harness. Ensure that all the seals are properly in place and ensure that the connectors are correctly coupled. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault. **Result:** All connectors, pins, and sockets are correctly coupled and/or inserted. The harness is free of corrosion, abrasion, and pinch points. The fuses are not blown. The bus bar is secured to the glow plugs and not shorted to ground. Proceed to Test Step 2.
2. Check for Active Diagnostic Codes **A.** Connect the electronic service tool to the diagnostic connector. **B.** Turn the keyswitch to the ON position. **Note:** Do not start the engine. **C.** Use the electronic service tool to select the “Glow Plug Start Aid Override Test” to turn on the power for the glow plugs. **D.** Check for an active or recently logged 676 diagnostic code.	Diagnostic codes	**Result:** No diagnostic codes are present. There may be an intermittent fault in an electrical component between the ECM and the glow plugs. The problem may be inside an electrical connector. Refer to Troubleshooting, “Electrical Connector - Inspect” to identify intermittent faults. There may be a fault in the glow plug switched power circuit. The ECM does not monitor the status of this condition. Proceed to Test Step 7 to test this circuit. **Result:** Diagnostic code 676-5 is active or recently logged. Proceed to Test Step 3. **Result:** Diagnostic code 676-6 is active or recently logged. Proceed to Test Step 5.

(continued)

(Table 98, contd)

Troubleshooting Test Steps	Values	Results
3. Create a Short Circuit at the Relay Connector **A.** Turn the keyswitch to the OFF position. **B.** Remove the glow plug start aid relay. **C.** Fabricate a jumper wire. Install the jumper wire between Test Point 1 and Test Point 2 on the harness connector for the glow plug relay. Refer to Illustration 18 . Refer to the appropriate Electrical Schematic. **D.** Turn the keyswitch to the ON position. **E.** Use the electronic service tool to select the “Glow Plug Start Aid Override Test” to turn on the power for the glow plugs. **F.** Use the electronic service tool to check for active diagnostic codes. Wait at least 30 seconds for activation of the diagnostic codes. **G.** Turn the keyswitch to the OFF position and remove the jumper wire.	Diagnostic code	**Result:** A 676-6 diagnostic code is active with the jumper installed. Install a replacement glow plug relay. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault. **Result:** The 676-5 diagnostic code is still active. Proceed to Test Step 4.
4. Check the Wiring Between the ECM and the Relay for an Open Circuit **A.** Verify that the keyswitch is in the OFF position. **B.** Disconnect the P1 connector from the ECM. **C.** Inspect the P1 connector. Refer to Troubleshooting, “Electrical Connectors - Inspect” for details. **D.** Perform a 30 N (6.7 lb) on P1:33. **E.** Measure the resistance between Test Point 1 on the harness connector for the relay and a suitable ground. **F.** Measure the resistance between Test Point 2 on the harness connector for the relay and P1:33. Refer to the appropriate Electrical Schematic.	Less than 2 Ohms	**Result:** At least one of the resistance measurements is greater than 2 Ohms - the fault is in the wiring for the relay control circuit. **Repair:** Repair the faulty wiring or replace the faulty wiring. **Result:** The resistance measurement is less than 2 Ohms. Contact the Dealer Solutions Network (DSN).
5. Create an Open Circuit at the Relay **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the glow plug start aid relay. **C.** Use the electronic service tool to select the “Glow Plug Start Aid Override Test” to turn on the power for the glow plugs. **D.** Use the electronic service tool to check for active diagnostic codes. Wait at least 30 seconds for activation of the diagnostic codes.	Diagnostic codes	**Result:**A 676-5 diagnostic code is active with the relay disconnected. **Repair:** Install a replacement glow plug start aid relay. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault. **Result:** The 676-6 diagnostic code is still active with the relay disconnected. Proceed to Test Step 6.

(continued)

(Table 98, contd)

Troubleshooting Test Steps	Values	Results
6. Check the Wiring Between the Relay and the ECM for a Short Circuit **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the P1 connector from the ECM. **C.** Inspect the P1 connector. Refer to Troubleshooting, “Electrical Connectors - Inspect” for details. **D.** Perform a 30 N (6.7 lb) on P1:33. **C.** Use a suitable multimeter to measure the resistance between P1:33 and all other terminals on the P1 connector.	Greater than 1 k Ohm	**Result:** At least one of the resistance measurements is less than 1 k Ohm. There is a short in the wiring between the relay and the ECM. **Repair:** Repair the faulty wiring or replace the faulty wiring. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault. **Result:** All resistance measurements are greater than 1 k Ohm. Contact the Dealer Solutions Network (DSN).
7. Check the Operation of the Glow Plugs **A.** Place a suitable clamp-on ammeter on the power supply wire. **B.** Use the electronic service tool to select the “Glow Plug Start Aid Override Test” to turn on the power for the glow plugs. **C.** Wait for 20 seconds and then note the reading on the clamp-on ammeter.	Approximately 28 Amps for a 12 VDC system.	**Result:** The reading on the clamp on ammeter near the expected reading. The glow plugs are operating correctly. Return the engine to service. **Result:** The reading on the clamp on ammeter is between zero and the expected reading. Proceed to Test Step 8. **Result:** The reading on the clamp on ammeter is zero. Proceed to Test Step 9.
8. Test the Continuity of the Glow Plugs **A.** Disconnect the power supply and remove the bus bar from the glow plugs. **B.** Use a suitable digital multimeter to check continuity (resistance). Turn the audible signal on the digital multimeter ON. **C.** Place one probe on the connection for one of the glow plugs and the other probe to a suitable ground. The digital multimeter should make an audible sound. **D.** Repeat the continuity check on the remaining glow plugs.	One or more glow plugs do not have continuity.	**Result:** One or more of the glow plugs do not display continuity. **Repair:** Replace any glow plugs that do not show continuity. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault. **Result:** All glow plugs display continuity. Repeat this procedure from Test Step 1.
9. Check the Fuse **A.** Turn the battery disconnect switch to the OFF position. **B.** Check the fuse for the glow plug start aid relay. Refer to the appropriate Electrical Schematic.	Blown fuse	**Result:** The fuse is blown - there is a short in the power circuit for the glow plugs. Check the wiring between the batteries and the glow plug relay for a short circuit. Refer to the appropriate Electrical Schematic. Make any necessary repairs. Replace the blown fuse. **Result:** The fuse is not blown. Proceed to Test Step 10.

(continued)

(Table 98, contd)

Troubleshooting Test Steps	Values	Results
10. Check the Power Supply to the Relay Connector **A.** Disconnect the connector for the glow plug relay. **B.** Measure the voltage between Test Point A on the harness connector for the relay and a suitable ground. Refer to Illustration 18 and the appropriate Electrical Schematic.	Battery voltage	**Result:** There is no battery voltage at Test Point A on the harness connector. **Repair:** Check all wiring between the batteries and the glow plug relay. Make any necessary repairs. **Result:** Battery voltage is present at Test Point A on the harness connector. Proceed to Test Step 11.
11. Check the Power Supply to the Glow Plugs **A.** Disconnect the power supply for the bus bar. Ensure that the glow plug relay is connected. **B.** Turn the keyswitch to the ON position. **C.** Use the electronic service tool to select the “Glow Plug Start Aid Override Test” to turn on the power for the glow plugs. **D.** Measure the voltage between the power supply wiring for the bus bar and engine ground.	Battery voltage	**Result:** There is no battery voltage at the power supply wiring to the bus bar. **Repair:** Check all wiring between the bus bar and the glow plug relay. Make any necessary repairs. If the wiring is OK, replace the glow plug relay. **Result:** Battery voltage is present at the power supply wiring to the bus bar. The glow plug circuit appears to be operating correctly. Return the engine to service.

i07816919

Idle Validation - Test

This procedure covers the following diagnostic codes:

Table 99

Diagnostic Trouble Codes for the Idle Validation Switches		
J1939 Code	**Code Description**	**Comments**
558-2	Accelerator Pedal #1 Low Idle Switch : Erratic, Intermittent, or Incorrect	The Electronic Control Module (ECM) detects the following condition: The signal from the Idle Validation Switch (IVS) is invalid. If equipped, the warning light will come on. The ECM will log the diagnostic code.
2970-2	Accelerator Pedal #2 Low Idle Switch : Erratic, Intermittent, or Incorrect	
Follow the troubleshooting procedure to identify the root cause of the fault.		

If the application is equipped with two throttles, the engine will use the second throttle until the fault is repaired.

If a second throttle is not installed or if the second throttle has a fault, the following conditions will occur:

- The engine will default to limp home mode.
- If the engine speed is higher than the speed in limp home mode, the engine will decelerate to limp home mode.
- If the engine speed is lower than the speed in limp home mode, the engine speed will remain at the current speed.

- The engine will remain at this speed while the diagnostic code remains active.
- All inputs from the faulty throttle are ignored by the ECM until the fault is repaired.
- All inputs from the repaired throttle will be ignored by the ECM until the keyswitch has been cycled.

The IVS may be installed. The IVS is required for mobile applications with an analog throttle installed. The IVS is part of the throttle position sensor. The IVS is CLOSED when the low idle is set.

The configuration parameters for the throttle and for the IVS thresholds are programmed into the ECM. Use the electronic service tool to display the configuration parameters for the throttle and for the IVS.

If the IVS operates outside of the programmed range, then the engine speed may not respond to changes in the throttle position.

The electronic service tool may be used for the following:

- If necessary, reset the IVS threshold for an existing IVS.
- If necessary, view the IVS change point and reset the IVS thresholds when a new throttle assembly is installed.

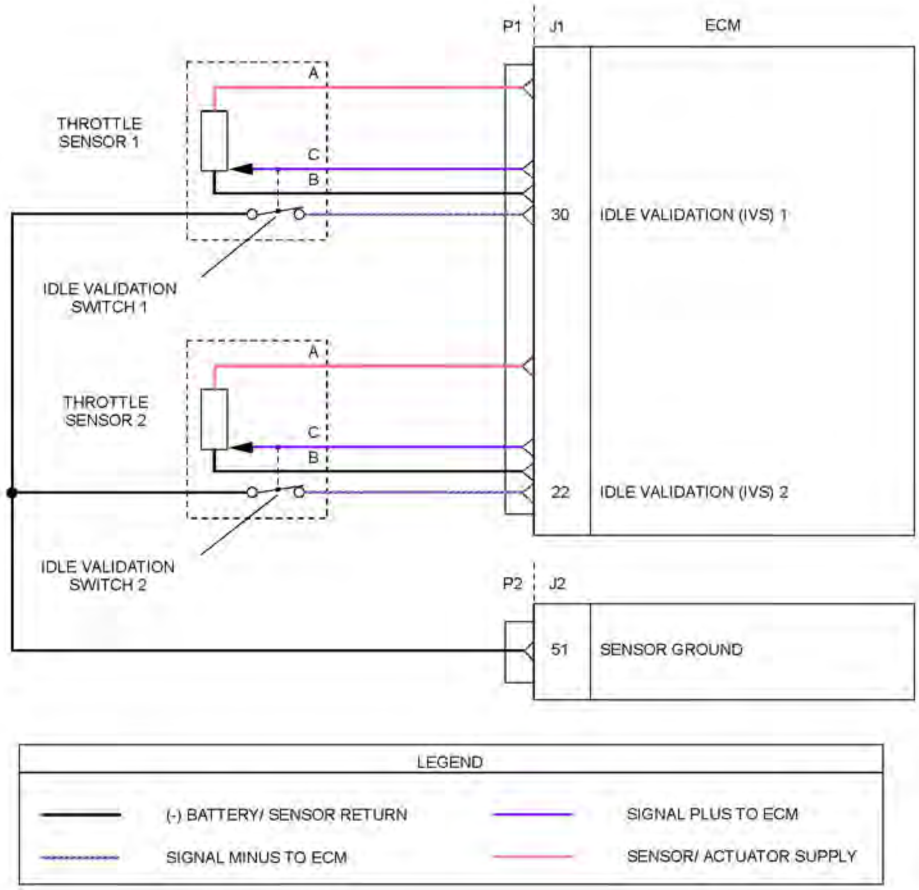


Illustration 19 g06443911

Schematic of the IVS circuit

Not all connectors are shown. Refer to the appropriate Electrical Schematic

Note: All connectors may not be shown. Refer to the Electrical Schematic for the application for details of any connectors between the throttle connectors and the ECM connectors.

Table 100

Troubleshooting Test Steps	Values	Results
1. Check for Active Diagnostic Codes and/or Recently Logged Diagnostic Codes **A.** Connect the electronic service tool to the diagnostic connector. **B.** Turn the keyswitch to the ON position. **C.** Monitor the active diagnostic code screen on the electronic service tool. Check and record any active diagnostic codes. **Note:** Wait at least 30 seconds in order for the diagnostic codes to become active. **Note:** A diagnostic code that is logged several times is an indication of an intermittent problem. Most intermittent problems are a poor connection in a connector.	Diagnostic codes	**Result:** No diagnostic codes are active - the problem may have been intermittent. **Repair:** Carefully inspect the connectors and wiring. Refer to Troubleshooting, “Electrical Connectors - Inspect”. **Result:** One of the diagnostic codes listed in Table 99 is active or recently logged. Proceed to Test Step 2.
2. Check the Operation of the IVS **A.** Connect the electronic service tool to the diagnostic connector. **B.** Turn the keyswitch to the ON position. **Note:** Do not start the engine. **C.** Use the electronic service tool to check the current “Throttle Configuration” . **D.** Select the “SERVICE” option from the drop-down menu of the electronic service tool. **E.** Select the “Throttle Configuration” option on the electronic service tool. Select the appropriate “Throttle Configuration” summary from the menu on the left of the screen. The IVS window for the throttle will indicate “YES” if an IVS is installed. **F.** Select the “Throttle status” function on the electronic service tool. Select “Status” function and then select “Throttles” function. **G.** The throttle is set in the low idle position. **H.** Operate the throttle slowly. The IVS status should change from CLOSED (ON) to OPEN (OFF).	IVS status change	**Result:** The IVS state changes from CLOSED (ON) to OPEN (OFF) Proceed to Test Step 3. **Result:** The IVS state does not change. Proceed to Test Step 4.

(continued)

(Table 100, contd)

Troubleshooting Test Steps	Values	Results
3. Check the IVS Threshold **A.** Connect the electronic service tool to the diagnostic connector. **B.** Turn the keyswitch to the ON position. **C.** Use the electronic service tool to check the current “Throttle Configuration” . **D.** Select the “SERVICE” option from the drop-down menu of the electronic service tool. **E.** Select the “Throttle Configuration” option on the electronic service tool. Select the appropriate “Throttle Configuration” summary from the menu on the left of the screen. The IVS window for the throttle will indicate “YES” if an IVS is installed. Make a note of the “Idle Validation Min OFF Threshold” parameters that are displayed in the “Throttle Configuration” menu of the electronic service tool. Make a note of the “Idle Validation Max ON Threshold” parameters that are displayed in the “Throttle Configuration” menu of the electronic service tool. **F.** To select the “Throttle status” function on the electronic service tool, select “Status” function and then select “Throttles” function. **G.** The throttle is set in the low idle position. **H.** Operate the throttle slowly. The IVS status should change from CLOSED (ON) to OPEN (OFF).	IVS operates within threshold.	**Result:** The IVS switch operates within the “Idle Validation Min OFF Threshold” and the “Idle Validation Max ON Threshold” parameters. The IVS is operating correctly. Return the engine to service. **Result:** The IVS switch cannot operate within the “Idle Validation Min OFF Threshold” and the “Idle Validation Max ON Threshold” parameters. Proceed to Test Step 9.
4. Inspect Electrical Connectors and the Harness **A.** Inspect the P1/J1 and P2/J2 connectors, the harness and all the connectors for the IVS. Refer to Troubleshooting, “Electrical Connectors - Inspect” for details. **B.** Perform a 30 N (6.7 lb) pull test on each of the wires in the ECM connector that are associated with the suspect idle validation switch. **C.** Check the harness for abrasion and pinch points from the throttle switch to the ECM.	Loose connection or damaged wire	**Result:** Faults found in harness or connectors. **Repair:** Repair the connectors or the harness and/or replace the connectors or the harness. Ensure that all the seals are correctly in place and ensure that the connectors are correctly connected. Use the electronic service tool to clear all logged diagnostic codes and then verify that the repair eliminates the fault. **Result:** No harness or connector faults found. Proceed to Test Step 5.

(continued)

(Table 100, contd)

Troubleshooting Test Steps	Values	Results
5. Check the Location of the Fault **A.** Disconnect the IVS harness connector. **B.** Fabricate a jumper wire. **C.** Turn the keyswitch to the ON position. **D.** Install a jumper wire between the IVS connections on the harness. Use the electronic service tool to check for diagnostic codes. **E.** Remove the jumper wire that is between the IVS connections on the harness. Use the electronic service tool to check for diagnostic codes.	IVS state on with jumper installed. IVS state off with jumper removed.	**Result:** With the jumper wire connected, the electronic service tool displays the IVS state in the ON position on the throttle status screen. With the jumper wire disconnected, the electronic service tool displays the IVS state in the OFF position on the throttle status screen. Proceed to Test Step 8. **Result:** The IVS status that is displayed on the electronic service tool does not change with the jumper wire either removed or installed. Proceed to Test Step 6.
6. Check the Wiring for an Open Circuit **A.** Disconnect the IVS harness connector. **B.** Disconnect the P1 connector. **C.** If the fault is on IVS1, use a multimeter to check the resistance between the IVS1 input terminal on the IVS harness connector and P1:30. **D.** If the fault is on IVS2, use a multimeter to check the resistance between the IVS2 input terminal on the IVS harness connector and P1:22. **E.** Use a multimeter to check the resistance between the IVS output terminal on the applicable IVS harness connector and P2:51.	Less than 2 Ohms	**Result:** One or more of the measured resistances is greater than 2 Ohms. There is an open circuit in the wiring. **Repair:** Repair the faulty wiring or replace the faulty wiring. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault. **Result:** The measured resistance in all wires is less than 2 Ohms. Proceed to Test Step 7.
7. Check the Wiring for a Short Circuit **A.** Disconnect the P1 connector. **B.** Disconnect both IVS harness connectors. **C.** Use a multimeter to check the resistance between the suspect IVS input terminal and a suitable ground.	Greater than 1 k Ohm	**Result:** The measured resistance is less than 1 k Ohm. There is a short circuit in the wiring. **Repair:** Repair the faulty wiring or replace the faulty wiring. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault. **Result:** All resistance measurements are greater than 1 k Ohm. Contact the Dealer Solutions Network (DSN).

(continued)

(Table 100, contd)

Troubleshooting Test Steps	Values	Results
8. Check the IVS Calibration **A.** Connect the electronic service tool to the diagnostic connector. **B.** Turn the keyswitch to the ON position. **C.** Select the “Throttle Configuration” option on the electronic service tool. Select the appropriate “Throttle Configuration” summary from the menu on the left of the screen. The IVS window for the throttle will indicate “YES” if an IVS is installed. Make a note of the “Idle Validation Min OFF Threshold” parameters that are displayed in the “Throttle Configuration” menu of the electronic service tool. Make a note of the “Idle Validation Max ON Threshold” parameters that are displayed in the “Throttle Configuration” menu of the electronic service tool. **D.** Select the “Throttle status” function on the electronic service tool. Select “Status” function and then select “Throttles” function. **E.** Set the throttle to low idle. **F.** Operate the throttle slowly toward high idle. The raw percentage values for the throttle that are shown on the electronic service tool should increase and the IVS status should change from CLOSED (ON) to OPEN (OFF) position. Make a note of the raw reading for the throttle when the IVS reading changes from the CLOSED position to the OPEN position. Repeat this step to obtain accurate raw percentage values for the throttle. The noted value should be within the previously noted “Idle Validation Min OFF Threshold” and “Idle Validation Max ON Threshold” limits. **G.** The throttle is set to the full throttle position or the high idle position. **H.** Operate the throttle slowly toward low idle. The raw percentage values for the throttle that are shown on the electronic service tool should decrease and the IVS status should change from OPEN (OFF) to CLOSED (ON) position. Make a note of the raw reading for the throttle when the IVS reading changes from the OPEN position to the CLOSED position. Repeat this step to obtain accurate raw percentage values for the throttle. The noted value should be within the previously noted “Idle Validation Min OFF Threshold” and “Idle Validation Max ON Threshold” limits.	The IVS operates within the thresholds.	**Result:** The IVS operates within the “Idle Validation Min OFF Threshold” and the “Idle Validation Max ON Threshold” values. The IVS is operating correctly. Return the engine to service. **Result:** The IVS does not operate within the “Idle Validation Min OFF Threshold” and the “Idle Validation Max ON Threshold” values. Proceed to Test Step 9.
9. Use the Electronic Service Tool to Reset the IVS Threshold Limits The electronic service tool can be used to change the following parameters to suit the type of throttle that is installed: · Idle Validation Min OFF Threshold · Idle Validation Max ON Threshold **Note:** The limits are shown in the “Throttle Configuration” screen which is located in the “Service” menu.	The fault is cleared.	**Result:** The fault is cleared after programming the new calculated values. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault. Return the engine to service. **Result:** The fault is not cleared. Contact the Dealer Solutions Network (DSN).

(continued)

(Table 100, contd)

Troubleshooting Test Steps	Values	Results
A. Refer to Test Step 8. “Check the IVS Calibration”. Record the raw value of the throttle signal when the idle validation switch changes from the CLOSED position to the OPEN position. **Note:** The default value for the “Idle Validation Min OFF Threshold” is 21%. The lowest value that should be set is 5%. The default value for the “Idle Validation Max ON Threshold” is 25%. The maximum value that is expected is 28%. **B.** Set the “Idle Validation Min OFF Threshold” to 3% below the raw value that was previously recorded. **C.** Set the “Idle Validation Max ON Threshold” to 3% above the raw value. **D.** Enter the new threshold limits into the electronic service tool. Click “Submit” on the electronic service tool screen. **E.** Turn the keyswitch to the OFF position and wait at least 5 seconds. Turn the keyswitch to the ON position. **F.** Repeat Test Step 8. Check that the IVS operates within the newly set threshold limits.		

i07816942

Indicator Lamp - Test

Use this procedure under the following circumstances:

- The lamps are not receiving battery voltage.
- The lamps are not operating correctly.

The following diagnostic lamps are available:

- Wait to start lamp
- Low oil pressure lamp
- Emissions system failure lamp
- Diesel Particulate Filter (DPF) lamp
- Shutdown lamp
- Warning lamp
- Engine running lamp
- Regeneration active Lamp
- Regeneration inhibit lamp

The electronic service tool can be used as a diagnostic aid to switch the individual lamps ON and OFF.

Note: The diagnostic aid that switches the lamps is contained in the “Override” section in the “diagnostics” menu of the electronic service tool.

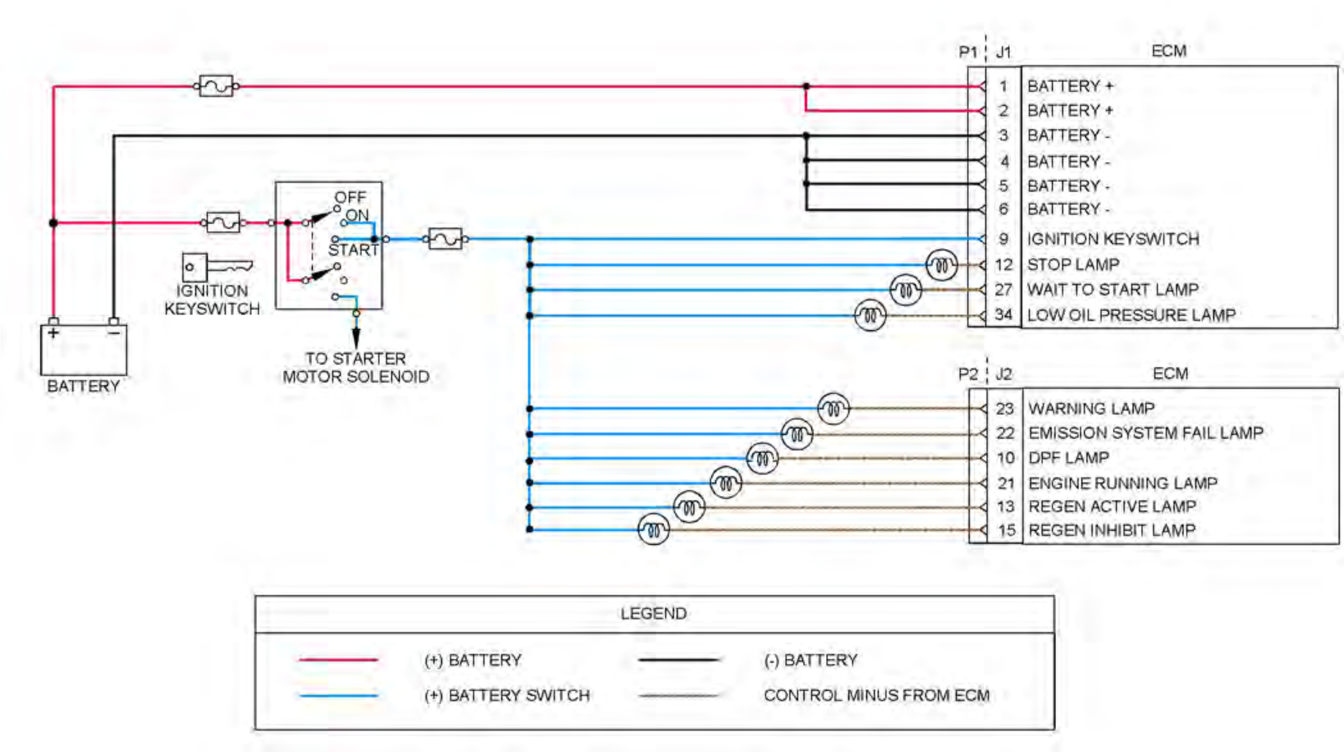


Illustration 20 g06367183

Typical schematic of the circuit for the indicator lamps

Note: All connectors may not be shown. Refer to the Electrical Schematic for the application for details of any connectors between the indicator lamps and the ECM connectors.

Table 101

Troubleshooting Test Steps	Values	Results
1. Inspect Electrical Connectors and Wiring **A.** Turn the keyswitch to the OFF position. **B.** Check that the fuses are not blown. **C.** Thoroughly inspect the P1/P2 connector and the lamp connections. Refer to Troubleshooting, “Electrical Connectors - Inspect” for details. **D.** Perform a 30 N (6.7 lb) pull test on each of the wires in the P1/P2 connector that are associated with the indicator lamps. **E.** Check the harness for abrasions and for pinch points from the battery to the ECM.	Loose connection or damaged wire	**Result:** There is a fault in a connector or the wiring. **Repair:** Repair any faulty connectors or replace the wiring harness. Ensure that all the seals are properly in place and ensure that the connectors are correctly coupled. Replace any blown fuses. Use the electronic service tool to verify that the repair eliminates the fault. **Result:** All connectors, pins, and sockets are correctly coupled and/or inserted. The harness is free of corrosion, abrasion, and pinch points. The fuses are not blown. Proceed to Test Step 2.
2. Inspect the Lamp **A.** Disconnect the lamp from the harness. Inspect the lamp to determine if the lamp has failed. **B.** Measure the resistance across the two terminals of the lamp.	Less than 2000 Ohms	**Result:** The lamp has greater than 2000 Ohms resistance. **Repair:** Replace the suspect lamp. Use the electronic service tool to verify that the repair eliminates the fault. **Result:** The lamp has less than 2000 Ohms resistance. Proceed to Test Step 3.
3. Measure the Input Voltage to the Lamp at the Lamp Socket **A.** Turn the keyswitch to the ON position. **B.** Use the electronic service tool to select the “override” function to switch individual lamps ON and OFF. **Note:** The “Override” function is contained in the “Diagnostics” menu of the electronic service tool. **C.** Measure the voltage at the lamp socket.	At least 10 VDC for a 12 V system.	**Result:** The voltage is not within the expected range - the fault is in the battery supply wiring to the lamp. **Repair:** Repair the faulty wiring or replace the faulty wiring. Use the electronic service tool to verify that the repair eliminates the fault. **Result:** The voltage is within the expected range. Proceed to Test Step 4.

(continued)

(Table 101, contd)

Troubleshooting Test Steps	Values	Results
4. Check the Wiring for an Open Circuit **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the P1 or P2 connector. **C.** Remove the bulb from the suspect lamp. **D.** Use a multimeter to measure the resistance between the ground connection on the lamp holder and the applicable terminal on the P1 or P2 connector.	Less than 2 Ohms	**Result:** The measured resistance is greater than 2 Ohms - the fault is in the wiring between the lamp holder and the ECM. **Repair:** Repair the faulty wiring or replace the faulty wiring. Use the electronic service tool to verify that the repair eliminates the fault. **Result:** The measured resistance is less than 2 Ohms. Proceed to Test Step 5.
5. Check the Wiring for a Short Circuit **A.** Disconnect the P1 or P2 connector. Disconnect the suspect lamp. **B.** Use a multimeter to check the resistance between the lamp socket and a suitable ground.	Greater than 1k Ohm	**Result:** The measured resistance is less than 1k Ohm. There is a short in the wiring between the lamp holder and the ECM. **Repair:** Repair the faulty wiring or replace the faulty wiring. Use the electronic service tool to verify that the repair eliminates the fault. **Result:** The measured resistance is greater than 1k Ohm. Contact the Dealer Solutions Network (DSN).

i08062950

Injector Data Incorrect - Test

This procedure covers the following codes:

Table 102

Diagnostic Codes for Injector Data Incorrect		
J1939 Code	**Code Description**	**Comments**
651-2	Engine Injector Cylinder #01 : Erratic, Intermittent, or Incorrect	The Electronic Control Module (ECM) detects an injector code that is incorrect for the engine. The warning lamp will come on.
652-2	Engine Injector Cylinder #02 : Erratic, Intermittent, or Incorrect	
653-2	Engine Injector Cylinder #03 : Erratic, Intermittent, or Incorrect	
654-2	Engine Injector Cylinder #04 : Erratic, Intermittent, or Incorrect	

The following background information is related to this procedure:

Injector codes are 30 hexadecimal character codes that are supplied with each injector and a card is also included in the packaging for the injector. The code is on a plate on the top of the injector. The code is used by the ECM to balance the performance of the injectors.

Refer to Troubleshooting, “Injector Code - Calibrate” for further information.

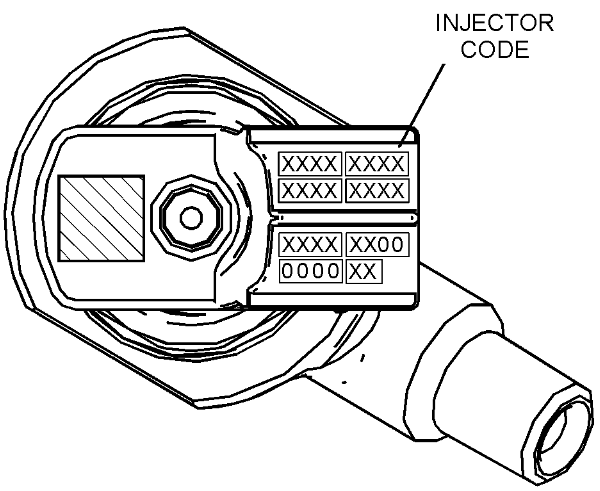


Illustration 21 g06360333

Typical code plate on an injector

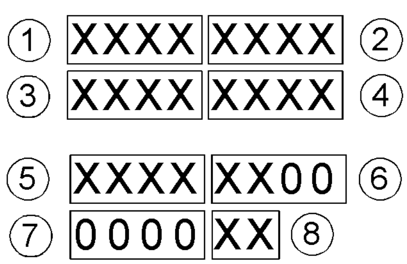


Illustration 22 g06360350

Sequence for recording the injector code

Table 103

Troubleshooting Test Steps	Values	Results
1. Check for Active Diagnostic Codes **A.** Connect the electronic service tool to the diagnostic connector. **B.** Turn the keyswitch to the ON position. **C.** Check for active diagnostic codes or recently logged diagnostic codes.	Diagnostic codes	**Result:** No diagnostic codes are present. Return the unit to service. **Result:** One or more of the preceding diagnostic codes are active. Make a note of any cylinder numbers with the active diagnostic code. Proceed to Test Step 2.
2. Check the Injector Code on any Suspect Cylinders **A.** Connect the electronic service tool to the diagnostic connector. Refer to Troubleshooting, “Electronic Service Tools”. **B.** Turn the keyswitch to the ON position. **C.** Select the following menu options on the electronic service tool to obtain the injector codes from the ECM: · “Service” · “Calibrations” · “Injector Codes Calibration” **D.** Make a note of the injector codes for any suspect cylinders.	Diagnostic code	**Result:** The card that was supplied with the injector is available for the suspect cylinders. **Repair:** Compare the injector code from the card with the injector code that was recorded from the electronic service tool for each suspect cylinder. If the codes match, proceed to Test Step 3. If the codes do not match, then use the electronic service tool to input the correct injector code. refer to Troubleshooting, Injector Code - Calibrate for the correct procedure. **Result:** The card with the injector code is not available. Proceed to Test Step 3.
3. Manually Program the Injector Code **A.** Make a note of the injector code that is on the injector in any suspect cylinders. **Note:** Refer to Illustration 22 for the correct sequence for recording the injector code. **B.** Compare the injector code from the injector with the injector code from the electronic service tool for each suspect cylinder.	Injector codes	**Result:** The code on the injector is the same as the code in the ECM. **Repair:** The injector is incorrect for the engine. Replace the injector with the correct injector for the engine. Refer to Disassembly and Assembly, “Electronic Unit Injector - Remove” and refer to Disassembly and Assembly, “Electronic Unit Injector - Install”. **Result:** The code on the injector is not the same as the code in the ECM. **Repair:** Use the electronic service tool to input the correct injector code. Refer to Troubleshooting, “Injector Code - Calibrate” for the correct procedure. Use the electronic service tool to clear all logged diagnostic codes and then verify that the repair eliminates the fault. If the procedure did not correct the issue, contact the Dealer Solutions Network (DSN).

i07849720

Injector Solenoid - Test

This procedure covers the following diagnostic codes:

Table 104

Diagnostic Trouble Codes for Injector Solenoid		
J1939 Code	**Code Description**	**Comments**
651-5	Engine Injector Cylinder #01 : Current Below Normal	The Electronic Control Module (ECM) detects a low current condition for the injector solenoid. The warning light will come on. The ECM will log the diagnostic code. The engine will have low power and/or rough running. When an "Cylinder Cutout Test" is performed, a faulty electronic unit injector will indicate a low reading in comparison with the other electronic unit injectors. The ECM will continue to attempt to operate the electronic unit injector after the diagnostic code has been logged. An open circuit will prevent the operation of the electronic unit injector.
652-5	Engine Injector Cylinder #02 : Current Below Normal	
653-5	Engine Injector Cylinder #03 : Current Below Normal	
654-5	Engine Injector Cylinder #04 : Current Below Normal	
651-6	Engine Injector Cylinder #01 : Current Above Normal	The ECM detects a high current condition for the injector solenoid. The warning light will come on. The ECM will log the diagnostic code. The engine will have low power and/or rough running. The ECM will continue to attempt to operate the electronic unit injector after the diagnostic code has been logged. A short circuit will prevent the operation of the electronic unit injector.
652-6	Engine Injector Cylinder #02 : Current Above Normal	
653-6	Engine Injector Cylinder #03 : Current Above Normal	
654-6	Engine Injector Cylinder #04 : Current Above Normal	
Follow the troubleshooting procedure to identify the root cause of the fault.		

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

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

An electrical fault can prevent the electronic unit injector from operating. An open or short circuit in the ECM that is unique to one electronic unit injector will prevent that electronic unit injector from operating. An open or short circuit in common wiring within the ECM can prevent the two electronic unit injectors that share that common wiring from operating.

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

"Injector Solenoid Test"

Use the "Injector Solenoid Test" to diagnose an open or short circuit diagnostic code while the engine is not running. The "Injector Solenoid Test" will send a signal to each solenoid. The electronic service tool will indicate the status of the solenoid as "OK" , "Open" , or "Short" .

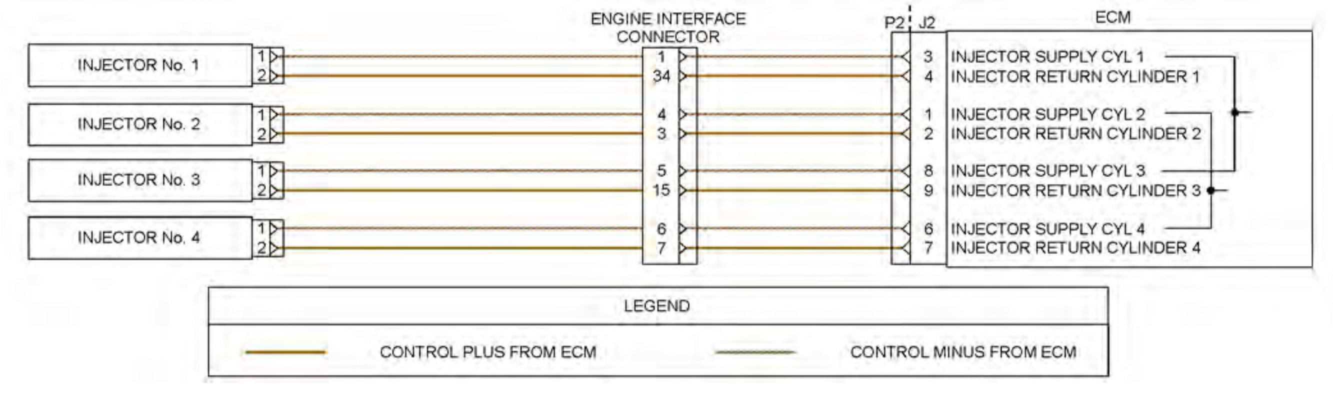


Illustration 23 g06364743

Schematic of the circuit for the injector solenoids on a 4 cylinder engine

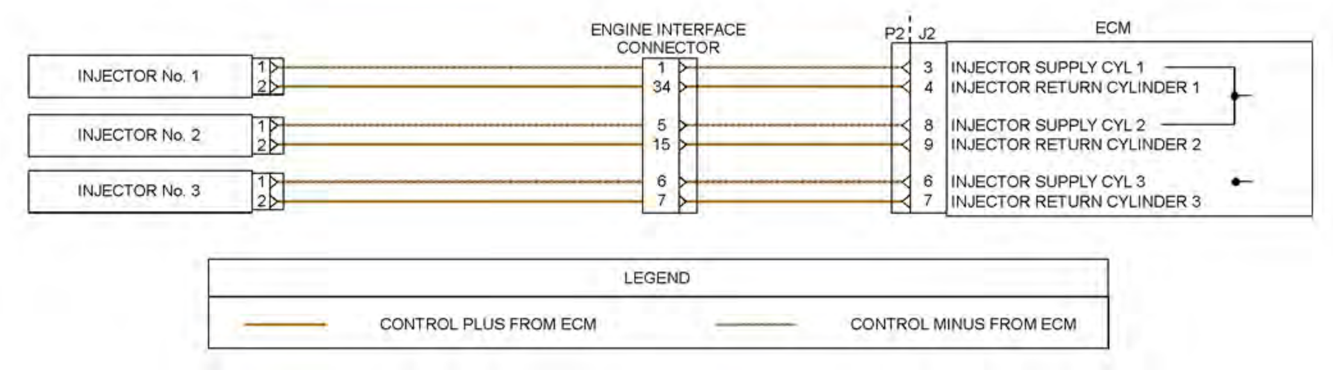


Illustration 24 g06457184

Schematic of the circuit for the injector solenoids on a 3 cylinder engine

WARNING

Electrical Shock Hazard. The electronic unit injectors use DC voltage. The ECM sends this voltage to the electronic unit injectors. Do not come in contact with the harness connector for the electronic unit injectors while the engine is operating. Failure to follow this instruction could result in personal injury or death.

Table 105

Troubleshooting Test Steps	Values	Results
1. Download Information Using the Electronic Service Tool **A.** Use the electronic service tool to download the "Product Status Report" (PSR) with histograms before performing any troubleshooting or clearing any diagnostic codes. **Note:** The downloaded information will be required by the Dealer Solutions Network (DSN) if troubleshooting assistance is required.	Downloaded information	**Result:** The information was successfully saved. Proceed to Test Step 2. **Result:** The electronic service tool information was not successfully saved. Contact the Dealer Solutions Network (DSN) for guidance.
2. Create an Electronic Service Tool Snapshot **A.** Select "Snapshot Viewer" on the electronic service tool, using menus: Information -> Snapshot -> Viewer **B.** Select the event code and then click "View Graph" . **C.** Select the following parameter and then click OK. · Engine Speed **D.** Select Save to "File to save" a Snapshot File (*.xml). This file will contain all the data in the snapshot and not only the data shown on the graph. **Note:** The downloaded information will be required by the DSN if troubleshooting assistance is required.	Snapshot saved	**Result:** The electronic service tool snapshot was successfully saved. Proceed to Test Step 3. **Result:** The electronic service tool snapshot was not successfully saved. Contact the DSN for guidance.
3. Inspect Electrical Connectors and Wiring **A.** Turn the keyswitch to the OFF position. A strong electrical shock hazard is present if the keyswitch is not turned OFF. **B.** Thoroughly inspect the connectors for the injectors and the engine interface connector. Refer to Troubleshooting, "Electrical Connectors - Inspect" for details. **C.** Check the harness and wiring for abrasion and for pinch points from the injectors to the ECM. **Note:** Do not disconnect the ECM connector at this stage. The ECM can only be disconnected and reconnected 10 times before damage to the harness connector may occur.	Loose connection or damaged wire	**Result:** There is a fault in a connector or the wiring. **Repair:** Repair any faulty connectors or replace the wiring harness. Ensure that all the seals are properly in place and ensure that the connectors are correctly coupled. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault. **Result:** All connectors, pins, and sockets are correctly coupled and/or inserted. The harness is free of corrosion, abrasion, and pinch points. Proceed to Test Step 4.

(continued)

(Table 105, contd)

Troubleshooting Test Steps	Values	Results
4. Use the “Injector Solenoid Test” **A.** Start the engine. **B.** Allow the engine to warm up to the normal operating temperature. **C.** Stop the engine. **D.** Turn the keyswitch to the ON position. **E.** Access the “Injector Solenoid Test” by accessing the following display screens in order: · “Diagnostics” · “Diagnostic Tests” · “Injector Solenoid Test” **F.** 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 to actuate the injector solenoids while the engine is not running.	“OK” , “OPEN” , or “SHORT”	**Result:** All cylinders indicate “OK” - There is not an electronic fault with the injectors. Use the electronic service tool to clear all logged diagnostic codes. Return the engine to service. **Result:** “OPEN” Note the cylinders that indicate “OPEN” . Proceed to Test Step 5. **Result:** “SHORT” Note the cylinders that indicate “SHORT” . Proceed to Test Step 8.
5. Create a Short Circuit at the Suspect Injector **A.** Turn the keyswitch to the OFF position. A strong electrical shock hazard is present if the keyswitch is not turned OFF. **B.** Disconnect the connector for the suspect injector. **C.** Fabricate a jumper wire 100 mm (4 inch) long with terminals on both ends of the wire. **D.** Install the jumper wire between the two terminals on the harness connector for the suspect injector. **E.** Turn the keyswitch to the ON position. **F.** Perform the “Injector Solenoid Test” at least two times. **G.** Repeat this test for each suspect injector. Stop the “Injector Solenoid Test” before handling the jumper wires.	Suspect injector indicates “SHORT”	**Result:** The electronic service tool displays “SHORT” for the cylinder with the jumper wire. **Repair:** Install a replacement fuel injector. Refer to Disassembly and Assembly, “Electronic Unit Injector - Remove” and Disassembly and Assembly, “Electronic Unit Injector - Install” **Result:** The electronic service tool does not display “SHORT” for the cylinder with the jumper wire. Remove all jumper wires. Proceed to Test Step 6.

(continued)

(Table 105, contd)

Troubleshooting Test Steps	Values	Results
6. Create a Short Circuit at the Engine Interface Connector **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the engine interface connector. **C.** Fabricate a jumper wire 100 mm (4 inch) long with terminals on both ends of the wire. **D.** Install the jumper wire between the injector supply and injector return terminals on the engine interface connector. **E.** Turn the keyswitch to the ON position. **F.** Perform the “Injector Solenoid Test” at least two times. **G.** Repeat this test for each suspect injector. Stop the “Injector Solenoid Test” before handling the jumper wires.	Suspect injector indicates “SHORT”	**Result:** The electronic service tool displays “SHORT” for the injector with the jumper wire. The fault is in the engine wiring harness. **Repair:** Repair the faulty wiring or replace the faulty wiring. **Result:** The electronic service tool does not display “SHORT” for the injector with the jumper wire. Remove all jumper wires. Proceed to Test Step 7.
7. Check the Wiring Between the Engine Interface Connector and the ECM for an Open Circuit **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the P2 connector from the ECM. Disconnect the engine interface connector. **C.** Inspect the P2/J2 connectors for damage or corrosion. Refer to Troubleshooting, Electrical Connectors - Inspect for more information. **D.** Perform a 30 N (6.7 lb) pull test on each wire in the P2 connector that is associated with the active diagnostic code. **E.** Use a suitable multimeter to measure the resistance between the suspect injector supply terminal on the engine interface connector and the suspect injector supply terminal on the P2 connector. **F.** Use a suitable multimeter to measure the resistance between the suspect injector return terminal on the engine interface connector and the suspect injector return terminal on the P2 connector.	Less than 2 Ohms	**Result:** At least one of the resistance measurements is greater than 2 Ohms. The fault is in the wiring between the engine interface connector and the P2 ECM connector. **Repair:** Repair the faulty wiring or replace the faulty wiring. Use the electronic service tool to perform the “Injector Solenoid Test” and verify that the repair eliminates the fault. **Result:** The resistance measurements are less than 2 Ohms. Contact the Dealer Solutions Network (DSN).

(continued)

(Table 105, contd)

Troubleshooting Test Steps	Values	Results
8. Create an Open Circuit at the Suspect Injector **A.** Turn the keyswitch to the OFF position. A strong electrical shock hazard is present if the keyswitch is not turned OFF. **B.** Disconnect the connector for the suspect injector. **C.** Turn the keyswitch to the ON position. **D.** Perform the “Injector Solenoid Test” at least two times. **E.** Repeat this test for each suspect injector. Stop the “Injector Solenoid Test” before handling the jumper wires.	Suspect injector indicates “OPEN”	**Result:** The electronic service tool displays “OPEN” for the suspect cylinder. **Repair:** Install a replacement fuel injector. Refer to Disassembly and Assembly, “Electronic Unit Injector - Remove” and Disassembly and Assembly, “Electronic Unit Injector - Install” Use the electronic service tool to perform the “Injector Solenoid Test” and verify that the repair eliminates the fault. **Result:** The electronic service tool does not display “OPEN” for the suspect cylinder Proceed to Test Step 9.
9. Create an Open Circuit at the Engine Interface Connector **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the engine interface connector. **C.** Turn the keyswitch to the ON position. **D.** Perform the “Injector Solenoid Test” at least two times. **E.** Repeat this test for each suspect injector.	Suspect injector indicates “OPEN”	**Result:** The electronic service tool displays “OPEN” for the suspect cylinder. The fault is in the engine wiring harness. **Repair:** Repair the faulty wiring or replace the faulty wiring. Use the electronic service tool to perform the “Injector Solenoid Test” and verify that the repair eliminates the fault. **Result:** The electronic service tool does not display “OPEN” for the suspect cylinder. Proceed to Test Step 10.
10. Check the Wiring Between the Engine Interface Connector and the ECM for an Open Circuit **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the P2 connector from the ECM. Disconnect the engine interface connector. **C.** Inspect the P2/J2 connectors for damage or corrosion. Refer to Troubleshooting, Electrical Connectors - Inspect for more information. **D.** Perform a 30 N (6.7 lb) pull test on each wire in the P2 connector that is associated with the active diagnostic code. **E.** Use a suitable multimeter to measure the resistance between the suspect injector supply terminal on the engine interface connector and all other terminals on the engine interface connector. **F.** Use a suitable multimeter to measure the resistance between the suspect injector return terminal on the engine interface connector and all other terminals on the engine interface connector.	Greater than 1 k Ohm	**Result:** At least one of the resistance measurements is less than 1 k Ohm. There is a short in the wiring between the engine interface connector and the ECM. **Repair:** Repair the faulty wiring or replace the faulty wiring. Use the electronic service tool to perform the “Injector Solenoid Test” and verify that the repair eliminates the fault. **Result:** All resistance measurements are greater than 1 k Ohm. Contact the Dealer Solutions Network (DSN).

i07851894

Mode Selection - Test

This procedure covers the following diagnostic code:

Table 106

Diagnostic Trouble Code for the Mode Selection Switch		
J1939 Code	**Code Description**	**Comments**
2882-2	Engine Alternate Rating Select : Erratic, Intermittent, or Incorrect	The Electronic Control Module (ECM) detects a combination of switch positions for the mode switches that has not been defined. If equipped, the warning lamp will come on and the ECM will log the diagnostic code. The ECM will return the engine to the last good mode selection or setting. The engine will start and the engine will default to the previous mode selection. The engine may operate at reduced speed or reduced power depending on the mode that is selected.
Follow the troubleshooting procedure to identify the root cause of the fault.		

Use this procedure to check if the mode selection switch operates correctly.

The mode selection switch inputs provide the operator with the ability to select a maximum of four different modes of operation. Different modes of operation can be used giving the operator a means to select the most efficient method of completing the required work.

Each mode has a single fuel limit map, a rated speed, and a matched fuel delivery. Each mode also has a specific droop value for throttle 1 and throttle 2.

Table 107

Mode Number	Switch 2	Switch 1	Enabled
1	Open	Open	Y/N
2	Open	Closed	Y/N
3	Closed	Open	Y/N
4	Closed	Closed	Y/N

If a fault occurs in the circuit for either of the switches, the mode of operation will be different to the mode that was selected. If the mode of operation is not enabled on the application, a 2882-2 diagnostic code will become active.

During the following procedure, refer to the electrical schematic for the application.

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

Table 108

Troubleshooting Test Steps	Values	Results
1. Inspect Electrical Connectors and Wiring **A.** Turn the keyswitch OFF. **B.** Thoroughly inspect the P1 connector. Thoroughly inspect the mode switch connectors, plugs, and interconnections on the harness. Refer to Troubleshooting, "Electrical Connectors - Inspect" for details. **C.** Perform a 30 N (6.7 lb) pull test on each of the wires in the P1 connector that are associated with the mode selector switches. **D.** Check the harness for abrasions and for pinch points from the mode section switches to the ECM.	Loose connection or damaged wire	**Result:** There is a fault in a connector or the wiring. **Repair:** Repair any faulty connectors or replace the wiring harness. Ensure that all the seals are properly in place and ensure that the connectors are correctly coupled. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault. **Result:** All connectors, pins, and sockets are correctly coupled and/or inserted. The harness is free of corrosion, abrasion, and pinch points. Proceed to Test Step 2.
2. Check the Status of the Mode Selection Switch **A.** Turn the keyswitch to the OFF position. **B.** Connect the electronic service tool to the diagnostic connector. **C.** Turn the keyswitch to the ON position. **D.** Monitor the status screen on the electronic service tool. Cycle the mode switch to the ON position and to the OFF position.	Switch status changes	**Result:** The switch status changes on the electronic service tool as the mode switches are cycled. Use the electronic service tool to clear all logged diagnostic codes. Return the engine to service. **Result:** The switch status does not change as the mode switches are cycled. Proceed to Test Step 3.
3. Insert a Jumper at the Suspect Mode Switch **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the connector for the suspect mode selection switch. **C.** Fabricate a jumper wire and install the jumper wire across the two contacts of the suspect switch. **D.** Turn the keyswitch to the ON position. Monitor the status screen on the electronic service tool. Connect the jumper wire and then disconnect the jumper wire. **E.** Turn the keyswitch to the OFF position. Remove the jumper wire.	Switch status "CLOSED" with jumper installed	**Result:** When the jumper wire is connected, the switch is in the CLOSED position. **Repair:** Replace the suspect mode selection switch. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault. **Result:** When the jumper wire is connected, the switch is in the OPEN position Proceed to Test Step 4.

(continued)

(Table 108, contd)

Troubleshooting Test Steps	Values	Results
4. Measure the Voltage at the Switch **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the connector for the mode selection switches. **C.** Turn the keyswitch to the ON position. **D.** Use the electronic service tool to turn both of the mode switches to the ON position. **E.** Measure the voltage from the input of each mode switch to a suitable ground.	At least 10 VDC	**Result:** One of the measured voltages is not within the expected range - The fault is in the wiring between the suspect mode switch and the ECM. **Repair:** Repair the faulty wiring or replace the faulty wiring. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault. **Result:** The measured voltages are within the expected range. Proceed to Test Step 5.
5. Check the Wiring for an Open Circuit **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the connector for the mode switches. **C.** Disconnect the P1 connector from the ECM. **D.** Measure the resistance between the “Mode Switch 1” terminal on the P1 connector and the applicable terminal on the mode switch harness connector. **E.** Measure the resistance between the “Mode Switch 2” terminal on the P1 connector and the applicable terminal on the mode switch harness connector.	Less than 2 Ohms	**Result:** One of the measured resistances is greater than 2 Ohms - The fault is in the wiring between the suspect mode switch and the P1 connector. **Repair:** Repair the faulty wiring or replace the faulty wiring. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault. **Result:** All measured resistances are less than 2 Ohms. Proceed to Test Step 6.
6. Check the Wiring for a Short Circuit **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the connector for the mode switches. **C.** Disconnect the P1 connector from the ECM. **D.** Measure the resistance between the “Mode Switch 1” terminal on the P1 connector and all other terminals on the P1 connector. **E.** Measure the resistance between the “Mode Switch 2” terminal on the P1 connector and all other terminals on the P1 connector.	Greater than 1k Ohms	**Result:** One of the measured resistances is less than 100 Ohms. The fault is in the wiring between the ECM and the mode switch. **Repair:** Repair the faulty wiring or replace the faulty wiring. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault. **Result:** All measured resistances are greater than 1k Ohms. There is a fault in the ECM. Contact the Dealer Solutions Network (DSN).

i08809246

Motorized Valve - Test

Note: If any air system valves are replaced, the “Air System Motor Valve Verification Test” must be run before returning the unit to service in order to reset and relearn the valve stop ends.

This procedure covers the following codes:

Table 109

Diagnostic Trouble Codes for the Motorized Valves		
J1939 Code	Description	Notes
2791-6	Engine Exhaust Gas Recirculation (EGR) Valve Control : Current Above Normal	The ECM detects a high current condition in the output for the EGR valve.
2791-7	Engine Exhaust Gas Recirculation (EGR) Valve Control : Not Responding Properly	The ECM detects the signal from the EGR valve position sensor indicates that the valve is not in the desired position. This diagnostic code can be caused by a loss of the 5 VDC supply to the EGR valve position sensor or a mechanical fault with the valve.
3464-6	Engine Throttle Actuator 1 Control Command : Current Above Normal	The ECM detects a high current condition in the output for the engine intake throttle valve.
3464-7	Engine Throttle Actuator 1 Control Command : Not Responding Properly	The ECM detects the signal from the intake throttle valve position sensor indicates that the valve is not in the desired position. This diagnostic code can be caused by a loss of the 5 VDC supply to the intake throttle valve position sensor or a mechanical fault with the valve.

The following background information is related to this procedure:

NRS Valve

The NRS valve is used to control the amount of exhaust gas which is recirculated into the intake manifold.

The amount of exhaust gas that is required is calculated by the software that is contained in the ECM. The NRS valve is controlled by a PWM signal from the ECM.

Intake Throttle Valve

The intake throttle valve is used to increase the exhaust gas temperature to aid the regeneration process.

“Air System Motor Valve Verification Test”

The “Air System Motor Valve Verification Test” will identify whether the NRS valve and the intake throttle valve are working correctly. This test must be performed when the engine speed is zero and the battery voltage is within an acceptable range. For a 12V system, the test must only be performed when the battery voltage is between 9V and 16V. For a 24V system, the test must only be performed when the battery voltage is between 18V and 32V. If the battery voltage is out of the required range, the test will be aborted.

The “Air System Motor Valve Verification Test” will actively check position sensor diagnostics, motor short diagnostics, and motor open circuit diagnostics. The test will abort if any of these diagnostic codes become active.

If the engine speed is not zero while the test is being performed, the test will be aborted. If no electrical diagnostic codes are active, the test will calibrate the NRS valve minimum position and the intake throttle valve minimum and maximum position. The test then moves the valves to various positions and checks the position sensor within each valve to confirm that the valve has responded correctly. Each valve will be tested in turn, starting with the NRS valve. If a test threshold is exceeded or any related diagnostic codes become active, the test will abort and generate a service tool error identifier.

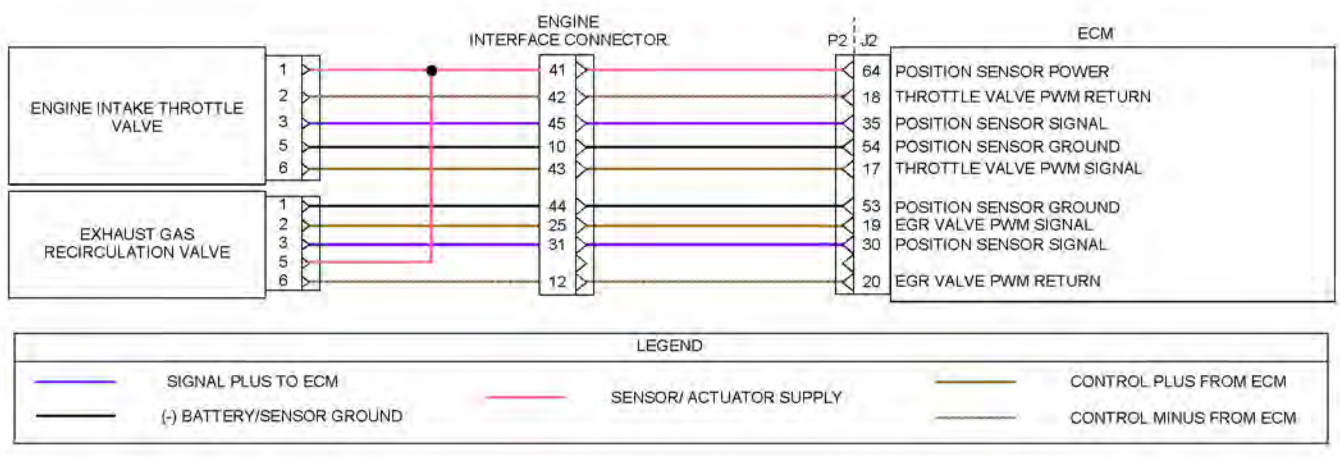


Illustration 25 g06457321

Schematic diagram for the motorized valves

Table 110

Troubleshooting Test Steps	Values	Results
1. Inspect Electrical Connectors and Wiring **A.** Thoroughly inspect connectors for the motorized valves. Refer to Troubleshooting, "Electrical Connectors - Inspect" for details. **B.** Thoroughly inspect the engine interface connector. Refer to Troubleshooting, "Electrical Connectors - Inspect" for details.	Damaged wire or connector	**Result:** A damaged wire or damaged connector was found. **Repair:** Repair the damaged wire or the damaged connector. Use the electronic service tool to clear all logged diagnostic codes. Perform the "Air System Motor Valves Verification Test" and verify that the repair eliminates the fault. **Result:** All connectors, pins, and sockets are correctly connected and/or inserted and the harness is free of corrosion, of abrasion or of pinch points. Proceed to Test Step 2.
2. Check for Diagnostic Codes **A.** Turn the keyswitch to the OFF position. **B.** Connect the electronic service tool to the diagnostic connector. **C.** Turn the keyswitch to the ON position. **D.** Monitor the electronic service tool for active diagnostic codes and/or logged diagnostic codes.	Diagnostic codes	**Result:** A -7 diagnostic code is active or recently logged for one or more of the motorized valves Proceed to Test Step 3. **Result:** A -6 diagnostic code is active or recently logged for one or more of the motorized valves. Proceed to Test Step 9.

(continued)

(Table 110, contd)

Troubleshooting Test Steps	Values	Results
3. Measure the Sensor Supply Voltage at the Valve Connector **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the suspect valve from the engine harness. **C.** Turn the keyswitch to the ON position. **D.** Measure the voltage at the harness connector for the valve from the 5 V supply terminal of the position sensor to the sensor ground terminal.	4.84 V to 5.16 V	**Result:** The measured voltage is within the expected range. Proceed to Test Step 5. **Result:** The measured voltage is not within the expected range. Reconnect the valve connector. Proceed to Test Step 4.
4. Measure the Sensor Supply Voltage at the Engine Interface Connector **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the engine interface connector. **C.** Turn the keyswitch to the ON position. **D.** Measure the voltage at the engine interface connector on the harness between the engine and the ECM from the 5 VDC sensor supply terminal for the suspect valve to the sensor ground terminal .	4.84 V to 5.16 V	**Result:** The measured voltage is within the expected range. The fault is in the 5 VDC supply wire or the ground wire between the suspect valve and the engine interface connector. **Repair:** Repair the faulty wiring or replace the faulty wiring. Use the electronic service tool to clear all logged diagnostic codes. Perform the "Air System Motor Valves Verification Test" and verify that the repair eliminates the fault. **Result:** The measured voltage is not within the expected range. The fault is in the 5 VDC supply wire or the ground wire between the ECM and the engine interface connector. **Repair:** Repair the faulty wiring or replace the faulty wiring. Use the electronic service tool to clear all logged diagnostic codes. Perform the "Air System Motor Valves Verification Test" and verify that the repair eliminates the fault.
5. Check the Wiring Between the Valve and the Engine Interface Connector for an Open Circuit **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the connector for the suspect valve. **C.** Disconnect the engine interface connector. **D.** Use a suitable multimeter to measure the resistance of the PWM signal wire between the suspect valve connector and the engine interface connector. **E.** Use a suitable multimeter to measure the resistance of the PWM return wire between the suspect valve connector and the engine interface connector.	Less than 2 Ohms	**Result:** At least one of the resistance measurements is greater than 2 Ohms. The fault is in the wiring between the suspect valve and the engine interface connector. **Repair:** Repair the faulty wiring or replace the faulty wiring. Use the electronic service tool to clear all logged diagnostic codes. Perform the "Air System Motor Valves Verification Test" and verify that the repair eliminates the fault. **Result:** All resistance measurements are less than 2 Ohms. Proceed to Test Step 6.

(continued)

(Table 110, contd)

Troubleshooting Test Steps	Values	Results
6. Check the Wiring Between the Valve and the Engine Interface Connector for a Short to Ground **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the connector for the suspect valve. **C.** Disconnect the engine interface connector. **D.** Use a suitable multimeter to measure the resistance between the PWM signal terminal on the harness connector for the suspect valve and engine ground. **E.** Use a suitable multimeter to measure the resistance between the PWM return terminal on the harness connector for the suspect valve and engine ground.	Greater than 1 k Ohm	**Result:** At least one of the resistance measurements is less than 1 k Ohm. The fault is in the wiring between the suspect valve and the engine interface connector. **Repair:** Repair the faulty wiring or replace the faulty wiring. Use the electronic service tool to clear all logged diagnostic codes. Perform the "Air System Motor Valves Verification Test" and verify that the repair eliminates the fault. **Result:** All resistance measurements are greater than 1 k Ohm. Proceed to Test Step 7.
7. Check the Wiring Between the Engine Interface Connector and the ECM for an Open Circuit **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the P2 connector from the ECM. Disconnect the engine interface connector. **C.** Inspect the P2/J2 connectors for damage or corrosion. Refer to Troubleshooting, Electrical Connectors - Inspect for more information. **D.** Perform a 30 N (6.7 lb) pull test on each wire in the P2 connector that is associated with the active diagnostic code. **E.** Use a suitable multimeter to measure the resistance between the suspect valve PWM signal terminal on the engine interface connector and the suspect valve PWM supply terminal on the P2 connector. **F.** Use a suitable multimeter to measure the resistance between the suspect valve PWM return terminal on the engine interface connector and the suspect valve PWM return terminal on the P2 connector.	Less than 2 Ohms	**Result:** At least one of the resistance measurements is greater than 2 Ohms. The fault is in the wiring between the engine interface connector and the P2 ECM connector. **Repair:** Repair the faulty wiring or replace the faulty wiring. Use the electronic service tool to clear all logged diagnostic codes. Perform the "Air System Motor Valves Verification Test" and verify that the repair eliminates the fault. **Result:** The resistance measurements are less than 2 Ohms. Proceed to Test Step 8.

(continued)

(Table 110, contd)

Troubleshooting Test Steps	Values	Results
8. Check the Wiring Between the Valve and the Engine Interface Connector for a Short to Ground **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the connector for the suspect valve. **C.** Disconnect the engine interface connector. **D.** Use a suitable multimeter to measure the resistance between the PWM signal terminal for the suspect valve on the engine interface connector and engine ground. **E.** Use a suitable multimeter to measure the resistance between the PWM return terminal for the suspect valve on the engine interface connector and engine ground.	Greater than 1 k Ohm	**Result:** At least one of the resistance measurements is less than 1 k Ohm. The fault is in the wiring between the engine interface connector and the ECM. **Repair:** Repair the faulty wiring or replace the faulty wiring. Use the electronic service tool to clear all logged diagnostic codes. Perform the "Air System Motor Valves Verification Test" and verify that the repair eliminates the fault. **Result:** All resistance measurements are greater than 1 k Ohm. **Repair:** Reconnect the connectors. Start the engine. Check for active diagnostic codes on the electronic service tool. Wait at least 30 seconds in order for the codes to be displayed. If the -7 diagnostic code returns, then replace the valve. Refer to Disassembly and Assembly for the correct procedure. Use the electronic service tool to clear all logged diagnostic codes and run the appropriate reset feature for the replaced valve. Refer to Troubleshooting, Service Tool Features. Use the electronic service tool to perform the "Air System Motor Valves Verification Test" and verify that the repair eliminates the fault.
9. Create an Open Circuit at the Valve Connector **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the connector for the suspect valve. **C.** Reconnect the suspect valve connector. **D.** Turn the keyswitch to the ON position. Check for active diagnostic codes on the electronic service tool. Wait at least 30 seconds in order for the codes to be displayed.	Diagnostic Codes	**Result:** A -7 diagnostic code is active with the wires disconnected. **Repair:** Reconnect the valve. Start the engine. Check for active diagnostic codes on the electronic service tool. Wait at least 30 seconds in order for the codes to be displayed. If the -6 diagnostic code returns, then replace the valve. Refer to Disassembly and Assembly for the correct procedure. Use the electronic service tool to clear all logged diagnostic codes and run the appropriate reset feature for the replaced valve. Refer to Troubleshooting, Service Tool Features. Use the electronic service tool to perform the "Air System Motor Valves Verification Test" and verify that the repair eliminates the fault. **Result:** A -6 diagnostic code is still active with the wires disconnected. Turn the keyswitch to the OFF position. Reinstall the wires. Proceed to Test Step 10.

(continued)

(Table 110, contd)

Troubleshooting Test Steps	Values	Results
10. Create an Open Circuit at the Engine Interface Connector **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the engine interface connector. **C.** Remove the PWM signal and PWM return wires for the suspect valve from the engine interface connector to create an open circuit. **D.** Reconnect the engine interface connector. **E.** Turn the keyswitch to the ON position. Wait at least 30 seconds for activation of the diagnostic codes. **F.** Check for an active -7 diagnostic code for the suspect valve. **G.** Turn the keyswitch to the OFF position.	Diagnostic codes	**Result:** A -7 diagnostic code is active with the wires disconnected. The fault is in the wiring between the suspect valve and the engine interface connector. **Repair:** Replace the faulty wiring. Use the electronic service tool to clear all logged diagnostic codes. Perform the “Air System Motor Valves Verification Test” and verify that the repair eliminates the fault. **Result:** A -6 diagnostic code is still active with the wires disconnected. Reinstall the wires. Proceed to Test Step 11.
11. Check the Wiring Between the Engine Interface Connector and the ECM for a Short Circuit **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the P2 connector from the ECM. Disconnect the engine interface connector. **C.** Inspect the P2/J2 connectors for damage or corrosion. Refer to Troubleshooting, Electrical Connectors - Inspect for more information. **D.** Perform a 30 N (6.7 lb) pull test on each wire in the P2 connector that is associated with the active diagnostic code. **E.** Use a suitable multimeter to measure the resistance between the suspect injector supply terminal on the engine interface connector and all other terminals on the engine interface connector. **F.** Use a suitable multimeter to measure the resistance between the suspect injector return terminal on the engine interface connector and all other terminals on the engine interface connector.	Diagnostic codes	**Result:** At least one of the resistance measurements is less than 1 k Ohm. There is a short in the wiring between the engine interface connector and the ECM. **Repair:** Repair the faulty wiring or replace the faulty wiring. Use the electronic service tool to clear all logged diagnostic codes. Perform the “Air System Motor Valves Verification Test” and verify that the repair eliminates the fault. **Result:** All resistance measurements are greater than 1 k Ohm. Contact the Dealer Solutions Network (DSN).

i07897336

Relay - Test
(Start Relay)

This procedure covers the following diagnostic codes:

Table 111

Diagnostic Trouble Codes for the Start Relay		
J1939 Code	**Code Description**	**Comments**
677-5	Engine Starter Motor Relay Current Below Normal	The Electronic Control Module (ECM) detects a low current condition (open circuit) in the start relay control circuit.
677-6	Engine Starter Motor Relay Current Above Normal	The Electronic Control Module (ECM) detects a high current condition (short circuit) in the start relay control circuit.
Follow the troubleshooting procedure to identify the root cause of the fault.		

During the following procedure, refer to the electrical schematic for the application.

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

Table 112

Troubleshooting Test Steps	Values	Results
1. Inspect Electrical Connectors and Wiring **A.** Check that the fuses are not blown. **B.** Inspect the terminals on the start relay. Refer to Troubleshooting, "Electrical Connector - Inspect" for details. **C.** Perform a 30 N (6.7 lb) pull test on each of the wires in the ECM connector that are associated with the start relay. **D.** Check the harness for abrasion and pinch points from the start relay back to the ECM.	Loose connection or damaged wire	**Result:** There is a fault in a connector or the wiring. **Repair:** Repair any faulty connectors or replace the wiring harness. Ensure that all the seals are properly in place and ensure that the connectors are correctly coupled. Replace any blown fuses. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault. **Result:** All connectors, pins, and sockets are correctly coupled and/or inserted. The harness is free of corrosion, abrasion, and pinch points. The fuses are not blown. Proceed to Test Step 2.
2. Check for Active Diagnostic Codes **A.** Connect the electronic service tool to the diagnostic connector. **B.** Turn the keyswitch to the ON position. **Note:** Do not start the engine. **C.** Use the electronic service tool to check for active diagnostic codes.	Diagnostic codes	**Result:** Diagnostic code 677-5 is active or recently logged. Proceed to Test Step 3. **Result:** Diagnostic code 677-6 is active or recently logged. Proceed to Test Step 6.

(continued)

(Table 112, contd)

Troubleshooting Test Steps	Values	Results
3. Check the Battery Supply Voltage at the Relay Connector **A.** Turn the keyswitch to the OFF position. **B.** Turn the keyswitch to the ON position. Do not start the engine. **C.** Measure the voltage between the battery input terminal on the relay and a suitable ground.	At least 11 VDC for a 12 VDC system.	**Result:** The voltage is not within the expected range. **Repair:** Repair or replace the battery supply wiring to the start relay. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault. **Result:** The voltage is within the expected range. Proceed to Test Step 4.
4. Create a Short Circuit at the Relay Connector **A.** Turn the keyswitch to the OFF position. **B.** Remove the start relay. **C.** Fabricate a jumper wire. Install the jumper wire between terminal 1 and terminal 2 on the harness connector for the start relay. **D.** Turn the keyswitch to the ON position. **E.** Use the electronic service tool to check for active diagnostic codes. Wait at least 30 seconds for activation of the diagnostic codes. **F.** Turn the keyswitch to the OFF position and remove the jumper wire.	Diagnostic code	**Result:** A 677-6 diagnostic code is active with the jumper installed. **Repair:** Install a replacement start relay. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault. **Result:** The 677-5 diagnostic code is still active. Proceed to Test Step 5.
5. Check the Relay Control Wiring for an Open Circuit **A.** Verify that the keyswitch is in the OFF position. **B.** Disconnect the P1 connector from the ECM. **C.** Inspect the P1 connector. Refer to Troubleshooting, "Electrical Connector - Inspect" for details. **D.** Measure the resistance between Terminal 1 on the harness connector for the start relay and the "Start Relay Control" terminal on the P1 connector. **E.** Measure the resistance between Terminal 2 on the harness connector for the start relay and ground. **Note:** If terminal 2 is connected to the engine ECM, measure the resistance between terminal 2 on the harness connector and the appropriate terminal on the P1 connector. Refer to the Electrical Schematic for the application.	Less than 5 Ohms	**Result:** At least one of the resistance measurements is greater than 5 Ohms - the fault is in the wiring for the start relay control circuit. **Repair:** Repair the faulty wiring or replace the faulty wiring. **Result:** Both resistance measurements are less than 5 Ohms. Contact the Dealer Solutions Network (DSN).

(continued)

(Table 112, contd)

Troubleshooting Test Steps	Values	Results
6. Create an Open Circuit at the Relay **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the start relay. **C.** Use the electronic service tool to check for active diagnostic codes. Wait at least 30 seconds for activation of the diagnostic codes.	Diagnostic codes	**Result:** A 677-5 diagnostic code is active with the relay disconnected. **Repair:** Install a replacement start relay. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault. **Result:** The 677-6 diagnostic code is still active with the relay disconnected. Proceed to Test Step 7.
7. Check the Wiring Between the Relay and the ECM for a Short Circuit **A.** Disconnect the P1 connector. **B.** Inspect the P1 connector. Refer to Troubleshooting, “Electrical Connectors - Inspect” for details. **C.** Measure the resistance between the “Start Relay Control” terminal and all other terminals on the P1 connector.	Greater than 1.0 k Ohm	**Result:** At least one of the resistance measurements is less than 1.0 k Ohm. There is a short in the wiring between the relay and the ECM. **Repair:** Repair the faulty wiring or replace the faulty wiring. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault. **Result:** All resistance measurements are greater than 1.0 k Ohm. Contact the Dealer Solutions Network (DSN).

i07852344

Sensor Calibration Required - Test

The Electronic Control Module (ECM) performs calibrations of pressure sensors automatically. Use this procedure if the diagnostic code in Table 113 is active or easily repeated.

Table 113

Diagnostic Codes Table for Sensor Calibration		
J1939 Code	**Code Description**	**Comments**
3251–13	Aftertreatment #1 DPF Differential Pressure : Out of Calibration	The ECM detects the following conditions: The Diesel Particulate Filter (DPF) differential pressure is outside the acceptable range during initialization check, or during sensor calibration when the engine is not running. The warning lamp will come on and the engine will derate. The code is logged.

(continued)

(Table 113, contd)

3563-13	Engine Intake Manifold #1 Absolute Pressure : Out of Calibration	The ECM detects the following conditions: The offset between the intake manifold air pressure and the barometric pressure is outside the acceptable range during initialization check. The offset between the intake manifold air pressure and the barometric pressure is outside the acceptable range during sensor calibration with the engine not running. The warning lamp will come on and the engine will derate. The code is logged.
3609–13	DPF #1 Intake Pressure : Out of Calibration	The ECM detects the following conditions: The offset between the DPF inlet pressure and the barometric pressure is outside the acceptable range during initialization check. The offset between the DPF inlet pressure and the barometric pressure is outside the acceptable range during sensor calibration with the engine not running. The warning lamp will come on and the engine will derate. The code is logged.

Table 114

Troubleshooting Test Steps	Values	Results
1. Check For Active Diagnostic Codes **A.** Turn the keyswitch to the OFF position. **B.** Connect the electronic service tool to the diagnostic connector. **C.** Turn the keyswitch to the ON position. **D.** Use the electronic service tool to check that coolant temperature, the DPF intake temperature, and the intake manifold air temperature are all at least 5° C (41° F). **Note:** Wait at least 10 seconds in order for the diagnostic codes to become active. **E.** Use the electronic service tool to monitor active diagnostic codes or recently logged diagnostic codes. Look for an active or logged -3 or -4 codes for the pressure sensor or the barometric pressure sensor. **F.** Use the electronic service tool to monitor active diagnostic codes or recently logged diagnostic codes. Look for an active or logged -13 code for a pressure sensor or the barometric pressure sensor. **G.** Turn the keyswitch to the OFF position.	Diagnostic codes	**Result:** There are no active diagnostic codes for the pressure sensors. **Repair:** If there are logged diagnostic codes for the intake manifold pressure sensor, the fault may be intermittent. Refer to Troubleshooting, “Electrical Connectors - Inspect” to identify intermittent faults. **Result:** One or more of the temperature sensors is reading less than 5° C (41° F). Proceed to Test Step 2. **Result:** There is an active -3 or -4 diagnostic code for a pressure sensor or the barometric pressure sensor. **Repair:** Troubleshoot these codes before continuing with this procedure. **Result:** There are multiple -13 diagnostic codes active. Proceed to Test Step 3. **Result:** There is an active -13 diagnostic code for only one sensor. Proceed to Test Step 4.
2. Ensure that the Systems are Fully Thawed **A.** Move the machine into an environment where the ambient temperature is greater than 5° C (41° F) during any troubleshooting. **B.** If engine has been operated or stored in cold ambient conditions where there is a risk of ice formation on a sensor or sensor pipes, run engine until the coolant temperature exceeds 65° C (149° F) for 20 minutes. **C.** Turn the keyswitch to the OFF position. Wait for at least 20 seconds. The electronic service tool will disconnect. **D.** Turn the keyswitch to the ON position. **E.** Verify that coolant temperature, the DPF intake temperature, and the intake manifold air temperature are all now at least 5° C (41° F). **F.** Check for active -13 diagnostic codes. **G.** Check that the suspect sensor is installed correctly. Check that the suspect sensor is fully seated into the engine.	Diagnostic codes	**Result:** There are no active -13 codes. **Repair:** The fault was caused by ice in the system that has now been thawed. Return the unit to service **Result:** There are multiple -13 diagnostic codes active. Proceed to Test Step 3. **Result:** A single -13 code is active or logged. Proceed to Test Step 4.

(continued)

(Table 114, contd)

Troubleshooting Test Steps	Values	Results
3. Check the Barometric Pressure Sensor **A.** Turn the keyswitch to the OFF position. **B.** Install a new Electronic Control Module (ECM). **Note:** The Barometric Pressure Sensor is located within the ECM so cannot be replaced separately. To replace the Barometric Pressure Sensor, the ECM must be replaced. **C.** Connect the electronic service tool and program the ECM with the required engine software. Refer to Troubleshooting, ECM Software - Install for the correct procedure. **D.** Turn the keyswitch to the ON position. Do not start the engine. **Note:** Wait at least 10 seconds in order for the diagnostic codes to become active. **E.** Monitor the status parameter for the suspect sensor on the electronic service tool.	Barometric pressure sensor fault	**Result:** There is no active -13 code. The fault was caused by a faulty barometric pressure sensor. Use the electronic service tool to clear all logged codes. Return the unit to service. **Result:** A -13 code is active. Proceed to Test Step 4.
4. Check the Suspect Pressure Sensor **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the connector for the suspect sensor and remove the sensor from the engine. **C.** Check the sensor for a blockage. **D.** Temporarily reconnect the sensor to the harness. Do not install the sensor on the engine. **E.** Turn the keyswitch to the ON position. Do not start the engine. **F.** Check for an active -13 diagnostic code for the suspect sensor.	Barometric pressure sensor fault	**Result:** There is an active -13 code or the sensor is blocked Temporarily connect a new sensor to the harness. Use the electronic service tool to confirm that the repair eliminates the fault. If the fault is eliminated, permanently install the new sensor. Refer to Disassembly & Assembly for the correct installation procedure. If the fault is still present, proceed to Test Step 3. **Result:** There is no active -13 code. Use the electronic service tool to clear all logged codes.

i08377441

Sensor (Data Link Type) - Test

Use this procedure to troubleshoot the electrical system if a fault is suspected with the CAN data link sensors. Also use this procedure if a diagnostic code in Table 115 is active or easily repeated.

Table 115

Diagnostic Trouble Codes for the Data Link Sensors		
J1939 Code	**Code Description**	**Comments**
5742–12	Aftertreatment Diesel Particulate Filter Temperature Sensor Module : Failure	The data received from the Diesel Oxidation Catalyst (DOC)/Diesel Particulate Filter (DPF) inlet temperature sensor is out of range. The code is logged. The warning lamp is illuminated.

If the electronic service tool will not communicate with the ECM, refer to Troubleshooting, "Electronic Service Tool Does Not Communicate" before starting this procedure. The procedure verifies that electrical power is being supplied to the ECM and to the diagnostic connector.

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

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

When the keyswitch is in the OFF position, the electronic service tool may communicate with the ECM. However, the communications may be disrupted and the communications may require frequent reconnection. To avoid any disruption, place the keyswitch in the ON position when the electronic service tool is being used.

The electronic service tool may display the following error message:

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

This message indicates that one of the following conditions exist:

- The flash file in the ECM is newer than the version of the electronic service tool.
- The latest version of the electronic service tool has not been installed.

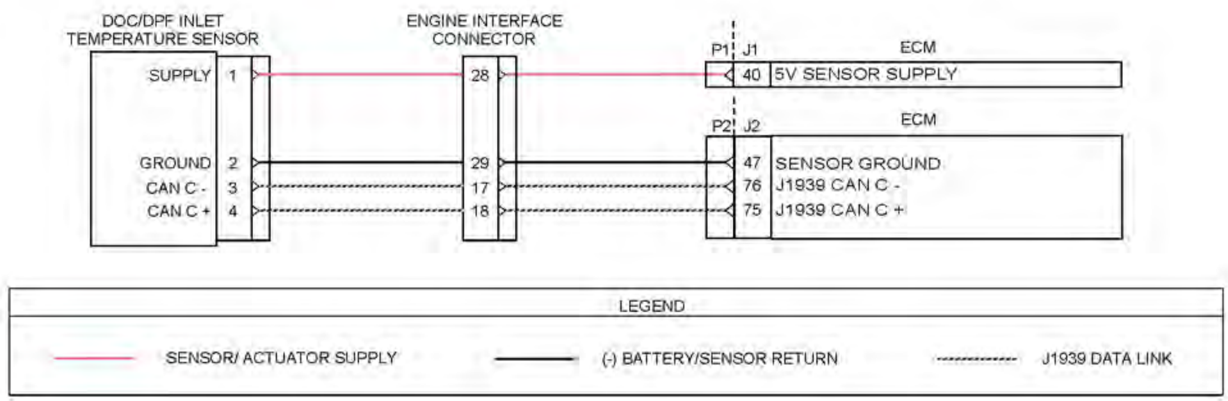


Illustration 26 g06648927

Schematic for the data-link type sensor

Note: All connectors may not be shown. Refer to the Electrical Schematic for the application for details of any connectors between the sensor connectors and the ECM connectors.

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

Table 116

Troubleshooting Test Steps	Values	Results
1. Check the Connectors **A.** Thoroughly inspect the connectors that are associated with the data link circuits. Verify that the connectors are free of debris, free of corrosion, and securely connected. **B.** Perform a 30 N (6.7 lb) pull test on all the wires associated with the data link circuits.	Connectors	**Result:** The connectors were connected correctly and did not have corrosion or moisture. Proceed to Test Step 2. **Result:** The connectors were not connected correctly or the connectors have corrosion or moisture. **Repair:** Repair the connectors and/or the wiring. Replace parts, if necessary. Proceed to Test Step 3.
2. Check for Active or Recently Logged Diagnostic Codes **A.**Establish communication between the electronic service tool and the engine Electronic Control Module (ECM). Refer to Troubleshooting, “Electronic Service Tools” **B.** Look for active or logged codes.	Diagnostic Trouble Codes	**Result:** There is an active or recently logged 5742–12 diagnostic code. **Repair:** Install a replacement DPF/DOC inlet temperature sensor. Refer to Disassembly and Assembly, Temperature Sensor (Exhaust) - Remove and Install (Temperature Sensor for Diesel Oxidation Catalyst (DOC), and Diesel Particulate Filter (DPF)). Proceed to Test Step 3.
3. Perform the “Aftertreatment System Functional Test” **A.** Turn the keyswitch to the ON position. **B.** Use the electronic service tool to perform the “Aftertreatment System Functional Test” .	Diagnostic Codes	**Result:** The test passed and no diagnostic codes became active. Return the engine to service. **Result:** The test failed. Troubleshoot any diagnostic codes that became active during the test. Refer to Troubleshooting “Diagnostic Trouble Codes”. If the procedure did not correct the fault, contact the Dealer Solutions Network (DSN).

i07852358

Sensor Signal (Analog, Active) - Test

This procedure covers the following diagnostic codes:

Table 117

Diagnostic Codes for the Active Analog Sensors		
J1939 Code	**Code Description**	**Comments**
108-12	Barometric Pressure : Failure	The ECM detects that the barometric pressure sensor has failed. The code is logged.
157-3	Fuel Rail Pressure Sensor : Voltage Above Normal	The ECM detects that the signal voltage for the fuel rail pressure sensor is greater than 4.8 V for 0.6 seconds. The code is logged.
157-4	Fuel Rail Pressure Sensor : Voltage Below Normal	The ECM detects that the signal voltage for the fuel rail pressure sensor is less than 0.2 V for 0.6 seconds. The code is logged.
157-12	Fuel Rail Pressure Sensor : Failure	The ECM detects that the fuel rail pressure sensor has failed. The code is logged. The value of the parameter is set to a gauge pressure.
1387–3	Auxiliary Pressure #1 : Voltage Above Normal	The ECM detects a signal voltage that is not in the acceptable range.
1387–4	Auxiliary Pressure #1 : Voltage Below Normal	The ECM detects a signal voltage that is not in the acceptable range.
3251–3	Aftertreatment #1 DPF Differential Pressure : Voltage Above Normal	The ECM detects that the signal voltage for the DPF differential pressure sensor is greater that 4.8 V for 8 seconds. The code is logged.
3251–4	Aftertreatment #1 DPF Differential Pressure : Voltage Below Normal	The ECM detects that the signal voltage for the DPF differential pressure sensor is less than 0.2 V for 8 seconds. The code is logged.
3563-3	Intake Manifold Pressure Sensor : Voltage Above Normal	The ECM detects that the signal voltage for the intake manifold air pressure sensor is greater than 4.8 V for 1 second. The code is logged.
3563-4	Intake Manifold Pressure Sensor : Voltage Below Normal	The ECM detects that the signal voltage for the intake manifold air pressure sensor is less than 0.4 V for 1 second. The code is logged.
3609–3	DPF #1 Intake Pressure : Voltage Above Normal	The ECM detects that the signal voltage for the DPF intake pressure sensor is greater than 4.8 V for 6 seconds. The code is logged.
3609–4	DPF #1 Intake Pressure : Voltage Below Normal	The ECM detects that the signal voltage for the DPF intake pressure sensor is less than 0.2 V for 6 seconds. The code is logged.
Follow the troubleshooting procedure to identify the root cause of the fault.		

The following conditions must exist before any of the above codes will become active:

- There are no active 3509 codes.
- There are no active 168 codes.

The following background information is related to this procedure:

The 5 VDC sensor supply provides power to all 5 VDC sensors. The sensor supply is output short circuit protected. A short circuit to the battery will not damage the circuit inside the ECM.

Pull-up Voltage

The ECM continuously outputs a pull-up voltage on the circuit for the sensor signal wire. The ECM uses this pull-up voltage to detect an open in the signal circuit. When the ECM detects a voltage above a threshold on the signal circuit, an open circuit diagnostic code (XXXX-3) is generated for the sensor.

If the sensor is disconnected, pull-up voltage indicates that the wires from the sensor connector to the ECM are not open or shorted to ground. If the sensor is disconnected, the absence of pull-up voltage indicates an open in the signal wire or a short to ground. If the sensor is disconnected and the voltage is different from pull-up voltage, the signal wire is shorted to another wire in the harness.

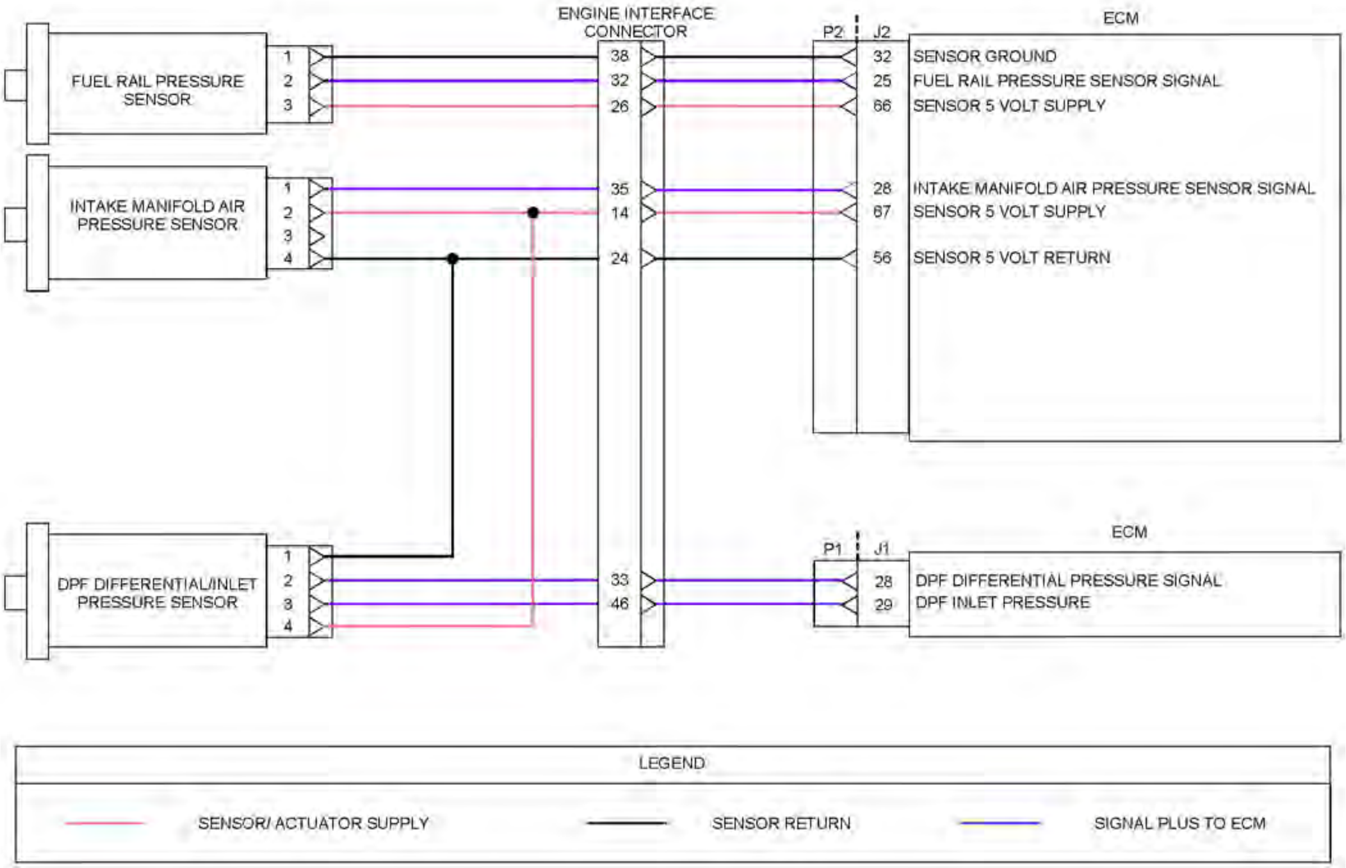


Illustration 27 g06457878

Schematic diagram for the active sensors

Table 118

Troubleshooting Test Steps	Values	Results
1. Download Information Using the Electronic Service Tool **A.** Use the electronic service tool to download the “Product Status Report” (PSR) with histograms before performing any troubleshooting or clearing any diagnostic codes. **Note:** The downloaded information will be required by the Dealer Solutions Network (DSN) if troubleshooting assistance is required.	Downloaded information	**Result:** The information was successfully saved. Proceed to Test Step 2. **Result:** The electronic service tool information was not successfully saved. Contact the Dealer Solutions Network (DSN) for guidance.
2. Create an Electronic Service Tool Snapshot (only applicable to 157–3 and 157–4 diagnostic codes) **A.** Select “Snapshot Viewer” on the electronic service tool, using menus: Information -> Snapshot -> Viewer **B.** Select the event code and then click “View Graph” . **C.** Select the following parameter and then click OK. · Engine Speed **D.** Select Save to "File to save" a Snapshot File (*.xml). This file will contain all the data in the snapshot and not only the data shown on the graph. **Note:** The downloaded information will be required by the DSN if troubleshooting assistance is required.	Snapshot saved	**Result:** The electronic service tool snapshot was successfully saved. Proceed to Test Step 3. **Result:** The electronic service tool snapshot was not successfully saved. Contact the DSN for guidance.
3. Check for Diagnostic Codes **A.** Establish communication between the electronic service tool and the ECM . Refer to Troubleshooting, “Electronic Service Tools”, if necessary. **B.** Turn the keyswitch to the ON position. **C.** Look for active or logged diagnostic codes for the active sensors.	Diagnostic code	**Result:** There are no active diagnostic codes for the active sensors. **Repair:** If there are logged diagnostic codes for the active sensors, the fault may be intermittent. Refer to Troubleshooting, “Electrical Connectors - Inspect” to identify intermittent faults. **Result:** A diagnostic code that is listed in Table 117 is active. Proceed to Test Step 4.
4. Check the 5 VDC Supply Voltage at the Sensor Connector **A.** Turn the keyswitch to the ON position. **B.** Measure the voltage between the sensor supply pin and the sensor return pin at the suspect sensor.	Test passed	**Result:** The supply voltage is approximately 5.0 ± 0.2 VDC Connect the sensor and then proceed to Test Step 5. **Result:** The supply voltage is not approximately 5.0 ± 0.2 VDC. The fault is in the 5 V supply wiring to the suspect sensor. Repair the wiring or replace the harness Verify that the problem is resolved.

(continued)

(Table 118, contd)

Troubleshooting Test Steps	Values	Results
5. Check the Type of Diagnostic Code that is Active **A.** Turn the keyswitch to the ON position. Wait at least 10 seconds for activation of the diagnostic codes. **B.** Use the electronic service tool to check for active diagnostic codes. Record all active diagnostic codes.	Diagnostic codes	**Result:** A 157-12 diagnostic code is active. **Repair:** Replace the fuel rail pressure sensor. **Note:** Do not replace the fuel rail pressure sensor if the 157-12 diagnostic code is logged. Only replace the sensor for an active 157-12 diagnostic code. Use the electronic service tool to clear all logged diagnostic codes. Return the unit to service. If the fault is still present, contact the Dealer Solutions Network (DSN). **Result:** A 108-12 diagnostic code is active. **Repair:** Install a replacement ECM. Use the electronic service tool to clear all logged diagnostic codes. Return the unit to service. **Result:** A -3 diagnostic code is active for one or more of the active sensors. Proceed to Test Step 6. **Result:** A -4 diagnostic code is active for one or more of the active sensors. Proceed to Test Step 9.
6. Create a Short at the Sensor Connector **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the connector for the suspect sensor. **C.** Use a jumper wire to create a short between the signal terminal and the ground terminal at the sensor connector. **D.** Turn the keyswitch to the ON position. **E.** Monitor the diagnostic codes on the electronic service tool. Check for an active -4 diagnostic code for the suspect sensor. **F.** Turn the keyswitch to the OFF position.	Short created	**Result:** A -4 diagnostic code became active after creating the short at the sensor connector. **Repair:** The wiring is OK. Replace the sensor. Verify that the problem is resolved. **Result:** A -4 diagnostic code does not become active for the suspect sensor. Proceed to Test Step 7.

(continued)

(Table 118, contd)

Troubleshooting Test Steps	Values	Results
5. Create a Short Circuit at the Engine Interface Connector **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the engine interface connector. **C.** Use a jumper wire to create a short between the signal terminal and the ground terminal at the engine interface connector. **D.** Turn the keyswitch to the ON position. **E.** Monitor the diagnostic codes on the electronic service tool. Check for an active -4 diagnostic code for the suspect sensor. **Note:** Diagnostic codes for all the engine sensors will be active with the engine interface connector disconnected. Disregard the other diagnostic codes. Only look for codes for the suspect sensor. **F.** Turn the keyswitch to the OFF position.	Short created	**Result:** A -4 diagnostic code became active after creating the short at the engine interface connector. **Repair:** The fault is in the engine wiring harness. Repair the harness or replace the harness. Verify that the problem is resolved. **Result:** A -4 diagnostic code does not become active for the suspect sensor. Proceed to Test Step 8.
8. Check the Wiring Between the Engine Interface Connector and the ECM for an Open Circuit **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the engine interface connector. Disconnect the P1/P2 connector from the ECM. Refer to Illustration 27 for the correct connector. **C.** Thoroughly inspect the P1/J1 or P2/J2 ECM connectors. Refer to Troubleshooting, Electrical Connectors - Inspect. **D.** Use a suitable multimeter to measure the resistance between the sensor signal terminal on the engine interface connector and the sensor signal terminal on the P1/P2 connector.	Less than 2 Ohms	**Result:** The resistance is greater than 2 Ohms - There is a fault in the wiring between the engine interface connector and the P1/P2 connector. **Repair:** Repair the faulty wiring or replace the faulty wiring. Verify that the repair eliminates the fault. **Result:** All measured resistances are less than 2 Ohms. Proceed to Test Step 12.
9. Create an Open at the Suspect Sensor Connector **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the sensor connector of the suspect sensor with the active -4 diagnostic code. **C.** Turn the keyswitch to the ON position. **D.** Monitor the diagnostic codes on the electronic service tool. Check for an active -3 diagnostic code for the suspect sensor. **E.** Turn the keyswitch to the OFF position.	Create an Open	**Result:** A -3 diagnostic code became active after disconnecting the sensor. The wiring is OK. Replace the sensor. Verify that the problem is resolved. **Result:** A -3 diagnostic code did not become active after disconnecting the sensor. Proceed to Test Step 10.

(continued)

(Table 118, contd)

Troubleshooting Test Steps	Values	Results
10. Create an Open at the Engine Interface Connector **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the engine interface connector. **C.** Turn the keyswitch to the ON position. **D.** Monitor the diagnostic codes on the electronic service tool. Check for an active -3 diagnostic code for the suspect sensor. **Note:** Diagnostic codes for all the engine sensors will be active with the engine interface connector disconnected. Disregard the other diagnostic codes. Only look for codes for the suspect sensor. **E.** Turn the keyswitch to the OFF position.	Create an Open	**Result:** A -3 diagnostic code became active for the suspect sensor after disconnecting the engine interface connector. **Repair:** The fault is in the engine wiring harness. Repair the engine wiring harness or replace the engine wiring harness. Verify that the problem is resolved. **Result:** A -3 diagnostic code did not become active after disconnecting the engine interface connector. Proceed to Test Step 11.
11. Check the Wiring Between the Engine Interface Connector and the ECM for a Short Circuit **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the engine interface connector. Disconnect the P1/P2 connector from the ECM. Refer to Illustration 27 for the correct connector. **C.** Thoroughly inspect the P1/J1 or P2/J2 ECM connectors. Refer to Troubleshooting, Electrical Connectors - Inspect. **D.** Use a suitable multimeter to measure the resistance between the suspect signal terminal on the engine interface connector (ECM side) and all other terminals on the engine interface connector.	Greater than 1k Ohm	**Result:** At least one of the resistance measurements is less than 1 k Ohm. The fault is in the wiring connected to the ECM connector. **Repair:** Repair the faulty wiring or replace the faulty wiring. **Result:** All resistance measurements are greater than 1 k Ohm. Proceed to Test Step 12.
12. Perform the Wiggle Test Carefully following this procedure is the best way to identify the root cause of an intermittent problem. **A.** Turn the keyswitch to the ON position. **B.** Use the electronic service tool to run the “Wiggle Test” . **C.** Slowly wiggle the wiring and the connectors between the P2 connector and the sensor. Pay particular attention to the wiring near each connector. Be sure to wiggle all the wiring. As you wiggle the wiring look for these problems. **1.** Loose connectors or damaged connectors **2.** Moisture on the connectors or the wiring **3.** Damaged that is caused by excessive heat **4.** Damage that is caused by chafing **5.** Improper routing of wiring **6.** Damaged insulation	Test passed	**Result:** The wiring failed the Wiggle Test. There is a problem with the wiring. Repair the wiring or replace the wiring. Verify that the problem is resolved. STOP **Result:** The wiring passed the Wiggle Test. The problem may be intermittent. Inspect the wiring. Refer to Troubleshooting, “Electrical Connectors - Inspect”. If the wiring looks OK, perform the following procedure. **1.** Turn the keyswitch to the OFF position. **2.** Disconnect the connectors. Carefully inspect the terminals for proper installation. Make sure that each terminal is clean and dry. **3.** Insert a pin into each socket. Verify that each socket grips the pin firmly. Repair any problems. **4.** Connect all connectors. **5.** Verify that the problem is resolved. **6.** Return the unit to service. STOP

i07852397

Sensor Signal (Analog, Passive) - Test

This procedure covers the following diagnostic codes:

Table 119

Diagnostic Trouble Codes for Analog Passive Sensors		
J1939 Code	Code Description	Comments
105-3	Engine Intake Manifold #1 Temperature : Voltage Above Normal	The Electronic Control Module (ECM) detects that the signal voltage for the intake manifold temperature sensor is greater than 4.975 V for 8 second
105-4	Engine Intake Manifold #1 Temperature : Voltage Below Normal	The ECM detects that the signal voltage for the intake manifold temperature sensor is less than 0.2 V for 8 seconds.
110-3	Engine Coolant Temperature : Voltage Above Normal	The ECM detects that the signal voltage for the coolant temperature sensor is greater than 4.95 V for 8 seconds.
110-4	Engine Coolant Temperature : Voltage Below Normal	The ECM detects that the signal voltage for the coolant temperature sensor is less than 0.2 V for 8 seconds.
172-3	Engine Air Inlet Temperature : Voltage Above Normal	The ECM detects that the signal voltage for the air inlet temperature sensor is greater than 4.95 V for 8 seconds.
172-4	Engine Air Inlet Temperature : Voltage Below Normal	The ECM detects that the signal voltage for the air inlet temperature sensor is less than 0.2 V for 8 seconds.
174-3	Engine Fuel Temperature 1 : Voltage Above Normal	The ECM detects that the signal voltage for the fuel temperature sensor is greater than 4.975 V for 8 seconds
174-4	Engine Fuel Temperature 1 : Voltage Below Normal	The ECM detects that the signal voltage for the fuel temperature sensor is less than 0.2 V for 8 seconds.
441–3	Auxiliary Temperature #1 : Voltage Above Normal	The ECM detects voltage that is above the acceptable range.
441–4	Auxiliary Temperature #1 : Voltage Below Normal	The ECM detects voltage that is below the acceptable range.
2630–3	Engine Charge Air Cooler Outlet Temperature : Voltage Above Normal	The ECM detects voltage that is above the acceptable range.
2630–4	Engine Charge Air Cooler Outlet Temperature : Voltage Below Normal	The ECM detects voltage that is below the acceptable range.
Follow the troubleshooting procedure to identify the root cause of the fault.		

Note: The following conditions must exist before any of the above codes will become active:

- The ECM has been powered for at least 2 seconds.
- There are no active 168-X diagnostic codes.

The ECM will log the diagnostic code. If equipped, the warning light will come on.

This procedure covers open circuit diagnostic codes and short circuit diagnostic codes that are associated with the following sensors that are connected to the ECM:

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

The following background information is related to this procedure:

The temperature sensors have two terminals. The signal line is connected to each sensor connector terminal 1. Terminal 2 is the return line. The signal voltage from terminal 1 of each sensor is supplied to the appropriate terminal in the ECM.

Pull-up Voltage

The ECM continuously outputs a pull-up voltage on the circuit for the sensor signal wire. The ECM uses this pull-up voltage to detect an open in the signal circuit. When the ECM detects a voltage above a threshold on a signal circuit, an open circuit diagnostic code (XXX-3) is communicated to the engine ECM.

If the sensor is disconnected, pull-up voltage at the connector indicates that the wires are not open or shorted to ground. If the sensor is disconnected, the absence of pull-up voltage indicates an open in the signal wire or a short to ground. If the sensor is disconnected and the voltage is different from pull-up voltage, the signal wire is shorted to another wire in the harness.

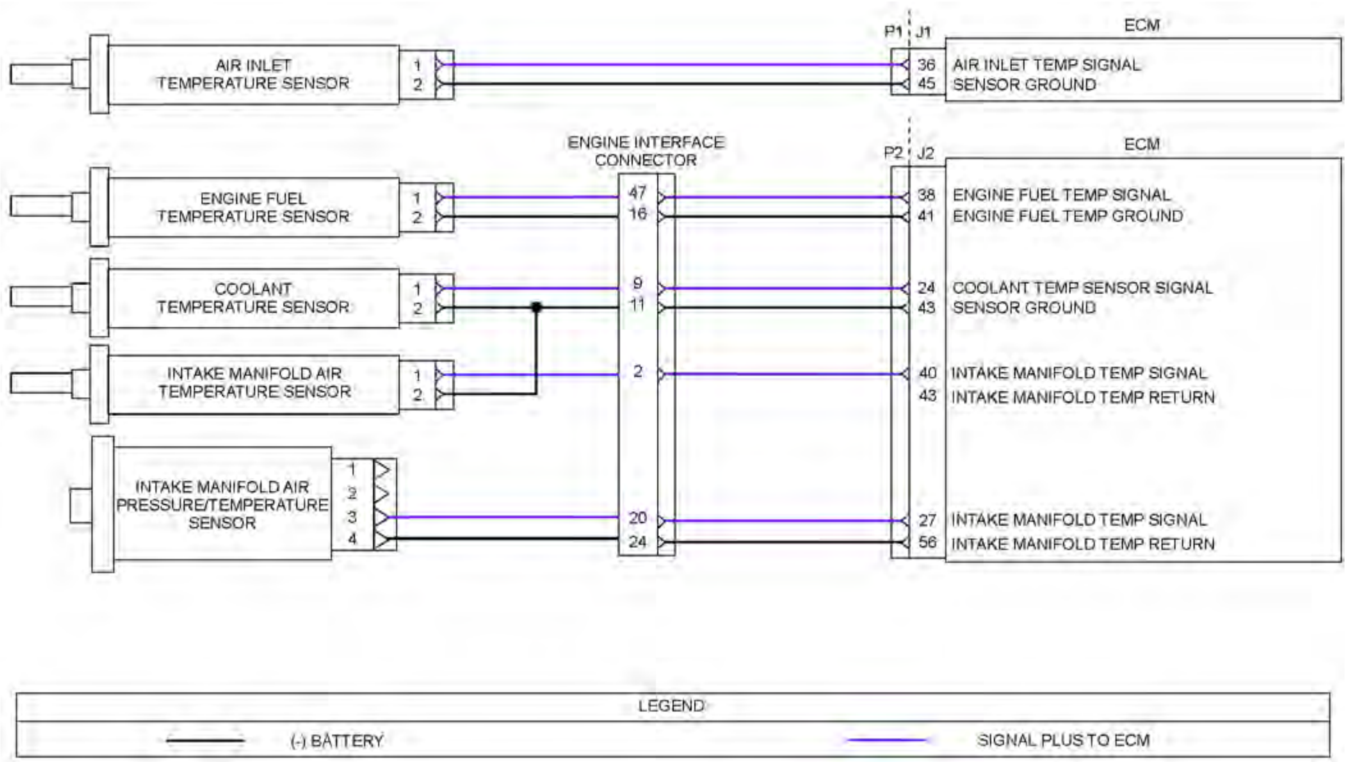


Illustration 28

g06458003

Schematic diagram for the engine temperature sensors

Table 120

Troubleshooting Test Steps	Values	Results
1. Download Information Using the Electronic Service Tool **A.** Use the electronic service tool to download the “Product Status Report” (PSR) with histograms before performing any troubleshooting or clearing any diagnostic codes. **Note:** The downloaded information will be required by the Dealer Solutions Network (DSN) if troubleshooting assistance is required.	Downloaded information	**Result:** The information was successfully saved. Proceed to Test Step 2. **Result:** The electronic service tool information was not successfully saved. Contact the Dealer Solutions Network (DSN) for guidance.
2. Create an Electronic Service Tool Snapshot (only applicable to 174–3 and 174–4 diagnostic codes) **A.** Select “Snapshot Viewer” on the electronic service tool, using menus: Information -> Snapshot -> Viewer **B.** Select the event code and then click “View Graph” . **C.** Select the following parameter and then click OK. · Engine Speed **D.** Select Save to "File to save" a Snapshot File (*.xml). This file will contain all the data in the snapshot and not only the data shown on the graph. **Note:** The downloaded information will be required by the DSN if troubleshooting assistance is required.	Snapshot saved	**Result:** The electronic service tool snapshot was successfully saved. Proceed to Test Step 3. **Result:** The electronic service tool snapshot was not successfully saved. Contact the DSN for guidance.
3. Check for Diagnostic Trouble Codes **A.** Connect to the electronic service tool. **B.** Turn the keyswitch to the ON position. **C.** Access the “Active Diagnostic Code” screen on the electronic service tool. **Wait at least 30 seconds in order for the diagnostic codes to become active.** **D.** Look for one of the diagnostic codes that are listed in Table 119 .	Codes	**Result:** A -3 diagnostic code is active. Proceed to Test Step 4. **Result:** A -4 diagnostic code is active. Proceed to Test Step 7. **Result:** For a diagnostic code that is **logged** but not currently active, Proceed to Test Step 10.

(continued)

(Table 120, contd)

Troubleshooting Test Steps	Values	Results
4. Create a Short at the Sensor Connector **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the suspect sensor. **C.** Use a jumper wire to create a short between the signal terminal and the ground terminal at the sensor connector. **D.** Turn the keyswitch to the ON position. **E.** Monitor the diagnostic codes on the electronic service tool. Check for an active -4 diagnostic code for the suspect sensor. **Wait at least 30 seconds in order for the diagnostic codes to become active.** **F.** Turn the keyswitch to the OFF position.	Short Circuit Recognized	**Result:** A -4 diagnostic code became active after creating the short at the sensor connector. **Repair:** The wiring is OK. Replace the sensor. Verify that the problem is resolved. **Result:** The -3 diagnostic code remains active for the suspect sensor. **Repair:** Proceed to Test Step 5.
5. Create a Short Circuit at the Engine Interface Connector **Note:** This Test Step is not applicable to the air inlet temperature sensor. If the suspect sensor is the air inlet temperature sensor, proceed to Test Step 6. **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the engine interface connector. **C.** Use a jumper wire to create a short between the signal terminal and the ground terminal at the engine interface connector. **D.** Turn the keyswitch to the ON position. **E.** Monitor the diagnostic codes on the electronic service tool. Check for an active -4 diagnostic code for the suspect sensor. **Note:** Diagnostic codes for all the engine sensors will be active with the engine interface connector disconnected. Disregard the other diagnostic codes. Only look for codes for the suspect sensor. **F.** Turn the keyswitch to the OFF position.	Short created	**Result:** A -4 diagnostic code became active after creating the short at the engine interface connector. **Repair:** The fault is in the engine wiring harness. Repair the harness or replace the harness. Verify that the problem is resolved. **Result:** A -4 diagnostic code does not become active for the suspect sensor. Proceed to Test Step 6.

(continued)

(Table 120, contd)

Troubleshooting Test Steps	Values	Results
6. Check the Wiring to the ECM for an Open Circuit **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the engine interface connector. Disconnect the P1/P2 connector from the ECM. Refer to Illustration 28 for the correct connector. **Note:** If the suspect sensor is the air inlet temperature sensor, disconnect the P1 connector and the sensor connector. **C.** Thoroughly inspect the P1/J1 or P2/J2 ECM connectors. Refer to Troubleshooting, Electrical Connectors - Inspect. **D.** Use a suitable multimeter to measure the resistance between the sensor signal terminal on the engine interface connector and the sensor signal terminal on the P1/P2 connector. **Note:** For the air inlet temperature sensor, measure the resistance between terminal 1 on the sensor connector and P1:36.	Less than 2 Ohms	**Result:** The resistance is greater than 2 Ohms - There is a fault in the wiring to the P1/P2 connector. **Repair:** Repair the faulty wiring or replace the faulty wiring. Verify that the repair eliminates the fault. **Result:** All measured resistances are less than 2 Ohms. Proceed to Test Step 10.
7. Create an Open at the Suspect Sensor Connector **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the sensor connector of the suspect sensor with the active -4 diagnostic code. **C.** Turn the keyswitch to the ON position. **D.** Monitor the diagnostic codes on the electronic service tool. Check for an active -3 diagnostic code for the suspect sensor. **Wait at least 30 seconds in order for the diagnostic codes to become active.** **· For a 110-3 code, start the engine and let the engine idle for 7 minutes. The engine must be running for at least 7 minutes in order for the diagnostic to run.** **E.** Turn the keyswitch to the OFF position.	Open Circuit Recognized	**Result:** A -3 diagnostic code became active after disconnecting the sensor. **Repair:** The wiring is OK. Replace the sensor. Verify that the problem is resolved. **Result:** The -4 or diagnostic code remains active for the suspect sensor. **Repair:** Proceed to Test Step 8.

(continued)

(Table 120, contd)

Troubleshooting Test Steps	Values	Results
8. Create an Open Circuit at the Engine Interface Connector **Note:** This Test Step is not applicable to the air inlet temperature sensor. If the suspect sensor is the air inlet temperature sensor, proceed to Test Step 9. **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the engine interface connector. **C.** Turn the keyswitch to the ON position. **D.** Monitor the diagnostic codes on the electronic service tool. Check for an active -3 diagnostic code for the suspect sensor. **Note:** Diagnostic codes for all the engine sensors will be active with the engine interface connector disconnected. Disregard the other diagnostic codes. Only look for codes for the suspect sensor. **E.** Turn the keyswitch to the OFF position.	Create an Open	**Result:** A -3 diagnostic code became active for the suspect sensor after disconnecting the engine interface connector. **Repair:** The fault is in the engine wiring harness. Repair the engine wiring harness or replace the engine wiring harness. Verify that the problem is resolved. **Result:** A -3 diagnostic code did not become active after disconnecting the engine interface connector. Proceed to Test Step 9.
9. Check the Wiring to the ECM for a Short Circuit **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the engine interface connector. Disconnect the P1/P2 connector from the ECM. Refer to Illustration 28 for the correct connector. **C.** Thoroughly inspect the P1/J1 or P2/J2 ECM connectors. Refer to Troubleshooting, Electrical Connectors - Inspect. **D.** Use a suitable multimeter to measure the resistance between the suspect signal terminal on the engine interface connector (ECM side) and all other terminals on the engine interface connector. **Note:** For the air inlet temperature sensor, measure the resistance between P1:36 and all other terminals on the P1 connector.	Greater than 1k Ohm	**Result:** At least one of the resistance measurements is less than 1 k Ohm. The fault is in the wiring connected to the ECM connector. **Repair:** Repair the faulty wiring or replace the faulty wiring. **Result:** All resistance measurements are greater than 1 k Ohm. Proceed to Test Step 10.

(continued)

(Table 120, contd)

Troubleshooting Test Steps	Values	Results
10. Perform the Wiggle Test Carefully following this procedure is the best way to identify the root cause of an intermittent problem. **A.** Turn the keyswitch to the ON position. **B.** Use the electronic service tool to run the “Wiggle Test” . **C.** Slowly wiggle the wiring and the connectors between the P2 connector and the sensor. Slowly wiggle the wiring and the connectors between the P1 connector and the sensor. Pay particular attention to the wiring near each connector. Be sure to wiggle all the wiring. **D.** As you wiggle the wiring look for these problems. **1.** Loose connectors or damaged connectors **2.** Moisture on the connectors or the wiring **3.** Damage that is caused by excessive heat **4.** Damage that is caused by chafing **5.** Improper routing of wiring **6.** Damaged insulation	Wiggle test	**Result:** The wiring failed the Wiggle Test. **Repair:** There is a problem with the wiring. Repair the wiring or replace the wiring. Verify that the problem is resolved. **Result:** The wiring passed the Wiggle Test. **Repair:** The problem may be intermittent. Inspect the wiring. Refer to Troubleshooting, “Electrical Connectors - Inspect”. If the wiring looks OK, perform the following procedure. **1.** Turn the keyswitch to the OFF position. **2.** Disconnect the connectors. Carefully inspect the terminals for proper installation. Make sure that each terminal is clean and dry. **3.** Insert a pin into each socket. Verify that each socket grips the pin firmly. Repair any problems. **4.** Connect all connectors. **5.** Verify that the problem is resolved. **6.** Return the unit to service.
If the procedure did not correct the fault, contact the Dealer Solutions Network (DSN).		

i08391531

Sensor Supply - Test

This procedure covers the following diagnostic codes:

Table 121

Diagnostic Trouble Codes for Sensor Supplies		
J1939 Code	Code Description	Comments
3509-3	Sensor Supply Voltage 1 : Voltage Above Normal	The Electronic Control Module (ECM) detects the following conditions: The 5 VDC supply for the sensors is greater than 5.16 VDC for more than 2 seconds. There are no active battery supply faults. The warning lamp will come on. The ECM sets all the sensors on the 5 VDC circuit to the default values. The engine will be derated.
3510-3	Sensor Supply Voltage 2 : Voltage Above Normal	
3509-4	Sensor Supply Voltage 1 : Voltage Below Normal	The ECM detects the following conditions: The 5 VDC supply for the sensors is less than 4.84 VDC for more than 2 seconds. There are no active battery supply faults. The warning lamp will come on. The ECM sets all the sensors on the 5 VDC circuit to the default values. The engine will be derated.
3510-4	Sensor Supply Voltage 2 : Voltage Below Normal	

Note: A 3509 diagnostic code indicates a fault in the 5 VDC circuit on J1:46, J2:62, J2:63, J2:64, J2:72, J2:73 or J2:74. A 3510 diagnostic code indicates a fault in the 5 VDC circuit on J1:39, J1:40, J2:65, J2:66, J2:67, or J2:68.

The following background information is related to this procedure:

The ECM supplies regulated +5 VDC to the following sensors. A 3510 diagnostic code will become active if a fault is detected on this circuit:

- Intake manifold air pressure sensor
- Fuel pressure sensor
- DPF intake and differential pressure sensor
- Primary speed/timing sensor (crank)
- Aftertreatment temperature sensor
- Coolant level switch (if equipped)
- Auxiliary pressure sensor (if equipped)
- Analog accel pedal #2 position (if equipped)

The ECM supplies regulated +5 VDC to the following sensors. A 3509 diagnostic code will become active if a fault is detected on this circuit:

- Intake throttle valve position sensor
- NRS valve position sensor
- Secondary speed/timing sensor (cam)
- Fan speed sensor (if equipped)
- Analog accel pedal #1 position (if equipped)

A diagnostic code can be caused by the following conditions:

- A short circuit in the harness
- A faulty sensor
- An open circuit in the harness

Note: Refer to the Electrical Schematic for the application for wiring information regarding components that are connected to the 5 V supplies.

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

Table 122

Troubleshooting Test Steps	Values	Results
1. Determine the Code **A.** Connect the electronic service tool to the service tool connector. Refer to Troubleshooting, “Electronic Service Tools”, if necessary. **B.** Turn the keyswitch to the ON position. **C.** Determine if a diagnostic trouble code is present.	Diagnostic Codes	**Result:** A -3 or -4 code is present. Note which sensor supply has the active diagnostic code. Proceed to Test Step 2.
2. Check for a Failed Sensor **A.** Connect to the electronic service tool. **B.** Turn the keyswitch to the ON position. **C.** Disconnect a sensor on the suspect sensor supply circuit. **D.** Monitor the electronic service tool when the sensor is disconnected to see if the active code changes to logged. **E.** Connect the suspect sensor to the wiring harness **F.** Repeat steps C through E for each sensor on the suspect sensor supply. Refer to Troubleshooting, Component Location for the locations of the sensors on the engine.	Failed Sensor	**Result:** The suspect sensor supply active code changes to logged when a sensor is unplugged. **Repair:** Replace the failed sensor. Verify that the repair resolved the problem. **Result:** The suspect sensor supply active code remains active after all sensors on the sensor supply circuit have been checked. **Repair:** A failed wiring harness has been detected. Repair or replace the wiring harness. Verify that the repair resolved the problem.
If the procedure did not correct the fault, contact the Dealer Solutions Network (DSN).		

i07818803

Speed Control (Analog) - Test

This procedure covers the following diagnostic codes:

Table 123

<table>
<tr><th colspan="3">Diagnostic Trouble Codes for Analog Throttles</th></tr>
<tr><th>J1939 Code</th><th>Code Description</th><th>Comments</th></tr>
<tr><td>91-3</td><td>Accelerator Pedal Position 1 : Voltage Above Normal</td><td rowspan="2">The Electronic Control Module (ECM) detects one of the following conditions:

The ECM has been powered for 3 seconds.

Diagnostic code 168-4 is not active.

3509 codes are not active.

The setting for the upper diagnostic limit has been exceeded for one second.

If equipped, the warning lamp will come on. The diagnostic code will be logged.</td></tr>
<tr><td>29-3</td><td>Accelerator Pedal Position 2: Voltage Above Normal</td></tr>
</table>

(continued)

(Table 123, contd)

Diagnostic Trouble Codes for Analog Throttles		
J1939 Code	Code Description	Comments
91-4	Accelerator Pedal Position 1 : Voltage Below Normal	The ECM detects one of the following conditions: The ECM has been powered for 3 seconds. Diagnostic code 168-4 is not active. 3510 codes are not active. The setting for the lower diagnostic limit has been exceeded for one second. If equipped, the warning lamp will come on. The diagnostic code will be logged.
29-4	Accelerator Pedal Position 2: Voltage Below Normal	
Follow the troubleshooting procedure to identify the root cause of the fault.		

If a fault occurs with the primary throttle with secondary throttle is installed, the secondary throttle will be used until the fault is repaired.

If a fault occurs with the secondary throttle, the engine will use the primary throttle until the fault is repaired.

If a functional throttle is not available, the following conditions will occur:

- The engine will default to the limp home speed.
- If the engine speed is higher than the limp home speed, the engine will decelerate to the limp home speed.
- If the engine speed is lower than the limp home speed, the engine speed will remain at the current speed.
- The engine will remain at this speed while the diagnostic code remains active.
- All inputs from the faulty throttle are ignored by the ECM until the fault is repaired.
- All inputs from the repaired throttle will be ignored by the ECM until the keyswitch has been cycled.

The diagnostic codes above relate to an analog sensor. Use this procedure only if the analog sensor uses an output from a variable resistor.

The sensor is most likely to be mounted on a throttle pedal. The sensor is attached directly to the throttle assembly. The sensor provides an output voltage to the ECM. The sensor output voltage will vary with the position of the throttle. Foot operated or hand operated throttle assemblies are available.

The sensor receives +5 VDC power from the ECM. The sensor will produce a raw signal voltage that will alter between low idle and high idle. The voltage is changed into a throttle position within the range 0% to 100% by the ECM.

The sensor senses the speed requirement from the throttle position. A second sensor may override this speed requirement from the first sensor. This override will be subject to an input from a secondary throttle or from the SAE J1939 (CAN) data link or from a PTO control.

Use the electronic service tool to check the input status.

Note: The identification letters for the terminals in the connectors may vary dependent on the manufacturer of the throttle pedal.

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

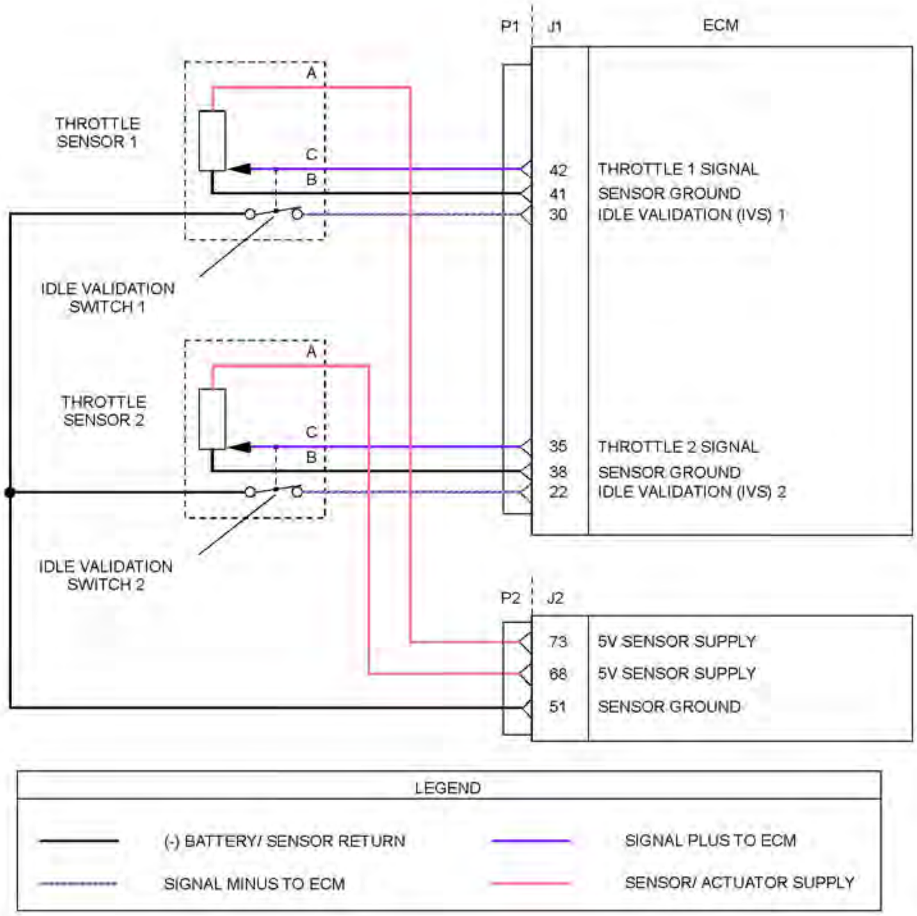


Illustration 29 g06445590

Schematic of the analog throttle position sensor circuit.

Note: All connectors may not be shown. Refer to the Electrical Schematic for the application for details of any connectors between the line heater connectors and the ECM connectors.

Table 124

Troubleshooting Test Steps	Values	Results
1. Inspect Electrical Connectors and Wiring **A.** Thoroughly inspect the terminal connections on the analog throttle position sensors and any interface connectors between the sensors and the ECM. Refer to Troubleshooting, "Electrical Connector - Inspect". **B.** Perform a 30 N (6.7 lb) pull test on each of the wires that are associated with the active diagnostic code in the analog throttle position sensor connectors and the interface connectors . **C.** Check the harness for corrosion, abrasion, and pinch points from the analog throttle position sensors to the ECM. **Note:** Do not disconnect the ECM connector at this stage. The ECM can only be disconnected and reconnected 10 times before damage to the harness connector may occur.	Loose connection or damaged wire	**Result:** There is a fault in a connector or the wiring. **Repair:** Repair any faulty connectors or replace the wiring harness. Ensure that all the seals are properly in place and ensure that the connectors are correctly coupled. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault. **Result:** All connectors, pins, and sockets are correctly coupled and/or inserted. The harness is free of corrosion, abrasion, and pinch points. Proceed to Test Step 2.
2. Check for Active Diagnostic Codes **A.** Turn the keyswitch to the OFF position. **B.** Connect the electronic service tool to the diagnostic connector. **C.** Turn the keyswitch to the ON position. Wait at least 10 seconds for activation of the diagnostic codes. **D.** Verify if any of the diagnostic codes that are listed in Table 123 are active. **E.** Turn the keyswitch to the OFF position.	Diagnostic codes	**Result:** There are no active diagnostic codes for the analog throttle position sensors. Proceed to Test Step 3. **Result:** One or more of the diagnostic codes listed in Table 123 is active. Proceed to Test Step 5.
3. Check the Throttle Position with the Electronic Service Tool **A.** Connect the electronic service tool to the diagnostic connector. **B.** Turn the keyswitch to the ON position. Do not start the engine. **C.** Observe the throttle position reading on the electronic service tool. **D.** Operate the throttle over the full range of movement.	20 percent to 27 percent at low idle. 80 percent to 87 percent at high idle	**Result:** The ECM is not receiving the correct signal from the sensor. **Repair:** Use the electronic service tool to verify that the throttle has been configured correctly before continuing with this procedure. If the fault is still present after the throttle has been configured correctly, replace the analog throttle position sensor. **Result:** The sensor is operating correctly. Proceed to Test Step 4.

(continued)

(Table 124, contd)

Troubleshooting Test Steps	Values	Results
4. Check the Throttle Selection Status with the Electronic Service Tool **A.** Check the status of the throttle selection switch (if equipped). Use the electronic service tool to check the status of the throttle selection switch.	Throttle 1 has control when status is "OFF" . Throttle 2 has control when status is ON.	**Result:** The throttle section switch is operating correctly. Return the engine to service. If an intermittent fault exists, refer to Troubleshooting, "Electrical Connector - Inspect" **Result:** The wrong throttle is selected. **Repair:** Switch to the other throttle. There may be a fault with the selector switch input. Check the connections between the throttle selection switch and the P1 connector. Refer to Troubleshooting, "Electrical Connector - Inspect".
5. Check the Sensor Supply Voltage **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the connector for the suspect throttle position sensor. **C.** Turn the keyswitch to the ON position. **D.** Measure the voltage between the 5 VDC terminal and the ground terminal on the harness connector for the sensor.	4.84 VDC to 5.16 VDC	**Result:** The correct supply voltage is not reaching the sensor. The fault is in the 5 VDC supply wire or the ground wire between the suspect throttle position sensor and the P1 connector. **Repair:** Repair the faulty wiring or replace the faulty wiring. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault. **Result:** The supply voltage is reaching the sensor. Proceed to Test Step 6.
6. Verify the Type of Active Diagnostic Code **A.** Turn the keyswitch to the ON position. Wait at least 10 seconds for activation of the diagnostic codes. **B.** Use the electronic service tool to check for active diagnostic codes that are listed in Table 123 . Record all active diagnostic codes.	Diagnostic codes	**Result:** A -3 diagnostic code is active. Proceed to Test Step 7. **Result:** A -4 diagnostic code is active. Proceed to Test Step 10. **Result:** There are no active diagnostic codes for the throttle position sensors - The fault may be intermittent. **Repair:** Refer to Troubleshooting, "Electrical Connector - Inspect".

(continued)

(Table 124, contd)

Troubleshooting Test Steps	Values	Results
7. Create a Short Circuit at the Sensor Connector **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the throttle position sensor with the -3 diagnostic code. **C.** Fabricate a jumper wire. Install the jumper wire between the sensor signal terminal and the ground terminal on the harness connector for the throttle position sensor. **D.** Turn the keyswitch to the ON position. **E.** Access the “Active Diagnostic Codes” screen on the electronic service tool. Look for an active -4 diagnostic code for the suspect sensor. **F.** Turn the keyswitch to the OFF position. **G.** Remove the jumper wire.	Diagnostic codes	**Result:** An -3 diagnostic code was active before the jumper was installed. An -4 diagnostic code is active with the jumper installed. **Repair:** Install a replacement analog throttle position sensor. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault. **Result:** The -3 diagnostic code remains active with the jumper installed. Proceed to Test Step 8.
8. Check the Wiring Between the Throttle Position Sensor and the Interface Connector (if equipped) for an Open Circuit **Note:** This step is only applicable if an interface connector is installed between the throttle position sensors and the ECM. Refer to the Electrical Schematic for the application for more information. Proceed to Test Step 9if no interface connector is installed. **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the connector for the suspect throttle position sensor. Disconnect the interface connector between the throttle sensor and the ECM. **C.** Use a suitable multimeter to measure the resistance between the sensor signal terminal on the sensor connector and the sensor signal terminal on the interface connector.	Less than 2 Ohms	**Result:** The resistance is greater than 2 Ohms - There is a fault in the wiring between the throttle position sensor connector and the interface connector. **Repair:** Repair the faulty wiring or replace the faulty wiring. **Result:** All measured resistances are less than 2 Ohms. Reconnect all connectors. Proceed to Test Step 9.
9. Check the Sensor Signal Wire for an Open Circuit **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the suspect throttle position sensor. Disconnect the P1 connector from the ECM. Thoroughly inspect the P1/J1 connectors for corrosion or damage. Refer to Troubleshooting, Electrical Connectors - Inspect. **C.** Measure the resistance between the sensor signal terminal on the harness connector and the appropriate sensor signal terminal on the P1 connector.	Less than 2 Ohms	**Result:** The resistance measurement is greater than 2 Ohms - There is an open circuit or high resistance in the sensor signal wire. **Repair:** Repair the faulty wiring or replace the faulty wiring. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault. **Result:** The resistance measurement is less than 2 Ohms. Contact the Dealer Solutions Network (DSN).

(continued)

(Table 124, contd)

Troubleshooting Test Steps	Values	Results
10. Create an Open Circuit at the Sensor Connector **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the throttle position sensor with the -4 diagnostic code. **C.** Turn the keyswitch to the ON position. Wait for at least 10 seconds for activation of the diagnostic codes. **D.** Use the electronic service tool to check the “Active Diagnostic Codes” screen on the electronic service tool. Check for an -3 diagnostic code. **E.** Turn the keyswitch to the OFF position.	Diagnostic codes	**Result:** An -4 diagnostic code was active before disconnecting the sensor. An -3 diagnostic code is active with the sensor disconnected. **Repair:** Install a replacement analog throttle position sensor. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault. **Result:** The -4 diagnostic code is still active with the sensor disconnected. Proceed to Test Step 11.
11. Check the Wiring Between the Throttle Position Sensor and the Interface Connector (if equipped) for a Short Circuit **Note:** This step is only applicable if an interface connector is installed between the throttle position sensors and the ECM. Refer to the Electrical Schematic for the application for more information. Proceed to Test Step 12 if no interface connector is installed. **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the connector for the suspect throttle position sensor. Disconnect the interface connector between the throttle position sensors and the ECM. **C.** Use a suitable multimeter to measure the resistance between the suspect sensor signal terminal on the interface connector and all other terminals on the interface connector.	Greater than 1 k Ohm	**Result:** At least one of the resistance measurements is less than 1 k Ohm. There is a fault in the wiring between the throttle position sensor connector and the interface connector. **Repair:** Repair the faulty wiring or replace the faulty wiring. **Result:** All measured resistances are greater than 1 k Ohm. Reconnect all connectors. Proceed to Test Step 12.
12. Check the Sensor Signal Wire for a Short Circuit **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the suspect throttle position sensor. Disconnect the P1 connector from the ECM. **C.** Measure the resistance between the suspect sensor signal terminal and all other terminals on the P1 connector.	Greater than 1k Ohm	**Result:** At least one of the resistance measurements is less than 1k Ohm - There is a short in the wiring harness. **Repair:** Repair the faulty wiring or replace the faulty wiring. **Result:** All resistance measurements are greater than 1k Ohm. Contact the Dealer Solutions Network (DSN).

i07819415

Speed Control (PWM) - Test

Use this procedure if the digital throttle position sensor is suspected of incorrect operation. This procedure also covers the following diagnostic codes:

Table 125

Diagnostic Trouble Codes for the Digital Throttles		
J1939 Code	Code Description	Comments
29-3	Accelerator Pedal Position 2 : Voltage Above Normal	The Electronic Control Module (ECM) detects the following conditions: The ECM has been powered for 3 seconds. Diagnostic code 168-4 is not active. The setting for the upper diagnostic limit has been exceeded for one second. If equipped, the warning lamp will come on. The diagnostic code will be logged.
29-4	Accelerator Pedal Position 2 : Voltage Below Normal	The ECM detects the following conditions: The ECM has been powered for 3 seconds. Diagnostic code 168-4 is not active. The setting for the lower diagnostic limit has been exceeded for one second. If equipped, the warning lamp will come on. The diagnostic code will be logged.
29-8	Accelerator Pedal Position 2 : Abnormal Frequency, Pulse Width, or Period	The ECM detects the following conditions: The signal frequency from the digital throttle position sensor is equal to 0% or 100% for more than 2 seconds. The ECM has been powered for at least 3 seconds. Diagnostic codes 29-3 and 29-4 are not active. The ECM sets the Throttle Position to “0%” . If equipped, the warning lamp will come on. The diagnostic code will be logged if the engine is running. The diagnostic code will not be logged if the engine is cranking.
91-3	Accelerator Pedal Position 1 : Voltage Above Normal	The Electronic Control Module (ECM) detects the following conditions: The ECM has been powered for 3 seconds. Diagnostic code 168-4 is not active. The setting for the upper diagnostic limit has been exceeded for one second. If equipped, the warning lamp will come on. The diagnostic code will be logged.

(continued)

(Table 125, contd)

Diagnostic Trouble Codes for the Digital Throttles		
J1939 Code	**Code Description**	**Comments**
91-4	Accelerator Pedal Position 1 : Voltage Below Normal	The ECM detects the following conditions: The ECM has been powered for 3 seconds. Diagnostic code 168-4 is not active. The setting for the lower diagnostic limit has been exceeded for one second. If equipped, the warning lamp will come on. The diagnostic code will be logged.
91-8	Accelerator Pedal Position 1 : Abnormal Frequency, Pulse Width, or Period	The ECM detects the following conditions: The signal frequency from the digital throttle position sensor is equal to 0% or 100% for more than 2 seconds. The ECM has been powered for at least 3 seconds. Diagnostic codes 91-3 and 91-4 are not active. The ECM sets the Throttle Position to “0%” . If equipped, the warning lamp will come on. The diagnostic code will be logged if the engine is running. The diagnostic code will not be logged if the engine is cranking.
Follow the troubleshooting procedure to identify the root cause of the fault.		

If a fault occurs with the primary throttle, the engine will use the secondary throttle until the fault is repaired.

If a fault occurs with the secondary throttle, the engine will use the primary throttle until the fault is repaired.

If a functional throttle is not available, the following conditions will occur:

- The engine will default to the limp home speed.
- If the engine speed is higher than the limp home speed, the engine will decelerate to the limp home speed.
- If the engine speed is lower than the limp home speed, the engine speed will remain at the current speed.
- The engine will remain at this speed while the diagnostic code remains active.
- All inputs from the faulty throttle are ignored by the ECM until the fault is repaired.
- All inputs from the repaired throttle will be ignored by the ECM until the keyswitch has been cycled.

Digital Throttle Position Sensor

The digital throttle position sensor is used to provide a digital throttle position signal to the ECM. The sensor output is a constant frequency signal with a pulse width that varies with the throttle position. This output signal is referred to as either a duty cycle or a pulse width modulated signal (PWM). This output signal is expressed as a percentage between 0 and 100 percent.

The digital throttle position sensor is most likely to be attached directly to the throttle assembly. The digital throttle position sensor requires no adjustment.

The duty cycle at low idle and the duty cycle at high idle can vary depending on the application. The percent of duty cycle is translated in the ECM into a throttle position of 3 to 100 percent.

The digital throttle position sensors are powered by +8 VDC from the ECM. The supply voltage is from J1: to the digital throttle position sensor connector.

If the application is using the ECM dedicated PTO functions, the digital throttle position sensor will be ignored while the engine is in PTO mode.

The ECM is in PTO mode if the PTO ON/OFF Switch is ON. This status can be checked with the electronic service tool. Refer to Troubleshooting, “Power Take-Off - Test” for testing if the PTO is being used.

Note: The identification letters for the terminals in the connectors may vary dependent on the manufacturer of the throttle pedal.

During the following procedure, refer to the electrical schematic for the application.

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

Table 126

Troubleshooting Test Steps	Values	Results
1. Inspect Electrical Connectors and Wiring **A.** Thoroughly inspect the terminal connections on the P1/J1 and P2/J2 ECM connectors and the PWM throttle position sensors. Refer to Troubleshooting, "Electrical Connector - Inspect". **B.** Perform a 30 N (6.7 lb) pull test on each of the wires in the ECM connector and the PWM throttle position sensor connector. **C.** Check the harness for corrosion, abrasion, and pinch points from the PWM throttle position sensor to the ECM.	Loose connection or damaged wire	**Result:** There is a fault in a connector or the wiring. **Repair:** Repair any faulty connectors or replace the wiring harness. Ensure that all the seals are properly in place and ensure that the connectors are correctly coupled. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault. **Result:** All connectors, pins, and sockets are correctly coupled and/or inserted. The harness is free of corrosion, abrasion, and pinch points. Proceed to Test Step 2.
2. Check for Active Diagnostic Codes **A.** Turn the keyswitch to the OFF position. **B.** Connect the electronic service tool to the diagnostic connector. **C.** Turn the keyswitch to the ON position. Wait at least 10 seconds for activation of the diagnostic codes. **D.** Verify if any of the diagnostic codes that are listed in Table 125 are active. **Note:** When the ECM calibrates new duty cycle values for the low and the high idle throttle position, the ECM assumes the initial lower position for the duty cycle at low idle and the initial upper position for the duty cycle at high idle. The initial lower position and the initial upper position can be obtained by accessing the following screens on the electronic service tool: · Service · Throttle Configuration · "Throttle# 1" As a result, the throttle position status may reach 100 percent well before the throttle pedal is fully depressed. This situation is normal. Cycle the throttle to the high idle position several times for the ECM to adjust the calibration automatically. During normal operation, more movement of the throttle can be required for the throttle position status to increase above 3 percent. The status may reach the 100 percent value prior to the limit of the high idle position. This process is done to ensure that the throttle reaches these two critical points for engine operation. **E.** Turn the keyswitch to the OFF position.	Diagnostic codes	**Result:** At least one of the diagnostic codes listed in Table 125 is active. Proceed to Test Step 4. **Result:** None of the preceding diagnostic codes are active or recently logged - There may be an intermittent fault. **Repair:** Refer to Troubleshooting, "Electrical Connector - Inspect" to identify intermittent faults. If the fault is still present, proceed to Test Step 3.

(continued)

(Table 126, contd)

Troubleshooting Test Steps	Values	Results
3. Check the Duty Cycle of the Digital Throttle Position Sensor **A.** Access the following screens on the electronic service tool to check the upper and the lower diagnostic limit of the throttle position sensors: · "Service" · "Throttle Configuration" · "Throttle# 1" **B.** Make a note of the lower diagnostic limit and the upper diagnostic limit. **C.** Verify that the keyswitch is in the ON position. **D.** Access the following screens on the electronic service tool to monitor the duty cycle of the throttle position: · "Status" · "Throttles" **E.** Monitor the duty cycle of the throttle at the "low idle" position and the "high idle" position.	Duty cycle above lower diagnostic limit at low idle Duty cycle below upper diagnostic limit at high idle	**Result:** OK - The digital throttle position sensor is operating correctly. Return the engine to service. **Result:** Not OK - The digital throttle position sensor circuit is not operating correctly. Proceed to Test Step 4.
4. Check the Supply Voltage at the Digital Throttle Position Sensor **A.** Turn the keyswitch to the OFF position. **B.** Install a breakout "T" with three terminals at the suspect digital throttle position sensor connector. **C.** Turn the keyswitch to the ON position. **D.** Measure the voltage between the +8 VDC terminal and the sensor return terminal.	7.5 VDC to 8.5 VDC	**Result:** The sensor supply voltage is not within the expected range. The fault is in the sensor supply wiring or the ground wiring between the sensor and the ECM. **Repair:** Repair the faulty wiring or replace the faulty wiring. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault. **Result:** The sensor supply voltage is within the expected range. Proceed to Test Step 5.

(continued)

(Table 126, contd)

Troubleshooting Test Steps	Values	Results
5. Check the Duty Cycle of the Throttle Position Sensor at the Sensor **Note:** Performing certain steps within this procedure requires the use of a multimeter that can measure a PWM duty cycle. **A.** Access the following screens on the electronic service tool to check the upper and the lower diagnostic limit of the suspect throttle position sensors: · "Service" · "Throttle Configuration" · "Throttle# 1" **B.** Make a note of the lower diagnostic limit and the upper diagnostic limit. **C.** Turn the keyswitch to the OFF position. **D.** Remove the signal wire for the suspect digital throttle position sensor from the connector. Refer to the Electrical Schematic for the application. **E.** Install a breakout "T" with three terminals at the digital throttle position sensor connector. **F.** Connect the multimeter probes to the sensor signal terminal and the sensor ground terminal of the breakout T. **G.** Turn the keyswitch to the ON position. **H.** While the duty cycle is being monitored on the multimeter, operate the throttle through the full range of movement.	Duty cycle above lower diagnostic limit at low idle Duty cycle below upper diagnostic limit at high idle	**Result:** Not OK. **Repair:** Replace the suspect digital throttle position sensor. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault. **Result:** OK. Proceed to Test Step 6.
6. Bypass the Signal Wire **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the suspect digital throttle position sensor connector. Disconnect the P1/P2 connector from the ECM. **C.** Remove the sensor signal wire from the connector for the suspect digital throttle position sensor. Remove the applicable signal wire from P1/P2. **D.** Install the jumper wire between P1/P2 and the signal terminal on the suspect throttle sensor connector. **E.** Access the following screens on the electronic service tool to check the upper and the lower diagnostic limit of the throttle position sensor: · "Service" · "Throttle Configuration" · "Throttle# 1" **F.** Make a note of the lower diagnostic limit and the upper diagnostic limit.	Duty cycle above lower diagnostic limit at low idle Duty cycle below upper diagnostic limit at high idle	**Result:** OK - The throttle operates correctly with the bypass installed. The fault is in the sensor signal wiring. **Repair:** Repair the faulty wiring or replace the faulty wiring. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault. **Result:** Not OK **Repair:** Recheck the wiring, the ECM connectors, and the digital throttle position sensor connector. If no faults are found, contact the Dealer Solutions Network (DSN).

(continued)

(Table 126, contd)

Troubleshooting Test Steps	Values	Results
G. Turn the keyswitch to the ON position. **H.** Check the duty cycle of the position sensor on the electronic service tool while the digital throttle is being moved over the full range.		

i07853906

Speed/Timing - Test

Use this procedure to troubleshoot the electrical system if a problem is suspected with the primary engine speed/timing sensor. Also use this procedure if a problem is suspected with the secondary engine speed/timing sensor. Use this procedure to troubleshoot the electrical system if a diagnostic code in Table 127 is active or easily repeated.

Table 127

Diagnostic Trouble Codes for the Speed/Timing Sensors		
J1939 Code	**Code Description**	**Comments**
190-8	Engine Speed Sensor : Abnormal Frequency, Pulse Width, or Period	The code is logged. The Electronic Control Module (ECM) can default to the secondary engine speed/timing sensor. The default will occur if a valid signal is not received from the primary engine speed/timing sensor. The engine will shut down only if the signals from the primary engine speed/timing sensor and the secondary engine speed/timing sensor are abnormal.
723-8	Engine Speed Sensor #2 : Abnormal Frequency, Pulse Width, or Period	The code is logged. If a valid signal is not received from the secondary engine speed/timing sensor, the ECM will default to the primary engine speed/timing sensor. The engine will shut down only if the signals from the primary engine speed/timing sensor and the secondary engine speed/timing sensor are abnormal.
637–11	Engine Timing Sensor : Other Failure Mode	The Electronic Control Module (ECM) detects the following conditions: The outputs from the primary speed/timing sensor and the secondary speed/timing sensor differ by more than 8 degrees of crankshaft rotation. The engine has been running for more than 5 seconds. The warning light will come on. This code will not be logged.

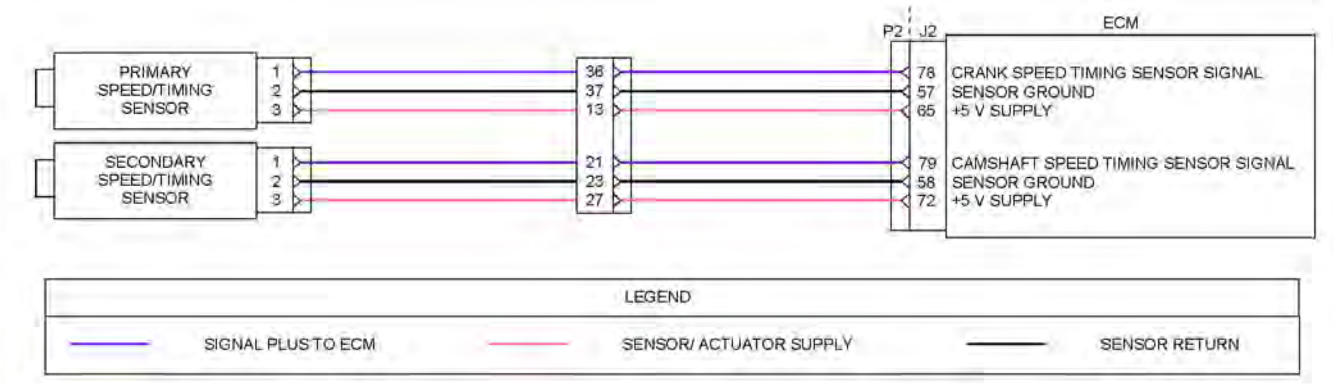


Illustration 30 g06458403

Schematic diagram for the speed/timing sensors

Table 128

Troubleshooting Test Steps	Values	Results
1. Check the Engine Speed/Timing Circuit **A.** Connect the electronic service tool to the service tool connector. Refer to Troubleshooting, “Electronic Service Tools”. **B.** Turn the keyswitch to ON. **C.** Start the engine and run the engine. **Note:** The problem may occur when the engine is at any operating temperature. However, the problem is more likely to occur when the engine is at the normal operating temperature.	Speed/Timing Circuit	**Result:** The engine started. Proceed to Test Step 2. **Result:** The engine did not start. Proceed to Test Step 3.
2. Check for Codes **A.** While the engine is running, monitor the electronic service tool for diagnostic codes. Also monitor the “Engine Starting” screen for an engine speed/timing that is “Not Detected” . **B.** Wait at least 30 seconds for activation of the diagnostic codes. Look for these codes on the electronic service tool: • 190-8 • 723-8 •637–11	Codes	**Result:** Diagnostic code 637–11 is active. Proceed to Test Step 3. **Result:** Diagnostic code 190–8 or 723–8 is active or there is a timing pattern that is “Not Detected” . Proceed to Test Step 4. **Result:** There is not an active diagnostic code and there is not a timing pattern that is “Not Detected” . **Repair:** Download the “Product Status Report” (PSR) from the engine ECM. Troubleshoot any diagnostic codes that may be present. Return the unit to service.

(continued)

(Table 128, contd)

Troubleshooting Test Steps	Values	Results
3. Inspect the Sensors **A.** Ensure that the speed/timing sensors are correctly seated in the flywheel housing and the cylinder block and that the retaining bolts are tightened to a torque of 22 N·m (16 lb ft). Ensure that the speed/timing sensors are not damaged. Replace any damaged sensors. Refer to Disassembly and Assembly, “Crankshaft Position Sensor - Remove and Install” or refer to Disassembly and Assembly, “Camshaft Position Sensor - Remove and Install”. **B.** Turn the keyswitch to the ON position. If the engine will run, then run the engine. **C.** Use the electronic service tool to check if the 637-11 diagnostic code is still active.	Faulty sensor	**Result:** A 637-11 diagnostic code is no longer active. Use the electronic service tool to clear all logged diagnostic codes. Return the engine to service. **Result:** A 637-11 diagnostic code is still active. **Repair:** If the engine has been reworked before the active 637-11 diagnostic code occurred, ensure that the flywheel and the camshaft gear have been aligned correctly. If the fault is still present, contact the Dealer Solutions Network (DSN).
4. Check the Battery Voltage **A.** Monitor the “Engine Starting” screen in the electronic service tool. **B.** Monitor the “Battery Voltage” . Crank the engine for 5 seconds.	Battery Voltage	**Result:** The battery voltage is OK. Proceed to Test Step 5. **Result:** The battery voltage is not OK. **Repair:** Refer to Troubleshooting, “Engine Cranks but Does Not Start”.
5. Check the Engine Speed and the Engine Speed/Timing Status **A.** Monitor the “Engine Starting” screen in the electronic service tool. **B.** Crank the engine for 5 seconds. While the engine is cranking, verify that the sensors show an acceptable cranking speed. **C.** While the engine is cranking, check the status of the engine speed/timing.	Speed/Timing Status	**Result:** The sensors show an acceptable cranking speed. The timing pattern shows “Detected” . **Repair:** Refer to Troubleshooting, “Engine Cranks but Does Not Start”. **Result:** A sensor does not show an acceptable cranking speed and/or the timing pattern shows “Not Detected” . Proceed to Test Step 6.
6. Check the Speed/Timing Sensor **A.** Turn the keyswitch to OFF. **B.** Visually inspect the sensor and the sensor assembly without removing the sensor assembly from the engine. Flanges must be flush against the surface of the timing gear housing and the flywheel housing to ensure proper operation. **C.** Disconnect the harness from the speed/timing sensors. Check the harness for debris and for corrosion. **D.** Perform a 30 N (6.7 lb) pull test on the harness wiring.	Speed/Timing Sensor	**Result:** The sensor and the sensor assembly mounting are OK. Do not reconnect the harness connector. Proceed to Test Step 7. **Result:** The sensor and/or the sensor assembly has a mechanical problem or the harness has debris and/or corrosion. **Repair:** Repair the sensor and/or the sensor assembly or replace the sensor and/or the sensor assembly. Replace the sensor and the sensor harness connector if there was debris and/or corrosion. Verify that the problem is resolved.

(continued)

(Table 128, contd)

Troubleshooting Test Steps	Values	Results
7. Use a Multimeter to Check the Harness Wiring at the Sensor Connector **A.** Disconnect the affected speed/timing sensor from the wiring harness. **B.** Turn the keyswitch to ON. **C.** Perform substeps D-E for the affected sensor. **D.** Measure the voltage between terminal 3 (5V SUPPLY) and terminal 2 (RETURN). The voltage should be 5V +/-.2V. **E.** Measure the voltage between terminal 1 (SIGNAL) and terminal 2 (RETURN). The voltage should be 4.8V +/- 0.3V.	Check Wiring Harness	**Result:** The voltage was OK for all the measurements. **Repair:** Replace the affected speed/timing sensor. **Result:** The voltage was not OK for at least one of the measurements. Proceed to Test Step 8.
8. Use a Multimeter to Check the Harness Wiring at the Engine Interface Connector **A.** Disconnect the engine interface connector. **B.** Turn the keyswitch to ON. **C.** Perform substeps D-E for the affected sensor. **D.** Measure the voltage between the 5V supply terminal and the sensor return terminal on the engine interface connector (ECM side). The voltage should be 5V +/-.2V. **E.** Measure the voltage between the sensor signal terminal and the sensor return terminal on the engine interface connector (ECM side). The voltage should be 4.8V +/- 0.3V.	Check Wiring Harness	**Result:** The voltage was OK for all the measurements. The fault is in the engine wiring harness. **Repair:** Repair or replace the engine wiring harness. **Result:** The voltage was not OK for at least one of the measurements. The fault is in the wiring between the engine interface connector and the ECM. Repair the faulty wiring or replace the faulty wiring.

If the procedure did not correct the issue, contact the Dealer Solutions Network (DSN).

i07705003

Switch Circuits - Test
(Air Filter Restriction Switch)

Use the following procedure to troubleshoot a problem with the air filter restriction switch circuit. The procedure that follows also covers the diagnostic codes that are listed in Table 129 .

Table 129

Diagnostic Trouble Codes for the Air Filter Restriction Switch		
J1939 Code	**Code Description**	**Comments**

(continued)

(Table 129, contd)

107-3	Air Filter Differential Pressure Switch voltage above normal	This code indicates a fault in the circuit for the air filter restriction switch. The Electronic Control Module (ECM) detects the following conditions: The air filter restriction switch circuit is open for at least 1 second. The engine is not running. Monitoring of air filter restriction when the engine is running will be disabled whilst this code is active.
107-4	Air Filter Differential Pressure Switch voltage below normal	This code indicates a fault in the circuit for the air filter restriction switch. The Electronic Control Module (ECM) detects the following conditions: The air filter restriction switch circuit is grounded for at least 1 second. The engine is not running. Monitoring of air filter restriction when the engine is running will be disabled whilst this code is active.

The engine is equipped with an air filter restriction switch. The type of switch that is installed can be a “Normally Open” switch or a “Normally Closed” switch.

Use the electronic service tool to check the configuration parameters to check the type of air filter restriction switch that is installed.

Table 130 and Table131 contain the normal engine conditions and switch states for the air filter restrictions switch.

Table 130

Diagnostic Summary for a “Normally Open” Air Filter Restriction Switch		
Engine Condition	**Switch State**	**Active Diagnostic Code**
Not running (key on)	Open	Normal condition
Running	Open	Normal Condition (no air filter restriction detected)
Not running (key on)	Closed	107-4
Running	Closed	107-15 or 107-16 (air filter restriction detected)

Table 131

Diagnostic Summary for a “Normally Closed” Air Filter Restriction Switch		
Engine Condition	**Switch State**	**Active Diagnostic Code**
Not running (key on)	Closed	Normal condition
Running	Closed	Normal Condition (no air filter restriction detected)
Not running (key on)	Open	107-3
Running	Open	107-15 or 107-16 (air filter restriction detected)

Note: A 107-15 or a 107-16 diagnostic code indicates that the air inlet is restricted. Refer to Troubleshooting, “Inlet Air Is Restricted”.

During the following procedure, refer to the electrical schematic for the application.

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

Table 132

Troubleshooting Test Steps	Values	Results
1. Check the “Air Filter Restriction Switch Configuration” **A.** Turn the keyswitch to ON. **B.** Connect the electronic service tool to the diagnostic connector. **C.** Under “Configuration Parameters” , check the “Air Filter Restriction Switch Configuration” . **Note:** If the type of switch cannot be identified using the electronic service tool, contact the Dealer Solutions Network (DSN) for the information.	Air Filter Restriction Switch Configuration	**Results :** The switch is configured to “Normally Open” . Proceed to Test Step 2. **Results :** The switch is configured to “Normally Closed” . Proceed to Test Step 3.
2. Check the Air Filter Restriction Switch **A.** Turn the keyswitch to OFF. **B.** Disconnect the air filter restriction switch from the wiring harness connector. **C.** Turn the keyswitch to ON. **D.** Monitor the electronic service tool for active fault codes.	Diagnostic codes	**Results :** There is not an active 107-3 diagnostic code. A failed air filter restriction switch has been detected. **Repair :** Replace the air filter restriction switch. Verify that the repairs eliminated the issue. Return the machine to service. **Results :** There is an active 107-3 diagnostic code. A short circuit in the wiring harness has been detected. **Repair :** Repair or replace the wiring harness. Verify that the repair has eliminated the issue. If the fault is still present, contact the Dealer Solutions Network (DSN).
3. Check the Air Filter Restriction Switch **A.** Turn the keyswitch to OFF. **B.** Disconnect the air filter restriction switch from the wiring harness connector. **C.** Install a jumper wire in the wiring harness connector between the signal and ground terminals. **D.** Turn the keyswitch to ON. **E.** Monitor the electronic service tool for active fault codes.	Diagnostic codes	**Results :** There is not an active 107-3 diagnostic code. A failed air filter restriction switch has been detected. **Repair :** Replace the air filter restriction switch. Verify that the repairs eliminated the issue. Return the machine to service. **Results :** There is an active 107-3 diagnostic code. An open circuit in the wiring harness has been detected. **Repair :** Repair or replace the wiring harness. Verify that the repair has eliminated the issue. If the fault is still present, contact the Dealer Solutions Network (DSN).

i07829933

Switch Circuits - Test (Multiposition Throttle Switch)

This procedure covers the following diagnostic codes:

Table 133

Diagnostic Trouble Codes for Throttle Switch		
J1939 Code	**Code Description**	**Comments**
29-2	Accelerator Pedal Position #2 : Erratic, Intermittent, or Incorrect	The Electronic Control Module (ECM) detects the following condition: There is an invalid combination of positions for the multi-position switch. If equipped, the warning light will come on. The ECM will log the diagnostic code.
91-2	Accelerator Pedal Position #1 : Erratic, Intermittent, or Incorrect	
Follow the troubleshooting procedure to identify the root cause of the fault.		

If the application is equipped with two throttles, the engine will use the second throttle until the fault is repaired.

If a second throttle is not installed or if the second throttle has a fault, the following conditions will occur:

- The engine will default to the limp home speed.
- If the engine speed is higher than the limp home speed, the engine will decelerate to the limp home speed.
- If the engine speed is lower than the limp home speed, the engine speed will remain at the current speed.
- The engine will remain at this speed while the diagnostic code remains active.
- All inputs from the faulty throttle are ignored by the ECM until the fault is repaired.
- All inputs from the repaired throttle will be ignored by the ECM until the keyswitch has been cycled.

Check that the software configuration in the ECM is correct for a multi-position throttle.

If the engine has an analog throttle with an Idle Validation Switch (IVS), then refer to Troubleshooting, “Idle Validation - Test”.

The throttle switch provides the operator with the ability to select the desired engine speed. The throttle switch configuration may be selected between 0 to 4 switches. A multi-position rotary switch may be used.

The throttle switch is typically connected to the four throttle inputs of the ECM. Each position generates a specific ON/OFF pattern on the throttle inputs. A diagnostic code is generated if a pattern that does not correspond with any of the switch positions is detected.

Once a diagnostic code is generated, the ECM ignores the throttle input signals. The desired engine speed is set to low idle if no alternative throttle is detected.

Voltage at the throttle inputs to the ECM should be 13.8 ± 0.5 VDC when the throttle inputs are open. The voltage should be less than 0.5 VDC when the throttle inputs are closed.

During the following procedure, refer to the electrical schematic for the application.

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

Table 134

Troubleshooting Test Steps	Values	Results
1. Inspect Electrical Connectors and Wiring **A.** Turn the keyswitch to the OFF position. **B.** Thoroughly inspect the P1 connector and any other connectors that are included in the application for this throttle switch. Refer to Troubleshooting, “Electrical Connectors - Inspect” for details. **C.** Perform a 30 N (6.7 lb) pull test on each of the wires in the switch connector and the ECM connector that are associated with the active diagnostic code. **D.** Check the ground connection on the ECM for abrasions and pinch points. **E.** Check the harness for abrasion and pinch points from the suspect sensor to the ECM.	Loose connection or damaged wire	**Result:** There is a fault in a connector or the wiring. **Repair:** Repair any faulty connectors or replace the wiring harness. Ensure that all the seals are properly in place and ensure that the connectors are correctly coupled. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault. **Result:** All connectors, pins, and sockets are correctly coupled and/or inserted. The harness is free of corrosion, abrasion, and pinch points. Proceed to Test Step 2.
2. Check Throttle Cab Switch Position on the Electronic Service Tool **A.** Connect the electronic service tool to the diagnostic connector. **B.** Turn the keyswitch to the ON position. **C.** Observe the status of the throttle switch and the throttle inputs on the electronic service tool while moving the throttle switch to each position.	Throttle switch status changes on the electronic service tool	**Result:** The throttle switch is functioning correctly. If there are logged diagnostic codes for the throttle switch, the fault may be intermittent. **Repair:** Refer to Troubleshooting, “Electrical Connectors - Inspect” to identify intermittent faults. **Result:** Record the suspect input. Proceed to Test Step 3.
3. Install a Jumper at the Throttle Switch Connector **A.** Disconnect the connector for the throttle switch. **B.** Observe the status of the suspect throttle input on the electronic service tool. **C.** Connect a suitable jumper wire between terminal 1 on the throttle switch connector and the terminal for the suspect throttle input. **D.** Observe the status of the suspect throttle input on the electronic service tool. **E.** Remove the jumper wire.	Status is ON with jumper installed Status is OFF with jumper removed	**Result:** The fault is in the throttle switch. **Repair:** Install a replacement throttle switch. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault. **Result:** The fault is not in the throttle switch. Proceed to Test Step 4.

(continued)

(Table 134, contd)

Troubleshooting Test Steps	Values	Results
4. Check the Harness for an Open Circuit **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the P1 ECM connector and the connector for the throttle switch. **C.** Measure the resistance between each of the throttle switch inputs and the appropriate terminal on the P1 connector. **D.** Measure the resistance between the return terminal on the throttle switch and the “Switch Return” terminal on the P1 connector.	Less than 2 Ohms	**Result:** At least one of the resistance measurements is greater than 2 Ohms. The fault is in the wiring between the throttle switch and the P1 connector. **Repair:** Repair the faulty wiring or replace the faulty wiring. Use the electronic service tool to clear all logged diagnostic codes and then verify that the repair has eliminated the fault. **Result:** All resistance measurements are less than 2 Ohms. Proceed to Test Step 5.
5. Check the Harness for a Short Circuit **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the P1 ECM connector and the connector for the throttle switch. **C.** Measure the resistance between the suspect input terminal and all other terminals on the P1 connector. **D.** Measure the resistance between the “Switch Return” terminal and all other terminals on the P1 connector.	Greater than 1k Ohms	**Result:** At least one of the resistance measurements is less than 1k Ohms. There is a short in the harness between the throttle switch connector and the P1 connector. **Repair:** Repair the faulty wiring or replace the faulty wiring. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault. **Result:** All resistance measurements are greater than 1k Ohms. Contact the Dealer Solutions Network (DSN).

i07853932

Switch Circuits - Test
(Engine Oil Pressure Switch)

Use this procedure to diagnose electronic faults in the oil pressure switch circuit.

This procedure covers the following diagnostic code:

Table 135

Diagnostic Trouble Codes for the Oil Pressure Switch		
J1939 Code	**Description**	**Notes**
100-2	Engine Oil Pressure : Erratic, Intermittent, or Incorrect	When the keyswitch is in the ON position (engine not running), the oil pressure switch circuit should be closed. This diagnostic code will be active when the Electronic Control Module (ECM) detects the following conditions: The engine is not running. The circuit for the oil pressure switch is open. The warning lamp will come on.

The engine is equipped with an oil pressure switch. While the engine is running and oil pressure is detected, the switch will be open. When no oil pressure is detected, the switch will be closed.

Table 136

Oil Pressure Switch States and Diagnostics Summary		
Engine Condition	**Oil Pressure Switch State**	**Active Diagnostic Code**
Not running	Closed	Normal condition (no oil pressure detected)
Running	Open	Normal condition (oil pressure detected)
Not running	Open	100-2
Running	Closed	100-1

Note: If a 100-1 diagnostic code is active, refer to Troubleshooting, "Oil Pressure Is Low" before returning to this procedure.

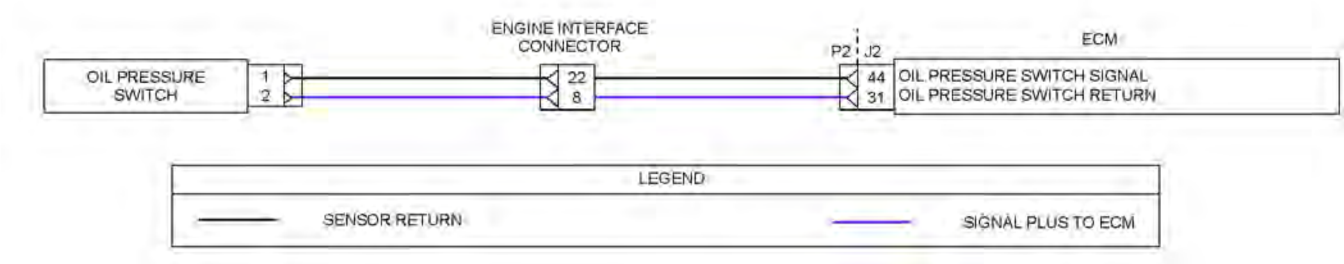


Illustration 31 g06458463

Schematic diagram for the oil pressure switch circuit

Note: All connectors may not be shown. Refer to the Electrical Schematic for the application for details of any connectors between the oil pressure switch connector and the ECM connectors.

Table 137

Troubleshooting Test Steps	Values	Results
1. Inspect Electrical Connectors and Wiring **A.** Thoroughly inspect the connector for the oil pressure switch and the engine interface connector. Refer to Trouble-shooting, “Electrical Connectors - Inspect”. **B.** Perform a 30 N (6.7 lb) pull test on each of the wires that are associated with the oil pressure switch in the oil pressure switch connector and the engine interface connector. **C.** Check the harness for abrasions and for pinch points from the oil pressure switch back to the ECM. **Note:** Do not disconnect the ECM connector at this stage. The ECM can only be disconnected and reconnected 10 times before damage to the harness connector may occur.	Damaged wire or connector	**Result:** A damaged wire or damaged connector was found. **Repair:** Repair the damaged wire or the damaged connector. Use the electronic service tool to clear all logged diagnostic co-des. Verify that the repair eliminates the fault. **Result:** All connectors, pins, and sockets are correctly con-nected and/or inserted and the harness is free of corrosion, of abrasion or of pinch points. Proceed to Test Step 2.
2. Check for Active or Recently Logged Diagnostic Codes **A.** Turn the keyswitch to the OFF position. **B.** Connect the electronic service tool to the diagnostic connector. **C.** Turn the keyswitch to the ON position. Do not start the engine. **D.** Check for any active or recently logged diagnostic codes. Wait at least 30 seconds for activation of the diagnostic codes.	Diagnostic codes	**Result:** A 100-1 diagnostic code is recently logged. This diagnostic code indicates that the oil pressure is low, but can also be caused by a short circuit condition in the oil pres-sure switch circuit. **Repair:** Check for engine oil pressure problems before return-ing to this procedure. refer to Troubleshooting, “Oil Pressure Is Low”. If the fault is still present, proceed to Test Step 3. **Result:** A 100-2 diagnostic code is active. Proceed to Test Step 6. **Result:** A 100-2 diagnostic code is not active. A 100-1 diag-nostic code is not recently logged. An intermittent 100-2 diagnostic code can be caused by turn-ing the keyswitch to the ON position after the engine has re-cently been stopped or an intermittent fault may exist. **Repair:** Refer to Troubleshooting, “Electrical Connectors - In-spect” to identify intermittent faults.
3. Create an Open Circuit at the Switch Connector **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the harness connector for the oil pressure switch. **C.** Turn the keyswitch to the ON position. Do not start the engine. **D.** Use the electronic service tool to check for an active 100-2 diagnostic code. Wait at least 30 seconds for activation of the diagnostic code.	Diagnostic codes	**Result:** A 100-2 diagnostic code is active with the switch disconnected. **Repair:** Replace the oil pressure switch. Refer to Disassembly and Assembly, “Engine Oil Pressure Switch - Remove and Install”. Use the electronic service tool to clear all logged diagnostic co-des and verify that the repair eliminates the fault. **Result:** A 100-2 diagnostic code is not active with the oil pres-sure switch disconnected. Reconnect the harness connector for the oil pressure switch and proceed to Test Step 4.

(continued)

(Table 137, contd)

Troubleshooting Test Steps	Values	Results
4. Create an Open Circuit at the Engine Interface Connector **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the engine interface connector. **C.** Turn the keyswitch to the ON position. Do not start the engine. Wait at least 30 seconds for activation of the diagnostic codes. **D.** Use the electronic service tool to check for an active 100-2 diagnostic code. **Note:** Diagnostic codes for all the engine sensors will be active with the engine interface connector disconnected. Ignore all other codes and only look for a 100-2 diagnostic code. **E.** Turn the keyswitch to the OFF position.	Diagnostic codes	**Result:** A 100-2 diagnostic code is active with the engine interface connector disconnected. The fault is in the wiring between the engine interface connector and the oil pressure switch. **Repair:** Replace the faulty wiring. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault. **Result:** A 100-2 diagnostic code is not active with the engine interface connector disconnected. Reconnect the engine interface connector. Proceed to Test Step 5.
5. Check the Oil Pressure Switch Signal Wire for a Short to Ground **A.** Disconnect the P2 connector from the ECM. Thoroughly inspect the P2/J2 connector for damage or corrosion. Refer to Troubleshooting, Electrical Connectors - Inspect for more information. **B.** Disconnect the engine interface connector. **C.** Use a suitable multimeter to measure the resistance between terminal 22 on the engine interface connector and a suitable ground.	Greater than 1k Ohm	**Result:** The measured resistance is less than 1k Ohm. There is a short to ground in the wiring between the engine interface connector and the P2 connector. **Repair:** Repair the faulty wiring or replace the faulty wiring. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault. **Result:** The measured resistance is greater than 1k Ohm. Contact the Dealer Solution Network (DSN).
6. Create a Short at the Switch Connector **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the harness connector for the oil pressure switch. **C.** Fabricate a jumper wire and install the jumper wire between the terminal 1 and terminal 2 on the harness connector for the oil pressure switch. **D.** Turn the keyswitch to the ON position. Do not start the engine. **E.** Use the electronic service tool to check for an active 100-2 diagnostic code. Wait at least 30 seconds for activation of the diagnostic code. **F.** Turn the keyswitch to the OFF position. **G.** Remove the jumper wire.	Diagnostic codes	**Result:** A 100-2 diagnostic code is not active with the jumper installed. **Repair:** Replace the oil pressure switch. Refer to Disassembly and Assembly, “Engine Oil Pressure Switch - Remove and Install”. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault. **Result:** A 100-2 diagnostic code is active with the jumper installed. Proceed to Test Step 7.

(continued)

(Table 137, contd)

Troubleshooting Test Steps	Values	Results
7. Create a Short at the Engine Interface Connector **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the engine interface connector. **C.** Fabricate a jumper wire and install the jumper wire between terminal 8 and terminal 22 on the engine interface connector (ECM side). **D.** Turn the keyswitch to the ON position. Do not attempt to start the engine. Wait at least 30 seconds for activation of the diagnostic codes. **E.** Use the electronic service tool to check for an active 100-2 diagnostic code. **Note:** Diagnostic codes for all the engine sensors will be active with the engine interface connector disconnected. Ignore all other codes and only look for a 100-2 diagnostic code.	Diagnostic codes	**Result:** A 100-2 diagnostic code is not active with the jumper installed. There is an open circuit in the wiring between the oil pressure switch and the engine interface connector. **Repair:** Repair the faulty wiring or replace the faulty wiring. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault. **Result:** A 100-2 diagnostic code is active with the jumper installed. Reconnect the engine interface connector. Proceed to Test Step 8.
8. Check the Wiring Between the Engine Interface Connector and the ECM for an Open Circuit **A.** Disconnect the P2 connector from the ECM. Thoroughly inspect the P2/J2 connector for damage or corrosion. Refer to Troubleshooting, Electrical Connectors - Inspect for more information. **B.** Disconnect the engine interface connector. **C.** Use a suitable multimeter to measure the resistance between terminal 8 on the engine interface connector and P2:31. **D.** Use a suitable multimeter to measure the resistance between terminal 22 on the engine interface connector and P2:44.	Less than 2 Ohms	**Result:** At least one of the resistance measurements is greater than 2 Ohms. There is an open circuit in the wiring between the engine interface connector and the P2 connector. **Repair:** Repair the faulty wiring or replace the faulty wiring. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault. **Result:** Both the resistance measurements are less than 2 Ohms. Contact the DSN.

i07854540

Valve Position - Test

This procedure covers the following diagnostic codes:

Table 138

Diagnostic Codes for the Valve Position Sensors		
J1939 Code	**Code Description**	**Comments**
27-3	EGR #1 Valve Position : Voltage Above Normal	The Electronic Control Module (ECM) detects that the signal voltage for the NOx Reduction System (NRS) valve position sensor is greater than 4.8 V for 0.1 second.
27-4	EGR #1 Valve Position : Voltage Below Normal	The ECM detects that the signal voltage for the NRS valve position sensor is less than 0.2 V for 0.1 second.
51-3	Engine Throttle Position : Voltage Above Normal	The ECM detects that the signal voltage for the intake throttle valve position sensor is greater than 4.8 V for 0.1 second.
51-4	Engine Throttle Position : Voltage Below Normal	The ECM detects that the signal voltage for the intake throttle valve position sensor is less than 0.2 V for 0.1 second.
Follow the troubleshooting procedure to identify the root cause of the fault.		

Use this procedure to troubleshoot the position sensors for the following valves:

- EGR valve
- Engine intake throttle valve

Each position sensor is integral in the associated valve. If the following procedure indicates a fault with the position sensor, then the entire valve must be replaced.

The following background information is related to this procedure:

The troubleshooting procedures for the diagnostic codes of each position sensor are identical. The 5 VDC sensor supply provides power to all 5 VDC sensors. The sensor supply is output short circuit protected. A short circuit to the battery will not damage the circuit inside the ECM. The signal voltage from the valve position sensors is supplied to the appropriate terminal at the P1 or P2 ECM connector.

Pull-up Voltage

The ECM continuously outputs a pull-up voltage on the circuit for the sensor signal wire. The ECM uses this pull-up voltage to detect an open in the signal circuit. When the ECM detects a voltage above a threshold, the ECM generates an open circuit diagnostic code (XXXX-3).

If the sensor is disconnected, pull-up voltage indicates that the wires are not open or shorted to ground. The absence of pull-up voltage indicates an open in the signal wire or a short to ground. If the voltage is different from pull-up voltage, the signal wire is shorted to another wire in the harness.

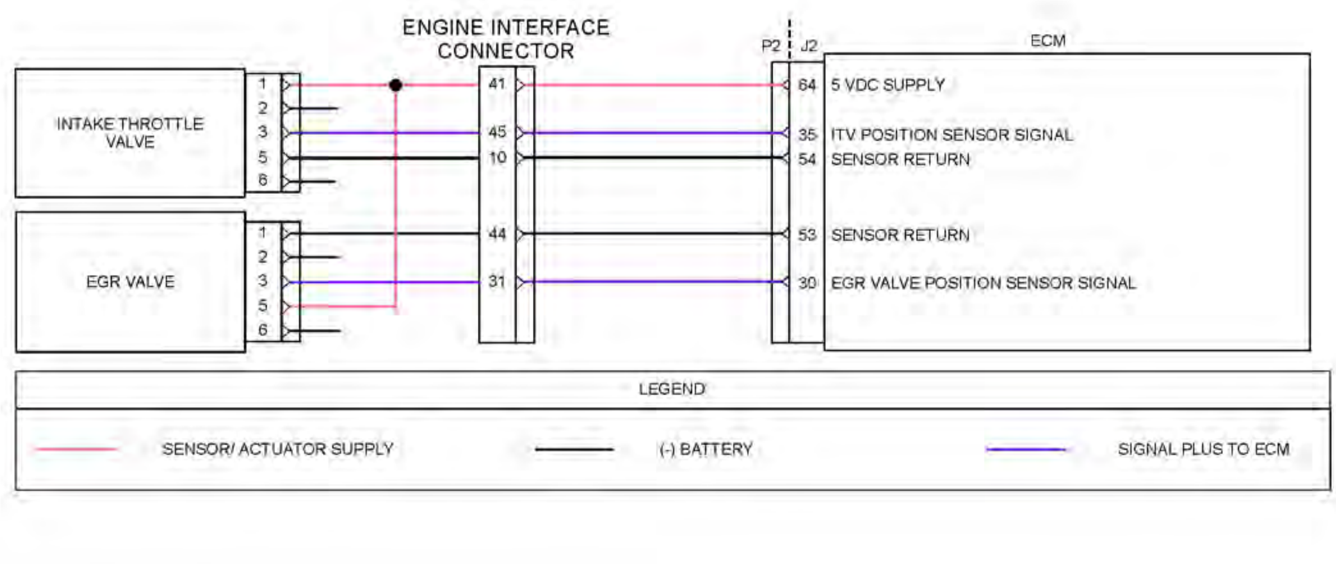


Illustration 32 g06459004

Schematic diagram for the valve position sensors

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

Table 139

Troubleshooting Test Steps	Values	Results
1. Verify All Active and Recently Logged Diagnostic Codes **A.** Turn the keyswitch to the ON position. **B.** Use the electronic service tool to perform the “Air System Motor Valves Verification Test” . **C.** Verify if any of the diagnostic codes that are listed in Table 138 are active or recently logged.	Diagnostic codes	**Result:** None of the preceding diagnostic codes are active or recently logged. **Repair:** The fault may be intermittent. Refer to Troubleshooting, “Electrical Connectors - Inspect” to identify intermittent faults. **Result:** One or more of the preceding diagnostic codes are active or recently logged. Proceed to Test Step 2.
2. Inspect Electrical Connectors and Wiring **A.** Thoroughly inspect the connector for the suspect valve and the engine interface connector. Refer to Troubleshooting, “Electrical Connectors - Inspect”. **B.** Perform a 30 N (6.7 lb) pull test on each of the wires that are associated with the suspect position sensor in the valve connector and the engine interface connector. **C.** Check the harness for abrasions and for pinch points from the suspect valve back to the ECM. **Note:** Do not disconnect the ECM connector at this stage. The ECM can only be disconnected and reconnected 10 times before damage to the harness connector may occur.	Damaged wire or connector	**Result:** A damaged wire or damaged connector was found. **Repair:** Repair the damaged wire or the damaged connector. Use the electronic service tool to clear all logged diagnostic codes. Verify that the repair eliminates the fault. **Result:** All connectors, pins, and sockets are correctly connected and/or inserted and the harness is free of corrosion, of abrasion or of pinch points. Proceed to Test Step 3.
3. Measure the Sensor Supply Voltage at the Valve Connector **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the suspect valve from the engine harness. **C.** Turn the keyswitch to the ON position. **D.** Measure the voltage at the harness connector for the valve from the 5 VDC supply terminal of the position sensor to the sensor ground terminal.	Between 4.84 V and 5.16 V	**Result:** The measured voltage is not within the expected range. Proceed to Test Step 4. **Result:** The measured voltage is within the expected range. Proceed to Test Step 5.

(continued)

(Table 139, contd)

Troubleshooting Test Steps	Values	Results
4. Measure the Supply Voltage at the Engine Interface Connector **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the engine interface connector. **C.** Turn the keyswitch to the ON position. **D.** Use a suitable voltmeter to measure the voltage at the engine interface connector. Measure the voltage between the 5 VDC supply pin and the return pin for the suspect valve. **E.** Reconnect the engine interface connector.	Between 4.84 V and 5.16 V	**Result:** The voltage is within the expected range. The fault is in the 5 VDC supply wire or the ground wire between the valve connector and the engine interface connector. **Repair:** Repair the faulty wiring or replace the faulty wiring. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault. **Result:** The voltage is not within the expected range. The fault is in the 5 VDC supply wire or the ground wire between the engine interface connector and the ECM. **Repair:** Repair the faulty wiring or replace the faulty wiring. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.
5. Verify the Type of Active Diagnostic Code **A.** Turn the keyswitch to the ON position. **B.** Use the electronic service tool to perform the “Air System Motor Valves Verification Test” . **C.** Use the electronic service tool to check for active diagnostic codes. Record all active diagnostic codes.	Diagnostic codes	**Result:** A -4 diagnostic code is active. Proceed to Test Step 6. **Result:** A -3 diagnostic code is active. Proceed to Test Step 9.
6. Create an Open Circuit at the Valve Connector **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the connector for the valve with the -4 diagnostic code. **C.** Turn the keyswitch to the ON position. **D.** Use the electronic service tool to perform the “Air System Motor Valves Verification Test” . Check for an -3 diagnostic code. **E.** Turn the keyswitch to the OFF position.	Diagnostic codes	**Result:** A -3 diagnostic code is active with the valve disconnected. **Repair:** Reconnect the connector for the valve. If the -4 diagnostic code returns, there is a short in the valve. Install a replacement valve. Refer to Disassembly and Assembly for the correct procedure. Use the electronic service tool to clear all logged diagnostic codes and run the appropriate reset feature for the replaced valve. Refer to Troubleshooting, Service Tool Features. Use the electronic service tool to perform the “Air System Motor Valves Verification Test” and verify that the repair eliminates the fault. **Result:** There is still a -4 diagnostic code active with the valve disconnected. Proceed to Test Step 7.

(continued)

(Table 139, contd)

Troubleshooting Test Steps	Values	Results
7. Create an Open Circuit at the Engine Interface Connector **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the engine interface connector. **C.** Turn the keyswitch to the ON position. **D.** Use the electronic service tool to perform the “Air System Motor Valves Verification Test” . Check for an -3 diagnostic code. **Note:** Diagnostic codes for all the engine sensors will be active with the engine interface connector disconnected. Ignore all other codes and only look for codes that relate to the suspect sensor. **E.** Turn the keyswitch to the OFF position.	Diagnostic codes	**Result:** A -3 diagnostic code is active with the engine interface connector disconnected. The fault is in the wiring between the valve connector and the engine interface connector. **Repair:** Repair the faulty wiring or replace the faulty wiring. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault. **Result:** A -4 diagnostic code is still active with the engine interface connector disconnected. Reconnect the engine interface connector. Proceed to Test Step 8.
8. Check the Signal Wire to the ECM for a Short Circuit **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the P2 connector from the ECM. Thoroughly inspect the P2/J2 connectors for damage or corrosion. Refer to Troubleshooting, Electrical Connectors - Inspect. **C.** Disconnect the engine interface connector. **D.** Use a suitable multimeter to measure the resistance between the suspect sensor signal terminal on the engine interface connector (ECM side) and all other terminals on the engine interface connector.	Greater than 1k Ohm	**Result:** At least one of the resistance measurements is less than 1k Ohm. The fault is in the wiring for the suspect sensor between the engine interface connector and the P2 connector. **Repair:** Repair the faulty wiring or replace the faulty wiring. Use the electronic service tool to clear all logged diagnostic codes and then verify that the repair eliminates the fault. **Result:** All resistance measurements are greater than 1k Ohm. Contact the Dealer Solution Network (DSN).

(continued)

(Table 139, contd)

Troubleshooting Test Steps	Values	Results
9. Create a Short Circuit at the Valve Connector **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the connector for the valve with the -3 diagnostic code. **C.** Fabricate a jumper wire that is 150 mm (6 inch) long. **D.** Insert one end of the jumper wire into the terminal for the valve position sensor signal on the harness connector for the suspect valve. Insert the other end of the jumper into the terminal for the sensor ground on the harness connector for the suspect valve. **E.** Turn the keyswitch to the ON position. **F.** Use the electronic service tool to perform the “Air System Motor Valves Verification Test” . Check for an active -4 diagnostic code for the suspect sensor. **G.** Turn the keyswitch to the OFF position. **H.** Remove the jumper.	Diagnostic codes	**Result:** A -4 diagnostic code is active when the jumper is installed. **Repair:** Reconnect the connector for the suspect valve. Turn the keyswitch to the ON position. Use the electronic service tool to check for active diagnostic codes. If the -3 diagnostic code returns, there is an open circuit in the valve. Install a replacement valve. Refer to Disassembly and Assembly for the correct procedure. Use the electronic service tool to clear all logged diagnostic codes and run the appropriate reset feature for the replaced valve. Refer to Troubleshooting, Service Tool Features. Use the electronic service tool to perform the “Air System Motor Valves Verification Test” and verify that the repair eliminates the fault. **Result:** A -3 diagnostic code remains active when the jumper is installed. Proceed to Test Step 10.
10. Create a Short Circuit at the Engine Interface Connector **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the engine interface connector. **C.** Fabricate a jumper wire that is 150 mm (6 inch) long. Install the jumper between the suspect sensor signal terminal and the sensor ground terminal on the engine interface connector (ECM side). **D.** Turn the keyswitch to the ON position. Do not attempt to start the engine. **E.** Use the electronic service tool to perform the “Air System Motor Valves Verification Test” . Check for an active -4 diagnostic code. **Note:** Diagnostic codes for all the engine sensors will be active with the engine interface connector disconnected. Ignore all other diagnostic codes and only look for codes that relate to the suspect sensor. **F.** Turn the keyswitch to the OFF position. **G.** Remove the jumper wire.	Diagnostic codes	**Result:** A -4 diagnostic code is active when the jumper is installed. The fault is in the wiring between the valve connector and the engine interface connector. **Repair:** Repair the faulty wiring or replace the faulty wiring. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault. **Result:** The -3 is still active with the jumper installed. Reconnect the engine interface connector. Proceed to Test Step 11.
11. Check the Signal Wire to the ECM for an Open Circuit **A.** Turn the keyswitch to the OFF position.	Less than 2 Ohms	**Result:** The measured resistance is greater than 2 Ohms. The fault is in the wiring for the suspect sensor between the engine interface connector and the P2 connector.

(continued)

(Table 139, contd)

Troubleshooting Test Steps	Values	Results
B. Disconnect the P2 connector from the ECM. Thoroughly inspect the P2/J2 connectors for damage or corrosion. Refer to Troubleshooting, Electrical Connectors - Inspect. **C.** Disconnect the engine interface connector. **D.** Use a suitable multimeter to measure the resistance between the suspect sensor signal terminal on the engine interface connector and the suspect sensor signal terminal on the P2 connector.		**Repair:** Repair the faulty wiring or replace the faulty wiring. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault. **Result:** The measured resistance is less than 2 Ohms. Contact the DSN.

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Water in Fuel - Test

For a 97-15 code, refer to Troubleshooting, “Fuel Contains Water” before returning to this procedure.

Use this procedure when the Water-In-Fuel sensor is suspect. This procedure also covers the following diagnostic code:

Table 140

Diagnostic Trouble Code for the Water-in-Fuel Sensor		
J1939 Code	**Code Description**	**Comments**
97-3	Water In Fuel Indicator : Voltage Above Normal	The ECM detects the following conditions: An open circuit in the Water-In-Fuel (WIF) sensor circuit or a faulty WIF sensor that is not sending the self check ground pulse on power up. The warning lamp will stay on when the “indicator lamp self check” has been completed. The ECM will disable the function to detect water in fuel while the code is active.

Water-in-Fuel Sensor Operation

The WIF sensor is a normally open sensor. During normal operation, there will be no signal sent from the WIF sensor to the ECM. If water is detected in the fuel, the sensor will send a signal to the ECM. If the signal remains constant for 5 seconds, a 97-15 diagnostic code will become active. If the signal remains constant for 30 minutes, a 97-16 diagnostic will become active. These diagnostic codes can also be caused by a short in the WIF sensor circuit.

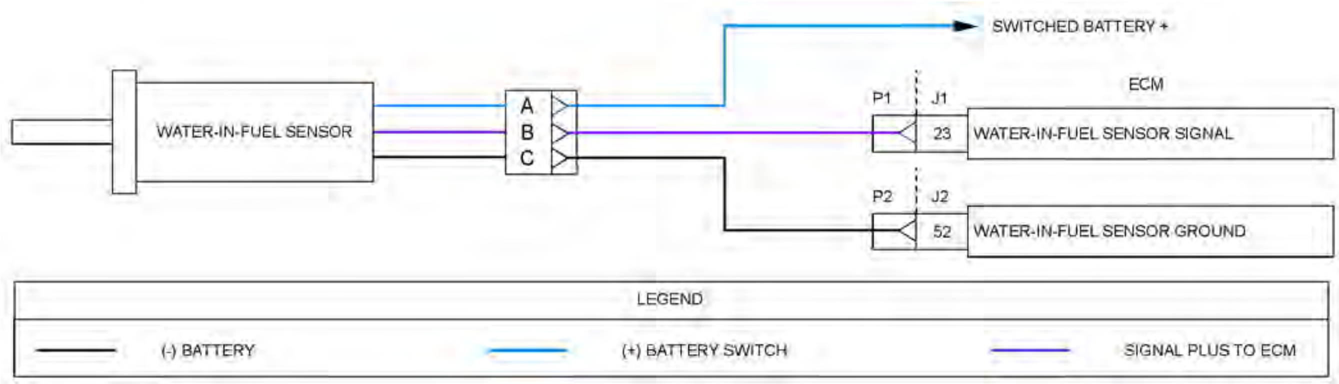

Illustration 33 g06459729

Schematic diagram for the WIF sensor

Note: All connectors may not be shown. Refer to the Electrical Schematic for the application for details of any connectors between the WIF sensor connector and the ECM connectors.

Table 141

Troubleshooting Test Steps	Values	Results
1. Inspect Electrical Connectors and Wiring **A.** Turn the keyswitch to the OFF position. **B.** Thoroughly inspect the connector for the WIF sensor and any interface connectors between the WIF sensor and the ECM connectors. Refer to Troubleshooting, “Electrical Connectors - Inspect”. **C.** Perform a 30 N (6.7 lb) pull test on each of the wires in the WIF sensor connector and any interface connectors that are associated with the WIF sensor. **D.** Check the harness for abrasions, for pinch points, and for corrosion. **Note:** Do not disconnect the ECM connector at this stage. The ECM can only be disconnected and reconnected 10 times before damage to the harness connector may occur.	Loose connection or damaged wire	**Result:** There is a fault in a connector or the wiring. **Repair:** Repair any faulty connectors or replace the wiring harness. Ensure that all the seals are properly in place and ensure that the connectors are correctly coupled. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault. **Result:** All connectors, pins, and sockets are correctly coupled and/or inserted. The harness is free of corrosion, abrasion, and pinch points. Proceed to Test Step 2.
2. Check For Active Diagnostic Codes **A.** Turn the keyswitch to the OFF position. **B.** Connect the electronic service tool to the diagnostic connector. **C.** Turn the keyswitch to the ON position. If the engine will start, then run the engine. **D.** Wait for at least 1 minute. **E.** Monitor the active diagnostic code screen on the electronic service tool. Check and record any active diagnostic codes.	Diagnostic codes	**Result:** There are no active diagnostic codes for the WIF sensor. There may be an intermittent fault. **Repair:** Refer to Troubleshooting, “Electrical Connectors - Inspect” to identify intermittent faults. **Result:** A 97-15 or 97-16 diagnostic code is active. Refer to Troubleshooting, “Fuel Contains Water” before continuing with this procedure. Proceed to Test Step 3. **Result:** A 97-3 diagnostic code is active. Proceed to Test Step 3.
3. Check the Supply Voltage at the Sensor Connector **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the WIF sensor connector. **C.** Turn the keyswitch to the ON position. **D.** Measure the voltage between the sensor supply and sensor return terminals on the harness connector for the WIF sensor. **E.** Turn the keyswitch to the OFF position.	Between 11 V and 13 V for a 12 V system.	**Result:** The voltage is not within the expected range. The fault is in the sensor supply wire or the return wire . **Repair:** Repair the faulty sensor connector or replace the faulty harness. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault. **Result:** The voltage is within the expected range. Reconnect the WIF sensor to the harness. Proceed to Test Step 4.

(continued)

(Table 141, contd)

Troubleshooting Test Steps	Values	Results
4. Check that the Diagnostic Code is Still Active **A.** Turn the keyswitch to the OFF position. **B.** Connect the electronic service tool to the diagnostic connector. **C.** Turn the keyswitch to the ON position. Wait for at least 1 minute. **D.** Monitor the active diagnostic code screen on the electronic service tool. Check and record any active diagnostic codes.	Diagnostic code	**Result:** A 97-3 diagnostic code is active. Proceed to Test Step 5. **Result:** A 97-15 diagnostic code is active. Proceed to Test Step 8. **Result:** No diagnostic code is active. Return the unit to service.
5. Create a Short Circuit at the Sensor Connector **A.**Turn the keyswitch to the ON position. Wait for at least 1 minute. **B.** Disconnect the WIF sensor from the harness. **C.** Fabricate a jumper wire that is 150 mm (6 inch) long. **D.** Use the jumper to connect the sensor signal terminal to the sensor return terminal on the harness connector for the WIF sensor. **E.** Monitor the active diagnostic code screen on the electronic service tool. Check and record any active diagnostic codes.	Open circuit	**Result:** A 97-3 diagnostic code was active before installing the jumper. A 97-15 code was active with the jumper installed. There is an open circuit in the WIF sensor. **Repair:** Install a replacement sensor. Refer to Disassembly and Assembly, “Water Separator and Fuel Filter (Primary) - Remove and Install” for the correct procedure. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault. **Result:** There is still an active 97-3 diagnostic code with the jumper installed. The sensor is OK. Proceed to Test Step 6.
6. Check the Wiring Between the WIF Sensor and the Interface Connector (if equipped) for an Open Circuit **Note:** This step is only applicable if an interface connector is installed between the WIF sensor and the ECM. Refer to the Electrical Schematic for the application for more information. Proceed to Test Step 7 if no interface connector is installed. **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the connector for the WIF sensor. Disconnect the interface connector between the WIF sensor and the ECM. **C.** Use a suitable multimeter to measure the resistance between the sensor signal terminal on the WIF sensor harness connector and the sensor signal terminal on the interface connector.	Less than 2 Ohms	**Result:** The resistance is greater than 2 Ohms - There is a fault in the wiring between the WIF sensor connector and the interface connector. **Repair:** Repair the faulty wiring or replace the faulty wiring. Use the electronic service tool to clear all logged diagnostic codes and check that the repair eliminates the fault. **Result:**The measured resistance is less than 2 Ohms. Reconnect all connectors. Proceed to Test Step 7.

(continued)

(Table 141, contd)

Troubleshooting Test Steps	Values	Results
7. Check the Signal Wire to the ECM for an Open Circuit **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the connector for the water-in-fuel sensor and the P1 connector. Thoroughly inspect the P1/J1 connector for damage or corrosion. Refer to Troubleshooting, Electrical Connectors - Inspect. **C.** Use a suitable multimeter to check the resistance of the sensor signal wiring between the sensor connector and the P1 connector. **D.** Install the removed connectors.	Less than 2 Ohms.	**Result:** The measured resistance is greater than 2 Ohms. There is an open circuit in the wiring to the ECM. **Repair:** Repair the faulty wiring or replace the faulty wiring. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault. **Result:** The measured resistance is less than 2 Ohms. Contact the Dealer Solutions Network (DSN).
8. Create an Open Circuit at the Sensor Connector **A.** Turn the keyswitch to the ON position. Wait for at least 1 minute. **B.** Disconnect the WIF sensor from the harness. **C.** Monitor the active diagnostic code screen on the electronic service tool. Check and record any active diagnostic codes.	Short circuit	**Result:** A 97-15 diagnostic code remains active with the WIF sensor connected. A 97-3 diagnostic code was active after disconnecting the WIF sensor. There is a short in the WIF sensor. Install a replacement sensor. Refer to Disassembly and Assembly, “Water Separator and Fuel Filter (Primary) - Remove and Install” for the correct procedure. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault. **Result:** The 97-15 diagnostic code is still active with the WIF sensor disconnected. The WIF sensor is OK. Proceed to Test Step 9.

(continued)

(Table 141, contd)

Troubleshooting Test Steps	Values	Results
9. Check the Wiring Between the WIF Sensor and the Interface Connector (if equipped) for a Short Circuit **Note:** This step is only applicable if an interface connector is installed between the WIF sensor and the ECM. Refer to the Electrical Schematic for the application for more information. Proceed to Test Step 7 if no interface connector is installed. **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the WIF sensor connector. Disconnect the interface connector between the WIF sensor and the ECM. **C.** Use a suitable multimeter to measure the resistance between the WIF sensor signal terminal on the interface connector and all other terminals on the interface connector.	Greater than 1 k Ohm	**Result:** At least one of the resistance measurements is less than 1k Ohm. There is a fault in the wiring between the WIF sensor connector and the interface connector. **Repair:** Repair the faulty wiring or replace the faulty wiring. Use the electronic service tool to clear all logged diagnostic codes and check that the repair eliminates the fault. **Result:** All measured resistances are greater than 1 k Ohm. Reconnect all connectors. Proceed to Test Step 10.
10. Check the Harness for a Short Circuit **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the WIF sensor from the harness. Disconnect the P1 connector. Thoroughly inspect the P1/J1 connector for damage or corrosion. Refer to Troubleshooting, Electrical Connectors - Inspect. **C.** Use a multimeter to measure the resistance between the WIF sensor signal terminal on the P1 connector and all other terminals on P1. **D.** Reconnect the WIF sensor to the harness. Reconnect the P1 connector.	Greater than 1k Ohm	**Result:** At least one of the resistance measurements is less than 1k Ohm. There is a short in the wiring to the ECM. **Repair:** Repair the faulty wiring or replace the faulty wiring. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault. **Result:** All resistance measurements are greater than 1k Ohm. Contact the DSN.

Service

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Service Tool Features

Note: The most recent version of the electronic service tool must be used when connecting to the ECMs.

Override Parameters

The override parameters screen has multiple overrides. The parameters control various functions on the engine and the aftertreatment. These functions and features allow the technician to troubleshoot different engine systems.

Override Parameters Listed in the Engine ECM Menu

Engine Fuel Supply Lift Pump Relay Override

This override is used to energize the Electric Fuel Lift Pump (EFLP) relay. The override can be used to test the EFLP relay only when engine speed is zero. The EFLP relay is switched to either ON or OFF.

Glow Plug Starting Aid Override

This override is used to check that the glow plugs are functioning correctly. The override requires that engine speed must be zero.

System Troubleshooting Settings

The “System Troubleshooting Settings” screen will allow overrides to be enabled.

System Troubleshooting Settings Listed in the Engine ECM Menu

Injection Disable Override

This override will allow the user to disable the injectors from activating when performing certain troubleshooting procedures.

Active Diagnostic Codes

The purpose of this screen is to show all the active diagnostic codes.

Select the “Diagnostics” tab.

Select the “Active Diagnostic Codes” tab.

Tab Functions At Bottom of Screen

Reset All

This tab will reset all the active codes.

Troubleshoot Code

This tab is not available. Refer to Troubleshooting, “Diagnostic Trouble Codes” for further information.

Troubleshoot Symptom

This tab is not available. Refer to Troubleshooting, “Diagnostic Trouble Codes” for further information.

Logged Diagnostic Codes

The purpose of this screen is to show all the logged diagnostic codes.

Select the “Diagnostics” tab.

Select the “Logged Diagnostic Codes” tab.

Tab Functions At Bottom of Screen

Clear

This tab will clear specific codes when highlighted.

Clear All

This tab will clear all logged diagnostic codes.

Troubleshoot Code

This tab is not available. Refer to Troubleshooting, “Diagnostic Trouble Codes” for further information.

Troubleshoot Symptom

This tab is not available. Refer to Troubleshooting, “Diagnostic Trouble Codes” for further information.

Active Event Codes

The purpose of this screen is to show all the active event codes.

Select the “Diagnostics” tab.

Select the “Events” tab.

Tab Function At Bottom of Screen

Reset All

This tab will reset all the active codes. Some of the event codes will "latch" to active status. Repairing the system will not "unlatch" the event codes and the event codes must be reset with the electronic service tool.

Logged Event Codes

The purpose of this screen is to show all the logged event codes.

Select the "Diagnostics" tab.

Select the "Events" tab.

Select the "Logged Events" tab.

Tab Functions At Bottom of Screen

Clear

This tab will clear specific codes when highlighted.

Clear All

This tab will clear all logged diagnostic codes.

Troubleshoot Code

This tab is not available. Refer to Troubleshooting, "Diagnostic Trouble Codes" for further information.

Troubleshoot Symptom

This tab is not available. Refer to Troubleshooting, "Diagnostic Trouble Codes" for further information.

Diagnostic Tests

Electronic service tool diagnostic tests are listed below.

Select the "Diagnostics" tab.

Select the "Diagnostic Tests" tab.

Diagnostic Tests Listed in the Engine ECM Menu

Injector Solenoid Test

The purpose of the injector solenoid test is to diagnose injector wiring and injector solenoid functionality.

This test identifies an open circuit or a short circuit in the circuit for the injector solenoids. The test activates the injector solenoids one at a time while the engine is not running. A good solenoid will create an audible click when the solenoid is activated. The electronic service tool indicates the status of the solenoid as "OK" , "Open" , or "Short" .

The injectors must be powered to enable the automatic test to be run. To start the test, select the "Start" button. The automatic test will continually cycle through the injectors until the "Stop" button is selected.

There are no test results if the "Change" button is selected to power or cutout an individual injector. When selected, the "Power All" and "Cutout All" buttons do not give test results.

Cylinder Cutout Test

The cylinder cutout test allows one cylinder or multiple cylinders to be deactivated. The cylinder cutout test is useful when troubleshooting poor engine performance or a suspected injector failure when used after a cylinder compression test.

The process involves cutting out power and restoring power to a selected cylinder. The remaining powered cylinders are then monitored for expected increases in delivered fuel volume. If the fuel volume does not increase, the cylinder that was not powered was not working prior to being cut out for the test.

A cylinder that is not working means that the power produced by that cylinder is comparatively less than the other cylinders. This fault can have numerous root causes relating to the cylinder including the injector, valves, and piston.

The cylinder cutout test can be performed automatically or manually. This function provides a way to identify misfiring cylinders when the engine is running.

Automatic Cylinder Cutout Test

Engine speed and load need to be constant and stable for the "Automatic Cylinder Cutout Test" average fuel measurements to be accurate. Changes in engine speed and load due to auxiliary equipment during the test may lead to inaccurate results.

From the "Diagnostics" menu, select "Diagnostic Tests" , then "Cylinder Cutout Test" . Click start to run the "Automatic Cylinder Cutout Test" . The automatic test will cut out power and restore power to each cylinder in turn, measuring the average fuel delivery when each cylinder is cut out.

Perform the "Automatic Cylinder Cutout Test" with the engine at approximately 50 percent load condition. Running the engine with some load applied will amplify the effects of any faults and make a fault easier to detect. If the engine load is too high, the vibration will be increased and the engine may stall.

Fuel measurements have successfully been taken when the test has completed. Save the “Cylinder Cutout Test” results for future reference.

Evaluating the “Automatic Cylinder Cutout Test” Fuel Measurements

The “Automatic Cylinder Cutout Test” does not provide a pass/fail criteria. At the end of the test, the delivered fuel volume for each cylinder will be provided.

The delivered fuel volume is displayed in units of cubic millimeters of governor requested fuel. When a cylinder is cut out, the governor fuel will increase the requested fuel for the other powered injectors to compensate.

Table 142

Cylinder Cutout	Delivered Fuel Volume (Cubic Millimeters)
Cylinder 1	51.3
Cylinder 2	50.8
Cylinder 3	51.3
Cylinder 4	49.8
Cylinder 5	51.8
Cylinder 6	50.8
All cylinders powered	41

Table 142 shows an example of when all cylinders are operating normally. The delivered fuel volumes are all similar. When a cylinder is cut out, the fuel delivery increases due to the loss of power from the cylinder and an additional increase in delivered fuel volume to overcome the pumping losses of the cut out cylinder.

If a cylinder that is weak is cut out, the fuel increase is less than cutting out a cylinder that is operating normally.

Table 143

Cylinder Cutout	Delivered Fuel Volume (Cubic Millimeters)
Cylinder 1	55.5
Cylinder 2	55
Cylinder 3	55.5
Cylinder 4	54
Cylinder 5	56
Cylinder 6	42.4
All cylinders powered	42.4

Table 143 shows an example of cylinder 6 not producing any power. The delivered fuel volume when cylinder 6 is cut out is the same as the delivered fuel volume when all cylinders are powered.

If a cylinder that is strong is cut out, the fuel increase will be more than if a cylinder that is operating normally is cut out.

Table 144

Cylinder Cutout	Delivered Fuel Volume (Cubic Millimeters)
Cylinder 1	56.8
Cylinder 2	56.3
Cylinder 3	56.8
Cylinder 4	59.1
Cylinder 5	57.3
Cylinder 6	57.3
All cylinders powered	47.3

Table 144 shows an example of cylinder 4 producing approximately 25% more power the other cylinders which are operating normally. The delivered fuel volume when cylinder 4 is cut out is higher than the delivered fuel volume when all the other cylinders are cut out.

Manual Cylinder Cutout Test

The “Manual Cylinder Cutout Test” is available as a method to manually cutout a cylinder to investigate issues such as “Engine Misfires Runs Rough or is Unstable” or “Engine Vibration is Excessive” .

The “Manual Cylinder Cutout” can be performed on one injector or multiple injectors at once. This function provides a way to identify misfiring cylinders when the engine is running.

From the “Diagnostics” menu, select “Diagnostic Tests” , then “Cylinder Cutout Test” . Select a cylinder to cut out, then click “Change” . The status of the selected cylinder will change from “Powered” to “Cutout” . Click “Change” again to change the status back to “Powered” .

Note: More than one cylinder can be cut out simultaneously, but cutting out too many cylinders may result in the engine stalling.

Click “Power All” to power all the cylinders.

When a cylinder is cut out, the engine noise, vibration, or smoke can be observed to help determine whether an individual cylinder is the cause of an issue.

Perform a cylinder compression test to isolate injector faults from a malfunctioning cylinder. If a cylinder passes the compression test, there may be a faulty injector. If a cylinder fails a compression test, there may still be a faulty injector which has damaged the cylinder, such as damage from over- fueling. Refer to Systems Operation, Testing and Adjusting, Compression - Test.

Wiggle Test

The purpose of the Wiggle Test is to detect intermittent electrical faults in electronic control systems. The Wiggle Test function allows the user to determine if there is an intermittent wiring fault. The test will indicate (by changing the value reading) which parameter moved beyond a predetermined range while wiggling the wiring harness, sensor, or connector.

This test requires that the engine is OFF and the key switch is in the ON position (or ECM energized and 0 engine speed). If the engine is started with the wiggle test active, the wiggle test will abort.

The Wiggle Test will reduce all ECM requirements to trip fault codes, making the diagnostics sensitive. Under normal operation some fault codes need multiple occurrences before the code will log. But during this test the fault codes will trip the first time.

The technician must wiggle and shake the wiring to check if codes go active. If any parameter changes state electrically, an audible alarm is also activated. Once the test has ended, the ECM returns to normal diagnostic trip requirements.

Fuel Rail Pressure Relief Valve Test

The purpose of this test is to check that the opening pressure for the pressure relief valve is above 200 MPa (29008 psi). The engine speed is automatically increased above a minimum threshold when this test is run and then the rail pressure is increased to 200 MPa (29008 psi). After a short time, the rail pressure is reduced to normal. For constant speed applications, the maximum rail pressure is equivalent to the specific engine speed. Expect lower rail pressure when compared to variable speed applications.

Fuel Rail Pressure Test

The purpose of this test is to check the integrity of the high-pressure fuel system after work has been completed. The test can also help with troubleshooting general fuel system-related issues.

The engine speed is automatically increased above a minimum threshold when this test is run. The rail pressure is increased to 200 MPa (29008 psi) and held at this pressure for a time. The rail pressure is then reduced to normal. For constant speed applications, the maximum rail pressure is equivalent to the specific engine speed. Expect lower rail pressure when compared to variable speed applications.

If the check is for system integrity after work, the engine must be shut down before inspecting the high-pressure fuel system for fuel leaks. If the reason for the test is troubleshooting general fuel system-related issues, check for error codes. Any error codes that occur during the test should be used to provide guidance for troubleshooting.

Aftertreatment Regeneration System Test

Before performing this test, make sure that loads that can cause power fluctuations are inhibited. An example of a fluctuating load is air conditioning.

This test must be run with the engine running but not under load. The engine must reach a minimum coolant temperature. Once the conditions are met, engine speed and load must be reduced to the minimum level that can be achieved with the engine/equipment configuration.

The ECM software performs the necessary checks to ensure that the test runs under the required conditions. If the test aborts before completion, the electronic service tool displays any relevant error identifiers.

The following conditions must be met before the Aftertreatment Regeneration System Test can begin:

- No related active diagnostic codes
- Coolant at the minimum required temperature
- Engine speed and load in the required range

The ECM will gradually close the engine Intake Throttle Valve (ITV) to establish a desired Intake Manifold Air Pressure (IMAP) setpoint. If the desired IMAP setpoint is not achieved, an error identifier will be displayed, indicating that the intake manifold pressure is too high.

If the desired IMAP setpoint is achieved, the test will wait for the DPF intake temperature to stabilize. The test will then check if the DPF intake temperature is above a minimum threshold. If the minimum temperature threshold is not met, an error identifier will be displayed to indicate that the DPF intake temperature is too low.

Note: If the DPF intake temperature is too low or the desired IMAP cannot be reached, the engine speed will be increased and the test will begin again. If the desired IMAP or DPF intake temperature still cannot be reached, the test will be aborted and the appropriate identifier will be displayed.

Air System Motor Valves Verification Test

The “Air System Motor Valve Verification Test” will identify whether the NRS valve and the intake throttle valve are working correctly. This test must be performed when the engine speed is zero and the battery voltage is within an acceptable range. For a 12V system, the test must only be performed when the battery voltage is between 9V and 16V. If the battery voltage is out of the required range, the test will be aborted.

The “Air System Motor Valve Verification Test” will actively check position sensor diagnostics, motor short diagnostics, and motor open circuit diagnostics. The test will abort if any of these diagnostic codes become active.

If the engine speed is not zero while the test is being performed, the test will be aborted. If no electrical diagnostic codes are active, the test will calibrate the NRS valve minimum position and the intake throttle valve minimum and maximum position. The test then moves the valves to various positions and checks the position sensor within each valve to confirm that the valve has responded correctly. Each valve will be tested in turn, starting with the NRS valve. If a test threshold is exceeded or any related diagnostic codes become active, the test will abort and generate a service tool error identifier.

Engine Throttle Valve Replacement Reset

The engine intake throttle valve minimum and maximum positions are calibrated automatically at each key off and stored in the ECM Non-Volatile Memory (NVM) to ensure accurate range over the life of the product. Engine intake throttle valve usage information is also stored in NVM. After replacement of the engine intake throttle valve, the “Engine Throttle Valve Replacement Reset” should be run to reset the minimum and maximum position calibrations to the nominal values and reset the usage information. Run the “Air System Motor Valve Verification Test” to recalibrate the specific minimum and maximum positions for the new engine intake throttle valve.

1. Connect to the electronic service tool.

2. Select the engine ECM.

3. Select the “Service” tab.

4. Select the “Engine Throttle Valve Replacement Reset” feature.

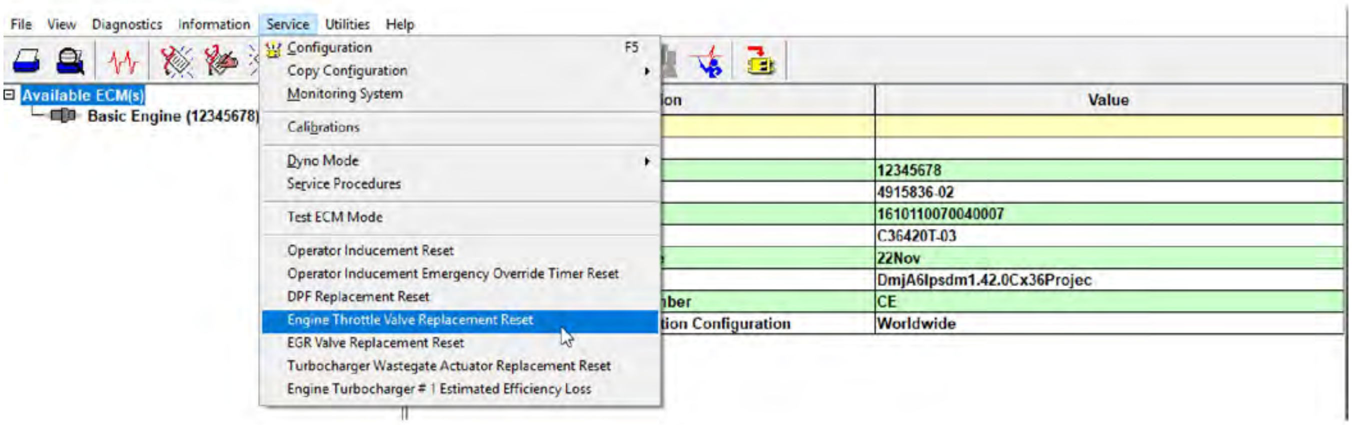


Illustration 34 g06518168

The screen will display the current minimum and maximum position calibrations and usage information:

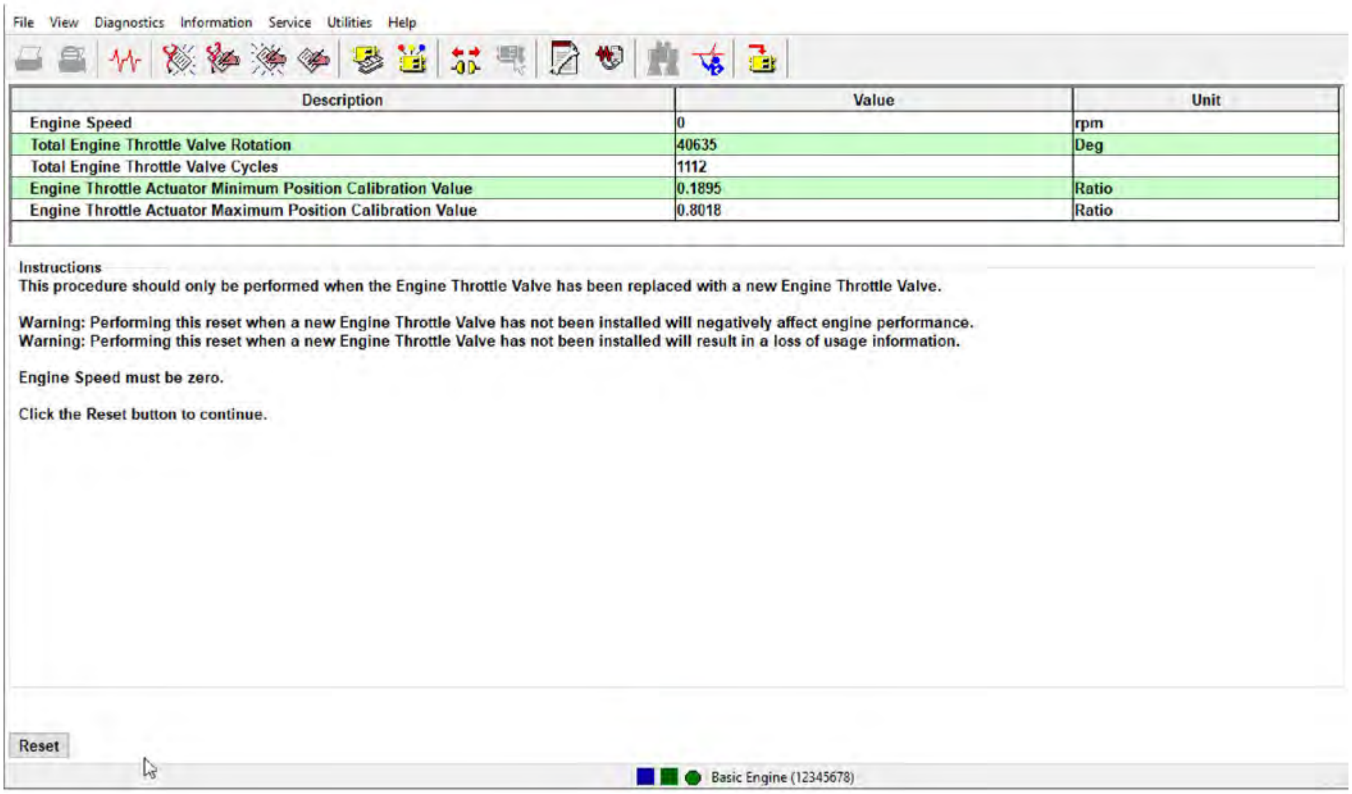


Illustration 35 g06518172

When the "Reset" button is selected, a warning message is displayed which must be accepted before the reset is triggered. Only perform this function after replacement of the Engine Intake Throttle Valve, as the loss of usage information and could negatively impact engine performance. Selecting "Yes" will command the service tool to request that the ECM resets this information:

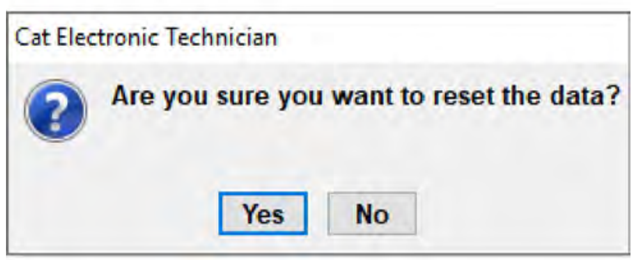


Illustration 36 g06518197

After the reset has completed, a "Reset was successful" message will be displayed on the screen:

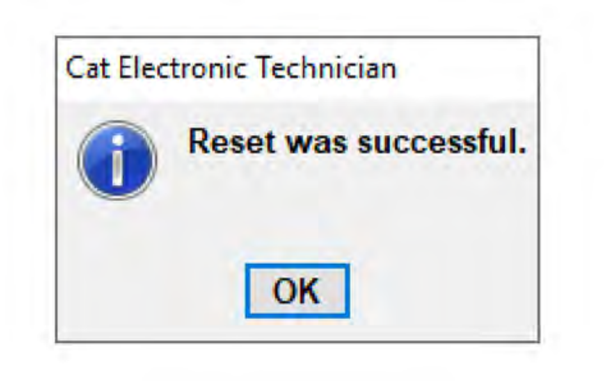


Illustration 37 g06518201

After selecting “OK” , the minimum and maximum position calibrations and usage information will be read again from the ECM and displayed in the reset feature. All will be 0, confirming the reset was successful:

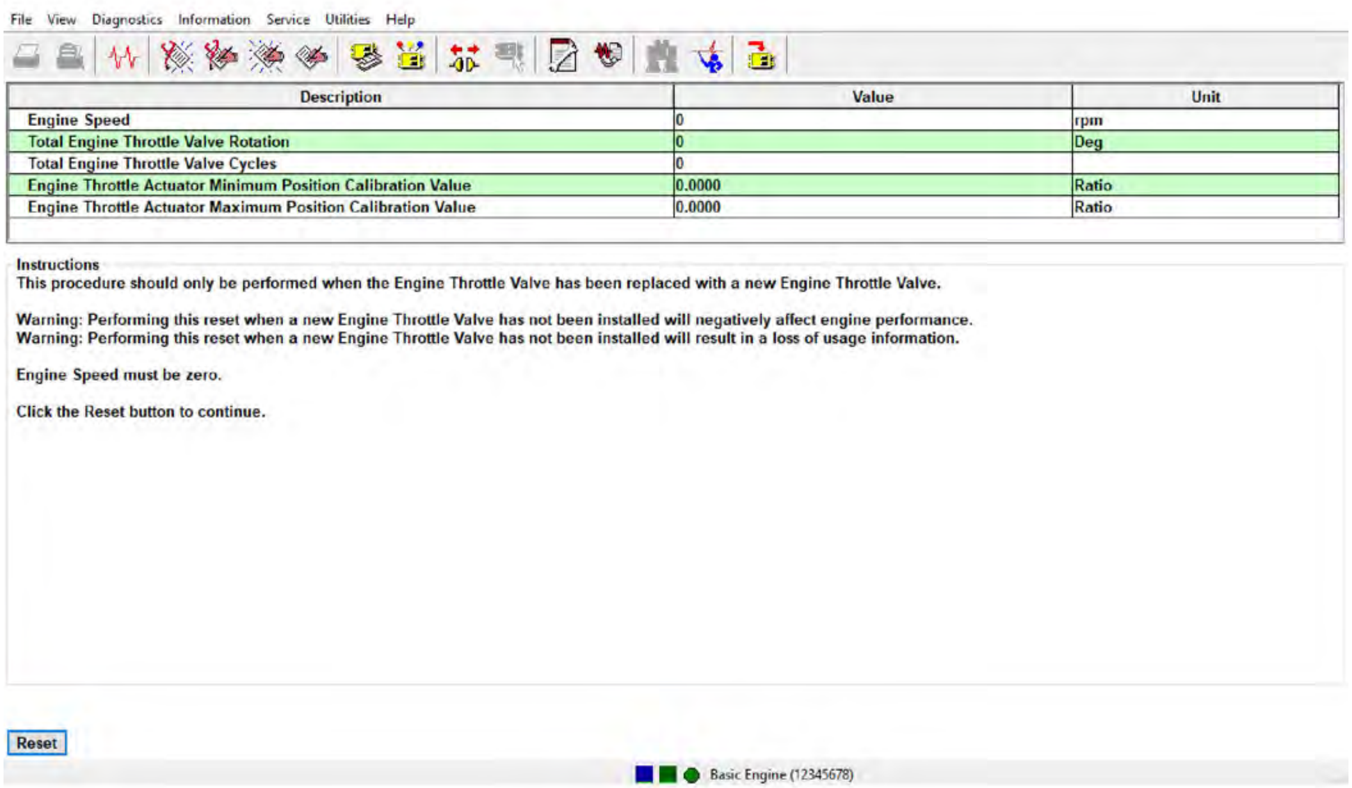


Illustration 38 g06518204

EGR Valve Replacement Reset

The EGR valve minimum position is calibrated automatically at each key off and stored in the ECM Non-Volatile Memory (NVM) to ensure accurate range over the life of the product. EGR valve usage information is also stored in NVM. After replacement of the EGR valve, the “EGR Valve Replacement Reset” feature should be run to reset the minimum position calibration to the nominal value and reset the usage information. Run the “Air System Motor Valve Verification Test” to recalibrate the specific minimum position for the new EGR Valve.

1. Connect to the electronic service tool.

2. Select the engine ECM.

3. Select the “Service” tab.

4. Select the “Engine EGR Valve Replacement Reset” feature.

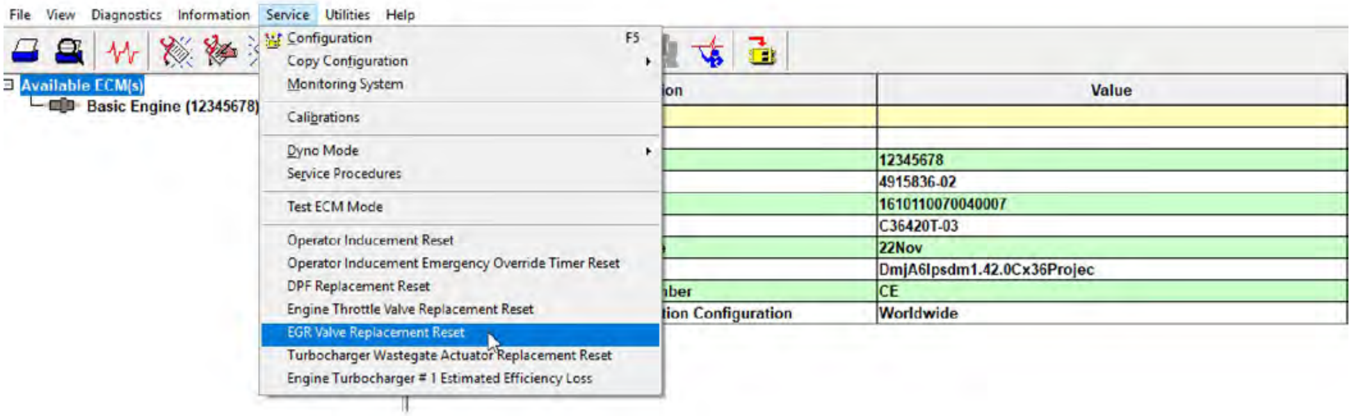


Illustration 39 g06518207

The screen will display the current minimum and maximum position calibrations and usage information:

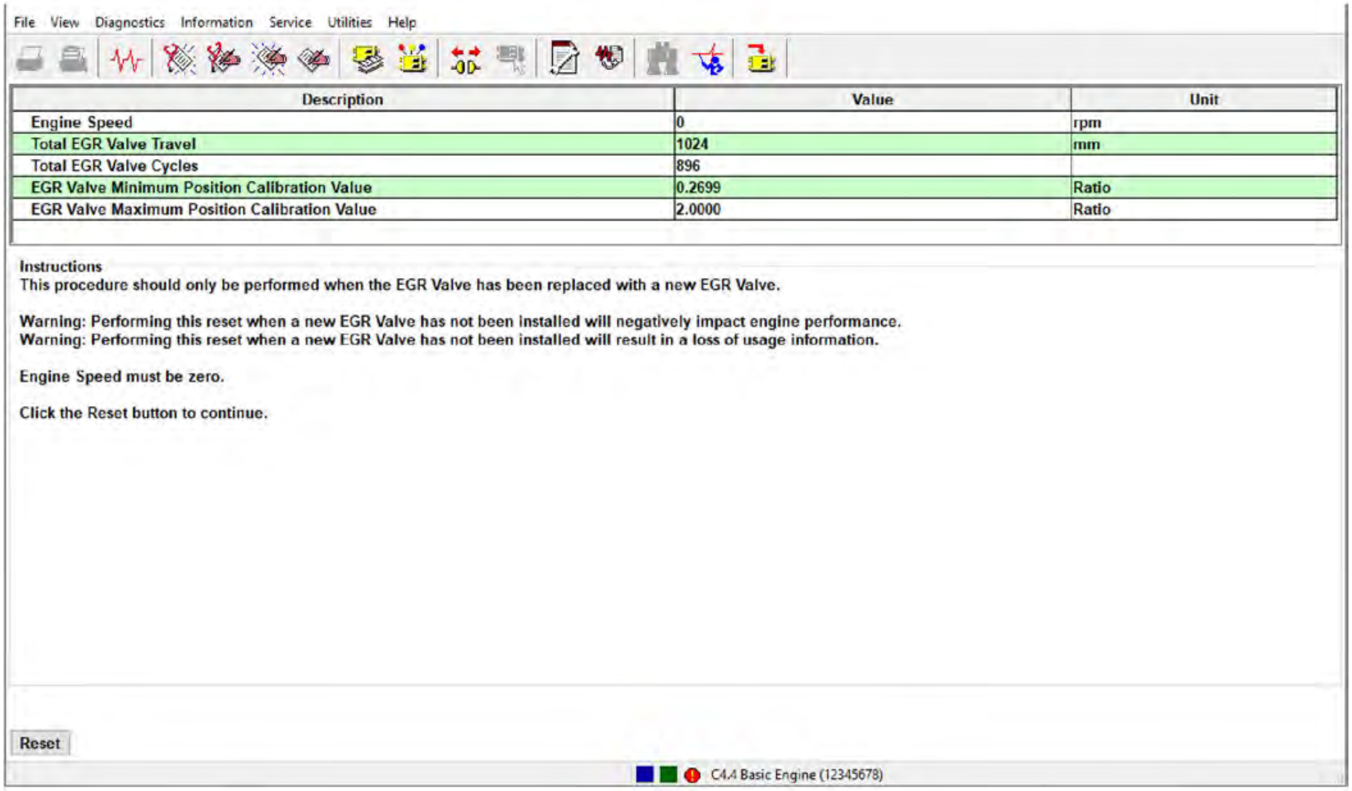


Illustration 40 g06518217

When the “Reset” button is selected, a warning message is displayed which must be accepted before the reset is triggered. This function should only be run after replacement of the EGR Valve, as the loss of usage information and could negatively impact engine performance. Selecting “Yes” will command the service tool to request that the ECM resets this information:

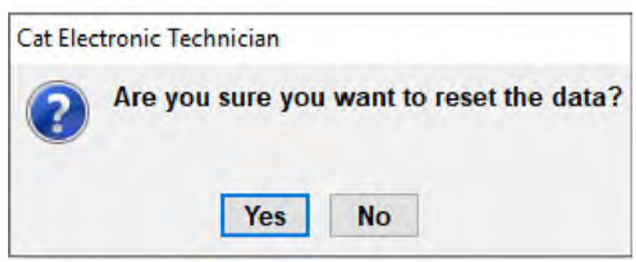


Illustration 41 g06518197

After the reset has completed, a “Reset was successful” message will be displayed on the screen:

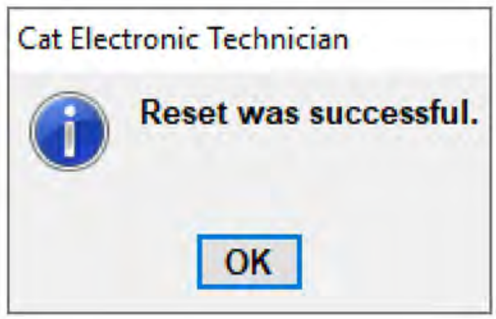


Illustration 42 g06518201

After selecting OK, the minimum and maximum position calibrations and usage information will be read again from the ECM and displayed in the reset feature. All will be 0, confirming the reset was successful:

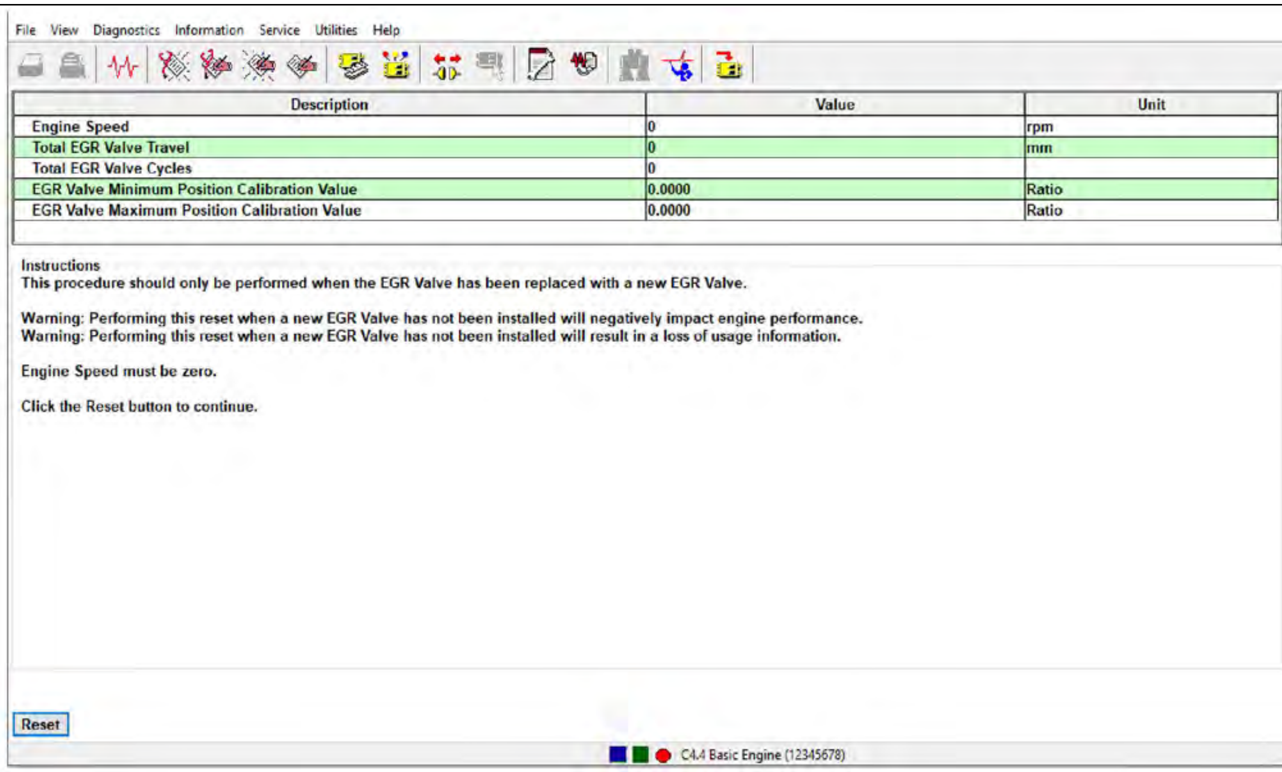


Illustration 43 g06518221

Manual Hydrocarbon Dosing Capability Test

Before performing this test, make sure that loads that can cause power fluctuations are inhibited. An example of a fluctuating load is air conditioning.

This test is used to check the HC dosing process. Periodic HC dosing elevates the exhaust gas temperature to clean the aftertreatment system.

Note: The test will check that HC dosing raises the DPF intake temperature to the correct level.

The test must be performed at low engine speed and low load. The test will only start when all the following criteria are met:

- The engine is running
- Coolant at the minimum required temperature

- No active diagnostic codes

Note: Engine speed may be automatically increased until the desired conditions are met.

If Exhaust Thermal Management is allowed, the ECM will gradually close the engine Intake Throttle Valve (ITV) to establish a desired Intake Manifold Air Pressure (IMAP) setpoint. If the desired IMAP setpoint is not achieved, an error identifier will be displayed, indicating that the intake manifold pressure is too high.
Once the desired IMAP setpoint is achieved, the test will use the Intake Throttle Valve (ITV) to increase the DOC intake temperature. When the target DOC inlet temperature is reached, HC dosing will be initiated automatically. The test will check for adequate heat rise across the DOC during HC dosing ignition phase. If the required temperature rise is achieved, HC dosing will increase until the DPF intake temperature reaches approximately 475° C (887° F). If the DOC intake temperature is too low, the test may increase the engine speed to elevated idle speed. If the engine speed has already been elevated, the test will abort with an error identifier. If the target DOC intake temperature is achieved, the test will end successfully.

Cooling System Capacity Test

This test is only used as part of the application and installation process.

Aftertreatment Regeneration Commissioning Test

This test is only used as part of the application and installation process.

Note: A 3722-16 diagnostic code will become active during this test. This code is only active during the test and will not be logged. The purpose of this code is to test the HC Dosing escalation logic without affecting the actual soot loading percent or creating a “High Soot Loading” event in the ECM memory. No further troubleshooting is required for a 3722-16 diagnostic code.

Aftertreatment System Temperature Drop Assessment Test

This test is only used as part of the application and installation process.

Calibrations

Electronic service tool calibration procedures are listed below.

In the electronic service tool, select the engine ECM.

Select the “Service” tab.

Select the “Calibrations” tab.

Calibrations Listed in the Engine ECM Menu

Injector Codes Calibration

Whenever an injector is replaced, the injector must be trimmed. Trimming the injector calibrates all the injectors to deliver the same amount of fuel. The injector trim code is on the injector. The Injector Codes Calibration allows the injector trim code information to be programmed into the ECM. After the injector is calibrated, the calibration data is checked for validity. For further information, refer to Troubleshooting, “Injector Code - Calibrate”.

High Pressure Fuel Pump Calibration

High-pressure fuel pump calibration is used to perform a pump calibration manually. In normal operation, this calibration procedure will occur automatically. Only perform this calibration as instructed during troubleshooting procedures. The pump calibration is used to optimize the dynamic characteristics of the rail pressure control. If there are issues with overshooting or undershooting the desired rail pressure, a pump calibration will improve the rail pressure control.

Dyno Mode

In the electronic service tool, select the engine ECM.

Select the “Service” tab.

Select the “Dyno Mode” tab.

Dyno Mode

When the engine is installed in a machine, the engine ECM receives inputs from various machine components, such as the transmission ECM or machine ECM. If the ECM does not see the inputs, the ECM assumes that something is wrong and sets a diagnostic trouble code.

Dyno Mode is used to run an engine on a dynamometer without derates or diagnostic trouble codes tripping from missing inputs. Dyno Mode does not require the CEM to be installed.

1. Select “Enable” to enable Dyno Mode.

2. Return to the “Service” tab.

3. Select the “Service Procedures” tab.

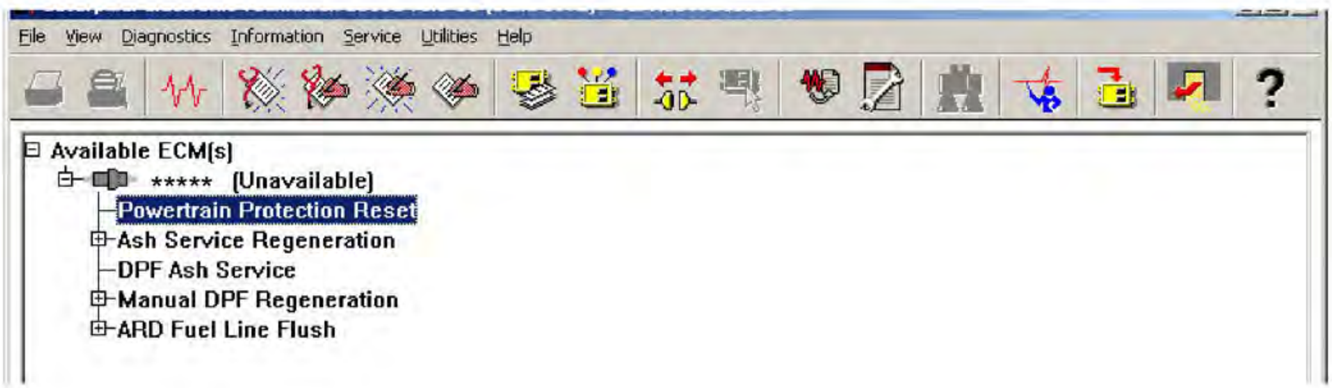


Illustration 44 g03826879

4. Select the “Powertrain Protection Reset” (Available on select models).

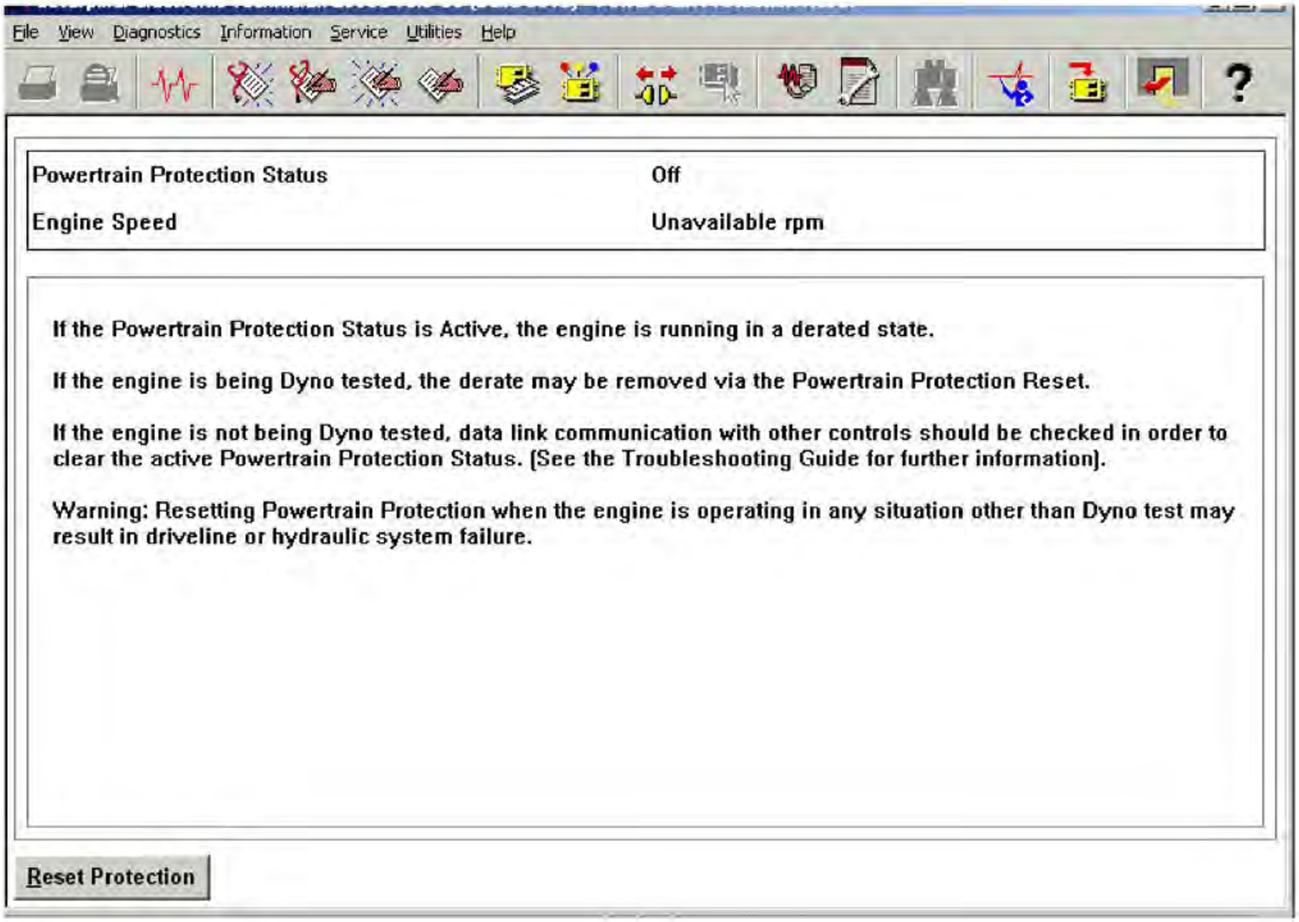


Illustration 45 g03826882

5. Select “Reset Protection” .

If the engine has multiple power ratings, select the highest rating.

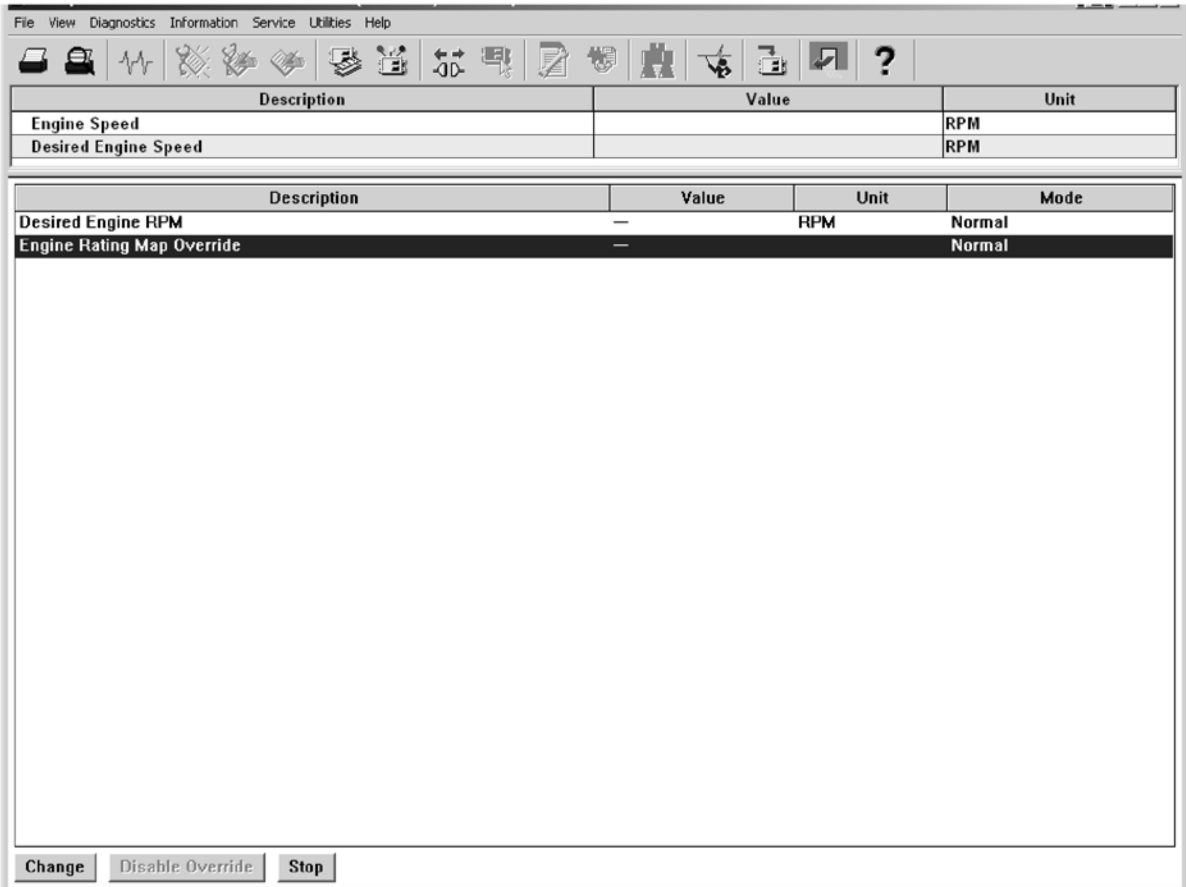


Illustration 46 g03826884

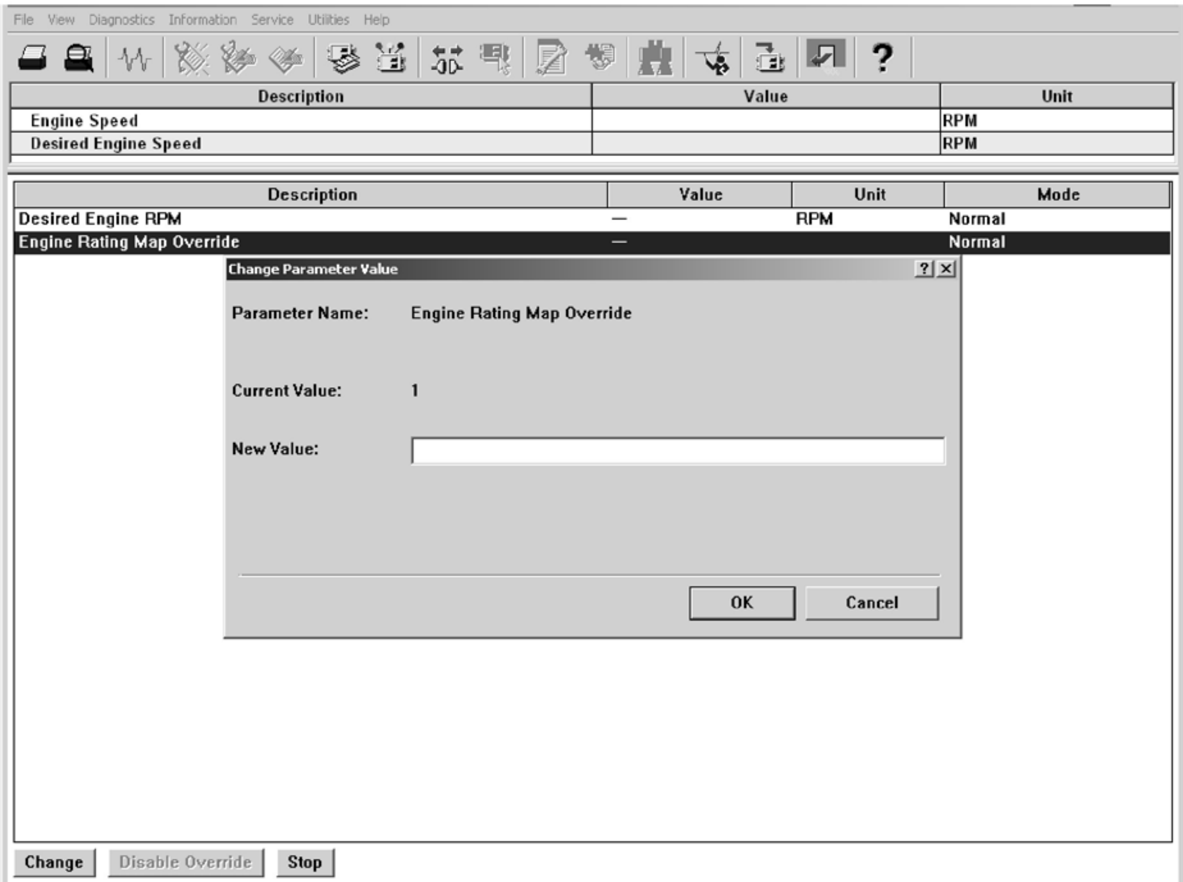


Illustration 47 g03826886

Service Procedures

Electronic service tool service procedures are listed below.

In the electronic service tool, select the engine ECM.

Select the “Service” tab.

Select the “Service Procedures” tab.

Service Procedures Listed in the Engine ECM Menu

Aftertreatment Recovery Procedure

Before performing this test, make sure that loads that can cause power fluctuations are inhibited. An example of a fluctuating load is air conditioning.

This procedure is used specifically for engines which require periodic HC dosing to clean the aftertreatment system to reduce DPF soot load. The purpose of the procedure is to recover performance of the complete aftertreatment system.

The ECM software will perform the necessary checks to ensure that the procedure runs under the required conditions. The checks will generate any relevant error identifiers if the procedure aborts before completion.

The following engine conditions must be met before the procedure will start:

- No related active diagnostic codes
- Coolant temperature condition met
- Engine speed and load in the required range
- DPF Soot load is not too high

If the engine speed is not within the desired range, engine speed may be automatically adjusted to approximately 1700 rpm. When the required conditions are met, the procedure assesses the DPF soot load. If soot loading is too high to allow HC Dosing, the procedure will use elevated idle and the engine intake throttle valve to reduce the soot load. The procedure will target a specific desired intake manifold air pressure.

The procedure also checks that the DPF intake temperature is above a minimum pass threshold. If the minimum temperature threshold is not met, an error identifier is displayed, indicating that the DPF intake temperature is too low. Once the system verification steps are complete, the procedure will continue to run for a set time to desulfate the DPF.

If the soot load is reduced sufficiently, the procedure will start HC dosing and assesses whether the system can generate the required aftertreatment temperature. The procedure will target a DPF intake temperature required to reduce soot load below the required level. A higher than normal DOC intake temperature is targeted to ensure that light-off occurs first time.

If the target DOC intake temperature is reached, HC dosing will be initiated automatically. The procedure will check for adequate heat rise across the DOC during the HC dosing ignition phase. If the temperature rise is not sufficient, the procedure will perform the DPF desulfation procedure before attempting HC Dosing again. If the DOC fails to ignite again, the procedure will abort with an error identifier.

Note: If DPF desulfation had been previously performed due to high soot load, the test will abort immediately with an error identifier. HC dosing will not be attempted.

If the heat rise target is achieved, the procedure will continue to increase the amount of HC dosing until the DPF intake temperature stabilizes at the target value.

If this part of the procedure is successful, HC dosing will continue until the required DPF intake temperature is achieved.

If the soot load has not sufficiently reduced, the test will abort with an error identifier.

Service Tool Error Identifiers

Error identifiers are displayed when an electronic service tool service test has failed. The error identifiers explain the reason for the service test failure. The service test error identifier may identify the failed component. For a list of error identifiers, refer to Troubleshooting, “Service Tool Error Identifiers”. If necessary, refer to the troubleshooting guide for the appropriate troubleshooting procedure.

Aftertreatment History

Connect to the electronic service tool.

Select the Engine ECM.

Select the Information tab.

Aftertreatment Abnormal Shutdown History

This feature allows the user to see when the engine was shut down incorrectly. This screen shows hot shutdown events, and cold shutdown events.

Hydrocarbon Dosing History

Connect to the electronic service tool.

Select the Engine ECM.

Select the Information tab.

Select History

Select the Hydrocarbon Dosing History

The ECM logs timestamp and engine data at the start and end of an HC dosing regeneration. Data can be viewed using the electronic service tool to analyze the process when HC dosing occurs.

Snapshots

Snapshots are only available for specific system faults. Other faults will not trigger a snapshot.

Snapshots record data for a predefined time before and after a diagnostic trouble code or event code is triggered and store the data in the ECM.

Only data for the most recent occurrence of the fault code is stored in the snapshot. Data from the previous snapshot occurrence will be overwritten. The data must be downloaded before either clearing codes or before taking troubleshooting action.

A service technician should not interpret snapshot data via the service tool in the field. Without specialist control system knowledge the data can be easily misinterpreted.

Download the data using the electronic service tool and supplied back to the Dealer Solutions Network (DSN) when requested for analysis.

1. Select the “Information” tab. Select the “Snapshot” tab and then select the “Viewer” tab.

   The following diagnostic codes and event codes will trigger snapshots.

Table 145

J1939 Code and Description
102-16 Engine Intake Manifold #1 Pressure : High - moderate severity (2)
102-18 Engine Intake Manifold #1 Pressure : Low - moderate severity (2)
157-3 Engine Injector Metering Rail #1 Pressure : Voltage Above Normal
157-4 Engine Injector Metering Rail #1 Pressure : Voltage Below Normal
651-5 Engine Injector Cylinder #01 : Current Below Normal
651-6 Engine Injector Cylinder #1: Current Above Normal
652-5 Engine Injector Cylinder #02 : Current Below Normal
652-6 Engine Injector Cylinder #2: Current Above Normal
653-5 Engine Injector Cylinder #03 : Current Below Normal
653-6 Engine Injector Cylinder #3: Current Above Normal
654-5 Engine Injector Cylinder #04 : Current Below Normal
654-6 Engine Injector Cylinder #4: Current Above Normal
174-3 Engine Fuel Temperature 1 : Voltage Above Normal
174-4 Engine Fuel Temperature 1 : Voltage Below Normal
1076-5 Engine Fuel Injection Pump Fuel Control Valve : Current Below Normal
1076-6 Engine Fuel Injection Pump Fuel Control Valve : Current Above Normal
174-16 Engine Fuel Temperature 1 : High - moderate severity (2)
157-16 Engine Injector Metering Rail #1 Pressure : High - moderate severity (2)
157-18 Engine Injector Metering Rail #1 Pressure : Low - moderate severity (2)
5571-0 High Pressure Common Rail Fuel Pressure Relief Valve : High - most severe (3)

Perform the following steps to download and save snapshot data from the electronic service tool:

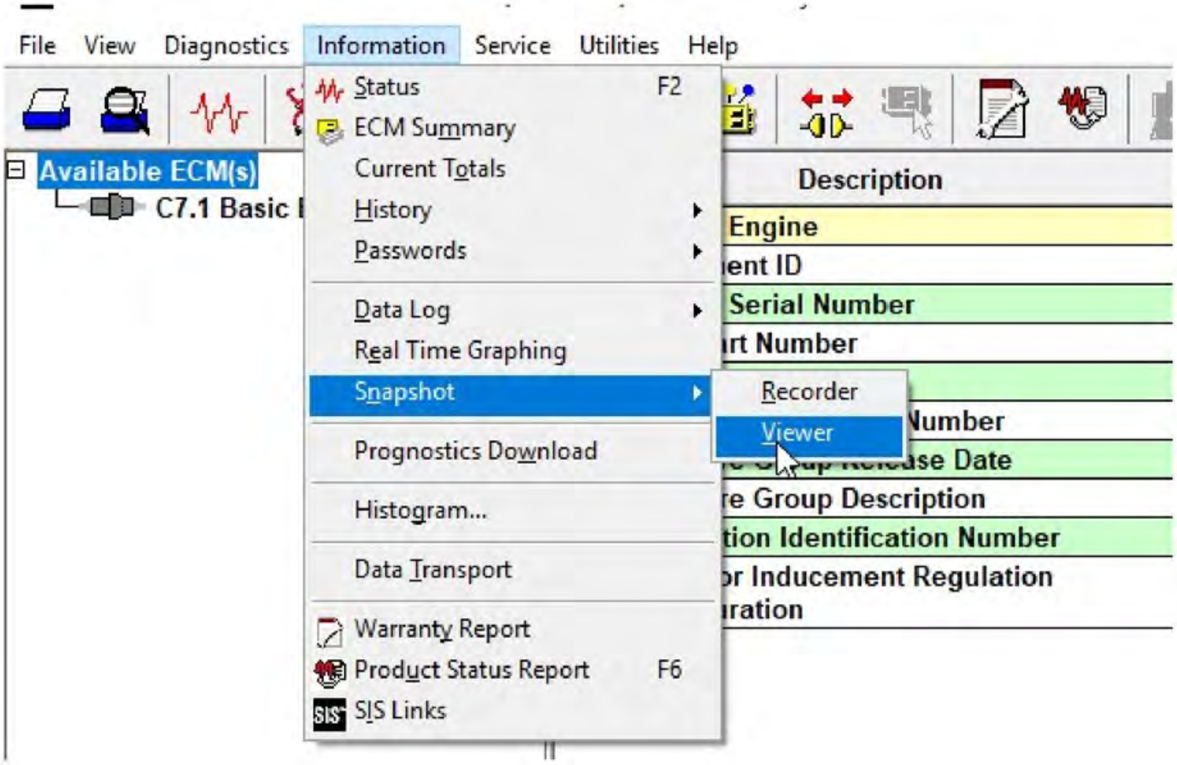


Illustration 48 g06395524

2. From the “Information” menu, select “Snapshot” , then select “Viewer” .

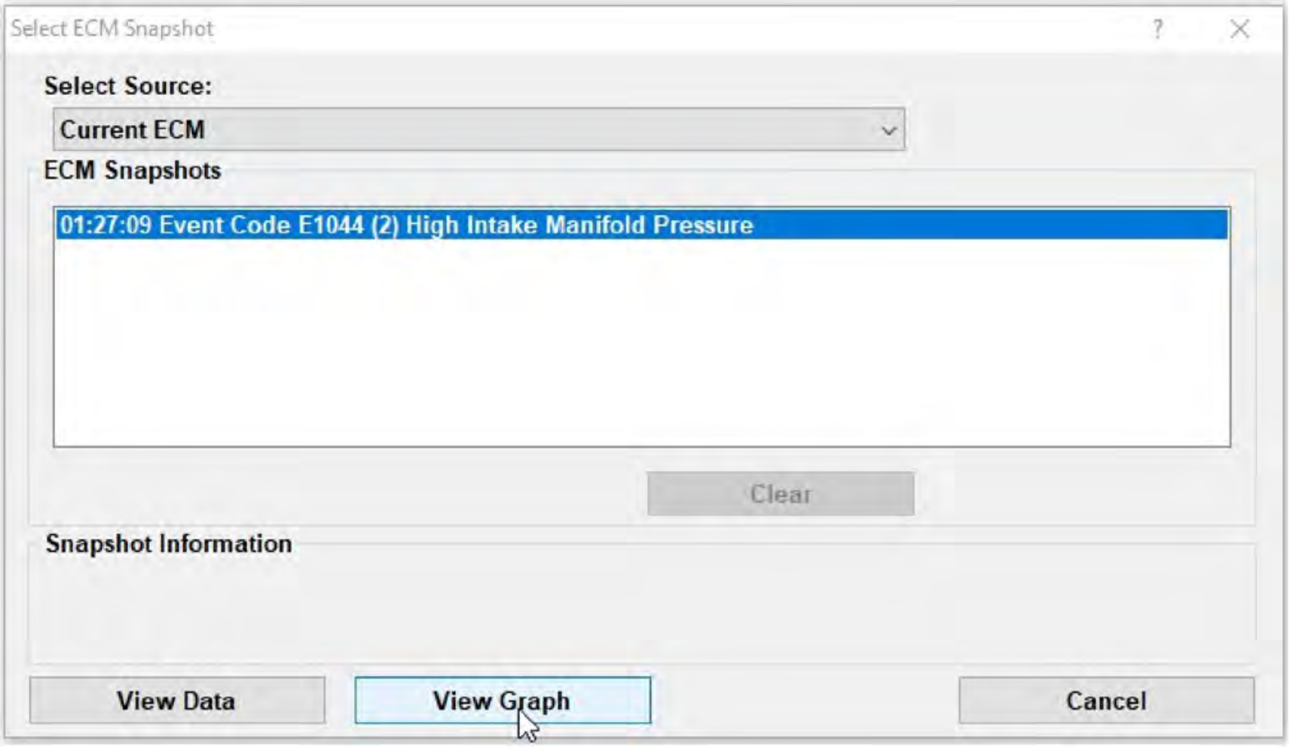


Illustration 49 g06395559

3. Select the diagnostic trouble code or event code, then click “View Graph” .

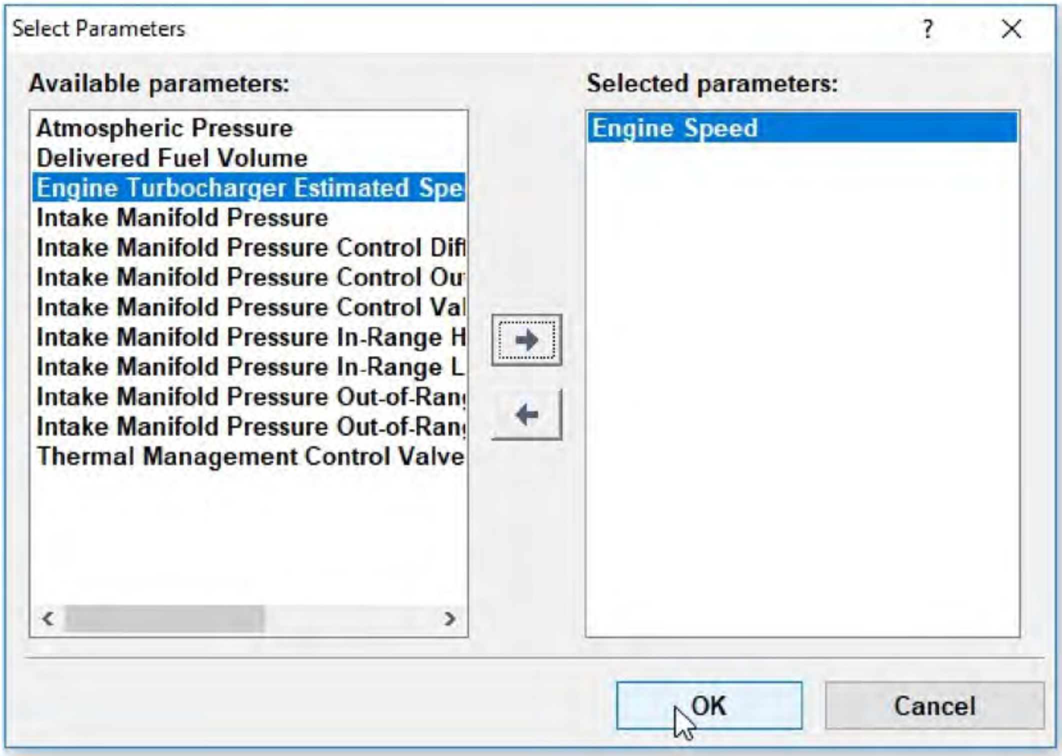


Illustration 50 g06395572

4. From the available parameters, select the “Engine Speed” parameter, then click “OK” .

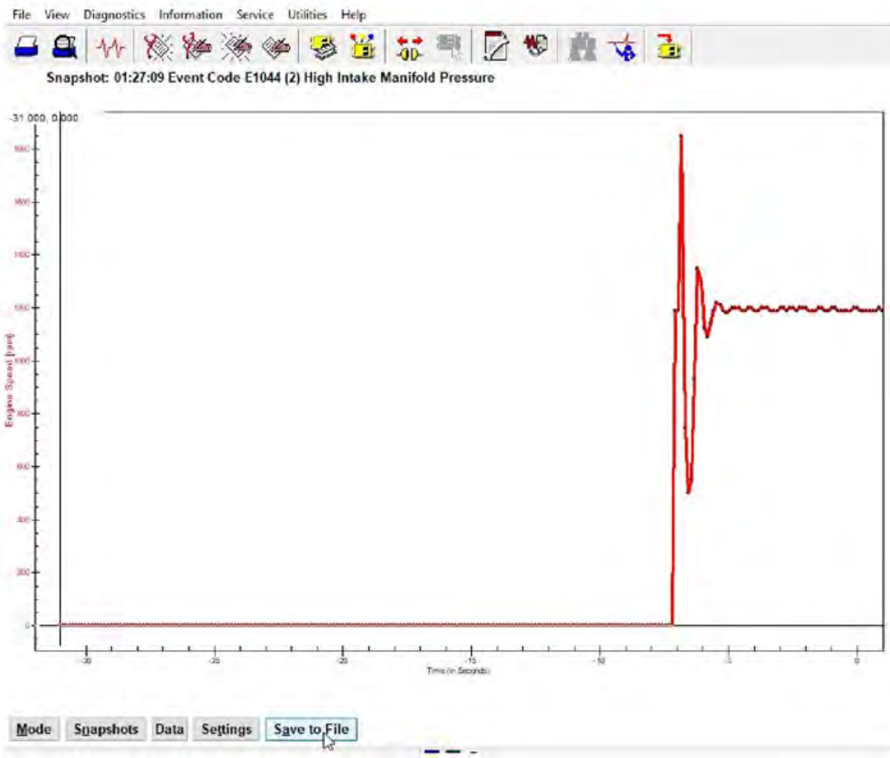


Illustration 51 g06395891

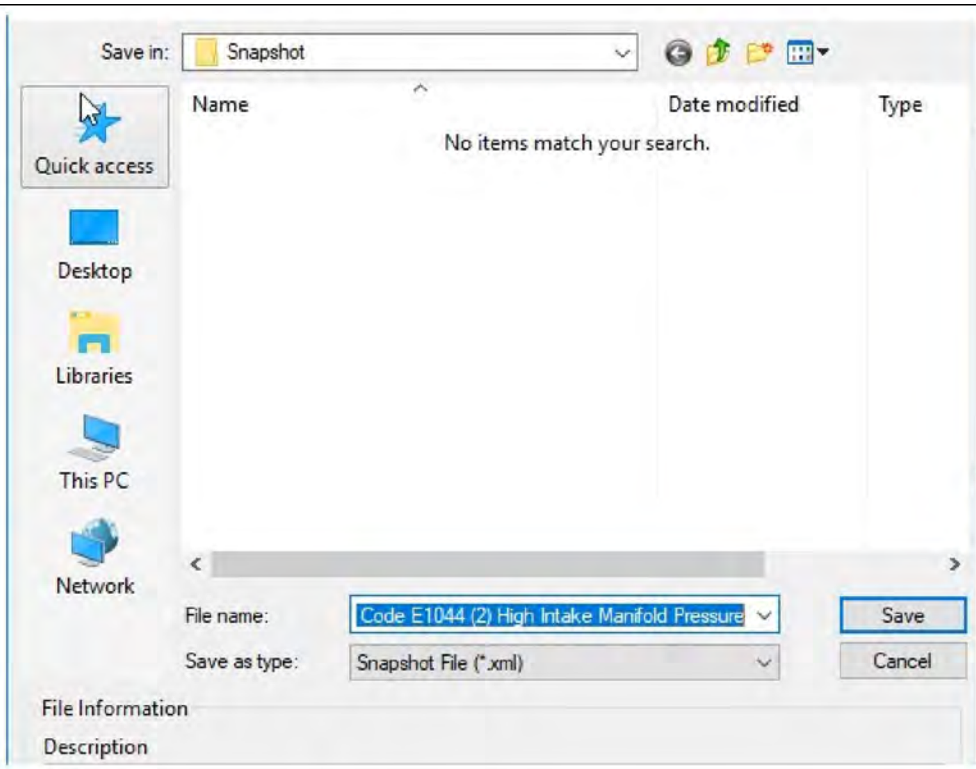


Illustration 52 g06395896

5. Select “Save to File” and save the snapshot file (*.xml). This file will contain all the data in the snapshot and not only the “Engine Speed” data shown on the graph.

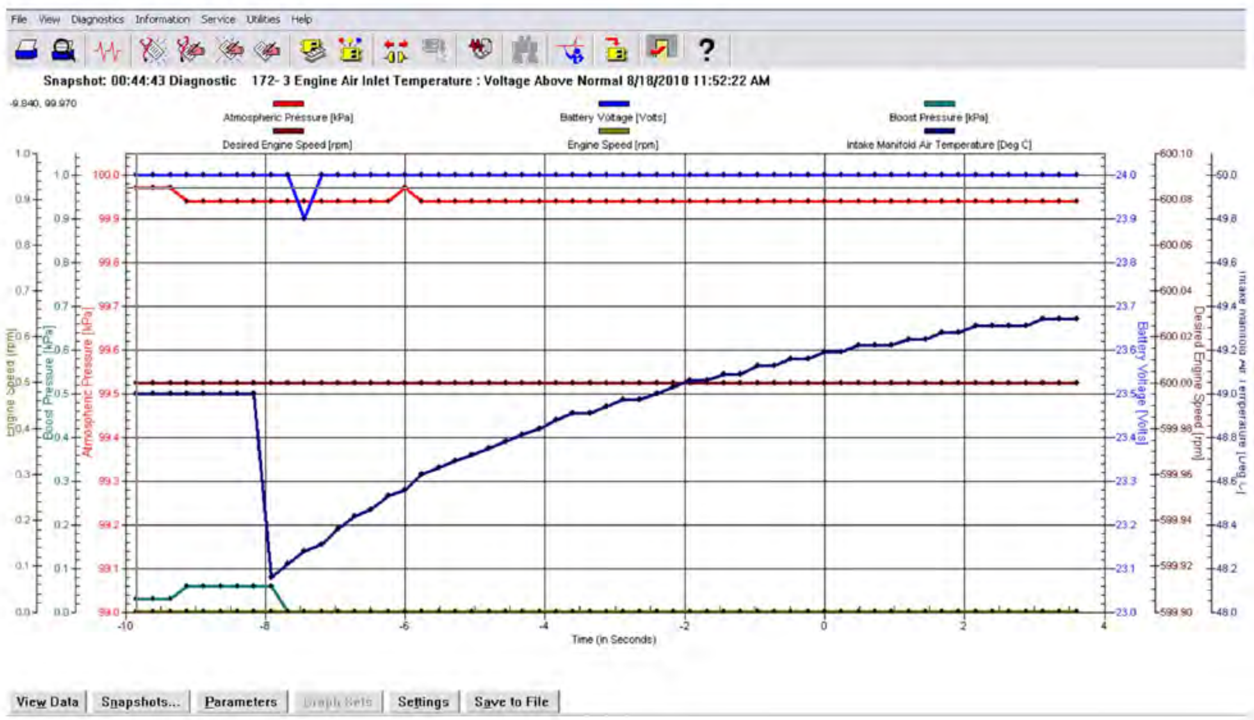


Illustration 53 g03826908

Histogram Screens

Tab Functions At Bottom of Screen

Histograms

This tab pulls up the histogram menu.

Clear

This tab is not available.

Clear All

This tab will clear the current histogram data for this key cycle.

Show All Labels

This labels all bars in the graph.

View Labels on Mouseover

This labels each bar in the graph as the mouse pointer is moved over the bar.

Screen Shots

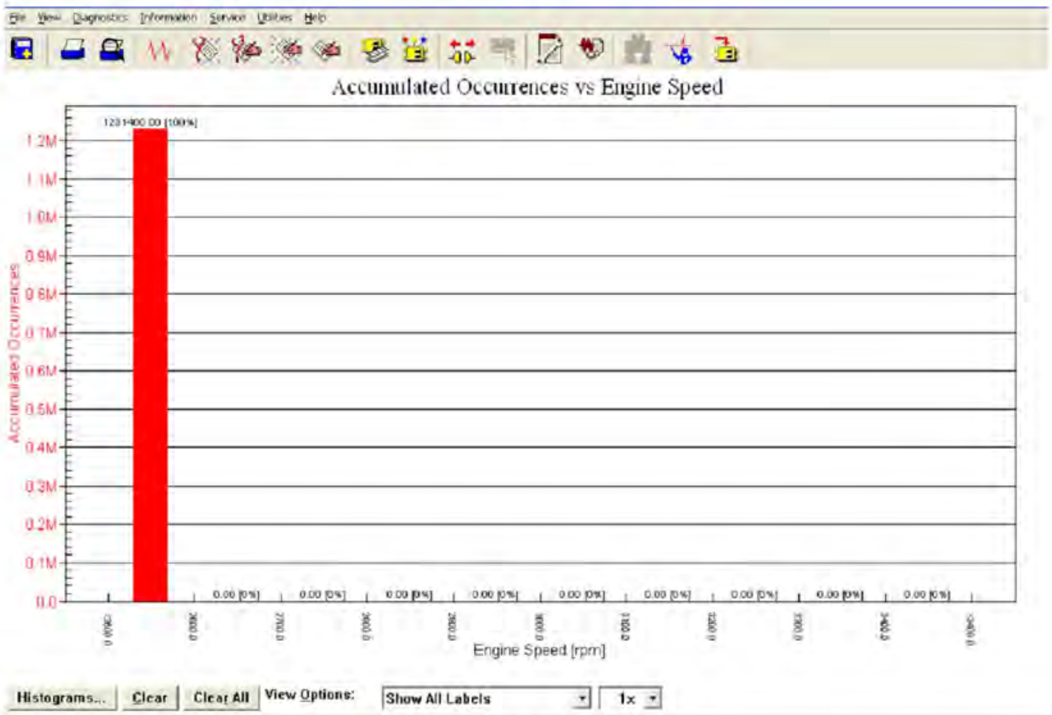


Illustration 54 g03826913

The total number of occurrences.

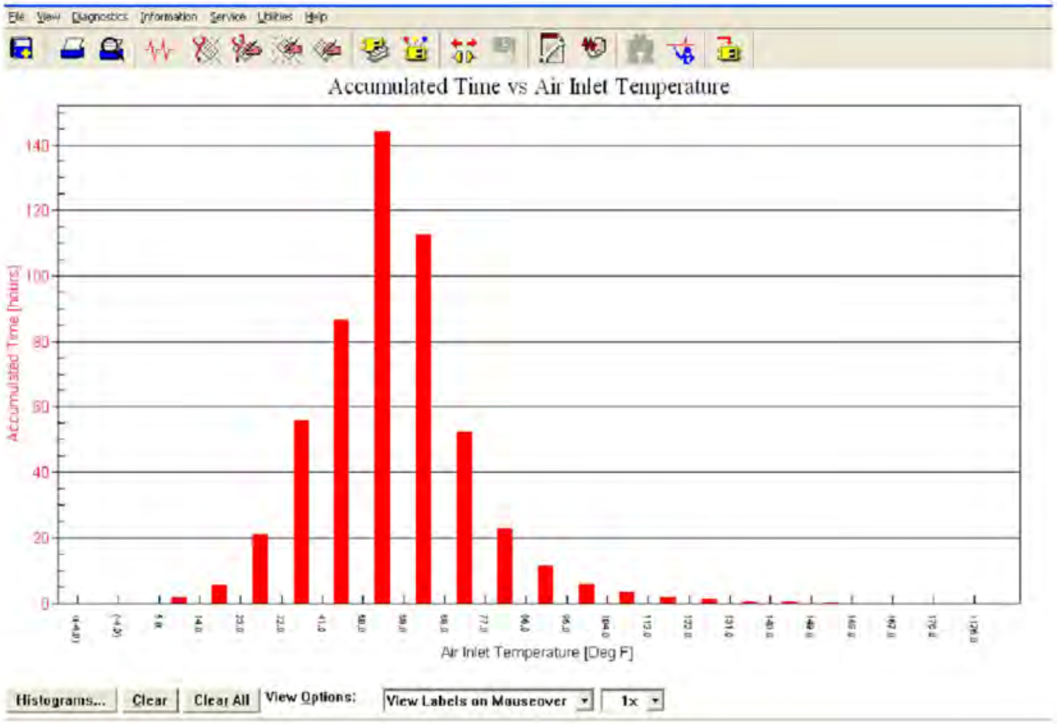


Illustration 55 g03826916

The amount of engine hours operated at indicated inlet temperature.

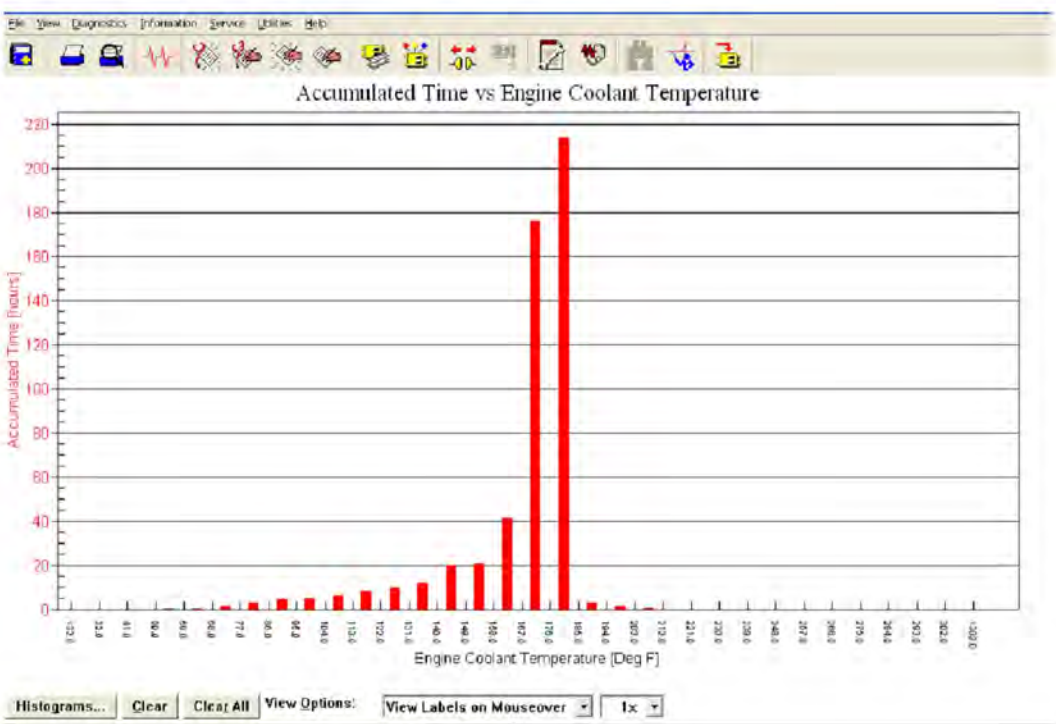


Illustration 56 g03826917

The amount of engine hours operated at indicated coolant temperature.

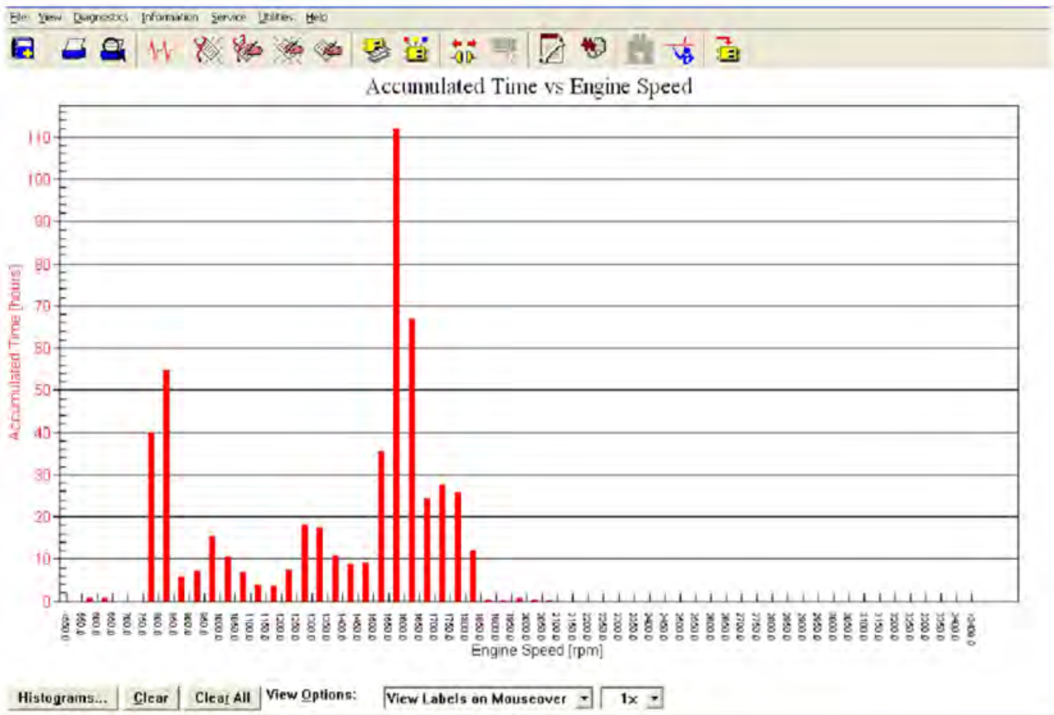


Illustration 57 g03826918

The amount of engine hours operated at indicated engine speed.

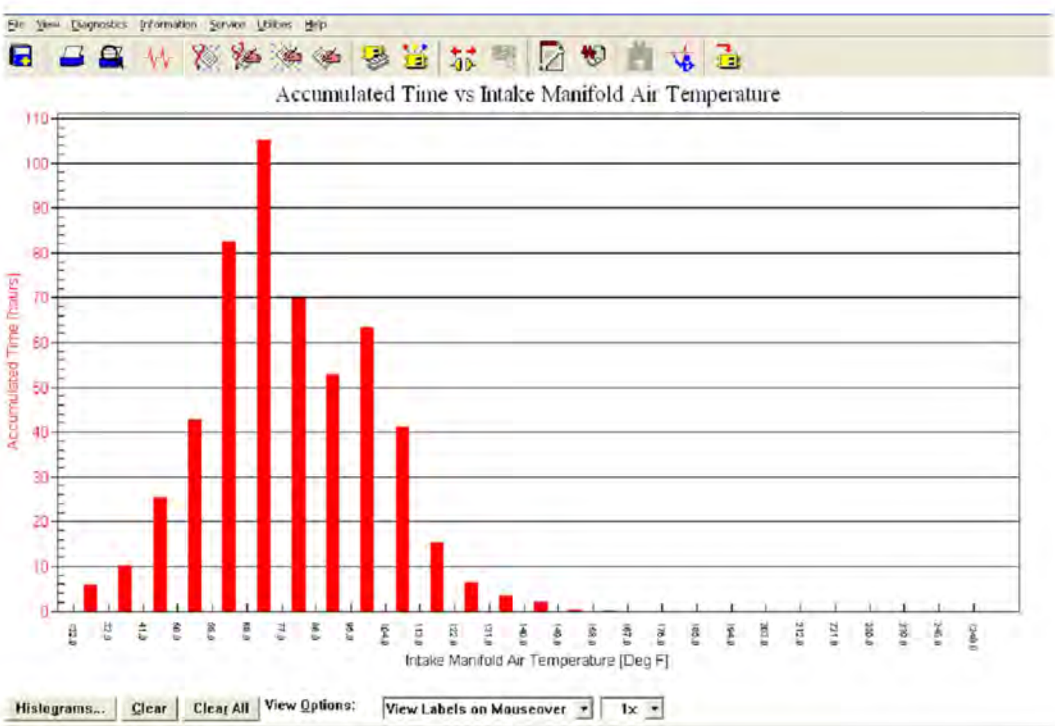


Illustration 58 g03826920

The amount of engine hours operated at indicated intake manifold air temperature.

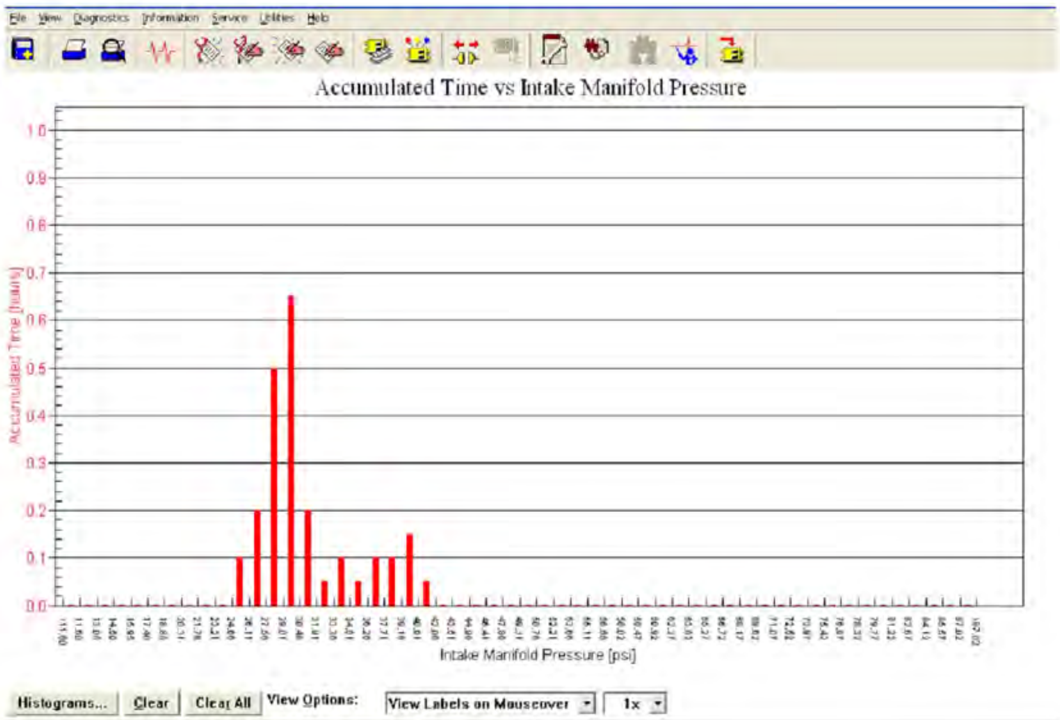
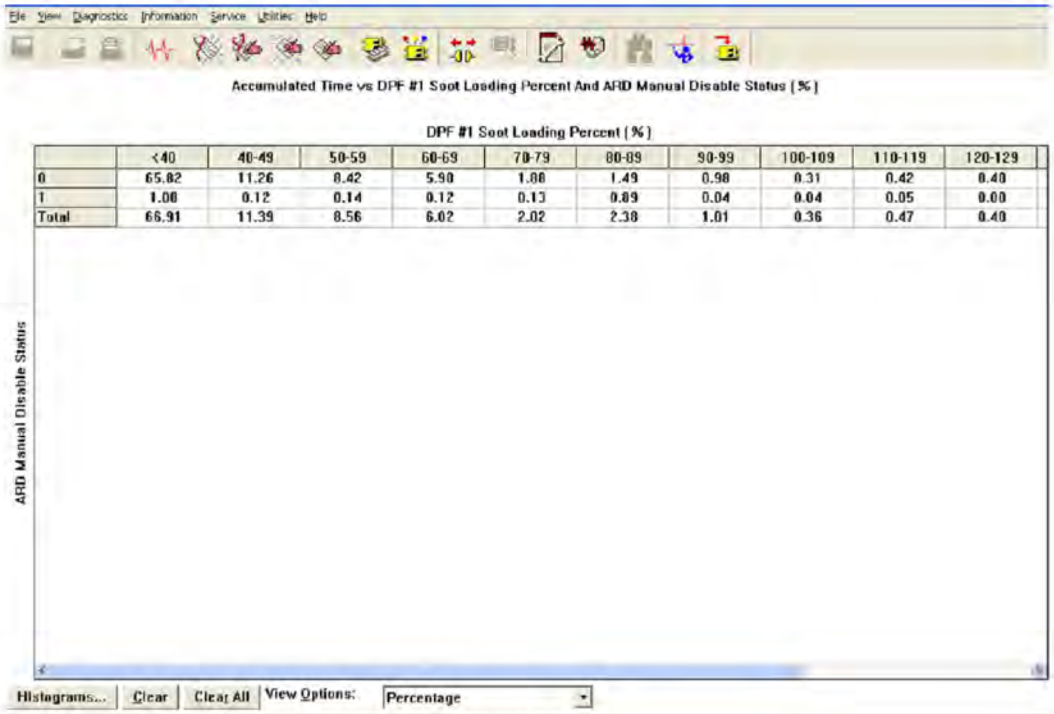


Illustration 59 g03826921

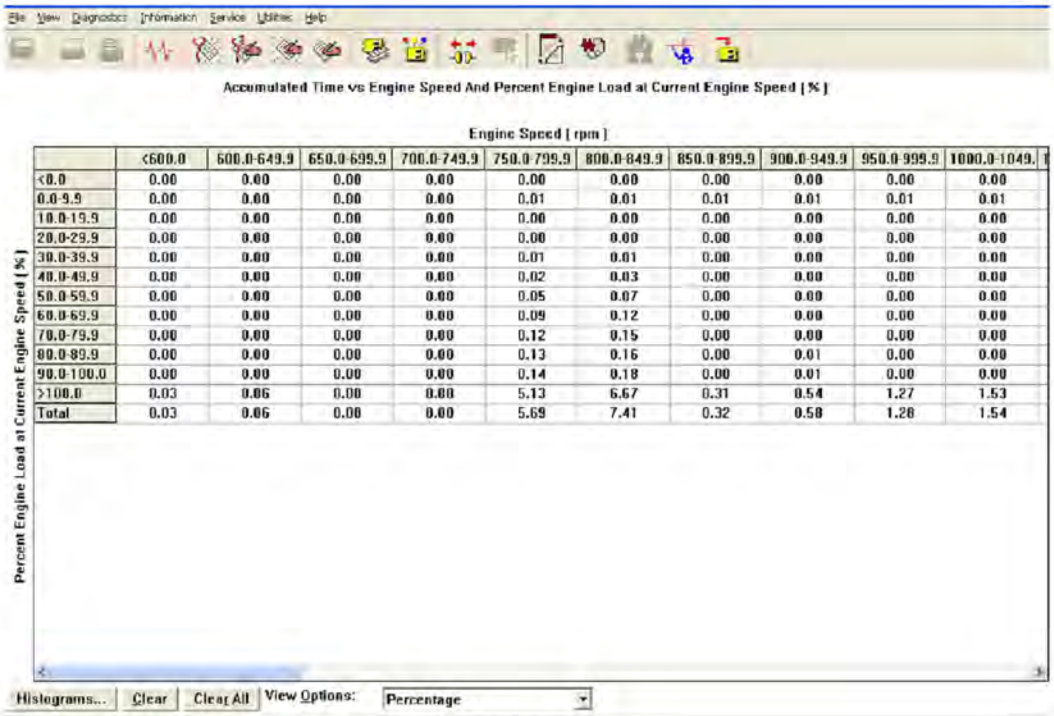
The amount of engine hours operated at indicated intake manifold pressure.



	<40	40-49	50-59	60-69	70-79	80-89	90-99	100-109	110-119	120-129
0	65.82	11.26	8.42	5.90	1.88	1.49	0.98	0.31	0.42	0.40
1	1.08	0.12	0.14	0.12	0.13	0.89	0.04	0.04	0.05	0.00
Total	66.91	11.39	8.56	6.02	2.02	2.38	1.01	0.36	0.47	0.40

Illustration 60 g03826922

This screen is used to help understand the operator use of the disable switch and at what soot load the regenerations take place. Manual disable status 0 = regenerations allowed due to switch position. Manual disable status 1= regenerations not allowed due to switch position.



Accumulated Time vs Engine Speed And Percent Engine Load at Current Engine Speed [%]

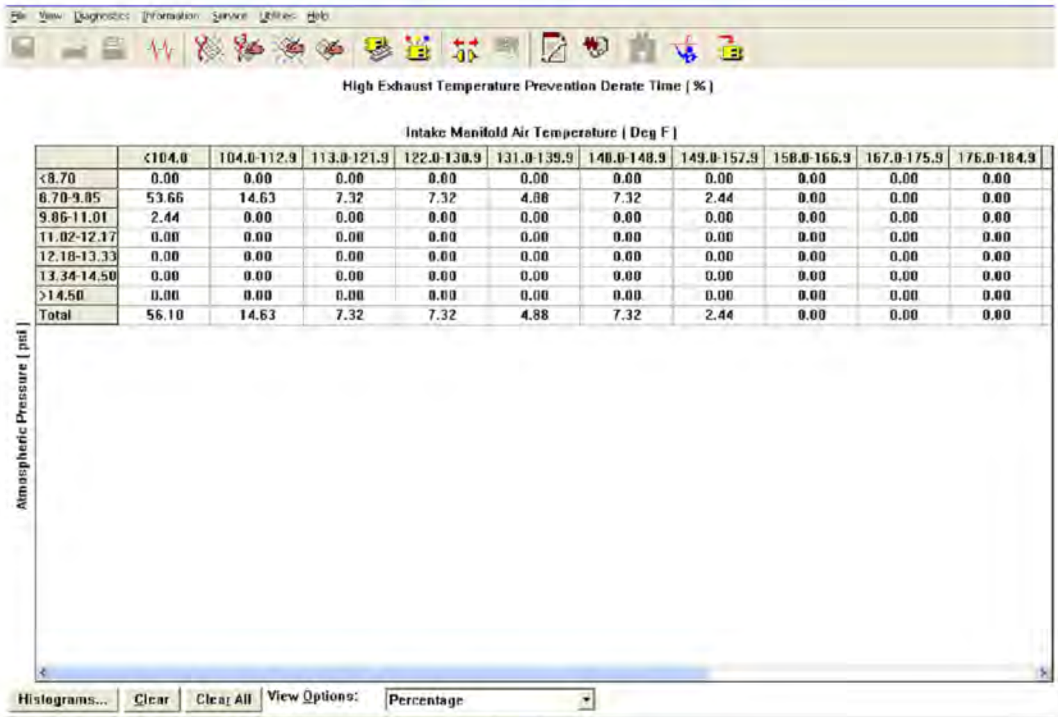
Engine Speed [rpm]

Percent Engine Load at Current Engine Speed [%]

	<600.0	600.0-649.9	650.0-699.9	700.0-749.9	750.0-799.9	800.0-849.9	850.0-899.9	900.0-949.9	950.0-999.9	1000.0-1049.
<0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.0-9.9	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01
10.0-19.9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
20.0-29.9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
30.0-39.9	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
40.0-49.9	0.00	0.00	0.00	0.00	0.02	0.03	0.00	0.00	0.00	0.00
50.0-59.9	0.00	0.00	0.00	0.00	0.05	0.07	0.00	0.00	0.00	0.00
60.0-69.9	0.00	0.00	0.00	0.00	0.09	0.12	0.00	0.00	0.00	0.00
70.0-79.9	0.00	0.00	0.00	0.00	0.12	0.15	0.00	0.00	0.00	0.00
80.0-89.9	0.00	0.00	0.00	0.00	0.13	0.16	0.00	0.01	0.00	0.00
90.0-100.0	0.00	0.00	0.00	0.00	0.14	0.18	0.00	0.01	0.00	0.00
>100.0	0.03	0.06	0.00	0.00	5.13	6.67	0.31	0.54	1.27	1.53
Total	0.03	0.06	0.00	0.00	5.69	7.41	0.32	0.58	1.28	1.54

Illustration 61 g03826923

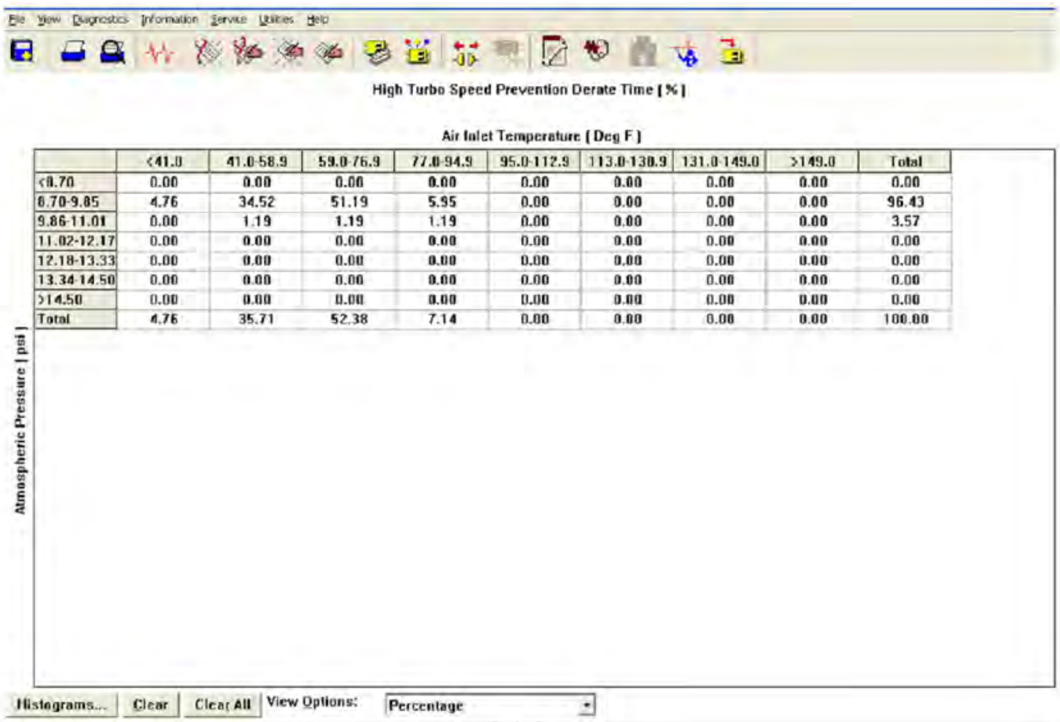
This screen is used to illustrate load percentage at the current engine speed. This screen can be helpful in understanding how the engine is being used. The screen can also be used for comparison between similar machines and/or operators.



	<104.0	104.0-112.9	113.0-121.9	122.0-130.9	131.0-139.9	140.0-148.9	149.0-157.9	158.0-166.9	167.0-175.9	176.0-184.9
<8.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.70-9.85	53.66	14.63	7.32	7.32	4.88	7.32	2.44	0.00	0.00	0.00
9.86-11.01	2.44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11.02-12.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12.18-13.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
13.34-14.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
>14.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	56.10	14.63	7.32	7.32	4.88	7.32	2.44	0.00	0.00	0.00

Illustration 62 g03826926

This histogram is populated when the engine system has calculated a condition in which high exhaust temperatures are present. A fault code for high exhaust temperature is not logged, but the engine will derate to protect the engine system. This situation is normal under most circumstances and no additional troubleshooting is necessary. Refer to Troubleshooting, “Exhaust Temperature is High” for additional information.



	<41.0	41.0-58.9	59.0-76.9	77.0-94.9	95.0-112.9	113.0-130.9	131.0-149.0	>149.0	Total
<8.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.70-9.85	4.76	34.52	51.19	5.95	0.00	0.00	0.00	0.00	96.43
9.86-11.01	0.00	1.19	1.19	1.19	0.00	0.00	0.00	0.00	3.57
11.02-12.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12.18-13.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
13.34-14.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
>14.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	4.76	35.71	52.38	7.14	0.00	0.00	0.00	0.00	100.00

Illustration 63 g03826928

There are certain engine conditions that risk turbocharger overspeed. The engine is calibrated and certified up to a certain altitude and ambient temperature limit. If the engine is operated outside this limit, the engine is more likely to experience overspeed of the turbo. This situation occurs because the turbo has to work harder to maintain the desired boost pressure. This situation is normal under most circumstances and no additional troubleshooting is necessary.

System Communication Status

Connect to the electronic service tool.

Select the engine ECM.

Select the “Diagnostics” tab.

This feature provides a means of troubleshooting J1939 data link issues. The feature shows which modules are not responding and which data link parameters are missing. Refer to Troubleshooting, “Data Link - Test” for further information.

Throttle Mode Configuration

The throttle configuration screen allows the ECM to be configured with up to two channel inputs. The inputs can be a combination of three types of speed control input. The three types of speed control input are:

- PWM throttle input providing a variable duty cycle input to control engine speed
- Analog throttle input providing a variable voltage signal to control engine speed
- Multi Position Throttle Switch (MPTS) which uses up to four switch inputs giving a total of 16 combinations. Each switch combination can then be programmed with a desired engine speed, which can be selected by the operator.

The permitted throttle combinations are shown in the following table:

Table 146

Channel 1	Channel 2
None	None
PWM	None
None	PWM
PWM	PWM
Analog	None
None	Analog
Analog	Analog
PWM	Analog
Analog	PWM
MPTS	None
MPTS	PWM
MPTS	Analog
None	MPTS
PWM	MPTS
Analog	MPTS

Note: The MPTS input can only be used on one channel.

There is also the option of using an Idle Validation Switch (IVS) on the analog throttle. This switch is used to confirm that the throttle pedal has been physically moved, before reacting to the analog speed demand signal. The IVS and software logic is designed to protect against signal faults which could cause unintended engine speed increases.

Programming each throttle input requires some technical knowledge of the throttle specification that is being used. Knowledge is required to program the specifications into the correct ECM parameter values.

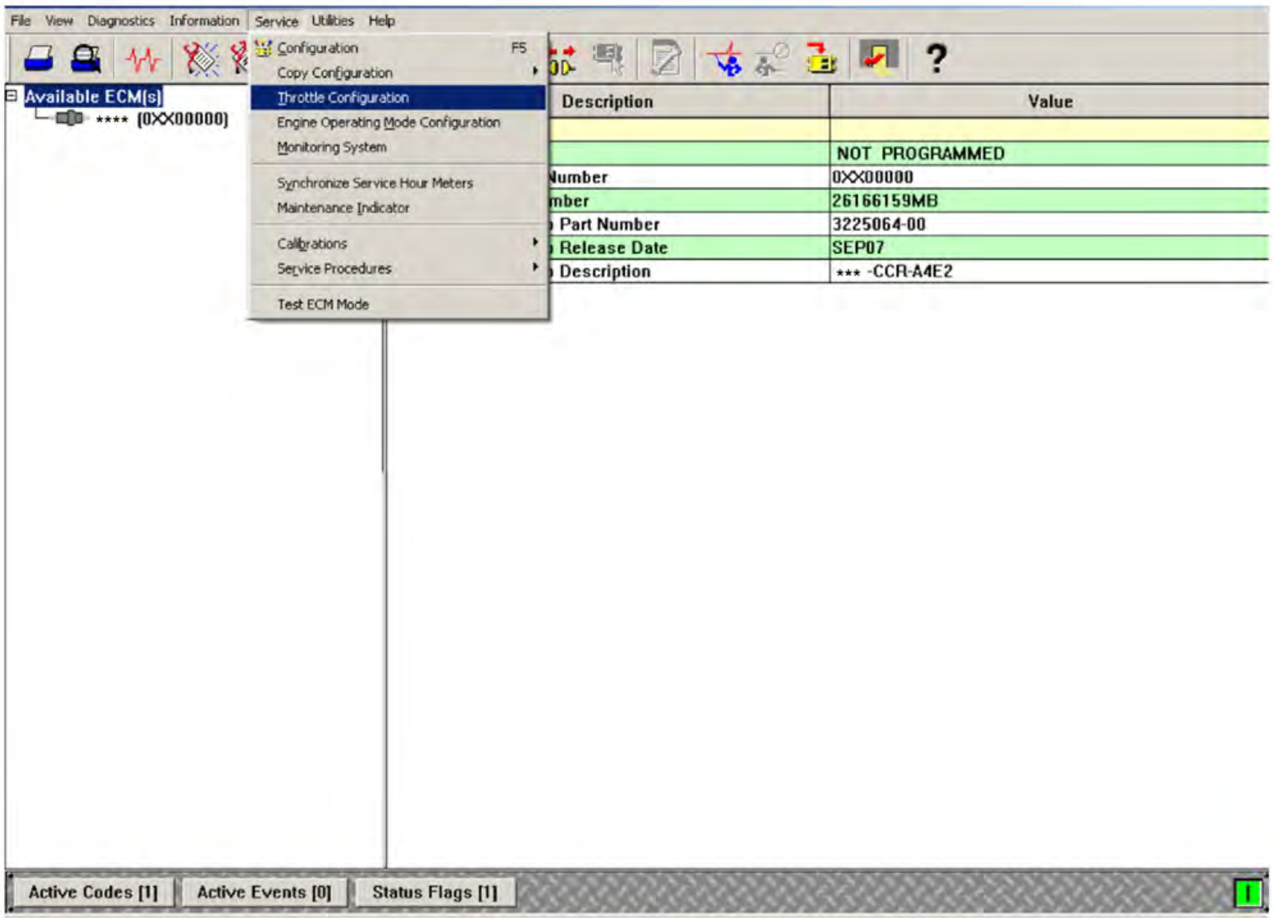


Illustration 64 g03826943

Screen 1

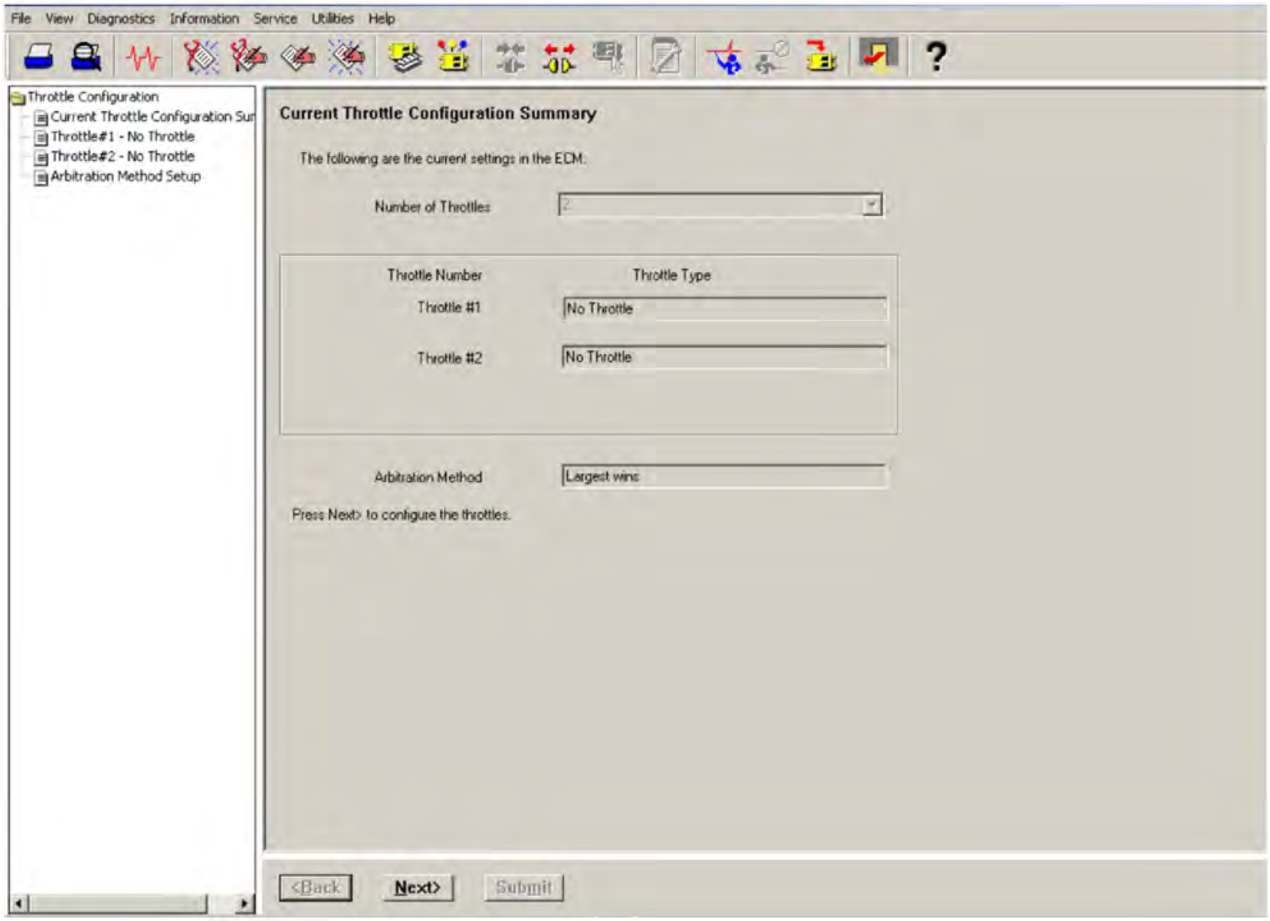


Illustration 65 g03826947

Screen 2

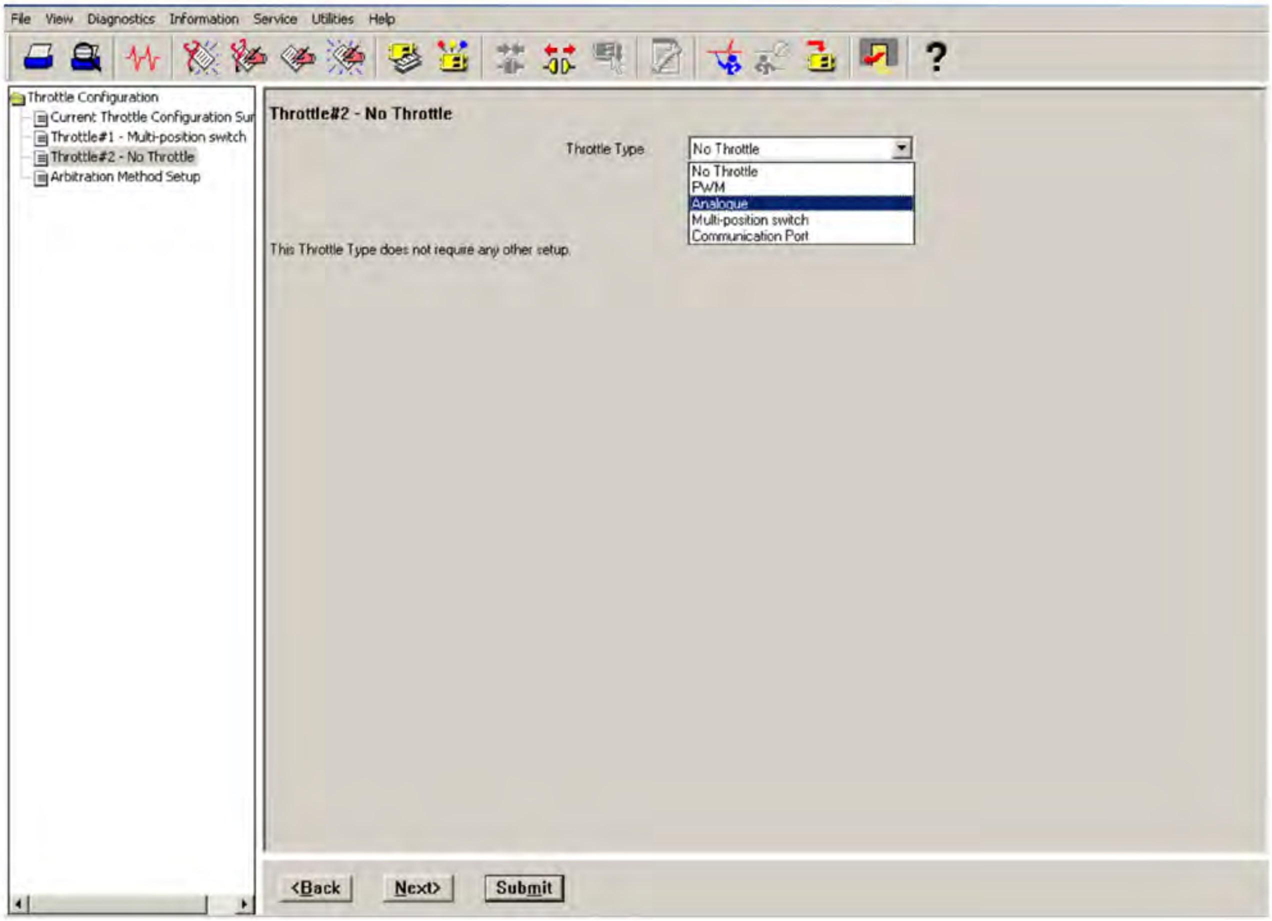


Illustration 66 g03826949

Screen 3

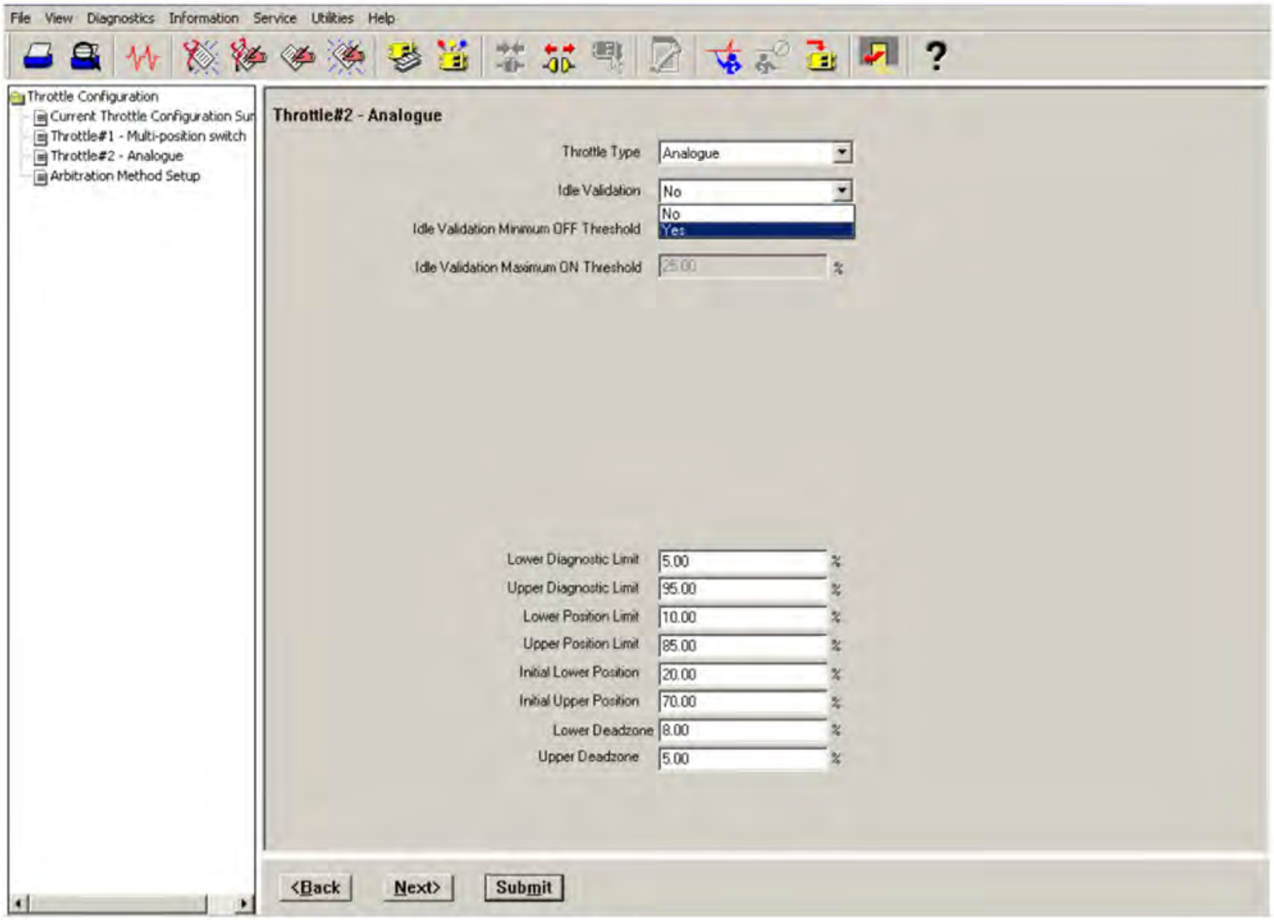


Illustration 67

g03826950

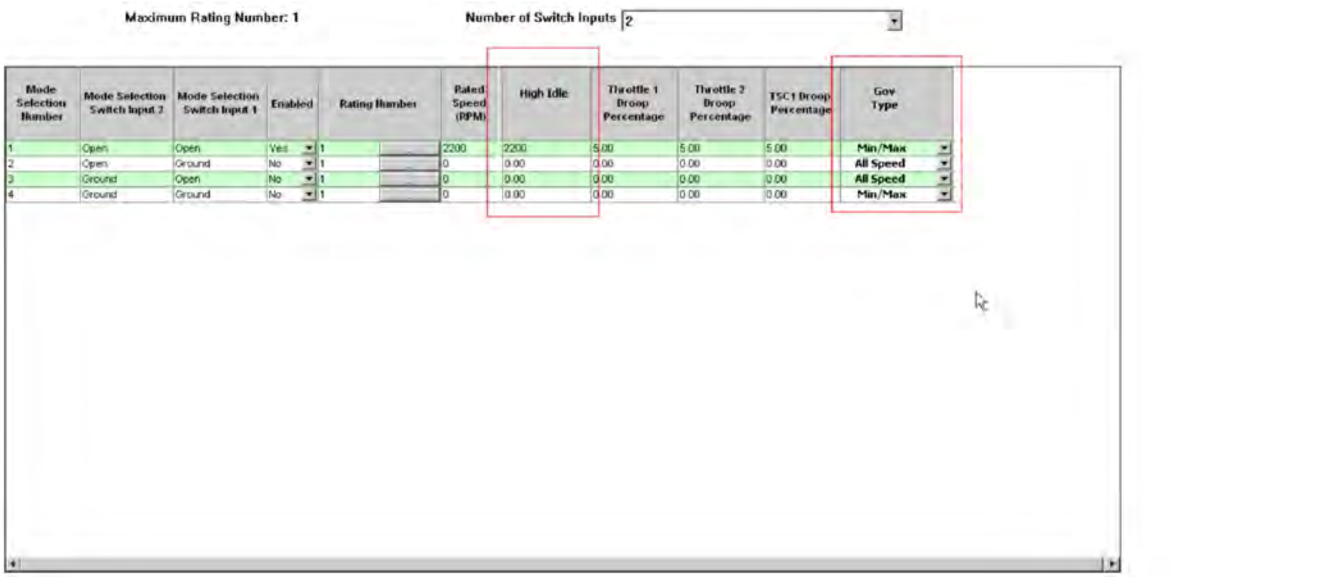
Screen 4

Engine Operating Mode Configuration

The engine operating mode configuration feature allows the configuration of up to four separate modes that can be selected via two switch inputs.

If only one mode is required, no switch inputs are required and Mode 1 will always be used.

If two modes are required, one switch input can be selected to toggle between Mode 1 and Mode 2. If three or four modes are required, two switch inputs will be required. The numbers of switches are selected in the drop-down box at the top of the screen.



Maximum Rating Number: 1

Number of Switch Inputs 2

Mode Selection Number	Mode Selection Switch Input 2	Mode Selection Switch Input 1	Enabled	Rating Number	Rated Speed (RPM)	High Idle	Throttle 1 Droop Percentage	Throttle 2 Droop Percentage	TSC1 Droop Percentage	Gov Type
1	Open	Open	Yes	1	2200	2200	5.00	5.00	5.00	Min/Max
2	Open	Ground	No	1	0	0.00	0.00	0.00	0.00	All Speed
3	Ground	Open	No	1	0	0.00	0.00	0.00	0.00	All Speed
4	Ground	Ground	No	1	0	0.00	0.00	0.00	0.00	Min/Max

Illustration 68 g03422567

Screen 1

Once the number of required modes and switches has been selected, each mode must be configured. Each mode is defined by the following selection:

- Mode Number - (1-4)
- Switch input 1 and 2 combinations to enable the mode
- Enabled - For example, if only three modes are required then mode 4 would be set to “NO” . If the switch combination was active for Mode 4, the ECM would display a fault code.
- Rating number – This parameter allows any available ratings in the flash file to be selected. The specific rating information can be found in the main configuration screen under “Ratings” .
- Rated Speed – This parameter is configurable between defined limits in the ECM (for example – 1800 rpm to 2200 rpm).
- High Idle – This parameter is configurable between 1800 rpm and 2800 rpm but also limited to 112% of the programmed rated speed.
- Throttle Channel 1 Droop Value – This parameter is configurable between 0-10%.
- Throttle Channel 2 Droop Value – This parameter is configurable between 0-10%.
- TSC1 Droop Value – This parameter is configurable between 0-10%.
- Governor Type – This parameter can be configured to “All Speed” governing or “Min Max” governing using the drop-down box.

Once the mode configuration has been set, the submit button must be clicked at the bottom of the page. The ECM power must be cycled from off to on.

The status of the mode switch inputs can be monitored on the status screen in the electronic service tool.

Maintenance Indicator

This feature is configured through the main configuration screen in the electronic service tool.

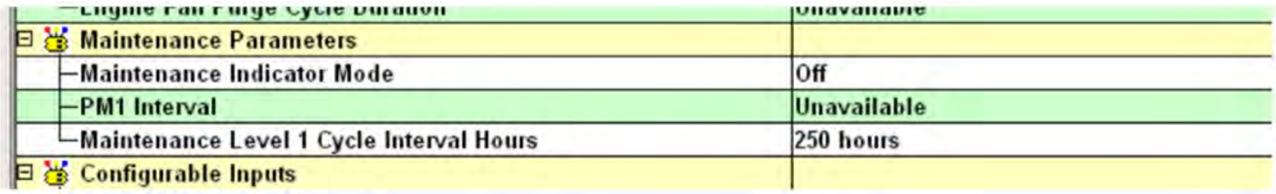


Illustration 69 g03422642

When this feature is installed, the number of maintenance cycle hours can be set. The ECM will then countdown these hours and flag an Event code and send a J1939 message once the cycle interval reaches 0.

This parameter can then be reset via the electronic service tool or over the CAN data link after the service has been completed.

The “PM1 Interval” is not applicable to this engine.

i07860521

Service Tool Error Identifiers

Service error identifiers are displayed when an electronic service tool service test has failed. The error identifiers help to explain the reason for the service test failure. There could be cases where the error identifier isolates the failed component. If applicable, use the appropriate troubleshooting procedure.

Table 147

Service Error Identifiers	Description	Troubleshooting
$0003	Another Service Test is Active	Only one service test may be active on a machine or engine at a time.
$0004	Service Test Active by Another ECM	Another service test from a different ECM is active. Either wait until the test is completed or abort the test to proceed.
$0005	Loss of Service Test Interlock	There is a communication issue between the ECM and the electronic service tool. There is too much data communicating across the data link. Disconnect any other data collecting tools.
$0006	Service Test Aborted by Tool/Monitor	Abort by user. Restart the test if desired.
$101A	Incorrect Throttle Position	The throttle is depressed or faulty. If the application contains a switched throttle, the switch may be faulty.
$101B	Shift Lever Not in Neutral	Shift the transmission lever to NEUTRAL.
$101C	Transmission Gear Incorrect	Shift the power train to NEUTRAL.
$1018	Parking Brake Not Engaged	Apply the parking brake.

(continued)

(Table 147, contd)

Service Error Identifiers	Description	Troubleshooting
$1109	Left Motor Rotation Direction Incorrect	The left drive motor velocity is greater than 0. The motor could be faulted or have a loss of communication on the datalink.
$110A	Right Motor Rotation Direction Incorrect	The right drive motor velocity is greater than 0. The motor could be faulted or have a loss of communication on the datalink.
$1180	Machine is Not Idle	Implements (or saws in forestry products) are actively in operation. Hydraulics are not locked out. Implement lockout solenoid is on “Hoist” and is not in float. AWD is installed and the AWD system is in “Creep” mode. Steering lockout is off. “OK To Elevate Speed” switch is OFF.
$1126	Ground Speed Too High	The machine is moving. Stop the machine to perform the service test.
$1012	Lever Not in Correct Position	Shift lever to neutral.
$110C	Brake Pedal Depressed	Release the brake.
$115C	Regeneration is Active	Wait for a DPF regeneration to complete or abort the test.
Wiggle Test		
$1011	Engine running	Engine speed must be zero.
Fuel Rail Pressure Relief Valve Test		
$0002	Active Diagnostic Present	Resolve any active diagnostic codes. Refer to the appropriate troubleshooting procedure.
$1161	Fuel Temperature Too High	Fuel temperature must be above the threshold shown in the service tool and no active high fuel temperature events.
$10FB	Engine Speed Too Low	Engine speed must be higher than or equal to low idle speed.
$10FC	Engine Speed Too High	Engine speed must be lower than or equal to rated speed.
$10CB	Engine Load Too High	Delivered fuel volume must be less than the limit shown during the service tool test. An engine speed from the application is preventing the service test from taking control of the desired engine speed. Check that the machine is in a suitable operating mode before running the service test.
$1162	Fuel Leakage Detected	Follow the troubleshooting procedure for the fuel leakage event.
$1101	Fuel Rail Pressure Too Low	Refer to Troubleshooting, “Fuel Rail Pressure Problem”.
$1100	Fuel Rail Pressure Too High	The pressure relief valve may have opened due to high rail pressure and is now regulating the rail pressure. The rail pressure may be controlling incorrectly to be too high. Refer to Troubleshooting, “Fuel Rail Pressure Problem”.

(continued)

(Table 147, contd)

Service Error Identifiers	Description	Troubleshooting
$1118	Fuel Pressure Not Responding	Indicates that the rail pressure control is unstable during the service test. Refer to Troubleshooting, "Fuel Rail Pressure Problem".
Fuel Rail Pressure Test		
$0002	Active Diagnostic Present	Resolve any active diagnostic codes. Refer to the appropriate troubleshooting procedure. Check that there are no electrical diagnostics on the fuel system-related sensors or actuators and no injector faults relating to injector trim codes.
$1161	Fuel Temperature Too High	Fuel temperature must be above the threshold shown in service tool and no high fuel temperature events are active.
$10FB	Engine Speed Too Low	Engine speed must be higher than or equal to low idle speed.
$10FC	Engine Speed Too High	Engine speed must be lower than or equal to rated speed.
$10CB	Engine Load Too High	Delivered fuel volume must be less than the limit shown during the service tool test. An engine speed from the application is preventing the service test from taking control of the desired engine speed. Check that the machine is in a suitable operating mode before running the service test.
$1162	Fuel Leakage Detected	Contact the Dealer Solutions Network (DSN) if this fault occurs repeatedly when performing this service test.
$1101	Fuel Rail Pressure Too Low	Refer to Troubleshooting, "Fuel Rail Pressure Problem".
$1100	Fuel Rail Pressure Too High	The pressure relief valve may have opened due to high rail pressure and is now regulating the rail pressure. The rail pressure may be controlling incorrectly to be too high. Refer to Troubleshooting, "Fuel Rail Pressure Problem".
$1118	Fuel Pressure Not Responding	Indicates that the rail pressure control is unstable during the service test. Contact the Dealer Solutions Network (DSN) if this fault occurs repeatedly when running the service test.
Air System Motor Valves Verification Test		
$0002	Active Diagnostic Present	Resolve any active diagnostic codes. Refer to the appropriate troubleshooting procedure.
$1050	Battery Voltage Too High	For a 12 VDC system, the service test must only be executed if the battery voltage is between 9 VDC and 16 VDC. For a 24 VDC system, the service test must only be executed if the battery voltage is between 18 VDC and 32 VDC. Correct the system voltage and restart the Air System Motor Valves Verification Test.

(continued)

(Table 147, contd)

Service Error Identifiers	Description	Troubleshooting
$1070	Battery Voltage Too Low	For a 12 VDC system, the service test must only be executed if the battery voltage is between 9 VDC and 16 VDC. For a 24 VDC system, the service test must only be executed if the battery voltage is between 18 VDC and 32 VDC. Correct the system voltage and restart the Air System Motor Valves Verification Test.
$1164	Engine Speed/Load Incorrect	The test must be run with keyswitch ON only, Stop Engine leaving ECM powered and restart the Air System Motor Valves Verification Test.
$116F	Engine Exhaust Gas Recirculation Valve Not Responding to Command	The test has verified that the valve is electrically OK, but the actuator is not responding to the desired test profile. Contact the Dealer Solutions Network (DSN) before proceeding.
$1171	Engine Throttle Actuator Not Responding to Command	The test has verified that the valve is electrically OK, but the actuator is not responding to the desired test profile. Contact the Dealer Solutions Network (DSN) before proceeding.
Aftertreatment System Functional Test		
$0002	Active Diagnostic Present	Resolve any active diagnostic codes. Refer to the appropriate troubleshooting procedure.
$105F	Service Test Timed Out	Not all conditions were met for the test to complete. Restart the Aftertreatment System Functional Test.
$10CB	Engine Load Too High	Bring engine to idle and remove load. Current operating load is too high to allow the NRS valve to close. Restart the Aftertreatment System Functional Test.
$10D0	Engine Has Not Been Running Long Enough	Allow engine to Idle for 2 minutes and restart the Aftertreatment System Functional test.
$10FB	Engine RPM Too Low	Lower the engine speed to idle. The test will attempt to take speed control to put engine in acceptable speed range. Restart the Aftertreatment System Functional Test.
$10FC	Engine RPM Too High	Lower the engine speed to idle. The test will attempt to take speed control to put engine in acceptable speed range. Restart the Aftertreatment System Functional Test.
$1121	Another Engine Speed Request Active	The test request to take speed control was denied by the application.
$115C	Regeneration is Active	HC dosing is active. Allow desulfation to complete and then restart the Aftertreatment System Functional Test.
$116F	Engine Exhaust Gas Recirculation Valve Not Responding to Command	Bring the engine to idle and remove load. The current operating load is too high to allow the NRS valve to close.
Manual HC Dosing Capability Test		
$0002	Active Diagnostic Present	Resolve any active diagnostic codes. Refer to the appropriate troubleshooting procedure.

(continued)

(Table 147, contd)

Service Error Identifiers	Description	Troubleshooting
$0009	Service Test Aborted by ECM	Engine may not be running in the correct thermal management mode. Contact the Dealer Solutions Network (DSN) for further advice.
$1010	Engine Stopped (No Engine RPM)	Start the engine. The test will then progress.
$10D0	Engine Has Not Been Running Long Enough	Allow engine to idle for 2 minutes and restart the Manual HC Dosing Capability Test
$1155	Diesel Particulate Filter Soot Loading Too High	DPF soot load is above an acceptable level for safe HC dosing. If soot load events are active, refer to the appropriate troubleshooting procedure.
$116F	Engine Exhaust Gas Recirculation Valve Not Responding to Command	The NRS valve must have closed to allow HC dosing to start. Check for associated NRS valve diagnostic codes. Run the “Air System Motor Valves Verification Test” to check for correct operation of the NRS valve.
$1108	Excessive Engine RPM Change	The engine speed has changed significantly during the test which can affect the service test assessment capability. Rerun the test without changing engine speed.
$10F5	Excessive Change in Engine Load	The engine load has been changed significantly during the test which can affect the service test assessment capability. Rerun the test without changing engine load.
$11CA	Aftertreatment Diesel Oxidation Catalyst Conversion Efficiency Too Low	The DOC may be sulfated. Run the “Aftertreatment Recovery Procedure” . If this procedure continues to fail, the DOC may be aged so that not enough heat is being generated for the amount of HC fuel being injected.
$11C0	Aftertreatment Diesel Oxidation Catalyst Intake Temperature Too Low	The DOC intake temperature is not reaching the target required by the test. Look for causes of excessive heat loss between the engine and the aftertreatment
$11E6	Intake Manifold Pressure Too high	The observed IMAP error when testing the ITV is too high. Look for associated IMAP diagnostic codes. Check for intake manifold system leaks. Run the “Air System Motor Valves Verification Test” to check the correct operation of the ITV.
High Pressure Fuel Pump Calibration		

(continued)

(Table 147, contd)

Service Error Identifiers	Description	Troubleshooting
$0002	Active Diagnostic Present	Check that there are no electrical diagnostics on fuel system sensors or actuators, no injector faults relating to injector trim codes. One of the following sensor status is not OK: Camshaft speed/timing Crankshaft speed/timing Coolant temperature Fuel rail pressure Fuel temperature. There may be an electrical fault on an injector or the HP fuel pump. An injector trim may not be loaded or incorrect. One of the following events is active: Fuel leakage Pressure relief valve activation Rail pressure event Battery supply diagnostic is active Resolve any active diagnostic codes. Refer to the appropriate troubleshooting procedure.
$10A7	Coolant Temperature Too Low	Coolant temperature is less than the trip point
$1072	Coolant Temperature Too High	Coolant temperature is greater than the trip point
$1160	Fuel Temperature Too Low	Fuel temperature must be within limits displayed during the test.
$1161	Fuel Temperature Too High	Fuel temperature must be within limits displayed during the test.
$1108	Excessive Engine RPM Change	Engine speed is not stable. Ensure that there is no cyclic loading from the application. Try running the test at a different engine speed or increase the load on the engine.
$1074	Engine RPM Too Low	Engine speed must be within limits displayed during the test.
$10FC	Engine RPM Too High	Engine speed must be within limits displayed during the test.
$1107	Engine Load Too Low	Fuel delivery must be within the limits displayed during the test.
$10CB	Engine Load Too High	Fuel delivery must be within the limits displayed during the test.
$1118	Fuel Pressure Not Responding	Refer to Troubleshooting, “Fuel Rail Pressure Problem”.
$115F	Engine Load Incorrect	Changing the engine operating condition may allow successful pump learn. A lower engine speed and/or a lower load condition should be used.
$000A	Calibration Failure	Likely loss of communication between the ECM and the electronic service tool. Restart the electronic service tool and retry the calibration test.
$0003	Another Calibration is Active	Likely loss of communication between the ECM and the electronic service tool. Restart the electronic service tool and retry the calibration test.

(continued)

(Table 147, contd)

Service Error Identifiers	Description	Troubleshooting
$105F	Calibration Timed Out	Retry the “High Pressure Fuel Pump Calibration” .
Aftertreatment Recovery Procedure		
$0002	Active Diagnostic Present	Resolve any active diagnostic codes. Refer to the appropriate troubleshooting procedure.
$1010	Engine Stopped (No Engine RPM)	Start the engine. The test will then progress.
$10D0	Engine Has Not Been Running Long Enough	Allow engine to idle for 2 minutes and restart the Aftertreatment Recovery Procedure.
$1155	Diesel Particulate Filter Soot Loading Too High	Observed DPF soot load is above an acceptable level for safe HC dosing and too high to allow procedure to regenerate soot within the DPF. Contact the Dealer Solutions Network (DSN) for further advice.
$112C	Particulate Filter Intake Temperature Too Low	The system cannot dose due to the DPF Inlet temperature not being high enough to allow DEF dosing to initiate. Refer to Troubleshooting, “Diesel Particulate Filter Intake temperature Is Low”. Check for exhaust leaks and then restart the Aftertreatment Recovery Procedure.
$10FB	Engine RPM Too Low	Lower the engine speed to idle. The test will try to take speed control to put engine in acceptable speed range. Restart the Aftertreatment Recovery Procedure.
$10FC	Engine RPM Too High	Lower the engine speed to idle. The test will try to take speed control to put engine in acceptable speed range. Restart the Aftertreatment Recovery Procedure.
$1173	Diesel Particulate Filter Regeneration Rate Too Low	The procedure is running in optimum conditions for DPF soot regeneration with no issues with soot load measurement from the DPF differential pressure sensor. However, observed soot load is not reducing. Contact the Dealer Solutions Network (DSN) for further advice.
$116F	Engine Exhaust Gas Recirculation Valve Not Responding to Command	Bring engine to idle and remove load. The current operating load may be too high to allow the NRS valve to close. Identify associated NRS valve diagnostics. Run the “Air System Motor Valves Verification Test” to check correct operation of the NRS valve.
$11C0	Aftertreatment Diesel Oxidation Catalyst Intake Temperature Too Low	The DOC intake temperature is lower than required for the test. Identify causes of excessive heat loss between the engine and the aftertreatment.
$11C1	Aftertreatment Recovery Unsuccessful	The procedure has run in optimum engine conditions but has been unable to recover the Aftertreatment system. Contact the Dealer Solutions Network (DSN) for further advice.

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Customer Passwords

Customer passwords may be used to protect customer parameters from being changed. The electronic service tool can be used to change certain parameters. There are some parameters that cannot be changed and there are some applications that do not allow any changes to the programmable monitoring system. The passwords are programmed into the Electronic Control Module (ECM) with the electronic service tool. One password may be programmed or both passwords may be programmed. If customer passwords are not programmed, customer parameters may be changed by anyone.

To obtain customer passwords, contact the owner of the machine. If the owner has forgotten the customer passwords, factory passwords are used to create temporary customer passwords. Temporary customer passwords can be used to change the original customer passwords or any parameter that is protected by a customer password. When the electronic service tool is disconnected, a prompt will request the restoration of the original customer passwords. If the original passwords are not restored, the passwords will be changed to the temporary passwords.

i07527582

Factory Passwords

Note: Factory passwords are provided only to Perkins authorized distributors.

Factory passwords are necessary to authorize access to certain screens on the electronic service tool. Factory passwords are also used to access specific configuration parameters in the Electronic Control Module (ECM). If changes are made that require factory passwords, the "Enter Factory Passwords" dialog box will automatically be displayed. A factory password must be obtained before the change can be made.

Factory passwords may be required to perform each of the following functions in the electronic service tool:

ECM Replacement – When an ECM is replaced, the system configuration parameters must be programmed into the new ECM. The new ECM will allow specific parameters to be programmed once without the use of factory passwords. There may be parameters that require factory passwords on the ECM that is being replaced. Factory passwords may be required to configure these parameters on the new ECM.

Rerate Engine Power – Changing the interlock code may be necessary. The interlock code is protected by factory passwords.

Software Enabled Attachments – The application may have special features that can be enabled with the electronic service tool. This customized software is available to provide enhanced operation for the application. These features may also require the installation of additional hardware on the application. A cost may be associated with these software enabled attachments. Factory passwords are necessary to enable this software.

Customer passwords – Factory passwords are required to restore customer passwords. Factory passwords are also required to reset customer passwords.

Set Configuration parameters – Factory passwords are required to modify specific configuration parameters.

If factory passwords are needed to change a parameter, the electronic service tool will request the password when the change is attempted. Newer versions of the electronic service tool display a padlock icon to indicate that a parameter requires a factory password for modification.

Clear engine events and certain diagnostic codes – Some engine events require factory passwords to clear the code from ECM memory. For example, factory passwords must be obtained to clear a code that is related to an engine overspeed condition. Clear these codes only when you are certain that the fault has been corrected.

i06071292

ECM Will Not Accept Factory Passwords

Probable Causes

- Incorrect information for the password request
- Incorrect passwords

Recommended Actions

Check the Information for the Password Request

The information for the password request must be obtained from the Electronic Control Module (ECM) that is being programmed. Do not use information from an old ECM in order to program factory passwords on a replacement ECM.

Verify that the information used for the password request is identical to the information that is displayed on the electronic service tool.

Engine Serial Number – The engine serial number must be from the electronic service tool screen rather than the engine information plate.

Reason Code – Use the reason code from the factory password screen. Reason codes are assigned for specific purposes and reason codes are not interchangeable.

Cycle the keyswitch. Try to enter the passwords again.

Incorrect Passwords

Verify that the correct passwords were entered. Check each character in each password.

If rechecking the passwords does not correct the problem, change a customer parameter. Change the parameter from the current value to another value and then change the customer parameter back to the original value. The sequence of events will change the total tattletale. The new total tattletale will require obtaining new factory passwords. Obtain and enter new factory passwords.

i07552220

Electronic Service Tool Does Not Communicate

Probable Causes

- Configuration of the communications adapter
- Electrical connectors
- Communication adapter and/or cables
- Electrical power supply to the diagnostic connector
- Electronic service tool and related hardware
- Electrical power supply to the Electronic Control Module (ECM)

Recommended Actions

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

Table 148

Troubleshooting Test Steps	Values	Results
1. Configuration of the Communications Adapter **A.** Access “Preferences” under the “Utilities” menu on the electronic service tool. **B.** Check for hardware that uses the same ports as the communications adaptor.	Communications adapter configuration	**Result:** The correct “Communications Interface Device” is not selected. **Repair:** Select the correct “Communications Interface Device” . **Result:** The correct port is not selected for use by the communication adapter. **Repair:** Select the correct port for use by the communication adapter. **Note:** The most commonly used port is “COM 1” . **Result:** Other hardware is sharing the port with the communications adaptor. **Repair:** Exit or close the software programs for that device. **Result:** The communications adaptor is correctly configured. Proceed to Test Step 2.
2. Electrical Connectors **A.** Check for correct installation of the P1 and P2 ECM connectors and of the connector for the electronic service tool.	Electrical connectors	**Result:** The connectors are not correctly installed. **Repair:** Repair or replace the connectors, as necessary. **Result:** The connectors are OK. Proceed to Test Step 3.
3. Communication Adapter and/or Cables **A.** Check that the firmware and driver files are the most current files for the type of communication adapter that is being used. Verify that the correct cable is being used between the communication adapter and the diagnostic connector. **B.** Disconnect and then reconnect the cable that attaches the communication adapter to the diagnostic connector. **C.** Check the operating system on the laptop computer.	Comms adaptor and cables	**Result:** The firmware or driver files are not the most current files. **Repair:** Update the firmware or driver files to the most current files. **Result:** The cable between the communication adapter and the diagnostic connector is not correct. **Repair:** Replace the cable between the communication adapter and the diagnostic connector with the correct type. **Result:** The laptop computer has a Windows operating system. **Repair:** Restart the laptop computer to eliminate the possibility of a conflict in the software. **Result:** The adaptor and cables are OK. Proceed to Test Step 4.

(continued)

(Table 148, contd)

Troubleshooting Test Steps	Values	Results
4. Electrical Power Supply to the Diagnostic Connector **A.** Use a multimeter to check that battery voltage is present between terminals A and B of the diagnostic connector. **Note:** If the communication adapter is not receiving power, the LED display on the communication adapter will be off.	Electrical power	**Result:** Battery voltage is not present between terminals A and B of the diagnostic connector. **Repair:** Investigate the cause and repair, as necessary. **Result:** Battery voltage is present between terminals A and B of the diagnostic connector. Proceed to Test Step 5.
5. Electronic Service Tool and Related Hardware **A.** Connect the electronic service tool to a different engine. **Note:** This process eliminates the electronic service tool and the related hardware as the fault.	Hardware	**Result:** The same fault occurs on a different engine. **Repair:** Check the electronic service tool and the related hardware for faults. **Result:** The fault does not occur on a different engine. Proceed to Test Step 6.
6. Electrical Power Supply to the Electronic Control Module (ECM) **A.** Check the power supply to the ECM. Refer to Troubleshooting, “Electrical Power Supply - Test”. **Note:** If the ECM is not receiving battery voltage, the ECM will not communicate.	Power to ECM	**Result:** The power supply to the ECM is incorrect. **Repair:** Investigate the cause and repair, as necessary. **Result:** The power supply to the ECM is OK. Contact the Dealer Solution Network (DSN).

i07860528

Codes that Inhibit Operation of Aftertreatment System

Diagnostic Trouble Codes that Affect the Aftertreatment System and the Conditions for Clearing the Code

The following tables list the codes that inhibit the aftertreatment system either during the current key cycle or through successive key cycles.

Table 149

Codes That Clear With Each Key Cycle		
J1939 Code	**Customer Action**	**Clearing Conditions**
102-16	Cycle key OFF for 2 minutes and then run engine per Clearing Conditions	Engine Speed >1400/1500 RPM
102-18	Cycle key OFF for 2 minutes and then run engine per Clearing Conditions	Engine Speed >1400/1500 RPM
105-3	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
105-4	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
110-0	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
110-3	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
110-4	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
110-15	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
110-16	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
157-3	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
157-4	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
157–12	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
157-16	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
157-18	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
168-15	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
168-17	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
651-5	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
651-6	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
652-5	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
652-6	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
653-5	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
653-6	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
654-5	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
654-6	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
2791-6	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
2791-7	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
3563-3	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
3563-4	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
3563-13	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
4765-17	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
5571-0	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)

Table 150

Codes That Stay Active Through Key Cycles			
J1939 Codes	PDL Codes	Customer Action	Clearing Conditions
27-3	3407-3	Cycle key OFF for 2 minutes and then run engine per Clearing Conditions	Rectification completed and NRS system operating OK.
27-4	3407-4	Cycle key OFF for 2 minutes and then run engine per Clearing Conditions	Rectification completed and NRS system operating OK.
2791-5	3405-5	Code must be cleared with the electronic service tool	The electronic service tool is required.
5298-17	E2180 (1)	Cycle key OFF for 2 minutes and then run engine per Clearing Conditions	Rectification completed and “Aftertreatment Recovery Procedure” completed successfully.

i07561799

Test ECM Mode

“Test ECM Mode” is a feature in the software that can be used to help troubleshoot an engine that may have a fault in the Electronic Control Module (ECM). This feature allows a standard ECM to be used as a test ECM. This feature eliminates the need to stock a test ECM.

1. Search for the latest flash file for the engine.

Note: If a newer software version is available for the engine, install the newest software on the suspect ECM. If the new software does not eliminate the fault, continue with this procedure.

2. Use the “Copy Configuration” feature on the electronic service tool to copy the parameters from the suspect ECM.

Note: If the “ECM Replacement” feature cannot be used, record the programmed values into the “Parameters Worksheet” . Also record the system configuration parameters.

3. Disconnect the suspect ECM. Temporarily connect the test ECM to the engine. Do not mount the test ECM on the engine.

4. Flash program the test ECM with the newest software that is available.

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

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

6. Use the “Copy Configuration” feature on the electronic service tool to program the test ECM.

Note: If the “ECM Replacement” feature cannot be used, program the test ECM with the values from Perkins Technical Marketing Information (PTMI).

7. Program the engine serial number into the test ECM.

Note: The “Test ECM Mode” must be activated before the engine serial number is programmed into the ECM.

8. Verify that the test ECM eliminates the fault.

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

If the test ECM eliminates the fault, the engine can be released while the “Test ECM Mode” is still active.

Once an ECM has been activated in the “Test ECM Mode” , the ECM will stay in the “Test ECM Mode” until the timer times out. Anytime prior to the “Test ECM Mode” timing out, the “Test ECM Mode” can be reset to 24 hours.

If the ECM is used as a test ECM for more than one engine, reactivate the “Test ECM Mode” . The reactivation will reset the parameters to default values. Then use the “Copy Configuration” feature to program the parameters into the test ECM or manually program the parameters to the correct values.

i07561439

ECM Software - Install

Table 151

Diagnostic Trouble Code for ECM Software		
J1939 Code	Code Description	Comments
631-2	Personality Module : Erratic, Intermittent, or Incorrect	The flash file is for a different engine family or for a different engine application. The engine will not start. Clearing this diagnostic code requires factory passwords. The personality module code must be reset to zero.

Flash Programming – A method of loading a flash file into the Electronic Control Module (ECM)

The electronic service tool is used to install a flash file into the ECM. The flash programming transfers the flash file from the PC to the ECM.

Flash Programming a Flash File

1. Obtain the part number for the new flash file.

Note: If the part number for the flash file is not available, use "PTMI" on the Perkins secured web site.

Note: The engine serial number must be available to search for the part number of the flash file.

2. Connect the electronic service tool to the diagnostic connector.

3. Turn the keyswitch 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 Does Not Communicate".

5. Flash program the flash file into the ECM.

a. Select the engine ECM under the "Detected ECMs" .

b. Press the "Browse" button 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. If the engine rating is being changed, factory passwords must be obtained before the flash file will be accepted.

7. Access the "Configuration" screen under the "Service" menu to determine the parameters that require programming. Look under the "Tattletale" column. All the parameters should have a tattletale of 1 or more. If a parameter has a tattletale of 0, program that parameter.

8. Start the engine and check for proper operation. Check that there are no active diagnostic codes.

"WinFlash" Error Messages

If any error messages are displayed during flash programming, click the "Cancel" button to stop the process. Access the information about the "ECM Summary" under the "Information" menu. Ensure that you are programming the correct flash file for your engine.

If a 630-2 diagnostic trouble code is displayed after flash programming, a required parameter is missing. Program the missing parameter.

i07561787

ECM - Replace

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Engine ECM

The engine is equipped with an Electronic Control Module (ECM). The ECM contains no moving parts. Follow the troubleshooting procedures in this manual to be sure that replacing the ECM will correct a fault. Verify that the suspect ECM is the cause of the fault.

Note: Ensure that the ECM is receiving power and that the ECM is properly grounded before replacement of the ECM is attempted. Refer to the schematic diagram.

A test ECM can be used to determine if the ECM on the engine is faulty. Install a test ECM in place of the suspect ECM. Install the flash file with the correct part number into the test ECM. Program the parameters for the test ECM. The parameters must match the parameters in the suspect ECM. Refer to the following test steps for details. If the test ECM resolves the fault, reconnect the suspect ECM. Verify that the fault returns. If the fault returns, replace the ECM.

Note: If an ECM is used as a test ECM, select “Test ECM Mode” on the electronic service tool before the engine serial number is entered.

Use the electronic service tool to read the parameters in the suspect ECM. Record the parameters in the suspect ECM. Install the flash file into the new ECM. After the ECM is installed on the engine, the parameters must be programmed into the new ECM.

Note: When a new ECM is not available, an ECM can be used from an engine that is not in service. The ECM must have the same serial number suffix. Ensure that the replacement ECM and the part number for the flash file match the suspect ECM. Be sure to record the parameters from the replacement ECM. Use the “Copy Configuration ECM Replacement” function in the electronic service tool.

NOTICE

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

Perform the following procedure to replace the ECM.

1. Connect the electronic service tool to the diagnostic connector.

2. Use the “Copy Configuration ECM Replacement” function from the electronic service tool. If the “Copy Configuration” is successful, proceed to Step 4. If the “Copy Configuration” failed, proceed to Step .

Note: Record any Logged Faults and Events for your records.

3. Record the following parameters:

- Record all the parameters on the “Configuration” screen.
- Record all the parameters on the “Throttle Configuration” screen.
- Record all the parameters on the “Mode Configuration” screen.
- Record the serial numbers of the electronic unit injectors. The injector serial numbers are shown on the “Injector Trim Calibration” screen.
- Record the data from the “Current Totals” screen.

Note: If the parameters cannot be read, the parameters must be obtained elsewhere. Some parameters are stamped on the engine information plate, but most parameters must be obtained from PTMI data.

4. Remove power from the ECM.

5. Remove the ECM. Refer to Disassembly and Assembly, “Electronic Control Module - Remove and Install”.

6. Install the replacement ECM. Refer to Disassembly and Assembly, “Electronic Control Module - Remove and Install”.

7. If the replacement ECM is used as a test ECM, select “Test ECM Mode” on the electronic service tool.

8. Download the flash file.

a. Connect the electronic service tool to the diagnostic connector.

b. Select “WinFlash” from the “Utilities” menu of the electronic service tool.

c. Select the downloaded flash file.

9. If necessary, use the electronic service tool to clear the rating interlock. To clear the rating interlock, enter the factory password when the electronic service tool is first connected. Activating the Test ECM mode will also clear the rating interlock.

10. Use the electronic service tool to program the parameters. Perform the following procedure.

a. If the “Copy Configuration” procedure was successful, use the “Copy Configuration, ECM Replacement” function to load the configuration file into the ECM.

Note: During the following procedure, factory passwords may be required.

b. If the “Copy Configuration” procedure failed, configure the parameters individually. The parameters should match the parameters from step 3.

11. Perform the “High Pressure Fuel Pump Calibration” .

12. Check for logged diagnostic codes. Factory passwords are required to clear logged events.

i08582995

Electrical Connectors - Inspect

NOTICE

Cleaning Electrical Connectors

To avoid damage to certain plastic materials, do not use contact cleaner on any electrical connectors. If the electrical contacts, seals, insulators, or ECM require cleaning use a cotton swab and denatured alcohol. Ensure that all the interior surfaces of connectors are clean and dry before reconnecting. If dirt or corrosion cannot be removed using this method, the entire connector must be replaced.

Most electrical faults are caused by poor connections. The following procedure will help in detecting faults with connectors and with wiring. If a fault is found, correct the condition and verify that the fault is resolved.

Intermittent electrical faults are sometimes resolved by disconnecting and reconnecting connectors. Check for diagnostic codes immediately before disconnecting a connector. Also check for diagnostic codes after reconnecting the connector. If the status of a diagnostic code is changed due to disconnecting and reconnecting a connector, there are several possible reasons. The likely reasons are loose terminals, improperly crimped terminals, moisture, corrosion, and inadequate mating of a connection.

Follow these guidelines:

- Always use a 2900A033 Crimp Tool to service Deutsch HD and DT connectors. Never solder the terminals onto the wires.
- Always use a 28170079 Removal Tool to remove wedges from DT connectors. Never use a screwdriver to pry a wedge from a connector.
- Always use a 2900A033 Crimp Tool to service AMP seal connectors.
- Refer to Troubleshooting, “Electrical Connectors” to service the connectors for the Electronic Control Module (ECM).
- Always use a breakout harness for a voltmeter probe or a test light. Never break the insulation of a wire to access a circuit for measurements.
- If a wire is cut, always install a new terminal for the repair.

WARNING

The connection of any electrical equipment and the disconnection of any electrical equipment may cause an explosion hazard which may result in injury or death. Do not connect any electrical equipment or disconnect any electrical equipment in an explosive atmosphere.

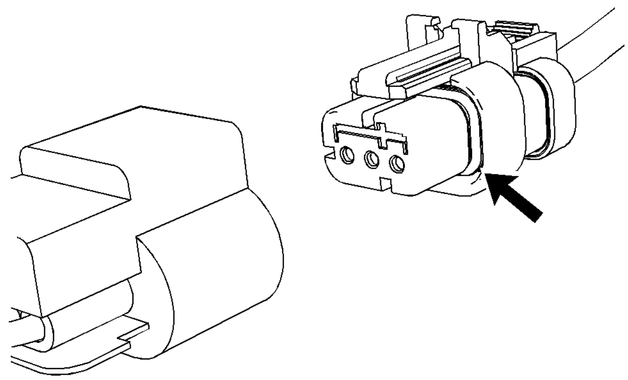

Illustration 70 g01131019

Seal for a three-pin connector (typical example)

Table 152

Troubleshooting Test Steps	Values	Results
1. Check Connectors for Moisture and Corrosion **A.** Inspect all the harnesses. Ensure that the routing of the wiring harness allows the wires to enter the face of each connector at a perpendicular angle. Otherwise, the wire will deform the seal bore. This situation can create a path for the entrance of moisture. Verify that the seals for the wires are sealing correctly. **B.** Ensure that the sealing plugs are in place. If any of the plugs are missing, replace the plug. Ensure that the plugs are inserted correctly into the connector. **C.** Disconnect the suspect connector and inspect the connector seal. Ensure that the seal is in good condition. If necessary, replace the connector. **D.** Thoroughly inspect the connectors for evidence of moisture entry. **Note:** Some minor seal abrasion on connector seals is normal. Minor seal abrasion will not allow the entry of moisture. If moisture or corrosion is evident in the connector, the source of the moisture entry must be found and repaired. If the source of the moisture entry is not repaired, the fault will recur. Simply drying the connector will not rectify the fault. Check the following items for the possible moisture entry path: · Missing seals · Incorrectly installed seals · Nicks in exposed insulation · Improperly mated connectors Moisture can also travel to a connector inside a wire. If moisture is found in a connector, thoroughly check the connector harness for damage. Also check other connectors that share the harness for moisture. **Note:** The ECM is a sealed unit. If moisture is found in an ECM connector, the ECM is not the source of the moisture. Do not replace the ECM.	Harness, connectors, and seals are OK.	**Result:** A fault has been found with the harness or the connectors. **Repair:** Repair the connectors or the wiring, as required. Ensure that all the seals are correctly installed. Ensure that the connectors have been reattached. If corrosion is evident on the pins, sockets, or the connector, use only denatured alcohol to remove the corrosion. Use a cotton swab or a soft brush to remove the corrosion. If moisture was found in the connectors, run the engine for several minutes and check again for moisture. If moisture reappears, the moisture is wicking into the connector. Even if the moisture entry path is repaired, replacement of the wires may be necessary. Use the electronic service tool to clear all logged diagnostic codes and then verify that the repair eliminates the fault. **Result:** The harness, connectors, and seals are in good condition. Proceed to Test Step 2.
2. Check the Wires for Damage to the Insulation **A.** Carefully inspect each wire for signs of abrasion, nicks, and cuts. Inspect the wires for the following conditions: · Exposed insulation · Rubbing of a wire against the engine · Rubbing of a wire against a sharp edge **B.** Check all the fasteners for the harness and the strain relief components on the ECM to verify that the harness is correctly secured. Also check all the fasteners to verify that the harness is not compressed. Pull back the harness sleeves to check for a flattened portion of wire. A fastener that has been overtightened flattens the harness. This condition damages the wires that are inside the harness.	The wiring is OK	**Result:** There is damage to the harness. **Repair:** Replace the harness. Use the electronic service tool to clear all logged diagnostic codes and then verify that the repair eliminates the fault. **Result:** The wires are free of abrasion, nicks, and cuts and the harness is correctly clamped. Proceed to Test Step 3.
3. Inspect the Connector Terminals	Terminals are aligned and undamaged	**Result:** The terminals of the connector are damaged.

(continued)

(Table 152, contd)

Troubleshooting Test Steps	Values	Results
A. Visually inspect each terminal in the connector. Verify that the terminals are not damaged. Verify that the terminals are correctly aligned in the connector and verify that the terminals are correctly located in the connector.		**Repair:** Repair the terminals and/or replace the terminals, as required. Use the electronic service tool to clear all logged diagnostic codes and then verify that the repair eliminates the fault. **Result:** The terminals are OK. Proceed to Test Step 4.

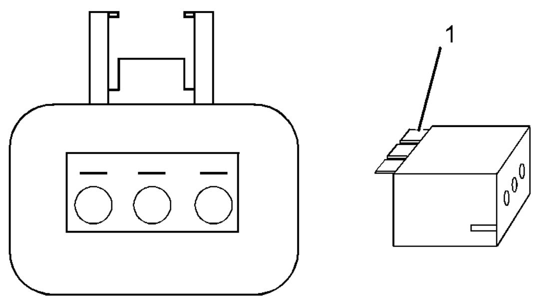

Illustration 71 g01802454

A typical example of the lock wedge.

(1) Lock wedge

Table 153

Troubleshooting Test Steps	Values	Results
4. Perform a Pull Test on Each Wire Terminal Connection **A.** Ensure that the locking wedge for the connector is installed correctly. Terminals cannot be retained inside the connector if the locking wedge is not installed correctly. **B.** Perform the 30 N (6.7 lb) pull test on each wire. Each terminal and each connector should easily withstand 30 N (6.7 lb) of tension and each wire should remain in the connector body. This test checks whether the wire was correctly crimped in the terminal and whether the terminal was correctly inserted into the connector.	Pull test OK	**Result:** A wire has been pulled from a terminal or a terminal has been pulled from the connector in the 30 N (6.7 lb) pull test. **Repair:** Use the 2900A033 Crimp Tool to replace the terminal. Replace damaged connectors, as required. Use the electronic service tool to clear all logged diagnostic codes and then verify that the repair eliminates the fault. **Result:** All terminals pass the pull test. Proceed to Test Step 5.
5. Check the Locking Mechanism of the Connectors **A.** Ensure that the connectors lock correctly. After locking the connectors, ensure that the two halves cannot be pulled apart. **B.** Verify that the latch tab of the connector is correctly latched. Also verify that the latch tab of the connector returns to the locked position.	The connectors are locked and are not damaged	**Result:** The locking mechanism for the connector is damaged or missing. **Repair:** Repair the connector or replace the connector, as required. Use the electronic service tool to clear all logged diagnostic codes and then verify that the repair eliminates the fault. **Result:** The connectors are in good condition. Proceed to Test Step 6.
6. Perform the “Wiggle Test” on the Electronic Service Tool **A.** Select the “Wiggle Test” from the diagnostic tests on the electronic service tool. **B.** Choose the appropriate group of parameters to monitor. **C.** Press the “Start” button. Wiggle the wiring harness to reproduce intermittent faults. If an intermittent fault exists, the status will be highlighted and an audible beep will be heard.	Intermittent faults were indicated.	**Result:** No intermittent faults were found. If directed here from another procedure, return to the procedure and continue testing. If this test confirms that the fault has been eliminated, return the engine to service. **Result:** At least one intermittent fault was indicated. **Repair:** Repair the harness or the connector. Use the electronic service tool to clear all logged diagnostic codes and then verify that the repair eliminates the fault.

i07561938

Injector Code - Calibrate

Injector codes are codes that are 30 hexadecimal characters in length that are supplied with each injector. The code is on a plate on the top of the injector and a card is also included in the packaging for the injector. The code is used by the Electronic Control Module (ECM) to balance the performance of the injectors.

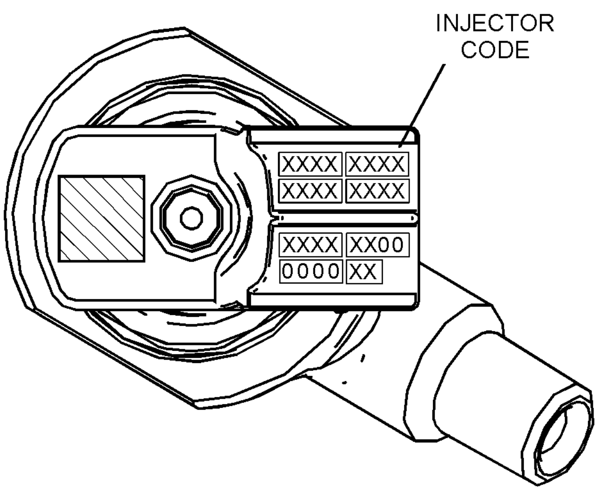

Illustration 72 g06360333

Label with the injector code

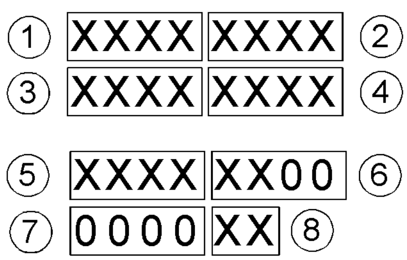

Illustration 73 g06360350

Sequence for recording the injector code

The electronic service tool is used to load the injector codes into the ECM.

The injector codes must be loaded into the ECM if any of the following conditions occur:

- An electronic unit injector is replaced.
- The ECM is replaced.
- A -2 diagnostic code is active for one or more of the injectors
- Electronic unit injectors are exchanged between cylinders.

If the ECM is replaced, the injector codes are normally transferred to the new ECM as part of the "Copy Configuration" procedure. If the "Copy Configuration" procedure fails, the injector codes must be loaded manually.

Installing Injector Codes

Note: The injector code is on the top of the electronic unit injector.

1. Record the injector code for each electronic unit injector.

2. Connect the electronic service tool to the diagnostic connector. Refer to Troubleshooting, "Electronic Service Tools".

3. Turn the keyswitch to the ON position.

4. Select the following menu options on the electronic service tool:

- Service
- Calibrations
- Injector Codes Calibration

5. Select the appropriate cylinder.

6. Click the "Change" button.

7. Input the applicable injector code that was recorded in Test Step 1.

8. Click the "OK" button.

The injector code is loaded into the ECM.

9. Repeat the procedure for each cylinder, as required.

Exchanging Electronic Unit Injectors

Exchanging electronic unit injectors can help determine if a combustion problem is in the electronic unit injector or in the cylinder. If two electronic unit injectors that are currently installed in the engine are exchanged between cylinders, the injector codes must also be exchanged. Press the "Exchange" button at the bottom of the "Injector Trim Calibration" screen on the electronic service tool. Select the two electronic unit injectors that will be exchanged and press the "OK" button.

Index

T

V

W