UENR0683-15 (en-us)
September 2019

Perkins®

THE HEART OF EVERY GREAT MACHINE

Troubleshooting

1206F-E70TA and 1206F-E70TTA Engines

BM (Engine)
BN (Engine)

Important Safety Information

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

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

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

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

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

⚠ 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.

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

Perkins 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 Perkins 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. Perkins dealers or Perkins distributors have the most current information available.

⚠ WARNING

When replacement parts are required for this product Perkins recommends using Perkins replacement parts.

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

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

Table of Contents

Troubleshooting Section

Index Section

Troubleshooting Section

Introduction

i06276600

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 in order 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 the Selective Catalyst Reduction (SCR) system
- 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 in order to indicate the status of switches. Correctly configure the ECM in order to interpret the inputs.

The ECM provides outputs for the application control system via the electrical connector in order 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).

Selective Catalyst Reduction (SCR) System – The SCR system is used to reduce NOx emissions from the engine. The SCR system is installed after the DPF in the exhaust.

Software – Software in the ECM monitors the DPF. The software also controls the amount of Diesel Exhaust Fluid (DEF) being injected into the exhaust stream.

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 two data links. The data links are the Data Link and CAN data link. The electronic service tool must communicate on both data links in order to service the engine. If a fault is suspected with the Data Link, refer to Troubleshooting, “Data Link - Test”.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.

Troubleshooting Associated Codes

Certain systems will display multiple codes for troubleshooting . These “Associated Codes” must be used in order to troubleshoot the system. The codes should be viewed as separate levels of troubleshooting. For example, a “DEF Tank Temperature Low” code may be generated. This main code is not the code that requires troubleshooting.

The system is designed to display the codes for this separate level of troubleshooting as an “Associated Code” . The “Associated Code” is the diagnostic or the event code that needs to have the troubleshooting procedure followed.

The following paragraph is an example of troubleshooting the engine system with “Associated Codes” :

After connecting the electronic service tool to an engine, the following codes are displayed:

- Aftertreatment 1 Diesel Exhaust Fluid Tank Temperature : Low - moderate severity
- Aftertreatment #1 SCR Catalyst Reagent Tank #1 Heater Coolant Diverter Solenoid : Current Below Normal

These codes are the result of a diverter valve fault. The Diesel Exhaust Fluid (DEF) is below the expected temperature because the diverter valve has not allowed coolant to circulate through the DEF tank. The troubleshooting procedure to use in this case is the “Aftertreatment #1 SCR Catalyst Reagent Tank #1 Heater Coolant Diverter Solenoid : Current Below Normal” code, which will fix the other issue.

i05971079

Welding Precaution

Proper welding procedures are necessary in order to avoid damage to the Electronic Control Module (ECM), Dosing Control Unit (DCU), sensors, and associated components. Also consider components that are for the driven equipment. Remove the component that requires welding. When welding on an engine that is equipped with an ECM and removal of the component is not possible, the following procedure must be followed. This procedure provides the minimum amount of risk to the electronic components.

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, turn the switch to the OFF position.

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

   - Electronic components for the driven equipment
   - Engine ECM
   - DCU
   - Sensors

NOTICE

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

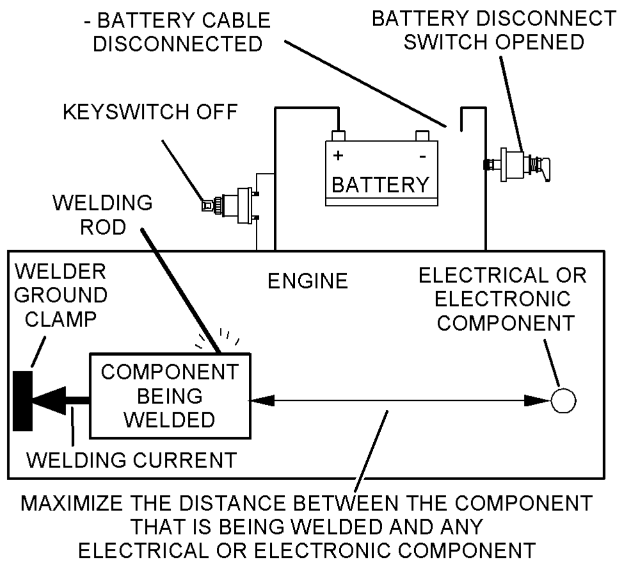


Illustration 1 g01143634

Service welding guide (typical diagram)

5. When possible, connect the welder ground clamp directly to the engine component that will be welded. Place the clamp as close as possible to the weld. A close connection will reduce the possibility 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 the welding spatter.

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

i06151874

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

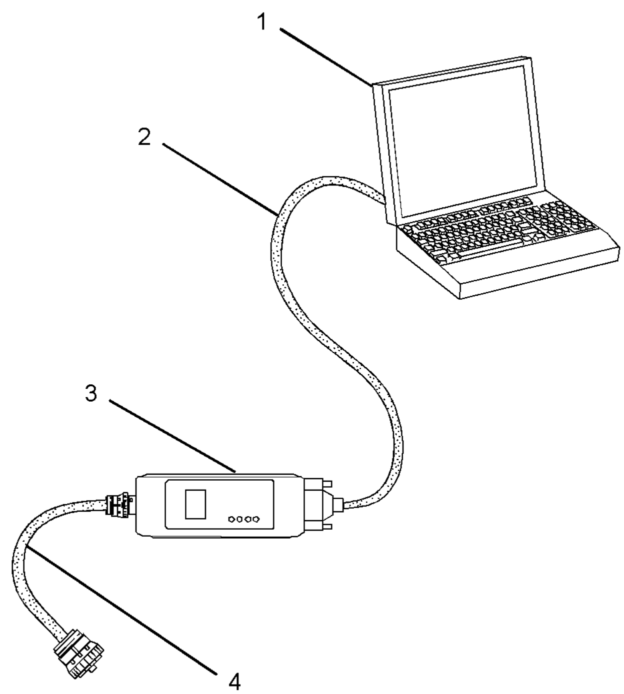


Illustration 2 g01121866

(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

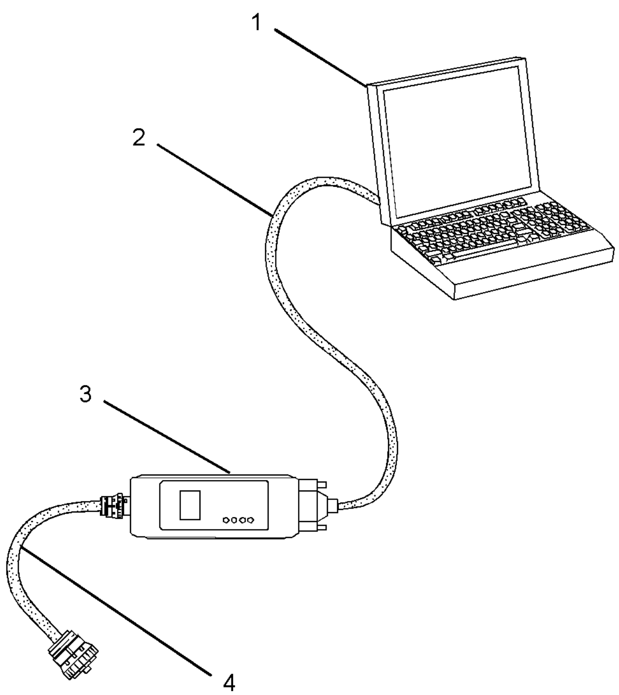


Illustration 3 g01121866

(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

i07797269

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 aftertreatment system is controlled by the engine ECM.

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 lower 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 dead 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.

i06836192

Component Location

Electronic Control Circuit Diagram

Engine ECM

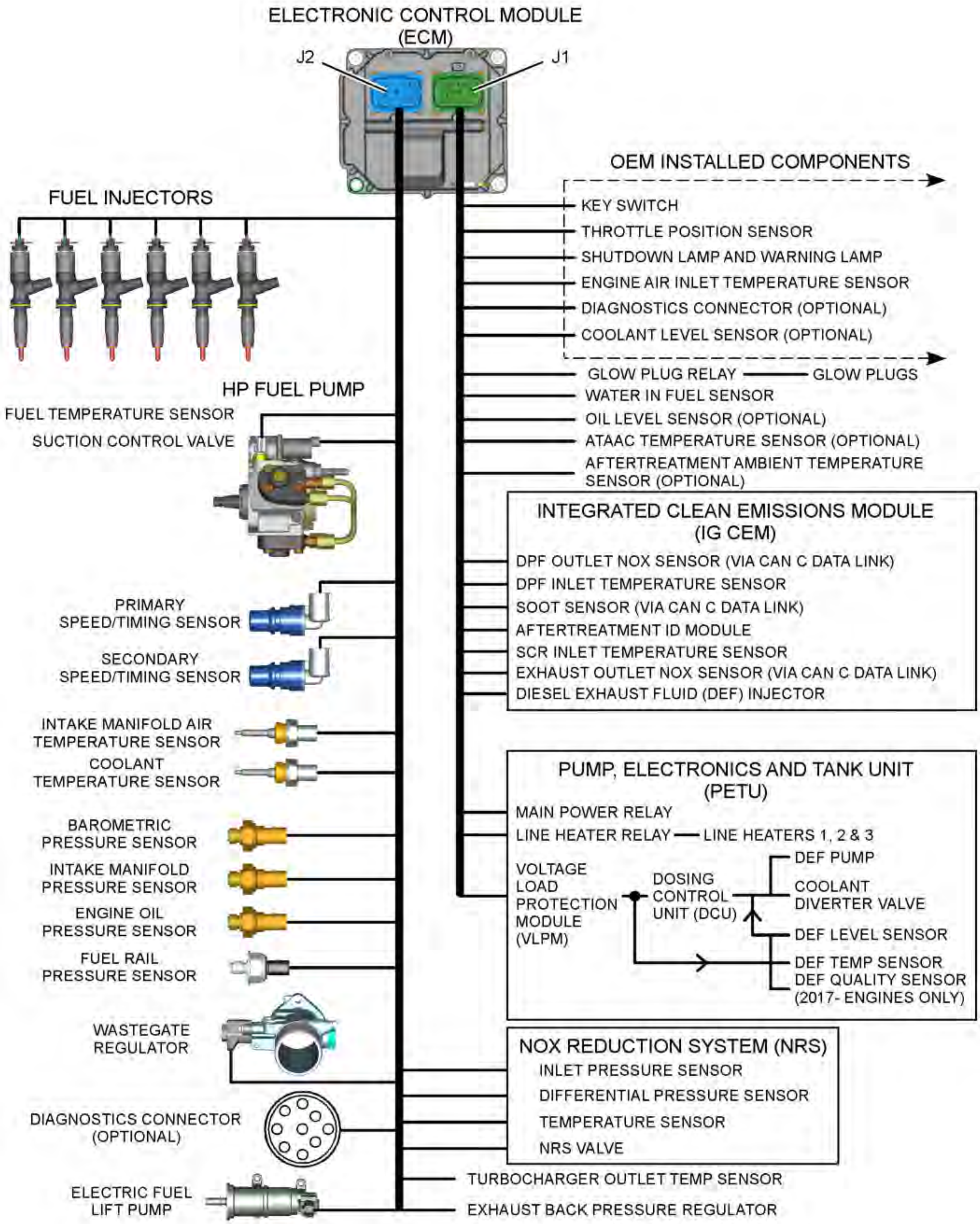


Illustration 4 g06136193

Sensors and components that are connected to the engine ECM

Table 4

Additional Components That May Be Applicable For Certain Applications	
Throttle Position Sensor	Cooling Fan Solenoid
Ambient Air Temperature Sensor	Engine Fan Reversing Solenoid
Coolant Level Sensor	Air Filter Restriction Pressure Sensor
Ether Solenoid	

Table 5

Component Name Conversion to the Electronic Service Tool	
Perkins EST Display Component Name	**Troubleshooting Guide Component Name**
Engine charge air cooler #1 outlet temperature	Charge air cooler outlet temperature
EGR differential pressure	NRS differential pressure sensor
EGR intake pressure (absolute)	NRS intake pressure sensor
EGR temperature	NRS temperature sensor
EGR valve	NRS valve
DPF #1 intake pressure	DPF intake pressure
DPF #1 intake temperature	DPF inlet temperature sensor

Engine

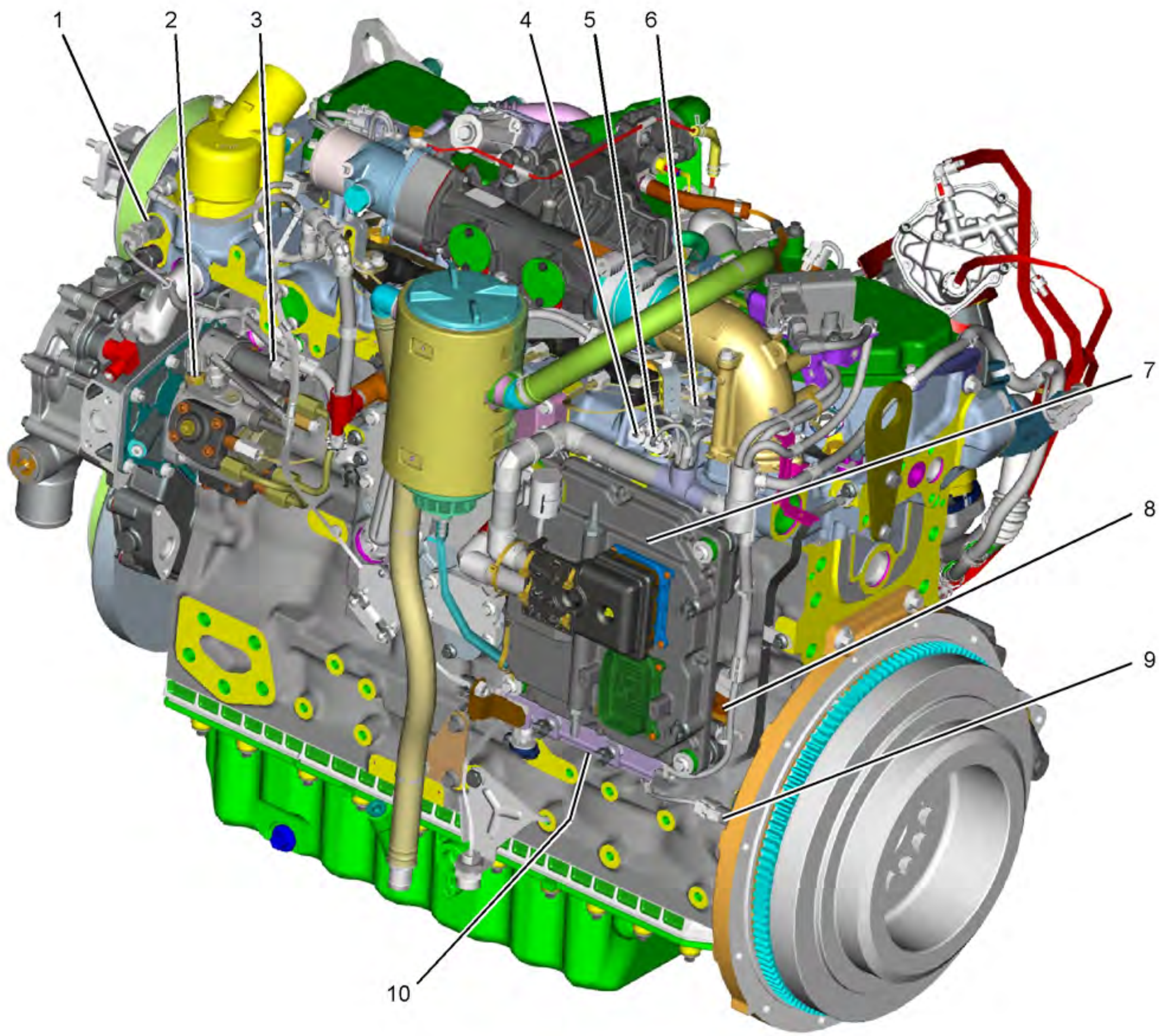


Illustration 5 g03842162

Sensor and component locations on the left side of the 1206F engine

(1) Coolant temperature sensor
(2) Fuel temperature sensor
(3) Solenoid for the high-pressure fuel pump
(4) Intake manifold air temperature sensor
(5) Intake manifold pressure sensor
(6) Fuel rail pressure sensor
(7) Electronic Control Module (ECM)
(8) Barometric pressure sensor
(9) Primary speed/timing sensor
(10) Oil pressure sensor

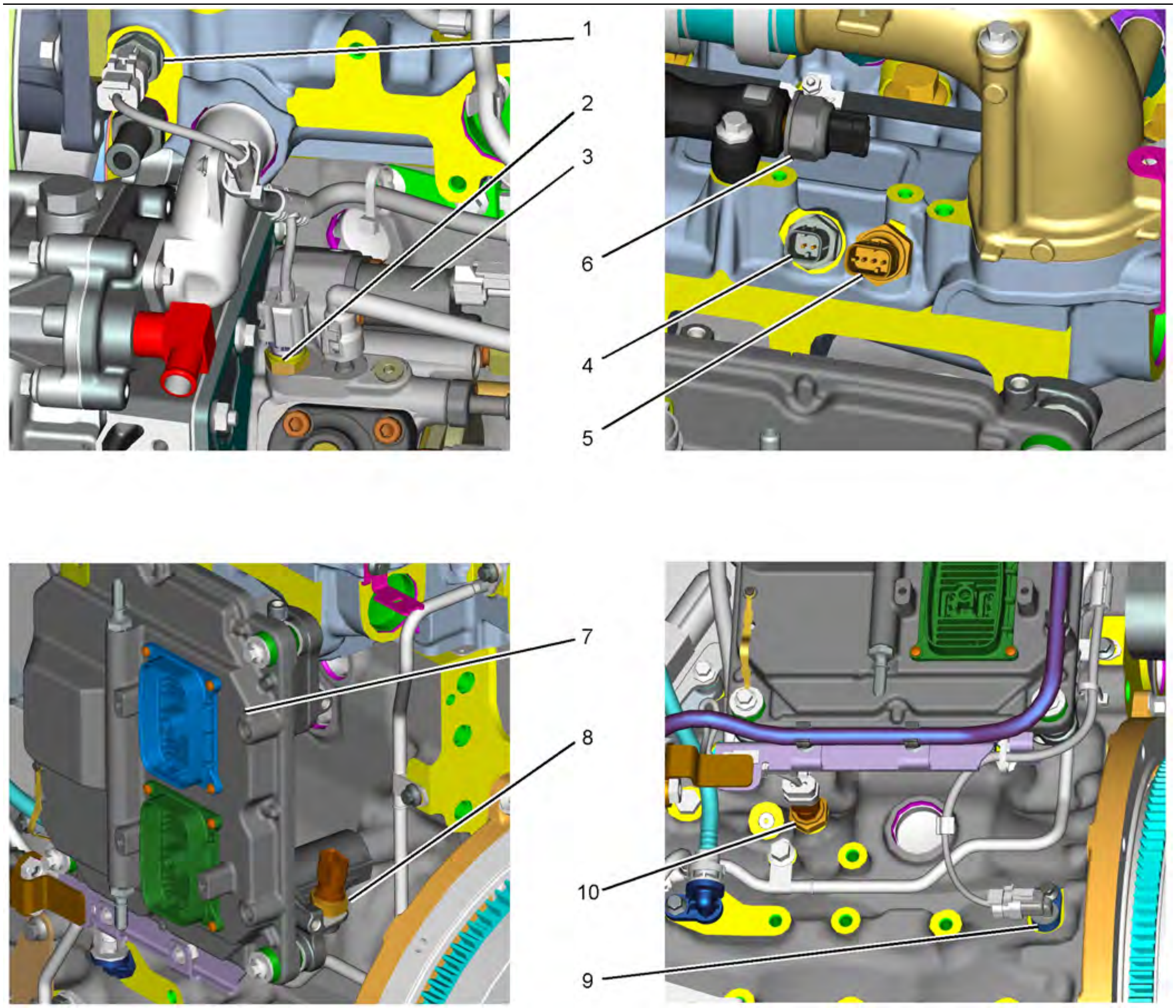


Illustration 6 g03744022

Close up views of sensor and component locations on the left side of 1206F engine

(1) Coolant temperature sensor
(2) Fuel temperature sensor
(3) Solenoid for the high-pressure fuel pump
(4) Intake manifold air temperature sensor
(5) Intake manifold pressure sensor
(6) Fuel rail pressure sensor
(7) Electronic Control Module (ECM)
(8) Barometric pressure sensor
(9) Primary speed/timing sensor
(10) Oil pressure sensor

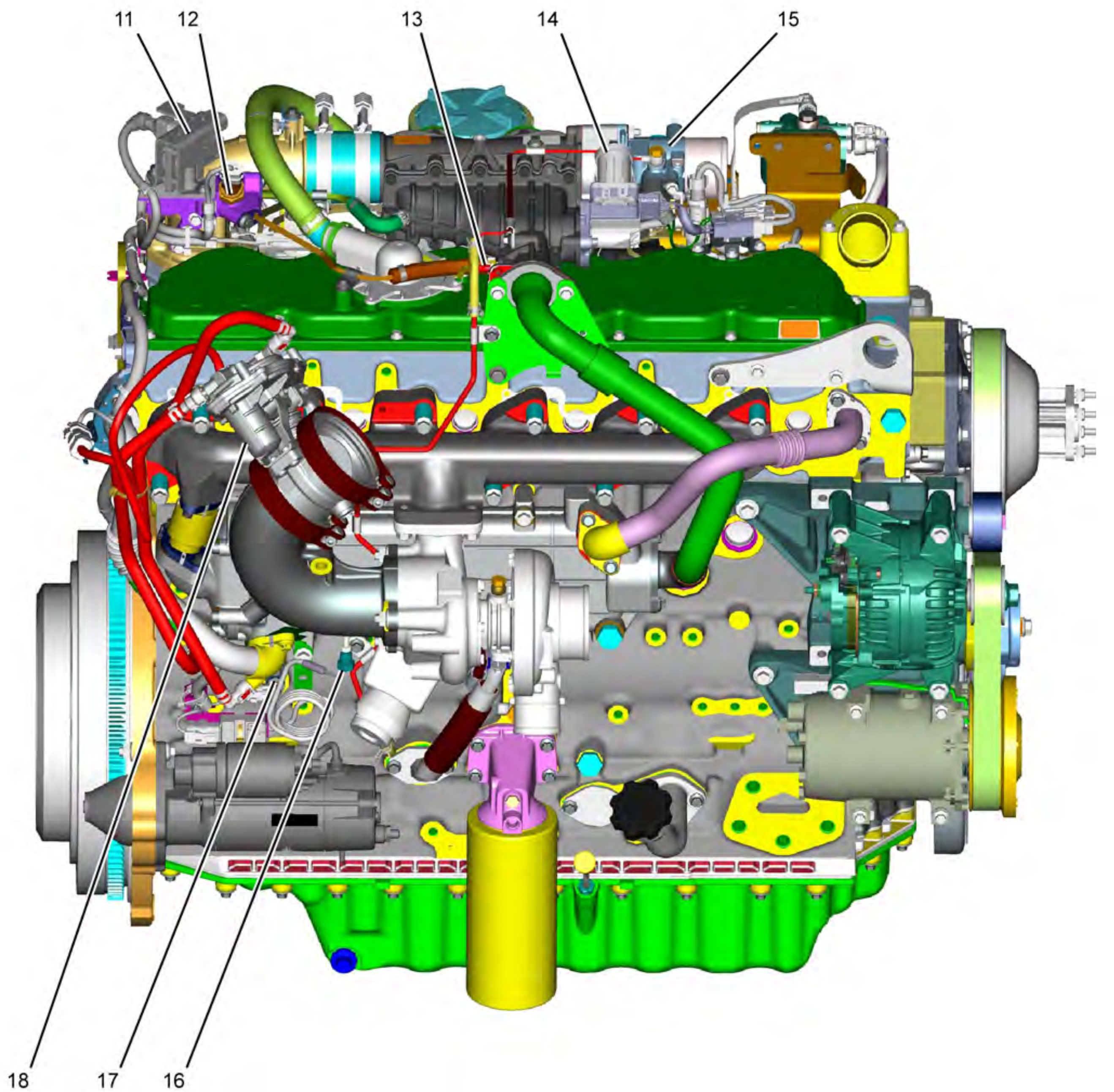


Illustration 7 g03744037

Sensor and component locations on the right side and top of a typical 1206F engine

(11) NOx Reduction System (NRS) differential pressure sensor
(12) NRS inlet pressure sensor
(13) NRS inlet temperature sensor
(14) NRS valve including a position sensor
(15) Wastegate regulator
(16) Turbocharger outlet temperature sensor
(17) Secondary speed/timing sensor
(18) Exhaust Back Pressure Regulator (EBPR)

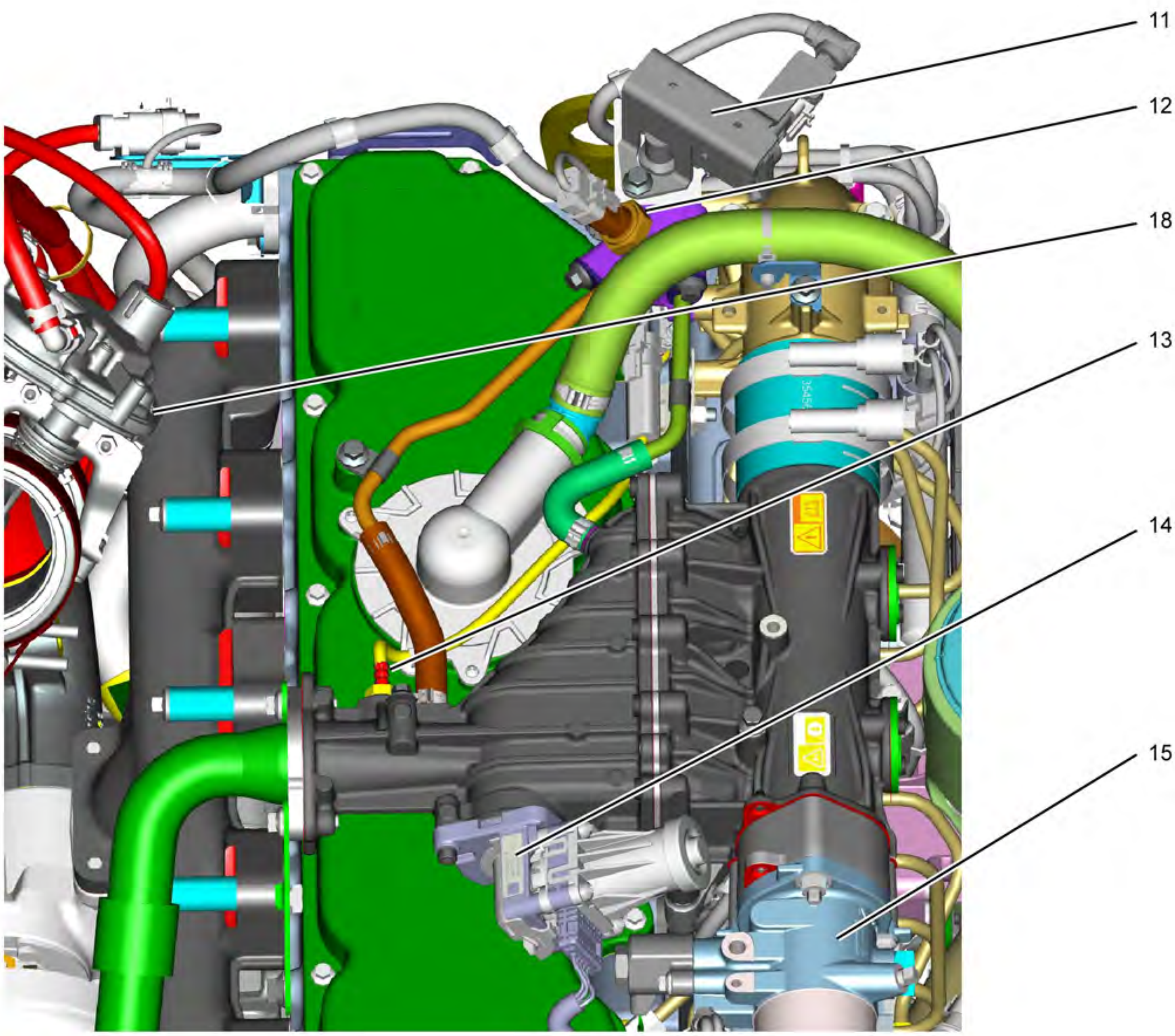


Illustration 8 g03744047

Close up views of sensor locations on the top of a typical 1206F engine

(11) NOx Reduction System (NRS) differential pressure sensor
(12) NRS inlet pressure sensor
(13) NRS inlet temperature sensor
(14) NRS valve including a position sensor
(15) Wastegate regulator
(18) Exhaust Back Pressure Regulator (EBPR)

Clean Emission Module (CEM)

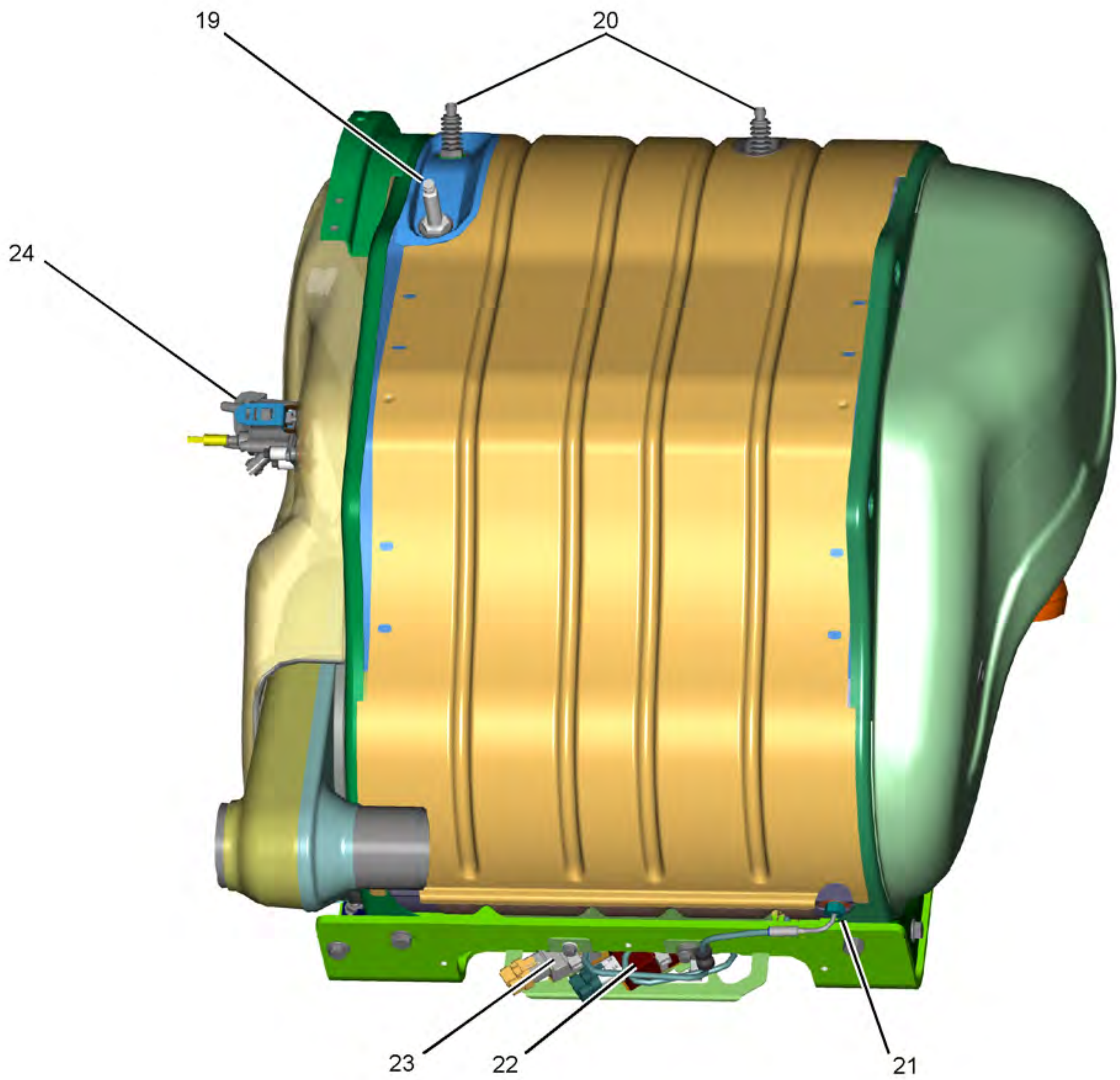


Illustration 9 g03744057

Sensors and components on the Integrated Clean Emissions Module (IG CEM) (view 1)

(19) Diesel Particulate Filter (DPF) outlet NOx sensor
(20) Soot sensor antenna
(21) SCR intake temperature probe
(22) Aftertreatment ID module
(23) Temperature sensor
(24) Diesel Exhaust Fluid (DEF) injector

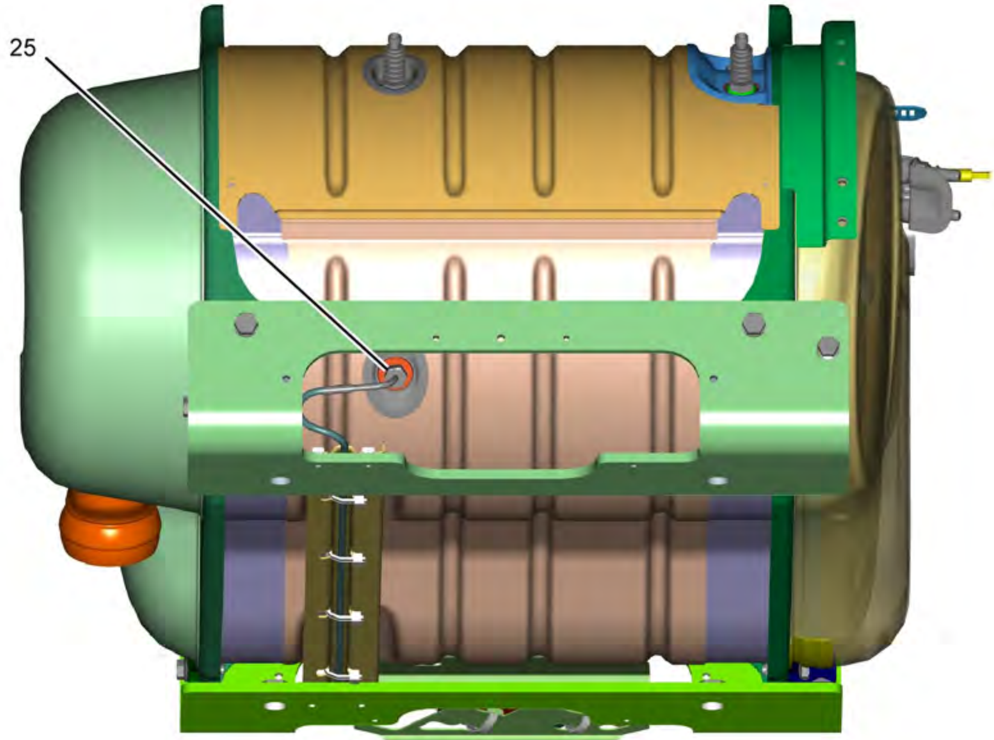


Illustration 10 g03744494

Sensors and components on the Integrated Clean Emissions Module (IG CEM) (view 2)

(25) DPF intake temperature probe

Pump, Electronics, and Tank Unit (PETU)

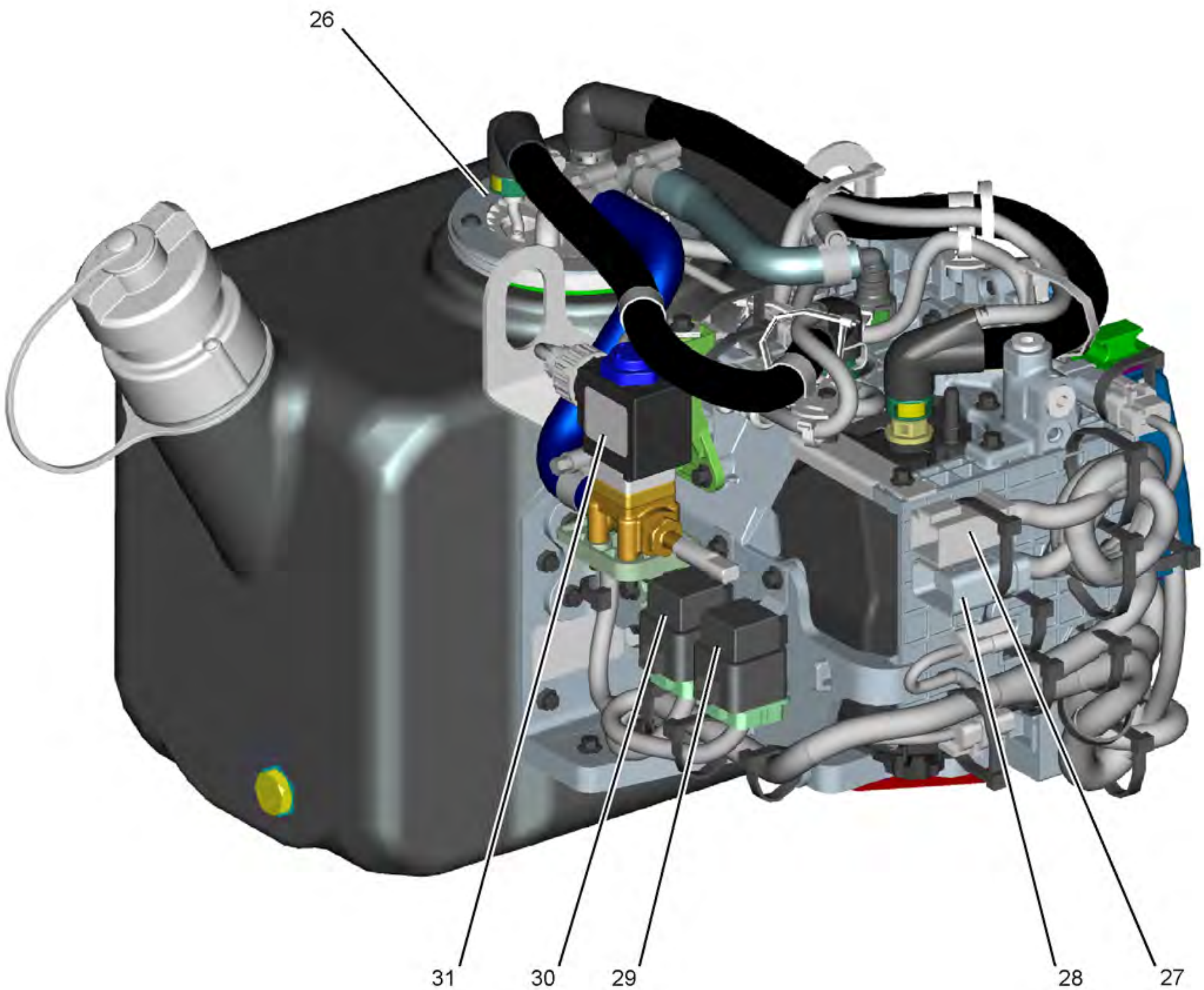


Illustration 11 g03744500

Sensors and components on the Pump, Electronics, and Tank Unit (PETU)

(26) DEF tank temperature, level, and quality sensor
(27) 4-pin connector
(28) 12-pin connector
(29) Power relay for heated DEF lines
(30) Power relay for DCU
(31) Coolant diverter valve

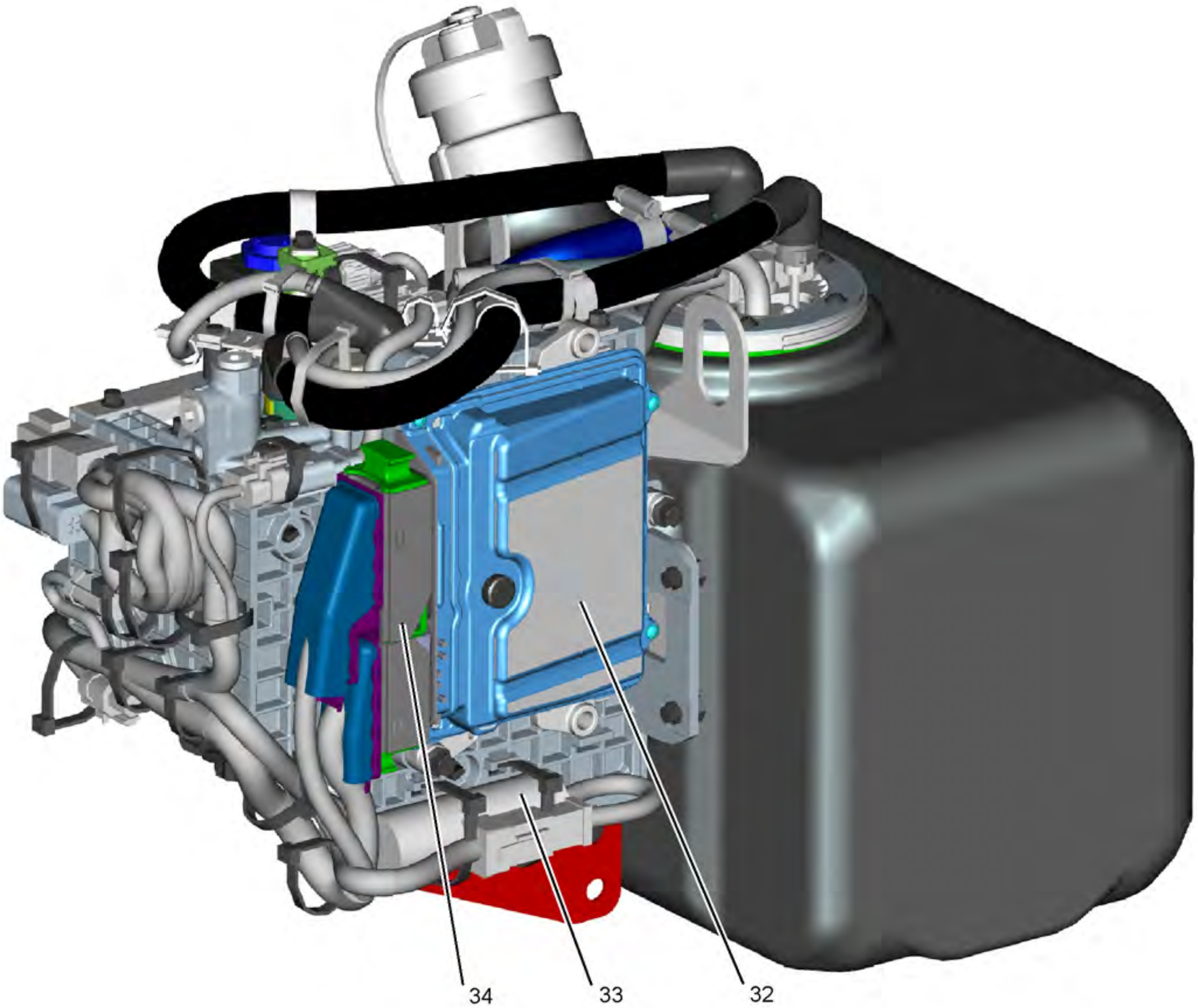


Illustration 12 g03744516

Sensors and components on the Pump, Electronics, and Tank Unit (PETU)

(32) Dosing Control Unit (DCU)

(33) Voltage Load Protection Module (VLPM)

(34) DCU connector

i06151879

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 in order 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 is dependent 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 are dependent 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. Refer to Table 6 .

Table 6

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

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 in order 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 in order 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).

i05977029

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.

An additional status screen is available for the Enhanced Troubleshooting Indicator ETI. The screen is accessed through the electronic service tool.

i07724184

Electrical Connectors

Connectors for the Electronic Control Module (ECM)

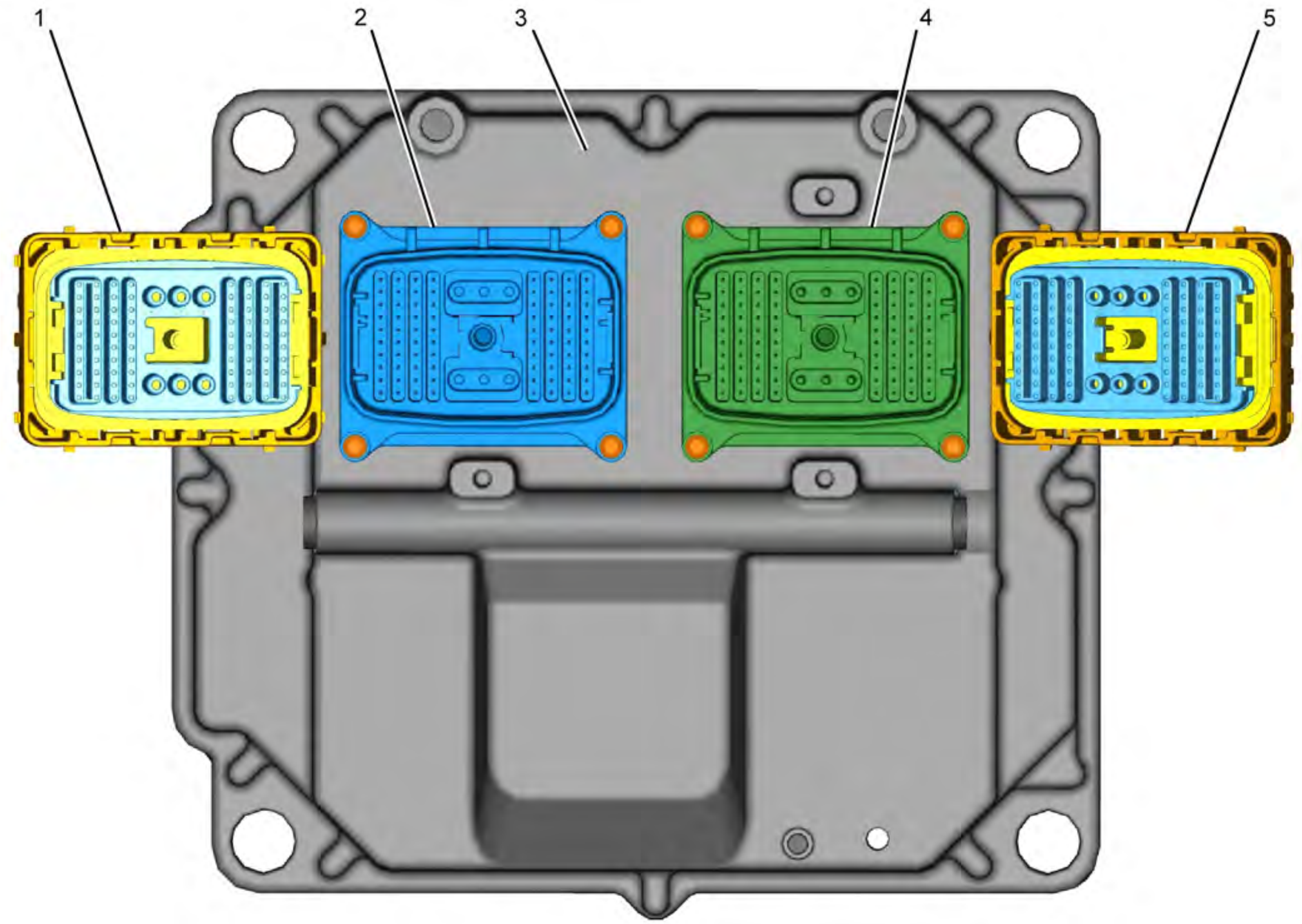


Illustration 13 g03744970

Locations of the components on the engine ECM

(1) P2 ECM connector (harness side)
(2) J2 ECM connector (ECM side)
(3) Engine ECM
(4) J1 ECM connector (ECM side)
(5) P1 ECM connector (harness side)

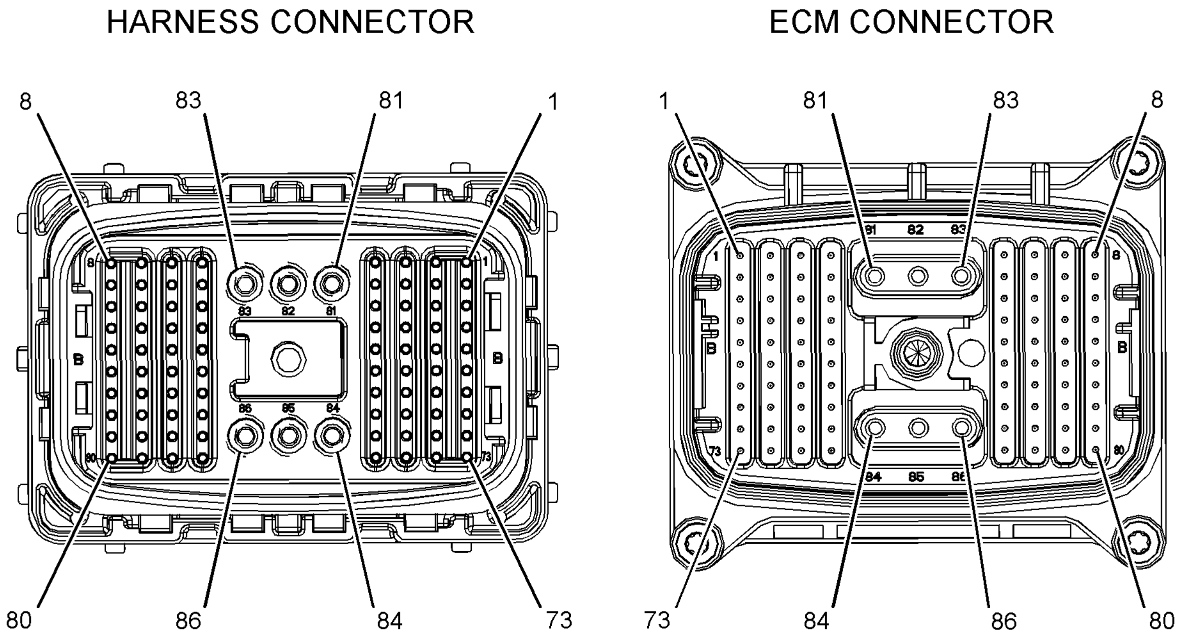


Illustration 14 g03744980

Numbering arrangement of ECM connector pins

Connectors on the Dosing Control Unit (DCU)

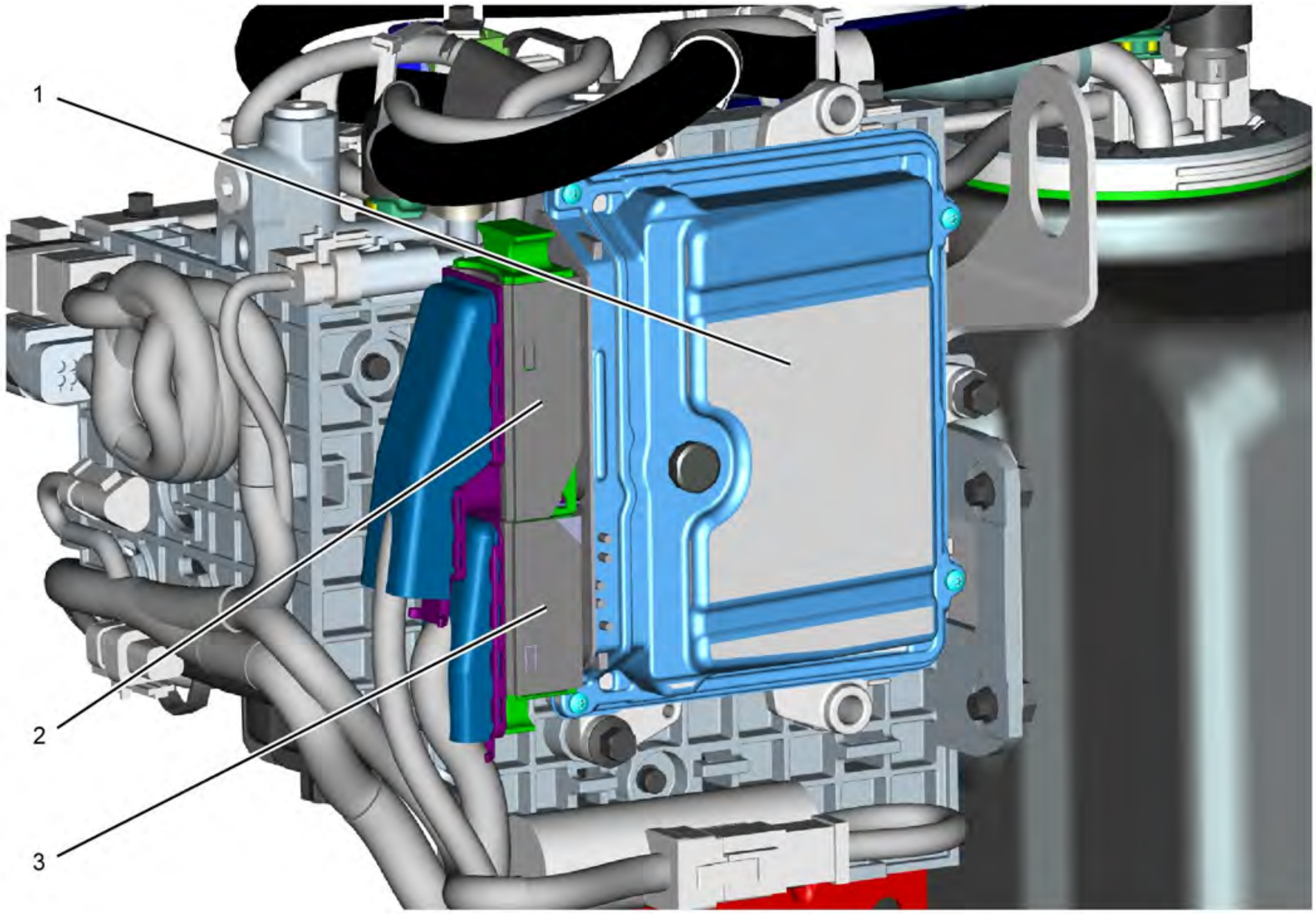


Illustration 15 g03745005

Locations of the connectors on the Dosing Control Unit (DCU)

(1) Dosing Control Unit (DCU) (2) 86-pin Connector (3) 53-pin Connector

Injector Connectors

Connectors at the Valve Cover

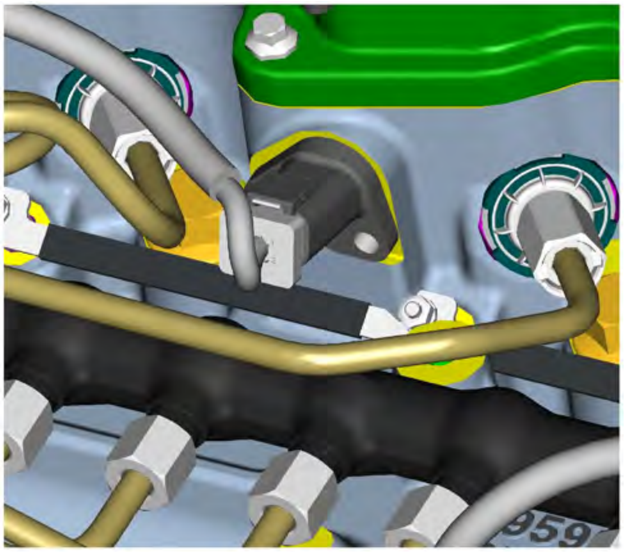


Illustration 16 g03745086

Sensor Connectors

Analog Sensor Connector (active)

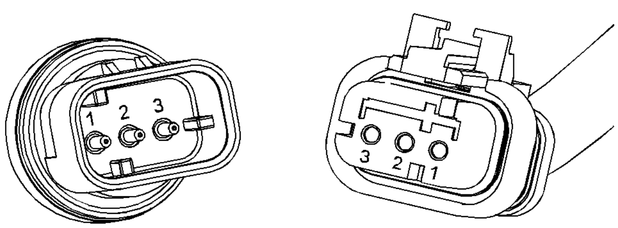


Illustration 17 g01240891

Analog Sensor Connector (passive)

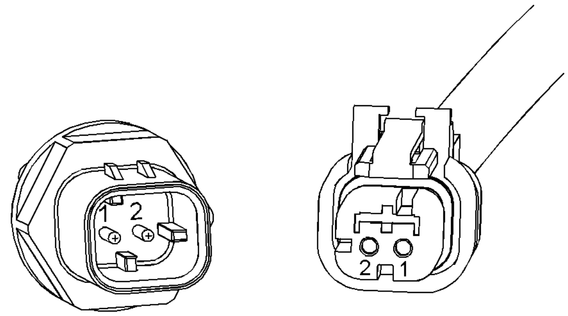


Illustration 18 g01241538

Connectors for the Termination Resistor

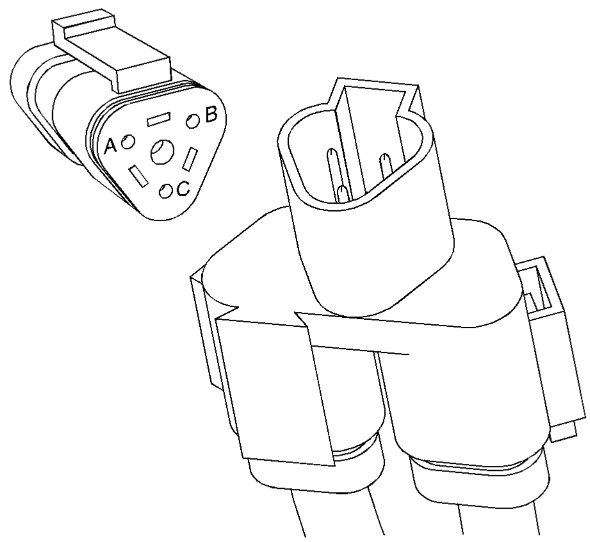


Illustration 19 g01355248

Engine Speed/Timing Connector

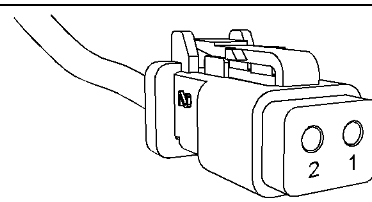


Illustration 20 g01155187

Ampseal Connector (typical)

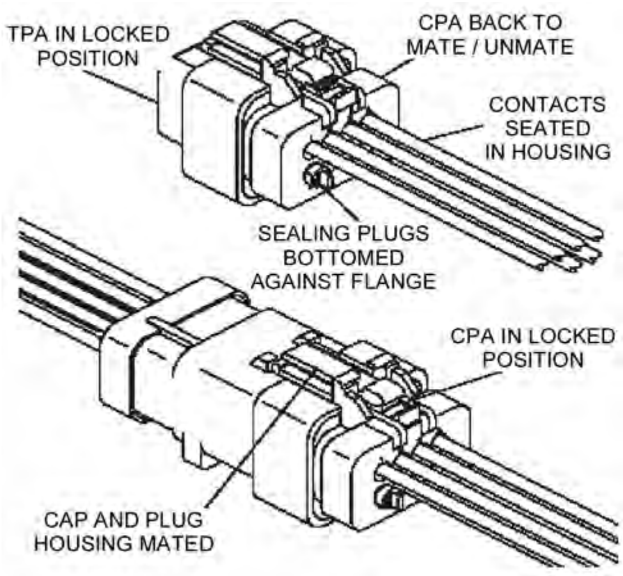


Illustration 21 g02219254

Deutsch Connectors (typical)

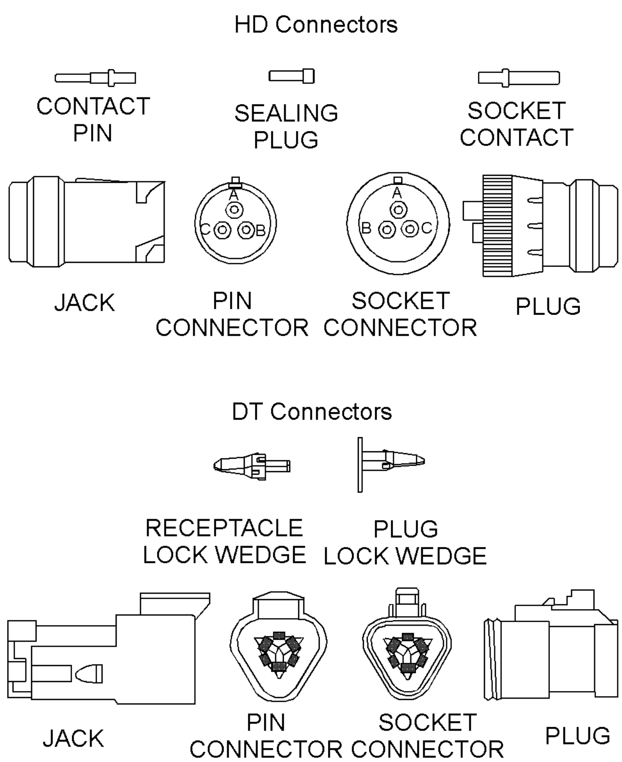


Illustration 22 g02220494

Configuration Parameters

i07118203

Configuration Parameters

Use this procedure if the diagnostic code in Table 7 is active.

Table 7

Codes That Relate to Configuration Parameters			
J1939 Code	PDL Code	Code Description (code descriptions may vary)	Comments
630-2	268-2	Programmed Parameter Fault : Erratic, Intermittent, or Incorrect	The engine 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.
Follow the troubleshooting procedure to identify the root cause of the problem.			

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.

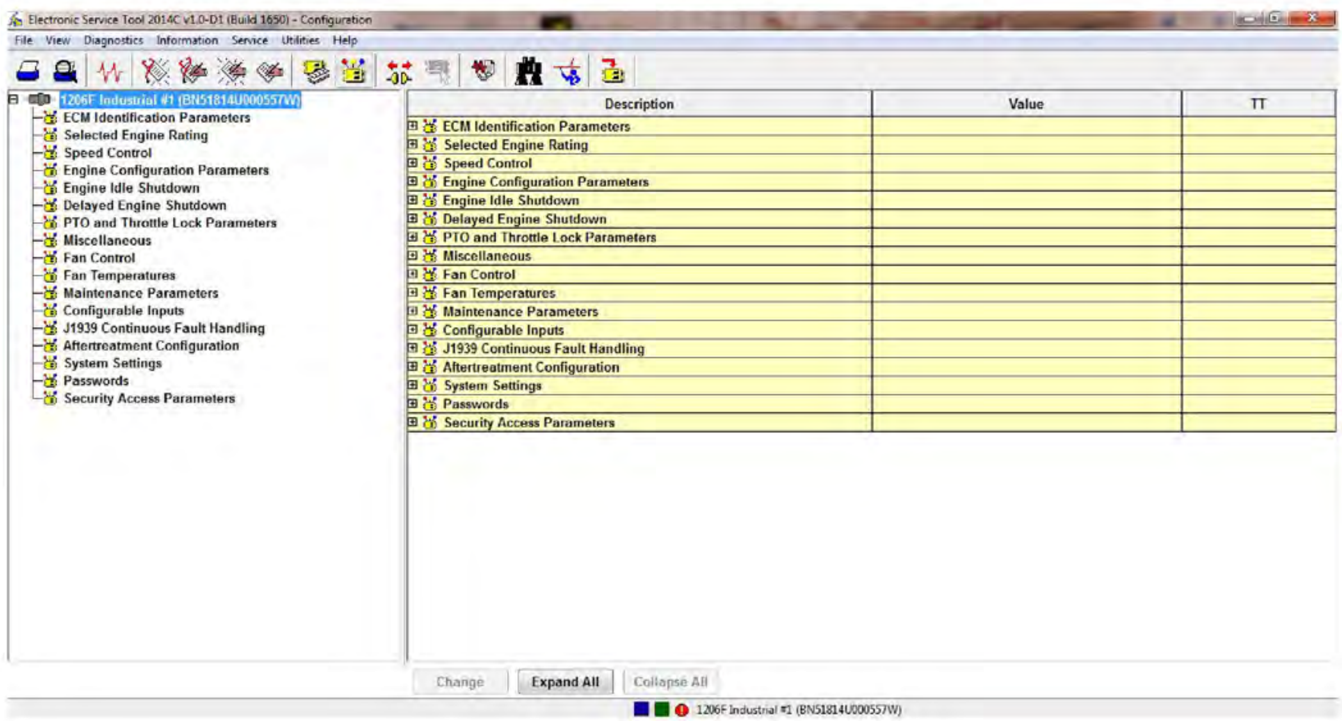


Illustration 23 g03747092

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 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 (630-2/268-2)

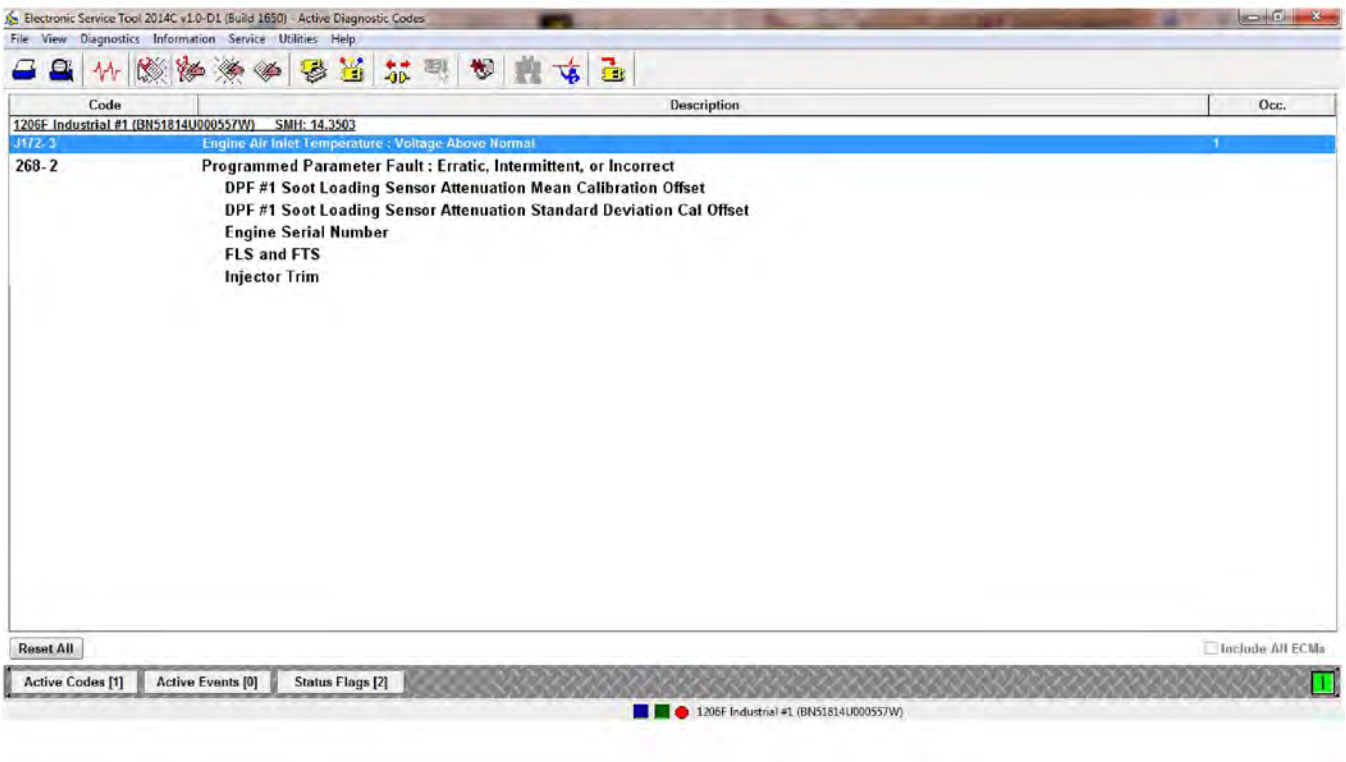


Illustration 24 g03747100

Typical active diagnostic codes screen

If a programmable parameter has not been programmed, the ECM will generate a 268-2 or 630-2 diagnostic code. The programmable parameter that is not programmed will be listed under the code. Illustration 24 shows the parameters that are not programmed under the 268-2 code. The unprogrammed parameters will be set to default. Certain aspects of the engines performance and engine monitoring may be affected.

If “Injector Trim” is displayed below a 268-2 or 630-2 diagnostic code on the electronic service tool, refer to Troubleshooting, “Injector Code - Calibrate”.

Diagnostic Trouble Codes

i07731047

Diagnostic Trouble Codes

Table 8 lists the diagnostic trouble codes in J1939 code order for the engines that are covered in this manual. Table 9 lists the diagnostic trouble codes in PDL code order for the engines that are covered in this manual. Use the electronic service tool to determine the codes that are active or logged. Then refer to the listed troubleshooting procedure for more information.

Table 8

Diagnostic Trouble Codes (J1939 Code Order)		
J1939 Code and Description	**PDL Code and Description**	**Troubleshooting Procedure**
27-3 EGR #1 Valve Position : Voltage Above Normal	3407-3 EGR Valve Position Sensor : Voltage Above Normal	Troubleshooting, “Valve Position - Test”
27-4 EGR #1 Valve Position : Voltage Below Normal	3407-4 EGR Valve Position Sensor : Voltage Below Normal	Troubleshooting, “Valve Position - Test”
29-3 Accelerator Pedal Position 2 : Voltage Above Normal	774-3 Secondary Throttle Position Sensor : Voltage Above Normal	Troubleshooting, “Speed Control (Analog) - Test” or Troubleshooting, “Speed Control (PWM) - Test”
29-4 Accelerator Pedal Position 2 : Voltage Below Normal	774-4 Secondary Throttle Position Sensor : 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	774-8 Secondary Throttle Position Sensor : Abnormal Frequency, Pulse Width, or Period	Troubleshooting, “Speed Control (PWM) - Test”
91-2 Accelerator Pedal Position 1 : Erratic, Intermittent, or Incorrect	91-2 Throttle Position Sensor : Erratic, Intermittent, or Incorrect	Troubleshooting, “Switch Circuits (Multiposition Throttle Switch) - Test”
91-3 Accelerator Pedal Position 1 : Voltage Above Normal	91-3 Throttle Position Sensor : Voltage Above Normal	Troubleshooting, “Speed Control (Analog) - Test” or Troubleshooting, “Speed Control (PWM) - Test”
91-4 Accelerator Pedal Position 1 : Voltage Below Normal	91-4 Throttle Position Sensor : Voltage Below Normal	Troubleshooting, “Speed Control (Analog) - Test” or Troubleshooting, “Speed Control (PWM) - Test”
91-8 Accelerator Pedal Position 1 : Abnormal Frequency, Pulse Width, or Period	91-8 Throttle Position Sensor : Abnormal Frequency, Pulse Width, or Period	Troubleshooting, “Speed Control (PWM) - Test”
97-3 Water In Fuel Indicator : Voltage Above Normal	3547-3 Water in Fuel System Switch : Voltage Above Normal	Troubleshooting, “Water in Fuel - Test”

(continued)

(Table 8, contd)

97-4 Water In Fuel Indicator : Voltage Below Normal	3547-4 Water in Fuel System Switch : Voltage Below Normal	Troubleshooting, "Water in Fuel - Test"
100-3 Engine Oil Pressure : Voltage Above Normal	100-3 Engine Oil Pressure Sensor : Voltage Above Normal	Troubleshooting, "Sensor Signal (Analog, Active) - Test (Sensors on the J2 ECM Connector)"
100-4 Engine Oil Pressure : Voltage Below Normal	100-4 Engine Oil Pressure Sensor : Voltage Below Normal	Troubleshooting, "Sensor Signal (Analog, Active) - Test (Sensors on the J2 ECM Connector)"
105-3 Engine Intake Manifold #1 Temperature : Voltage Above Normal	172-3 Intake Manifold Air Temperature Sensor : Voltage Above Normal	Troubleshooting, "Sensor Signal (Analog, Passive) - Test"
105-4 Engine Intake Manifold #1 Temperature : Voltage Below Normal	172-4 Intake Manifold Air Temperature Sensor : Voltage Below Normal	Troubleshooting, "Sensor Signal (Analog, Passive) - Test"
107-3 Engine Air Filter 1 Differential Pressure : Voltage Above Normal	582-3 Air Filter Differential Pressure Switch : Voltage Above Normal	Troubleshooting, "Switch Circuits (Air Filter Restriction Switch) - Test"
107-4 Engine Air Filter 1 Differential Pressure : Voltage Below Normal	582-4 Air Filter Differential Pressure Switch : Voltage Below Normal	Troubleshooting, "Switch Circuits (Air Filter Restriction Switch) - Test"
108-3 Barometric Pressure : Voltage Above Normal	3528-3 Atmospheric Pressure Sensor : Voltage Above Normal	Troubleshooting, "Sensor Signal (Analog, Active) - Test (Sensors on the J2 ECM Connector)"
108-4 Barometric Pressure : Voltage Below Normal	3528-4 Atmospheric Pressure Sensor : Voltage Below Normal	Troubleshooting, "Sensor Signal (Analog, Active) - Test (Sensors on the J2 ECM Connector)"
110-3 Engine Coolant Temperature : Voltage Above Normal	110-3 Engine Coolant Temperature Sensor : Voltage Above Normal	Troubleshooting, "Sensor Signal (Analog, Passive) - Test"
110-4 Engine Coolant Temperature : Voltage Below Normal	110-4 Engine Coolant Temperature Sensor : Voltage Below Normal	Troubleshooting, "Sensor Signal (Analog, Passive) - Test"
157-3 Engine Injector Metering Rail #1 Pressure : Voltage Above Normal	1797-3 Fuel Rail Pressure Sensor : Voltage Above Normal	Troubleshooting, "Sensor Signal (Analog, Active) - Test (Sensors on the J2 ECM Connector)"
157-4 Engine Injector Metering Rail #1 Pressure : Voltage Below Normal	1797-4 Fuel Rail Pressure Sensor : Voltage Below Normal	Troubleshooting, "Sensor Signal (Analog, Active) - Test (Sensors on the J2 ECM Connector)"
157-12 Engine Injector Metering Rail #1 Pressure : Failure	1797-12 Fuel Rail Pressure Sensor : Failure	Troubleshooting, "Sensor Signal (Analog, Active) - Test (Sensors on the J2 ECM Connector)"
168-3 Battery Potential / Power Input 1 : Voltage Above Normal	168-3 Electrical System Voltage : Voltage Above Normal	Troubleshooting, "Electrical Power Supply - Test"
168-4 Battery Potential / Power Input 1 : Voltage Below Normal	168-4 Electrical System Voltage : Voltage Below Normal	Troubleshooting, "Electrical Power Supply - Test"
172-3 Engine Air Inlet Temperature : Voltage Above Normal	2526-3 Air Inlet Temperature Sensor : Voltage Above Normal	Troubleshooting, "Sensor Signal (Analog, Passive) - Test"

(continued)

(Table 8, contd)

172-4 Engine Air Inlet Temperature : Voltage Below Normal	2526-4 Air Inlet Temperature Sensor : Voltage Below Normal	Troubleshooting, “Sensor Signal (Analog, Passive) - Test”
174-3 Engine Fuel Temperature 1 : Voltage Above Normal	174-3 Fuel Temperature Sensor : Voltage Above Normal	Troubleshooting, “Sensor Signal (Analog, Passive) - Test”
174-4 Engine Fuel Temperature 1 : Voltage Below Normal	174-4 Fuel Temperature Sensor : Voltage Below Normal	Troubleshooting, “Sensor Signal (Analog, Passive) - Test”
190-8 Engine Speed : Abnormal Frequency, Pulse Width, or Period	190-8 Engine Speed Sensor : Abnormal Frequency, Pulse Width, or Period	Troubleshooting, “Speed/Timing - Test”
411-2 Engine Exhaust Gas Recirculation Differential Pressure : Erratic, Intermittent, or Incorrect	3387-2 EGR Differential Pressure Sensor : Erratic, Intermittent, or Incorrect	Troubleshooting, “Sensor Signal (Analog, Active) - Test (Sensors on the J2 ECM Connector)”
411-3 Engine Exhaust Gas Recirculation Differential Pressure : Voltage Above Normal	3387-3 EGR Differential Pressure Sensor : Voltage Above Normal	Troubleshooting, “Sensor Signal (Analog, Active) - Test (Sensors on the J2 ECM Connector)”
411-4 Engine Exhaust Gas Recirculation Differential Pressure : Voltage Below Normal	3387-4 EGR Differential Pressure Sensor : Voltage Below Normal	Troubleshooting, “Sensor Signal (Analog, Active) - Test (Sensors on the J2 ECM Connector)”
411-13 Engine Exhaust Gas Recirculation Differential Pressure : Calibration Required	3387-13 EGR Differential Pressure Sensor : Calibration Required	Troubleshooting, “Sensor Calibration Required - Test”
412-3 Engine Exhaust Gas Recirculation Temperature : Voltage Above Normal	3386-3 EGR Temperature Sensor : Voltage Above Normal	Troubleshooting, “Sensor Signal (Analog, Passive) - Test”
412-4 Engine Exhaust Gas Recirculation Temperature : Voltage Below Normal	3386-4 EGR Temperature Sensor : Voltage Below Normal	Troubleshooting, “Sensor Signal (Analog, Passive) - Test”
558-2 Accelerator Pedal #1 Low Idle Switch : Erratic, Intermittent, or Incorrect	1634-2 Idle Validation Switch #1 : Erratic, Intermittent, or Incorrect	Troubleshooting, “Idle Validation - Test”
626-5 Engine Start Enable Device 1 : Current Below Normal	2417-5 Ether Injection Control Solenoid : Current Below Normal	Troubleshooting, “Ether Starting Aid - Test”
626-6 Engine Start Enable Device 1 : Current Above Normal	2417-6 Ether Injection Control Solenoid : Current Above Normal	Troubleshooting, “Ether Starting Aid - Test”
630-2 Calibration Memory : Erratic, Intermittent, or Incorrect	268-2 Programmed Parameter Fault : Erratic, Intermittent, or Incorrect	Troubleshooting, “Configuration Parameters”
631-2 Calibration Module : Erratic, Intermittent, or Incorrect	253-2 Personality Module : Erratic, Intermittent, or Incorrect	Troubleshooting, “ECM Software - Install”
637-11 Engine Timing Sensor : Other Failure Mode	261-11 Engine Timing Offset fault	Troubleshooting, “Speed/Timing - Test”

(continued)

(Table 8, contd)

639-9 J1939 Network #1 : Abnormal Update Rate	247-9 SAE J1939 Data Link : Abnormal Update Rate	Troubleshooting, “CAN Data Link - Test”
639-14 J1939 Network #1 : Special Instruction	247-14 SAE J1939 Data Link : Special Instruction	Troubleshooting, “Data Link Configuration Status - Test”
649-5 Engine Exhaust Back Pressure Regulator Control Command : Current Below Normal	3512-5 Engine Exhaust Back Pressure Regulator : Current Below Normal	Troubleshooting, “Motorized Valve - Test”
649-6 Engine Exhaust Back Pressure Regulator Control Command : Current Above Normal	3512-6 Engine Exhaust Back Pressure Regulator : Current Above Normal	Troubleshooting, “Motorized Valve - Test”
651-2 Engine Injector Cylinder #01 : Erratic, Intermittent, or Incorrect	1-2 Cylinder #1 Injector : Erratic, Intermittent, or Incorrect	Troubleshooting, “Injector Data Incorrect - Test”
651-5 Engine Injector Cylinder #01 : Current Below Normal	1-5 Cylinder #1 Injector : Current Below Normal	Troubleshooting, “Injector Solenoid - Test”
651-6 Engine Injector Cylinder #01 : Current Above Normal	1-6 Cylinder #1 Injector : Current Above Normal	Troubleshooting, “Injector Solenoid - Test”
652-2 Engine Injector Cylinder #02 : Erratic, Intermittent, or Incorrect	2-2 Cylinder #2 Injector : Erratic, Intermittent, or Incorrect	Troubleshooting, “Injector Data Incorrect - Test”
652-5 Engine Injector Cylinder #02 : Current Below Normal	2-5 Cylinder #2 Injector : Current Below Normal	Troubleshooting, “Injector Solenoid - Test”
652-6 Engine Injector Cylinder #02 : Current Above Normal	2-6 Cylinder #2 Injector : Current Above Normal	Troubleshooting, “Injector Solenoid - Test”
653-2 Engine Injector Cylinder #03 : Erratic, Intermittent, or Incorrect	3-2 Cylinder #3 Injector : Erratic, Intermittent, or Incorrect	Troubleshooting, “Injector Data Incorrect - Test”
653-5 Engine Injector Cylinder #03 : Current Below Normal	3-5 Cylinder #3 Injector : Current Below Normal	Troubleshooting, “Injector Solenoid - Test”
653-6 Engine Injector Cylinder #03 : Current Above Normal	3-6 Cylinder #3 Injector : Current Above Normal	Troubleshooting, “Injector Solenoid - Test”
654-2 Engine Injector Cylinder #04 : Erratic, Intermittent, or Incorrect	4-2 Cylinder #4 Injector : Erratic, Intermittent, or Incorrect	Troubleshooting, “Injector Data Incorrect - Test”
654-5 Engine Injector Cylinder #04 : Current Below Normal	4-5 Cylinder #4 Injector : Current Below Normal	Troubleshooting, “Injector Solenoid - Test”
654-6 Engine Injector Cylinder #04 : Current Above Normal	4-6 Cylinder #4 Injector : Current Above Normal	Troubleshooting, “Injector Solenoid - Test”
655-2 Engine Injector Cylinder #05 : Erratic, Intermittent, or Incorrect	5-2 Cylinder #5 Injector : Erratic, Intermittent, or Incorrect	Troubleshooting, “Injector Data Incorrect - Test”

(continued)

(Table 8, contd)

655-5 Engine Injector Cylinder #05 : Current Below Normal	5-5 Cylinder #5 Injector : Current Below Normal	Troubleshooting, "Injector Solenoid - Test"
655-6 Engine Injector Cylinder #05 : Current Above Normal	5-6 Cylinder #5 Injector : Current Above Normal	Troubleshooting, "Injector Solenoid - Test"
656-2 Engine Injector Cylinder #06 : Erratic, Intermittent, or Incorrect	6-2 Cylinder #6 Injector : Erratic, Intermittent, or Incorrect	Troubleshooting, "Injector Data Incorrect - Test"
656-5 Engine Injector Cylinder #06 : Current Below Normal	6-5 Cylinder #6 Injector : Current Below Normal	Troubleshooting, "Injector Solenoid - Test"
656-6 Engine Injector Cylinder #06 : Current Above Normal	6-6 Cylinder #6 Injector : Current Above Normal	Troubleshooting, "Injector Solenoid - Test"
676-5 Engine Glow Plug Relay : Current Below Normal	2246-5 Glow Plug Start Aid Relay : Current Below Normal	Troubleshooting, "Glow Plug Starting Aid - Test"
676-6 Engine Glow Plug Relay : Current Above Normal	2246-6 Glow Plug Start Aid Relay : Current Above Normal	Troubleshooting, "Glow Plug Starting Aid - Test"
677-5 Engine Starter Motor Relay : Current Below Normal	444-5 Starter Motor Relay : Current Below Normal	Troubleshooting, "Relay - Test (Start Relay)"
677-6 Engine Starter Motor Relay : Current Above Normal	444-6 Starter Motor Relay : Current Above Normal	Troubleshooting, "Relay - Test (Start Relay)"
678-3 ECU 8 Volts DC Supply : Voltage Above Normal	41-3 8 Volt DC Supply : Voltage Above Normal	Troubleshooting, "Sensor Supply - Test"
678-4 ECU 8 Volts DC Supply : Voltage Below Normal	41-4 8 Volt DC Supply : Voltage Below Normal	Troubleshooting, "Sensor Supply - Test"
723-8 Engine Speed Sensor #2 : Abnormal Frequency, Pulse Width, or Period	342-8 Secondary Engine Speed Sensor : Abnormal Frequency, Pulse Width, or Period	Troubleshooting, "Speed/Timing - Test"
1075-5 Engine Electric Lift Pump for Engine Fuel Supply : Current Below Normal	3666-5 Engine Fuel Supply Lift Pump Relay : Current Below Normal	Troubleshooting, "Fuel Transfer Pump - Test"
1075-6 Engine Electric Lift Pump for Engine Fuel Supply : Current Above Normal	3666-6 Engine Fuel Supply Lift Pump Relay : Current Above Normal	Troubleshooting, "Fuel Transfer Pump - Test"
1076-5 Engine Fuel Injection Pump Fuel Control Valve : Current Below Normal	18-5 Fuel Control Valve : Current Below Normal	Troubleshooting, "Solenoid Valve - Test (Solenoid Valves that Connect to the Engine ECM)"
1076-6 Engine Fuel Injection Pump Fuel Control Valve : Current Above Normal	18-6 Fuel Control Valve : Current Above Normal	Troubleshooting, "Solenoid Valve - Test (Solenoid Valves that Connect to the Engine ECM)"

(continued)

(Table 8, contd)

1176-3 Engine Turbocharger 1 Compressor Inlet Pressure : Voltage Above Normal	2738-3 Turbocharger #1 Compressor Inlet Pressure Sensor : Voltage Above Normal	Troubleshooting, "Sensor Signal (Analog, Active) - Test (Sensors on the J1 ECM Connector)"
1176-4 Engine Turbocharger 1 Compressor Inlet Pressure : Voltage Below Normal	2738-4 Turbocharger #1 Compressor Inlet Pressure Sensor : Voltage Below Normal	Troubleshooting, "Sensor Signal (Analog, Active) - Test (Sensors on the J1 ECM Connector)"
1184-3 Engine Turbocharger #1 Turbine Outlet Temperature : Voltage Above Normal	3782-3 Engine Turbocharger Turbine Outlet Temperature Sensor : Voltage Above Normal	Troubleshooting, "Sensor Signal (Analog, Active) - Test (Sensors on the J2 ECM Connector)"
1184-4 Engine Turbocharger #1 Turbine Outlet Temperature : Voltage Below Normal	3782-4 Engine Turbocharger Turbine Outlet Temperature Sensor : Voltage Below Normal	Troubleshooting, "Sensor Signal (Analog, Active) - Test (Sensors on the J2 ECM Connector)"
1184-8 Engine Turbocharger #1 Turbine Outlet Temperature : Abnormal Frequency, Pulse Width, or Period	3782-8 Engine Turbocharger Turbine Outlet Temperature Sensor : Abnormal Frequency, Pulse Width, or Period	Troubleshooting, "Sensor Signal (Analog, Active) - Test (Sensors on the J2 ECM Connector)"
1188-5 Engine Turbocharger #1 Wastegate Drive : Current Below Normal	526-5 Turbo Wastegate Drive : Current Below Normal	Troubleshooting, "Solenoid Valve - Test (Solenoid Valves that Connect to the Engine ECM)"
1188-6 Engine Turbocharger #1 Wastegate Drive : Current Above Normal	526-6 Turbo Wastegate Drive : Current Above Normal	Troubleshooting, "Solenoid Valve - Test (Solenoid Valves that Connect to the Engine ECM)"
1231-9 J1939 Network #2 : Abnormal Update Rate	2348-9 SAE J1939 Data Link #2 : Abnormal Update Rate	Troubleshooting, "CAN Data Link - Test"
1231-14 J1939 Network #2 : Special Instruction	2348-14 SAE J1939 Data Link #2 : Special Instruction	Troubleshooting, "Data Link Configuration Status - Test"
1235-9 J1939 Network #3 : Abnormal Update Rate	5856-9 SAE J1939 Data Link #3:Abnormal Update Rate	Troubleshooting, "CAN Data Link - Test"
1235-14 J1939 Network #3 : Special Instruction	5856-14 SAE J1939 Data Link #3: Special Instruction	Troubleshooting, "Data Link Configuration Status - Test"
1761-3 Aftertreatment 1 Diesel Exhaust Fluid Tank Level : Voltage Above Normal	3130-3 Aftertreatment #1 SCR Catalyst Reagent Tank #1 Level Sensor : Voltage Above Normal	Troubleshooting, "DEF Tank Sensor - Test"
1761-4 Aftertreatment 1 Diesel Exhaust Fluid Tank Level : Voltage Below Normal	3130-4 Aftertreatment #1 SCR Catalyst Reagent Tank #1 Level Sensor : Voltage Below Normal	Troubleshooting, "DEF Tank Sensor - Test"
2630-3 Engine Charge Air Cooler Outlet Temperature : Voltage Above Normal	3372-3 Engine Charge Air Cooler #1 Outlet Temperature Sensor : Voltage Above Normal	Troubleshooting, "Sensor Signal (Analog, Passive) - Test"
2630-4 Engine Charge Air Cooler Outlet Temperature : Voltage Below Normal	3372-4 Engine Charge Air Cooler #1 Outlet Temperature Sensor : Voltage Below Normal	Troubleshooting, "Sensor Signal (Analog, Passive) - Test"

(continued)

(Table 8, contd)

2634-5 Power Relay : Current Below Normal: Current Below Normal	3467-5 Main Power Relay : Current Below Normal	Troubleshooting, “Relay - Test (ECM Power Relay)”
2634-6 Power Relay : Current Below Normal: Current Above Normal	3467-6 Main Power Relay : Current Above Normal	Troubleshooting, “Relay - Test (ECM Power Relay)”
2791-5 Engine Exhaust Gas Recirculation (EGR) Valve Control : Current Below Normal	3405-5 EGR Valve Control : Current Below Normal	Troubleshooting, “Motorized Valve - Test”
2791-6 Engine Exhaust Gas Recirculation (EGR) Valve Control : Current Above Normal	3405-6 EGR Valve Control : Current Above Normal	Troubleshooting, “Motorized Valve - Test”
2882-2 Engine Alternate Rating Select : Erratic, Intermittent, or Incorrect	1743-2 Engine Operation Mode Selector Switch : Erratic, Intermittent, or Incorrect	Troubleshooting, “Mode Selection - Test”
3031-3 Aftertreatment 1 Diesel Exhaust Fluid Tank Temperature : Voltage Above Normal	3134-3 Aftertreatment #1 SCR Catalyst Reagent Tank #1 Temperature Sensor : Voltage Above Normal	Troubleshooting, “DEF Tank Sensor - Test”
3031-4 Aftertreatment 1 Diesel Exhaust Fluid Tank Temperature : Voltage Below Normal	3134-4 Aftertreatment #1 SCR Catalyst Reagent Tank #1 Temperature Sensor : Voltage Below Normal	Troubleshooting, “DEF Tank Sensor - Test”
3216-5 Aftertreatment #1 Intake NOx : Current Below Normal	3002-5 Engine Exhaust NOx Level Sensor : Current Below Normal	Troubleshooting, “Electrical Power Supply - Test”
3216-6 Aftertreatment #1 Intake NOx : Current Above Normal	3002-6 Engine Exhaust NOx Level Sensor : Current Above Normal	Troubleshooting, “Electrical Power Supply - Test”
3216-11 Aftertreatment #1 Intake NOx : Other Failure Mode	3002-11 Engine Exhaust NOx Level Sensor : Other Failure Mode	Troubleshooting, “Sensor (Data Link Type) - Test”
3216-12 Aftertreatment #1 Intake NOx : Failure	3002-12 Engine Exhaust NOx Level Sensor : Failure	Troubleshooting, “Sensor (Data Link Type) - Test”
3226-5 Aftertreatment #1 Outlet NOx : Current Below Normal	3609-5 Aftertreatment #1 Outlet #1 NOx Level Sensor : Current Below Normal	Troubleshooting, “Electrical Power Supply - Test”
3226-6 Aftertreatment #1 Outlet NOx : Current Above Normal	3609-6 Aftertreatment #1 Outlet #1 NOx Level Sensor : Current Above Normal	Troubleshooting, “Electrical Power Supply - Test”
3226-11 Aftertreatment #1 Outlet NOx : Other Failure Mode	3609-11 Aftertreatment #1 Outlet #1 NOx Level Sensor : Other Failure Mode	Troubleshooting, “Sensor (Data Link Type) - Test”
3226-12 Aftertreatment #1 Outlet NOx : Failure	3609-12 Aftertreatment #1 Outlet #1 NOx Level Sensor : Failure	Troubleshooting, “Sensor (Data Link Type) - Test”
3242-3 Particulate Trap Intake Gas Temperature : Voltage Above Normal	2452-3 DPF #1 Intake Temperature Sensor : Voltage Above Normal	Troubleshooting, “Sensor Signal (Analog, Active) - Test (Sensors on the J1 ECM Connector)”

(continued)

(Table 8, contd)

3242-4 Particulate Trap Intake Gas Temperature : Voltage Below Normal	2452-4 DPF #1 Intake Temperature Sensor : Voltage Below Normal	Troubleshooting, “Sensor Signal (Analog, Active) - Test (Sensors on the J1 ECM Connector)”
3242-8 Aftertreatment #1 DPF Intake Gas Temperature : Abnormal Frequency, Pulse Width, or Period	2452-8 DPF #1 Intake Temperature Sensor : Abnormal Frequency, Pulse Width, or Period	Troubleshooting, “Sensor Signal (Analog, Active) - Test (Sensors on the J1 ECM Connector)”
3358-3 Engine Exhaust Gas Recirculation Inlet Pressure : Voltage Above Normal	3385-3 EGR Intake Pressure Sensor : Voltage Above Normal	Troubleshooting, “Sensor Signal (Analog, Active) - Test (Sensors on the J2 ECM Connector)”
3358-4 Engine Exhaust Gas Recirculation Inlet Pressure : Voltage Below Normal	3385-4 EGR Intake Pressure Sensor : Voltage Below Normal	Troubleshooting, “Sensor Signal (Analog, Active) - Test (Sensors on the J2 ECM Connector)”
3358-13 Engine Exhaust Gas Recirculation Inlet Pressure : Calibration Required	3385-13 EGR Intake Pressure Sensor : Calibration Required	Troubleshooting, “Sensor Calibration Required - Test”
3360-3 Aftertreatment 1 Diesel Exhaust Fluid Controller : Voltage Above Normal	3820-3 Aftertreatment #1 Diesel Exhaust Fluid Controller : Voltage Above Normal	Troubleshooting, “DEF Control Module Power - Test”
3360-4 Aftertreatment 1 Diesel Exhaust Fluid Controller : Voltage Below Normal	3820-4 Aftertreatment #1 Diesel Exhaust Fluid Controller : Voltage Below Normal	Troubleshooting, “DEF Control Module Power - Test”
3360-9 Aftertreatment #1 DEF Controller : Abnormal Update Rate	3820-9 Aftertreatment #1 Diesel Exhaust Fluid Controller : Abnormal Update Rate	Troubleshooting, “CAN Data Link - Test”
3360-12 Aftertreatment 1 Diesel Exhaust Fluid Controller : Failure	3820-12 Aftertreatment #1 Diesel Exhaust Fluid Controller : Failure	Troubleshooting, “Sensor (Data Link Type) - Test”
3361-5 Catalyst Dosing Unit : Current Below Normal	3821-5 Aftertreatment #1 Diesel Exhaust Fluid Dosing Valve Actuator : Current Below Normal	Troubleshooting, “Solenoid Valve - Test (Solenoid Valves that Connect to the Dosing Control Unit (DCU))”
3361-6 Catalyst Dosing Unit : Current Above Normal	3821-6 Aftertreatment #1 Diesel Exhaust Fluid Dosing Valve Actuator : Current Above Normal	Troubleshooting, “Solenoid Valve - Test (Solenoid Valves that Connect to the Dosing Control Unit (DCU))”
3361-7 Catalyst Dosing Unit : Not Responding Properly	3821-7 Aftertreatment #1 Diesel Exhaust Fluid Dosing Valve Actuator : Not Responding Properly	Troubleshooting, “DEF Module Does Not Respond”
3361-11 Catalyst Dosing Unit : Other Failure Mode	3821-11 Aftertreatment #1 Diesel Exhaust Fluid Dosing Valve Actuator : Other Failure Mode	Troubleshooting, “DEF Module Does Not Respond”
3361-14 Catalyst Dosing Unit : Special Instruction	3821-14 Aftertreatment #1 Diesel Exhaust Fluid Dosing Valve Actuator : Special Instruction	Troubleshooting, “DEF Module Does Not Respond”
3363-5 Aftertreatment 1 Diesel Exhaust Fluid Tank Heater : Current Below Normal	3126-5 Aftertreatment #1 SCR Catalyst Reagent Tank #1 Heater Coolant Diverter Solenoid : Current Below Normal	Troubleshooting, “Solenoid Valve - Test (Solenoid Valves that Connect to the Dosing Control Unit (DCU))”

(continued)

(Table 8, contd)

3363-6 Aftertreatment 1 Diesel Exhaust Fluid Tank Heater : Current Above Normal	3126-6 Aftertreatment #1 SCR Catalyst Reagent Tank #1 Heater Coolant Diverter Solenoid : Current Above Normal	Troubleshooting, "Solenoid Valve - Test (Solenoid Valves that Connect to the Dosing Control Unit (DCU))"
3363-7 Aftertreatment 1 Diesel Exhaust Fluid Tank Heater : Not Responding Properly	3126-7 Aftertreatment #1 SCR Catalyst Reagent Tank #1 Heater Coolant Diverter Solenoid : Not Responding Properly	Troubleshooting, "DEF Temperature Is Low"
3509-3 Sensor Supply Voltage 1 : Voltage Above Normal	262-3 5 Volt Sensor DC Power Supply : Voltage Above Normal	Troubleshooting, "Sensor Supply - Test"
3509-4 Sensor Supply Voltage 1 : Voltage Below Normal	262-4 5 Volt Sensor DC Power Supply : Voltage Below Normal	Troubleshooting, "Sensor Supply - Test"
3510-3 Sensor Supply Voltage 2 : Voltage Above Normal	2131-3 5 Volt Sensor DC Power Supply #2 : Voltage Above Normal	Troubleshooting, "Sensor Supply - Test"
3510-4 Sensor Supply Voltage 2 : Voltage Below Normal	2131-4 5 Volt Sensor DC Power Supply #2 : Voltage Below Normal	Troubleshooting, "Sensor Supply - Test"
3511-11 Sensor Supply Voltage 3 : Other Failure Mode	3482-11 Sensor Supply #3 : Other Failure Mode	Troubleshooting, "DEF Pump Sensor Supply - Test"
3512-3 Sensor Supply Voltage 4 : Voltage Above Normal	3483-3 Sensor Supply #4 : Voltage Above Normal	Troubleshooting, "Speed/Timing - Test"
3512-4 Sensor Supply Voltage 4 : Voltage Below Normal	3483-4 Sensor Supply #4 : Voltage Below Normal	Troubleshooting, "Speed/Timing - Test"
3516-2 Aftertreatment #1 DEF Concentration: Erratic, Intermittent, or Incorrect (2017- Engines Only)	3100-2 Aftertreatment #1 SCR Catalyst Tank Reagent Quality Sensor : Erratic, Intermittent, or Incorrect (2017- Engines Only)	Troubleshooting, "Sensor (Data Link Type) - Test"
3516-11 Aftertreatment #1 DEF Concentration: Other Failure Mode	3100-11 Aftertreatment #1 DEF Tank Quality Sensor: Other Failure Mode	Troubleshooting, "NOx Conversion Is Low"
3516-12 Catalyst Reagent Concentration : Failure (2017- Engines Only)	3100-12 Aftertreatment #1 SCR Catalyst Tank Reagent Quality Sensor : Failure (2017- Engines Only)	Troubleshooting, "Sensor (Data Link Type) - Test"
3563-3 Engine Intake Manifold #1 Absolute Pressure : Voltage Above Normal	1785-3 Intake Manifold Pressure Sensor : Voltage Above Normal	Troubleshooting, "Sensor Signal (Analog, Active) - Test (Sensors on the J2 ECM Connector)"
3563-4 Engine Intake Manifold #1 Absolute Pressure : Voltage Below Normal	1785-4 Intake Manifold Pressure Sensor : Voltage Below Normal	Troubleshooting, "Sensor Signal (Analog, Active) - Test (Sensors on the J2 ECM Connector)"
3563-13 Engine Intake Manifold #1 Absolute Pressure : Calibration Required	1785-13 Intake Manifold Pressure Sensor : Calibration Required	Troubleshooting, "Sensor Calibration Required - Test"

(continued)

(Table 8, contd)

4215-3 Ground-Level Shutdown Activated : Voltage Above Normal	267-3 Remote Shutdown Input : Voltage Above Normal	Troubleshooting, “Shutdown (Ground Level) - Test”
4215-4 Ground-Level Shutdown Activated : Voltage Below Normal	267-4 Remote Shutdown Input : Voltage Below Normal	Troubleshooting, “Shutdown (Ground Level) - Test”
4334-3 Aftertreatment 1 Diesel Exhaust Fluid Doser Absolute Pressure : Voltage Above Normal	3090-3 Aftertreatment #1 SCR Dosing Reagent Pressure Sensor : Voltage Above Normal	Troubleshooting, “DEF Pump Pressure Sensor - Test”
4334-4 Aftertreatment 1 Diesel Exhaust Fluid Doser Absolute Pressure : Voltage Below Normal	3090-4 Aftertreatment #1 SCR Dosing Reagent Pressure Sensor : Voltage Below Normal	Troubleshooting, “DEF Pump Pressure Sensor - Test”
4334-7 Aftertreatment 1 Diesel Exhaust Fluid Doser Absolute Pressure : Not Responding Properly	3090-7 Aftertreatment #1 SCR Dosing Reagent Pressure Sensor : Not Responding Properly	Troubleshooting, “DEF Pressure Is Low”
4337-8 Aftertreatment 1 Diesel Exhaust Fluid Dosing Temperature : Abnormal Frequency, Pulse Width, or Period	3096-8 Aftertreatment #1 SCR Dosing Reagent Temperature #1 Sensor : Abnormal Frequency, Pulse Width, or Period	Troubleshooting, “DEF Pump - Replace”
4354-5 Aftertreatment 1 Diesel Exhaust Fluid Line Heater 1 : Current Below Normal	3110-5 Aftertreatment #1 SCR Catalyst Reagent Line Heater #1 : Current Below Normal	Troubleshooting, “DEF Line Heater - Test”
4354-6 Aftertreatment 1 Diesel Exhaust Fluid Line Heater 1 : Current Above Normal	3110-6 Aftertreatment #1 SCR Catalyst Reagent Line Heater #1 : Current Above Normal	Troubleshooting, “DEF Line Heater - Test”
4354-12 Aftertreatment #1 DEF Line Heater #1 : Failure	3110-12 Aftertreatment #1 DEF Line Heater #1 : Failure	Troubleshooting, “DEF Line Heater - Test”
4355-5 Aftertreatment 1 Diesel Exhaust Fluid Line Heater 2 : Current Below Normal	3111-5 Aftertreatment #1 SCR Catalyst Reagent Line Heater #2 : Current Below Normal	Troubleshooting, “DEF Line Heater - Test”
4355-6 Aftertreatment 1 Diesel Exhaust Fluid Line Heater 2 : Current Above Normal	3111-6 Aftertreatment #1 SCR Catalyst Reagent Line Heater #2 : Current Above Normal	Troubleshooting, “DEF Line Heater - Test”
4356-5 Aftertreatment 1 Diesel Exhaust Fluid Line Heater 3 : Current Below Normal	3112-5 Aftertreatment #1 SCR Catalyst Reagent Line Heater #3 : Current Below Normal	Troubleshooting, “DEF Line Heater - Test”
4356-6 Aftertreatment 1 Diesel Exhaust Fluid Line Heater 3: Current Above Normal	3112-6 Aftertreatment #1 SCR Catalyst Reagent Line Heater #3 : Current Above Normal	Troubleshooting, “DEF Line Heater - Test”
4360-3 Aftertreatment #1 SCR Catalyst Intake Gas Temperature : Voltage Above Normal	3105-3 Aftertreatment #1 SCR Catalyst Intake Gas Temperature Sensor : Voltage Above Normal	Troubleshooting, “Sensor Signal (PWM) - Test”

(continued)

(Table 8, contd)

4360-4 Aftertreatment #1 SCR Catalyst Intake Gas Temperature : Voltage Below Normal	3105-4 Aftertreatment #1 SCR Catalyst Intake Gas Temperature Sensor : Voltage Below Normal	Troubleshooting, “Sensor Signal (PWM) - Test”
4360-8 Aftertreatment #1 SCR Catalyst Intake Gas Temperature : Abnormal Frequency, Pulse Width, or Period	3105-8 Aftertreatment #1 SCR Catalyst Intake Gas Temperature Sensor : Abnormal Frequency, Pulse Width, or Period	Troubleshooting, “Sensor Signal (PWM) - Test”
4374-5 Aftertreatment #1 Diesel Exhaust Fluid Pump Motor Speed : Current Below Normal	3118-5 Aftertreatment #1 SCR Catalyst Reagent Pump Motor Speed Sensor : Current Below Normal	Troubleshooting, “DEF Pump Motor - Test”
4374-6 Aftertreatment #1 Diesel Exhaust Fluid Pump Motor Speed : Current Above Normal	3118-6 Aftertreatment #1 SCR Catalyst Reagent Pump Motor Speed Sensor : Current Above Normal	Troubleshooting, “DEF Pump Motor - Test”
4374-8 Aftertreatment #1 Diesel Exhaust Fluid Pump Motor Speed : Abnormal Frequency, Pulse Width, or Period	3118-8 Aftertreatment #1 SCR Catalyst Reagent Pump Motor Speed Sensor : Abnormal Frequency, Pulse Width, or Period	Troubleshooting, “DEF Pump - Replace”
4376-5 Aftertreatment 1 Diesel Exhaust Fluid Return Valve : Current Below Normal	3862-5 Aftertreatment #1 Diesel Exhaust Fluid Return Valve Solenoid : Current Below Normal	Troubleshooting, “DEF Return Valve - Test”
4376-6 Aftertreatment 1 Diesel Exhaust Fluid Return Valve : Current Above Normal	3862-6 Aftertreatment #1 Diesel Exhaust Fluid Return Valve Solenoid : Current Above Normal	Troubleshooting, “DEF Return Valve - Test”
4376-7 Aftertreatment 1 Diesel Exhaust Fluid Return Valve : Not Responding Properly	3862-7 Aftertreatment #1 Diesel Exhaust Fluid Return Valve Solenoid : Not Responding Properly	Troubleshooting, “DEF Pump - Replace”
4783-3 DPF #1 Mean Soot Signal : Voltage Above Normal	3397-3 DPF #1 Soot Loading Sensor : Voltage Above Normal	Troubleshooting, “Soot Sensor - Test”
4783-4 DPF #1 Mean Soot Signal : Voltage Below Normal	3397-4 DPF #1 Soot Loading Sensor : Voltage Below Normal	Troubleshooting, “Soot Sensor - Test”
4783-12 DPF #1 Mean Soot Signal : Failure	3397-12 DPF #1 Soot Loading Sensor : Failure	Troubleshooting, “Soot Sensor - Test”
4783-21 DPF #1 Mean Soot Signal : Data Drifted Low	3397-21 DPF #1 Soot Loading Sensor : Data Drifted Low	Troubleshooting, “Soot Sensor - Test”
5491-5 Aftertreatment #1 DEF Line Heater Relay : Current Below Normal	3822-5 Aftertreatment #1 Diesel Exhaust Fluid Line Heater Relay : Current Below Normal	Troubleshooting, “DEF Line Heater - Test”
5491-6 Aftertreatment #1 DEF Line Heater Relay : Current Above Normal	3822-6 Aftertreatment #1 Diesel Exhaust Fluid Line Heater Relay : Current Above Normal	Troubleshooting, “DEF Line Heater - Test”

(continued)

(Table 8, contd)

5576-2 Aftertreatment #1 Identification : Erratic, Intermittent, or Incorrect	3468-2 Aftertreatment #1 Identification Number Module : Erratic, Intermittent, or Incorrect	Troubleshooting, “Aftertreatment Identification Module - Test”
5576-8 Aftertreatment #1 Identification : Abnormal Frequency, Pulse Width, or Period	3468-8 Aftertreatment #1 Identification Number Module : Abnormal Frequency, Pulse Width, or Period	Troubleshooting, “Aftertreatment Identification Module - Test”
5576-14 Aftertreatment #1 Identification : Special Instruction	3468-14 Aftertreatment #1 Identification Number Module : Special Instruction	Troubleshooting, “Data Link Configuration Status - Test”
5625-3 Engine Exhaust Back Pressure Regulator Position : Voltage Above Normal	3513-3 Engine Exhaust Back Pressure Regulator Valve Position Sensor : Voltage Above Normal	Troubleshooting, “Valve Position - Test”
5625-4 Engine Exhaust Back Pressure Regulator Position : Voltage Below Normal	3513-4 Engine Exhaust Back Pressure Regulator Valve Position Sensor : Voltage Below Normal	Troubleshooting, “Valve Position - Test”
5758-11 Aftertreatment #1 Intake Gas Sensor Power Supply : Other Failure Mode	3621-11 Engine Exhaust NOx Level Sensor Power Supply : Other Failure Mode	Troubleshooting, “Electrical Power Supply - Test”
5759-11 Aftertreatment #1 Outlet Gas Sensor Power Supply : Other Failure Mode	3619-11 Aftertreatment #1 Outlet #1 NOx Level Sensor Power Supply : Other Failure Mode	Troubleshooting, “Electrical Power Supply - Test”
5798-2 Aftertreatment #1 DEF Dosing Unit Heater Temperature : Erratic, Intermittent, or Incorrect	3096-2 Aftertreatment #1 DEF Temperature #1 Sensor : Erratic, Intermittent, or Incorrect	Troubleshooting, “DEF Pump - Replace”
5965-5 Aftertreatment 1 Diesel Exhaust Fluid Control Module Relay Control : Current Below Normal	3838-5 Aftertreatment #1 Diesel Exhaust Fluid Dosing Control Module Relay : Current Below Normal	Troubleshooting, “Solenoid Valve - Test (Solenoid Valves that Connect to the Dosing Control Unit (DCU))”
5965-6 Aftertreatment 1 Diesel Exhaust Fluid Control Module Relay Control : Current Above Normal	3838-6 Aftertreatment #1 Diesel Exhaust Fluid Dosing Control Module Relay : Current Above Normal	Troubleshooting, “Solenoid Valve - Test (Solenoid Valves that Connect to the Dosing Control Unit (DCU))”
5966-5 Aftertreatment 1 Diesel Exhaust Fluid Control Module Power Supply : Current Below Normal	3965-5 Aftertreatment #1 Diesel Exhaust Fluid Control Module Power Supply #1 : Current Below Normal	Troubleshooting, “DEF Control Module Power - Test”
5966-6 Aftertreatment 1 Diesel Exhaust Fluid Control Module Power Supply : Current Above Normal	3965-6 Aftertreatment #1 Diesel Exhaust Fluid Control Module Power Supply #1 : Current Above Normal	Troubleshooting, “DEF Control Module Power - Test”
6309-6 Aftertreatment #1 Diesel Exhaust Fluid Control Module Power Supply #2 : Current Above Normal	3966-6 Aftertreatment #1 Diesel Exhaust Fluid Control Module Power Supply #2 : Current Above Normal	Troubleshooting, “DEF Control Module Power - Test”
7441-3 Aftertreatment Ambient Air Temperature : Voltage Above Normal	4648-3 Aftertreatment Ambient Air Temperature Sensor : Voltage Above Normal	Troubleshooting, “Sensor Signal (Analog, Passive) - Test”
7441-4 Aftertreatment Ambient Air Temperature : Voltage Below Normal	4648-4 Aftertreatment Ambient Air Temperature Sensor : Voltage Below Normal	Troubleshooting, “Sensor Signal (Analog, Passive) - Test”

Table 9

Diagnostic Trouble Codes (PDL Code Order)		
PDL Code and Description	J1939 Code and Description	Troubleshooting Procedure
1-2 Cylinder #1 Injector : Erratic, Intermittent, or Incorrect	651-2 Engine Injector Cylinder #01 : Erratic, Intermittent, or Incorrect	Troubleshooting, “Injector Data Incorrect - Test”
1-5 Cylinder #1 Injector : Current Below Normal	651-5 Engine Injector Cylinder #01 : Current Below Normal	Troubleshooting, “Injector Solenoid - Test”
1-6 Cylinder #1 Injector : Current Above Normal	651-6 Engine Injector Cylinder #01 : Current Above Normal	Troubleshooting, “Injector Solenoid - Test”
2-2 Cylinder #2 Injector : Erratic, Intermittent, or Incorrect	652-2 Engine Injector Cylinder #02 : Erratic, Intermittent, or Incorrect	Troubleshooting, “Injector Data Incorrect - Test”
2-5 Cylinder #2 Injector : Current Below Normal	652-5 Engine Injector Cylinder #02 : Current Below Normal	Troubleshooting, “Injector Solenoid - Test”
2-6 Cylinder #2 Injector : Current Above Normal	652-6 Engine Injector Cylinder #02 : Current Above Normal	Troubleshooting, “Injector Solenoid - Test”
3-2 Cylinder #3 Injector : Erratic, Intermittent, or Incorrect	653-2 Engine Injector Cylinder #03 : Erratic, Intermittent, or Incorrect	Troubleshooting, “Injector Data Incorrect - Test”
3-5 Cylinder #3 Injector : Current Below Normal	653-5 Engine Injector Cylinder #03 : Current Below Normal	Troubleshooting, “Injector Solenoid - Test”
3-6 Cylinder #3 Injector : Current Above Normal	653-6 Engine Injector Cylinder #03 : Current Above Normal	Troubleshooting, “Injector Solenoid - Test”
4-2 Cylinder #4 Injector : Erratic, Intermittent, or Incorrect	654-2 Engine Injector Cylinder #04 : Erratic, Intermittent, or Incorrect	Troubleshooting, “Injector Data Incorrect - Test”
4-5 Cylinder #4 Injector : Current Below Normal	654-5 Engine Injector Cylinder #04 : Current Below Normal	Troubleshooting, “Injector Solenoid - Test”
4-6 Cylinder #4 Injector : Current Above Normal	654-6 Engine Injector Cylinder #04 : Current Above Normal	Troubleshooting, “Injector Solenoid - Test”
5-2 Cylinder #5 Injector : Erratic, Intermittent, or Incorrect	655-2 Engine Injector Cylinder #05 : Erratic, Intermittent, or Incorrect	Troubleshooting, “Injector Data Incorrect - Test”
5-5 Cylinder #5 Injector : Current Below Normal	655-5 Engine Injector Cylinder #05 : Current Below Normal	Troubleshooting, “Injector Solenoid - Test”
5-6 Cylinder #5 Injector : Current Above Normal	655-6 Engine Injector Cylinder #05 : Current Above Normal	Troubleshooting, “Injector Solenoid - Test”
6-2 Cylinder #6 Injector : Erratic, Intermittent, or Incorrect	656-2 Engine Injector Cylinder #06 : Erratic, Intermittent, or Incorrect	Troubleshooting, “Injector Data Incorrect - Test”

(continued)

(Table 9, contd)

6-5 Cylinder #6 Injector : Current Below Normal	656-5 Engine Injector Cylinder #06 : Current Below Normal	Troubleshooting, “Injector Solenoid - Test”
6-6 Cylinder #6 Injector : Current Above Normal	656-6 Engine Injector Cylinder #06 : Current Above Normal	Troubleshooting, “Injector Solenoid - Test”
18-5 Fuel Control Valve : Current Below Normal	1076-5 Engine Fuel Injection Pump Fuel Control Valve : Current Below Normal	Troubleshooting, “Solenoid Valve - Test (Solenoid Valves that Connect to the Engine ECM)”
18-6 Fuel Control Valve : Current Above Normal	1076-6 Engine Fuel Injection Pump Fuel Control Valve : Current Above Normal	Troubleshooting, “Solenoid Valve - Test (Solenoid Valves that Connect to the Engine ECM)”
41-3 8 Volt DC Supply : Voltage Above Normal	678-3 ECU 8 Volts DC Supply : Voltage Above Normal	Troubleshooting, “Sensor Supply - Test”
41-4 8 Volt DC Supply : Voltage Below Normal	678-4 ECU 8 Volts DC Supply : Voltage Below Normal	Troubleshooting, “Sensor Supply - Test”
91-2 Throttle Position Sensor : Erratic, Intermittent, or Incorrect	91-2 Accelerator Pedal Position 1 : Erratic, Intermittent, or Incorrect	Troubleshooting, “Switch Circuits (Multiposition Throttle Switch) - Test”
91-3 Throttle Position Sensor : Voltage Above Normal	91-3 Accelerator Pedal Position 1 : Voltage Above Normal	Troubleshooting, “Speed Control (Analog) - Test” or Troubleshooting, “Speed Control (PWM) - Test”
91-4 Throttle Position Sensor : Voltage Below Normal	91-4 Accelerator Pedal Position 1 : Voltage Below Normal	Troubleshooting, “Speed Control (Analog) - Test” or Troubleshooting, “Speed Control (PWM) - Test”
91-8 Throttle Position Sensor : Abnormal Frequency, Pulse Width, or Period	91-8 Accelerator Pedal Position 1 : Abnormal Frequency, Pulse Width, or Period	Troubleshooting, “Speed Control (PWM) - Test”
100-3 Engine Oil Pressure Sensor : Voltage Above Normal	100-3 Engine Oil Pressure : Voltage Above Normal	Troubleshooting, “Sensor Signal (Analog, Active) - Test (Sensors on the J2 ECM Connector)”
100-4 Engine Oil Pressure Sensor : Voltage Below Normal	100-4 Engine Oil Pressure : Voltage Below Normal	Troubleshooting, “Sensor Signal (Analog, Active) - Test (Sensors on the J2 ECM Connector)”
110-3 Engine Coolant Temperature Sensor : Voltage Above Normal	110-3 Engine Coolant Temperature : Voltage Above Normal	Troubleshooting, “Sensor Signal (Analog, Passive) - Test”
110-4 Engine Coolant Temperature Sensor : Voltage Below Normal	110-4 Engine Coolant Temperature : Voltage Below Normal	Troubleshooting, “Sensor Signal (Analog, Passive) - Test”
168-3 Electrical System Voltage : Voltage Above Normal	168-3 Battery Potential / Power Input 1 : Voltage Above Normal	Troubleshooting, “Electrical Power Supply - Test”
168-4 Electrical System Voltage : Voltage Below Normal	168-4 Battery Potential / Power Input 1 : Voltage Below Normal	Troubleshooting, “Electrical Power Supply - Test”

(continued)

(Table 9, contd)

172-3 Intake Manifold Air Temperature Sensor : Voltage Above Normal	105-3 Engine Intake Manifold #1 Temperature : Voltage Above Normal	Troubleshooting, “Sensor Signal (Analog, Passive) - Test”
172-4 Intake Manifold Air Temperature Sensor : Voltage Below Normal	105-4 Engine Intake Manifold #1 Temperature : Voltage Below Normal	Troubleshooting, “Sensor Signal (Analog, Passive) - Test”
174-3 Fuel Temperature Sensor : Voltage Above Normal	174-3 Engine Fuel Temperature 1 : Voltage Above Normal	Troubleshooting, “Sensor Signal (Analog, Passive) - Test”
174-4 Fuel Temperature Sensor : Voltage Below Normal	174-4 Engine Fuel Temperature 1 : Voltage Below Normal	Troubleshooting, “Sensor Signal (Analog, Passive) - Test”
190-8 Engine Speed Sensor : Abnormal Frequency, Pulse Width, or Period	190-8 Engine Speed : Abnormal Frequency, Pulse Width, or Period	Troubleshooting, “Speed/Timing - Test”
247-9 SAE J1939 Data Link : Abnormal Update Rate	639-9 J1939 Network #1 : Abnormal Update Rate	Troubleshooting, “CAN Data Link - Test”
247-14 SAE J1939 Data Link : Special Instruction	639-14 J1939 Network #1 : Special Instruction	Troubleshooting, “Data Link Configuration Status - Test”
253-2 Personality Module : Erratic, Intermittent, or Incorrect	631-2 Calibration Module : Erratic, Intermittent, or Incorrect	Troubleshooting, “ECM Software - Install”
261-11 Engine Timing Offset fault	637-11 Engine Timing Sensor : Other Failure Mode	Troubleshooting, “Speed/Timing - Test”
262-3 5 Volt Sensor DC Power Supply : Voltage Above Normal	3509-3 Sensor Supply Voltage 1 : Voltage Above Normal	Troubleshooting, “Sensor Supply - Test”
262-4 5 Volt Sensor DC Power Supply : Voltage Below Normal	3509-4 Sensor Supply Voltage 1 : Voltage Below Normal	Troubleshooting, “Sensor Supply - Test”
267-3 Remote Shutdown Input : Voltage Above Normal	4215-3 Ground-Level Shutdown Activated : Voltage Above Normal	Troubleshooting, “Shutdown (Ground Level) - Test”
267-4 Remote Shutdown Input : Voltage Below Normal	4215-4 Ground-Level Shutdown Activated : Voltage Below Normal	Troubleshooting, “Shutdown (Ground Level) - Test”
268-2 Programmed Parameter Fault : Erratic, Intermittent, or Incorrect	630-2 Calibration Memory : Erratic, Intermittent, or Incorrect	Troubleshooting, “Configuration Parameters”
342-8 Secondary Engine Speed Sensor : Abnormal Frequency, Pulse Width, or Period	723-8 Engine Speed Sensor #2 : Abnormal Frequency, Pulse Width, or Period	Troubleshooting, “Speed/Timing - Test”
444-5 Starter Motor Relay : Current Below Normal	677-5 Engine Starter Motor Relay : Current Below Normal	Troubleshooting, “Relay - Test (Start Relay)”
444-6 Starter Motor Relay : Current Above Normal	677-6 Engine Starter Motor Relay : Current Above Normal	Troubleshooting, “Relay - Test (Start Relay)”

(continued)

(Table 9, contd)

526-5 Turbo Wastegate Drive : Current Below Normal	1188-5 Engine Turbocharger #1 Wastegate Drive : Current Below Normal	Troubleshooting, “Solenoid Valve - Test (Solenoid Valves that Connect to the Engine ECM)”
526-6 Turbo Wastegate Drive : Current Above Normal	1188-6 Engine Turbocharger #1 Wastegate Drive : Current Above Normal	Troubleshooting, “Solenoid Valve - Test (Solenoid Valves that Connect to the Engine ECM)”
582-3 Air Filter Differential Pressure Switch : Voltage Above Normal	107-3 Engine Air Filter 1 Differential Pressure : Voltage Above Normal	Troubleshooting, “Switch Circuits (Air Filter Restriction Switch) - Test”
582-4 Air Filter Differential Pressure Switch : Voltage Below Normal	107-4 Engine Air Filter 1 Differential Pressure : Voltage Below Normal	Troubleshooting, “Switch Circuits (Air Filter Restriction Switch) - Test”
774-3 Secondary Throttle Position Sensor : Voltage Above Normal	29-3 Accelerator Pedal Position 2 : Voltage Above Normal	Troubleshooting, “Speed Control (Analog) - Test” or Troubleshooting, “Speed Control (PWM) - Test”
774-4 Secondary Throttle Position Sensor : Voltage Below Normal	29-4 Accelerator Pedal Position 2 : Voltage Below Normal	Troubleshooting, “Speed Control (Analog) - Test” or Troubleshooting, “Speed Control (PWM) - Test”
774-8 Secondary Throttle Position Sensor : Abnormal Frequency, Pulse Width, or Period	29-8 Accelerator Pedal Position 2 : Abnormal Frequency, Pulse Width, or Period	Troubleshooting, “Speed Control (PWM) - Test”
1634-2 Idle Validation Switch #1 : Erratic, Intermittent, or Incorrect	558-2 Accelerator Pedal #1 Low Idle Switch : Erratic, Intermittent, or Incorrect	Troubleshooting, “Idle Validation - Test”
1743-2 Engine Operation Mode Selector Switch : Erratic, Intermittent, or Incorrect	2882-2 Engine Alternate Rating Select : Erratic, Intermittent, or Incorrect	Troubleshooting, “Mode Selection - Test”
1785-3 Intake Manifold Pressure Sensor : Voltage Above Normal	3563-3 Engine Intake Manifold #1 Absolute Pressure : Voltage Above Normal	Troubleshooting, “Sensor Signal (Analog, Active) - Test (Sensors on the J2 ECM Connector)”
1785-4 Intake Manifold Pressure Sensor : Voltage Below Normal	3563-4 Engine Intake Manifold #1 Absolute Pressure : Voltage Below Normal	Troubleshooting, “Sensor Signal (Analog, Active) - Test (Sensors on the J2 ECM Connector)”
1785-13 Intake Manifold Pressure Sensor : Calibration Required	3563-13 Engine Intake Manifold #1 Absolute Pressure : Calibration Required	Troubleshooting, “Sensor Calibration Required - Test”
1797-3 Fuel Rail Pressure Sensor : Voltage Above Normal	157-3 Engine Injector Metering Rail #1 Pressure : Voltage Above Normal	Troubleshooting, “Sensor Signal (Analog, Active) - Test (Sensors on the J2 ECM Connector)”
1797-4 Fuel Rail Pressure Sensor : Voltage Below Normal	157-4 Engine Injector Metering Rail #1 Pressure : Voltage Below Normal	Troubleshooting, “Sensor Signal (Analog, Active) - Test (Sensors on the J2 ECM Connector)”
1797-12 Fuel Rail Pressure Sensor : Failure	157-12 Engine Injector Metering Rail #1 Pressure : Failure	Troubleshooting, “Sensor Signal (Analog, Active) - Test (Sensors on the J2 ECM Connector)”
2131-3 5 Volt Sensor DC Power Supply #2 : Voltage Above Normal	3510-3 Sensor Supply Voltage 2 : Voltage Above Normal	Troubleshooting, “Sensor Supply - Test”

(continued)

(Table 9, contd)

2131-4 5 Volt Sensor DC Power Supply #2 : Voltage Below Normal	3510-4 Sensor Supply Voltage 2 : Voltage Below Normal	Troubleshooting, “Sensor Supply - Test”
2246-5 Glow Plug Start Aid Relay : Current Below Normal	676-5 Engine Glow Plug Relay : Current Below Normal	Troubleshooting, “Glow Plug Starting Aid - Test”
2246-6 Glow Plug Start Aid Relay : Current Above Normal	676-6 Engine Glow Plug Relay : Current Above Normal	Troubleshooting, “Glow Plug Starting Aid - Test”
2348-9 SAE J1939 Data Link #2 : Abnormal Update Rate	1231-9 J1939 Network #2 : Abnormal Update Rate	Troubleshooting, “CAN Data Link - Test”
2348-14 SAE J1939 Data Link #2 : Special Instruction	1231-14 J1939 Network #2 : Special Instruction	Troubleshooting, “Data Link Configuration Status - Test”
2417-5 Ether Injection Control Solenoid : Current Below Normal	626-5 Engine Start Enable Device 1 : Current Below Normal	Troubleshooting, “Ether Starting Aid - Test”
2417-6 Ether Injection Control Solenoid : Current Above Normal	626-6 Engine Start Enable Device 1 : Current Above Normal	Troubleshooting, “Ether Starting Aid - Test”
2452-3 DPF #1 Intake Temperature Sensor : Voltage Above Normal	3242-3 Particulate Trap Intake Gas Temperature : Voltage Above Normal	Troubleshooting, “Sensor Signal (PWM) - Test”
2452-4 DPF #1 Intake Temperature Sensor : Voltage Below Normal	3242-4 Particulate Trap Intake Gas Temperature : Voltage Below Normal	Troubleshooting, “Sensor Signal (PWM) - Test”
2452-8 DPF #1 Intake Temperature Sensor : Abnormal Frequency, Pulse Width, or Period	3242-8 Aftertreatment #1 DPF Intake Gas Temperature : Abnormal Frequency, Pulse Width, or Period	Troubleshooting, “Sensor Signal (PWM) - Test”
2526-3 Air Inlet Temperature Sensor : Voltage Above Normal	172-3 Engine Air Inlet Temperature : Voltage Above Normal	Troubleshooting, “Sensor Signal (Analog, Passive) - Test”
2526-4 Air Inlet Temperature Sensor : Voltage Below Normal	172-4 Engine Air Inlet Temperature : Voltage Below Normal	Troubleshooting, “Sensor Signal (Analog, Passive) - Test”
2738-3 Turbocharger #1 Compressor Inlet Pressure Sensor : Voltage Above Normal	1176-3 Engine Turbocharger 1 Compressor Inlet Pressure : Voltage Above Normal	Troubleshooting, “Sensor Signal (Analog, Active) - Test (Sensors on the J1 ECM Connector)”
2738-4 Turbocharger #1 Compressor Inlet Pressure Sensor : Voltage Below Normal	1176-4 Engine Turbocharger 1 Compressor Inlet Pressure : Voltage Below Normal	Troubleshooting, “Sensor Signal (Analog, Active) - Test (Sensors on the J1 ECM Connector)”
3002-5 Engine Exhaust NOx Level Sensor : Current Below Normal	3216-5 Aftertreatment #1 Intake NOx : Current Below Normal	Troubleshooting, “Electrical Power Supply - Test”
3002-6 Engine Exhaust NOx Level Sensor : Current Above Normal	3216-6 Aftertreatment #1 Intake NOx : Current Above Normal	Troubleshooting, “Electrical Power Supply - Test”

(continued)

(Table 9, contd)

3002-11 Engine Exhaust NOx Level Sensor : Other Failure Mode	3216-11 Aftertreatment #1 Intake NOx : Other Failure Mode	Troubleshooting, "Sensor (Data Link Type) - Test"
3002-12 Engine Exhaust NOx Level Sensor : Failure	3216-12 Aftertreatment #1 Intake NOx : Failure	Troubleshooting, "Sensor (Data Link Type) - Test"
3090-3 Aftertreatment #1 SCR Dosing Reagent Pressure Sensor : Voltage Above Normal	4334-3 Aftertreatment 1 Diesel Exhaust Fluid Doser Absolute Pressure : Voltage Above Normal	Troubleshooting, "DEF Pump Pressure Sensor - Test"
3090-4 Aftertreatment #1 SCR Dosing Reagent Pressure Sensor : Voltage Below Normal	4334-4 Aftertreatment 1 Diesel Exhaust Fluid Doser Absolute Pressure : Voltage Below Normal	Troubleshooting, "DEF Pump Pressure Sensor - Test"
3090-7 Aftertreatment #1 SCR Dosing Reagent Pressure Sensor : Not Responding Properly	4334-7 Aftertreatment 1 Diesel Exhaust Fluid Doser Absolute Pressure : Not Responding Properly	Troubleshooting, "DEF Pressure Does Not Respond"
3096-2 Aftertreatment #1 DEF Temperature #1 Sensor : Erratic, Intermittent, or Incorrect	5798-2 Aftertreatment #1 DEF Dosing Unit Heater Temperature : Erratic, Intermittent, or Incorrect	Troubleshooting, "DEF Pump - Replace"
3096-8 Aftertreatment #1 SCR Dosing Reagent Temperature #1 Sensor : Abnormal Frequency, Pulse Width, or Period	4337-8 Aftertreatment 1 Diesel Exhaust Fluid Dosing Temperature : Abnormal Frequency, Pulse Width, or Period	Troubleshooting, "DEF Pump - Replace"
3100-11 Aftertreatment #1 DEF Tank Quality Sensor: Other Failure Mode	3516-11 Aftertreatment #1 DEF Concentration: Other Failure Mode	Troubleshooting, "NOx Conversion Is Low"
3100-12 Aftertreatment #1 SCR Catalyst Tank Reagent Quality Sensor : Failure	3516-12 Catalyst Reagent Concentration : Failure	Troubleshooting, "Sensor (Data Link Type) - Test"
3105-3 Aftertreatment #1 SCR Catalyst Intake Gas Temperature Sensor : Voltage Above Normal	4360-3 Aftertreatment #1 SCR Catalyst Intake Gas Temperature : Voltage Above Normal	Troubleshooting, "Sensor Signal (Analog, Active) - Test (Sensors on the J1 ECM Connector)"
3105-4 Aftertreatment #1 SCR Catalyst Intake Gas Temperature Sensor : Voltage Below Normal	4360-4 Aftertreatment #1 SCR Catalyst Intake Gas Temperature : Voltage Below Normal	Troubleshooting, "Sensor Signal (Analog, Active) - Test (Sensors on the J1 ECM Connector)"
3105-8 Aftertreatment #1 SCR Catalyst Intake Gas Temperature Sensor : Abnormal Frequency, Pulse Width, or Period	4360-8 Aftertreatment #1 SCR Catalyst Intake Gas Temperature : Abnormal Frequency, Pulse Width, or Period	Troubleshooting, "Sensor Signal (Analog, Active) - Test (Sensors on the J1 ECM Connector)"
3110-5 Aftertreatment #1 SCR Catalyst Reagent Line Heater #1 : Current Below Normal	4354-5 Aftertreatment 1 Diesel Exhaust Fluid Line Heater 1 : Current Below Normal	Troubleshooting, "DEF Line Heater - Test"
3110-6 Aftertreatment #1 SCR Catalyst Reagent Line Heater #1 : Current Above Normal	4354-6 Aftertreatment 1 Diesel Exhaust Fluid Line Heater 1 : Current Above Normal	Troubleshooting, "DEF Line Heater - Test"

(continued)

(Table 9, contd)

3110-12 Aftertreatment #1 DEF Line Heater #1 : Failure	4354-12 Aftertreatment #1 DEF Line Heater #1 : Failure	Troubleshooting, "DEF Line Heater - Test"
3111-5 Aftertreatment #1 SCR Catalyst Reagent Line Heater #2 : Current Below Normal	4355-5 Aftertreatment 1 Diesel Exhaust Fluid Line Heater 2 : Current Below Normal	Troubleshooting, "DEF Line Heater - Test"
3111-6 Aftertreatment #1 SCR Catalyst Reagent Line Heater #2 : Current Above Normal	4355-6 Aftertreatment 1 Diesel Exhaust Fluid Line Heater 2 : Current Above Normal	Troubleshooting, "DEF Line Heater - Test"
3112-5 Aftertreatment #1 SCR Catalyst Reagent Line Heater #3 : Current Below Normal	4356-5 Aftertreatment 1 Diesel Exhaust Fluid Line Heater 3 : Current Below Normal	Troubleshooting, "DEF Line Heater - Test"
3112-6 Aftertreatment #1 SCR Catalyst Reagent Line Heater #3 : Current Above Normal	4356-6 Aftertreatment 1 Diesel Exhaust Fluid Line Heater 3: Current Above Normal	Troubleshooting, "DEF Line Heater - Test"
3118-5 Aftertreatment #1 SCR Catalyst Reagent Pump Motor Speed Sensor : Current Below Normal	4374-5 Aftertreatment #1 Diesel Exhaust Fluid Pump Motor Speed : Current Below Normal	Troubleshooting, "DEF Pump Motor - Test"
3118-6 Aftertreatment #1 SCR Catalyst Reagent Pump Motor Speed Sensor : Current Above Normal	4374-6 Aftertreatment #1 Diesel Exhaust Fluid Pump Motor Speed : Current Above Normal	Troubleshooting, "DEF Pump Motor - Test"
3118-8 Aftertreatment #1 SCR Catalyst Reagent Pump Motor Speed Sensor : Abnormal Frequency, Pulse Width, or Period	4374-8 Aftertreatment #1 Diesel Exhaust Fluid Pump Motor Speed : Abnormal Frequency, Pulse Width, or Period	Troubleshooting, "DEF Pump - Replace"
3126-5 Aftertreatment #1 SCR Catalyst Reagent Tank #1 Heater Coolant Diverter Solenoid : Current Below Normal	3363-5 Aftertreatment 1 Diesel Exhaust Fluid Tank Heater : Current Below Normal	Troubleshooting, "Solenoid Valve - Test (Solenoid Valves that Connect to the Dosing Control Unit (DCU))"
3126-6 Aftertreatment #1 SCR Catalyst Reagent Tank #1 Heater Coolant Diverter Solenoid : Current Above Normal	3363-6 Aftertreatment 1 Diesel Exhaust Fluid Tank Heater : Current Above Normal	Troubleshooting, "Solenoid Valve - Test (Solenoid Valves that Connect to the Dosing Control Unit (DCU))"
3126-7 Aftertreatment #1 SCR Catalyst Reagent Tank #1 Heater Coolant Diverter Solenoid : Not Responding Properly	3363-7 Aftertreatment 1 Diesel Exhaust Fluid Tank Heater : Not Responding Properly	Troubleshooting, "DEF Temperature Is Low"
3130-3 Aftertreatment #1 SCR Catalyst Reagent Tank #1 Level Sensor : Voltage Above Normal	1761-3 Aftertreatment 1 Diesel Exhaust Fluid Tank Level : Voltage Above Normal	Troubleshooting, "DEF Tank Sensor - Test"
3130-4 Aftertreatment #1 SCR Catalyst Reagent Tank #1 Level Sensor : Voltage Below Normal	1761-4 Aftertreatment 1 Diesel Exhaust Fluid Tank Level : Voltage Below Normal	Troubleshooting, "DEF Tank Sensor - Test"

(continued)

(Table 9, contd)

3134-3 Aftertreatment #1 SCR Catalyst Reagent Tank #1 Temperature Sensor : Voltage Above Normal	3031-3 Aftertreatment 1 Diesel Exhaust Fluid Tank Temperature : Voltage Above Normal	Troubleshooting, “DEF Tank Sensor - Test”
3134-4 Aftertreatment #1 SCR Catalyst Reagent Tank #1 Temperature Sensor : Voltage Below Normal	3031-4 Aftertreatment 1 Diesel Exhaust Fluid Tank Temperature : Voltage Below Normal	Troubleshooting, “DEF Tank Sensor - Test”
3372-3 Engine Charge Air Cooler #1 Outlet Temperature Sensor : Voltage Above Normal	2630-3 Engine Charge Air Cooler Outlet Temperature : Voltage Above Normal	Troubleshooting, “Sensor Signal (Analog, Passive) - Test”
3372-4 Engine Charge Air Cooler #1 Outlet Temperature Sensor : Voltage Below Normal	2630-4 Engine Charge Air Cooler Outlet Temperature : Voltage Below Normal	Troubleshooting, “Sensor Signal (Analog, Passive) - Test”
3385-3 EGR Intake Pressure Sensor : Voltage Above Normal	3358-3 Engine Exhaust Gas Recirculation Inlet Pressure : Voltage Above Normal	Troubleshooting, “Sensor Signal (Analog, Active) - Test (Sensors on the J2 ECM Connector)”
3385-4 EGR Intake Pressure Sensor : Voltage Below Normal	3358-4 Engine Exhaust Gas Recirculation Inlet Pressure : Voltage Below Normal	Troubleshooting, “Sensor Signal (Analog, Active) - Test (Sensors on the J2 ECM Connector)”
3385-13 EGR Intake Pressure Sensor : Calibration Required	3358-13 Engine Exhaust Gas Recirculation Inlet Pressure : Calibration Required	Troubleshooting, “Sensor Calibration Required - Test”
3386-3 EGR Temperature Sensor : Voltage Above Normal	412-3 Engine Exhaust Gas Recirculation Temperature : Voltage Above Normal	Troubleshooting, “Sensor Signal (Analog, Passive) - Test”
3386-4 EGR Temperature Sensor : Voltage Below Normal	412-4 Engine Exhaust Gas Recirculation Temperature : Voltage Below Normal	Troubleshooting, “Sensor Signal (Analog, Passive) - Test”
3387-2 EGR Differential Pressure Sensor : Erratic, Intermittent, or Incorrect	411-2 Engine Exhaust Gas Recirculation Differential Pressure : Erratic, Intermittent, or Incorrect	Troubleshooting, “Sensor Signal (Analog, Active) - Test (Sensors on the J2 ECM Connector)”
3387-3 EGR Differential Pressure Sensor : Voltage Above Normal	411-3 Engine Exhaust Gas Recirculation Differential Pressure : Voltage Above Normal	Troubleshooting, “Sensor Signal (Analog, Active) - Test (Sensors on the J2 ECM Connector)”
3387-4 EGR Differential Pressure Sensor : Voltage Below Normal	411-4 Engine Exhaust Gas Recirculation Differential Pressure : Voltage Below Normal	Troubleshooting, “Sensor Signal (Analog, Active) - Test (Sensors on the J2 ECM Connector)”
3387-13 EGR Differential Pressure Sensor : Calibration Required	411-13 Engine Exhaust Gas Recirculation Differential Pressure : Calibration Required	Troubleshooting, “Sensor Calibration Required - Test”
3397-3 DPF #1 Soot Loading Sensor : Voltage Above Normal	4783-3 DPF #1 Mean Soot Signal : Voltage Above Normal	Troubleshooting, “Soot Sensor - Test”

(continued)

(Table 9, contd)

3397-4 DPF #1 Soot Loading Sensor : Voltage Below Normal	4783-4 DPF #1 Mean Soot Signal : Voltage Below Normal	Troubleshooting, “Soot Sensor - Test”
3397-12 DPF #1 Soot Loading Sensor : Failure	4783-12 DPF #1 Mean Soot Signal : Failure	Troubleshooting, “Soot Sensor - Test”
3397-21 DPF #1 Soot Loading Sensor : Data Drifted Low	4783-21 DPF #1 Mean Soot Signal : Data Drifted Low	Troubleshooting, “Soot Sensor - Test”
3405-5 EGR Valve Control : Current Below Normal	2791-5 Engine Exhaust Gas Recirculation (EGR) Valve Control : Current Below Normal	Troubleshooting, “Motorized Valve - Test”
3405-6 EGR Valve Control : Current Above Normal	2791-6 Engine Exhaust Gas Recirculation (EGR) Valve Control : Current Above Normal	Troubleshooting, “Motorized Valve - Test”
3407-3 EGR Valve Position Sensor : Voltage Above Normal	27-3 EGR #1 Valve Position : Voltage Above Normal	Troubleshooting, “Valve Position - Test”
3407-4 EGR Valve Position Sensor : Voltage Below Normal	27-4 EGR #1 Valve Position : Voltage Below Normal	Troubleshooting, “Valve Position - Test”
3467-5 Main Power Relay : Current Below Normal	2634-5 Power Relay : Current Below Normal: Current Below Normal	Troubleshooting, “Relay - Test (ECM Power Relay)”
3467-6 Main Power Relay : Current Above Normal	2634-6 Power Relay : Current Below Normal: Current Above Normal	Troubleshooting, “Relay - Test (ECM Power Relay)”
3468-2 Aftertreatment #1 Identification Number Module : Erratic, Intermittent, or Incorrect	5576-2 Aftertreatment #1 Identification : Erratic, Intermittent, or Incorrect	Troubleshooting, “Aftertreatment Identification Module - Test”
3468-8 Aftertreatment #1 Identification Number Module : Abnormal Frequency, Pulse Width, or Period	5576-8 Aftertreatment #1 Identification : Abnormal Frequency, Pulse Width, or Period	Troubleshooting, “Aftertreatment Identification Module - Test”
3468-14 Aftertreatment #1 Identification Number Module : Special Instruction	5576-14 Aftertreatment #1 Identification : Special Instruction	Troubleshooting, “Data Link Configuration Status - Test”
3482-11 Sensor Supply #3 : Other Failure Mode	3511-11 Sensor Supply Voltage 3 : Other Failure Mode	Troubleshooting, “DEF Pump Sensor Supply - Test”
3483-3 Sensor Supply #4 : Voltage Above Normal	3512-3 Sensor Supply Voltage 4 : Voltage Above Normal	Troubleshooting, “Speed/Timing - Test”
3483-4 Sensor Supply #4 : Voltage Below Normal	3512-4 Sensor Supply Voltage 4 : Voltage Below Normal	Troubleshooting, “Speed/Timing - Test”
3512-5 Engine Exhaust Back Pressure Regulator : Current Below Normal	649-5 Engine Exhaust Back Pressure Regulator Control Command : Current Below Normal	Troubleshooting, “Motorized Valve - Test”

(continued)

(Table 9, contd)

3512-6 Engine Exhaust Back Pressure Regulator : Current Above Normal	649-6 Engine Exhaust Back Pressure Regulator Control Command : Current Above Normal	Troubleshooting, “Motorized Valve - Test”
3513-3 Engine Exhaust Back Pressure Regulator Valve Position Sensor : Voltage Above Normal	5625-3 Engine Exhaust Back Pressure Regulator Position : Voltage Above Normal	Troubleshooting, “Valve Position - Test”
3513-4 Engine Exhaust Back Pressure Regulator Valve Position Sensor : Voltage Below Normal	5625-4 Engine Exhaust Back Pressure Regulator Position : Voltage Below Normal	Troubleshooting, “Valve Position - Test”
3528-3 Atmospheric Pressure Sensor : Voltage Above Normal	108-3 Barometric Pressure : Voltage Above Normal	Troubleshooting, “Sensor Signal (Analog, Active) - Test (Sensors on the J2 ECM Connector)”
3528-4 Atmospheric Pressure Sensor : Voltage Below Normal	108-4 Barometric Pressure : Voltage Below Normal	Troubleshooting, “Sensor Signal (Analog, Active) - Test (Sensors on the J2 ECM Connector)”
3547-3 Water in Fuel System Switch : Voltage Above Normal	97-3 Water In Fuel Indicator : Voltage Above Normal	Troubleshooting, “Water in Fuel - Test”
3547-4 Water in Fuel System Switch : Voltage Below Normal	97-4 Water In Fuel Indicator : Voltage Below Normal	Troubleshooting, “Water in Fuel - Test”
3609-5 Aftertreatment #1 Outlet #1 NOx Level Sensor : Current Below Normal	3226-5 Aftertreatment #1 Outlet NOx : Current Below Normal	Troubleshooting, “Electrical Power Supply - Test”
3609-6 Aftertreatment #1 Outlet #1 NOx Level Sensor : Current Above Normal	3226-6 Aftertreatment #1 Outlet NOx : Current Above Normal	Troubleshooting, “Electrical Power Supply - Test”
3609-11 Aftertreatment #1 Outlet #1 NOx Level Sensor : Other Failure Mode	3226-11 Aftertreatment #1 Outlet NOx : Other Failure Mode	Troubleshooting, “Sensor (Data Link Type) - Test”
3609-12 Aftertreatment #1 Outlet #1 NOx Level Sensor : Failure	3226-12 Aftertreatment #1 Outlet NOx : Failure	Troubleshooting, “Sensor (Data Link Type) - Test”
3619-11 Aftertreatment #1 Outlet #1 NOx Level Sensor Power Supply : Other Failure Mode	5759-11 Aftertreatment #1 Outlet Gas Sensor Power Supply : Other Failure Mode	Troubleshooting, “Electrical Power Supply - Test”
3621-11 Engine Exhaust NOx Level Sensor Power Supply : Other Failure Mode	5758-11 Aftertreatment #1 Intake Gas Sensor Power Supply : Other Failure Mode	Troubleshooting, “Electrical Power Supply - Test”
3666-5 Engine Fuel Supply Lift Pump Relay : Current Below Normal	1075-5 Engine Electric Lift Pump for Engine Fuel Supply : Current Below Normal	Troubleshooting, “Fuel Transfer Pump - Test”
3666-6 Engine Fuel Supply Lift Pump Relay : Current Above Normal	1075-6 Engine Electric Lift Pump for Engine Fuel Supply : Current Above Normal	Troubleshooting, “Fuel Transfer Pump - Test”
3782-3 Engine Turbocharger Turbine Outlet Temperature Sensor : Voltage Above Normal	1184-3 Engine Turbocharger #1 Turbine Outlet Temperature : Voltage Above Normal	Troubleshooting, “Sensor Signal (PWM) - Test”

(continued)

(Table 9, contd)

3782-4 Engine Turbocharger Turbine Outlet Temperature Sensor : Voltage Below Normal	1184-4 Engine Turbocharger #1 Turbine Outlet Temperature : Voltage Below Normal	Troubleshooting, "Sensor Signal (PWM) - Test"
3782-8 Engine Turbocharger Turbine Outlet Temperature Sensor : Abnormal Frequency, Pulse Width, or Period	1184-8 Engine Turbocharger #1 Turbine Outlet Temperature : Abnormal Frequency, Pulse Width, or Period	Troubleshooting, "Sensor Signal (PWM) - Test"
3820-3 Aftertreatment #1 Diesel Exhaust Fluid Controller : Voltage Above Normal	3360-3 Aftertreatment 1 Diesel Exhaust Fluid Controller : Voltage Above Normal	Troubleshooting, "DEF Control Module Power - Test"
3820-4 Aftertreatment #1 Diesel Exhaust Fluid Controller : Voltage Below Normal	3360-4 Aftertreatment 1 Diesel Exhaust Fluid Controller : Voltage Below Normal	Troubleshooting, "DEF Control Module Power - Test"
3820-9 Aftertreatment #1 Diesel Exhaust Fluid Controller : Abnormal Update Rate	3360-9 Aftertreatment #1 DEF Controller : Abnormal Update Rate	Troubleshooting, "CAN Data Link - Test"
3820-12 Aftertreatment #1 Diesel Exhaust Fluid Controller : Failure	3360-12 Aftertreatment 1 Diesel Exhaust Fluid Controller : Failure	Troubleshooting, "Sensor (Data Link Type) - Test"
3821-5 Aftertreatment #1 Diesel Exhaust Fluid Dosing Valve Actuator : Current Below Normal	3361-5 Catalyst Dosing Unit : Current Below Normal	Troubleshooting, "Solenoid Valve - Test (Solenoid Valves that Connect to the Dosing Control Unit (DCU))"
3821-6 Aftertreatment #1 Diesel Exhaust Fluid Dosing Valve Actuator : Current Above Normal	3361-6 Catalyst Dosing Unit : Current Above Normal	Troubleshooting, "Solenoid Valve - Test (Solenoid Valves that Connect to the Dosing Control Unit (DCU))"
3821-7 Aftertreatment #1 Diesel Exhaust Fluid Dosing Valve Actuator : Not Responding Properly	3361-7 Catalyst Dosing Unit : Not Responding Properly	Troubleshooting, "DEF Module Does Not Respond"
3821-11 Aftertreatment #1 Diesel Exhaust Fluid Dosing Valve Actuator : Other Failure Mode	3361-11 Catalyst Dosing Unit : Other Failure Mode	Troubleshooting, "DEF Module Does Not Respond"
3821-14 Aftertreatment #1 Diesel Exhaust Fluid Dosing Valve Actuator : Special Instruction	3361-14 Catalyst Dosing Unit : Special Instruction	Troubleshooting, "DEF Module Does Not Respond"
3822-5 Aftertreatment #1 Diesel Exhaust Fluid Line Heater Relay : Current Below Normal	5491-5 Aftertreatment #1 DEF Line Heater Relay : Current Below Normal	Troubleshooting, "DEF Line Heater - Test"
3822-6 Aftertreatment #1 Diesel Exhaust Fluid Line Heater Relay : Current Above Normal	5491-6 Aftertreatment #1 DEF Line Heater Relay : Current Above Normal	Troubleshooting, "DEF Line Heater - Test"
3838-5 Aftertreatment #1 Diesel Exhaust Fluid Dosing Control Module Relay : Current Below Normal	5965-5 Aftertreatment 1 Diesel Exhaust Fluid Control Module Relay Control : Current Below Normal	Troubleshooting, "Solenoid Valve - Test (Solenoid Valves that Connect to the Dosing Control Unit (DCU))"

(continued)

(Table 9, contd)

3838-6 Aftertreatment #1 Diesel Exhaust Fluid Dosing Control Module Relay : Current Above Normal	5965-6 Aftertreatment 1 Diesel Exhaust Fluid Control Module Relay Control : Current Above Normal	Troubleshooting, “Solenoid Valve - Test (Solenoid Valves that Connect to the Dosing Control Unit (DCU))”
3862-5 Aftertreatment #1 Diesel Exhaust Fluid Return Valve Solenoid : Current Below Normal	4376-5 Aftertreatment 1 Diesel Exhaust Fluid Return Valve : Current Below Normal	Troubleshooting, “DEF Return Valve - Test”
3862-6 Aftertreatment #1 Diesel Exhaust Fluid Return Valve Solenoid : Current Above Normal	4376-6 Aftertreatment 1 Diesel Exhaust Fluid Return Valve : Current Above Normal	Troubleshooting, “DEF Return Valve - Test”
3862-7 Aftertreatment #1 Diesel Exhaust Fluid Return Valve Solenoid : Not Responding Properly	4376-7 Aftertreatment 1 Diesel Exhaust Fluid Return Valve : Not Responding Properly	Troubleshooting, “DEF Pump - Replace”
3965-5 Aftertreatment #1 Diesel Exhaust Fluid Control Module Power Supply #1 : Current Below Normal	5966-5 Aftertreatment 1 Diesel Exhaust Fluid Control Module Power Supply : Current Below Normal	Troubleshooting, “DEF Control Module Power - Test”
3965-6 Aftertreatment #1 Diesel Exhaust Fluid Control Module Power Supply #1 : Current Above Normal	5966-6 Aftertreatment 1 Diesel Exhaust Fluid Control Module Power Supply : Current Above Normal	Troubleshooting, “DEF Control Module Power - Test”
3966-6 Aftertreatment #1 Diesel Exhaust Fluid Control Module Power Supply #2 : Current Above Normal	6309-6 Aftertreatment #1 Diesel Exhaust Fluid Control Module Power Supply #2 : Current Above Normal	Troubleshooting, “DEF Control Module Power - Test”
4648-3 Aftertreatment Ambient Air Temperature Sensor : Voltage Above Normal	7441-3 Aftertreatment Ambient Air Temperature : Voltage Above Normal	Troubleshooting, “Sensor Signal (Analog, Passive) - Test”
4648-4 Aftertreatment Ambient Air Temperature Sensor : Voltage Below Normal	7441-4 Aftertreatment Ambient Air Temperature : Voltage Below Normal	Troubleshooting, “Sensor Signal (Analog, Passive) - Test”
5856-9 SAE J1939 Data Link #3:Abnormal Update Rate	1235-9 J1939 Network #3 : Abnormal Update Rate	Troubleshooting, “CAN Data Link - Test”
5856-14 SAE J1939 Data Link #3: Special Instruction	1235-14 J1939 Network #3 : Special Instruction	Troubleshooting, “Data Link Configuration Status - Test”

Event Codes

i07731045

Event Codes

Cross-Reference Information for Event Codes

Table 10 is a list of the event codes in J1939 code order for the engine. Table 11 is a list of the event codes in PDL code order for the engine. The event codes reference the appropriate procedure that can be used to troubleshoot the code.

Event codes are generated when abnormal operating conditions exist. A further explanation of event codes and the engine monitoring system are described after Table 11 .

Table 10

Event Codes (J1939 Code Order)		
J1939 Code and Description	**PDL Code and Description**	**Troubleshooting Procedure**
-	E265 (1) User Defined Shutdown	This code records that the engine has been shut down using the ground level shutdown switch. No diagnostics are required.
-	E268 (1) Unexpected Engine Shutdown	Troubleshooting, “Engine Shutdown Occurrence”
-	E441 (1) Idle Elevated to Increase Battery Voltage	This code indicates that the engine idle speed has been increased due to low battery voltage. No diagnostics are required.
-	E878 (2) High Hydraulic Oil Temperature	Refer to the machine troubleshooting guide
-	E878 (3) High Hydraulic Oil Temperature	Refer to the machine troubleshooting guide
-	E1363 (1) Low Engine Cooling Fan Speed	Troubleshooting, “Cooling Fan Speed - Test”
-	E1377 (1) Machine Disable Pending Due to Machine Security	This code indicates that the machine security system does not recognize the ignition key. Ensure that the correct key is in use.
-	E1377 (2) Machine Disable Pending Due to Machine Security	This code indicates that the machine security system does not recognize the ignition key. Ensure that the correct key is in use.
97-15 Water In Fuel Indicator : High - least severe (1)	E232 (1) High Fuel/Water Separator Water Level	Troubleshooting, “Fuel Contains Water”
97-16 Water In Fuel Indicator : High - moderate severity (2)	E232 (2) High Fuel/Water Separator Water Level	Troubleshooting, “Fuel Contains Water”

(continued)

(Table 10, contd)

Event Codes (J1939 Code Order)		
J1939 Code and Description	**PDL Code and Description**	**Troubleshooting Procedure**
98-1 Engine Oil Level : Low - most severe (3)	E360 (3) Low Engine Oil Level	Troubleshooting, "Oil Level Is Low"
98-18 Engine Oil Level : Low - moderate severity (2)	E360 (2) Low Engine Oil Level	Troubleshooting, "Oil Level Is Low"
100-1 Engine Oil Pressure : Low - most severe (3)	E360 (3) Low Engine Oil Pressure	Troubleshooting, "Oil Pressure Is Low"
100-17 Engine Oil Pressure : Low - least severe (1)	E360 (1) Low Engine Oil Pressure	Troubleshooting, "Oil Pressure Is Low"
100-18 Engine Oil Pressure : Low - moderate severity (2)	E360 (2) Low Engine Oil Pressure	Troubleshooting, "Oil Pressure Is Low"
102-16 Engine Intake Manifold #1 Pressure : High - moderate severity (2)	E1044 (2) High Intake Manifold Pressure	Troubleshooting, "Intake Manifold Air Pressure Is High"
102-18 Engine Intake Manifold #1 Pressure : Low - moderate severity (2)	E1045 (2) Low Intake Manifold Pressure	Troubleshooting, "Intake Manifold Air Pressure Is Low"
105-15 Engine Intake Manifold #1 Temperature : High - least severe (1)	E539 (1) High Intake Manifold Air Temperature	Troubleshooting, "Intake Manifold Air Temperature Is High"
105-16 Engine Intake Manifold #1 Temperature : High - moderate severity (2)	E539 (2) High Intake Manifold Air Temperature	Troubleshooting, "Intake Manifold Air Temperature Is High"
107-15 Engine Air Filter 1 Differential Pressure : High - least severe (1)	E583 (1) High Air Inlet #1 Differential Pressure	Troubleshooting, "Inlet Air Is Restricted"
107-16 Engine Air Filter 1 Differential Pressure : High - moderate severity (2)	E583 (2) High Air Inlet #1 Differential Pressure	Troubleshooting, "Inlet Air Is Restricted"
110-0 Engine Coolant Temperature : High - most severe (3)	E361 (3) High Engine Coolant Temperature	Troubleshooting, "Coolant Temperature Is High"
110-15 Engine Coolant Temperature : High - least severe (1)	E361 (1) High Engine Coolant Temperature	Troubleshooting, "Coolant Temperature Is High"
110-16 Engine Coolant Temperature : High - moderate severity (2)	E361 (2) High Engine Coolant Temperature	Troubleshooting, "Coolant Temperature Is High"
111-1 Engine Coolant Level : Low - most severe (3)	E2143 (3) Low Engine Coolant Level	Troubleshooting, "Coolant Level Is Low"
111-18 Engine Coolant Level : Low - moderate severity (2)	E2143 (2) Low Engine Coolant Level	Troubleshooting, "Coolant Level Is Low"

(continued)

(Table 10, contd)

Event Codes (J1939 Code Order)		
J1939 Code and Description	**PDL Code and Description**	**Troubleshooting Procedure**
157-16 Engine Injector Metering Rail #1 Pressure : High - moderate severity (2)	E396 (2) High Fuel Rail Pressure	Troubleshooting, “Fuel Rail Pressure Problem”
157-18 Engine Injector Metering Rail #1 Pressure : Low - moderate severity (2)	E398 (2) Low Fuel Rail Pressure	Troubleshooting, “Fuel Rail Pressure Problem”
174-15 Engine Fuel Temperature 1 : High - least severe (1)	E363 (1) High Fuel Supply Temperature	Troubleshooting, “Fuel Temperature Is High”
174-16 Engine Fuel Temperature 1 : High - moderate severity (2)	E363 (2) High Fuel Supply Temperature	Troubleshooting, “Fuel Temperature Is High”
190-0 Engine Speed : High - most severe (3)	E362 (3) Engine Overspeed	Troubleshooting, “Engine Overspeeds”
190-15 Engine Speed : High - least severe (1)	E362 (1) Engine Overspeed	Troubleshooting, “Engine Overspeeds”
412-15 Engine Exhaust Gas Recirculation Temperature : High - least severe (1)	E1092 (1) High EGR Temperature	Troubleshooting, “NRS Exhaust Gas Temperature Is High”
412-16 Engine Exhaust Gas Recirculation Temperature : High - moderate severity (2)	E1092 (2) High EGR Temperature	Troubleshooting, “NRS Exhaust Gas Temperature Is High”
592-31 Engine Idle Shutdown Timer Override (3)	E1217 (3) Delayed Engine Shutdown Override	The “Delayed Engine Shutdown” has been overridden. The engine will stop, no troubleshooting required.
593-31 Engine Idle Shutdown has Shutdown Engine : Low - most severe (3)	E1171 (1) Engine Idle Shutdown Occurred	This code indicates that an engine idle shutdown has occurred. This code does not represent a fault. Refer to Troubleshooting, “Configuration Parameters” for further information.
594-18 Engine Idle Shutdown Driver Alert Mode : Low - moderate severity (2)	E1172 (2) Engine Idle Shutdown Pending	This code indicates that an engine idle shutdown will occur due to a long period at idle speed. This code does not represent a fault. Refer to Troubleshooting, “Configuration Parameters” for further information.
594-31 Engine Idle Shutdown Driver Alert Mode	E1172 (3) Engine Idle Shutdown Pending	This code indicates that an engine idle shutdown is about to occur. This code does not represent a fault. Refer to Troubleshooting, “Configuration Parameters” for further information.
649-7 Engine Exhaust Back Pressure Regulator Control Command : Not Responding Properly	E1263 (2) Engine Exhaust Back Pressure Regulator Not Responding to Command	Troubleshooting, “Motorized Valve - Test”
1239-0 Engine Fuel Leakage 1 : High - most severe (3)	E499 (3) Fuel Rail #1 Pressure Leak	Troubleshooting, “Fuel Rail Pressure Problem”

(continued)

(Table 10, contd)

Event Codes (J1939 Code Order)		
J1939 Code and Description	**PDL Code and Description**	**Troubleshooting Procedure**
1664-31 Engine Automatic Start Failed	E225 (2) Engine Overcrank	Troubleshooting, “Engine Overcrank Occurrence”
1761-1 Aftertreatment 1 Diesel Exhaust Fluid Tank Level : Low - most severe (3)	E954 (3) Low Aftertreatment #1 SCR Catalyst Reagent Tank #1 Level	Troubleshooting, “DEF Tank Level Is Low”
1761-17 Aftertreatment 1 Diesel Exhaust Fluid Tank Level : Low - least severe (1)	E954 (1) Low Aftertreatment #1 SCR Catalyst Reagent Tank #1 Level	Troubleshooting, “DEF Tank Level Is Low”
1761-18 Aftertreatment 1 Diesel Exhaust Fluid Tank Level : Low - moderate severity (2)	E954 (2) Low Aftertreatment #1 SCR Catalyst Reagent Tank #1 Level	Troubleshooting, “DEF Tank Level Is Low”
2659-7 Engine Exhaust Gas Recirculation (EGR) Mass Flow Rate : Not Responding Properly	E1319 (2) EGR Mass Flow Rate Not Responding	Troubleshooting, “NRS Mass Flow Rate Problem”
2791-7 Engine Exhaust Gas Recirculation (EGR) Valve Control : Not Responding Properly	E1121 (2) EGR Valve Control Not Responding to Command	Troubleshooting, “Motorized Valve - Test”
3031-7 Aftertreatment 1 Diesel Exhaust Fluid Tank Temperature : Not Responding Properly	E1441 (2) Aftertreatment #1 Diesel Exhaust Fluid Tank Temperature Not Responding	Troubleshooting, “DEF Temperature Is Low”
3031-16 Aftertreatment 1 Diesel Exhaust Fluid Tank Temperature : High - moderate severity (2)	E960 (2) High Aftertreatment #1 SCR Catalyst Reagent Tank #1 Temperature	Troubleshooting, “DEF Tank Temperature Is High”
3031-18 Aftertreatment 1 Diesel Exhaust Fluid Tank Temperature : Low - moderate severity (2)	E1398 (2) Low Aftertreatment #1 SCR Catalyst Reagent Tank #1 Temperature	Troubleshooting, “DEF Temperature Is Low”
3216-7 Aftertreatment #1 Intake NOx : Not Responding Properly	E1431 (2) Invalid Aftertreatment #1 Intake NOx Level	Troubleshooting, “NOx Sensor - Test”
3217-16 Aftertreatment #1 Intake O2 : High - moderate severity (2)	E1407 (2) High Aftertreatment #1 Intake O2 Concentration	Troubleshooting, “Clean Emissions Module Has High Oxygen Level”
3226-7 Aftertreatment #1 Outlet NOx : Not Responding Properly	E1432 (2) Aftertreatment #1 Outlet #1 NOx Level	Troubleshooting, “NOx Sensor - Test”
3227-16 Aftertreatment #1 Outlet O2 : High - moderate severity (2)	E1408 (2) High Aftertreatment #1 Outlet O2 Concentration	Troubleshooting, “Clean Emissions Module Has High Oxygen Level”
3242-17 Particulate Trap Intake Gas Temperature : Low - least severe (1)	E1014 (1) Low DPF #1 Intake Temperature	Troubleshooting, “Diesel Particulate Filter Temperature Is Low”

(continued)

(Table 10, contd)

Event Codes (J1939 Code Order)		
J1939 Code and Description	**PDL Code and Description**	**Troubleshooting Procedure**
3242-18 Particulate Trap Intake Gas Temperature : Low - moderate severity (2)	E1014 (2) Low DPF #1 Intake Temperature	Troubleshooting, “Diesel Particulate Filter Temperature Is Low”
3362-14 Aftertreatment 1 Diesel Exhaust Fluid Dosing Unit Input Lines : Special Instruction	E114 (1) Aftertreatment #1 Diesel Exhaust Fluid Dosing Unit Input Lines Not Purged	Troubleshooting, “DEF Does Not Purge”
3516-15 Aftertreatment #1 DEF Concentration: High - least severe (1)	E1365 (1) High Aftertreatment #1 DEF Concentration	Troubleshooting, “NOx Conversion Is Low”
3516-16 Catalyst Reagent Concentration : High - moderate severity (2)	E1365 (2) Aftertreatment 1 Diesel Exhaust Fluid Concentration : High - moderate severity (2)	Troubleshooting, “NOx Conversion Is Low”
3516-18 Catalyst Reagent Concentration : Low - moderate severity (2)	E1364 (2) Aftertreatment 1 Diesel Exhaust Fluid Concentration : Low - moderate severity (2)	Troubleshooting, “NOx Conversion Is Low”
3719-0 Particulate Trap #1 Soot Load Percent : High - most severe (3)	E995 (3) High DPF #1 Soot Loading	Troubleshooting, “Diesel Particulate Filter Collects Excessive Soot”
3719-16 Particulate Trap #1 Soot Load Percent : High - moderate severity (2)	E995 (2) High DPF #1 Soot Loading	Troubleshooting, “Diesel Particulate Filter Collects Excessive Soot”
4215-31 Ground-Level Shutdown Activated	E678 (1) Ground Level Shutdown	The ground level shutdown switch has been activated. No troubleshooting is required.
4334-16 Aftertreatment 1 Diesel Exhaust Fluid Doser Absolute Pressure : High - moderate severity (2)	E930 (2) High Aftertreatment #1 SCR Dosing Reagent Pressure	Troubleshooting, “DEF Pressure Is High”
4334-18 Aftertreatment 1 Diesel Exhaust Fluid Doser Absolute Pressure - moderate severity (2)	E931 (2) Low Aftertreatment #1 SCR Dosing Reagent Pressure	Troubleshooting, “DEF Pressure Is Low”
4360-16 Aftertreatment #1 SCR Catalyst Intake Gas Temperature : High - moderate severity (2)	E946 (2) High Aftertreatment #1 SCR Catalyst Intake Gas Temperature	Troubleshooting, “SCR Catalyst Has Incorrect Inlet Temperature”
4360-17 Aftertreatment #1 SCR Catalyst Intake Gas Temperature : Low - least severe (1)	E947 (1) Low Aftertreatment #1 SCR Catalyst Intake Gas Temperature	Troubleshooting, “SCR Catalyst Has Incorrect Inlet Temperature”
4360-18 Aftertreatment #1 SCR Catalyst Intake Gas Temperature : Low - moderate severity (2)	E947 (2) Low Aftertreatment #1 SCR Catalyst Intake Gas Temperature	Troubleshooting, “SCR Catalyst Has Incorrect Inlet Temperature”

(continued)

(Table 10, contd)

Event Codes (J1939 Code Order)		
J1939 Code and Description	**PDL Code and Description**	**Troubleshooting Procedure**
4364-2 Aftertreatment #1 SCR Catalyst Conversion Efficiency : Erratic, Intermittent, or Incorrect	E1410 (2) Invalid Aftertreatment #1 SCR Conversion Efficiency	Troubleshooting, "NOx Conversion Is Low"
4364-18 Aftertreatment #1 SCR Catalyst Conversion Efficiency : Low - moderate severity (2)	E1309 (2) Low Aftertreatment #1 SCR Catalyst Conversion Efficiency	Troubleshooting, "NOx Conversion Is Low"
4792-14 Aftertreatment #1 SCR System : Special Instruction	E1390 (2) Aftertreatment #1 SCR Monitoring System Malfunction	Diesel Exhaust Fluid (DEF) is not being dosed as expected. Update the Engine Software to the latest version.
4765-17 Aftertreatment #1 Diesel Oxidation Catalyst Intake Gas Temperature : Low - least severe (1)	E2165 (1) Low Aftertreatment #1 Diesel Oxidation Catalyst #1 Intake Gas Temperature	Troubleshooting, "Diesel Oxidation Catalyst Has Incorrect Inlet Temperature"
5246-0 Aftertreatment SCR Operator Inducement Severity : High - most severe (3)	E1389 (3) Aftertreatment #1 SCR Operator Inducement	Troubleshooting, "SCR Warning System Problem"
5246-15 Aftertreatment SCR Operator Inducement Severity : High - least severe (1)	E1389 (1) Aftertreatment #1 SCR Operator Inducement	Troubleshooting, "SCR Warning System Problem"
5246-16 Aftertreatment SCR Operator Inducement Severity : High - moderate severity (2)	E1389 (2) Aftertreatment #1 SCR Operator Inducement	Troubleshooting, "SCR Warning System Problem"
5298-17 Aftertreatment #1 Diesel Oxidation Catalyst Conversion Efficiency : Low - least severe (1)	E2180 (1) Low Aftertreatment #1 Diesel Oxidation Catalyst #1 Conversion Efficiency	Troubleshooting, "Diesel Oxidation Catalyst Has Low Conversion Efficiency"
5392-31 Aftertreatment Diesel Exhaust Fluid Dosing Unit Loss of Prime	E1370 (2) Aftertreatment #1 Diesel Exhaust Fluid Dosing Unit Loss of Prime	Troubleshooting, "DEF Pressure Is Low"
5480-16 Aftertreatment 1 Diesel Exhaust Fluid Controller Temperature : High - moderate severity (2)	E1430 (2) High Aftertreatment #1 Diesel Exhaust Fluid Controller Temperature	Troubleshooting, "DEF Control Module Temperature Is High"
5571-0 High Pressure Common Rail Fuel Pressure Relief Valve : High - most severe (3)	E1264 (2) High Pressure Common Rail Fuel Pressure Relief Valve Active	Troubleshooting, "Fuel Rail Pressure Problem"
5588-14 Proprietary Network #2 : Special Instruction	E1132 (2) Inconsistent Configuration Detected	Troubleshooting, "Data Link Configuration Status - Test"
5798-7 Aftertreatment 1 Diesel Exhaust Fluid Dosing Unit Heater Temperature : Not Responding Properly	E1427 (1) Aftertreatment #1 SCR Dosing Pump Temperature Not Responding	Troubleshooting, "DEF Temperature Is Low"

(continued)

(Table 10, contd)

Event Codes (J1939 Code Order)		
J1939 Code and Description	**PDL Code and Description**	**Troubleshooting Procedure**
6588-31 Operator Shutdown With High Exhaust Temperature	E1466 (1) Operator Forced Shutdown with High Exhaust Temperature	Troubleshooting, “Engine Shutdown Occurrence”
7343—31 SCR Operator Inducement Override Renewal Required	E1598 (2) Engine Emissions Operator Inducement Emergency Override Renewal	Troubleshooting, “SCR Inducement Emergency Override”
7440-31 Aftertreatment Active Regeneration Inhibited Due to Low Exhaust Pressure	E1645 (1) Aftertreatment Active Regeneration Inhibited Due to Low Exhaust Pressure	Troubleshooting, “Diesel Particulate Filter Collects Excessive Soot”

Table 11

Event Codes (PDL Code Order)		
PDL Code and Description	**J1939 Code and Description**	**Troubleshooting Procedure**
E114 (1) Aftertreatment #1 Diesel Exhaust Fluid Dosing Unit Input Lines Not Purged	3362-14 Aftertreatment 1 Diesel Exhaust Fluid Dosing Unit Input Lines : Special Instruction	Troubleshooting, “DEF Does Not Purge”
E173 (2) Low Engine Oil Level	98-18 Engine Oil Level : Low - moderate severity (2)	Troubleshooting, “Oil Level Is Low”
E173 (3) Low Engine Oil Level	98-1 Engine Oil Level : Low - most severe (3)	Troubleshooting, “Oil Level Is Low”
E225 (2) Engine Overcrank	1664-31 Engine Automatic Start Failed	Troubleshooting, “Engine Overcrank Occurrence”
E232 (1) High Fuel/Water Separator Water Level	97-15 Water In Fuel Indicator : High - least severe (1)	Troubleshooting, “Fuel Contains Water”
E232 (2) High Fuel/Water Separator Water Level	97-16 Water In Fuel Indicator : High - moderate severity (2)	Troubleshooting, “Fuel Contains Water”
E265 (1) User Defined Shutdown	-	This code records that the engine has been shut down using the ground level shutdown switch. No diagnostics are required.
E268 (1) Unexpected Engine Shutdown	-	Troubleshooting, “Engine Shutdown Occurrence”
E360 (1) Low Engine Oil Pressure	100-17 Engine Oil Pressure : Low - least severe (1)	Troubleshooting, “Oil Pressure Is Low”
E360 (2) Low Engine Oil Pressure	100-18 Engine Oil Pressure : Low - moderate severity (2)	Troubleshooting, “Oil Pressure Is Low”
E360 (3) Low Engine Oil Pressure	100-1 Engine Oil Pressure : Low - most severe (3)	Troubleshooting, “Oil Pressure Is Low”

(continued)

(Table 11, contd)

Event Codes (PDL Code Order)		
PDL Code and Description	**J1939 Code and Description**	**Troubleshooting Procedure**
E361 (1) High Engine Coolant Temperature	110-15 Engine Coolant Temperature : High - least severe (1)	Troubleshooting, “Coolant Temperature Is High”
E361 (2) High Engine Coolant Temperature	110-16 Engine Coolant Temperature : High - moderate severity (2)	Troubleshooting, “Coolant Temperature Is High”
E361 (3) High Engine Coolant Temperature	110-0 Engine Coolant Temperature : High - most severe (3)	Troubleshooting, “Coolant Temperature Is High”
E362 (1) Engine Overspeed	190-15 Engine Speed : High - least severe (1)	Troubleshooting, “Engine Overspeeds”
E362 (3) Engine Overspeed	190-0 Engine Speed : High - most severe (3)	Troubleshooting, “Engine Overspeeds”
E363 (1) High Fuel Supply Temperature	174-15 Engine Fuel Temperature 1 : High - least severe (1)	Troubleshooting, “Fuel Temperature Is High”
E363 (2) High Fuel Supply Temperature	174-16 Engine Fuel Temperature 1 : High - moderate severity (2)	Troubleshooting, “Fuel Temperature Is High”
E396 (2) High Fuel Rail Pressure	157-16 Engine Injector Metering Rail #1 Pressure : High - moderate severity (2)	Troubleshooting, “Fuel Rail Pressure Problem”
E398 (2) Low Fuel Rail Pressure	157-18 Engine Injector Metering Rail #1 Pressure : Low - moderate severity (2)	Troubleshooting, “Fuel Rail Pressure Problem”
E441 (1) Idle Elevated to Increase Battery Voltage	-	This code indicates that the engine idle speed has been increased due to low battery voltage. No diagnostics are required.
E499 (3) Fuel Rail #1 Pressure Leak	1239-0 Engine Fuel Leakage 1 : High - most severe (3)	Troubleshooting, “Fuel Rail Pressure Problem”
E539 (1) High Intake Manifold Air Temperature	105-15 Engine Intake Manifold #1 Temperature : High - least severe (1)	Troubleshooting, “Intake Manifold Air Temperature Is High”
E539 (2) High Intake Manifold Air Temperature	105-16 Engine Intake Manifold #1 Temperature : High - moderate severity (2)	Troubleshooting, “Intake Manifold Air Temperature Is High”
E583 (1) High Air Inlet #1 Differential Pressure	107-15 Engine Air Filter 1 Differential Pressure : High - least severe (1)	Troubleshooting, “Inlet Air Is Restricted”
E583 (2) High Air Inlet #1 Differential Pressure	107-16 Engine Air Filter 1 Differential Pressure : High - moderate severity (2)	Troubleshooting, “Inlet Air Is Restricted”

(continued)

(Table 11, contd)

Event Codes (PDL Code Order)		
PDL Code and Description	**J1939 Code and Description**	**Troubleshooting Procedure**
E678 (1) Ground Level Shutdown	4215-31 Ground-Level Shutdown Activated	The ground level shutdown switch has been activated. No troubleshooting is required.
E878 (2) High Hydraulic Oil Temperature	-	Refer to the machine troubleshooting guide
E878 (3) High Hydraulic Oil Temperature	-	Refer to the machine troubleshooting guide
E930 (2) High Aftertreatment #1 SCR Dosing Reagent Pressure	4334-16 Aftertreatment 1 Diesel Exhaust Fluid Doser Absolute Pressure : High - moderate severity (2)	Troubleshooting, “DEF Pressure Is High”
E931 (2) Low Aftertreatment #1 SCR Dosing Reagent Pressure	4334-18 Aftertreatment 1 Diesel Exhaust Fluid Doser Absolute Pressure - moderate severity (2)	Troubleshooting, “DEF Pressure Is Low”
E946 (2) High Aftertreatment #1 SCR Catalyst Intake Gas Temperature	4360-16 Aftertreatment #1 SCR Catalyst Intake Gas Temperature : High - moderate severity (2)	Troubleshooting, “SCR Catalyst Has Incorrect Inlet Temperature”
E947 (1) Low Aftertreatment #1 SCR Catalyst Intake Gas Temperature	4360-17 Aftertreatment #1 SCR Catalyst Intake Gas Temperature : Low - least severe (1)	Troubleshooting, “SCR Catalyst Has Incorrect Inlet Temperature”
E947 (2) Low Aftertreatment #1 SCR Catalyst Intake Gas Temperature	4360-18 Aftertreatment #1 SCR Catalyst Intake Gas Temperature : Low - moderate severity (2)	Troubleshooting, “SCR Catalyst Has Incorrect Inlet Temperature”
E954 (1) Low Aftertreatment #1 SCR Catalyst Reagent Tank #1 Level	1761-17 Aftertreatment 1 Diesel Exhaust Fluid Tank Level : Low - least severe (1)	Troubleshooting, “DEF Tank Level Is Low”
E954 (2) Low Aftertreatment #1 SCR Catalyst Reagent Tank #1 Level	1761-18 Aftertreatment 1 Diesel Exhaust Fluid Tank Level : Low - moderate severity (2)	Troubleshooting, “DEF Tank Level Is Low”
E954 (3) Low Aftertreatment #1 SCR Catalyst Reagent Tank #1 Level	1761-1 Aftertreatment 1 Diesel Exhaust Fluid Tank Level : Low - most severe (3)	Troubleshooting, “DEF Tank Level Is Low”
E960 (2) High Aftertreatment #1 SCR Catalyst Reagent Tank #1 Temperature	3031-16 Aftertreatment 1 Diesel Exhaust Fluid Tank Temperature : High - moderate severity (2)	Troubleshooting, “DEF Tank Temperature Is High”
E995 (2) High DPF #1 Soot Loading	3719-16 Particulate Trap #1 Soot Load Percent : High - moderate severity (2)	Troubleshooting, “Diesel Particulate Filter Collects Excessive Soot”
E995 (3) High DPF #1 Soot Loading	3719-0 Particulate Trap #1 Soot Load Percent : High - most severe (3)	Troubleshooting, “Diesel Particulate Filter Collects Excessive Soot”

(continued)

(Table 11, contd)

Event Codes (PDL Code Order)		
PDL Code and Description	**J1939 Code and Description**	**Troubleshooting Procedure**
E1014 (1) Low DPF #1 Intake Temperature	3242-17 Particulate Trap Intake Gas Temperature : Low - least severe (1)	Troubleshooting, "Diesel Particulate Filter Temperature Is Low"
E1014 (2) Low DPF #1 Intake Temperature	3242-18 Particulate Trap Intake Gas Temperature : Low - moderate severity (2)	Troubleshooting, "Diesel Particulate Filter Temperature Is Low"
E1044 (2) High Intake Manifold Pressure	102-16 Engine Intake Manifold #1 Pressure : High - moderate severity (2)	Troubleshooting, "Intake Manifold Air Pressure Is High"
E1045 (2) Low Intake Manifold Pressure	102-18 Engine Intake Manifold #1 Pressure : Low - moderate severity (2)	Troubleshooting, "Intake Manifold Air Pressure Is Low"
E1092 (1) High EGR Temperature	412-15 Engine Exhaust Gas Recirculation Temperature : High - least severe (1)	Troubleshooting, "NRS Exhaust Gas Temperature Is High"
E1092 (2) High EGR Temperature	412-16 Engine Exhaust Gas Recirculation Temperature : High - moderate severity (2)	Troubleshooting, "NRS Exhaust Gas Temperature Is High"
E1121 (2) EGR Valve Control Not Responding to Command	2791-7 Engine Exhaust Gas Recirculation (EGR) Valve Control : Not Responding Properly	Troubleshooting, "Motorized Valve - Test"
E1132 (2) Inconsistent Configuration Detected	5588-14 Proprietary Network #2 : Special Instruction	Troubleshooting, "Data Link Configuration Status - Test"
E1171 (1) Engine Idle Shutdown Occurred	593-31 Engine Idle Shutdown has Shutdown Engine : Low - most severe (3)	This code indicates that an engine idle shutdown has occurred. This code does not represent a fault. Refer to Troubleshooting, "Configuration Parameters" for further information.
E1172 (2) Engine Idle Shutdown Pending	594-18 Engine Idle Shutdown Driver Alert Mode : Low - moderate severity (2)	This code indicates that an engine idle shutdown will occur due to a long period at idle speed. This code does not represent a fault. Refer to Troubleshooting, "Configuration Parameters" for further information.
E1172 (3) Engine Idle Shutdown Pending	594-31 Engine Idle Shutdown Driver Alert Mode	This code indicates that an engine idle shutdown is about to occur. This code does not represent a fault. Refer to Troubleshooting, "Configuration Parameters" for further information.
E1217 (3) Delayed Engine Shutdown Override	592-31 Engine Idle Shutdown Timer Override (3)	The "Delayed Engine Shutdown" has been overridden. The engine will stop, no troubleshooting required.
E1263 (2) Engine Exhaust Back Pressure Regulator Not Responding to Command	649-7 Engine Exhaust Back Pressure Regulator Control Command : Not Responding Properly	Troubleshooting, "Motorized Valve - Test"
E1264 (2) High Pressure Common Rail Fuel Pressure Relief Valve Active	5571-0 High Pressure Common Rail Fuel Pressure Relief Valve : High - most severe (3)	Troubleshooting, "Fuel Rail Pressure Problem"

(continued)

(Table 11, contd)

Event Codes (PDL Code Order)		
PDL Code and Description	**J1939 Code and Description**	**Troubleshooting Procedure**
E1309 (2) Low Aftertreatment #1 SCR Catalyst Conversion Efficiency	4364-18 Aftertreatment #1 SCR Catalyst Conversion Efficiency : Low - moderate severity (2)	Troubleshooting, “NOx Conversion Is Low”
E1319 (2) EGR Mass Flow Rate Not Responding	2659-7 Engine Exhaust Gas Recirculation (EGR) Mass Flow Rate : Not Responding Properly	Troubleshooting, “NRS Mass Flow Rate Problem”
E1363 (1) Low Engine Cooling Fan Speed	-	Troubleshooting, “Cooling Fan Speed - Test”
E1364 (2) Aftertreatment 1 Diesel Exhaust Fluid Concentration : Low - moderate severity (2)	3516-18 Catalyst Reagent Concentration : Low - moderate severity (2)	Troubleshooting, “NOx Conversion Is Low”
E1365 (1) High Aftertreatment #1 DEF Concentration	3516-15 Aftertreatment #1 DEF Concentration: High - least severe (1)	Troubleshooting, “NOx Conversion Is Low”
E1365 (2) Aftertreatment 1 Diesel Exhaust Fluid Concentration : High - moderate severity (2)	3516-16 Catalyst Reagent Concentration : High - moderate severity (2)	Troubleshooting, “NOx Conversion Is Low”
E1370 (2) Aftertreatment #1 Diesel Exhaust Fluid Dosing Unit Loss of Prime	5392-31 Aftertreatment Diesel Exhaust Fluid Dosing Unit Loss of Prime	Troubleshooting, “DEF Pressure Is Low”
E1377 (1) Machine Disable Pending Due to Machine Security	-	This code indicates that the machine security system does not recognize the ignition key. Ensure that the correct key is in use.
E1377 (2) Machine Disable Pending Due to Machine Security	-	This code indicates that the machine security system does not recognize the ignition key. Ensure that the correct key is in use.
E1389 (1) Aftertreatment #1 SCR Operator Inducement	5246-15 Aftertreatment SCR Operator Inducement Severity : High - least severe (1)	Troubleshooting, “SCR Warning System Problem”
E1389 (2) Aftertreatment #1 SCR Operator Inducement	5246-16 Aftertreatment SCR Operator Inducement Severity : High - moderate severity (2)	Troubleshooting, “SCR Warning System Problem”
E1389 (3) Aftertreatment #1 SCR Operator Inducement	5246-0 Aftertreatment SCR Operator Inducement Severity : High - most severe (3)	Troubleshooting, “SCR Warning System Problem”
E1390 (2) Aftertreatment #1 SCR Monitoring System Malfunction	4792-14 Aftertreatment #1 SCR System : Special Instruction	Diesel Exhaust Fluid (DEF) is not being dosed as expected. Update the Engine Software to the latest version.
E1398 (2) Low Aftertreatment #1 SCR Catalyst Reagent Tank #1 Temperature	3031-18 Aftertreatment 1 Diesel Exhaust Fluid Tank Temperature : Low - moderate severity (2)	Troubleshooting, “DEF Temperature Is Low”

(continued)

(Table 11, contd)

Event Codes (PDL Code Order)		
PDL Code and Description	**J1939 Code and Description**	**Troubleshooting Procedure**
E1407 (2) High Aftertreatment #1 Intake O2 Concentration	3217-16 Aftertreatment #1 Intake O2 : High - moderate severity (2)	Troubleshooting, “Clean Emissions Module Has High Oxygen Level”
E1408 (2) High Aftertreatment #1 Outlet O2 Concentration	3227-16 Aftertreatment #1 Outlet O2 : High - moderate severity (2)	Troubleshooting, “Clean Emissions Module Has High Oxygen Level”
E1410 (2) Invalid Aftertreatment #1 SCR Conversion Efficiency	4364-2 Aftertreatment #1 SCR Catalyst Conversion Efficiency : Erratic, Intermittent, or Incorrect	Troubleshooting, “NOx Conversion Is Low”
E1427 (1) Aftertreatment #1 SCR Dosing Pump Temperature Not Responding	5798-7 Aftertreatment 1 Diesel Exhaust Fluid Dosing Unit Heater Temperature : Not Responding Properly	Troubleshooting, “DEF Temperature Is Low”
E1430 (2) High Aftertreatment #1 Diesel Exhaust Fluid Controller Temperature	5480-16 Aftertreatment 1 Diesel Exhaust Fluid Controller Temperature : High - moderate severity (2)	Troubleshooting, “DEF Control Module Temperature Is High”
E1431 (2) Invalid Aftertreatment #1 Intake NOx Level	3216-7 Aftertreatment #1 Intake NOx : Not Responding Properly	Troubleshooting, “NOx Sensor - Test”
E1432 (2) Aftertreatment #1 Outlet #1 NOx Level	3226-7 Aftertreatment #1 Outlet NOx : Not Responding Properly	Troubleshooting, “NOx Sensor - Test”
E1441 (2) Aftertreatment #1 Diesel Exhaust Fluid Tank Temperature Not Responding	3031-7 Aftertreatment 1 Diesel Exhaust Fluid Tank Temperature : Not Responding Properly	Troubleshooting, “DEF Temperature Is Low”
E1466 (1) Operator Forced Shutdown with High Exhaust Temperature	6588-31 Operator Shutdown With High Exhaust Temperature	Troubleshooting, “Engine Shutdown Occurrence”
E1598 (2) Engine Emissions Operator Inducement Emergency Override Renewal	7343—31 SCR Operator Inducement Override Renewal Required	Troubleshooting, “SCR Inducement Emergency Override”
E1645 (1) Aftertreatment Active Regeneration Inhibited Due to Low Exhaust Pressure	7440-31 Aftertreatment Active Regeneration Inhibited Due to Low Exhaust Pressure	Troubleshooting, “Diesel Particulate Filter Collects Excessive Soot”
E2143 (2) Low Engine Coolant Level	111-18 Engine Coolant Level : Low - moderate severity (2)	Troubleshooting, “Coolant Level Is Low”
E2143 (3) Low Engine Coolant Level	111-1 Engine Coolant Level : Low - most severe (3)	Troubleshooting, “Coolant Level Is Low”
E2165 (1) Low Aftertreatment #1 Diesel Oxidation Catalyst #1 Intake Gas Temperature	4765-17 Aftertreatment #1 Diesel Oxidation Catalyst Intake Gas Temperature : Low - least severe (1)	Troubleshooting, “Diesel Oxidation Catalyst Has Incorrect Inlet Temperature”
E2180 (1) Low Aftertreatment #1 Diesel Oxidation Catalyst #1 Conversion Efficiency	5298-17 Aftertreatment #1 Diesel Oxidation Catalyst Conversion Efficiency : Low - least severe (1)	Troubleshooting, “Diesel Oxidation Catalyst Has Low Conversion Efficiency”

Parts of the Event Code

Event Code – "E" identifies the code as an event code. "XXX(X)" represents a numeric identifier for the event code. The fourth "(X)" assigns one of three levels to the active event code according to the severity of the abnormal system condition. Next is a code description. Refer to the following example:

- E360(1) Low Oil Pressure
- E360(2) Low Oil Pressure
- E360(3) Low Oil Pressure

The definition for the levels of severity for an event are defined below:

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

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

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

Active Event Codes

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

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

Illustration 25 is an example of the operating range of a sensor.

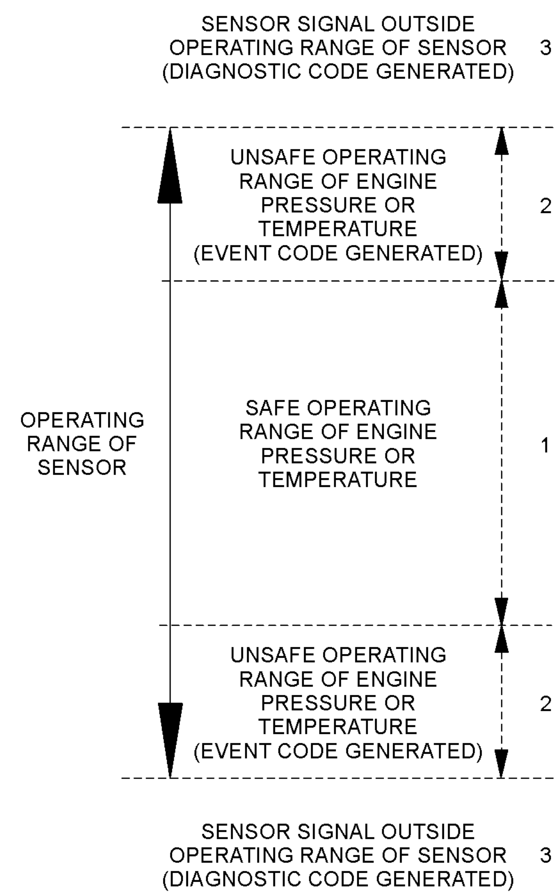


Illustration 25 g01365757

Example of the typical operating range of a sensor

(1) This area represents the normal operating range of the engine parameter.
(2) In these areas, the engine is operating in an unsafe operating range of the monitored parameter. An event code will be generated for the monitored parameter. The sensor circuit does not have an electronic problem.
(3) In these areas, the signal from the sensor is outside of the operating range of the sensor. The sensor circuit has an electronic problem. A diagnostic code will be generated for the sensor circuit. Refer to Troubleshooting, "Diagnostic Trouble Codes" for additional information on diagnostic codes.

Logged Event Codes

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

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

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

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

Clearing Event Codes

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

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

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

Troubleshooting

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

1. Obtain the following information about the complaint:

  - The event and the time of the event
  - Determine the conditions for the event. The conditions will include the engine rpm and the load.
  - Determine if there are any systems that were installed by the distributor or by the customer that could cause the event.
  - Determine whether any additional events occurred.

2. Verify that the complaint is not due to normal engine operation. Verify that the complaint is not due to error of the operator.

3. Narrow the probable cause. Consider the operator information, the conditions of operation, and the history of the engine.

4. Perform a visual inspection. Inspect the following items:

  - Fuel supply
  - Oil level
  - Oil supply
  - Wiring
  - Connectors

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

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

Symptom Troubleshooting

i06189301

Acceleration Is Poor or Throttle Response Is Poor

Probable Causes

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

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.

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 12

Troubleshooting Test Steps	Values	Results
1. Diagnostic Codes **Note:** Certain diagnostic codes and/or event codes may cause poor performance. Refer to in the electronic service tool. **A.** Use the electronic service tool to check for active or logged codes. **B.** Use the electronic service tool to check the histogram information if the engine has been derated. **Note:** If the histograms contain engine derates and no diagnostic codes are present, then the engine is operating normally.	Engine Derate or Diagnostic 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. 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. Electrical connectors **A.** Turn the start switch to the ON position. **B.** Use the electronic service tool to check the intake manifold pressure. **C.** Run the engine until the speed is equal to the maximum no-load speed. **D.** Use the electronic service tool to make sure that the throttle is set to reach the maximum no-load speed.	Electrical connections	**Result:** The intake manifold pressure is not zero ± 0.5 kPa (zero ± 0.070 psi). **Repair:** Check the 5 VDC sensor supply for the intake manifold pressure. Refer to Troubleshooting, "Sensor Supply - Test". **Result:** The throttle response is not as expected. **Repair:** If the maximum no-load speed cannot be obtained refer to Troubleshooting, "Switch Circuits - Test" and Troubleshooting, "Mode Selection - Test". If the engine speed is erratic refer to Troubleshooting, "Speed Control - Test". **Result:** All responses are normal. Proceed to Test Step 4.

(continued)

(Table 12, contd)

Troubleshooting Test Steps	Values	Results
4. Air Intake and Exhaust System **A.** Observe the check engine lamp. Check for an air filter restriction indicator, if equipped. Replace a plugged air filters. Refer to the Operation and Maintenance Manual. **B.** Check the air inlet and exhaust system for restrictions and/or leaks.	Restrictions	**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:** There are no restrictions in the air inlet or exhaust system. Proceed to Test Step 5.
5. 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. For engines with a single turbocharger, proceed to Test Step 6. For engines with twin turbochargers, proceed to Test Step 7.

(continued)

(Table 12, contd)

Troubleshooting Test Steps	Values	Results
6. Turbocharger This Test Step is applicable to engines with a single 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. **F.** Ensure that the wastegate on the turbocharger is adjusted correctly. Refer to Systems Operation, Testing, and Adjusting, “Turbocharger - Inspect”. If the wastegate actuator is faulty, replace the turbocharger. Refer to Disassembly and Assembly, “Turbocharger - Remove” and Disassembly and Assembly, “Turbocharger - Install”.	Turbocharger	**Result:** There is a fault on the turbocharger. **Repair:** Repair the turbocharger or 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.
7. Turbochargers This Test Step is applicable to engines with twin turbochargers. **Note:** The turbochargers that are installed on the engine are nonserviceable items. If any mechanical fault exists, then the faulty turbocharger must be replaced. **A.** Ensure that the mounting bolts for the turbochargers are tight. **B.** Check that the oil drains for the turbochargers are not blocked or restricted. **C.** Check that the compressor housings for the turbochargers are free of dirt and debris. Make sure that the housings are not damaged. **D.** Check that the turbine housings for the turbochargers are free of dirt and debris. Make sure that the housings are not damaged. **E.** Check that the turbine blades rotate freely in the turbochargers.	Turbochargers	**Result:** There is a fault on one of the turbochargers. **Repair:** Repair the faulty turbocharger or replace the faulty turbocharger. Refer to Disassembly and Assembly, “Turbocharger - Remove” and Disassembly and Assembly, “Turbocharger - Install”. **Result:** The turbochargers are OK. Proceed to Test Step 8.

(continued)

(Table 12, contd)

Troubleshooting Test Steps	Values	Results
F. Ensure that the wastegate on the high-pressure turbocharger is adjusted correctly. Refer to Systems Operation, Testing, and Adjusting, “Turbocharger - Inspect”. If the wastegate actuator is faulty, replace the high-pressure turbocharger. Refer to Disassembly and Assembly, “Turbocharger - Remove” and Disassembly and Assembly, “Turbocharger - Install”.		
8. 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 Fuel Lift Pump (EFLP) is operating. If the EFLP is suspect, refer to Troubleshooting, “Fuel Transfer Pump - Test”. **I.** Replace the in-line fuel filter that is upstream of the primary fuel filter. **J.** Replace the primary and secondary fuel filters. **K.** Check the diesel fuel for contamination. Refer to Systems Operation, Testing, and Adjusting, “Fuel Quality - Test”. **L.** Check for air in the fuel system. Refer to Systems Operation, Testing, and Adjusting, “Air in Fuel - Test”. **M.** 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 9.

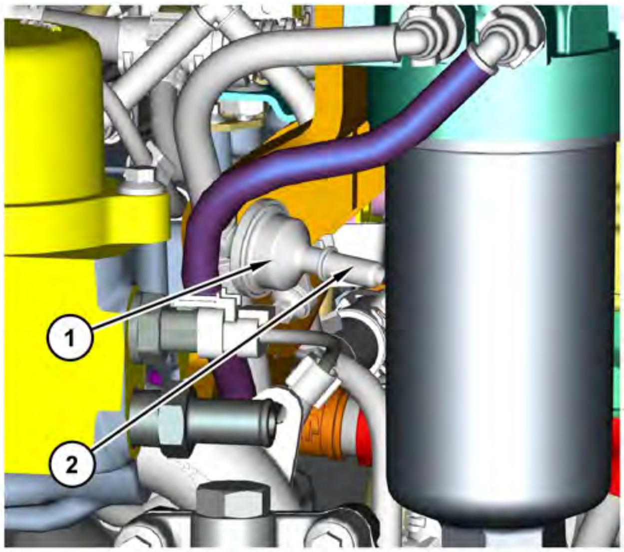


Illustration 26 g03750256

Transfer Pump Inlet Regulator (TPIR) components

(1) Transfer Pump Inlet Regulator (TPIR)
(2) TPIR return port

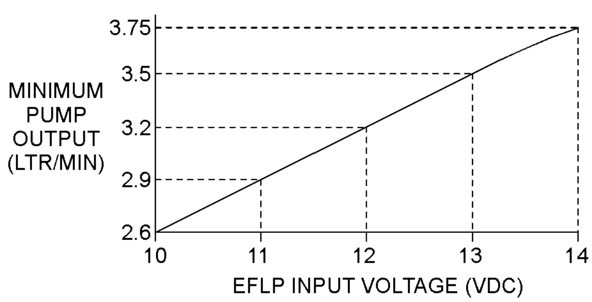


Illustration 27 g02355128

Minimum TPIR flow rate in a 12 VDC system

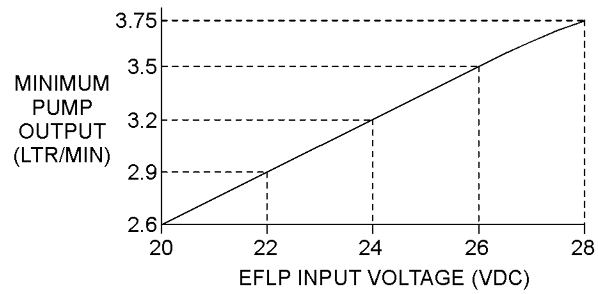


Illustration 28 g02355130

Minimum TPIR flow rate in a 24 VDC system

Table 13

Troubleshooting Test Steps	Values	Results
9. Transfer Pump Inlet Regulator (TPIR) Flow Test Refer to Illustration 26 . **A.** Disconnect the TPIR return line from the drain port on the TPIR. Install a suitable blanking cap on the open port in the TPIR return line. **B.** Connect a temporary drain line to the drain port on the TPIR. **C.** Place the end of the temporary drain line into a suitable calibrated container. **D.** With the isolator switch in the ON position but the engine not running, use a suitable multimeter to measure the input voltage to the EFLP. Record the reading. **E.** With the isolator switch in the ON position but the engine not running, measure the fuel flow from the temporary drain line. **F.** Refer to Illustration 27 or 28 for the minimum acceptable flow rate. **G.** Remove the temporary drain line from the drain port on the TPIR. Connect the TPIR return line to the TPIR.	TPIR flow rate	**Result:** The fuel flow is greater than the minimum limit. Proceed to Test Step 11. **Result:** The fuel flow is less than the minimum limit. Proceed to Test Step 10.

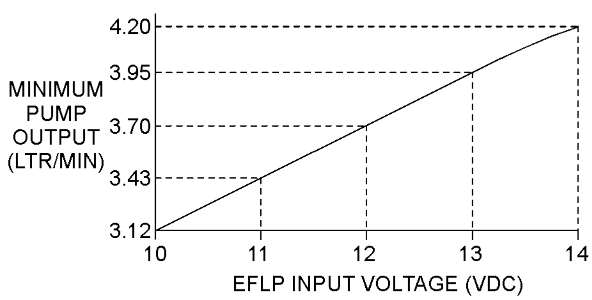


Illustration 29 g02527498

Minimum EFLP flow rate in a 12 VDC system

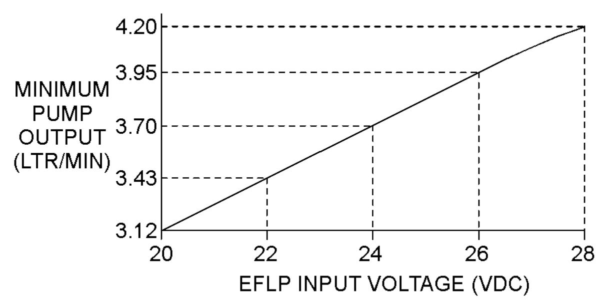


Illustration 30 g02527518

Minimum EFLP flow rate in a 24 VDC system

Table 14

Troubleshooting Test Steps	Values	Results
10. EFLP Flow Test at the Primary Fuel Filter Inlet **A.** Make sure the keyswitch is in the OFF position. **B.** Disconnect the fuel inlet connection from the primary fuel filter head. **C.** Install a suitable blank on the fuel inlet port on the primary fuel filter head. **D.** Place the open end of the fuel inlet line in a suitable calibrated container. **E.** With the keyswitch in the ON position, measure the input voltage at the EFLP. Record the result. **F.** With the keyswitch in the ON position, measure the flow from the fuel inlet line. Record the result. **G.** Check the recorded voltage and fuel flow on the graph in Illustration 29 or 30 .	EFLP flow	**Result:** The fuel flow is below the minimum value for the recorded voltage. **Repair:** Replace the EFLP. Refer to Disassembly and Assembly, “Fuel Priming Pump - Remove and Install ”. **Result:** The fuel flow is above the minimum value for the recorded voltage. Proceed to Test Step 11.
11. Check the Return Fuel Lines **A.** Make sure that the TPIR return line is not blocked or kinked.. **B.** If the TPIR return line is clear, confirm that the Electric Fuel Lift Pump (EFLP) is operating. Make sure that fuel lines between the EFLP and the TPIR are not blocked or kinked.	Return lines	**Result:** The TPIR return line or the fuel lines between the EFLP and the TPIR are blocked or kinked. **Repair:** Clear or replace the blocked line. **Result:** The TPIR return line and the fuel lines between the EFLP and the TPIR are clear. **Repair:** Replace the EFLP. If the fault is still present, 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.

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 15

Troubleshooting Test Steps	Values	Results
13. 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 12 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 14.
14. 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).

i07702691

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.

Table 16

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 Mount-ing Bracket	**Result:** The alternator mounting bracket is cracked and distorted. **Repair:** Repair the mounting bracket or replace the mount-ing bracket. **Note:** The repair/replacement will ensure that the alterna-tor 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 not OK. **Repair:** Repair the alternator or replace the alternator, as needed. Refer to Disassembly and Assembly for the cor-rect procedure. **Result:** The alternator bearings are OK. Proceed to Test Step 5.

(continued)

(Table 16, 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 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. **Result:** The regulator and alternator are operating correctly. Proceed to Test Step 6.
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).

i06151975

Battery Problem

Probable Causes

- Charging circuit
- Batteries
- Auxiliary device

Recommended Actions

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

Table 17

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).

i06189297

Clean Emissions Module Has High Oxygen Level

Table 18

Diagnostic Trouble Codes for CEM High Oxygen Level			
J1939 Code	**PDL Code**	**Code Description (code descriptions may vary)**	**Comments**
3217-16	E1407 (2)	Aftertreatment #1 Intake O2 : High - moderate severity (2)	The engine out NOx Sensor is reading high O^2
3227-16	E1408 (2)	Aftertreatment #1 Outlet O2 : High - moderate severity (2)	The tailpipe out NOx Sensor is reading high O^2
Follow the troubleshooting procedure in order to identify the root cause of the fault.			

The engine out NOx sensor is located in the CEM. The tailpipe out NOx sensor is located in the exhaust tail pipe. Refer to Illustration 31 .

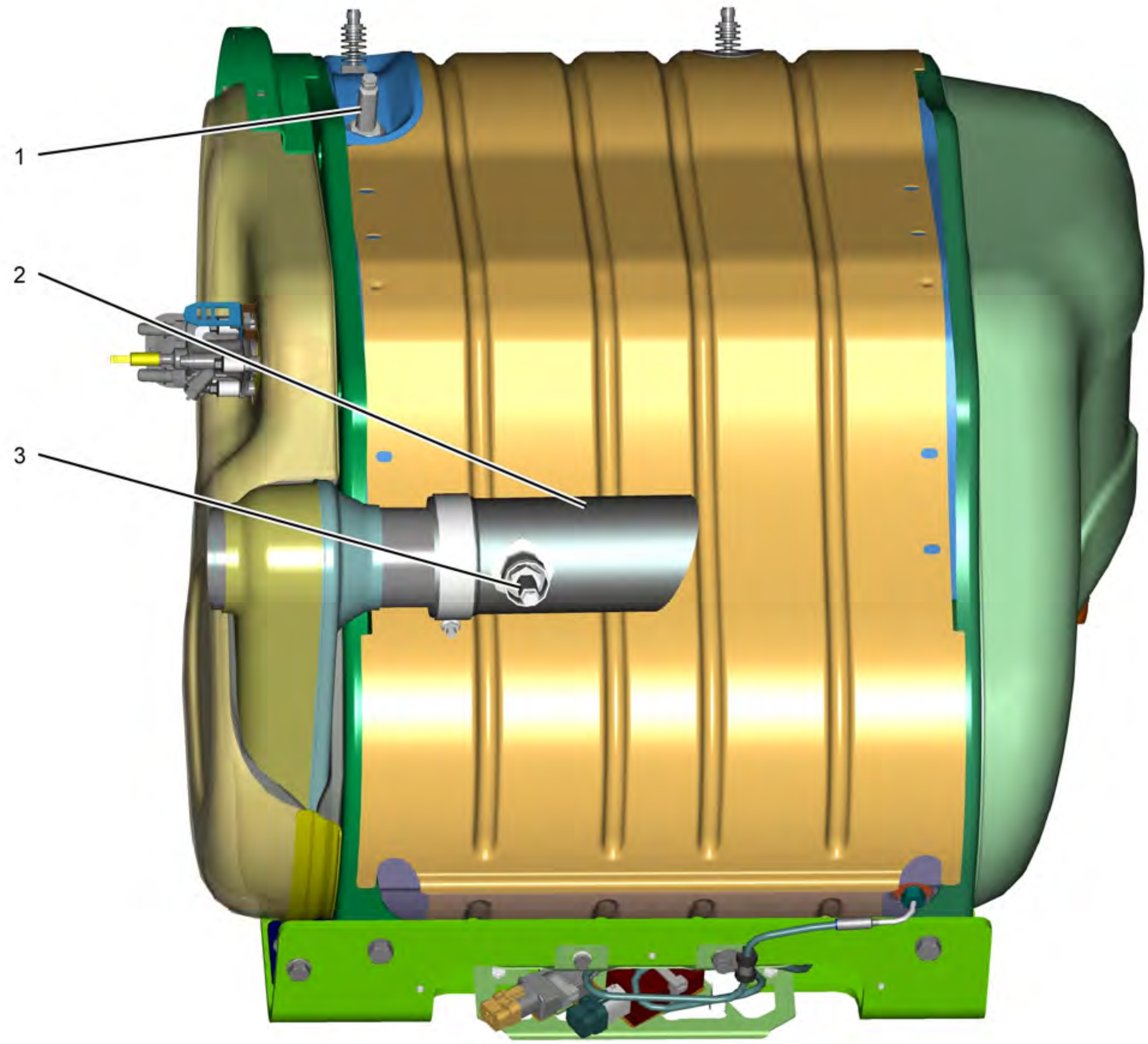


Illustration 31 g03752556

Typical NOx sensor locations

(1) Engine out NOx sensor
(2) Exhaust tailpipe (typical example)
(3) Tailpipe out NOx sensor

The exhaust system has two NOx sensors that measure O2 and NOx. The engine out NOx sensor is located in the CEM. This sensor monitors the NOx and O2 exiting the DPF. The tailpipe out NOx sensor is located in the exhaust tail pipe after the SCR catalyst and monitors the NOx and O2 exiting the CEM.

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

Table 19

Troubleshooting Test Steps	Values	Results
1. Check the Installation of the NOx Sensors **A.** Locate the appropriate NOx Sensor. **B.** Check if the sensor is installed correctly.	Correctly Installed / Not installed correctly	**Result:** The sensor is not installed correctly. **Repair:** Install the sensor correctly. Proceed to Test Step 3. **Result:** The sensor is installed correctly. Proceed to Test Step 2.
2. Check for an Exhaust Leak Between the Turbocharger and the Tailpipe **A.** Check for disconnected exhaust lines. **B.** Check for broken/loose joints.	Leak found	**Result:** An exhaust leak is found between the turbo and the tail pipe. **Repair:** Repair the exhaust leak. Proceed to Test Step 3.
3. Perform the Aftertreatment System Functional Test **A.** Reset all active codes and clear all logged codes. **B.** Use the electronic service tool to perform the “Aftertreatment System Functional Test” in order to verify that the fault is eliminated.	Test passed	**Result:** The Aftertreatment System Functional Test passed. The NOx Sensing system is fully functional and the fault has been eliminated. Return the unit to service. **Result:** The Aftertreatment System Functional Test did not pass and the diagnostic code is still present. **Repair:** Replace the sensor. If the fault is still present, contact the Dealer Solutions Network (DSN).

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 20

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 20, 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).

i07694339

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 21

Diagnostic Trouble Codes for Low Coolant Level			
J1939 Code	**PDL Code**	**Code Description** (code descriptions may vary)	**Comments**
111-1	E2143-3	Engine Coolant Level : Low - Level 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 will shutdown if engine shutdowns are enabled in the Electronic Service Tool. The code is logged.
111-17	E2143-1	Engine Coolant Level : Low - Level 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. A warning is displayed. The code is logged.
111-18	E2143-2	Engine Coolant Level : Low - Level 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 22

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 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).

i06152526

Coolant Temperature Is High

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

Table 23

Diagnostic Trouble Codes for High Coolant Temperature			
J1939 Code	PDL Code	Code Description (code descriptions may vary)	Comments
110-15	E361 (1)	Engine Coolant Temperature : High - least severe	The coolant temperature has been at 109° C (228° F) for 10 seconds. The ECM has been powered for at least 2 seconds. The engine has been running for at least 185 seconds. There are no electrical faults or battery faults on the circuit.
110-16	E361 (2)	Engine Coolant Temperature : High - moderate severity	The coolant temperature has been at 111° C (232° F) for 10 seconds. The ECM has been powered for at least 2 seconds. The engine has been running for at least 185 seconds. There are no electrical faults or battery faults on the circuit. The engine will be derated.
110-0	E361 (3)	Engine Coolant Temperature : High - most severe	The coolant temperature has been at 114° C (237° F) for 10 seconds. The ECM has been powered for at least 2 seconds. The engine has been running for at least 185 seconds. There are no electrical faults or battery faults on the circuit. The engine will be derated. The engine may shut down.

Probable Causes

- Diagnostic codes
- Coolant level
- 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 24

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 Troubleshooting, "Coolant Level is Low" for additional information. Repair any leaks immediately. **Result:** The engine coolant level is OK. Proceed to Test Step 3.
3. 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 4.
4. 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 is dependent 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 5.
5. 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 6.

(continued)

(Table 24, contd)

Troubleshooting Test Steps	Values	Results
6. 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 7.
7. 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 8.
8. 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 9.
9. Inspection of the Coolant Pump **A.** Inspect the impeller of the coolant pump for damage and/or erosion. **B.** Make sure that the drive gear is not loose on the drive shaft 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 10.

(continued)

(Table 24, contd)

Troubleshooting Test Steps	Values	Results
10. 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 11.
11. 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).

i06060423

Crankcase Breather Ejects Oil

The crankcase breather canister includes a pressure relief valve that prevents a build-up of excessive pressure in the breather canister.

In normal operation of the engine, the pressure relief valve remains closed. If there is evidence of oil staining on the cylinder head behind the breather canister, perform the following procedure in order to diagnose the fault.

Probable Causes

- Breather filter
- Breather hoses
- Excessive blow-by

Recommended Actions

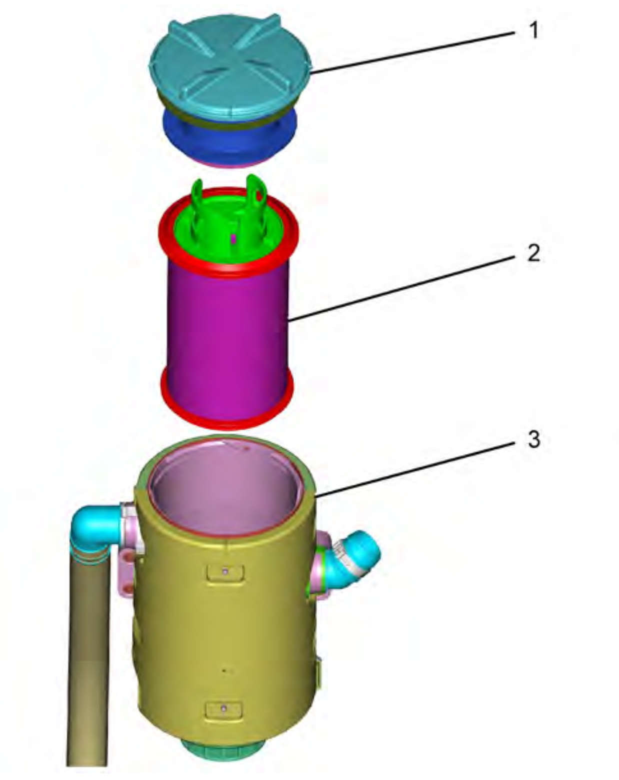


Illustration 32 g03758596

Typical breather canister

(1) Breather canister cap
(2) Filter element
(3) Breather canister

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

Table 25

Troubleshooting Test Steps	Values	Results
1. Breather Filter **A.** Check that filter element (2) is correctly installed and that the element is not damaged. **B.** Check for restrictions or blockages in breather canister (3). **Note:** In cold ambient conditions, ice can form in the outlets of the breather canister.	Filter	**Result:** The filter element (2) is not correctly installed or the element is damaged. **Repair:** Install the filter element correctly or replace the filter element. **Result:** There are restrictions or blockages in the breather canister. **Repair:** Clean the interior of the breather canister. **Result:** The breather is clean and operating correctly. Proceed to Test Step 2.
2. Breather Hoses **A.** Make sure that the oil return hose from the breather canister is not pinched or blocked. **B.** Make sure that the breather outlet hose from the breather canister is not pinched or blocked.	Hoses	**Result:** One or more of the hoses is pinched or blocked. **Repair:** Clear the hose or replace the hose. **Result:** All of the hoses are clear. Proceed to Test Step 3.
3. Excessive Blow-by **Note:** Excessive blow-by increases the flow of fumes through the breather system and can cause the breather filter to block. The pressure relief valve may then open. **A.** Check the engine for excessive blow-by.	Blow-by	**Result:** There is excessive blow-by. **Repair:** Replace the breather filter. Investigate the cause of the excessive blow-by. Refer to Troubleshooting, “Oil Consumption Is Excessive”. **Result:** The blow-by is not excessive. Contact the Dealer Solutions Network (DSN).

i05998449

Crankcase Fumes Disposal Tube Has Oil Draining

A discharge of condensation from the breather is normal. The discharge is normally clear but can contain soot. Although the discharge can contain oil vapor, any liquid oil must be limited to 0.5 g (0.02 oz) per hour. An oil discharge in excess of 0.5 g (0.02 oz) must be investigated.

Probable Causes

- Breather filter
- Engine oil level
- One-way valve
- Excessive blow-by

Recommended Actions

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

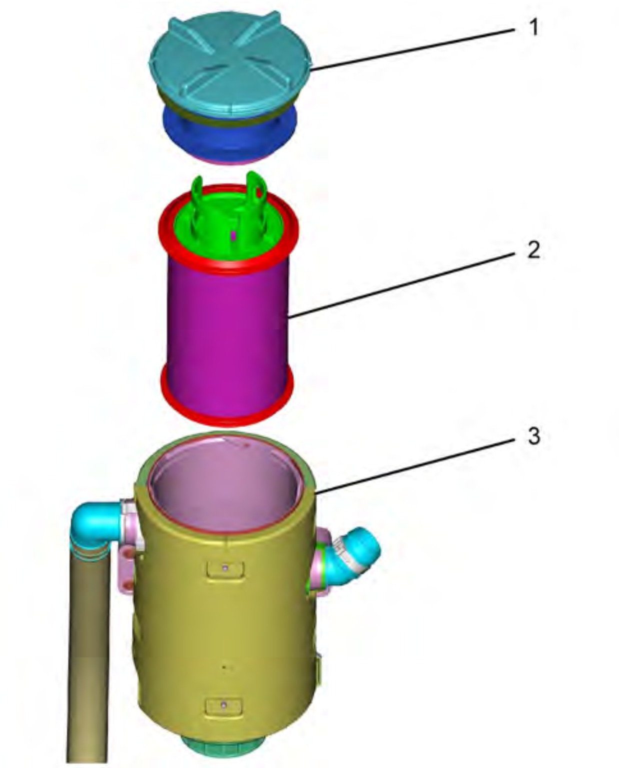


Illustration 33 g03758596

Typical breather canister

(1) Breather canister cap
(2) Filter element
(2) Breather canister

Table 26

Troubleshooting Test Steps	Values	Results
1. Breather Filter **A.** Check that filter element (2) is correctly installed and that the element is not damaged. **B.** Check for restrictions or blockages in breather canister (3). **Note:** If a new filter element blocks before the service period is completed, the blockage can indicate a fault in the engine. **Note:** In cold ambient conditions, ice can form in the outlets of the breather canister.	Filter	**Result:** The filter element (1) is not correctly installed or the element is damaged. **Repair:** Install the filter element correctly or replace the filter element. **Result:** There are restrictions or blockages in the breather canister. **Repair:** Clean the interior of the breather canister. **Result:** The breather is clean and operating correctly. Proceed to Test Step 2.
2. Engine Oil Level **A.** Check the oil level in the engine.	Oil level	**Result:** The engine oil level is high. **Repair:** Check for contamination of the oil with fuel or coolant. Refer to Troubleshooting, “Oil Contains Fuel” or Troubleshooting, “Oil Contains Coolant”. If the engine oil is not contaminated, remove the excess oil. **Result:** The engine oil level is correct. Proceed to Test Step 3.

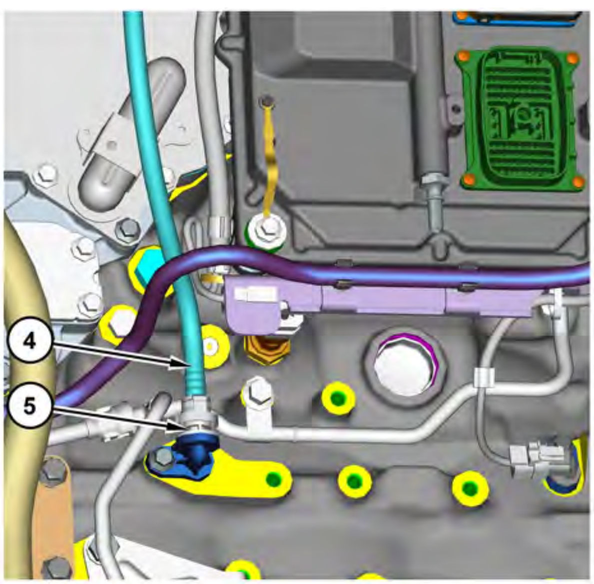


Illustration 34 g03758618

(4) Breather drain hose
(5) One-way valve

Table 27

Troubleshooting Test Steps	Values	Results
3. One-way Valve **A.** Disconnect breather drain hose (4) from one-way valve (5) and then remove the one-way valve from the engine. Refer to Disassembly and Assembly, "Crankcase Breather - Remove". **B.** Use a suitable cleaning solution to flush the one-way valve. **C.** Connect a low-pressure air supply breather drain hose side of the one-way valve. The air must flow freely through the valve. **D.** Connect a low-pressure air supply crankcase side of the one-way valve. The valve must block the airflow.	One-way valve	**Result:** The one-way valve does not operate correctly. **Repair:** Install a replacement valve. Refer to Disassembly and Assembly, "Crankcase Breather - Install". **Result:** The one-way valve operates correctly. Proceed to Test Step 4.
4. Excessive Blow-by **Note:** Excessive blow-by increases the flow of fumes through the breather system and can cause oil discharge from the fumes disposal tube. **A.** Check the engine for excessive blow-by.	Blow-by	**Result:** There is excessive blow-by. **Repair:** Replace the breather filter. Investigate the cause of the excessive blow-by. Refer to Troubleshooting, "Oil Consumption Is Excessive". **Result:** The blow-by is not excessive. Contact the Dealer Solutions Network (DSN).

i06154889

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 28

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 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". 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 · Hydraulic lifters Refer to the 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 28, 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 **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 Cut Out Test" . **Note:** If the compression test that was performed in Test Step 4 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 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).

i06190212

DEF Control Module Temperature Is High

Use this procedure if one of the following event codes are active. Refer to Troubleshooting, “Event Codes” for information about event codes. For information on the engine monitoring system, refer to Troubleshooting, “Engine Monitoring System”.

Table 29

Diagnostic Trouble Codes for DEF Control Module Temperature Is High			
J1939 Code	PDL Code	Code Description (code descriptions may vary)	Comments
5480-16	E1430 (2)	Aftertreatment 1 Diesel Exhaust Fluid Controller Temperature : High - moderate severity (2)	The temperature of the Dosing Control Unit (DCU) has exceeded the trip point of 116° C (240° F).

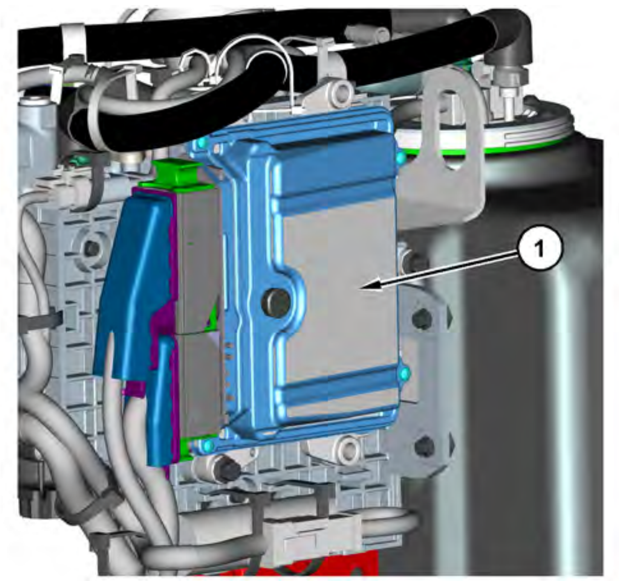


Illustration 35 g03760956

(1) Dosing Control Unit (DCU)

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

Table 30

Troubleshooting Test Steps	Values	Results
1. Determine the Source of the High Temperature **A.** Evaluate the installation location of the DCU. **B.** Check for heat sources close to the DCU.	Heat Source	**Result:** The DCU is located close to a heat source. **Repair:** Eliminate the heat source by installing a heat shield or moving the component creating the heat. Proceed to Test Step 2.
2. Replace the DCU **A.** Replace the DCU.	DCU	**Result:** The DCU was replaced. Verify that the problem is resolved. If the fault is still present, contact the Dealer Solutions Network (DSN).

i06190216

DEF Does Not Purge

Table 31

Diagnostic Trouble Codes for DEF Does Not Purge			
J1939 Code	**PDL Code**	**Code Description (code descriptions may vary)**	**Comments**
3362-14	E114 (1)	Aftertreatment #1 DEF Dosing Unit Input Lines : Special Instruction	The DEF system did not completely purge after the engine was turned OFF. The code is logged.

NOTICE

Wait 2 minutes after the engine has stopped before turning the battery disconnect switch to the OFF position. The DEF system requires 2 minutes in order to purge diesel exhaust fluid (DEF) from system components automatically. Failing to complete the purge could damage the SCR system.

Table 32

Associated Codes	
J1939 Code	**PDL Code**
4334-16	E930 (2)
4374-5	3118-5
4374-6	3118-6
4376-5	3862-5
4376-6	3862-6
5966-6	3965-6
6309-6	3966-6

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

Table 33

Troubleshooting Test Steps	Values	Results
1. Review the "Aftertreatment Abnormal Shutdown History" **A.** Connect to the ECM using the electronic service tool. **B.** Proceed to "Aftertreatment Abnormal Shutdown History" . Select the "Information" tab, then select the "History" tab in the electronic service tool menu. **C.** Review the engine shutdown type for cold shutdown occurrences.	DEF Pump	**Result:** The system was not allowed 2 minutes to purge before the battery disconnect was turned to the OFF position. Inform the operator to wait 2 minutes after key-off before turning the battery disconnect to the OFF position. Return the unit to service. **Result:** The system was allowed 2 minutes to purge before the battery disconnect was turned to the OFF position. Proceed to Test Step 2.
2. Check for Associated Diagnostic Trouble Codes **A.** Connect to the ECM using the electronic service tool. **B.** Check for associated diagnostic trouble codes.	Diagnostic trouble code	**Result:** An associated diagnostic trouble code is present. **Repair:** Troubleshoot the associated code. Refer to Troubleshooting, "Diagnostic Trouble Codes". **Result:** An associated diagnostic trouble code is not present. Contact the Dealer Solutions Network (DSN).

i06835555

DEF Module Does Not Respond

Download the "Warranty Report" from the engine ECM before performing any troubleshooting or clearing diagnostic trouble codes.

Use this procedure to troubleshoot the following codes:

Note: Refer to Troubleshooting, "Service Tool Features" for more information about service features.

Table 34

Diagnostic Trouble Codes for DEF Module Does Not Respond			
J1939 Code	**PDL Code**	**Code Description (code descriptions may vary)**	**Comments**
3361-7	3821-7	Aftertreatment #1 DEF Dosing Unit : Not Responding Properly	The DEF injector is not functioning properly.
3361-11	3821-11	Aftertreatment #1 DEF Dosing Unit : Other Failure Mode	There is a short circuit in the DEF injector wiring.
3361-14	3821-14	Aftertreatment #1 DEF Dosing Unit : Special Instruction	The DEF injector is not functioning properly.

Table 35

Required Tools			
Tool	Part Number	Part Description	Qty
A	T40-0241	Probe - Female	2
B	T40-0240	Probe - Male	2

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

Table 36

Troubleshooting Test Steps	Values	Results
1. Check the Resistance of the DEF Injector **A.** Turn the keyswitch to the OFF position. Allow 2 minutes to elapse before proceeding. **B.** Disconnect the DEF injector from the applicable harness. **C.** Inspect the connector for damage or debris. **D.** Connect Tooling A to the DEF injector. The probes must be used to prevent damage to the DEF injector connector. **E.** Measure the resistance of the DEF injector.	10 Ohms to 20 Ohms	10 Ohms to 20 Ohms10 Ohms to 20 Ohms **Result :** The resistance of the DEF injector measured between 10 Ohms and 20 Ohms. Proceed to Test Step 2. **Result :** The resistance of the DEF injector did not measure between 10 Ohms and 20 Ohms. A failed DEF injector has been detected. **Repair :** Replace the failed DEF injector. Refer to the Disassembly and Assembly, “DEF Injector and Mounting - Remove and Install”. Proceed to Test Step 8.
2. Check for a Short Circuit in the Wiring Harness. **A.** Turn the keyswitch to the OFF position. Allow 2 minutes to elapse before proceeding. **B.** Disconnect the injector from the applicable harness **C.** Connect Tooling B to the DEF injector harness connector. The probes must be used to prevent damage to the connector. **D.** Measure the resistance between the two probes. **Note :** The reading will measure the resistance in the wiring harness between the DEF injector connector and the DCU.	Ohms	**Result :** The resistance of the DEF injector wiring harness measured greater than 10K Ohms. **Repair :** Connect the injector to the applicable harness. Proceed to Test Step 3. **Result :** The resistance of the DEF injector wiring harness did not measure greater than 10K Ohms. **Repair :** There is a short circuit in the wiring harness between the DEF injector connector and the DCU. Repair or replace the wiring harness. Connect the injector to the applicable harness. Proceed to Test Step 8.

(continued)

(Table 36, contd)

Troubleshooting Test Steps	Values	Results
3. Check the Diesel Exhaust Fluid (DEF) Quality. **A.** Measure the DEF quality. Refer to Testing and Adjusting, “Diesel Exhaust fluid Quality - Test” for the correct procedure.	DEF	**Result :** The DEF is not contaminated and the concentration is within the acceptable range. Proceed to Test Step 4. **Result :** The DEF is not contaminated but the concentration is not within the acceptable range. **Repair :** Drain the DEF from the tank. Refill the tank with DEF that meets ISO 22241 quality standards. Proceed to Test Step 8. **Result :** The DEF is contaminated. **Repair :** Contact the Dealer Solutions Network (DSN) for further information.
4. Perform the “DEF Dosing System Accuracy Test” **A.** Use the electronic service tool to perform the “DEF Dosing System Accuracy Test” . Refer to Systems Operation, Testing and Adjusting, “Aftertreatment SCR System Dosing - Test” for the correct procedure.	DEF dosing system accuracy test	**Result :** The quantity collected is below specification. Proceed to Test Step 5. **Result :** The quantity collected is within the desired range. The desired range is 100 mL (3.4 oz) minimum to 130 mL (4.4 oz) maximum. Proceed to Test Step 9. **Result :** The quantity collected is above specification. **Repair :** A failed DEF injector has been detected, replace the failed DEF injector. Refer to the Disassembly and Assembly, “DEF Injector and Mounting - Remove and Install”. Proceed to Test Step 7.
5. Check the DEF Pressure Line **A.** Turn the keyswitch to the OFF position. Allow 2 minutes to elapse before proceeding. **B.** Visually inspect the lines for leaks or damage. **C.** Remove the DEF pressure line between the DEF pump and the DEF injector. Refer to Disassembly and Assembly, “Diesel Exhaust Fluid Lines - Remove and Install” for the correct procedure. **D.** Inspect the DEF pressure line for obstructions. Flush the line with water or low-pressure air, if necessary. **Note :** Possible obstructions are ice, DEF deposits, or debris.	Restriction, obstructions, and leaks	**Result :** There are restrictions or leaks in the lines. **Repair :** Flush or replace the line. Proceed to Test Step 7. **Result :** An obstruction was not found and the line was not damaged. Proceed to Test Step 6.

(continued)

(Table 36, contd)

Troubleshooting Test Steps	Values	Results
6. Replace the DEF Injector **A.** Turn the keyswitch to the OFF position. **B.** Remove the DEF injector. Refer to Disassembly and Assembly, “DEF Injector and Mounting - Remove and Install”. **C.** Connect the new DEF injector to the DEF pressure line and the electrical connector. **Note:** Do not install the new injector until Test Step 7 has been completed.	DEF injector	**Result:** The DEF injector was connected to the DEF pressure line and the electrical connector. Proceed to Test Step 7.
7. Perform the DEF Dosing System Accuracy Test **A.** Use the electronic service tool to perform a “DEF Dosing System Accuracy Test” . Refer to Testing and Adjusting, “Aftertreatment SCR System Dosing Test” for the correct procedure.	DEF dosing system accuracy test	**Result:** The quantity collected is within specification. Install the new DEF injector. Refer to Disassembly and Assembly, DEF Injector and Mounting Remove and Install. Proceed to Test Step 8. **Result:** The quantity collected is not within specification. **Repair :** Replace the DEF pump. Refer to the Disassembly and Assembly manual for the correct procedure. Install the new DEF injector. Refer to Disassembly and Assembly, DEF Injector and Mounting Remove and Install. Proceed to Test Step 8.
8. Perform the Aftertreatment Recovery Procedure **A.** Connect to the electronic service tool. **B.** Perform the “Aftertreatment Recovery Procedure” .	Aftertreatment Recovery Procedure	**Result:** The Aftertreatment Recovery Procedure completed successfully. Proceed to Test Step 9. **Result:** The Aftertreatment Recovery Procedure was not successful. Contact the Dealer Solutions Network (DSN).
9. Perform an “Aftertreatment System Functional Test” **A.** Turn the keyswitch to the ON position. **B.** Use the electronic service tool to perform an “Aftertreatment System Functional Test” . **C.** Download a warranty report. Refer to “Aftertreatment Abnormal Shutdown History” under the “Information” tab in the “Engine #1 Aftertreatment Controller” . **Note :** If hot shutdowns have occurred, allow the engine to cool down before shutting the machine OFF.	Electronic service tool test	**Result :** The test was successful. Return the unit to service. **Result :** The test not was successful and additional codes were logged. **Repair :** Troubleshoot the additional codes, refer to the-Troubleshooting manual for the correct procedure.

i06298622

DEF Pressure Is High

Table 37

Diagnostic Trouble Codes for DEF Pressure Is High			
J1939 Code	**PDL Code**	**Code Description (code descriptions may vary)**	**Comments**
4334-16	E930 (2)	Aftertreatment #1 DEF #1 Pressure (absolute) : High - moderate severity (2)	The DCU detects that the DEF pump pressure is above the acceptable range. The code is logged.
Follow the troubleshooting procedure in order to identify the root cause of the fault.			

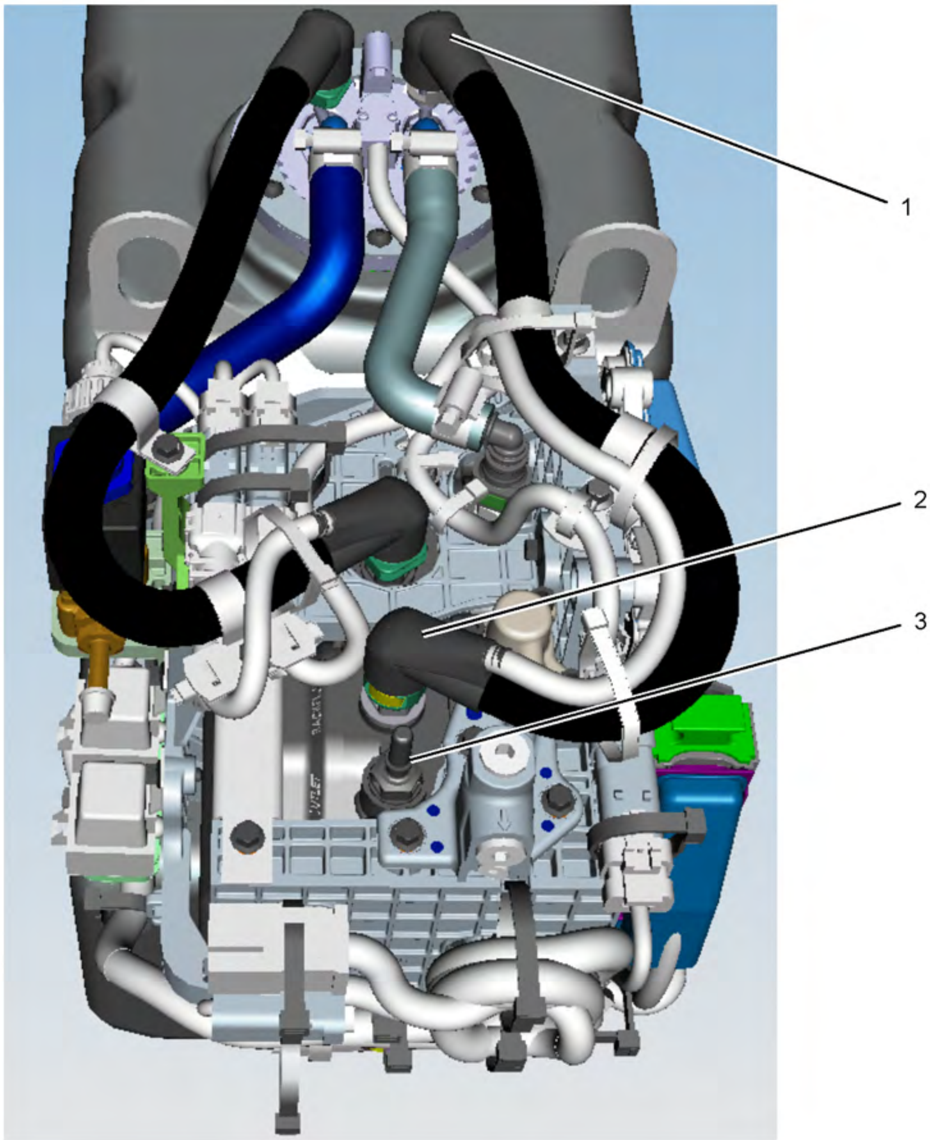


Illustration 36 g03843796

(1) Backflow line connection at the DEF tank header

(2) Backflow line connection at the DEF Pump

(3) Connector for pressure line at the DEF pump

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

Table 38

Troubleshooting Test Steps	Values	Results
1. Check the DEF Lines for a Restriction **A.** Turn the keyswitch to the OFF position. Allow 2 minutes to elapse before proceeding. **B.** Remove the backflow line from DEF tank header (1) and DEF pump (2). **C.** Remove the pressure line from the DEF pump (3) and the DEF injector. **D.** Inspect the removed lines for obstructions. **Note:** Possible obstructions are ice, DEF deposits, debris, or a trapped line.	DEF return line restriction	**Result:** An obstruction was found. **Repair:** If the line is blocked, flush line with water/low pressure air. If the line is trapped, reroute the line. If necessary, replace the line. Proceed to Test Step 4. **Result:** An obstruction was not found. Proceed to Test Step 2.
2. Replace the Pressure and Backflow Fittings **A.** Replace the pressure and backflow fittings on the DEF pump. Refer to Disassembly and Assembly, "Diesel Exhaust Fluid Pump - Remove and Install" for the correct procedure.	Replace Backflow Fitting	**Result:** The fittings were replaced. Proceed to Test Step 3.
3. Check for a Restriction in the DEF Pump **A.** Connect the pressure line to DEF pump (3) and the DEF injector. **B.** Connect the backflow line to DEF pump (2). Place the other end of the line into a suitable container to collect the DEF. **C.** Turn the keyswitch to the ON position. Do not start the engine. **D.** Connect to the electronic service tool. **E.** Perform the "DEF Dosing System Verification Test" . Refer to Systems Operation, Testing, and Adjusting, "Aftertreatment SCR System Dosing Test". Wait for the test to complete.	DEF pump restriction	**Result:** DEF did not flow from the DEF backflow line into the container. **Repair:** Replace the DEF pump. Refer to Disassembly and Assembly, "Diesel Exhaust Fluid Pump - Remove and Install" for the correct procedure. Proceed to Test Step 4. **Result:** DEF flowed from the backflow line into the container. **Repair:** Connect the backflow line to DEF tank header (1). Proceed to Test Step 4.
4. Perform a "Aftertreatment System Functional Test " **A.** Start the engine. **B.** Connect to the electronic service tool. **C.** Perform the "Aftertreatment System Functional Test " .	Diagnostic code	**Result:** The test was successful. Return the unit to service. **Result:** The test was not successful. There are additional codes. **Repair:** Troubleshoot the additional codes. Refer to Troubleshooting, "Diagnostic Trouble Codes". Repeat Test Step 4. **Result:** The test was not successful. There are no additional codes. Contact the Dealer Solutions Network (DSN).

i07888411

DEF Pressure Is Low

Table 39

Diagnostic Trouble Codes for DEF Pressure Is Low			
J1939 Code	**PDL Code**	**Code Description (code descriptions may vary)**	**Comments**
4334-7	3090-7	Aftertreatment #1 DEF #1 Pressure (absolute) : Not Responding Properly	DEF pump pressure is not stable after the initial priming sequence **OR** The DEF pump is not able to supply DEF after the line heaters have been energized and a heating cycle has been completed
4334-18	E931 (2)	Aftertreatment #1 SCR Dosing Reagent Absolute Pressure : Low - moderate severity (2)	Diesel Exhaust Fluid (DEF) system pressure dropped below the acceptable threshold during dosing
5392-31	E1370 (2)	Aftertreatment Diesel Exhaust Fluid Dosing Unit Loss of Prime	Diesel Exhaust Fluid (DEF) system pressure was not achieved during priming

Table 40

Troubleshooting Test Steps	Values	Results
1. Check the Diesel Exhaust Fluid (DEF) tank filler cap **A.** Clean dirt and debris from around the tank cap before removing the cap. Blockages can be caused by a build-up of dirt and debris around the cap. **Note :** A blocked DEF filler cap can cause a 5392-31 or E1370 (2) code. **B.** Remove and inspect the filler cap for blockages.	DEF filler cap	**Result :** A blockage was not found. Proceed to Test Step 2. **Result :** A blockage was found. **Repair :** Rinse the cap gently with clean water or replace the cap. **Note:** The cap contains a membrane so care must be taken not to damage the membrane. If the cap cannot be cleaned, the cap must be replaced. Proceed to Test Step 2.
2. Check the Diesel Exhaust Fluid (DEF) Gauge **A.** Turn the keyswitch to the ON position. Do not start the engine. **B.** Check the current position of the DEF gauge. **C.** Turn the keyswitch to the OFF position. **D.** Clean dirt and debris from around the tank cap before removing the cap. Add or remove DEF from the DEF tank. **Note :** Only use DEF that meets ISO 22241 quality standards. **E.** Turn the keyswitch to the ON position. **Do not start the engine.** **F.** Check for a change in the DEF gauge position.	DEF gauge	**Result :** The gauge did not move by adding or removing DEF from the tank. Proceed to Test Step 3. **Result :** The gauge moved by adding or removing DEF from the tank. Proceed to Test Step 4.

(continued)

(Table 40, contd)

Troubleshooting Test Steps	Values	Results
3. Check the Electrical Connection at the DEF Tank Header **A.** Turn the keyswitch to the OFF position. **B.** Inspect the electrical connections to the DEF tank header. Refer to Troubleshooting, “Electrical Connectors - Inspect” for further information. **C.** Inspect the connections for corrosion or loose wires.	Electrical connections	**Result :** The electrical connections are free of corrosion and loose wires. **Repair :** Replace the DEF tank header. Refer to the Disassembly and Assembly manual for the correct procedure. Proceed to Test Step 11. **Result :** The electrical connections are not free of corrosion or loose wires. **Repair :** Make the necessary repairs. Proceed to Test Step 11.
4. Inspect the DEF Lines for Leaks **A.** Turn the keyswitch to the ON position. Do not start the engine. **B.** Connect to the “Aftertreatment Diesel Exhaust Fluid Controller #1” using the electronic service tool. **C.** Navigate to “Diagnostics Tests” . **D.** Perform the “DEF Dosing System Verification Test” to pressurize the system. **Note:** This test may take up to 30 minutes to complete. **E.** Inspect all DEF lines from the tank to the DEF injector. Check for pinched, damaged, disconnected, or leaking lines. **F.** Turn the keyswitch to the OFF position.	DEF lines	**Result:** A leaking or disconnected line was found. **Repair :** Repair or replace the failed DEF line. Proceed to Test Step 11. **Result:** A leaking or disconnected line was not found. Proceed to Test Step 5.

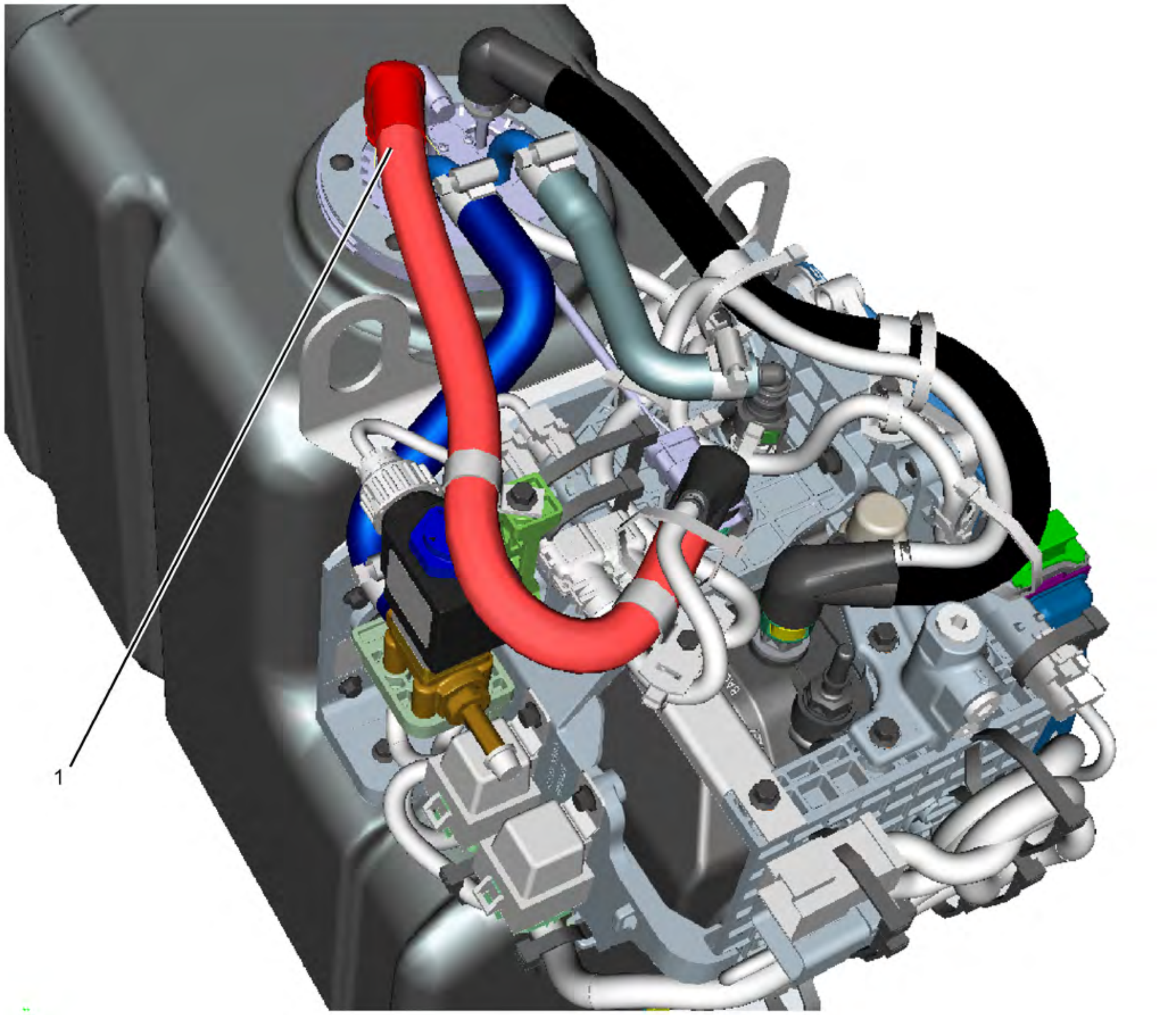


Illustration 37 g03337472

(1) DEF suction line connection on the header unit

Table 41

Troubleshooting Test Steps	Values	Results
5. Check the Diesel Exhaust Fluid (DEF) Quality **A.** Measure the DEF quality. Refer to Testing and Adjusting, “Diesel Exhaust Fluid Quality - Test” for the correct procedure.	DEF	**Result :** The DEF is not contaminated. Proceed to Test Step 6. **Result :** The DEF is contaminated. **Repair :** Contact the Dealer Solutions Network (DSN) for further information.
6. Check for Suction Line Restrictions **A.** Disconnect the suction line from the DEF tank header and DEF pump. **B.** Inspect the suction line for obstructions or damage. Also, check that the line is connected in the proper locations. **Note :** Possible obstructions are ice, DEF deposits, or debris.	Restrictions	**Result:** An obstruction or damage was found. **Repair :** Flush the line with water or low-pressure air or replace the suction line. Proceed to Test Step 11. **Result:** An obstruction or damage was not found. **Repair :** Reinstall the suction line. Proceed to Test Step 7.

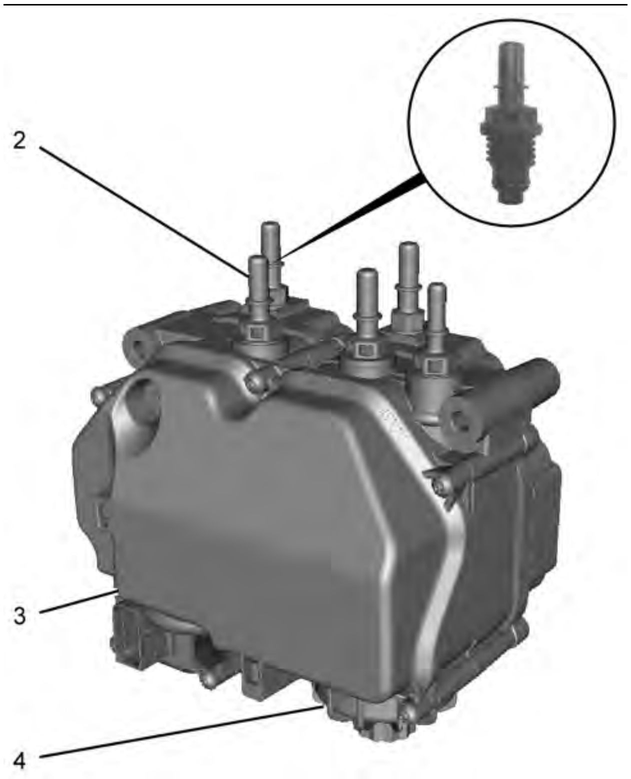


Illustration 38 g03763616

(2) DEF suction line filter fitting
(3) DEF pump
(4) DEF pump filter cap

Table 42

Troubleshooting Test Steps	Values	Results
7. Check for Return Line Restrictions **A.** Disconnect the return line from the DEF manifold and DEF pump. **B.** Inspect the return line and return line fitting for obstructions or damage. Also, check that the line is connected in the proper locations. **Note :** Possible obstructions are ice, DEF deposits, or debris.	Restrictions	**Result:** An obstruction or damage was found. **Repair :** Flush the line or connector with water or low-pressure air or replace the return line or return line fitting. Proceed to Test Step 11. **Result:** An obstruction or damage was not found. **Repair :** Reinstall the return line. Proceed to Test Step 8.
8. Check for Manifold Leaks **A.** Turn the keyswitch to OFF. **B.** Remove the DEF manifold from the DEF tank. **C.** Inspect the suction pipe on the manifold for any leaks or cracks.	Leaks	**Result:** A leak or crack was found in the suction pipe. **Repair :** Replace the DEF manifold. Proceed to Test Step 11. **Result:** An obstruction or damage was not found. **Repair :** Reinstall the return line. Proceed to Test Step 9.
9. Replace the DEF Pump Filters **A.** Turn the keyswitch to OFF. **B.** Clean the area around the pump filters. **C.** Replace the DEF pump suction line filter fitting. Tighten the new filter fitting to a torque of 4.5 N·m (40 lb in). **D.** Replace the DEF pump filter. Refer to Operation and Maintenance Manual, “Diesel Exhaust Fluid Filter - Clean/Replace” for the correct procedure. **E.** Remove DEF tank header from the DEF tank. **F.** Flush the DEF tank and replace the DEF filters. Refer to Systems Operation Testing and Adjusting, Diesel Exhaust Fluid Tank - Flush for the correct procedure.	DEF Pump and DEF Tank Filters	**Result :** The DEF tank was flushed, the DEF tank filters were replaced and the DEF pump filters were replaced. Proceed to Test Step 10.

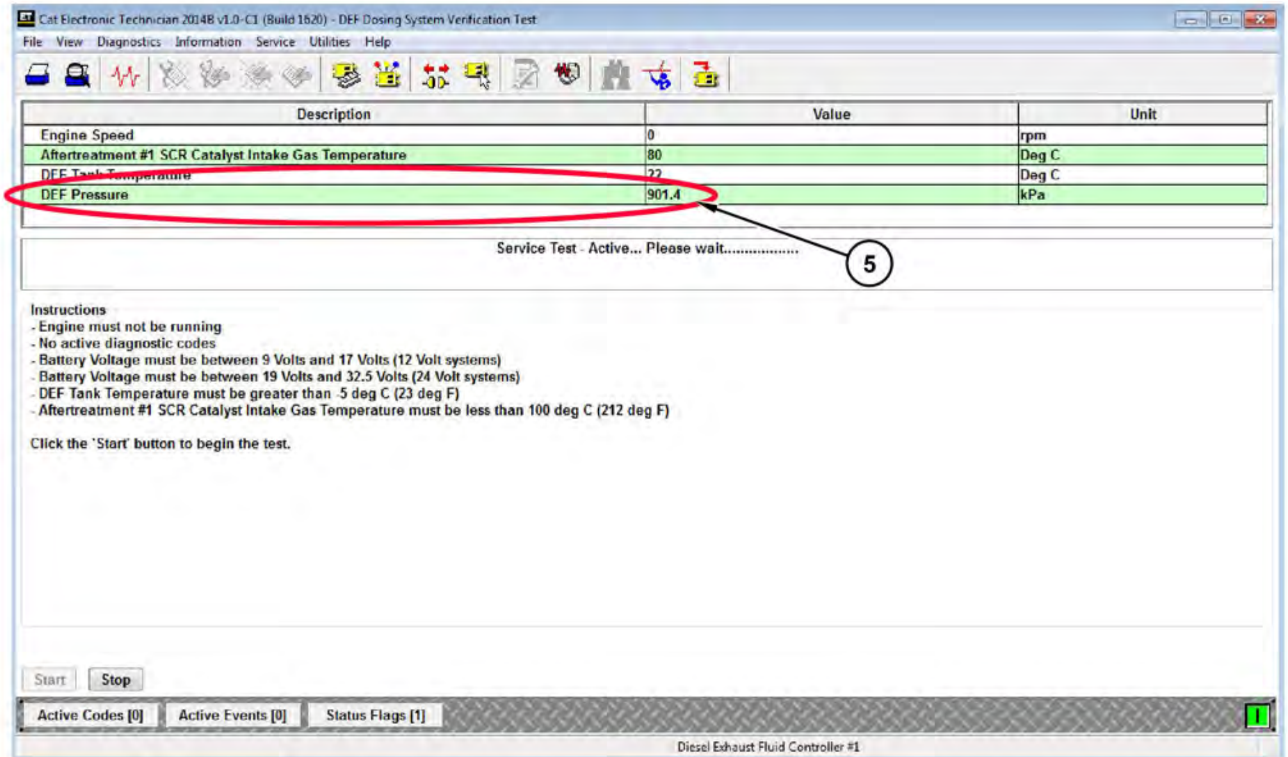


Illustration 39 g03670169

(5) DEF Pressure

Table 43

Troubleshooting Test Steps	Values	Results
10. Check the DEF Pump **A.** Turn the keyswitch to the ON position. Do not start the engine. **B.** Connect to the “Aftertreatment Diesel Exhaust Fluid #1” the electronic service tool. **C.** Navigate to “Diagnostics Tests” . **D.** Perform the “DEF Dosing System Verification Test” to pressurize the system. **E.** Monitor the DEF Pressure (5) on the electronic service tool during the test to see if the pressure stabilizes.	DEF pump	**Result :** The DEF pump maintained at least 800 kPa (116 psi) during the test. Proceed to Test Step 11. **Result :** The DEF pump did not maintain at least 800 kPa (116 psi) during the test. **Repair :** Replace the DEF pump. Refer to Disassembly and Assembly, “Diesel Exhaust Fluid Pump - Remove and Install” for the correct procedure. Proceed to Test Step 11.

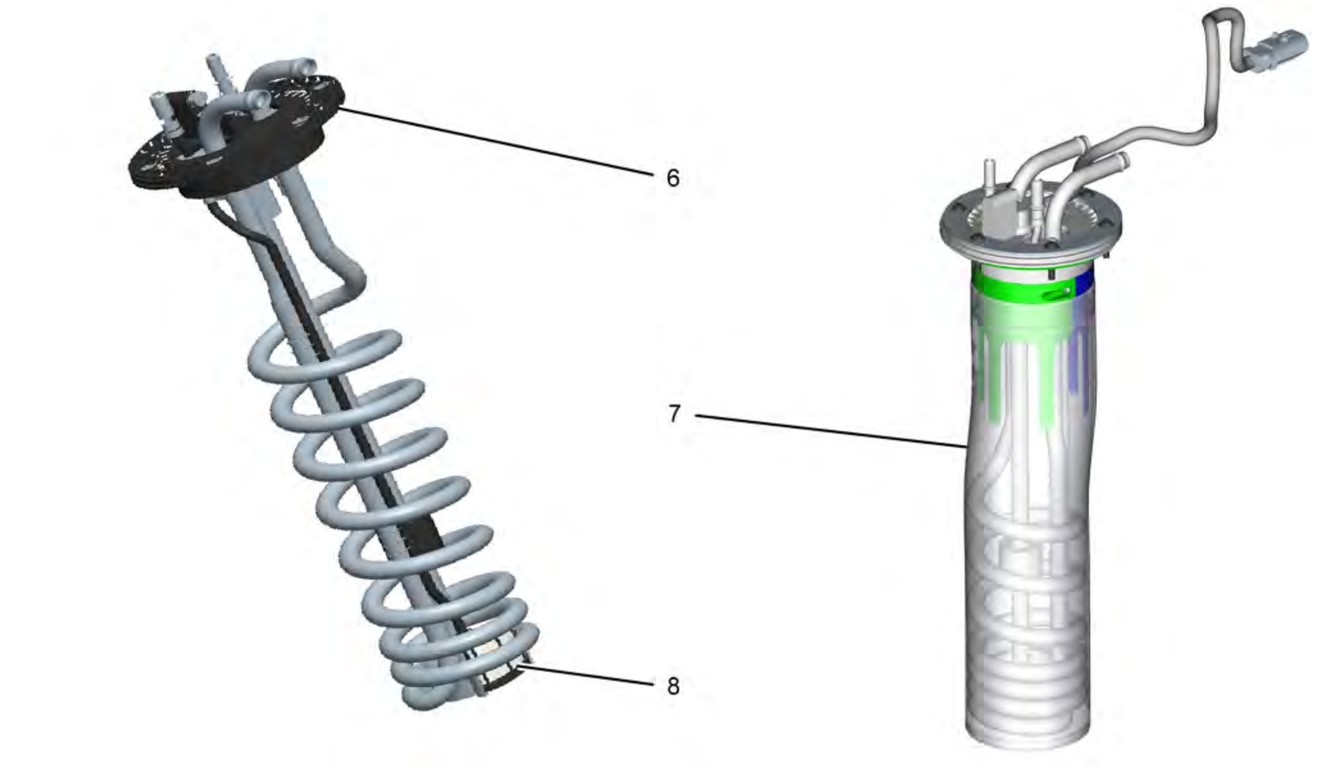


Illustration 40 g03765376

Typical DEF tank header

(6) DEF header (7) DEF manifold filter (8) DEF header filter

Table 44

Troubleshooting Test Steps	Values	Results
11. Perform an "Aftertreatment System Functional Test" **A.** Start the engine. **B.** Connect to the "Engine #1 Aftertreatment Controller" using the electronic service tool. **C.** Navigate to "Diagnostics Tests" . **D.** Perform the "Aftertreatment System Functional Test" .	"Aftertreatment System Functional Test"	**Result:** The test is successful. Return the unit to service. **Result:** The test is not successful. Proceed to Test Step 12.

(continued)

(Table 44, contd)

Troubleshooting Test Steps	Values	Results
12. Perform a “DEF Dosing System Accuracy Test” **A.** Connect to the electronic service tool. **B.** Navigate to “Diagnostics Tests” . **C.** Perform a “DEF Dosing System Accuracy Test” . Refer to Systems Operation, Testing, and Adjusting, “Aftertreatment SCR System Dosing Test” for the correct procedure.	“DEF Dosing System Accuracy Test”	**Result:** The quantity collected is below specification. A failed DEF injector has been detected. **Repair :** Replace the DEF injector. Refer to Disassembly and Assembly, DEF Injector and Mounting - Remove and Install. Proceed to Test Step 13. **Result:** The quantity collected is above specification. A failed DEF injector has been detected. **Repair :** Replace the DEF injector. Refer to Disassembly and Assembly, DEF Injector and Mounting - Remove and Install. Proceed to Test Step 13.
13. Perform an “Aftertreatment System Functional Test” . **A.** Start the engine. **B.** Connect to the electronic service tool. **C.** Navigate to “Diagnostics Tests” . **D.** Perform the “Aftertreatment System Functional Test” .	“Aftertreatment System Functional Test”	**Result:** The test is successful. Return the unit to service. **Result:** The test is not successful. There are additional codes. **Repair :** Troubleshoot the additional codes. Refer to the Troubleshooting manual for the correct procedure. **Result:** The test is not successful. There are no additional codes. Contact the Dealer Solutions Network (DSN).

i06836187

DEF Tank Level Is Low

Diesel Exhaust Fluid (DEF Tank Level Inducement

Inducements are engine derates or other actions intended to prompt the operator to seek repair or maintenance of the emissions control system.

Table 45

Diagnostic Trouble Codes for DEF Tank Level Is Low			
J1939 Code	**PDL Code**	**Code Description (code descriptions may vary)**	**Comments**
1761-1	E954 (3)	Aftertreatment #1 DEF Tank Volume : Low - most severe (3)	This code is a Level 3 inducement that becomes active when the DEF tank is empty. The engine is derated 100%, limited to low idle or 1000 RPM, and may experience 5 minute rolling shutdowns.
1761-17	E954 (1)	Aftertreatment #1 DEF Tank Volume : Low - least severe (1)	This code is a Level 1 inducement that becomes active when the DEF level is critically low.
1761-18	E954 (2)	Aftertreatment #1 DEF Tank Volume : Low - moderate severity (2)	This code is a Level 2 inducement that becomes active when the DEF level is critically low. Power loss may occur.
Follow the troubleshooting procedure to identify the root cause of the problem.			

Refer to Systems Operation, “DEF Dosing Control System” for details on inducement configuration options and inducement actions for specific tank levels.

Note: Always turn the keyswitch to the OFF position before adding DEF to the tank.

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

Table 46

Troubleshooting Test Steps	Values	Results
1. Check the DEF Level **A.** Turn the keyswitch to the ON position. Do not start the engine. **B.** Check the current position of the DEF gauge. **C.** Turn the keyswitch to the OFF position. **D.** Clean dirt and debris from around the cap before removing the cap. **E.** Fill the DEF tank to at least 25% capacity. **Note:** Only use DEF that meets ISO 22241 quality standards. **F.** Turn the keyswitch to the ON position. **G.** Check for a change in the gauge position.	Gauge position	**Result:** The gauge did not move when DEF was added to the tank. Proceed to Test Step 2. **Result:** The gauge moved when DEF was added to the tank. Turn the keyswitch to the OFF position for 2 minutes to allow the DEF pump to purge, reset the code, and reset the Dosing Control Unit (DCU). Return the unit to service.

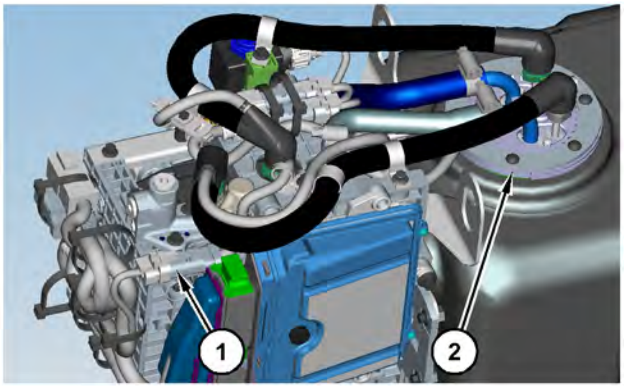


Illustration 41 g03410399

(1) DEF Tank Header connector
(2) DEF Tank Header

Table 47

Troubleshooting Test Steps	Values	Results
2. Check the Electrical Connection at the DEF Tank Header **A.** Inspect the electrical connector (1) to the DEF tank header. Refer to Troubleshooting, “Electrical Connectors - Inspect” for further information. Look for corrosion or loose wires.	Electrical connections	**Result:** The electrical connectors are free of corrosion and are not loose. Proceed to Test Step 3. **Result:** The electrical connections are not free of corrosion and/or are loose. **Repair:** Make the necessary repairs to the connectors. Turn the keyswitch to the OFF position for 2 minutes to allow the DEF pump to purge, reset the code, and reset the Dosing Control Unit (DCU). Repeat the procedure from Test Step 1.
3. Inspect the DEF Tank Header **A.** Turn the keyswitch to the OFF position. **B.** Remove the DEF tank header (2) from the DEF tank. Refer to Disassembly and Assembly, “Manifold (DEF Heater) - Remove and Install”. **C.** If necessary, remove the filter sock from the DEF tank header. **C.** Inspect the DEF tank header for a stuck float.	Correct operation of the float	**Result:** The float was not operating correctly. **Repair:** If possible, repair the float and then install the filter sock. If the float cannot be repaired, replace the DEF tank header. Refer to Disassembly and Assembly, “Manifold (DEF Heater) - Remove and Install”. Return the unit to service. **Result:** The float was operating correctly. **Repair:** Install a replacement DEF tank header. Refer to Disassembly and Assembly, “Manifold (DEF Heater) - Remove and Install”. If the fault is still present, contact the Dealer Solutions Network (DSN).

i06191856

DEF Tank Temperature Is High

Table 48

Diagnostic Trouble Code for DEF Tank Temperature Is High			
J1939 Code	**PDL Code**	**Code Description (code descriptions may vary)**	**Comments**
3031-16	E960-2	Aftertreatment #1 DEF Tank Temperature : High - moderate severity (2)	The code is logged when the DEF tank temperature exceeds 80° C (176° F).

Table 49

Associated Diagnostic Trouble Codes	
J1939 Code	**PDL Code**
110-0	E361 (3)
110-15	E361 (1)
110-16	E361 (2)
Follow the troubleshooting procedure in order to identify the root cause of the fault.	

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

Table 50

Troubleshooting Test Steps	Values	Results
1. Check for Associated Codes **A.** Connect to the electronic service tool. **B.** Determine if an associated code is present.	Associated code	**Result:** An associated code is present. **Repair:** Troubleshoot the associated code. Refer to Troubleshooting, “Diagnostic Trouble Codes” for the correct procedure. **Result:** An associated code is not present. Proceed to Test Step 2.
2. Check the Electrical Connections **A.** Inspect the electrical connections to the coolant diverter valve. Inspect all electrical connections to the Diesel Exhaust Fluid (DEF) tank header. Refer to Troubleshooting, “Electrical Connectors - Inspect” for further information. **B.** Inspect for corrosion or loose wires.	Corrosion or loose wires	**Result:** The connections are free of corrosion and are not loose. Proceed to Test Step 3. **Result:** The connections are corroded and/or are loose. **Repair:** Make the necessary repairs. Proceed to Test Step 4.

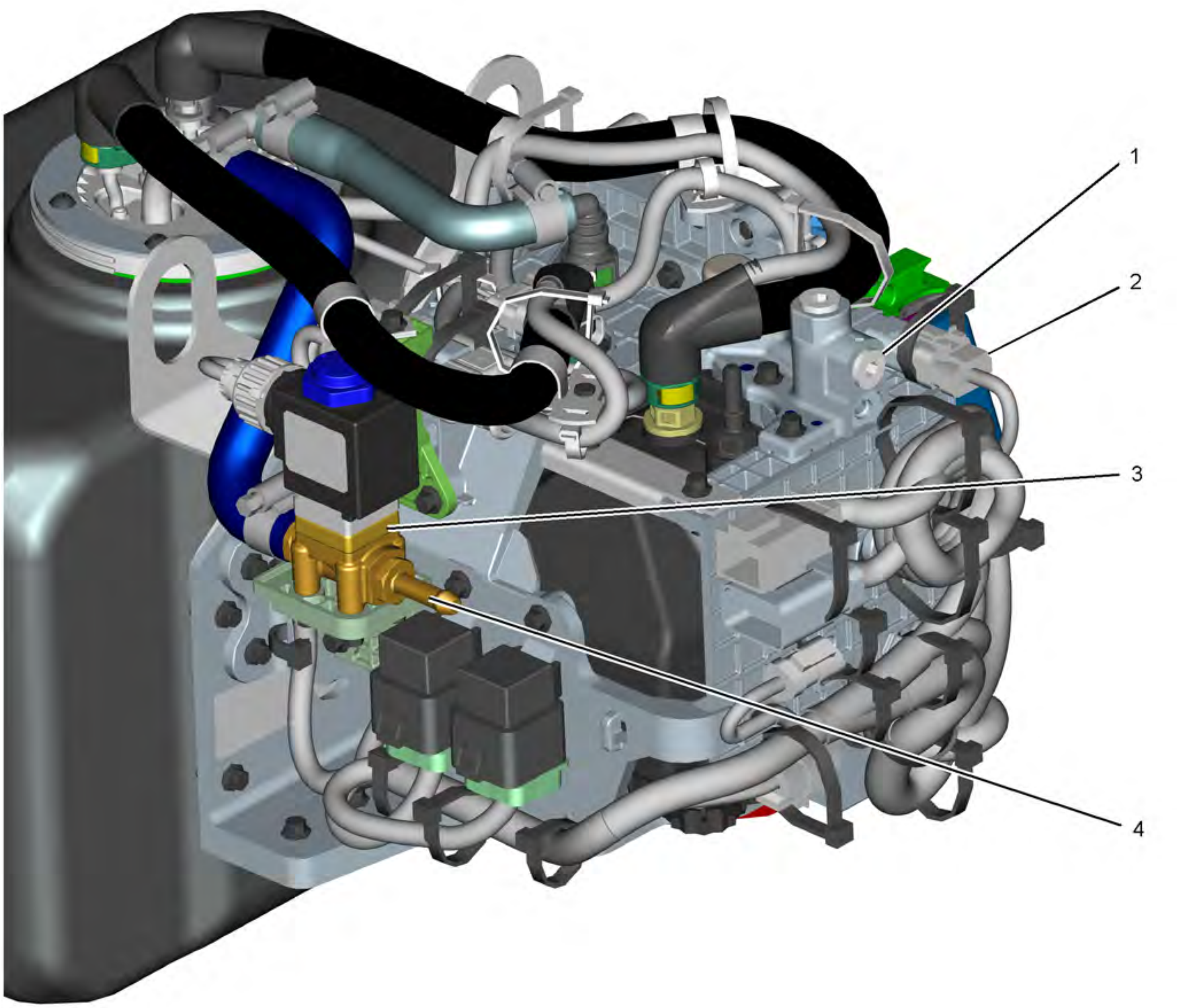


Illustration 42 g03767336

Coolant line configuration may be different depending on the application.

(1) Coolant return fitting
(2) DEF tank header connector
(3) Coolant diverter valve
(4) Coolant supply fitting

Table 51

Troubleshooting Test Steps	Values	Results
3. Check the Coolant Supply and Return Lines for Proper Installation **A.** Check the coolant supply line and the coolant return line from the engine to the Pump Electronic Tank Unit (PETU). Make sure that the coolant is flowing in the correct direction. Refer to Illustration 42 .	Correct Installation	**Result:** The lines are installed correctly. Proceed to Test Step 4. **Result:** The lines are not installed correctly. **Repair:** Correctly install the lines. Proceed to Test Step 5.
4. Check the Coolant Diverter Valve Solenoid for Proper Operation **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the coolant diverter valve wiring harness connector from the coolant diverter valve. **C.** Turn the keyswitch to the ON position. **D.** Connect to the electronic service tool. **E.** Start the engine. Allow the engine to warm up to operating temperature. **F.** Use the electronic service tool to monitor the “DEF Tank Temperature” . **G.** Turn the keyswitch to the OFF position.	Temperature rise	**Result:** The tank temperature did not increase. **Repair:** Connect the coolant diverter valve to the wiring harness. Proceed to Test Step 5. **Result:** The tank temperature did increase. **Repair:** A failed coolant diverter valve has been detected. Replace the coolant diverter valve. Refer to Disassembly and Assembly, “Solenoid Valve (DEF Heater Coolant) - Remove and Install” for the correct procedure. Proceed to Test Step 5.
5. Replace the DEF **A.** Drain the DEF from the tank. **B.** Fill the tank with DEF that meets ISO 22241 standards.	DEF	**Result:** The tank fluid was replaced. Return the unit to service. **Result:** The fault is still present. Contact the Dealer Solutions Network (DSN).

i06836250

DEF Temperature Is Low

Table 52

Diagnostic Trouble Codes for DEF Tank Temperature Is Low			
J1939 Code	**PDL Code**	**Code Description (code descriptions may vary)**	**Comments**
3031-7	E1441 (2)	Aftertreatment #1 DEF Tank Temperature : Not Responding Properly	The DCU detects that the DEF tank temperature is not responding properly. The code is logged.
3031-18	E1398 (2)	Aftertreatment #1 DEF Tank Temperature : Low - moderate severity (2)	The DCU detects that the Diesel Exhaust Fluid (DEF) tank temperature is lower than expected.

(continued)

(Table 52, contd)

Diagnostic Trouble Codes for DEF Tank Temperature Is Low			
J1939 Code	**PDL Code**	**Code Description (code descriptions may vary)**	**Comments**
3363-7	3126-7	Aftertreatment #1 DEF Tank Heater : Not Responding Properly	The DCU detects that the DEF tank temperature is not responding properly during a heating cycle. The code is logged.
5798-7	E1427 (1)	Aftertreatment #1 DEF Dosing Unit Heater Temperature : Not Responding Properly	The DCU detects that the DEF pump temperature sensor is not responding properly. The code is logged.
Follow the troubleshooting procedure to identify the root cause of the problem.			

The E1441 (2) or 3031-7 code will be logged when the engine is running, the Diesel Exhaust Fluid (DEF) tank temperature is colder than −8° C (17.6° F) and the DEF tank temperature started to rise, but has fallen back below−8° C (17.6° F).

The E1427 (1) or 5798-7 code will be logged when the engine is running, the DEF tank temperature is warmer than −8° C (17.6° F), the DEF tank temperature has increased, but the DEF pump temperature has not changed.

Table 53

Associated Diagnostic Trouble Codes	
J1939 Code	**PDL Code**
3363-5	3126-5
3363-6	3126-6
4354-5	3110-5
4354-6	3110-6
4355-5	3111-5
4355-6	3111-6
4356-5	3112-5
4356-6	3112-6
5491-5	3822-5
5491-6	3822-6

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

Table 54

Troubleshooting Test Steps	Values	Results
1. Check for Associated Diagnostic Trouble Codes **A.** Connect the electronic service tool to the engine ECM. **B.** Determine if an associated diagnostic code is present.	Diagnostic trouble codes	**Result:** An associated diagnostic trouble code is not present. Proceed to Test Step 2. **Result:** An associated diagnostic trouble code is present. **Repair:** Troubleshoot the associated code.
2. Check the Coolant Level of the Engine **A.** Determine if the engine coolant level is full.	Coolant level	**Result:** The coolant level is full. Proceed to Test Step 3. **Result:**The coolant level is not full. **Repair:** Add coolant to the system. Determine the cause of low coolant. Refer to Troubleshooting, “Coolant Level Is Low” for additional information. Proceed to Test Step 3.
3. Check for Coolant Leaks **A.** Check the entire engine cooling system for signs of coolant leaks. **B.** Inspect the coolant supply and return lines to the Pump Electronic Tank Unit (PETU) for leaks or damage that may cause restrictions.	Leaks	**Result:** No leaks were detected. Proceed to Test Step 4. **Result:** There were leaks or damaged lines detected. **Repair:** Repair the leaks or damaged lines and refill the coolant system. Proceed to Test Step 4.

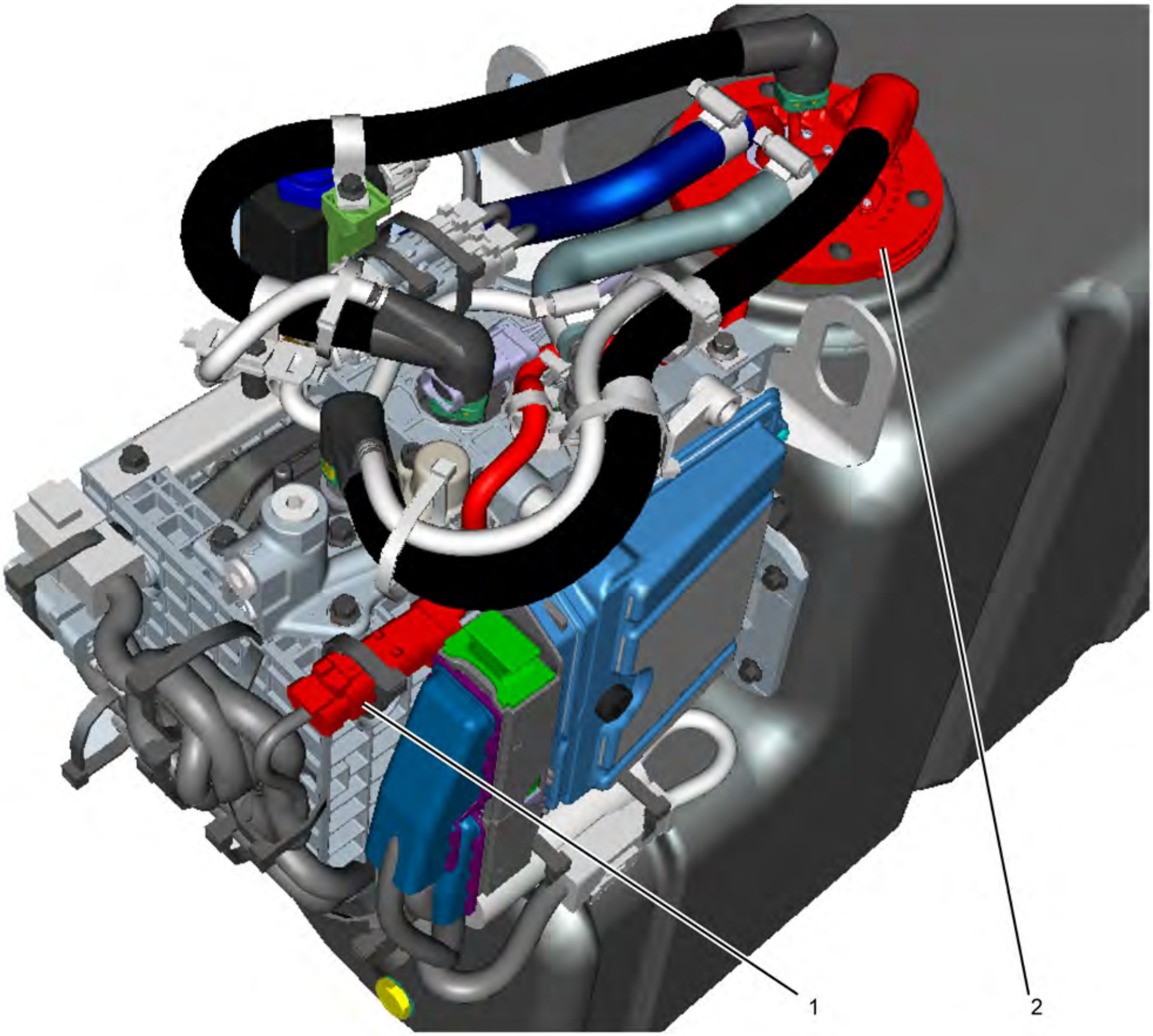


Illustration 43 g03767578

Typical Pump, Electronics, and Tank Unit (PETU)

(1) DEF tank header electrical connector
(2) DEF tank header

Table 55

Troubleshooting Test Steps	Values	Results
4. Check the Electrical Connection at the DEF Tank Header **A.** Inspect electrical connector (1) to DEF tank header (2). Refer to Troubleshooting, “Electrical Connectors - Inspect” for further information. Check for corrosion or loose wires.	Electrical connections	**Result:** The electrical connections are free of corrosion and are not loose. Proceed to Test Step 5. **Result:** The electrical connections are corroded and/or are loose. **Repair:** Make the necessary repairs to the connector. Proceed to Test Step 5.
5. Check the Engine Coolant Temperature **A.** Start the engine. Allow the engine to warm to normal operating temperature. **B.** Connect to the electronic service tool. **C.** Select the “Status Parameters” tab. **D.** Check the coolant temperature. The temperature should be greater than 50° C (122° F).	Coolant temperature	**Result:** The coolant temperature is greater than 50° C (122° F). Proceed to Test Step 6. **Result:** The coolant temperature is not greater than 50° C (122° F). Investigate the cause of low coolant temperature.

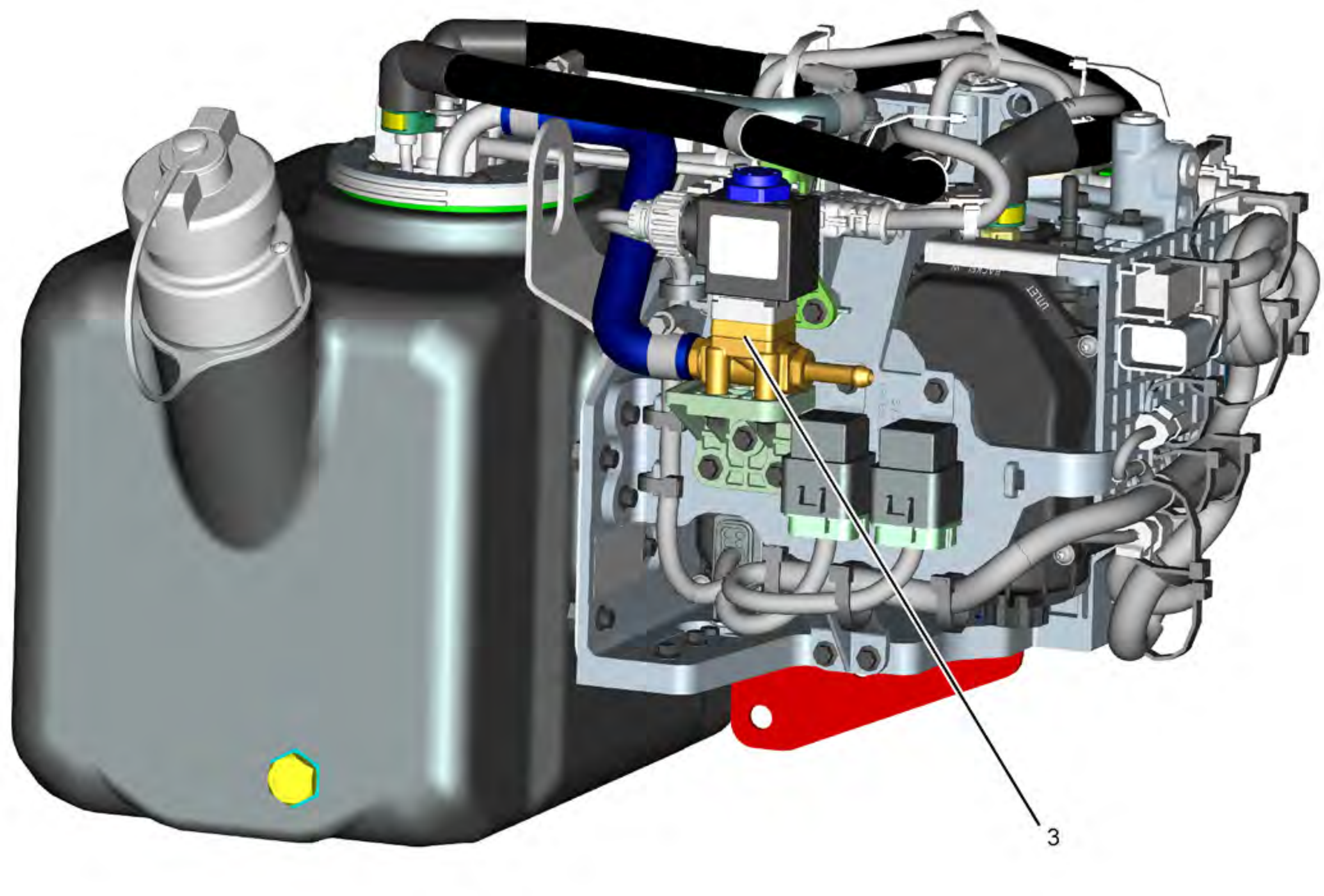


Illustration 44 g03767596

(3) Coolant diverter valve

Table 56

Troubleshooting Test Steps	Values	Results
6. Check the DEF Coolant Diverter Valve Solenoid Operation **A.** Turn the keyswitch to the ON position. **B.** Start the engine. **C.** Connect to the electronic service tool. **D.** Connect to the Dosing Control Unit (DCU). **E.** Set the status of the coolant diverter valve to OPEN using the “DEF Coolant Diverter Valve Solenoid Override” for 20 minutes. **F.** Monitor the “DEF Tank Temperature” and make sure that there is an increase of at least 3° C (5.4° F). **Note:** The DEF tank temperature must be within 5° C (9° F) of ambient air temperature prior to performing this override.	Temperature rise	**Result:** The DEF tank temperature increased. Proceed to Test Step 7. **Result:** The DEF tank temperature did not increase. **Repair:** A failed coolant diverter valve has been detected. Replace the coolant diverter valve. Proceed to Test Step 7.
7. Check the DEF Coolant Diverter Valve Solenoid Operation **A.** Turn the keyswitch to the ON position. **B.** Start the engine. **C.** Connect to the electronic service tool. **D.** Connect to the “Diesel Exhaust Fluid Controller #1” . **E.** Set the status of the coolant diverter valve to OPEN using the “DEF Coolant Diverter Valve Solenoid Override” for 20 minutes. **F.** Monitor the “DEF Tank Temperature” and make sure that there is an increase of at least 3° C (5.4° F). **The DEF tank temperature must be within 5° C (9° F) of ambient air temperature prior to performing this override.**	Temperature rise	**Result:** The DEF tank temperature increased. Return the unit to service. **Result:** The DEF tank temperature did not increase. **Repair:** A failed DEF tank temperature sensor has been detected. Replace the DEF tank header assembly. Repeat the “DEF Coolant Diverter Valve Solenoid Override” for 20 minutes. If there is a temperature rise in the DEF fluid, return the unit to service. If the fault is still present, contact the Dealer Solutions Network (DSN).

i06191864

Diesel Oxidation Catalyst Has Incorrect Inlet Temperature

Table 57

Diagnostic Trouble Code for DOC Has Incorrect Inlet Temperature			
J1939 Code	**PDL Code**	**Code Description (code descriptions may vary)**	**Comments**
4765-17	E2165 (1)	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 in order to identify the root cause of the fault.			

Table 58

Associated Codes	
J1939 Codes	**PDL Codes**
649-5	3512-5
649-6	3512-6
649-7	E1263 (2)
5625-3	3513-3
5625-4	3513-4

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

Table 59

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 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 Exhaust Back Pressure Regulator (EBPR) and the Clean Emissions Module (CEM). **B.** Check for missing or damaged exhaust system insulation. **C.** Make sure that the exhaust piping between the EBPR and the CEM is no longer than 1.83 m (6 ft).	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 exhaust system 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 “HC Dosing Capability Test” .	Test	**Result:** The “HC Dosing Capability Test” completed successfully. Return the unit to service. **Result:** The “HC Dosing Capability Test” failed. Associated diagnostic trouble codes are active. Troubleshoot the logged or active code. Refer to Troubleshooting, “Diagnostic Trouble Codes”. **Result:** The “HC 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 “HC Dosing Capability Test” failed. No associated diagnostic trouble codes are active. Contact the Dealer Solutions Network (DSN).

i06861575

Diesel Oxidation Catalyst Has Low Conversion Efficiency

Table 60

Diagnostic Trouble Code for DOC Has Low Conversion Efficiency			
J1939 Code	**PDL Code**	**Code Description (code descriptions may vary)**	**Comments**
5298-17	E2180 (1)	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 61

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 or E2180 code is active or recently logged. Proceed to Test Step 2. **Result:** A recurrence of 5298-17 or E2180 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 or E2180 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 Exhaust Back Pressure Regulator (EBPR) and the Clean Emissions Module (CEM).	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 “HC Dosing Capability Test” . Proceed to Test Step 3.

(continued)

(Table 61, 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. **Repair:** Refer to Special Instruction, M0078202, Soot Antennae Check to check for damage to the aftertreatment system. 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).

i06605978

Diesel Particulate Filter Collects Excessive Soot

The Electronic Control Module (ECM) uses the soot 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 62

Diagnostic Trouble Codes for Excessive Soot Load			
J1939 Code	PDL Code	Code Description (code descriptions may vary)	Comments
3719-16	E995 (2)	DPF #1 Soot Loading Percent : High - moderate severity (2)	The estimated soot load is above 116 percent. Engine power is gradually derated as the soot load increases. The emissions system failure lamp will flash.
3719-0	E995 (3)	DPF #1 Soot Loading Percent : High - most severe (3)	The estimated soot load is above 127 percent. Engine power is derated 100 percent. The emissions system failure lamp will flash and a warning horn will sound.
7440-31	E1645 (1)	Aftertreatment Active Regeneration Inhibited Due to Low Exhaust Pressure	The exhaust gas pressure is too low to support DPF regeneration.

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

- Faulty soot sensor system
- Oil in the exhaust system
- Faulty injectors
- A mechanical fault in a cylinder
- Low exhaust gas pressure
- A faulty exhaust back pressure valve
- A fault in the NOx Reduction System (NRS)
- Fuel with a high sulfur content

Table 63

Required Tools			
Tool	Part Number	Part Description	Qty
A	T40-0025	Attenuator	1

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 64

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 code is active. Proceed to Test Step 2. **Result:** A 7440-31 code is active. Proceed to Test Step 6. **Result:** A code other than 3719-xx or 7440-31 is active. Diagnose and rectify the fault before continuing with this procedure. Refer to Troubleshooting, “Diagnostic Trouble Codes”.
2. Visually Inspect the Soot Sensor System **A.** Inspect the coaxial cables between the soot sensor and the antennas for damage. **B.** Make sure that the antenna connectors are correctly tightened to 1.2 N·m (10.6 lb in).	Soot sensor	**Result:** The soot sensor cables are damaged. Replace the soot sensor. Proceed to Test Step 3. **Result:** Other corrective actions were performed. **Repair:** Start the engine and then use the electronic service tool to perform the “Aftertreatment Regeneration System Test” . Stop the engine and then check for a 3719-xx code. If the 3719-xx code has been eliminated, proceed to Test Step 9. If the 3719-xx code is still present, proceed to Test Step 3. **Result:** No corrective actions were performed. Proceed to Test Step 3.
3. Test the Soot Sensor System **A.** Disconnect the soot antenna connectors and install Tooling A. **B.** Perform the “DPF Soot Loading Sensor Functional Test” on the electronic service tool by selecting the following menus: · “Diagnostics” · “Diagnostic Tests” · “DPF Soot Loading Sensor Functional Test” **C.** Disconnect the coaxial cables from the attenuator.	Soot sensor	**Result:** The “DPF Soot Loading Sensor Functional Test” fails. **Repair:** Replace the soot sensor. Use the electronic service tool to perform the “Aftertreatment Regeneration System Test” . If necessary, diagnose any reported fault codes and then proceed to Test Step 9. **Result:** The “DPF Soot Loading Sensor Functional Test” is successful. Proceed to Test Step 4.

(continued)

(Table 64, contd)

Troubleshooting Test Steps	Values	Results
4. Check for Oil in the Exhaust System **A.** Remove the flexible exhaust pipe. Refer to Disassembly and Assembly, "Flexible Exhaust Pipe - Remove and Install". **B.** Inspect the exhaust system and Clean Emissions Module (CEM) inlet for oil deposits.	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 5.
5. Check for Engine Faults **A.** Start the engine. **B.** Use the electronic service tool to perform the "Cylinder Cutout Test" .	Engine	**Result:** The "Cylinder Cutout Test" fails. **Repair:** Investigate the cause of the fault and rectify. If necessary, contact the Dealer Solutions Network (DSN). **Result:** The "Cylinder Cutout Test" is successful. Proceed to Test Step 6.
6. Investigate Cause of 7440-31 Code **Note:** Diagnostic code 7440-31 indicates that the exhaust gas pressure is too low to promote DPF regeneration. **A.** Check the exhaust system from the engine to the CEM for gas leaks. **B.** Check the sensors on the CEM for signs of gas leaks. **C.** Check that the exhaust system insulation is correctly installed.	Diagnostic code	**Result:** Exhaust gas leaks are found in the exhaust system or the CEM. **Repair:** Rectify the gas leak or make sure that the CEM sensors are correctly installed. Proceed to Test Step 9. **Result:** Exhaust system insulation is missing or damaged. **Repair:** Repair the exhaust system insulation. Proceed to Test Step 9. **Result:** There are no exhaust gas leaks and the insulation is OK. Proceed to Test Step 7.
7. Check the Exhaust Back Pressure Regulator and the NRS system **A.** Use the Electronic service tool to check for diagnostic codes that are associated with the Exhaust Back Pressure Regulator (EBPR) or the NRS system.	Diagnostic codes	**Result:** A diagnostic code is present that is associated with the EBPR or the NRS system. Refer to Troubleshooting, "Diagnostic Trouble Codes"for information on troubleshooting the code. **Result:** There are no diagnostic codes present for the EBPR or the NRS system. Proceed to Test Step 8.

(continued)

(Table 64, contd)

Troubleshooting Test Steps	Values	Results
8. 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. Start the engine and use the electronic service tool to perform the “Aftertreatment Recovery Procedure” . **Result:** The fuel is the correct specification. Contact the Dealer Solutions Network (DSN).
9. Prepare the Unit for Service A. Start the engine and use the electronic service tool to perform a “Manual DPF Regeneration.”	DPF	**Result:** The soot content of the DPF returns to normal. Return the unit to service. **Result:** The soot content of the DPF remains high. Contact the Dealer Solutions Network (DSN).

i06191927

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 code when the conditions are met.

Table 65

Diagnostic Trouble Codes for Diesel Particulate Filter Temperature Is Low			
J1939 Codes	**PDL Codes**	**Code Description (code descriptions may vary)**	**Comments**
3242-17	E1014 (1)	Aftertreatment #1 DPF Intake Gas Temperature : Low - least severe (1)	The temperature at the intake of the DPF is below the trip point that is calculated by the ECM. The trip point varies depending on engine operating conditions. The code is logged. The code remains active until electrical power to the ECM is cycled.
3242-18	E1014 (2)	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 66

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 3242-17 code is active. Proceed to Test Step 2. **Result:** A 3242-18 code is active. Proceed to Test Step 4. **Result:** A code other than 3242-17 or 3242-18 is active. **Repair:** Diagnose and rectify the fault before continuing with this procedure. Refer to Troubleshooting, "Diagnostic Trouble Codes".
2. Visually Inspect the Insulation on the Exhaust Duct (if equipped) **A.** Check the insulation on the exhaust duct between the engine and the Clean Emissions Module (CEM). Make sure that insulation is not missing or damaged.	Insulation	**Result:** The insulation is missing or damaged. **Repair:** Replace the insulation. Proceed to Test Step 5. **Result:** The insulation is not missing or damaged. Proceed to Test Step 3.
3. Check for Exhaust Back Pressure Regulator Faults **A.** Use the electronic service tool to check for any active diagnostic trouble codes that are associated with the Exhaust Back Pressure Regulator (EBPR).	EBPR	**Result:** There are active diagnostic trouble codes that are associated with the EBPR. **Repair:** Investigate and rectify any faults. Refer to Troubleshooting, "Motorized Valve - Test". Proceed to Test Step 5. **Result:** There are no active diagnostic trouble codes that are associated with the EBPR. Contact the Dealer Solutions Network (DSN).

(continued)

(Table 66, contd)

Troubleshooting Test Steps	Values	Results
4. 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 5. **Result:** The temperature sensor is correctly installed and is not loose. Proceed to Test Step 5.
5. Check for Engine Faults **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).

i06191932

Engine Cranks but Does Not Start

Probable Causes

- Diagnostic codes
- Visible faults
- Air intake and exhaust system
- Speed/timing sensor
- Low-pressure fuel system
- Transfer Pump Inlet Regulator (TPIR)
- EFLP flow rate
- Return fuel lines
- High-pressure fuel system
- Starting aids
- 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 67

Troubleshooting Test Steps	Values	Results
1. Diagnostic Codes **A.** Download the 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 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. **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. **Note:** If the DPF frequently collects excessive soot prior to this fault, there may be a faulty cylinder in the engine. Proceed to Test Step 12. **Result:** All checks are OK. Proceed to Test Step 3.

(continued)

(Table 67, contd)

Troubleshooting Test Steps	Values	Results
3. Air Intake and Exhaust System **A.** Check the air filter restriction indicator, if equipped. **B.** Check the air intake and exhaust systems for the following defects: · Blockages · Restrictions · Damage to lines or hoses	Air and Exhaust System restrictions	**Result:** The air filter is restricted. **Repair:** Replace the air filter. **Result:** There are system restrictions. Refer to Systems Operation/Testing and Adjusting, “Air Inlet and Exhaust System” for additional information on the air inlet and exhaust systems. **Result:** The air intake and exhaust system is OK. Proceed to Test Step 4.
4. Speed/Timing Sensors **A.** Crank the engine and observe the engine speed on the electronic service tool status screen. Refer to Troubleshooting, “Speed/Timing - Test” for additional information. **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 5.
5. 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.** Replace the in-line fuel filter that is installed upstream of the Electric Fuel Lift Pump (EFLP). **F.** Check that the EFLP is operating correctly. **G.** Check for air in the fuel system and that the fuel system is primed. **H.** 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. **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. Replace the primary fuel filter and the secondary fuel filters. Refer to the Operation and Maintenance Manual for further information. **Result:** The EFLP is not operating correctly. Investigate the fault with the EFLP. Refer to Troubleshooting, “Relay - 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.

(continued)

(Table 67, contd)

Troubleshooting Test Steps	Values	Results
		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 6.

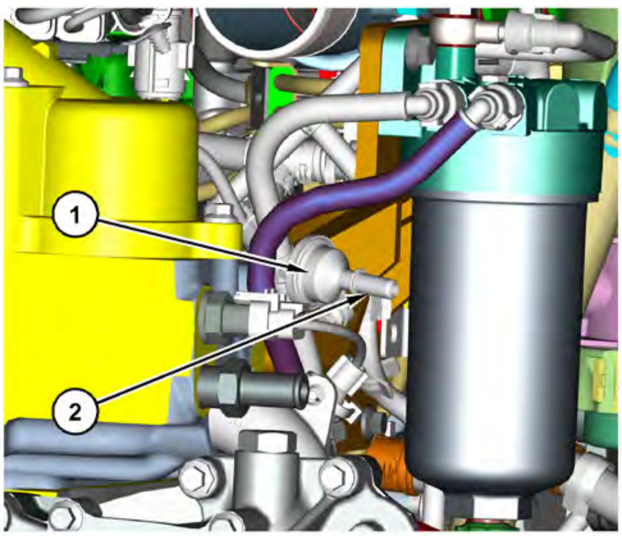


Illustration 45 g03769456

Transfer Pump Inlet Regulator (TPIR) components

(1) Transfer Pump Inlet Regulator (TPIR)
(2) TPIR return port

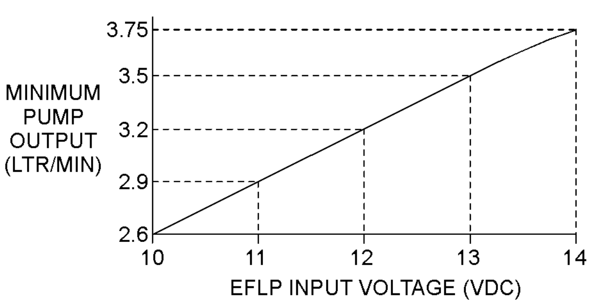


Illustration 46 g02355128

Minimum TPIR flow rate in a 12 VDC system

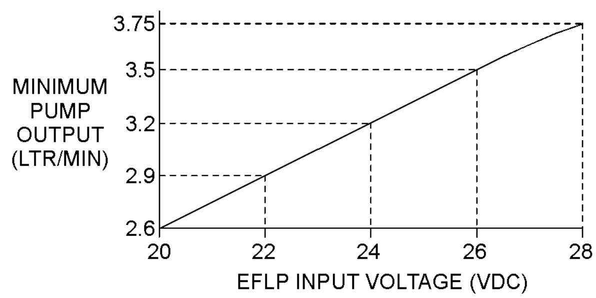


Illustration 47 g02355130

Minimum TPIR flow rate in a 24 VDC system

Table 68

Troubleshooting Test Steps	Values	Results
6. Transfer Pump Inlet Regulator (TPIR) Flow Test Refer to Illustration 45 . **A.** Disconnect the TPIR return line from the drain port on the TPIR. Install a suitable blanking cap on the open port in the TPIR return line. **B.** Connect a temporary drain line to the drain port on the TPIR. **C.** Place the end of the temporary drain line into a suitable calibrated container. **D.** With the isolator switch in the ON position but the engine not running, use a suitable multimeter to measure the input voltage to the EFLP. Record the reading. **E.** With the isolator switch in the ON position but the engine not running, measure the fuel flow from the temporary drain line. **F.** Refer to Illustration 46 or 47 for the minimum acceptable flow rate. **G.** Remove the temporary drain line from the drain port on the TPIR. Connect the TPIR return line to the TPIR.	TPIR flow rate	**Result:** The fuel flow is greater than the minimum limit. Proceed to Test Step 8. **Result:** The fuel flow is less than the minimum limit. Proceed to Test Step 7.

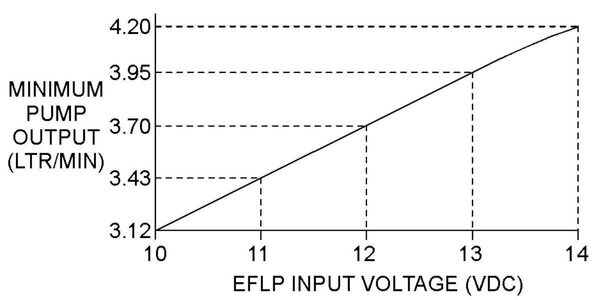


Illustration 48 g02527498

Minimum EFLP flow rate in a 12 VDC system

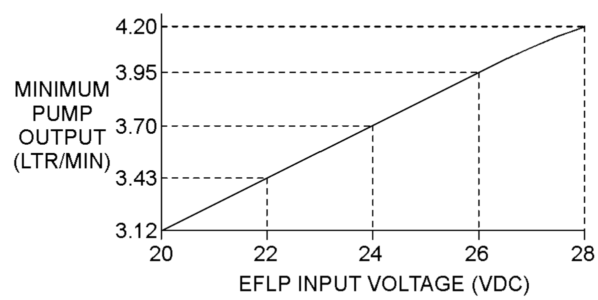


Illustration 49 g02527518

Minimum EFLP flow rate in a 24 VDC system

Table 69

Troubleshooting Test Steps	Values	Results
7. EFLP Flow Test at the Primary Fuel Filter Inlet **A.** Make sure the keyswitch is in the OFF position. **B.** Disconnect the fuel inlet connection from the primary fuel filter head. **C.** Install a suitable blank on the fuel inlet port on the primary fuel filter head. **D.** Place the open end of the fuel inlet line in a suitable calibrated container. **E.** With the keyswitch in the ON position, measure the input voltage at the EFLP. Record the result. **F.** With the keyswitch in the ON position, measure the flow from the fuel inlet line. Record the result. **G.** Check the recorded voltage and fuel flow on the graph in Illustration 48 or 49 .	EFLP flow	**Result:** The fuel flow is below the minimum value for the recorded voltage. **Repair:** Replace the EFLP. Refer to Disassembly and Assembly, "Fuel Priming Pump - Remove and Install ". **Result:** The fuel flow is above the minimum value for the recorded voltage. Proceed to Test Step 8.
8. Check the Return Fuel Lines **A.** Make sure that the TPIR return line is not blocked or kinked. **B.** If the TPIR return line is clear, confirm that the Electric Fuel Lift Pump (EFLP) is operating. Make sure that fuel lines between the EFLP and the TPIR are not blocked or kinked.	Return lines	**Result:** The TPIR return line or the fuel lines between the EFLP and the TPIR are blocked or kinked. **Repair:** Clear or replace the blocked line. **Result:** The TPIR return line and the fuel lines between the EFLP and the TPIR are clear. **Repair:** Replace the EFLP. If the fault is still present, 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 70

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, "Solenoid Valve - 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 70, 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. Starting Aids **A.** Check the operation of the glow plugs. Refer to Troubleshooting, “Glow Plug Starting Aid - Test”. **B.** If equipped, check the operation of the ether starting aid. Refer to Troubleshooting, “Ether 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 13. **Result:** The ether starting aid is faulty. **Repair:** Diagnose the ether system. Refer to Troubleshooting, “Ether Starting Aid - Test”. Check that the engine starts normally. If the engine will not start, proceed to Test Step 13.
13. 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

(continued)

(Table 70, contd)

Troubleshooting Test Steps	Values	Results
		· Damaged cylinder head **Result:** The results of the compression test are OK. Contact the Dealer Solutions Network (DSN).

i06156000

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 71

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 machine electrical schematic.	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.

(continued)

(Table 71, contd)

Troubleshooting Test Steps	Values	Results
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.
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 rear gear group · 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 an injector has been replaced, evacuate any fluids from the cylinder and attempt to start the engine. Fuel will flow from the cylinder head into the cylinders when a unit injector is removed. **B.** 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 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 72

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 72, 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).

i07119342

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 73

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. Fuel Injection **A.** Perform the "Fuel System Verification Test" in the "Diagnostic Tests" under the "Diagnostics" menu.	Fuel system verification test	**Result:** The test was successful. Proceed to Test Step 4. **Result:** The test was not successful. **Repair:** Diagnose and repair the fault. Reset all active codes and clear all logged codes. Verify that the repair eliminated the fault.
4. 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 5. **Result:** The fuel quality is not OK. **Repair:** Replace the fuel. Verify that the repair eliminated the fault.

(continued)

(Table 73, contd)

Troubleshooting Test Steps	Values	Results
5. 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 6. **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.
6. 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 7.
7. 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 8. **Result:** The valve train components are damaged. **Repair:** Make the necessary repairs, Verify that the repair eliminated the fault.

(continued)

(Table 73, contd)

Troubleshooting Test Steps	Values	Results
8. 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 9.
9. 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).

i07905907

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
- Fuel supply
- Transfer Pump Inlet Regulator (TPIR)
- Electric Fuel Lift Pump (EFLP)
- Return fuel lines
- Throttle position sensor
- CAN data link
- High-pressure fuel pump
- Low compression (cylinder pressure)
- Electronic unit injectors
- Individual malfunctioning cylinder
- Sticking NRS Valve (Open)

Recommended Actions

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

Table 74

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. 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 lines that are restricted. **F.** Check that the Electric Fuel Lift Pump (EFLP) is operating. If the EFLP is suspect, refer to Troubleshooting, “Relay - Test (Electric Fuel Lift Pump)”. **G.** Check for air in the fuel system. Refer to Systems Operation, Testing, and Adjusting, “Air in Fuel - Test”. **H.** Obtain a fuel analysis in order 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 EFLP. Replace the primary and secondary fuel filters. Verify that the repair eliminated the fault. Proceed to Test Step 13. **Result:** The fuel quality is OK. Proceed to Test Step 3.

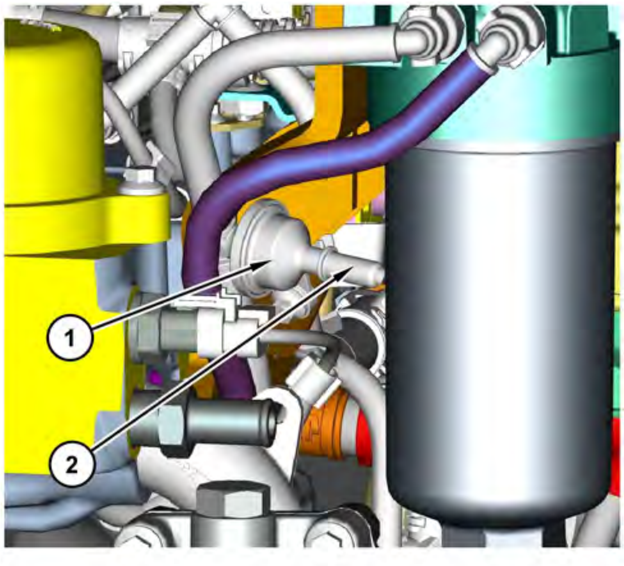


Illustration 50 g03750256

Transfer Pump Inlet Regulator (TPIR) components

(1) Transfer Pump Inlet Regulator (TPIR)
(2) TPIR return port

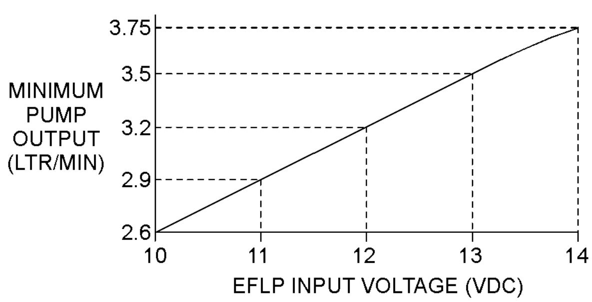


Illustration 51 g02355128

Minimum TPIR flow rate in a 12 VDC system

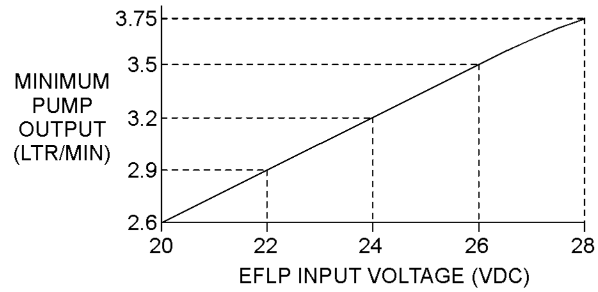


Illustration 52 g02355130

Minimum TPIR flow rate in a 24 VDC system

Table 75

Troubleshooting Test Steps	Values	Results
3. Transfer Pump Inlet Regulator (TPIR) Flow Test Refer to Illustration 50 . **A.** Disconnect the TPIR return line from the drain port on the TPIR. Install a suitable blanking cap on the open port in the TPIR return line. **B.** Connect a temporary drain line to the drain port on the TPIR. **C.** Place the end of the temporary drain line into a suitable calibrated container. **D.** With the isolator switch in the ON position but the engine not running, use a suitable multimeter to measure the input voltage to the EFLP. Record the reading. **E.** With the isolator switch in the ON position but the engine not running, measure the fuel flow from the temporary drain line. **F.** Refer to Illustration 51 or 52 for the minimum acceptable flow rate. **G.** Remove the temporary drain line from the drain port on the TPIR. Connect the TPIR return line to the TPIR.	TPIR flow rate	**Result:** The fuel flow is greater than the minimum limit. Proceed to Test Step 5. **Result:** The fuel flow is less than the minimum limit. Proceed to Test Step 4.

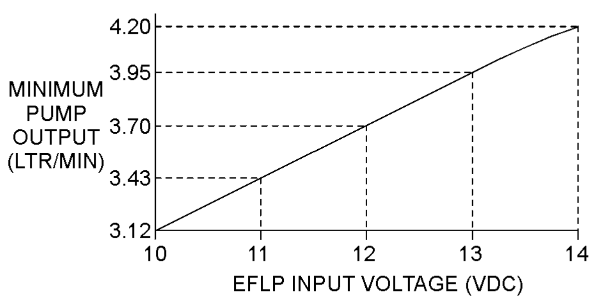


Illustration 53 g02527498

Minimum EFLP flow rate in a 12 VDC system

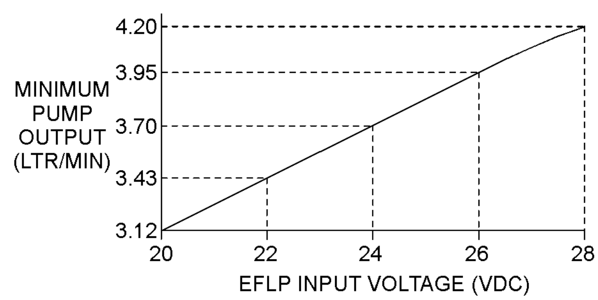


Illustration 54 g02527518

Minimum EFLP flow rate in a 24 VDC system

Table 76

Troubleshooting Test Steps	Values	Results
4. EFLP Flow Test at the Primary Fuel Filter Inlet **A.** Make sure the keyswitch is in the OFF position. **B.** Disconnect the fuel inlet connection from the primary fuel filter head. **C.** Install a suitable blank on the fuel inlet port on the primary fuel filter head. **D.** Place the open end of the fuel inlet line in a suitable calibrated container. **E.** With the keyswitch in the ON position, measure the input voltage at the EFLP. Record the result. **F.** With the keyswitch in the ON position, measure the flow from the fuel inlet line. Record the result. **G.** Check the recorded voltage and fuel flow on the graph in Illustration 53 or 54 .	EFLP flow	**Result:** The fuel flow is below the minimum value for the recorded voltage. **Repair:** Replace the EFLP. Refer to Disassembly and Assembly, “Fuel Priming Pump - Remove and Install”. **Result:** The fuel flow is above the minimum value for the recorded voltage. Proceed to Test Step 5.
5. Check the Return Fuel Lines **A.** Make sure that the TPIR return line is not blocked or kinked. **B.** If the TPIR return line is clear, confirm that the Electric Fuel Lift Pump (EFLP) is operating. Make sure that fuel lines between the EFLP and the TPIR are not blocked or kinked.	Return lines	**Result:** The TPIR return line or the fuel lines between the EFLP and the TPIR are blocked or kinked. **Repair:** Clear or replace the blocked line. Proceed to Test Step 13. **Result:** The TPIR return line and the fuel lines between the EFLP and the TPIR are clear. **Repair:** Replace the EFLP. If the fault is still present, proceed to Test Step 6. If the fault is eliminated, proceed to Test Step 13.
6. 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 13. **Result:** The throttle position sensor response is OK. Proceed to Test Step 7.

(continued)

(Table 76, contd)

Troubleshooting Test Steps	Values	Results
7. 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 13. **Result:** The CAN data link is OK. Proceed to Test Step 8.
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 13. **Result:** The solenoid valve test passes successfully. Proceed to Test Step 9.
9. High-Pressure Fuel Pump **Note:** The fuel injection pump that is installed by the factory is a nonserviceable item. If any fault occurs within the fuel injection pump, the fuel injection pump must be replaced. **A.** Use the electronic service tool to select the correct screen in order to display any diagnostic trouble codes that relate to the fuel injection pump.	HP fuel pump	**Result:** There are diagnostic codes associated with the high-pressure fuel pump. **Repair:** Diagnose the codes. Refer to Troubleshooting, “Troubleshooting with a Diagnostic Code”. If necessary, replace the high-pressure fuel pump. Proceed to Test Step 13. **Result:** The high-pressure fuel pump is OK. Proceed to Test Step 10.
10. 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 13. **Result:** The results of the compression test are OK. Proceed to Test Step 11.

⚠ 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 77

Troubleshooting Test Steps	Values	Results
11. 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 10 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”. Proceed to Test Step 13. **Result:** All injectors are OK. Proceed to Test Step 12.
12. 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. Proceed to Test Step 13. **Result:** The test indicates that all cylinders are OK. Contact the Dealer Solutions Network (DSN).

(continued)

(Table 77, contd)

Troubleshooting Test Steps	Values	Results
13. Check the NRS Valve **A.** Use the electronic service tool to perform the “Air System Motor Valve Verification Test” .	NRS Valve	**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 14.
14. 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 1.0 L (1.05669 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 1.0 L (1.05669 qt). Proceed to Test Step 15.
15. 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).

i06191981

Engine Overspeeds

This procedure covers the following diagnostic trouble code:

Table 78

Diagnostic Trouble Codes for Engine Overspeed			
J1939 Code	**PDL Code**	**Code Description (code descriptions may vary)**	**Comments**
190-15	E362 (1)	Engine Overspeed Warning - Level 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	E362 (3)	Engine Overspeed Warning - Level 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 in order 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 (E362) code will be reset.

If the engine speed exceeds the trip point in the ECM, the warning lamp is illuminated and a 190-x (E362) code is logged. Factory passwords are required in order to clear the code.

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

Probable Causes

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

Recommended Actions

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

Table 79

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. Control the engine speed during steep grades. **Result:** Steep grades are not the cause of the overspeed. Proceed to Test Step 2.
2. 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 not active or logged. Return the unit to service. **Result:** A 190-15, E362 (1), 190-0, or E362 (3) event code is present. Proceed to Test Step 3.
3. Turbocharger or Turbochargers **Note:** The turbocharger or turbochargers that are installed on the engine are nonserviceable items. 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	**Result:** A turbocharger is leaking oil into the intake air. **Repair:** Replace the faulty turbocharger. Proceed to Test Step 5. **Result:** A turbocharger is not leaking oil into the intake air. Proceed to Test Step 4.
4. 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. 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 contains combustible gases. Contact the Dealer Solutions Network (DSN).

(continued)

(Table 79, contd)

Troubleshooting Test Steps	Values	Results
5. 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 1.0 L (1.05669 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 1.0 L (1.05669 qt). Proceed to Test Step 6.
6. 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. 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).

i06191994

Engine Shutdown Occurrence

The “Delayed Engine Shutdown” (DES) feature allows the engine to run after the keyswitch has been turned to the OFF position. “Delayed Engine Shutdown” (DES) allows the engine and exhaust temperatures to cool to an acceptable level prior to shutting the engine down. If the delayed engine shutdown is aborted, potential damage to the engine and/or aftertreatment system can occur. These fault codes may indicate that the engine was shut down while the exhaust temperatures were still above the acceptable threshold.

Use this procedure in order to troubleshoot the following event codes.

Table 80

Diagnostic Trouble Codes for Engine Shutdown Occurrence			
J1939 Code	PDL Code	Code Description (code descriptions may vary)	Comments
N/A	E265 (1)	User Defined Shut down	The inputs from the user-defined shutdown switch to the Electronic Control Module (ECM) have changed states. The engine will shut down. The code is logged.
5272-31	E268 (1)	Unexpected Engine Shutdown	The engine was stopped before cooling of the exhaust system could complete. Delayed Engine Shutdown (DES) was not allowed to complete.
6588-31	E1466(1)	Operator Shutdown With High Exhaust Temperature	The Engine was stopped before cooling of the exhaust system could complete. Allow Delayed Engine Shutdown to complete.

Probable Causes for a 6588-31 or E1466 Code

- An operator turning the keyswitch to the fourth position or forcing a shutdown prior to DES completing
- DES may not be enabled
- Fuel ran out prior to DES completion
- Mechanical failure causing the engine to stop prior to DES completion

Probable Causes for a E265 Code

- Activated shutdown switch
- Circuit for the shutdown switch

Probable Causes for a 5272-31 or E268 Code

- Operator caused the engine to stall
- Fuel supply
- Mechanical Failure

Table 81

Associated Diagnostic Trouble Codes	
J1939 Code	PDL Code
4215-31	E678 (1)
592-31	E1217 (3)

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

Table 82

Troubleshooting Test Steps	Values	Results
1. Determine the Code **A.** Establish communication between the electronic service tool and the ECM. Refer to Troubleshooting, “Electronic Service Tools”, if necessary. **B.** Determine the event code.	Active codes	**Result:** An associated code is active. **Repair:** Refer to Troubleshooting, “Event Codes” in order to troubleshoot the associated diagnostic code. **Note:** Troubleshoot the associated code before continuing with this procedure. **Result:** An E265 (1) code is active or logged. Proceed to Test Step 6. **Result:** A 5272-31 or E268 (1) code is active or logged. Proceed to Test Step 3. **Result:** A 6588-31 or E1466 (1) code is active or logged. Proceed to Test Step 2.
2. Delayed Engine Shutdown **Note:** This Test Step is only applicable to applications that do not have a DEF injector cooling tank. Applications that have a DEF injector cooling tank should have Delayed Engine Shutdown disabled. For these applications, proceed to Test Step 3. **A.** Check if “Delayed Engine Shutdown” is enabled. **B.** Connect to the electronic service tool and then navigate to the “Configuration” tab in the engine ECM. Select the “Delayed Engine Shutdown” tab and check the status of the parameter.	Delayed engine shutdown	**Result:** “Delayed Engine Shutdown” is enabled. Proceed to Test Step 3. **Result:** “Delayed Engine Shutdown” is not enabled. **Repair:** Enable “Delayed Engine Shutdown” . Verify that enabling “Delayed Engine Shutdown” eliminated the fault.
3. Correct Engine Operation **A.** Interview the operator and determine the events that caused the engine to stall. **Note:** Delayed engine shutdown (DES) may not have completed.	Operator	**Result:** The operator is operating the engine correctly. Proceed to Test Step 4. **Result:** The operator is not operating the engine correctly. **Repair:** Make sure that the operator understands correct engine operation.
4. Fuel **A.** Check the engine fuel supply.	Fuel	**Result:** The engine is out of fuel. **Repair:** Fill the fuel tank with fuel of the correct specification. Verify that the repair eliminated the fault. **Result:** The engine is not out of fuel. Proceed to Test Step 5.

(continued)

(Table 82, contd)

Troubleshooting Test Steps	Values	Results
5. Mechanical Failure **A.** Check for a mechanical failure.	Mechanical failure	**Result:** A mechanical failure has occurred. **Repair:** Diagnose and then repair the fault. Verify that the repair eliminated the fault.
6. Activated Shutdown Switch **A.** Interview the operator and determine the reason for the emergency stop shutdown.	Emergency shutdown switch	**Result:** The emergency stop shutdown was activated. **Repair:** Diagnose and repair the fault. Verify that the repair eliminated the fault. **Result:** The emergency shutdown was not activated. Proceed to Test Step 7.
7. Check the Emergency Shutdown Switch Circuit **A.** Inspect the stop switches for evidence of damage that has been caused by vibration, moisture, or corrosion. **B.** Check the circuit for the shutdown switch. Refer to Troubleshooting, "Shutdown (Ground Level) - Test".	Emergency shutdown switch circuit	**Result:** The emergency stop shutdown switch is not operating correctly or there is a fault in the emergency shutdown circuit. **Repair:** Repair or replace the failed component. Verify that the repair eliminated the fault. If the fault is still present, contact the Dealer Solutions Network (DSN).

i06192372

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 83

Associated Diagnostic Trouble Codes	
J1939 Code	**PDL Code**
3719-0	E995 (3)
3719-16	E995 (2)
5246-0	E1389 (3)
5272-31	E268 (1)

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. 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 83	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. **Note:** 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.	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.
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.

(continued)

(Table 84, contd)

Troubleshooting Test Steps	Values	Results
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.
8. 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).

i06192374

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 85

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.** Check whether the power mode control is using the Perkins data link or the CAN data link and then use the appropriate test. Refer to Troubleshooting, “Data Link - Test” or 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 85, 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 Fuel Lift Pump (EFLP). **G.** Check that the EFLP is operating correctly. **H.** Replace the primary and secondary fuel filters. **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 Pump Relay Circuit - Test". Replace the primary fuel filter and the secondary fuel filters. 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 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 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. **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 6.

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 86

Troubleshooting Test Steps	Values	Results
6. 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 5 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. Contact the Dealer Solutions Network (DSN).

i06192387

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 or turbochargers
- Fuel supply
- Transfer Pump Inlet Regulator (TPIR)
- Electric Fuel Lift Pump (EFLP)
- Return fuel lines
- Low compression (cylinder pressure)
- Electronic unit injectors
- Individual malfunctioning cylinders

Table 87

Associated Diagnostic Trouble Codes	
J1939 Code	**PDL Code**
157-18	E398 (2)

Recommended Actions

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

Table 88

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.	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.

(continued)

(Table 88, contd)

Troubleshooting Test Steps	Values	Results
5. Throttle Signal **A.** Use the electronic service tool and observe the signal for the throttle. 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 Troubleshooting, “Speed Control (Analog) - Test” or refer to Troubleshooting, “Speed Control (PWM) - Test”. If the engine has a multi-position Throttle switch, refer to Troubleshooting, “Switch Circuits - Test”. **Result:** The throttle signal is OK. Proceed to Test Step 6.
6. Air Intake and Exhaust System **A.** Check the air filter restriction indicator, if equipped. **B.** Check the air inlet and exhaust system for restrictions and/or leaks.	Restrictions	**Result:** The air filter is plugged. **Repair:** Clean or replace the air filter. Refer to the Operation and Maintenance Manual for further information. **Result:** There are restrictions in the air inlet or exhaust system. **Repair:** Make the necessary repairs, Verify that the repair eliminated the fault. **Result:** There are no restrictions in the air inlet or exhaust system. For engines with a single turbocharger, proceed to Test Step 7. For engines with a two turbochargers, proceed to Test Step 8.
7. Turbocharger A. Check for the correct operation of the turbocharger.	Turbocharger	**Result:** The turbocharger is not operating correctly. **Repair:** Repair or replace the turbocharger. Verify that the repair eliminated the fault. **Result:** The turbocharger is operating correctly. Proceed to Test Step 9.
8. Turbochargers A. Check for correct operation of the turbochargers.	Turbochargers	**Result:** The turbochargers are not operating correctly. **Repair:** Repair or replace the faulty turbocharger. Verify that the repair eliminated the fault. **Result:** The turbochargers are operating correctly. 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 89

Troubleshooting Test Steps	Values	Results
9. 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 Fuel Lift Pump (EFLP). **H.** Replace the primary and secondary fuel filters. **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 and the secondary fuel filters. 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 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 fuel supply is OK. Proceed to Test Step 10.

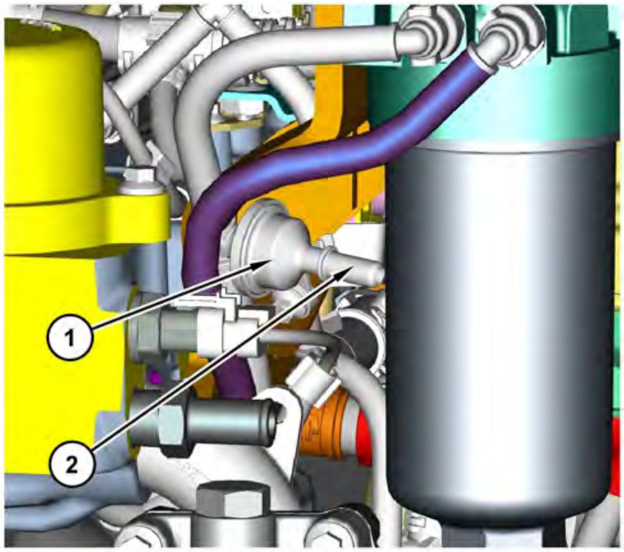


Illustration 55 g03750256

Transfer Pump Inlet Regulator (TPIR) components

(1) Transfer Pump Inlet Regulator (TPIR)
(2) TPIR return port

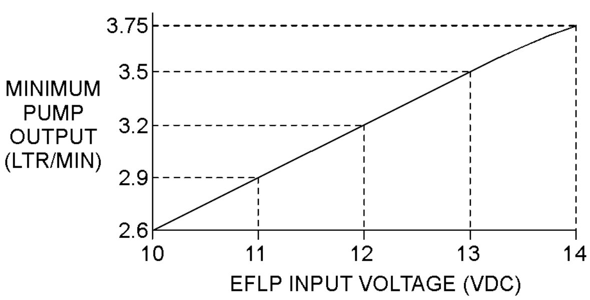


Illustration 56 g02355128

Minimum TPIR flow rate in a 12 VDC system

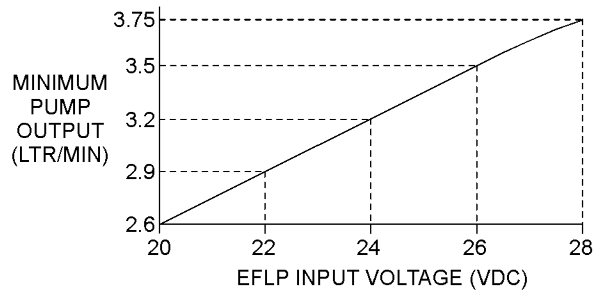


Illustration 57 g02355130

Minimum TPIR flow rate in a 24 VDC system

Table 90

Troubleshooting Test Steps	Values	Results
10. Transfer Pump Inlet Regulator (TPIR) Flow Test Refer to Illustration 55 . **A.** Disconnect the TPIR return line from the drain port on the TPIR. Install a suitable blanking cap on the open port in the TPIR return line. **B.** Connect a temporary drain line to the drain port on the TPIR. **C.** Place the end of the temporary drain line into a suitable calibrated container. **D.** With the isolator switch in the ON position but the engine not running, use a suitable multimeter to measure the input voltage to the EFLP. Record the reading. **E.** With the isolator switch in the ON position but the engine not running, measure the fuel flow from the temporary drain line. **F.** Refer to Illustration 56 or 57 for the minimum acceptable flow rate. **G.** Remove the temporary drain line from the drain port on the TPIR. Connect the TPIR return line to the TPIR.	TPIR flow rate	**Result:** The fuel flow is greater than the minimum limit. Proceed to Test Step 12. **Result:** The fuel flow is less than the minimum limit. Proceed to Test Step 11.

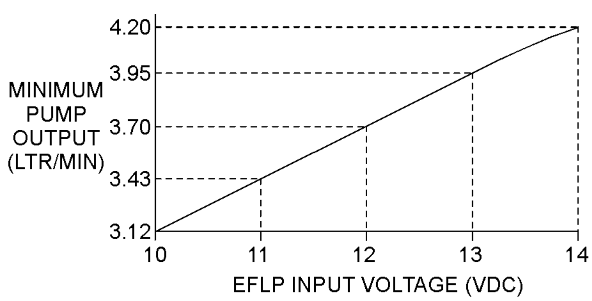


Illustration 58 g02527498

Minimum EFLP flow rate in a 12 VDC system

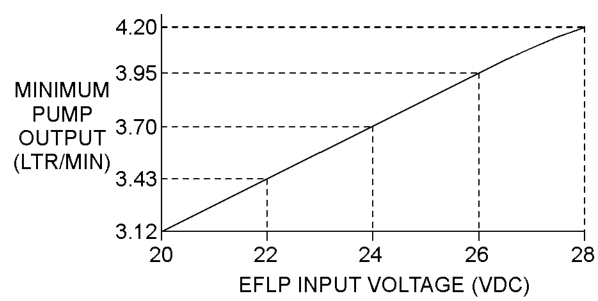


Illustration 59 g02527518

Minimum EFLP flow rate in a 24 VDC system

Table 91

Troubleshooting Test Steps	Values	Results
11. EFLP Flow Test at the Primary Fuel Filter Inlet **A.** Make sure the keyswitch is in the OFF position. **B.** Disconnect the fuel inlet connection from the primary fuel filter head. **C.** Install a suitable blank on the fuel inlet port on the primary fuel filter head. **D.** Place the open end of the fuel inlet line in a suitable calibrated container. **E.** With the keyswitch in the ON position, measure the input voltage at the EFLP. Record the result. **F.** With the keyswitch in the ON position, measure the flow from the fuel inlet line. Record the result. **G.** Check the recorded voltage and fuel flow on the graph in Illustration 58 or 59 .	EFLP flow	**Result:** The fuel flow is below the minimum value for the recorded voltage. **Repair:** Replace the EFLP. Refer to Disassembly and Assembly, "Fuel Priming Pump - Remove and Install ". **Result:** The fuel flow is above the minimum value for the recorded voltage. Proceed to Test Step 12.
12. Check the Return Fuel Lines **A.** Make sure that the TPIR return line is not blocked or kinked. **B.** If the TPIR return line is clear, confirm that the Electric Fuel Lift Pump (EFLP) is operating. Make sure that fuel lines between the EFLP and the TPIR are not blocked or kinked.	Return lines	**Result:** The TPIR return line or the fuel lines between the EFLP and the TPIR are blocked or kinked. **Repair:** Clear or replace the blocked line. **Result:** The TPIR return line and the fuel lines between the EFLP and the TPIR are clear. **Repair:** Replace the EFLP. If the fault is still present, proceed to Test Step 13.
13. 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 14.

(continued)

(Table 91, contd)

Troubleshooting Test Steps	Values	Results
14. 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 13 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 15.
15. 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. **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).

i06192388

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
- Vibration damper
- 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 92

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 the engine is operated through the speed range. Check for mounts and brackets that are loose and/or broken. **B.** Check the alignment of the mounts before operating the engine under load for any length of time.	Engine supports	**Result:** The mounts and brackets are loose and/or broken. **Repair:** 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. Inspect the Vibration Damper **A.** Clean any debris from around the vibration damper. Check the vibration damper for damage or leakage. **B.** Inspect the mounting bolts for damage and/or for wear. Refer to Disassembly and Assembly, “Vibration Damper and Pulley - Remove” and Disassembly and Assembly, “Vibration Damper and Pulley - Install”.	Vibration damper	**Result:** The vibration damper or the mounting bolts are damaged. **Repair:** Replace the damaged vibration damper or the damaged mounting bolts. **Result:** The vibration damper or the mounting bolts are not damaged. 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 92, contd)

Troubleshooting Test Steps	Values	Results
5. 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 4 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 6.
6. 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).

i06193302

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
- Valve lash
- Turbocharger or turbochargers
- Low compression (cylinder pressure)
- Electronic unit injectors
- Individual malfunctioning cylinder

Recommended Actions

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

Table 93

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.** Observe the check engine lamp. Check for an air filter restriction indicator, if equipped. Replace a plugged air filters. Refer to the Operation and Maintenance Manual. **B.** Check the air inlet and exhaust system for restrictions and/or leaks.	Restrictions	**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:** There are no restrictions in the air inlet or exhaust system. Proceed to Test Step 4.
4. 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. For engines with a single turbocharger, proceed to Test Step 5. For engines with two turbochargers, proceed to Test Step 6.

(continued)

(Table 93, contd)

Troubleshooting Test Steps	Values	Results
5. Turbocharger **Note:** This Test Step is only applicable to engines with a single 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. **F.** Ensure that the wastegate on the turbocharger is adjusted correctly. Refer to Systems Operation, Testing, and Adjusting, “Turbocharger - Inspect”. If the wastegate actuator is faulty, replace the turbocharger. Refer to Disassembly and Assembly, “Turbocharger - Remove” and Disassembly and Assembly, “Turbocharger - Install”.	Turbocharger	**Result:** There is a fault in the turbocharger. **Repair:** Repair the turbocharger or 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 7.
6. Turbochargers **Note:** This Test Step is only applicable to engines with two turbochargers. **Note:** The turbochargers that are installed on the engine are non-serviceable items. If any mechanical fault exists, then the faulty turbocharger must be replaced. **A.** Ensure that the mounting bolts for the turbochargers are tight. **B.** Check that the oil drains for the turbochargers are not blocked or restricted. **C.** Check that the compressor housings for the turbochargers are free of dirt and debris. Make sure that the housings are not damaged. **D.** Check that the turbine housings for the turbochargers are free of dirt and debris. Make sure that the housings are not damaged. **E.** Check that the turbine blades rotate freely in the turbochargers.	Turbocharger	**Result:** There is a fault in one of the turbochargers. **Repair:** Repair the turbocharger or replace the turbocharger. Refer to Disassembly and Assembly, “Turbocharger - Remove” and Disassembly and Assembly, “Turbocharger - Install”. **Result:** The turbochargers are OK. Proceed to Test Step 7.

(continued)

(Table 93, contd)

Troubleshooting Test Steps	Values	Results
F. Ensure that the wastegate on the high-pressure turbocharger is adjusted correctly. Refer to Systems Operation, Testing, and Adjusting, "Turbocharger - Inspect". If the wastegate actuator is faulty, replace the turbocharger. Refer to Disassembly and Assembly, "Turbocharger - Remove" and Disassembly and Assembly, "Turbocharger - Install".		
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 94

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. 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).

i07715460

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
- Ether injection
- 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 95

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 between 5° C (41° F) and −25° C (−13° F). **A.** Check operation of glow plugs. Verify that the glow plugs are operating correctly. Refer to Troubleshooting, “Glow Plug Starting Aid - Test”. **B.** Check the configuration screen on the electronic service tool to verify that ether injection is not enabled.	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. Ether Injection **Note:** A faulty ether starting aid will only affect the production of white smoke when the ambient temperature is below −25° C (−13° F). **A.** Use the electronic service tool to test the ether starting aid.	Glow plugs	**Result:** The ether starting aid is faulty. **Repair:** Test the ether system. Refer to Troubleshooting, “Ether Starting Aid - Test”. **Result:** The ether starting aid is operating correctly. Proceed to Test Step 5.

(continued)

(Table 95, contd)

Troubleshooting Test Steps	Values	Results
5. 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 6.
6. 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 7.
7. 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 8.
8. 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 12. **Result:** The valve lash is correct. Proceed to Test Step 9.

(continued)

(Table 95, contd)

Troubleshooting Test Steps	Values	Results
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 12. **Result:** The results of the compression test are OK. Proceed to Test Step 10.
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 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”. Proceed to Test Step 12. **Result:** All injectors are OK. Proceed to Test Step 11.

(continued)

(Table 95, contd)

Troubleshooting Test Steps	Values	Results
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).
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 1.0 L (1.05669 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 1.0 L (1.0 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).

i06078724

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 96

Troubleshooting Test Steps	Values	Results
1. NRS cooler **A.** Check the NRS cooler for leaks for utilizing the "On Engine Test Procedure" . 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.

(continued)

(Table 96, contd)

Troubleshooting Test Steps	Values	Results
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.
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 additional diagnostic codes. **Repair:** Troubleshoot the additional codes. Refer to Troubleshooting, “Diagnostic Trouble Codes” manual for the correct procedure.

i07124144

Exhaust System Contains Oil

Probable Causes

- Extended idle times
- Failed turbocharger seals
- Worn valve guide seals or faulty valve guide seals
- Worn valve guides
- Worn piston rings

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

Table 97

Troubleshooting Test Steps	Values	Results
1. Extended Idle Times **A.** Extended idle times will allow oil to pass into the exhaust system.	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. Failed Turbocharger Seals **A.** Check the inlet manifold and the exhaust manifold for oil.	Turbo seals	**Result:** Oil is present in the inlet or exhaust manifold. **Repair:** Replace the turbocharger. Verify the repair. Proceed to Test Step 6. **Result:** Oil is not present in the inlet or exhaust manifold. 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.
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 **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).

(continued)

(Table 97, contd)

Troubleshooting Test Steps	Values	Results
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 1.0 L (1.05669 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 1.0 L (1.0 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. **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).

i07861167

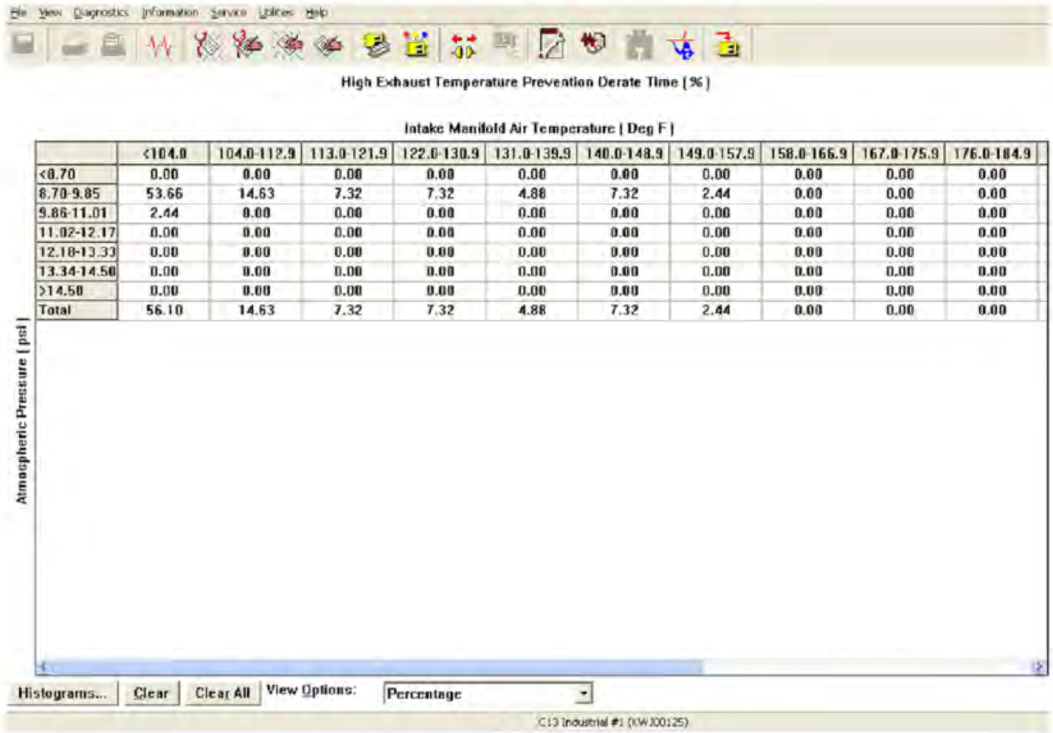
Exhaust Temperature Is High

The Electronic Control Module (ECM) monitors the temperature sensor in the outlet from the low-pressure 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 in order 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
- Engine operating conditions
- Failed exhaust back pressure 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 60 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 in order 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 98

Troubleshooting Test Steps	Values	Results
1. Check for Inlet System Leakage **A.** Apply a light load to the engine and check for leakage from the inlet system downstream of the low-pressure turbocharger.	Boost leaks	**Result:** Leakage was found. **Repair:** Repair the leaks. Return the unit to service. **Result:** Leakage was not 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 Exhaust Back Pressure Regulator (EBPR) **A.** Check the EBPR for correct operation. Refer to Troubleshooting, “Motorized Valve - Test” for the correct troubleshooting procedure. **Note:** An EBPR that has failed in the closed position can cause high exhaust temperatures.	Failed exhaust back pressure regulator	**Result:** The exhaust back pressure regulator has failed. **Repair:** Repair or replace the valve. Return the unit to service. **Result:** The exhaust back pressure regulator has not failed. Proceed to Test Step 4.
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).

i06157556

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 99

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”. **Result:** The fuel quality meets specifications. Proceed to Test Step 5.

(continued)

(Table 99, contd)

Troubleshooting Test Steps	Values	Results
5. 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 6.
6. 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 7.
7. 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 8.
8. Air Intake and Exhaust System **A.** Check the air filter restriction indicator, if equipped. **B.** Check the air intake and exhaust systems for the following defects: · Blockages · Restrictions · Damage to lines or hoses	Air and Exhaust System restrictions	**Result:** The air filter is restricted. **Repair:** Replace the air filter. **Result:** There are system restrictions. **Repair:** Refer to Systems Operation/Testing and Adjusting, “Air Inlet and Exhaust System” for additional information on the air inlet and exhaust systems. **Result:** The air intake and exhaust system is OK. Proceed to Test Step 9.

(continued)

(Table 99, contd)

Troubleshooting Test Steps	Values	Results
9. 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 10.
10. 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 11.
11. 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 12.
12. 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).

i06157567

Fuel Contains Water

This procedure covers the following diagnostic code:

Table 100

Diagnostic Trouble Code for Water in Fuel			
J1939 Code	PDL Code	Code Description (code descriptions may vary)	Comments
97-15	E232 (1)	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 40 seconds. The warning lamp will come on.
97-16	E232 (2)	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 17.5% per second up to a maximum of 35%.

Note: Visual identification of water in the bowl may be impossible. Water may turn dark yellow in color 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 101

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).

i07597212

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 102

Diagnostic Trouble Codes for Fuel Rail Pressure Problem			
J1939 Code	**PDL Code**	**Code Description (Code descriptions may vary)**	**Comments**
157-16	E396 (2)	Engine Injector Metering Rail #1 Pressure: High - moderate severity (2)	No other 157-XX or 1797-XX codes are active. 3509-XX or 262-XX codes are not active. 3510-XX or 2131-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	E398 (2)	Engine Injector Metering Rail #1 Pressure: Low - moderate severity (2)	No other 157-XX or 1797-XX codes are active. 3509-XX or 262-XX codes are not active. 3510-XX or 2131-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.
1239-0	E499 (3)	Engine Fuel Leakage 1: High - most severe (3)	3509-XX or 262-XX codes are not active. 3510-XX or 2131-XX codes are not active. There is a probable fuel leak from the high-pressure fuel system. The amount of leakage is a calculated parameter. The code is logged. The engine will shut down.
5571-0	E1264 (2)	High Pressure Common Rail Fuel Pressure Relief Valve : Active	3509-XX or 262-XX codes are not active. 3510-XX or 2131-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 fuel rail pressure
- Transfer Pump Inlet Regulator (TPIR)
- Transfer Pump Inlet Regulator (TPIR) return
- Return fuel lines
- Low fuel rail pressure
- Transfer Pump Inlet Regulator (TPIR)
- Transfer Pump Inlet Regulator (TPIR) Return
- Electric Fuel Lift Pump (EFLP)
- Return fuel lines

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 103

Troubleshooting Test Steps	Values	Results
1. Diagnostic Codes **A.** Connect the electronic service tool to the diagnostic connector. Refer to Troubleshooting, “Electronic Service Tools”, if necessary. **B.** Download the Warranty Report and the Product Status Report (PSR) with Histograms before diagnosing the fault. **Note:** The downloaded information will be required by the Dealer Solutions Network (DSN) if diagnostic assistance is needed. **C.** Determine if a diagnostic is active or recently logged.	Diagnostic codes	**Result:** A code other than the codes in Table 102 is present. **Repair:** Troubleshoot the code. Refer to the applicable troubleshooting procedure. **Result:** One of the codes in Table 102 is present. Proceed to Test Step 2.
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 Dealer Solutions Network (DSN) if diagnostic assistance is needed.	Diagnostic Codes	**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. 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 and on the Suction Control Valve for 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 4.
4. Fuel Filters **A.** Replace the in-line fuel filter that is upstream of the electric fuel lift pump (if equipped). Refer to the Operation and Maintenance Manual for further information. If an in-line fuel filter is not installed, replace the fuel strainer on the fuel tank pickup pipe. Refer to the documentation for the machine. **B.** Replace the primary fuel filter and the secondary fuel filters. Refer to the Operation and Maintenance Manual for further information. **C.** If equipped, check the Fuel Tank Breather and replace if necessary.	Fuel filters	**Result:** The filters have been replaced and the fault is eliminated. Return the unit to service. **Result:** The filters have been replaced and the fault is still present. Proceed to Test Step 5.

(continued)

(Table 103, contd)

Troubleshooting Test Steps	Values	Results
5. Fuel Rail Pressure Sensor **A.** Make sure that the engine has been stopped 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 Troubleshooting, "Sensor Signal (analog, Active) - Test". Use the electronic service tool to perform the "Fuel Rail Pressure Test" . If the test fails, replace the fuel rail. Refer to Disassembly and Assembly, "Fuel Manifold (Rail) - Remove and Install". Confirm that the fault has been eliminated. **Result:** The "Fuel Rail Pressure (absolute)" is less than 5,000 kPa (725 psi). For a high fuel rail pressure symptom, proceed to Test Step 6. For a low fuel rail pressure symptom, proceed to Test Step 11.
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" . Use the electronic service tool to perform the "Fuel Rail Pressure Test" . If the "Fuel Rail Pressure Test" is successful, return the unit to service. If the "Fuel Rail Pressure Test" generates additional diagnostic codes, troubleshoot the additional codes. Refer to Troubleshooting, Diagnostic Trouble Codes or Troubleshooting, Event Codes. **Result:** Fuel rail pressure is still high after performing the "High Pressure Fuel Pump Calibration" . **Repair:** Run the engine for a minimum of 30 minutes. Proceed to Test Step 7.

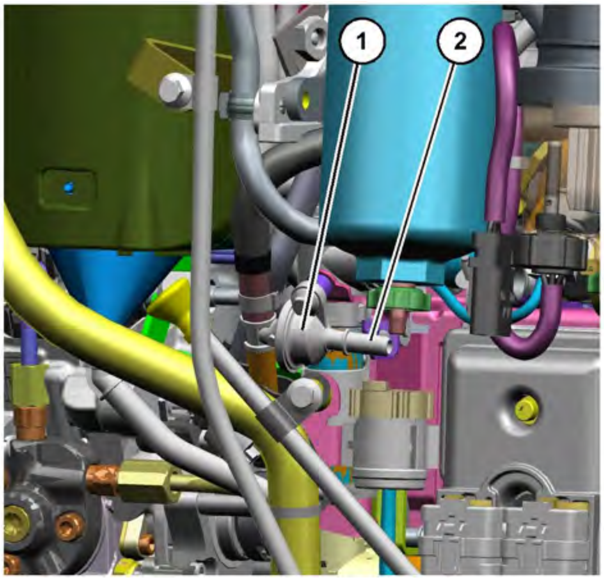


Illustration 61 g06231813

Transfer Pump Inlet Regulator (TPIR) components

(1) Transfer Pump Inlet Regulator (TPIR)
(2) TPIR return port

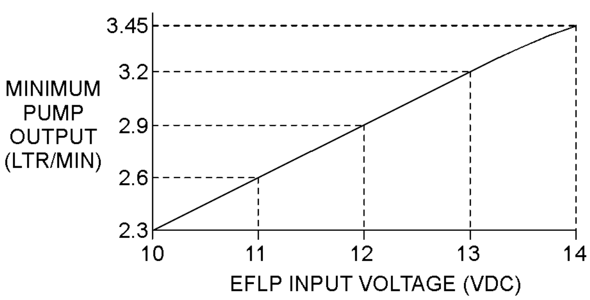


Illustration 62 g02485896

Minimum TPIR flow rate in a 12 VDC system

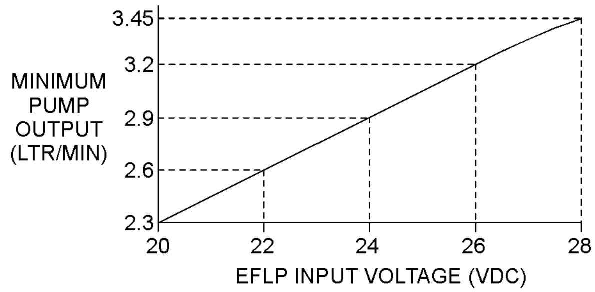


Illustration 63 g02485897

Minimum TPIR flow rate in a 24 VDC system

Table 104

Troubleshooting Test Steps	Values	Results
7. Transfer Pump Inlet Regulator (TPIR) Flow Test **Note:** When performing the following fuel system tests, the Electric Fuel Lift Pump (EFLP) will only operate for 2 minutes unless the engine is running. If necessary, cycle the keyswitch to reactivate the pump. Refer to Illustration 61 . **A.** Disconnect the TPIR return line from the drain port on the TPIR. Install a suitable blanking cap on the open port in the TPIR return line. **B.** Connect a temporary drain line to the drain port on the TPIR. **C.** Place the end of the temporary drain line into a suitable calibrated container. **D.** With the isolator switch in the ON position but the engine not running, use a suitable multimeter to measure the input voltage to the EFLP. Record the reading. **E.** With the isolator switch in the ON position but the engine not running, measure the fuel flow from the temporary drain line. **F.** Refer to Illustration 62 or 63 for the minimum acceptable flow rate. **G.** Remove the temporary drain line from the drain port on the TPIR. Connect the TPIR return line to the TPIR.	TPIR flow rate	**Result:** The fuel flow is greater than the minimum limit. Proceed to Test Step 9. **Result:** The fuel flow is less than the minimum limit. Proceed to Test Step 8.

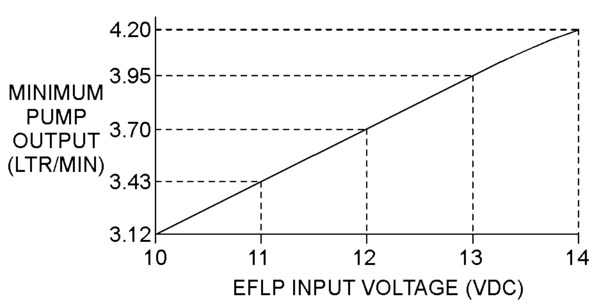


Illustration 64 g02527498

Minimum EFLP flow rate in a 12 VDC system

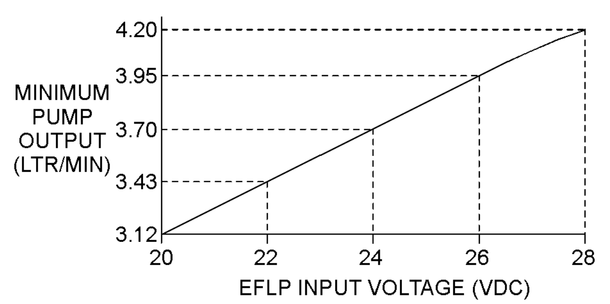


Illustration 65 g02527518

Minimum EFLP flow rate in a 24 VDC system

Table 105

Troubleshooting Test Steps	Values	Results
8. EFLP Flow Test at the Primary Fuel Filter Inlet **A.** Make sure the keyswitch is in the OFF position. **B.** Disconnect the fuel inlet connection from the primary fuel filter head. **C.** Install a suitable blank on the fuel inlet port on the primary fuel filter head. **D.** Place the open end of the fuel inlet line in a suitable calibrated container. **E.** With the keyswitch in the ON position, measure the input voltage at the EFLP. Record the result. **F.** With the keyswitch in the ON position, measure the flow from the fuel inlet line. Record the result. **G.** Check the recorded voltage and fuel flow on the graph in Illustration 64 or 65 .	EFLP flow	**Result:** The fuel flow is below the minimum value for the recorded voltage. **Repair:** Replace the EFLP. Refer to Disassembly and Assembly, “Fuel Priming Pump - Remove and Install”. **Result:** The fuel flow is above the minimum value for the recorded voltage. Proceed to Test Step 9.
9. Transfer Pump Inlet Regulator (TPIR) Return Test **A.** Make sure that the TPIR return line is not blocked or kinked. **B.** Check that the Electric Fuel Lift Pump (EFLP) is operating correctly.	TPIR return line	**Result:** The TPIR return line is blocked or kinked. **Repair:** Clear the TPIR return line or replace the line Confirm that the fault is eliminated. **Result:** The EFLP is not operating correctly. **Repair:** Refer to Troubleshooting, “Relay - Test”. **Result:** The TPIR return line and the EFLP are OK. Proceed to Test Step 10.

(continued)

(Table 105, contd)

Troubleshooting Test Steps	Values	Results
10. Check the Return Fuel Lines **A.** Make sure that the TPIR return line is not blocked or kinked. **B.** If the TPIR return line is clear, confirm that the Electric Fuel Lift Pump (EFLP) is operating. Make sure that fuel lines between the EFLP and the TPIR are not blocked or kinked.	Return lines	**Result:** The TPIR return line or the fuel lines between the EFLP and the TPIR are blocked or kinked. **Repair:** Clear or replace the blocked line. **Result:** The TPIR return line and the fuel lines between the EFLP and the TPIR are clear. **Repair:** Replace the EFLP. If the fault is still present, contact the DSN and provide the Warranty Report, PSR and Snapshot Data as saved in steps 1 and 2.
11. Low Fuel Rail Pressure **A.** Visually check the fuel tank for fuel. **Note:** The fuel gauge may be faulty. **B.** Inspect the high-pressure fuel system for leaks. **C.** Use the electronic service tool to perform the “High Pressure Fuel Pump Calibration” . **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 or not correctly installed. **G.** Replace the in-line fuel filter that is installed upstream of the Electric Fuel Lift Pump (EFLP). **H.** Check that the EFLP is operating correctly. **I.** Replace the primary fuel filter and the secondary fuel filters. Refer to the Operation and Maintenance Manual for further information. **J.** Check for air in the fuel system and that the fuel system is primed. **K.** Check the diesel fuel for contamination. Refer to Systems Operation, Testing, and Adjusting, “Fuel Quality - Test”. **L.** Use the electronic service tool to perform the “Fuel Rail Pressure Relief Valve Test” . **Note:** This test will identify excessive leakage through the Pressure Limiting Valve (PLV) in the fuel rail.	Low-pressure 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. **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 EFLP is not operating correctly. **Repair:** Investigate the fault with the EFLP. Refer to Troubleshooting, “Relay - 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:** “Fuel Rail Pressure Relief Valve Test” fails **Repair:** Replace the Fuel Rail Pressure Relief Valve. Refer to Disassembly & Assembly, “Relief Valve (Fuel) - Remove and Install”.

(continued)

(Table 105, contd)

Troubleshooting Test Steps	Values	Results
		Result: “Fuel Rail Pressure Relief Valve Test” passes **Repair:** The Fuel Rail Pressure Relief Valve is operating correctly and should not be replaced. **Result:** The low-pressure fuel system is OK. Before performing the following fuel system tests, the engine must be run for a minimum of 30 minutes. Proceed to Test Step 12.

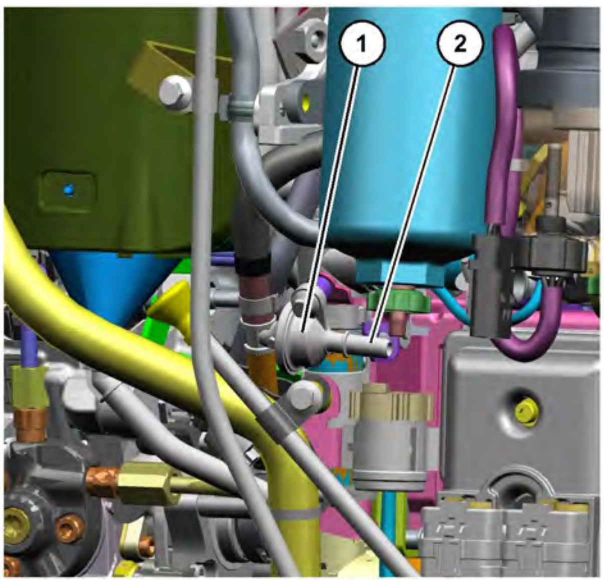


Illustration 66 g06231813

Transfer Pump Inlet Regulator (TPIR) components

(1) Transfer Pump Inlet Regulator (TPIR)
(2) TPIR return port

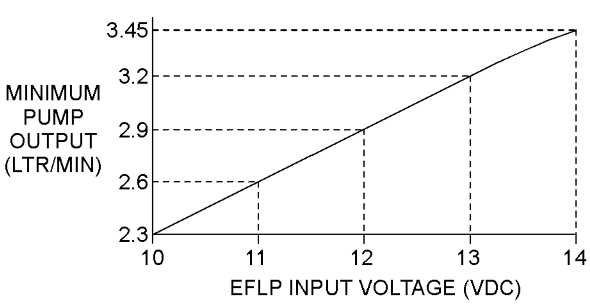


Illustration 67 g02485896

Minimum TPIR flow rate in a 12 VDC system

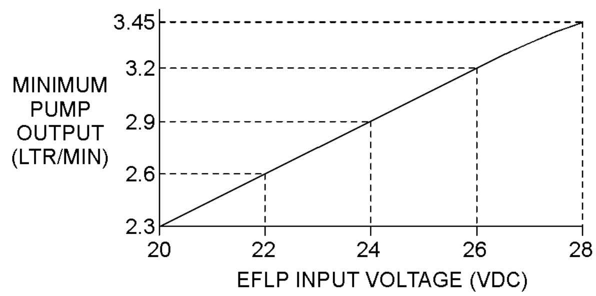


Illustration 68 g02485897

Minimum TPIR flow rate in a 24 VDC system

Table 106

Troubleshooting Test Steps	Values	Results
12. Transfer Pump Inlet Regulator (TPIR) Flow Test **Note:** When performing the following fuel system tests, the Electric Fuel Lift Pump (EFLP) will only operate for 2 minutes unless the engine is running. If necessary, cycle the keyswitch to reactivate the pump. Refer to Illustration 66 . **A.** Disconnect the TPIR return line from the drain port on the TPIR. Install a suitable blanking cap on the open port in the TPIR return line. **B.** Connect a temporary drain line to the drain port on the TPIR. **C.** Place the end of the temporary drain line into a suitable calibrated container. **D.** With the isolator switch in the ON position but the engine not running, use a suitable multimeter to measure the input voltage to the EFLP. Record the reading. **E.** With the isolator switch in the ON position but the engine not running, measure the fuel flow from the temporary drain line. **F.** Refer to Illustration 67 or 68 for the minimum acceptable flow rate. **G.** Remove the temporary drain line from the drain port on the TPIR. Connect the TPIR return line to the TPIR.	TPIR flow rate	**Result:** The fuel flow is greater than the minimum limit. Proceed to Test Step 14. **Result:** The fuel flow is less than the minimum limit. Proceed to Test Step 13.
13. Transfer Pump Inlet Regulator (TPIR) Return Test **A.** Make sure that the TPIR return line is not blocked or kinked. **B.** Check that the Electric Fuel Lift Pump (EFLP) is operating correctly.	TPIR return line	**Result:** The TPIR return line is blocked or kinked. **Repair:** Clear the TPIR return line or replace the line Confirm that the fault is eliminated. **Result:** The EFLP is not operating correctly. **Repair:** Refer to Troubleshooting, “Relay - Test”. **Result:** The TPIR return line and the EFLP are OK. Proceed to Test Step 14.

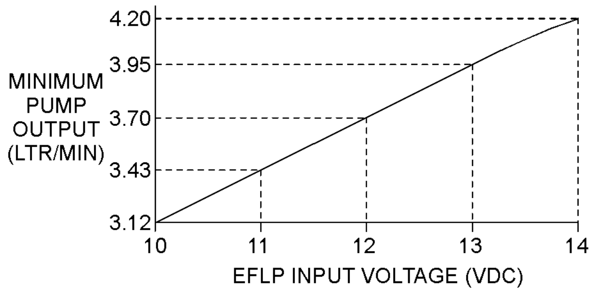


Illustration 69 g02527498

Minimum EFLP flow rate in a 12 VDC system

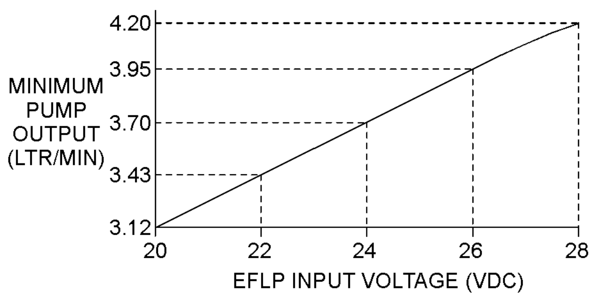


Illustration 70 g02527518

Minimum EFLP flow rate in a 24 VDC system

Table 107

Troubleshooting Test Steps	Values	Results
14. EFLP Flow Test at the Primary Fuel Filter Inlet **A.** Make sure the keyswitch is in the OFF position. **B.** Disconnect the fuel inlet connection from the primary fuel filter head. **C.** Install a suitable blank on the fuel inlet port on the primary fuel filter head. **D.** Place the open end of the fuel inlet line in a suitable calibrated container. **E.** With the keyswitch in the ON position, measure the input voltage at the EFLP. Record the result. **F.** With the keyswitch in the ON position, measure the flow from the fuel inlet line. Record the result. **G.** Check the recorded voltage and fuel flow on the graph in Illustration 69 or 70 .	EFLP flow	**Result:** The fuel flow is below the minimum value for the recorded voltage. **Repair:** Replace the EFLP. Refer to Disassembly and Assembly, “Fuel Priming Pump - Remove and Install”. **Result:** The fuel flow is above the minimum value for the recorded voltage. Proceed to Test Step 15.
15. Check the Return Fuel Lines **A.** Make sure that the TPIR return line is not blocked or kinked. **B.** If the TPIR return line is clear, confirm that the Electric Fuel Lift Pump (EFLP) is operating. Make sure that fuel lines between the EFLP and the TPIR are not blocked or kinked.	Return lines	**Result:** The TPIR return line or the fuel lines between the EFLP and the TPIR are blocked or kinked. **Repair:** Clear or replace the blocked line. **Result:** The TPIR return line and the fuel lines between the EFLP and the TPIR are clear. **Repair:** Replace the EFLP. If the fault is still present, contact the DSN and provicde the Warranty Report, PSR and Snapshot Data as saved in steps 1 and 2.

i06193311

Fuel Temperature Is High

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

Table 108

Diagnostic Trouble Codes for Fuel Temperature Is High			
J1939 Code	**PDL Code**	**Code Description** (Code descriptions may vary)	**Comments**

(continued)

(Table 108, contd)

174-15	E363 (1)	Engine Fuel Temperature 1 : High - least severe (1)	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 warning lamp will go off when the temperature drops below the trip point.
174-16	E363 (2)	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 20%. 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 109

Troubleshooting Test Steps	Values	Results
1. 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.** 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.	Diagnostic Active or Logged codes	**Result:** A diagnostic code is active or logged other than a 174-XX or E363-X code. **Repair:** Troubleshoot the active or logged code. **Result:** A 174-XX or E363-X diagnostic code is active or logged. Proceed to Test Step 2.
2. 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 3.
3. 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 4.
4. 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 5.

(continued)

(Table 109, contd)

5. 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 6.
6. 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. Contact the Dealer Solutions Network (DSN).

i06074898

Indicator Lamp Problem

Note: This procedure is only applicable to applications that have individual indicator lamps.

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
- Wait to disconnect lamp
- Low DEF level lamp
- Shutdown lamp
- Warning lamp

The electronic service tool can be used as a diagnostic aid in order 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.

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 110

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 connector and the lamp connections. Refer to Troubleshooting, "Electrical Connectors - Inspect" for details. **D.** Perform a 45 N (10 lb) pull test on each of the wires in the P1 connector that are associated with the indicator lamps. **E.** Check the screw for the ECM connector for the correct torque of 6 N·m (53 lb in). **F.** 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 of 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 in order 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 in order 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. At least 22 VDC for a 24 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 110, 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 connector. **C.** Remove the bulb from the suspect lamp. **D.** Measure the resistance between the ground connection on the lamp holder and the applicable terminal on the P1 connector.	Less than two Ohms	**Result:** The measured resistance is greater than two 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 two Ohms. Proceed to Test Step 5.
5. Check the Wiring for a Short Circuit **A.** Disconnect the P1 connector. **B.** Check the resistance between the terminal for the suspect lamp and all the other terminals on the P1 connector.	Greater than 100 Ohms	**Result:** One or more of the measured resistances is less than 100 Ohms. 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:** All resistance measurements are greater than 100 Ohms. Contact the Dealer Solutions Network (DSN).

i06160422

Inlet Air Is Restricted

Use this procedure in order to troubleshoot a high differential pressure for the air inlet system. Use this procedure if one of the following event codes are active. Refer to Troubleshooting, “Event Codes” for information about event codes. Access the engine monitoring system on the electronic service tool in order to view the current trip points for these codes. For information on the engine monitoring system, refer to Troubleshooting, “Engine Monitoring System”.

Table 111

Diagnostic Trouble Codes for Inlet Air Is Restricted			
J1939 Code	**PDL Code**	**Code Description** (Code descriptions may vary)	**Comments**
107-15	E583(1)	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	E583(2)	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 112

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).

i06160442

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 113

Diagnostic Trouble Code for Intake Manifold Air Pressure Is High			
J1939 Code	**PDL Code**	**Code Description (Code descriptions may vary)**	**Comments**
102-16	E1044 (2)	Engine Intake Manifold #1 Pressure : High - moderate severity (2)	This pressure is a variable value that is calculated by the ECM. The resulting value is dependent on the operating conditions of the engine.

Probable Causes

- Turbocharger wastegate
- Wastegate regulator

Recommended Actions

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

Table 114

Troubleshooting Test Steps	Values	Results
1. Turbocharger Wastegate **Note:** On engines with a single turbocharger, the wastegate is attached to the turbocharger. On engines with twin turbochargers, the wastegate is attached to the high-pressure turbocharger. **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:** Disconnect the output rod in the wastegate actuator from the lever that operates the wastegate. Operate the wastegate lever by hand and check for full and free movement. Check that the output rod in the wastegate actuator is biased towards the retracted position. Connect the output rod in the wastegate actuator to the lever that operates the wastegate. If the wastegate is not operating correctly, replace the turbocharger. Refer to Disassembly and Assembly, "Turbocharger - Remove" and Disassembly and Assembly, "Turbocharger - Install". **Result:** There is a suspected fault in the wastegate or the wastegate actuator. **Repair:** Replace the turbocharger. Refer to Disassembly and Assembly, "Turbocharger - Remove" and Disassembly and Assembly, "Turbocharger - Install". **Result:** The wastegate and the wastegate actuator operate correctly. Proceed to Test Step 2.
2. Wastegate Regulator **A.** Use the electronic service tool to check for diagnostic trouble codes that relate to the wastegate regulator.	Wastegate regulator	**Result:** Diagnostic codes are present that relate to the wastegate regulator. **Repair:** Rectify the cause of any related codes. Refer to Troubleshooting, "Diagnostic Trouble Codes". **Result:** There are no diagnostic codes that relate to the wastegate regulator. Contact the Dealer Solutions Network (DSN).

i06193313

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 115

Diagnostic Trouble Code for Low Intake Manifold Air Pressure			
J1939 Code	PDL Code	Code Description (Code descriptions may vary)	Comments
102-18	E1045 (2)	Engine Intake Manifold #1 Pressure : Low - moderate severity (2)	This pressure is a variable value that is calculated by the ECM. The resulting value is dependent on the operating conditions of the engine.

Probable Causes

- Intake air filter
- Air intake system
- Wastegate regulator
- Low battery voltage
- Turbocharger or turbochargers

Recommended Actions

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

Table 116

Troubleshooting Test Steps	Values	Results
1. Intake Air Filter **A.** Check the air filter restriction indicator, if equipped. **B.** 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:** The air filter is OK. Proceed to Test Step 2.
2. 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 3.

(continued)

(Table 116, contd)

Troubleshooting Test Steps	Values	Results
3. Wastegate Regulator **A.** Use the electronic service tool to check for diagnostic codes that relate to the wastegate regulator.	Wastegate regulator	**Result:** Diagnostic codes are present that relate to the wastegate regulator. **Repair:** Rectify the cause of any related codes. Refer to Troubleshooting, “Diagnostic Trouble Codes”. **Result:** There are no diagnostic codes that relate to the wastegate regulator. Proceed to Test Step 4.
4. Low Battery Voltage **Note:** This possible cause of the fault is only applicable to 12 VDC systems. If the application operates with a 24 VDC system, proceed to Test Step 5 or Test Step 6, as applicable. **A.** Use a suitable multimeter to check the output voltage from the battery or batteries.	Turbocharger	**Result:** The battery voltage is less than 9.75 VDC. **Repair:** The voltage requirement is not satisfied. Refer to Troubleshooting, “Battery Problem”. Ensure that any repairs have eliminated the fault. **Result:** The battery voltage is OK. For engines that have a single turbocharger, proceed to Test Step 5. For engines that have two turbochargers, proceed to Test Step 6.
5. 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. Contact the Dealer Solutions Network (DSN).
6. Turbochargers **Note:** The turbochargers that are installed on the engine are nonserviceable items. If any mechanical fault exists, then the faulty turbocharger must be replaced. **A.** Check that the compressor housings for the turbochargers are free of dirt and debris. **B.** Check that the turbine housings for the turbochargers are free of dirt and debris. **C.** Check that the turbine blades rotate freely in the turbochargers.	Turbochargers	**Result:** There is a fault in a turbocharger. **Repair:** Replace the faulty turbocharger. Refer to Disassembly and Assembly, “Turbocharger - Remove” and Disassembly and Assembly, “Turbocharger - Install”. **Result:** The turbochargers are OK. Contact the Dealer Solutions Network (DSN).

i06193314

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 117

Diagnostic Trouble Codes for High Intake Manifold Air Temperature			
J1939 Code	PDL Code	Code Description (Code descriptions may vary)	Comments
105-15	E539 (1)	Engine Intake Manifold #1 Temperature : High - least severe (1)	The engine has been running for 3 minutes. No other 105 (172) codes are active. 168 codes are not active. Code 412-16 (E1092-2) 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	E539 (2)	Engine Intake Manifold #1 Temperature : High - Moderate Severity (2)	The engine has been running for 3 minutes. No other 105 (172) codes are active. 168 codes are not active. Code 412-16 (E1092-2) 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 less than 124° C (255° F) for 20 seconds.

Probable Causes

- Coolant level
- Air-to-air aftercooler (ATAAC)
- Cooling fan
- Air inlet and exhaust system
- Exhaust Back Pressure Regulator (EBPR)
- Ambient temperature
- Altitude
- Running condition

Recommended Actions

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

Table 118

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 intake and exhaust system for the following defects: · Blockages · Restrictions · Damage to the air intake ducts and hoses · Loose connections and air leaks	Air intake and exhaust	**Result:** The air intake or exhaust system is blocked, restricted, damaged, or loose. **Repair:** Make all necessary repairs to the air intake system. **Result:** The air intake and exhaust system is OK. Proceed to Test Step 5.
5. Exhaust Back Pressure Regulator (EBPR) **A.** Check for the correct operation of the exhaust back pressure regulator.	EBPR	**Result:** The EBPR is suspect. **Repair:** Investigate the EBPR. Refer to Troubleshooting, “Motorized Valve - Test”. **Result:** The EBPR is OK. Proceed to Test Step 6.

(continued)

(Table 118, contd)

Troubleshooting Test Steps	Values	Results
6. 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 7.
7. 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 8.
8. 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).

i07907009

NOx Conversion Is Low

This procedure covers the following diagnostic codes.

Table 119

Diagnostic Trouble Codes for NOx Conversion Is Low			
J1939 Code	**PDL Code**	**Code Description (code descriptions may vary)**	**Comments**
3516-11	3100-11	Aftertreatment # 1 Diesel Exhaust Fluid Concentration : Other failure mode	The Diesel Emissions Fluid (DEF) sensor is unable to determine the DEF quality percentage.
3516-15	E1365 (1)	High Aftertreatment #1 DEF Concentration	The Diesel Emissions Fluid (DEF) has a high concentration.
3516-16	E1365 (2)	Aftertreatment 1 Diesel Exhaust Fluid Concentration : High - moderate severity (2)	The Diesel Emissions Fluid (DEF) has a high concentration.
3516-18	E1364 (2)	Aftertreatment 1 Diesel Exhaust Fluid Concentration : Low - moderate severity (2)	The Diesel Emissions Fluid (DEF) has a low concentration.

(continued)

(Table 119, contd)

Diagnostic Trouble Codes for NOx Conversion Is Low			
J1939 Code	**PDL Code**	**Code Description (code descriptions may vary)**	**Comments**
4364-2	E1410 (2)	Aftertreatment #1 SCR Catalyst Conversion Efficiency : Erratic, Intermittent, or Incorrect	The Engine Out and Tailpipe Out NOx Sensors are installed in the incorrect locations.
4364-18	E1309 (2)	Aftertreatment #1 SCR Catalyst Conversion Efficiency : Low - moderate severity (2)	The SCR System is not able to reduce NOx in the exhaust system.
7105-31	E1585 (2)	Aftertreatment #1 Inconsistent Configuration Detected	Data received from the NOx sensor is not compatible with the engine software.
Follow the troubleshooting procedure to identify the root cause of the problem.			

Table 120

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	441-0451	Kit - Test	1

Table 121

Associated Diagnostic Trouble Codes	
J1939 Code	**PDL Code**
412-15	E1092 (1)
412-16	E1092 (2)
4360-17	E947 (1)
4360-18	E947 (2)
4765-17	E2165 (1)
5298-17	E2180 (1)

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

Table 122

Troubleshooting Test Steps	Values	Results
1. Determine the Code **A.** Establish communication between the electronic service tool and the Electronic Control Module (ECM). Refer to Troubleshooting, “Electronic Service Tools”, if necessary. **B.** Determine the diagnostic trouble code that is active.	Diagnostic trouble code	**Result:** An associated code is active or logged. **Note:** Troubleshoot associated codes before continuing with this procedure. Refer to Troubleshooting, “Diagnostic Trouble Codes” for further information. **Result:** A 4364-2 (E1410 (2)) code is active or logged. Proceed to Test Step 2. **Result:** A 3516-16 (E1365 (2)), 3516-18 (E1364 (2)) or 4364-18 (E1309 (2)) code is active or logged. Proceed to Test Step 3. **Result:** A 7105-31 (E1585 (2)) code is active or logged. Proceed to Test Step 21.
2. Check the NOx sensors for proper installation. **A.** Turn the keyswitch to the OFF position. **B.** Verify that the sensors are located in the correct position. **Note :** The “Engine Out NOx” sensor wiring has a black sheath. The “Tailpipe Out NOx” sensor wiring has a gray sheath. **C.** If the sensors are installed in the wrong positions, install the sensors in the correct positions. Refer to Special Instruction, “REHS8151” for the correct handling procedures. **D.** Use the electronic service tool to perform the “Aftertreatment System Functional Test” .	NOx sensors	**Result :** The “Aftertreatment System Functional Test” completed successfully. Return the unit to service. **Result :** The “Aftertreatment System Functional Test” did not complete successfully and other codes were logged. **Repair:** Troubleshoot the logged codes. Refer to Troubleshooting, “Diagnostic Trouble Codes” for the code that became active during the test.
3. Check the DEF Level and Temperature	DEF Level and Quality	**Result:** The DEF level is above 30% and the DEF tank temperature is below 58° C (136° F). Proceed to Test Step 4. **Result:** The DEF tank level is below 30% or the DEF tank temperature is above 58° C (136° F). **Repair :** Refill the DEF tank to above 50% level and ensure that the DEF tank temperature is below 58° C (136° F). Proceed to Test Step 4.

(continued)

(Table 122, contd)

Troubleshooting Test Steps	Values	Results
4. Check the Diesel Exhaust Fluid (DEF) Quality **A.** Measure the DEF quality. Refer to Systems Operation, Testing and Adjusting, Diesel Exhaust Fluid Quality - Test for the correct procedure.	DEF	**Result :** The DEF is not contaminated and the concentration is not within the acceptable range. **Repair:** Drain the DEF from the tank. Refill the tank with DEF that meets ISO 22241 quality standards. Proceed to Test Step 15. **Result :** The DEF is not contaminated and the concentration is within the acceptable range. Proceed to Test Step 5. **Result :** The DEF is contaminated. **Repair:** Flush the DEF tank. Refer to Systems Operation, Testing and Adjusting, Diesel Exhaust Fluid Tank - Flush for the correct procedure. Proceed to Test Step 15.
5. Determine the DEF Quality Sensor Installation Status **A.** Use the electronic service tool to check the status of Configuration Parameter “Aftertreatment #1 DEF Quality Sensor Installation Status” .	Parameter status	**Result :** Configuration Parameter “Aftertreatment #1 DEF Quality Sensor Installation Status” is set to “Installed” . Proceed to Test Step 6. **Result :** Configuration Parameter “Aftertreatment #1 DEF Quality Sensor Installation Status” is set to “Not Installed” or the parameter is not listed. Proceed to Test Step 8.
6. Determine the Diagnostic Code **A.** Use the electronic service tool to check active or logged diagnostic codes.	Diagnostic codes	**Result :** A 3516-15 (E1365(1)), 3516-16 (E1365 (2)) or 3516-18 (E1364 (2)) code is active or logged. **Repair:** Replace the DEF tank header assembly. Refer to Disassembly and Assembly, Manifold (DEF Heater) - Remove and Install for the correct procedure. Flush the system, refer to Systems Operation, Testing and Adjusting, Diesel Exhaust Fluid Tank - Flush. Proceed to Test Step 15. **Result :** A 4364-18 (E1309 (2)) code is active or logged. Proceed to Test Step 8. **Result:** A 3516-11 (3100-11) code is active or logged. Proceed to Test Step 7

(continued)

(Table 122, contd)

Troubleshooting Test Steps	Values	Results
7. Remove the DEF Tank Header Assembly and Sock Filter from DEF Tank **A.** Inspect for debris or obstructions blocking the DEF Quality Sensor optical path.	Turbocharger wastegate actuator rod	**Result:** Debris or an obstruction was blocking the DEF quality sensor optical path. **Repair:** Remove any debris blocking the DEF quality sensor optical path. Replace the sock filter. Reinstall the DEF tank header assembly and flush the system. Refer to Systems Operation, Testing and Adjusting, Diesel Exhaust Fluid Tank - Flush. Proceed to Test Step 16. **Result:** Debris or obstructions were not blocking the DEF Quality Sensor optical path. **Repair:** Replace the DEF tank header assembly and flush the system. Refer to Systems Operation, Testing and Adjusting, Diesel Exhaust Fluid Tank - Flush Proceed to Test Step 15.
8. Check the Turbocharger Actuator Rod **Note:** There have been isolated instances where the turbocharger wastegate actuator rod has become detached, causing low CEM inlet temperature. This situation can prevent the correct operation of the SCR filter. **A.** Check that the turbocharger wastegate actuator rod is securely attached to the wastegate. **B.** Check the operation of the wastegate actuator. Refer to Systems Operation, Testing and Adjusting, Turbocharger - Inspect.	Turbocharger wastegate actuator rod	**Result :** The turbocharger wastegate actuator rod is securely attached to the wastegate. The retaining clip is securely installed. The wastegate actuator is operating to specification. Proceed to Test Step 9. **Result :** The turbocharger wastegate actuator rod is detached from the wastegate. The retaining clip is missing. Contact the Dealer Solutions Network (DSN) for further information. **Result:** The wastegate actuator is not operating to specification. **Repair:** Install a replacement turbocharger. Refer to Disassembly and Assembly, Turbocharger - Remove and Disassembly and Assembly, Turbocharger - Install. Proceed to Test Step 15.

(continued)

(Table 122, contd)

Troubleshooting Test Steps	Values	Results
9. Inspect All the DEF Lines for Leaks **A.** Use the electronic service tool to perform the "Aftertreatment System Functional Test" . **Note:** This test clears any diagnostic codes. **B.** Cycle the keyswitch to the ON position. Do not start the engine. **C.** Use the electronic service tool to perform the "DEF Dosing System Verification Test" to pressurize the system. Refer to Troubleshooting, "Service Tool Features" for more information. **D.** Visually inspect all DEF lines from the DEF tank to the DEF injector. Look for pinched, damaged, or disconnected lines. **E.** Inspect the lines for leakage. **F.** Turn the keyswitch to the OFF position.	Leaks	**Result:** The lines are leaking, damaged, pinched, or disconnected. **Repair:** Make the necessary repairs. Proceed to Test Step 15. **Result:** The lines are not leaking, damaged, pinched, or disconnected. Proceed to Test Step 10.
10. Perform a DEF Dosing System Accuracy Test **A.** Perform the "DEF Dosing System Accuracy Test" . Refer to Testing and Adjusting, "Aftertreatment SCR System Dosing Test" for the correct procedure.	DEF dosing system accuracy test	**Result:** The amount of DEF collected is within specification. Install the DEF injector. Refer to Disassembly and Assembly, "DEF Injector and Mounting - Remove and Install". Proceed to Test Step 14. **Result:** The amount of DEF collected is below specification. Proceed to Test Step 11. **Result:** The amount of DEF collected is above specification. **Repair:** Install a replacement DEF injector. Refer to Disassembly and Assembly, "DEF Injector and Mounting - Remove and Install". Proceed to Test Step 15.

(continued)

(Table 122, contd)

Troubleshooting Test Steps	Values	Results
11. Check the DEF Pressure Line **A.** Turn the keyswitch to the OFF position for 2 minutes. **Note:** The keyswitch must be OFF for 2 minutes to allow the DEF pump to purge, reset the code, and reset the DEF Control Unit (DCU). **B.** Remove the DEF pressure line between the DEF pump and the DEF injector. Refer to Disassembly and Assembly, Diesel Exhaust Fluid Lines - Remove and Install. **C.** Inspect the line for obstructions. Flush the line with water or low-pressure air, if necessary. Possible obstructions are ice, DEF deposits, or debris.	Restrictions, obstructions, or leaks	**Result:** There are restrictions in the lines. **Repair:** Replace the line. Proceed to Test Step 13. **Result:** There are no restrictions in the lines. Proceed to Test Step 12.
12. Replace the DEF injector **A.** Turn the keyswitch to the OFF position. **B.** Remove the DEF injector. Refer to the Disassembly and Assembly, DEF Injector and Mounting - Remove and Install. **C.** Connect the replacement DEF injector to the DEF pressure line and the electrical connector. **Note :** Do not install the injector until Step 13 has been completed.	DEF Injector	**Result:** The DEF injector was replaced. The DEF injector was connected to the DEF pressure line and the electrical connector, but the injector was not installed. Proceed to Test Step 13.
13. Perform a DEF Dosing System Accuracy Test **A.** Perform the “DEF Dosing System Accuracy Test” . Refer to Testing and Adjusting, “Aftertreatment SCR System Dosing Test” for the correct procedure.	DEF dosing system accuracy test	**Result:** The amount of DEF collected is within specification. Install the DEF injector. Refer to Disassembly and Assembly, “DEF Injector and Mounting - Remove and Install”. Proceed to Test Step 15. **Result:** The amount of DEF collected is below specification. Install the DEF injector. Refer to Disassembly and Assembly, “DEF Injector and Mounting - Remove and Install”. Install a replacement DEF pump. Refer to Disassembly and Assembly, “Diesel Exhaust Fluid Pump - Remove and Install”. Proceed to Test Step 15.

(continued)

(Table 122, contd)

Troubleshooting Test Steps	Values	Results
14. 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 quality	**Result:** High sulfur fuel is in use. **Repair:** Refer to Special Instruction, M0078202, Soot Antennae Check to check for damage to the aftertreatment system. 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 15. **Result:** High Sulfur fuel is not in use. Proceed to Test Step 15.
15. Perform the Aftertreatment Recovery Procedure **A.** Connect to the electronic service tool. **B.** Perform the “Aftertreatment Recovery Procedure” .	Aftertreatment Recovery Procedure	**Result:** The Aftertreatment Recovery Procedure completed successfully. Proceed to Test Step 16. **Result:** The Aftertreatment Recovery Procedure was not successful. Contact the Dealer Solutions Network (DSN).
16. Check the NRS Valve **A.** Use the electronic service tool to perform the “Air System Motor Valve Verification Test” .	NRS Valve	**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 17.
17. Perform an Aftertreatment System Functional Test **A.** Start the engine. **B.** Connect to the electronic service tool. **C.** Use the electronic service tool to perform the “Aftertreatment System Functional Test” .	Aftertreatment System Functional Test	**Result:** The test completed successfully. Return the unit to service. **Result:** A 4364-18 (E1309 (2)) with no ETI code is active. Proceed to Test Step 18. **Result:** A 4364-18 (E1309 (2)) with an ETI code of 1 is active. Proceed to Test Step 19.

(continued)

(Table 122, contd)

Troubleshooting Test Steps	Values	Results
18. Replace both NOx sensors **A.** Turn the keyswitch to the OFF position. **B.** Allow time for the exhaust system to cool down. **C.** Replace both NOx sensors. Refer to Special Instruction, REHS8151 for the correct handling procedures. **D.** Use the electronic service tool to perform the “Aftertreatment System Functional Test” .	NOx Sensors	**Result :** The test completed successfully. Return the unit to service. **Result :** The test did not complete successfully. Contact the Dealer Solutions Network (DSN).
19. Check the Coolant Level **A.** Check the coolant level in the engine cooling system. Refer to the Operation and Maintenance Manual, Coolant Level - Check.	Coolant level	**Result :** The coolant level is low and a leak is identified. **Repair:** Repair the coolant leak and fill the coolant system to the correct level. **Result :** The coolant level is low and no leaks are identified. **Repair:** Fill the coolant system to the correct level. **Result :** The coolant level is correct. Proceed to Test Step 20.
20. Inspect the NRS Cooler **A.** Perform a leak test on the NRS cooler. Refer to Systems Operation, Testing and Adjusting, Exhaust Cooler (NRS) - Test.	NRS cooler	**Result :** An internal leak is identified in the NRS cooler. **Repair:**Install a replacement NRS cooler. Refer to Disassembly and Assembly, Exhaust Cooler (NRS) - Remove and Install. Use the electronic service tool to perform the “Aftertreatment System Functional Test” . If the “Aftertreatment System Functional Test” is passed, return the unit to service. If the “Aftertreatment System Functional Test” fails, contact the Dealer Solutions Network (DSN). **Result :** The NRS cooler does not have any internal leaks and the fault is still present. Contact the Dealer Solutions Network (DSN).

(continued)

(Table 122, contd)

Troubleshooting Test Steps	Values	Results
21. Check the Engine Software Version **A.** Ensure the latest version of the Engine Software is installed.	Engine Software	**Result :** The latest version of the Engine Software is not installed. **Repair:** Update the Engine Software to the latest version. . If the fault has cleared, return the unit to service. If the fault is still present, proceed to Test Step 22.
22. Check the compatibility of the NOx sensors **A.** Check for correct part numbers of both the Tailpipe Out and Engine Out NOx sensors that are fitted.	NOx Sensors	**Result :** The NOx sensors are not an approved part. **Repair:** Replace the NOx sensors with approved parts. **Result :** The NOx sensors are an approved part and the fault is still present. Contact the Dealer Solutions Network (DSN).

i07905911

NRS Exhaust Gas Temperature Is High

This procedure covers the following diagnostic trouble codes:

Table 123

Diagnostic Codes for NRS Exhaust Gas Temperature Is High			
J1939 Code	**PDL Code**	**Code Description (code descriptions may vary)**	**Comments**
412-15	E1092 (1)	Engine Exhaust Gas Recirculation Temperature : High - least severe (1)	The exhaust gas temperature in the NRS has reached 178° C (352° F) for 8 seconds. The ECM has been powered for at least 2 seconds. The engine has been running for at least 180 seconds. There are no electrical faults on the circuit.
412-16	E1092 (2)	Engine Exhaust Gas Recirculation Temperature : High - moderate severity (2)	The exhaust gas temperature in the NRS has reached 180° C (356° F) for 8 seconds. The engine will be derated. The ECM has been powered for at least 2 seconds. The engine has been running for at least 180 seconds. There are no electrical faults on the circuit.

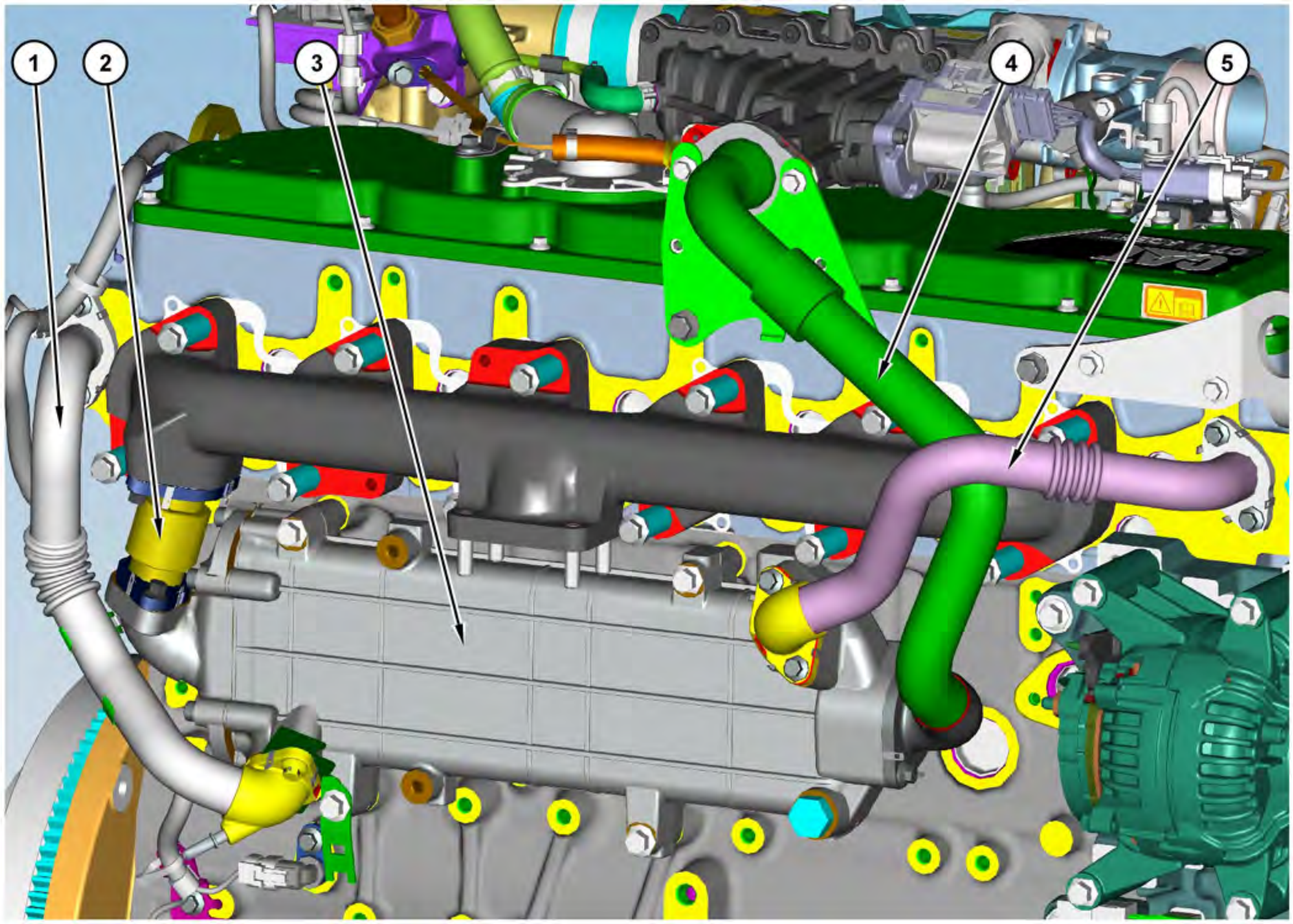


Illustration 71 g03776141

Components of the NRS cooler

(1) Coolant inlet pipe
(2) NRS Exhaust inlet pipe
(3) NRS cooler
(4) NRS Exhaust outlet pipe
(5) Coolant outlet pipe

Table 124

Associated Codes		
J1939 Code	**PDL Code**	**Code Description**
110-15	E361 (1)	Engine Coolant Temperature : High - least severe (1)
110-16	E361 (2)	Engine Coolant Temperature : High - moderate severity (2)
110-0	E361 (3)	Engine Coolant Temperature : High - most severe (3)

Probable Causes

- Diagnostic codes
- Coolant leak or low coolant level
- NRS Cooler
- NRS Valve

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 125

Troubleshooting Test Steps	Values	Results
1. Diagnostic Codes **A.** Download the 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 needed. **B.** Use the electronic service tool to check for active or logged codes.	Diagnostic codes	**Result:** A 412-X or E1092 code and a 110-X or E361 code are present. **Repair:** Rectify the 110-X or E361 code. Refer to Trouble-shooting, “Coolant Temperature Is High”. **Result:** A 412-X or E1092 code is present. Proceed to Test Step 2.
2. Coolant Check **A.** Check for leaks from the coolant system. **B.** Check that the coolant level is correct. Refer to the Operation and Maintenance Manual, Coolant Level - Check.	Coolant	**Result:** Coolant leaks were identified. **Repair:** Repair any coolant leaks. Repeat the procedure from Step 1. **Result:** Coolant level is low. **Repair:** Ensure that the coolant level is corrected. Repeat the procedure from Step 1. **Result:** The coolant level is OK and there are no leaks. Proceed to Test Step 3.
3. Inspect the NRS Cooler Refer to Illustration 71 . **A.** Perform a leak test on the NRS cooler. Refer to Systems Operation, Testing, and Adjusting, “Exhaust Cooler (NRS) - Test”.	NRS cooler	**Result:** The NRS cooler has internal leakage. **Repair:** Replace the NRS cooler. Refer to Disassembly and Assembly, “Exhaust Cooler (NRS) - Remove and Install”. Use the electronic service tool to clear all related diagnostic codes and then run the engine and ensure that the fault has been eliminated. If the fault is still present, proceed to Test Step 4.
4. Check the NRS Valve **A.** Use the electronic service tool to perform the “Air System Motor Valve Verification Test” .	NRS Valve	**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. Contact the Dealer Solutions Network (DSN).

i06836892

NRS Mass Flow Rate Problem

This procedure covers the following diagnostic trouble code:

Table 126

Diagnostic Trouble Code for NRS Mass Flow Rate Problem			
J1939 Code	**PDL Code**	**Code Description (code descriptions may vary)**	**Comments**
2659-7	E1319 (2)	Engine Exhaust Gas Recirculation (EGR) Mass Flow Rate : Not Responding Properly	Actual mass flow through the NOx Reduction System (NRS) does not match the desired mass flow. The Electronic Control Module (ECM) has been powered for at least 2 seconds. The engine is running. There are no active codes for the 5 VDC supply. There are no active 27, 157, 411, 1188, 2791, 3358 or 3563 codes. 412-3 or 412-4 codes are not active.

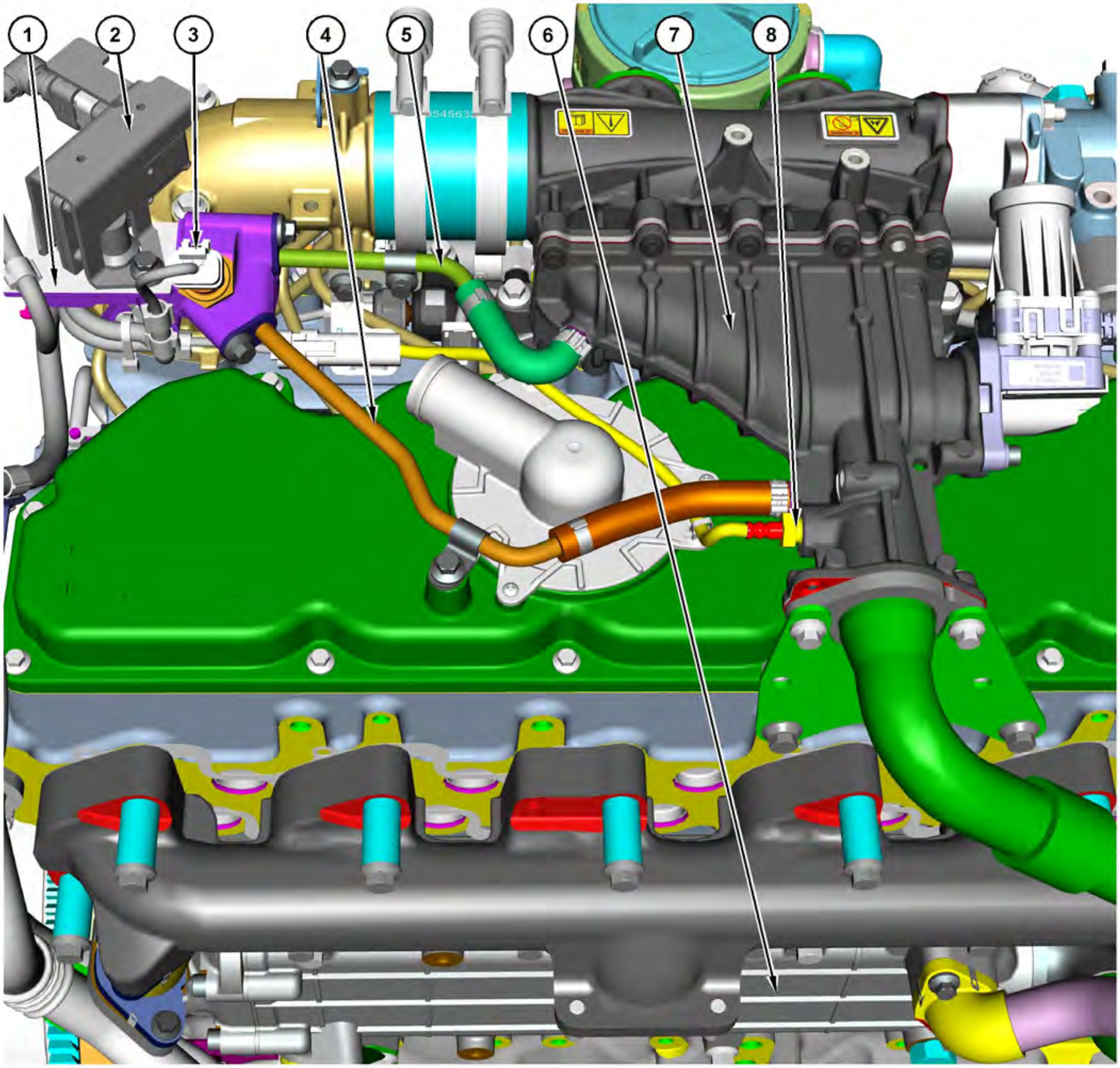


Illustration 72 g06136435

(1) Manifold for the NRS pressure sensors
(2) NRS differential pressure sensor
(3) NRS inlet pressure sensor
(4) Pipe for the NRS inlet pressure sensor
(5) Pipe for the NRS differential pressure sensor
(6) NRS cooler
(7) NRS mixer
(8) NRS inlet temperature sensor

Table 127

Associated Codes	
J1939 Code	**CDL Code**
412-15	E1092 (1)
412-16	E1092 (2)

Probable Causes

- Diagnostic codes
- Electrical connectors and harness
- Air inlet and exhaust system
- NRS inlet pressure sensor and sensor pipes
- NRS temperature sensor
- NRS mixer
- NRS cooler

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 128

Troubleshooting Test Steps	Values	Results
1. Diagnostic Codes **A.** Download the 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 needed. **B.** Use the electronic service tool to check for active or logged codes.	Diagnostic codes	**Result:** An associated code is active or logged. **Repair:** Troubleshoot associated codes before continuing with this procedure. Refer to Troubleshooting, Event Codes for further information. **Result:** A diagnostic code for the NRS valve is active or logged. **Repair:** Rectify the NRS valve code. Refer to Troubleshooting, “Motorized Valve - Test”. **Result:** A 2659-7 (E1319 (2)) code is active with no ETI code active. Proceed to Test Step 2. **Result:** A 2659-7 (E1319 (2)) code is active with an ETI code of 1 active. Proceed to Test Step 7.
2. Inspect the Electrical Connectors and the Harness **A.** Turn the keyswitch to the OFF position. **B.** Inspect the connectors for the components in the NRS system. Refer to Troubleshooting, “Electrical Connectors - Inspect”. **C.** Perform a 45 N (10 lb) pull test on each of the wires in any suspect connector and the connections at the ECM. **D.** Check that the ground connection on the ECM and the negative terminal on the battery are correctly installed. **E.** Check the ground connection on the ECM for abrasions and pinch points. **F.** Check the screws for the ECM connector for the correct torque of 6 N·m (53 lb in). **G.** Check the harness for abrasion and pinch points from the NRS components to the ECM. **H.** Check that any suspect connector is installed correctly.	Connectors and harness	**Result:** An electrical connector or a cable is not correctly installed. **Repair:** Install the connector or cable correctly. **Result:** The harness is faulty. **Repair:** Install a replacement harness. **Result:** The harness and connectors are OK. Proceed to Test Step 3.

(continued)

(Table 128, contd)

Troubleshooting Test Steps	Values	Results
3. Check the Air Inlet and Exhaust System **A.** Check the air inlet system for leaks and for restrictions. **B.** Check the exhaust system for leaks and for restrictions. **C.** Test the exhaust back pressure regulator. Refer to Troubleshooting, “Motorized Valve - Test”.	Air inlet and exhaust system	**Result:** The air inlet system has a leak or is restricted. **Repair:** Clear any restrictions in the air inlet system. Repair any air leaks in the air inlet system. **Result:** The exhaust system has a leak or is restricted. **Repair:** Clear any restrictions in the exhaust system. Repair any air leaks in the exhaust system. If the fault is still present, proceed to Test Step 4.
4. Check the NRS Inlet Pressure Sensor and Sensor Pipes Refer to Illustration 72 . **A.** Check pipe (4) for the NRS inlet pressure sensor for leaks, restrictions, or blockage. **B.** Check pipe (3) for the NRS differential pressure sensor for leaks or any restriction. **C.** Test the exhaust back pressure regulator. Refer to Troubleshooting, “Motorized Valve - Test”.	Pressure sensor and pipes	**Result:** There is a leak, a restriction, or a blockage in one of the sensor pipes. **Repair:** If a pipe has a leak or a restriction, replace the pipe. If a pipe is blocked with soot or condensates, remove the pipe. Clear the blockage with an air line that is set at a maximum pressure of 200 kPa (29 psi). If the blockage is cleared, install the pipe. If the blockage cannot be cleared, replace the pipe. **Result:** The NRS inlet pressure sensor is blocked. **Repair:** Replace the NRS inlet pressure sensor. **Result:** There are no leaks, restrictions, or blockages in the sensor or the pipes. Proceed to Test Step 5.
5. Check the NRS Temperature Sensor Refer to Illustration 72 . **A.** Remove temperature sensor (1) from NRS mixer (2). Refer to Disassembly and Assembly, “Temperature Sensor (Cooled Exhaust Gas) - Remove and Install”. **B.** Check the sensor probe for excessive deposits.	Temperature sensor	**Result:** The probe on the temperature sensor has excessive deposits. **Repair:** Carefully remove the deposits from the sensor probe. Make sure that the sensor probe is not damaged. If the deposits cannot be easily removed, replace the temperature sensor. Refer to Disassembly and Assembly, “Temperature Sensor (Cooled Exhaust Gas) - Remove and Install”. **Result:** The probe on the temperature sensor does not have excessive deposits. Proceed to Test Step 6.

(continued)

(Table 128, contd)

Troubleshooting Test Steps	Values	Results
6. Inspect the NRS Mixer **A.** Inspect the NRS mixer for cracks, holes, or damage.	NRS mixer	**Result:** The NRS mixer is defective. **Repair:** Replace the NRS mixer. Refer to Disassembly and Assembly, “Inlet Air Control - Remove” and Disassembly and Assembly, “Inlet Air Control - Install”. **Result:** There are no visible faults on the NRS mixer. Contact the Dealer Solutions Network (DSN).
7. Check the Coolant Level **A.** Check the coolant level. **B.** Check for leaks from the coolant system.	Coolant level	**Result :** The coolant level is low or a coolant leak is identified. Rectify any coolant leaks and fill the coolant system to the correct level. **Result :** The coolant level is normal and there are no coolant leaks. Proceed to Test Step 8.
8. Inspect the NRS Cooler **A.** Perform a leak test on the NRS cooler. Refer to System Operation, Testing, Adjusting, Exhaust Cooler (NRS) - Test.	NRS cooler	**Result :** The NRS Cooler has internal leakage or fouling. **Repair:** Replace the NRS Cooler. Refer to Disassembly and Assembly, Exhaust Cooler (NRS) - Remove and Install. **Result :** The NRS Cooler has no internal leakage or fouling. The fault is still present. Contact the Dealer Solutions Network (DSN).

i06021023

Oil Consumption Is Excessive

Probable Causes

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

Recommended Actions

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

Table 129

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 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 3.
3. Engine Crankcase Breather **A.** Check the engine crankcase breather for blockage or restrictions. **B.** Check for excessive oil from the outlet of the breather.	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. If the breather filter element is saturated with oil, replace the filter. **Result:** No oil is ejected through the breather. Proceed to Test Step 4.
4. 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. **Result:** The oil level is OK. Proceed to Test Step 5.

(continued)

(Table 129, contd)

Troubleshooting Test Steps	Values	Results
5. Air Intake and Exhaust System **A.** Check the air filter restriction indicator, if equipped. 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	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:** The air intake or the exhaust system is OK. For engines that have a single turbocharger, proceed to Test Step 6. For engines that have two turbochargers, proceed to Test Step 7.
6. Turbocharger **Note:** This step is only applicable to engines that have a single 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. **B.** Remove the turbocharger compressor outlet duct to check for evidence of a turbocharger internal oil leak.	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. **Result:** The turbocharger has an internal oil leak. **Repair:** Replace the turbocharger. Check the front face of the Diesel Particulate Filter (DPF) for contamination with oil. If oil is found on the inlet face of the DPF, refer to Troubleshooting, “Exhaust System Contains Oil”. Check that the repairs have eliminated the faults. **Result:** The turbocharger is OK. Proceed to Test Step 8.

(continued)

(Table 129, contd)

Troubleshooting Test Steps	Values	Results
7. Turbochargers **Note:** This step is only applicable to engines that have two turbochargers. **Note:** The turbochargers that are installed on this engine are non-serviceable items. If any mechanical fault exists, then the faulty turbocharger must be replaced. **A.** Check that the oil drains for the turbochargers are not blocked or restricted. **B.** Remove the turbocharger compressor outlet ducts to check for evidence of a turbocharger internal oil leak.	Turbochargers	**Result:** The oil drain for a turbocharger is blocked or restricted. **Repair:** Remove the blockage or restriction. If necessary, replace the oil drain line. **Result:** A turbocharger has an internal oil leak. **Repair:** Replace the faulty turbocharger. Check the front face of the Diesel Particulate Filter (DPF) for contamination with oil. If oil is found on the inlet face of the DPF, refer to Troubleshooting, "Exhaust System Contains Oil". Check that the repairs have eliminated the faults. **Result:** The turbochargers are OK. 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 · Worn piston · Worn 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).

i07865391

Oil Contains Coolant

Probable Causes

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

Recommended Actions

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

Table 130

Troubleshooting Test Steps	Values	Results
1. Engine Oil Cooler **A.** Drain the engine lubricating oil and coolant from the engine. **B.** Inspect the oil cooler for signs of damage or leaks. Refer to Systems Operation, Testing and Adjusting, Engine Oil Cooler - Inspect for more information.	Oil cooler	**Result:** There is evidence of leaks from the oil cooler or damage to the 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. Refill the engine oil and coolant. Refer to Operation and Maintenance Manual for the correct procedure. **Result:** There is no evidence of damage or leaks. Proceed to Test Step 2.
2. Engine Water Pump **A.** Inspect the water pump for signs of damage or leaks. Refer to Systems Operation, Testing and Adjusting, Water Pump - Inspect for more information.	Water pump	**Result:** There is evidence of leaks from the water pump or damage to the water pump. **Repair:** Install a new water pump. Refer to Disassembly and Assembly, “Water Pump - Remove” and Disassembly and Assembly, “Water Pump - Install” for the correct procedure. Refill the engine oil and coolant. Refer to Operation and Maintenance Manual for the correct procedure. **Result:** There is no evidence of damage or leaks. Proceed to Test Step 3.

(continued)

(Table 130, contd)

Troubleshooting Test Steps	Values	Results
3. 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 4.
4. 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". 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).

i06162603

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 in order 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 131

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 in excess of 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 132

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 the primary fuel filter and the secondary fuel filters. Refer to the Operation and Maintenance Manual for further information. Replace the Transfer Pump Inlet Regulator (TPIR). 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).

i06162619

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 133

Diagnostic Trouble Codes for Oil Level Is Low			
J1939 Code	**PDL Code**	**Code Description (code descriptions may vary)**	**Comments**
98-18	E173 (2)	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	E173 (3)	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 shut down.

Probable Causes

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

Recommended Actions

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

Table 134

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 of 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 in order to become closed. **A.** Disconnect the switch and remove the switch. **B.** Connect an ohmmeter to the switch terminals and measure the resistance. The correct resistance for the normally open switch is greater than 20,000 Ohms. **C.** Continue to monitor the ohmmeter and submerge the switch in water. The correct resistance for the closed switch is less than five 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).

i07605883

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.

The Electronic Control Module (ECM) monitors the engine oil pressure. The following events are associated with low engine oil pressure:

Table 135

Diagnostic Codes for Low Engine Oil Pressure			
J1939 Code	**PDL Code**	**Code Description (code descriptions may vary)**	**Comments**
100-17	E360 (1)	Engine Oil Pressure : Low - least severe (1)	The ECM has been powered for at least 2 seconds. The engine has been running for at least 10 seconds. There are no diagnostic trouble codes for the oil pressure sensor. There are no diagnostic trouble codes for the 5 VDC supply. Refer to Illustration 73 for the trip point for the oil pressure.
100-18	E360 (2)	Engine Oil Pressure : Low - moderate severity (2)	The ECM has been powered for at least 2 seconds. The engine has been running for at least 10 seconds. There are no diagnostic trouble codes for the oil pressure sensor. There are no diagnostic trouble codes for the 5 VDC supply. The engine will be derated. Refer to Illustration 74 for the trip point for the oil pressure.
100-1	E360 (3)	Engine Oil Pressure : Low - most severe (3)	The ECM has been powered for at least 2 seconds. The engine has been running for at least 10 seconds. There are no diagnostic trouble codes for the oil pressure sensor. There are no diagnostic trouble codes for the 5 VDC supply. The engine will be derated. Refer to Illustration 75 for the trip point for the oil pressure.

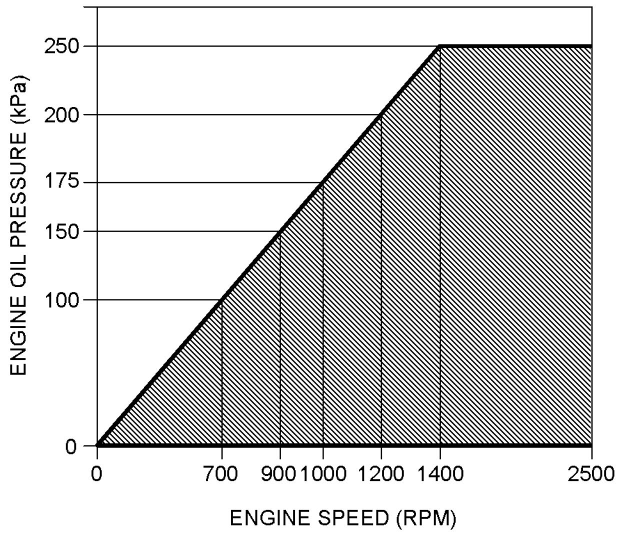


Illustration 73 g02856758

Diagnostic code 100-17 Engine Oil Pressure versus Engine Speed

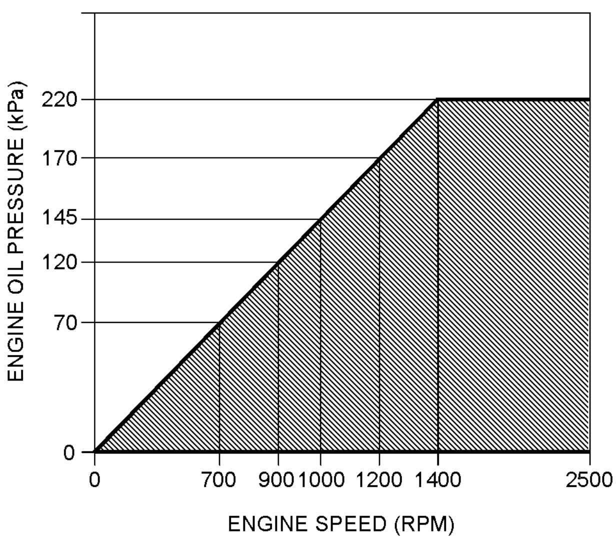


Illustration 74 g02856759

Diagnostic code 100-18 Engine Oil Pressure versus Engine Speed

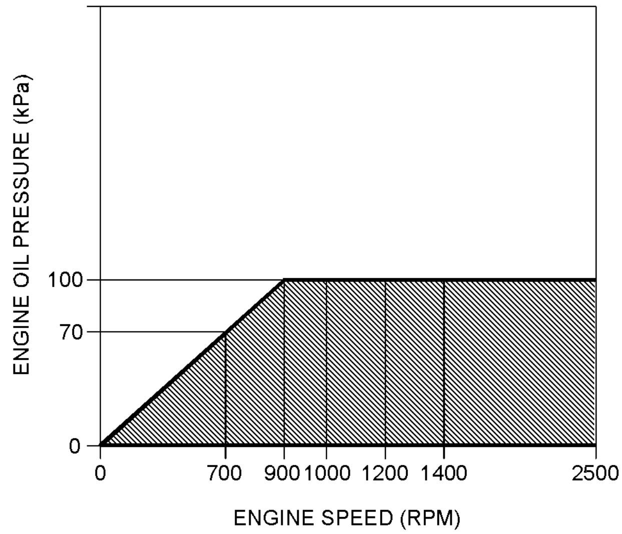


Illustration 75 g02856760

Diagnostic code 100-1 Engine Oil Pressure versus Engine Speed

Probable Causes

- Engine oil level
- Oil specification
- Aerated oil
- Engine oil pressure
- Engine oil filter
- Engine oil cooler
- Fuel in the engine oil
- Piston cooling jets
- 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 136

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. Compare the oil pressure reading from the electronic service tool to the pressure on the test gauge.	Oil pressure	**Result:** The oil pressure reading from the electronic service tool and the pressure on the test gauge are different. **Repair:** Install a new oil pressure transmitter. Refer to Disassembly and Assembly, “Engine Oil Pressure Sensor - Remove and Install”. **Result:** The oil pressure reading from the electronic service tool and the pressure on the test gauge are similar. 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 136, 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. Piston Cooling Jets **A.** Inspect the piston cooling jets for cracks, damage, or missing jets.	Piston cooling jets	**Result:** A piston cooling jet is cracked, damaged, or missing. **Repair:** Install a new piston cooling jet. Refer to Disassembly and Assembly, "Piston Cooling Jets - Remove and Install". **Result:** The piston cooling jets are OK. Proceed to Test Step 9.
9. 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 10.
10. 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 11.

(continued)

(Table 136, contd)

Troubleshooting Test Steps	Values	Results
11. 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 12.
12. 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).

i06193918

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
- Transfer Pump Inlet Regulator (TPIR) flow
- Transfer Pump Inlet Regulator (TPIR) return
- Electric Fuel Lift Pump (EFLP) flow
- Return fuel lines

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 137

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.	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”. 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 connector is 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 137, 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 Fuel Lift Pump (EFLP) is operating correctly. **I.** Replace the in-line fuel filter that is upstream of the primary fuel filter. **J.** Replace the primary and secondary fuel filters. **K.** Check the diesel fuel for contamination. Refer to Systems Operation, Testing, and Adjusting, “Fuel Quality - Test”. **L.** Check for air in the fuel system. Refer to Systems Operation, Testing, and Adjusting, “Air in Fuel - Test”. **M.** 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.

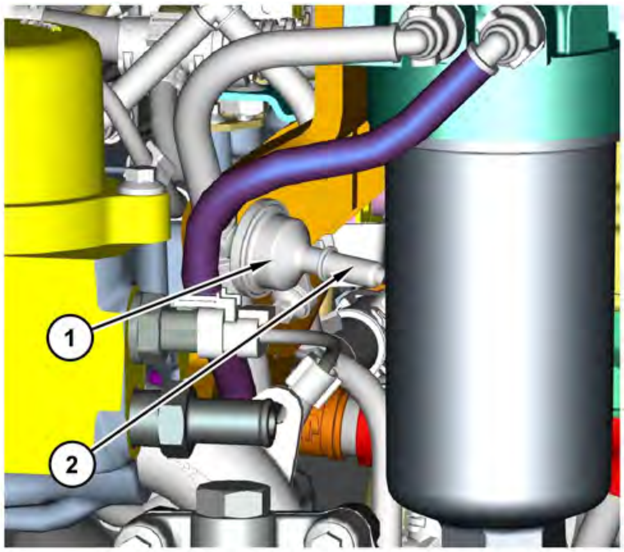


Illustration 76 g03750256

Transfer Pump Inlet Regulator (TPIR) components

(1) Transfer Pump Inlet Regulator (TPIR)
(2) TPIR return port

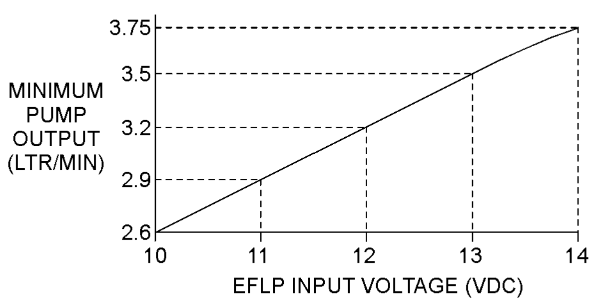


Illustration 77 g02355128

Minimum TPIR flow rate in a 12 VDC system

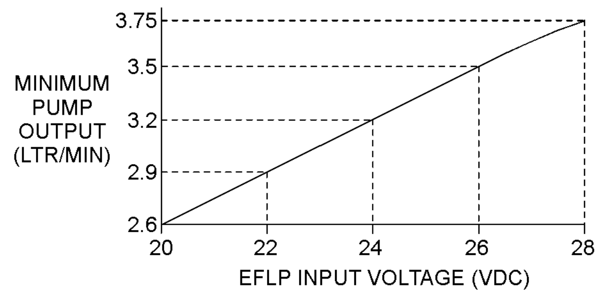


Illustration 78 g02355130

Minimum TPIR flow rate in a 24 VDC system

Before performing the following fuel system tests, the engine must be run for a minimum of 30 minutes.

Note: When performing the following fuel system tests, the Electric Fuel Lift Pump (EFLP) will only operate for 2 minutes unless the engine is running. If necessary, cycle the keyswitch in order to reactivate the pump.

Table 138

Troubleshooting Test Steps	Values	Results
6. Transfer Pump Inlet Regulator (TPIR) Flow Test Refer to Illustration 76 . **A.** Disconnect the TPIR return line from the drain port on the TPIR. Install a suitable blanking cap on the open port in the TPIR return line. **B.** Connect a temporary drain line to the drain port on the TPIR. **C.** Place the end of the temporary drain line into a suitable calibrated container. **D.** With the isolator switch in the ON position but the engine not running, use a suitable multimeter to measure the input voltage to the EFLP. Record the reading. **E.** With the isolator switch in the ON position but the engine not running, measure the fuel flow from the temporary drain line. **F.** Refer to Illustration 77 or 78 for the minimum acceptable flow rate. **G.** Remove the temporary drain line from the drain port on the TPIR. Connect the TPIR return line to the TPIR.	TPIR flow rate	**Result:** The fuel flow is greater than the minimum limit. Proceed to Test Step 8. **Result:** The fuel flow is less than the minimum limit. Proceed to Test Step 7.
7. Transfer Pump Inlet Regulator (TPIR) Return Test **A.** Make sure that the TPIR return line is not blocked or kinked. **B.** Check that the Electric Fuel Lift Pump (EFLP) is operating correctly. **C.** Make sure that the fuel lines between the EFLP and the TPIR are not blocked or kinked.	TPIR return	**Result:** A fuel line is blocked or kinked. **Repair:** Clear the fuel line or replace the fuel line. **Result:** The EFLP is not operating correctly. **Repair:** Refer to Troubleshooting, “Relay - Test”. **Result:** All fuel lines are OK and the EFLP appears to be operating correctly. Proceed to Test Step 8.

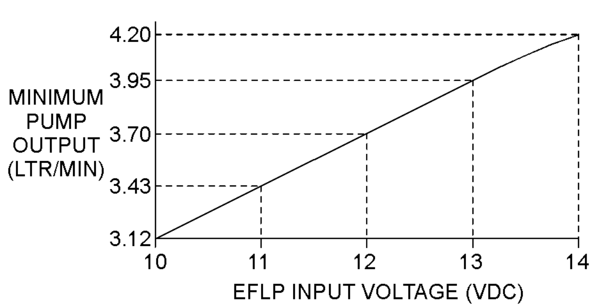


Illustration 79 g02527498

Minimum EFLP flow rate in a 12 VDC system

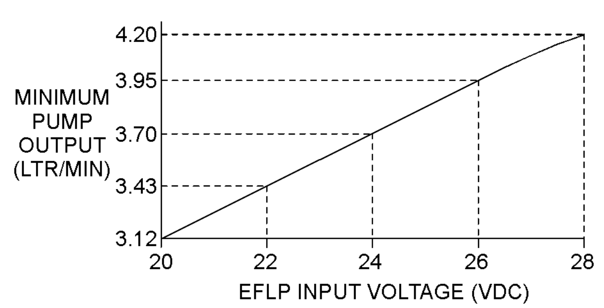


Illustration 80 g02527518

Minimum EFLP flow rate in a 24 VDC system

Table 139

Troubleshooting Test Steps	Values	Results
8. EFLP Flow Test at the Primary Fuel Filter Inlet **A.** Make sure the keyswitch is in the OFF position. **B.** Disconnect the fuel inlet connection from the primary fuel filter head. **C.** Install a suitable blank on the fuel inlet port on the primary fuel filter head. **D.** Place the open end of the fuel inlet line in a suitable calibrated container. **E.** With the keyswitch in the ON position, measure the input voltage at the EFLP. Record the result. **F.** With the keyswitch in the ON position, measure the flow from the fuel inlet line. Record the result. **G.** Check the recorded voltage and fuel flow on the graph in Illustration 79 or 80 .	EFLP flow	**Result:** The fuel flow is below the minimum value for the recorded voltage. **Repair:** Replace the EFLP. Refer to Disassembly and Assembly, “Fuel Priming Pump - Remove and Install ”. **Result:** The fuel flow is above the minimum value for the recorded voltage. Proceed to Test Step 9.
9. Check the Return Fuel Lines **A.** Make sure that the TPIR return line is not blocked or kinked. **B.** If the TPIR return line is clear, confirm that the Electric Fuel Lift Pump (EFLP) is operating. Make sure that fuel lines between the EFLP and the TPIR are not blocked or kinked.	Return lines	**Result:** The TPIR return line or the fuel lines between the EFLP and the TPIR are blocked or kinked. **Repair:** Clear or replace the blocked line. **Result:** The TPIR return line and the fuel lines between the EFLP and the TPIR are clear. **Repair:** Replace the EFLP. If the fault is still present, contact the Dealer Solutions Network (DSN).

i06193919

SCR Catalyst Has Incorrect Inlet Temperature

Table 140

Diagnostic Trouble Code for SCR Catalyst Has Incorrect Inlet Temperature			
J1939 Codes	**PDL Codes**	**Code Description (code descriptions may vary)**	**Comments**
4360-16	E946 (2)	Aftertreatment #1 SCR Catalyst Intake Gas Temperature : High - moderate severity (2)	The aftertreatment SCR catalyst intake gas temperature sensor has detected that the SCR intake temperature is above the normal operating range.
4360-17	E947 (1)	Aftertreatment #1 SCR Catalyst Intake Gas Temperature : Low - least severe (1)	ECM detects that the SCR catalyst intake temperature is below the acceptable range. The code is logged.
4360-18	E947 (2)	Aftertreatment #1 SCR Catalyst Intake Gas Temperature : Low - moderate severity (2)	The aftertreatment SCR catalyst intake gas temperature sensor has detected that the SCR intake temperature is far below the normal operating range.
Follow the troubleshooting procedure in order to identify the root cause of the fault.			

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

Probable causes

- Diagnostic codes
- High exhaust temperature
- Exhaust system

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

Table 141

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 4360-X, E946-2, or E947-X code is active or recently logged. Proceed to Test Step 2. **Result:** An associated code other than 4360-X, E946-X, or E947-X 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 5.
2. Check the Operation of the SCR Catalyst Inlet Temperature Sensor **Note :** Only perform this step on a cold engine. **A.** Remove the SCR catalyst inlet temperature sensor and allow the sensor to rest in ambient air for 2 minutes. **B.** Connect the electronic service tool to the diagnostic connector. **C.** Monitor the value of the SCR catalyst inlet temperature sensor on the electronic service tool.	Sensor	**Result :** The value of the SCR catalyst inlet temperature sensor is within ±9° C (15° F) of ambient temperature. **Repair :** Reinstall the sensor. torque the sensor to the proper specification. For a 4360-16 or E946 (2) code proceed to Test Step 3. For a 4360-17, E947 (1), 4360-18 or E947 (2) code proceed to Test Step 4. **Result :** The value of the SCR catalyst inlet temperature sensor is not within ±9° C (15° F) of ambient temperature. **Repair :** Replace the SCR catalyst inlet temperature sensor. Refer to the Disassembly and Assembly manual for more information. Proceed to Test Step 5.
3. Check for Cause of High Temperature **A.** Check for evidence of an exothermic event in the DOC and DPF. **B.** Check for evidence of excessive fuel reaching the DOC or DPF	High temperature	**Result:** There has been an exothermic event in the DOC or DPF. **Repair:** Replace the Clean Emissions Module (CEM). **Result:** There is evidence of excessive fuel reaching the DOC or DPF. **Repair:** Investigate the cause of the excess fuel.

(continued)

(Table 141, contd)

Troubleshooting Test Steps	Values	Results
4. Check the Exhaust System **A.** Check the exhaust system for gas leaks between the Exhaust Back Pressure Regulator (EBPR) and the exhaust tail pipe. **B.** Check for gas leaks around the following items in the Clean Emissions Module (CEM): · Soot antennas · Temperature sensors · SCR intake NOx sensor · DEF injector **C.** Check for signs of internal exhaust gas leaks on the outer casing of the CEM. **D.** Check for missing or damaged exhaust system insulation. **E.** Make sure that the exhaust piping between the EBPR and the CEM is no longer than 1.83 m (6 ft). **F.** Make sure the cooling air flow over the CEM is not excessive for the ambient conditions.	Exhaust System	**Result:** The exhaust system or the CEM has a gas leak. **Repair:** Make the necessary repairs. Proceed to Test Step 5. **Result:** The exhaust system insulation is damaged or missing. **Repair:** Make the necessary repairs. Proceed to Test Step 5. **Result:** Review and correct the routing of the exhaust system. If necessary, consult the Dealer Solutions Network (DSN) for further advice. Proceed to Test Step 5. **Result:** There is excessive cooling air flow over the CEM. **Repair:** Reduce the cooling air flow. If necessary, consult the Dealer Solutions Network (DSN) for further advice. Proceed to Test Step 5.
5. Check the SCR Catalyst Temperature **A.** Connect to the electronic service tool. **B.** Run the engine. **C.** Perform the “Manual Hydrocarbon Dosing Capability Test” .	Manual hydrocarbon dosing capability test	**Result:** The “Manual Hydrocarbon Dosing Capability Test” completed successfully. Return the unit to service. **Result:** The “Manual Hydrocarbon Dosing Capability Test” failed. An error identifier is generated by the electronic service tool. **Repair:** Troubleshoot the error identifier. Refer to Troubleshooting, “Service tool Error Identifiers”. Repeat Test Step 4. **Result:** The “Manual Hydrocarbon Dosing Capability Test” failed. No error identifiers are generated. Contact the Dealer Solutions Network (DSN).

i07731060

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 while the control actions are imposed:

- Lamps
- Messages
- Audible alarms

Table 142

Diagnostic Trouble Codes for SCR Warning System Problem			
J1939 Code	**PDL Code**	**Code Description** (code descriptions may vary)	**Comments**
5246-15	E1389 (1)	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	E1389 (2)	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	E1389 (3)	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 143 that are present. Refer to "Inducement Type" in Table 143 for the correct Inducement table.

Table 143

Associated Codes			
J1939 Codes	**PDL Codes**	**Code Description** (code descriptions may vary)	**Inducement Type**
678-3	41-3	ECU 8 Volts DC Supply : Voltage Above Normal	DEF Quality/Tampering/Dosing Interruption
678-4	41-4	ECU 8 Volts DC Supply : Voltage Below Normal	DEF Quality/Tampering/Dosing Interruption
1235-9	5856-9	J1939 Network #3 : Abnormal Update Rate	DEF Quality/Tampering/Dosing Interruption
1235-14	5856-14	J1939 Network #3 : Special Instruction	DEF Quality/Tampering/Dosing Interruption
1761-1	E954 (3)	Catalyst Tank Level : Low - most severe (3)	DEF Tank Level Inducement
1761-3	3130-3	Catalyst Tank Level : Voltage Above Normal	DEF Quality/Tampering/Dosing Interruption
1761-4	3130-4	Catalyst Tank Level : Voltage Below Normal	DEF Quality/Tampering/Dosing Interruption
1761-17	E954 (1)	Catalyst Tank Level : Low - least severe (1)	DEF Tank Level Inducement
1761-18	E954 (2)	Catalyst Tank Level : Low - moderate severity (2)	DEF Tank Level Inducement
2659-7	E1319 (2)	Engine Exhaust Gas Recirculation (EGR) Mass Flow Rate : Not Responding Properly	NRS Inducement
2791-5	3405-5	Engine Exhaust Gas Recirculation (EGR) Valve Control : Current Below Normal	NRS Inducement
3031-7	E1441 (2)	Catalyst Tank Temperature : Not Responding Properly	DEF Quality/Tampering/Dosing Interruption
3031-16	E960 (2)	Catalyst Tank Temperature : High - moderate severity (2)	DEF Quality/Tampering/Dosing Interruption

(continued)

(Table 143, contd)

3031-18	E1398 (2)	Catalyst Tank Temperature : Low - moderate severity	DEF Quality/Tampering/Dosing Interruption
3216-5	3002-5	Aftertreatment 1 Intake NOx : Current Below Normal	DEF Quality/Tampering/Dosing Interruption
3216-6	3002-6	Aftertreatment 1 Intake NOx : Current Above Normal	DEF Quality/Tampering/Dosing Interruption
3216-7	E1431 (2)	Aftertreatment #1 Intake NOx : Not Responding Properly	DEF Quality/Tampering/Dosing Interruption
3216-11	3002-11	Aftertreatment #1 Intake NOx : Other Failure Mode	DEF Quality/Tampering/Dosing Interruption
3216-12	3002-12	Aftertreatment #1 Intake NOx : Failure	DEF Quality/Tampering/Dosing Interruption
3217-16	E1407 (2)	Aftertreatment #1 Intake O2 : High - moderate severity (2)	DEF Quality/Tampering/Dosing Interruption
3226-5	3609-5	Aftertreatment 1 Outlet NOx : Current Below Normal	DEF Quality/Tampering/Dosing Interruption
3226-6	3609-6	Aftertreatment 1 Outlet NOx : Current Above Normal	DEF Quality/Tampering/Dosing Interruption
3226-7	E1432 (2)	Aftertreatment #1 Outlet NOx : Not Responding Properly	DEF Quality/Tampering/Dosing Interruption
3226-11	3609-11	Aftertreatment #1 Outlet NOx : Other Failure Mode	DEF Quality/Tampering/Dosing Interruption
3226-12	3609-12	Aftertreatment #1 Outlet NOx : Failure	DEF Quality/Tampering/Dosing Interruption
3227-16	E1408 (2)	Aftertreatment #1 Outlet O2 : High - moderate severity (2)	DEF Quality/Tampering/Dosing Interruption
3242-3	2452-3	Aftertreatment #1 DPF Intake Gas Temperature : Voltage Above Normal	DEF Quality/Tampering/Dosing Interruption
3242-4	2452-4	Aftertreatment #1 DPF Intake Gas Temperature : Voltage Below Normal	DEF Quality/Tampering/Dosing Interruption
3242-8	2452-8	Aftertreatment #1 DPF Intake Gas Temperature : Abnormal Frequency, Pulse Width, or Period	DEF Quality/Tampering/Dosing Interruption
3360-3	3820-3	Catalyst Tank Controller : Voltage Above Normal	DEF Quality/Tampering/Dosing Interruption
3360-4	3820-4	Catalyst Tank Controller : Voltage Below Normal	DEF Quality/Tampering/Dosing Interruption
3360-9	3820-9	Catalyst Tank Controller : Abnormal Update Rate	DEF Quality/Tampering/Dosing Interruption
3360-12	3820-12	Catalyst Tank Controller : Failure	DEF Quality/Tampering/Dosing Interruption
3361-5	3821-5	Catalyst Dosing Unit : Current Below Normal	DEF Quality/Tampering/Dosing Interruption
3361-6	3821-6	Catalyst Dosing Unit : Current Above Normal	DEF Quality/Tampering/Dosing Interruption
3361-7	3821-7	Catalyst Dosing Unit : Not Responding Properly	DEF Quality/Tampering/Dosing Interruption
3361-14	3821-14	Catalyst Dosing Unit : Special Instruction	DEF Quality/Tampering/Dosing Interruption
3361-11	3821-11	Catalyst Dosing Unit : Other Failure Mode	DEF Quality/Tampering/Dosing Interruption
3363-5	3126-5	Catalyst Tank Heater : Current Below Normal	DEF Quality/Tampering/Dosing Interruption
3363-6	3126-6	Catalyst Tank Heater : Current Above Normal	DEF Quality/Tampering/Dosing Interruption

(continued)

(Table 143, contd)

3511-11	3482-11	Sensor Supply #3:Other Failure Mode	DEF Quality/Tampering/Dosing Interruption
3516-18	E1364 (2)	Aftertreatment 1 Diesel Exhaust Fluid Concentration : Low - moderate severity (2)	DEF Quality/Tampering/Dosing Interruption
4334-3	3090-3	Aftertreatment #1 SCR Dosing Reagent Absolute Pressure : Voltage Above Normal	DEF Quality/Tampering/Dosing Interruption
4334-4	3090-4	Aftertreatment #1 SCR Dosing Reagent Absolute Pressure : Voltage Below Normal	DEF Quality/Tampering/Dosing Interruption
4334-7	3090-7	Aftertreatment #1 SCR Dosing Reagent Absolute Pressure : Not Responding Properly	DEF Quality/Tampering/Dosing Interruption
4334-16	E930 (2)	Aftertreatment #1 SCR Dosing Reagent Absolute Pressure : High - moderate severity (2)	DEF Quality/Tampering/Dosing Interruption
4334-18	E931 (2)	Aftertreatment #1 SCR Dosing Reagent Absolute Pressure : Low - moderate severity (2)	DEF Quality/Tampering/Dosing Interruption
4337-8	3096-8	Aftertreatment #1 SCR Dosing Reagent Temperature : Abnormal Frequency, Pulse Width, or Period	DEF Quality/Tampering/Dosing Interruption
4354-5	3110-5	Aftertreatment #1 SCR Catalyst Reagent Line Heater #1 : Current Below Normal	DEF Quality/Tampering/Dosing Interruption
4354-6	3110-6	Aftertreatment #1 SCR Catalyst Reagent Line Heater #1 : Current Above Normal	DEF Quality/Tampering/Dosing Interruption
4355-5	3111-5	Aftertreatment #1 SCR Catalyst Reagent Line Heater #2 : Current Below Normal	DEF Quality/Tampering/Dosing Interruption
4355-6	3111-6	Aftertreatment #1 SCR Catalyst Reagent Line Heater #2 : Current Above Normal	DEF Quality/Tampering/Dosing Interruption
4356-5	3112-5	Aftertreatment #1 SCR Catalyst Reagent Line Heater #3 : Current Below Normal	DEF Quality/Tampering/Dosing Interruption
4356-6	3112-6	Aftertreatment #1 SCR Catalyst Reagent Line Heater #3 : Current Above Normal	DEF Quality/Tampering/Dosing Interruption
4360-3	3105-3	Aftertreatment #1 SCR Catalyst Intake Gas Temperature : Voltage Above Normal	DEF Quality/Tampering/Dosing Interruption
4360-4	3105-4	Aftertreatment #1 SCR Catalyst Intake Gas Temperature : Voltage Below Normal	DEF Quality/Tampering/Dosing Interruption
4360-8	3105-8	Aftertreatment #1 SCR Catalyst Intake Gas Temperature : Abnormal Frequency, Pulse Width, or Period	DEF Quality/Tampering/Dosing Interruption
4360-16	E946 (2)	Aftertreatment #1 SCR Catalyst Intake Gas Temperature : High - moderate severity (2)	DEF Quality/Tampering/Dosing Interruption
4360-18	E947 (2)	Aftertreatment #1 SCR Catalyst Intake Gas Temperature : Low - moderate severity (2)	DEF Quality/Tampering/Dosing Interruption
4364-2	E1410 (2)	Aftertreatment #1 SCR Catalyst Conversion Efficiency : Erratic, Intermittent, or Incorrect	DEF Quality/Tampering/Dosing Interruption
4364-18	E1309 (2)	Aftertreatment #1 SCR Catalyst Conversion Efficiency : Low - moderate severity (2)	DEF Quality/Tampering/Dosing Interruption
4374-5	3118-5	Aftertreatment #1 Diesel Exhaust Fluid Pump Motor Speed : Current Below Normal	DEF Quality/Tampering/Dosing Interruption
4374-6	3118-6	Aftertreatment #1 Diesel Exhaust Fluid Pump Motor Speed : Current Above Normal	DEF Quality/Tampering/Dosing Interruption

(continued)

(Table 143, contd)

4374-8	3118-8	Aftertreatment #1 Diesel Exhaust Fluid Pump Motor Speed : Abnormal Frequency, Pulse Width, or Period	DEF Quality/Tampering/Dosing Interruption
4376-6	3862-6	Aftertreatment #1 SCR Catalyst Reagent Return Valve : Current Below Normal	DEF Quality/Tampering/Dosing Interruption
4376-7	3862-7	Aftertreatment #1 SCR Catalyst Reagent Return Valve : Not Responding Properly	DEF Quality/Tampering/Dosing Interruption
4792-14	1390-2	Aftertreatment #1 SCR System : Special Instruction	DEF Quality/Tampering/Dosing Interruption
5392-31	E1370 (2)	Aftertreatment Diesel Exhaust Fluid Dosing Unit Loss of Prime	DEF Quality/Tampering/Dosing Interruption
5480-16	E1430 (2)	Aftertreatment #1 DEF Controller Temperature : High - moderate severity (2)	DEF Quality/Tampering/Dosing Interruption
5491-5	3822-5	Aftertreatment #1 DEF Line Heater Relay : Current Below Normal	DEF Quality/Tampering/Dosing Interruption
5491-6	3822-6	Aftertreatment #1 DEF Line Heater Relay : Current Above Normal	DEF Quality/Tampering/Dosing Interruption
5588-14	E1132 (2)	Proprietary Network #2 : Special Instruction	DEF Quality/Tampering/Dosing Interruption
5758-11	3621-11	Engine Exhaust NOx Level Sensor Power Supply: Other Failure Mode	DEF Quality/Tampering/Dosing Interruption
5759-11	3619-11	Aftertreatment #1 Outlet #1 NOx Level Sensor Power Supply : Other Failure Mode	DEF Quality/Tampering/Dosing Interruption
5965-5	3838-5	Aftertreatment #1 Diesel Exhaust Fluid Dosing Control Unit Relay : Current Below Normal	DEF Quality/Tampering/Dosing Interruption
5965-6	3838-6	Aftertreatment #1 Diesel Exhaust Fluid Dosing Control Unit Relay : Current Above Normal	DEF Quality/Tampering/Dosing Interruption
5966-6	3965-6	Aftertreatment #1 DEF Control Module Power Supply: Current Above Normal	DEF Quality/Tampering/Dosing Interruption

Service Override Mode

Service Override mode allows a technician to service inducement-related faults on an engine while having full engine operation and no derate effects. This mode is initiated through the electronic service tool. Service Override Mode can be entered as many times as necessary and does not have a time limit. Any active faults still appear in the electronic service tool when an engine is in Service Override Mode.

Service Override mode pauses all inducement-related timers that have been activated by triggering faults. This pause prevents the system from escalating to a higher inducement level.

Table 144

Troubleshooting Test Steps	Values	Results
1. Connect the Electronic Service Tool **A.** Connect the electronic service tool. **B.** Activate the Service Inducement Override in the electronic service tool. Refer to Service Override Mode listed below for details pertaining to the Service Override.	Service Inducement Override	**Result:** The Service Inducement Override has been activated. Proceed to Test Step 2.
2. Check for Associated Codes **A.** Check for associated codes before performing any troubleshooting or clearing diagnostic trouble 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.

DEF Tank Level Inducement

DEF Tank Level Fault Occurrence

Two options are available but only one option will be enabled.

Option 1 - Reduced Performance (Derates)

Option 1 is the default setting for inducement.

If the DEF level falls below 19%, an amber indicator will illuminate below the DEF level gauge on the panel. To avoid further inducements, add DEF to the DEF tank.

Level 1: If the DEF level falls below 12.5%, the Emissions System Malfunction lamp will illuminate. The amber indicator next to the DEF level gauge on the panel will remain lit.

Level 2 (Mild): If the DEF level is below 6%, the Emissions System Malfunction lamp will flash slowly. The amber indicator below the DEF level gauge on the panel will remain lit.

Level 2 (Severe): If the DEF level falls to 0% without a loss of DEF pressure, the engine is derated by 25% torque over a 10 minute period.

Level 3: When the DEF level falls to empty with a loss of DEF pressure, the engine enters a 5 minute cool down period. The engine is derated by 50% torque. The reduced performance is followed by engine at low idle only or engine shutdown. The following indications will be present:

- The Emissions System Malfunction lamp will flash quickly
- The Shutdown lamp will be on
- The engine will be restricted to low idle or will stop
- The amber indicator below the DEF level gauge on the panel will be lit.

OPTION 1 (Reduced Performance)				
J1939 CODE	PDL CODE	DEF TANK LEVEL	LAMP INDICATION	DESCRIPTION
No Code Activated	No Code Activated	Above 19%		DEF System OK
No Code Activated	No Code Activated	Below 19%		DEF Level Lamp on
1761-17	E954 (1)	Below 12.5%	Steady	DEF Level and Emissions System Malfunction Lamps on
1761-18	E954 (2)	Below 6%	Slow Flashing	DEF Level Lamp on Emissions System Malfunction lamp flashing slowly
1761-18	E954 (2)	0% (DEF System Still Pressurized)	Slow Flashing	DEF Level Lamp on Emissions System Malfunction lamp flashing slowly Engine derated by 25% torque
1761-1	E954 (3)	Empty (with an associated loss of DEF pressure)	Quick Flashing; STOP Steady	DEF Level Lamp on Emissions System Malfunction lamp flashing quickly Shutdown lamp on 5 minute cool down with 50% torque derate followed by engine to low idle or shutdown

Illustration 81 g06180235

Option 2 - Reduced Time (No Derates)

Option 2 is an alternative setting for applications with auxiliary equipment that could be damaged if the engine is derated.

If the DEF level falls below 19%, an amber indicator will illuminate below the DEF level gauge on the panel. To avoid further inducements, add DEF to the DEF tank.

Level 1: If the DEF level falls below 12.5%, the Emissions System Malfunction lamp will illuminate. The amber indicator next to the DEF level gauge on the panel will remain lit.

Level 2: If the DEF level is below 6%, the Emissions System Malfunction lamp will flash slowly. The amber indicator below the DEF level gauge on the panel will remain lit.

Level 3: If the DEF level is 0%, the engine enters a 5 minute cool down period. The engine is derated by 50% torque. The following indications will be present:

- The Emissions System Malfunction lamp will flash quickly
- The Shutdown lamp will be on
- The amber indicator below the DEF level gauge on the panel will be lit.

OPTION 2 (Reduced Time)				
J1939 CODE	PDL CODE	DEF TANK LEVEL	LAMP INDICATION	DESCRIPTION
No Code Activated	No Code Activated	Above 19%		DEF System OK
No Code Activated	No Code Activated	Below 19%		DEF Level Lamp on
1761-17	E954 (1)	Below 12.5%	Steady	DEF Level and Emissions System Malfunction Lamps on
1761-18	E954 (2)	Below 6%	Slow Flashing	DEF Level Lamp on Emissions System Malfunction lamp flashing slowly
1761-1	E954 (3)	0%	Quick Flashing STOP Steady	DEF Level Lamp on Emissions System Malfunction lamp flashing quickly Shutdown lamp on 5 minute cool down with 50% torque derate followed by engine to low idle or shutdown

Illustration 82 g06180236

Tampering/Dosing Interruption

The Emissions System Malfunction lamp will illuminate for a fault resulting from SCR system tampering or an SCR system fault. If the fault is the result of system tampering, a first occurrence will result in a level 1 inducement for a duration of 2.5 hours. Repeat occurrences will result in a level 1 inducement duration of 5 minutes.

If a fault condition exists for the entire duration of inducement level 1, the strategy advances to inducement level 2. For a fault resulting from SCR system tampering or an SCR system fault, the Emissions System Malfunction lamp will flash.

The duration for a level 2 inducement is always 70 minutes for the first occurrence. Repeat occurrences will result in a level 2 inducement duration of 5 minutes.

If a fault condition exists for the entire duration of inducement level 2, the strategy advances to inducement level 3. The Emissions System Malfunction lamp will flash and the Shutdown lamp will be on. The engine will be restricted to low idle or will stop. After the final inducement, the keyswitch can be cycled once which will allow 20 minutes of engine run time with full torque. After 20 minutes, the engine will allow idle only or will stop until the fault has been resolved. The override can only be used once.

The system must be fault-free for 40 hours before the system resets to zero. If the fault is intermittent and returns within 40 hours, the repeat inducement timings will be triggered.

Timeline For First Fault Occurrence

Time After First Occurrence	J1939 Code	PDL Code	Lamp Indication	Description
0 Hours	5246-15	E1389 (1)		Emissions System Malfunction lamp on
2.5 Hours	5246-16	E1389 (2)	Flashing	Emissions System Malfunction lamp flashing
3.6 Hours	5246-0	E1389 (3)	Flashing STOP Steady	Emissions System Malfunction lamp flashing Shutdown lamp on Engine may shut down or be limited to 1000 rpm
One keyswitch cycle is allowed at this point. The keyswitch cycle will allow the engine to run for 20 minutes at 100% torque.				
4 Hours	5246-0	E1389 (3)	Flashing	Emissions System Malfunction lamp flashing Audible warning

Illustration 83 g03845357

Timeline For Second Fault Occurrence

Time After First Occurrence	J1939 Code	PDL Code	Lamp Indication	Description
0 Hours	5246-15	E1389 (1)		Emissions System Malfunction lamp on
5 Minutes	5246-16	E1389 (2)	Flashing	Emissions System Malfunction lamp flashing
10 Minutes	5246-0	E1389 (3)	Flashing STOP Steady	Emissions System Malfunction lamp flashing Shutdown lamp on Engine to Low Idle or Shutdown
One keyswitch cycle is allowed at this point. The keyswitch cycle will allow the engine to run for 20 minutes at 100% torque.				
30 Minutes	5246-0	E1389 (3)	Flashing	Emissions System Malfunction lamp flashing

Illustration 84 g03845358

NRS Inducement

The Emissions System Malfunction lamp will illuminate for a fault resulting from an impeded NOx Reduction System (NRS). A first occurrence will result in a level 1 inducement for a duration of 35 hours. Repeat occurrences will result in a level 1 inducement duration of 48 minutes.

If a fault condition exists for the entire duration of inducement level 1, the strategy advances to inducement level 2. The Emissions System Malfunction lamp will flash for a fault resulting from an impeded NRS. The duration for a level 2 inducement is always 60 minutes for the first occurrence. Repeat occurrences will result in a level 2 inducement duration of 60 minutes.

If a fault condition exists for the entire duration of inducement level 2, the strategy advances to inducement level 3. The Emissions System Malfunction lamp will flash and the Shutdown lamp will be on. The engine will be restricted to low idle or will stop. After the final inducement, the keyswitch can be cycled once which will allow 20 minutes of engine run time with full torque. After 20 minutes, the engine will allow idle only or will stop until the fault has been resolved. The override can only be used once.

The system must be fault-free for 40 hours before the system resets to zero. If the fault is intermittent and returns within 40 hours, the repeat inducement timings will be triggered.

Timeline For First Fault Occurrence

Time After First Occurrence	J1939 Code	PDL Code	Lamp Indication	Description
0 Hours	5246-15	E1389 (1)		Emissions System Malfunction lamp on
35 Hours	5246-16	E1389 (2)	Flashing	Emissions System Malfunction lamp flashing
36 Hours	5246-0	E1389 (3)	Flashing Steady	Emissions System Malfunction lamp flashing Shutdown lamp on Engine to low idle or shutdown
One keyswitch cycle is allowed at this point. The keyswitch cycle will allow the engine to run for 20 minutes at 100% torque.				
36.8 Hours	5246-0	E1389 (3)	Flashing	Emissions System Malfunction lamp flashing

Illustration 85 g03845359

Timeline For Second Fault Occurrence

Time After First Occurrence	J1939 Code	PDL Code	Lamp Indication	Description
0 Hours	5246-15	E1389 (1)		Emissions System Malfunction lamp on
48 Minutes	5246-16	E1389 (2)	Flashing	Emissions System Malfunction lamp flashing
1 Hours 48 Minutes	5246-0	E1389 (3)	Flashing STOP Steady	Emissions System Malfunction lamp flashing Shutdown lamp on Engine to low idle or shutdown
One keyswitch cycle is allowed at this point. The keyswitch cycle will allow the engine to run for 20 minutes at 100% torque.				
2 Hours 8 Minutes	5246-0	E1389 (3)	Flashing	Emissions System Malfunction lamp flashing

Illustration 86 g03845360

i06026810

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 145

<table>
<tr><th>Troubleshooting Test Steps</th><th>Values</th><th>Results</th></tr>
<tr><td>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.</td><td>Lubrication</td><td>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.</td></tr>
<tr><td>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
· Hydraulic lifters
· Camshaft
· Valve stems
· Rocker shafts</td><td>Valve train components</td><td>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).</td></tr>
</table>

Circuit Tests

i06193986

Aftertreatment Identification Module - Test

This procedure covers the following codes:

Table 146

Diagnostic Trouble Codes for the Aftertreatment Identification Module			
J1939 Code	**PDL Code**	**Code Description** (code descriptions may vary)	**Comments**
5576-2	3468-2	Aftertreatment #1 Identification : Erratic, Intermittent, or Incorrect	The Electronic Control Module (ECM) detects the following conditions: The installed Clean Emissions Module (CEM) is not a certified match with the engine. Diagnostic codes 5576-8 or 5576-14 are not active. There are no active 3509 diagnostic codes. The ECM has been powered for 2 seconds. **"This is a violation of the emissions regulations, and may result in severe fines and/or legal action if not corrected immediately." Do not operate the engine with the active fault.** Engine power is derated.
5576-8	3468-8	Aftertreatment #1 Identification : Abnormal Frequency, Pulse Width, or Period	The ECM detects the following conditions: No signal is detected from the aftertreatment identification module. There are no active 3509 diagnostic codes. The ECM has been powered for 2 seconds. **Do not continue to operate the engine with the active fault.** Engine power is derated.

The aftertreatment identification module communicates with the engine ECM to ensure that the correct Integrated Clean Emissions Module (IGCEM) is installed.

If the total operating hours of the engine are greater than 100, the aftertreatment identification module will cease to send the signal. The diagnostic codes that are listed in Table 146 will be disabled.

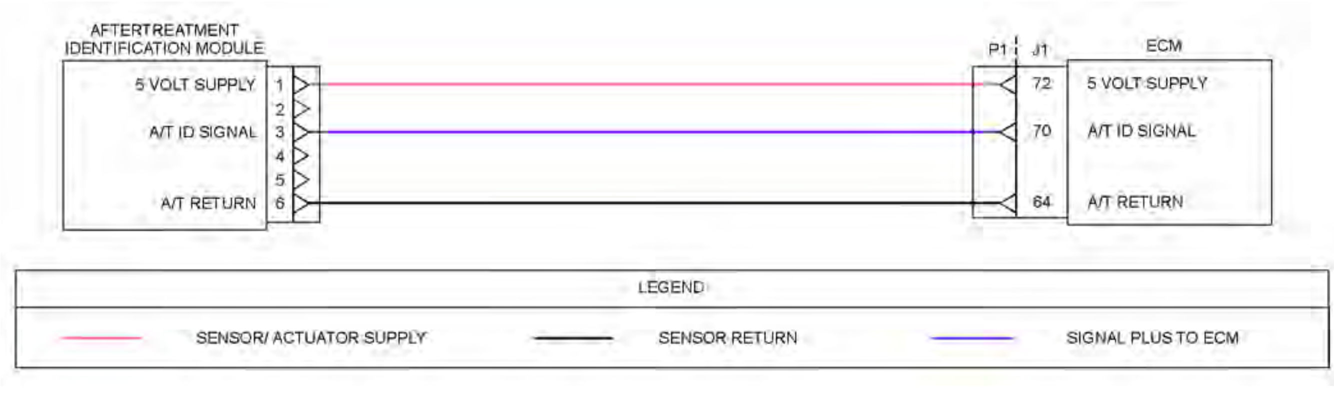


Illustration 87 g03671526

Schematic for the aftertreatment identification module

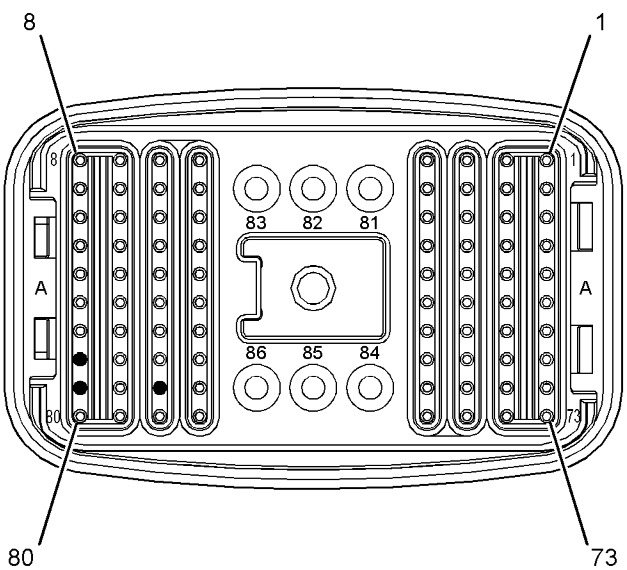


Illustration 88 g03136440

View of the pin locations on the P1 connector for the aftertreatment identification module

(64) Aftertreatment identification module return
(70) Aftertreatment identification module signal
(72) 5 VDC supply

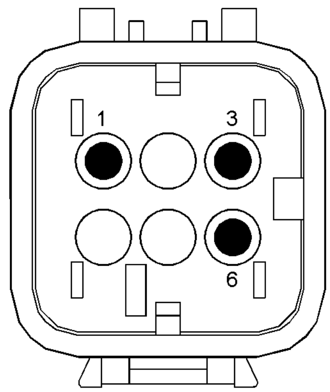


Illustration 89 g03136458

Connector for the aftertreatment identification module

(1) 5 VDC Supply
(3) Signal
(6) Ground

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

Table 147

Troubleshooting Test Steps	Values	Results
1. Check for Diagnostic Codes **A.** Establish communication between the electronic service tool and the Dosing Control Unit (DCU) . Refer to Troubleshooting, "Electronic Service Tools", if necessary. **B.** Turn the keyswitch to the ON position. **C.** Look for "-2" or " -8" active or logged codes.	Diagnostic code	**Result:** A 5576-2 or 3468-2 diagnostic code is active. Proceed to Test Step 6. **Result:** A 5576-8 or 3468-8 diagnostic code is active. Proceed to Test Step 2.
2. Inspect Electrical Connectors and Wiring **A.** Inspect the P1/J1 connector. Refer to Troubleshooting, "Electrical Connectors - Inspect" for details. **B.** Inspect the connector for the aftertreatment identification module. Refer to Troubleshooting, "Electrical Connectors - Inspect" for details. **C.** Perform a 45 N (10 lb) pull test on each of the wires in the ECM connector that are associated with the aftertreatment identification module. **D.** Check the screw for the ECM connector for the correct torque of 6 N·m (53 lb in). **E.** Check the harness for abrasion and pinch points from the aftertreatment identification module back to the ECM.	Connectors and wiring	**Result:** There is a fault with the harness and connectors. **Repair:** Repair the connectors or the harness and/or replace the connectors or the harness. Ensure that all of the seals are correctly in place and ensure that the connectors are correctly connected. Use the electronic service tool in order to clear all logged diagnostic codes and then verify that the repair has eliminated 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. Measure the Voltage to the Aftertreatment Identification Module **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the aftertreatment identification module from the harness. **C.** Turn the keyswitch to the ON position. **D.** Measure the voltage at the harness connector for the aftertreatment identification module from terminal 1 to terminal 6.	4.84 to 5.16 VDC.	**Result:** The supply voltage is out of the nominal range. **Repair:** Replace the harness. Use the electronic service tool to verify that the repair eliminates the fault. **Result:** The supply voltage is correct. Proceed to Test Step 4.
4. Check the Signal Wire for an Open Circuit **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the connector for the aftertreatment ID module. Disconnect the P1 connector on the engine ECM. **C.** Check the resistance between P1:70 and terminal 3 on the harness connector for the aftertreatment identification module.	Less than two Ohms	**Result:** The measured resistance is more than two Ohms. **Repair:** Replace the harness. Use the electronic service tool to verify that the repair eliminates the fault. **Result:** The measured resistance is less than two Ohms Proceed to Test Step 5.

(continued)

(Table 147, contd)

Troubleshooting Test Steps	Values	Results
5. Check the Signal Wire for a Short Circuit **A.** Turn the keyswitch to the OFF position. **B.** Measure the resistance between P1:70 and all other terminals on the P1 connector.	Greater than 100 Ohms	**Result:** At least one of the resistance measurements is less than 100 Ohms. **Repair:** Replace the wiring between the aftertreatment identification module and the ECM. Use the electronic service tool to verify that the repair eliminates the fault. **Result:** All measured resistances are greater than 100 Ohms. Proceed to Test Step 6.
6. Manually Enter the “Aftertreatment Identification Information” **A.** Record the “IGCEM serial number” and the “configuration group” from the IGCEM Identification Plate. The identification plate is on the end cover of the IGCEM. **B.** Contact the Dealer Solutions Network (DSN) for a list of approved RF and CEM configurations for the engine. **C.** Verify that the IGCEM is a certified match with the engine. **D.** Establish communication between the electronic service tool and the ECM . If necessary, refer to Troubleshooting, “Electronic Service Tools”. **E.** Navigate to the “Aftertreatment Configuration” page. **F.** Program the “Factory Installed Aftertreatment #1 Identification Number” with the serial number from the IGCEM Identification Plate. **G.** Program the “DPF #1 Soot Loading Sensing System Configuration Code” with the “configuration group” from the IGCEM Identification Plate. **Note:** The code is automatically cleared.	Manual programming	**Result:** The IGCEM is not a certified match to the engine. **Repair:** Replace the IGCEM with a certified match to the engine. Refer to Disassembly and Assembly for removal and installation procedures. When the new IGCEM is installed, the aftertreatment identification module will begin communicating with the ECM and the diagnostic code will be cleared. **Note:** The engine ECM will only communicate with the IGCEM if the total operating hours of the engine are less than 100. If the hours are greater than 100, the IGCEM information must be programmed into the ECM by using the electronic service tool. **Result:** The IGCEM is a certified match to the engine. Contact the Dealer Solutions Network (DSN).

i06833876

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 148

Diagnostic Trouble Codes for the CAN Data Link Circuit			
J1939 Code	PDL Code	Code Description	Comments
639-9	247-9	J1939 Network #1 : Abnormal Update Rate	Another controller has incorrectly stopped transmitting a J1939 speed request (TSC1) or another controller has incorrectly started transmitting a J1939 speed request. The ECM will log the diagnostic code. The engine will not start.
1196-2	1639-2	Anti-theft Component Status States : Erratic, Intermittent, or Incorrect	The Electronic Control Module (ECM) detects poor communications with the Machine Security System (MSS). The engine warning lamp will come on and the ECM will log the diagnostic code. The engine will not start.
1196-9	1639-9	Anti-theft Component Status States : Abnormal Update Rate	The Electronic Control Module (ECM) detects a loss of communications with the Machine Security System (MSS). The warning lamp will come on and the ECM will log the diagnostic code. The engine will not start.
1231-9	2348-9	J1939 Network #2 : Abnormal Update Rate	An OEM unit has incorrectly stopped transmitting data or the soot sensor has incorrectly started transmitting a data request. The ECM will log the diagnostic code. The engine will not start.
1235-9	5856-9	J1939 Network #3 : Abnormal Update Rate	The Pump, Electronics, and Tank Unit (PETU), the soot sensor, or a NOx sensor has incorrectly stopped or started transmitting a data request. The ECM will log the diagnostic code.
-	1603-9	Machine Control Module : Abnormal Update Rate	The machine ECM has incorrectly stopped or started transmitting a data request. The engine ECM will log the diagnostic code. The engine will not start.

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.

-9 Detected Problems:

ECM 1 is unable to communicate on the data link.

- ECM 1 cannot communicate with other ECM's on the data link, but can communicate with the service tool. This situation indicates a problem with the data link wiring.

ECM 1 is unable to communicate with ECM 2 on the data link.

- ECM 1 cannot communicate with ECM 2, indicating a problem with the data link wiring, power or ground circuit, or ECM 2.

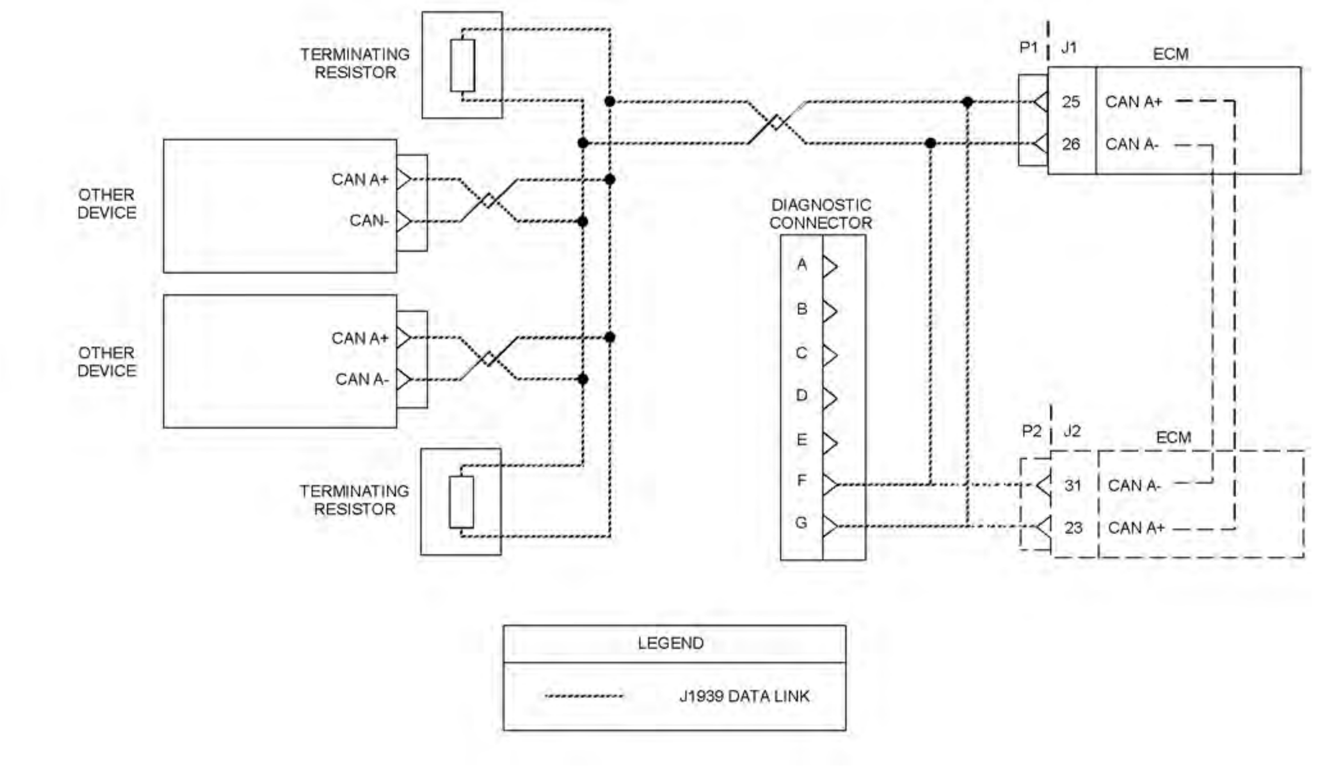


Illustration 90 g03810116

Typical example of the schematic for the CAN A data link

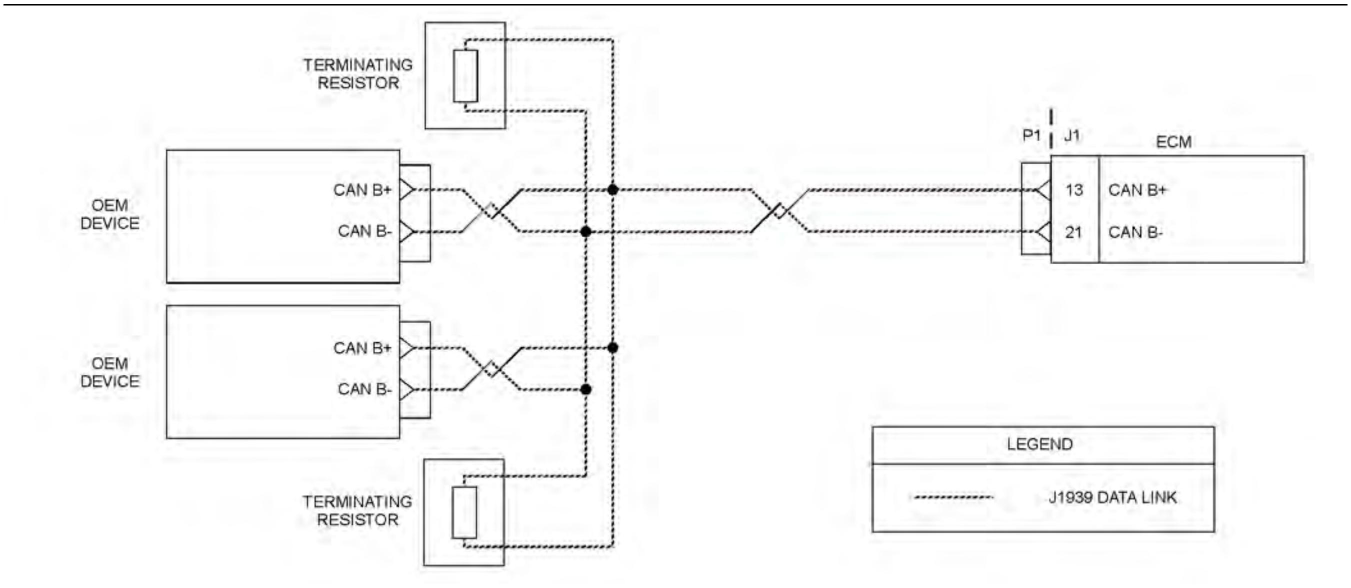


Illustration 91 g03810547

Typical example of the schematic for the CAN B data link

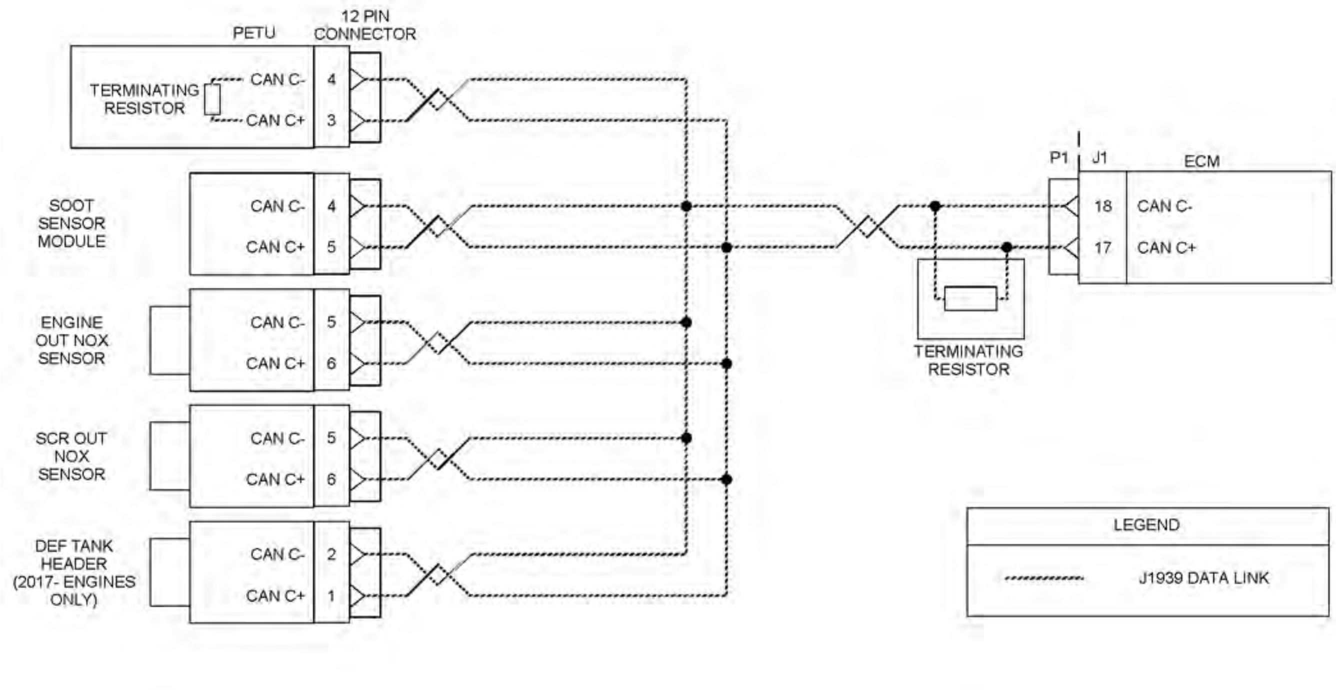


Illustration 92 g06134835

Typical example of the schematic for the CAN C data link

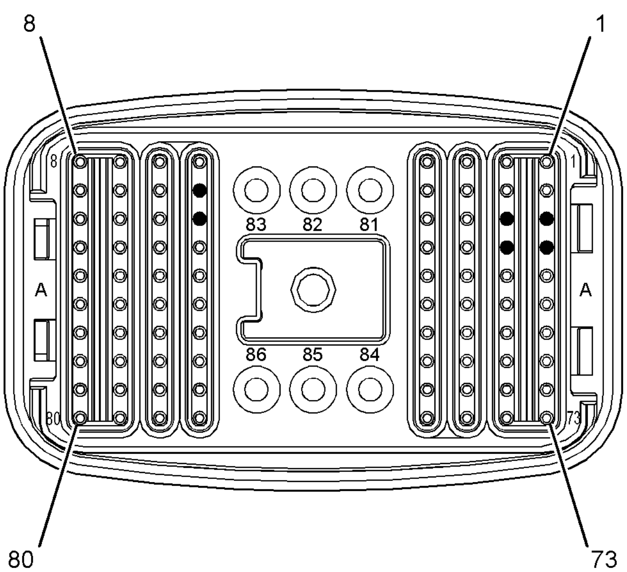


Illustration 93 g03132596

Typical view of the pin locations on the P1 connector

(13) CAN B+
(17) CAN C+
(18) CAN C-
(21) CAN B-
(25) CAN A+
(26) CAN A-

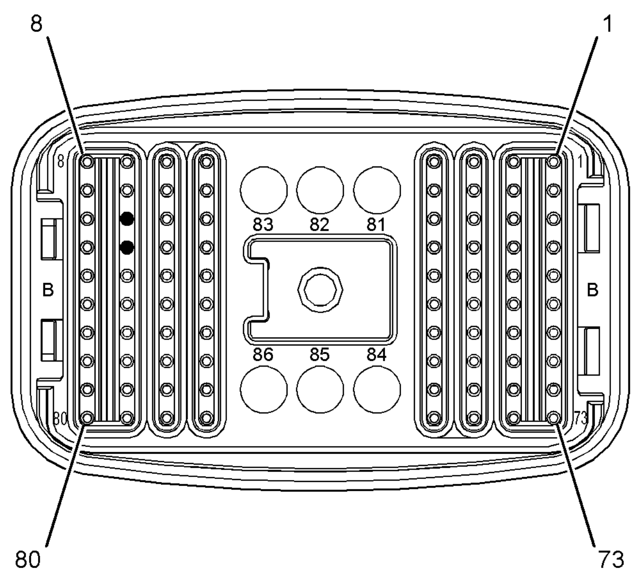


Illustration 94 g03132736

Typical view of the pin locations on the P2 connector

(23) CAN A+
(31) CAN A-

Table 149

Required Tools			
Tool	Part Number	Part Description	Qty
A	T4000243	Break-out Connector	1

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

Table 150

Troubleshooting Test Steps	Values	Results
1. Check for Associated Diagnostic Trouble Codes **A.** Establish communication between the electronic service tool and the ECM. Refer to Troubleshooting, “Electronic Service Tools”, if necessary. **B.** Troubleshoot any associated diagnostic codes that are present before continuing with this procedure.	Associated Codes	**Result:** Another diagnostic trouble code is not active or logged. Proceed to Test Step 2. **Result:** Another code is active or logged. **Repair:** Troubleshoot the other codes before continuing with this procedure. Refer to Troubleshooting, “Diagnostic Trouble Codes” to troubleshoot the other diagnostic code.
2. Use the “System Communication Status” to Determine the Communication Issue **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. **Note:** The **Aftertreatment #1 Intake NOx Level Sensor** is displayed as **Aftertreatment #1 Information #1** in some versions of software.	Component Identified	**Result:** A -9 or -2 code is active. **Repair:** Refer to the above -9 detected problems for more information. Proceed to Test Step 3.
3. Use the System Communication Status to Determine the Cause **A.** Determine if both ECM 1 and ECM 2 are present in the “**ECMs**” column (1) within the “System Communication Status” screen. **Note:** The **Aftertreatment #1 Intake NOx Level Sensor** is displayed as **Aftertreatment #1 Information #1** in some versions of software.	Component Identified	**Result:** ECM 1 and ECM 2 are both present. Record the devices identified as ECM 1 and ECM 2 in column 1. Proceed to Test Step 4. **Result:** Only ECM 1 is present. Record the device identified as ECM 1 in column 1. Proceed to Test Step 5.

(continued)

(Table 150, contd)

Troubleshooting Test Steps	Values	Results
4. Check the Resistance of the Data link **A.** Turn the keyswitch to the OFF position. **B.** Measure the resistance of the datalink between ECM 2 datalink (+) wire and the datalink (-) wire on the wiring harness connector of ECM 2. Refer to the appropriate wiring diagram. **Note:** If ECM 2 is the Dosing Control Unit (DCU), Tooling A must be used to prevent damage to the DCU connector.	60+/-10 Ohms	**Result:** The resistance is less than 50 Ohms. There are more than two terminating resistors installed in the wiring harness or a short circuit has been detected. **Repair:** Repair or replace parts as necessary. Proceed to Test Step 8. **Result:** The resistance is 60 ±10 Ohms. The terminating resistors are OK. Proceed to Test Step 5. **Result:** The resistance is 120 ±10 Ohms. There is a problem with a terminating resistor. **Repair:** Check the resistance on each terminating resistor. Replace the failed terminating resistor. Proceed to Test Step 8. **Result:** The resistance is greater than 130 Ohms. There is a problem with both terminating resistors or an open circuit has been detected. **Repair:** Determine the cause of the problem. Repair the problem, when possible. Replace parts, if necessary. Verify that the problem is resolved. Proceed to Test Step 8.
5. Check the Power and Ground to ECM 2 **A.** Turn the keyswitch to the ON position. **B.** Measure the voltage between the battery (+) and battery (-) terminals on the wiring harness connector of ECM 2. Refer to the appropriate wiring diagram. **Note:** If ECM 2 is the DCU, Tooling A must be used to prevent damage to the DCU connector.	Battery Voltage	**Result:** The voltage is not equal to battery voltage. There is an open or short in the wiring circuit. Repair or replace the wiring circuit as necessary. Refer to the machine-specific schematic for wiring information. Proceed to Test Step 8. **Result:** The voltage is equal to battery voltage and ECM 2 is **NOT** the DCU. **Repair:** Replace the component identified as ECM 2. Proceed to Test Step 8. **Result:** The voltage is equal to battery voltage and ECM 2 is not the DCU. Proceed to Test Step 6. **Result:** The voltage is equal to battery voltage and ECM 2 is the DCU.

(continued)

(Table 150, contd)

Troubleshooting Test Steps	Values	Results
		Proceed to Test Step 7.
6. Check the Resistance of the Data Link **A.** Turn the keyswitch to the OFF position. **B.** Measure the data link resistance between ECM 1 data link (+) wire and the data link (-) wire on the wiring harness connector of ECM 1. Refer to the appropriate wiring diagram. **Note:** If measuring at the DCU wiring harness connector, Tooling A must be used to prevent damage to the DCU connector.	60+/-10 Ohms	**Result:** The resistance is less than 50 Ohms. There are more than two terminating resistors installed in the wiring harness or a short circuit has been detected. **Repair:** Repair or replace parts as necessary. Proceed to Test Step 8. **Result:** The resistance is 60 ±10 Ohms. The terminating resistors are OK. Check the power, ground, and keyswitch (if applicable) supply to each module on the affected data link. Refer to the appropriate wiring diagram. **Note: Keyswitch must be in the ON position when checking the power supply.** Repair the power or ground supply to the modules if necessary. Proceed to Test Step 8. **Result:** The resistance is 120 ±10 Ohms. There is a problem with a terminating resistor. Check the resistance on each terminating resistor. **Repair:** Replace the failed terminating resistor. Proceed to Test Step 8. **Result:** The resistance is greater than 130 Ohms. There is a problem with the wiring harness between ECM 1 and the splice point into the data link wiring. Refer to the appropriate wiring diagram. **Repair:** Determine the cause of the problem. Repair the problem, when possible. Replace parts, if necessary. Verify that the problem is resolved. Proceed to Test Step 8.

(continued)

(Table 150, contd)

Troubleshooting Test Steps	Values	Results
7. Check the Keyswitch Circuit to the DCU **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the 53-pin connector from the DCU. **C.** Connect Tooling A to pin 52 at the DCU connector. **The connectors must be used to prevent damage to the DCU connector.** **D.** Turn the keyswitch to the ON position. **E.** Measure the voltage between keyswitch power (pin 52) and a known good ground source.	Battery Voltage	**Result:** The voltage is equal to battery voltage. **Repair:** Replace the DCU. Proceed to Test Step 8. **Result:** The voltage is not equal to battery voltage. **Repair:** There is an open circuit or a short circuit in the keyswitch wiring circuit. Repair or replace the wiring circuit as necessary. Refer to Troubleshooting, “DEF Control Module Power - Test”.
8. Use the “Systems Communication Status” to Determine the Communication Issue **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. **C.** Click the “Load from ECM” button to determine if any devices are not communicating.	Component Identified	**Result:** The “Systems Communication Status” does not show any communication issues. Return the unit to service. **Result:** The datalink health monitor shows that there are devices that are not communicating. Contact the Dealer Solutions Network (DSN) for assistance.

i07178078

Coolant Level - Test

This test procedure is only applicable on applications that have a coolant level sensor installed.

Use this procedure to troubleshoot any suspect faults with the circuit for the coolant level sensor.

The coolant level sensor monitors the engine coolant level to warn the operator when the coolant level is low.

When the probe is not immersed in coolant, a voltage is sent to the sensor signal wire. When this condition is detected by the Electronic Control Module (ECM), an event code is activated.

If applicable and prior to troubleshooting any faults with the coolant level sensor, use the electronic service tool to check the installation status for the sensor. The coolant level sensor configuration parameter must be set to “Installed” in order for the ECM to monitor the signal from the sensor. Not all applications have the parameter available.

The activation of an event code and/or a warning lamp is probably caused by a low coolant level. The other possible cause is a fault in the wiring harness, a connector, or the sensor.

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 151

Troubleshooting Test Steps	Values	Results
1. Check the Coolant Level **A.** Remove electrical power from the ECM. **B.** Check the coolant level. Refer to the Operation and Maintenance Manual for the correct procedure to check the coolant level.	Coolant level	**Result:** The coolant level is low. **Repair:** Add coolant according to the procedure in the Operation and Maintenance Manual. There may be a leak in the cooling system. Identify the source of the coolant leak. Repair the leak. Refer to Systems Operation/Testing and Adjusting, “Cooling System” for additional information. **Result:** The coolant is at the correct level. For applications that have a “Coolant Level Sensor” parameter, proceed to Test Step 2. For applications that do not have a “Coolant Level Sensor” parameter, proceed to Test Step 3.
2. Verify that the “Coolant Level Sensor” Parameter is Programmed Correctly This Test Step is only applicable to applications that have a “Coolant Level Sensor” parameter. **A.** Connect the electronic service tool to the diagnostic connector. **B.** Establish communication with the ECM. **C.** Verify that the “Coolant Level Sensor” parameter is programmed to “Installed” . **D.** Remove electrical power from the ECM.	Parameter programmed	**Result:** The “Coolant Level Sensor” parameter is not programmed correctly. **Repair:** Program the “Coolant Level Sensor” parameter to “Installed” . Verify that the repair eliminates the fault. **Result:** The “Coolant Level Sensor” parameter is programmed correctly. Proceed to Test Step 3.

(continued)

(Table 151, contd)

Troubleshooting Test Steps	Values	Results
3. Check the Supply Voltage at the Sensor Connector **A.** Disconnect the coolant level sensor at the sensor connector. **B.** Restore electrical power to the ECM. **C.** Measure the voltage between terminals A (sensor supply) and B (sensor return) at the harness connector for the coolant level sensor. **D.** Remove electrical power from the ECM.	8.0 ± 0.5 VDC	**Result:** The voltage measurement is not correct for the application. **Repair:** The sensor supply voltage is not reaching the sensor. There is a fault in the circuit for the sensor supply. Repair the wiring between the sensor and the ECM. **Result:** The voltage measurement is correct for the application. The correct supply voltage is reaching the sensor. Proceed to Test Step 4.
4. Short the Signal Wire to Ground and Monitor the Status for "Coolant Level" **A.** Fabricate a jumper wire that is long enough to create a short circuit between two terminals at the coolant level sensor harness connector. Crimp connector pins to each end of the jumper wire. **B.** Install the jumper wire between terminals B (sensor return) and C (sensor signal) on the harness connector for the coolant level sensor. **C.** Restore electrical power to the ECM. **D.** Monitor the status of "Coolant Level" on the electronic service tool while the jumper wire is installed. Wait at least 30 seconds for activation of the status indicator. **E.** Remove the jumper wire. Connect the harness connector for the coolant level sensor.	Status change	**Result:** The status changes from "LOW" to "OK" when the jumper wire is installed. The ECM and the wiring harness to the coolant level sensor are OK. **Repair:** Replace the coolant level sensor. Verify that the repair eliminates the fault. **Result:** The status does not change from "LOW" to "OK" when the jumper wire is installed. **Repair:** The fault is between the ECM and the sensor connector. Repair the wiring. Verify that the repair eliminates the fault. If the fault is still present, contact the Dealer Solutions Network (DSN).

i06200567

Data Link - Test

Use this procedure if the electronic service tool will not communicate with the ECM through the data link.

The following background information is related to this procedure:

The data link is the standard data link that is used by the ECM in order to communicate with the electronic service tool.

The ECM provides multiple connections for the data link. The technician must ensure that the correct connector is being tested. The connection that is used is dependent on the application.

If the diagnostic connector is off the engine, the positive data link signal will be from P1:20 to pin "D" of the diagnostic connector. The negative data link signal will be from P1:28 to pin "E" of the diagnostic connector.

If the diagnostic connector is on the engine, the positive data link signal will be from P2:47 to pin "D" of the diagnostic connector. The negative data link signal will be from P2:55 to pin "E" of the diagnostic connector.

The following information refers to the pin number. Ensure that the correct connector is used.

Communication

The electronic service tool may indicate the following error message:

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

This message will indicate that the version of the software that is in the electronic service tool is obsolete. Install the latest version of the software for the electronic service tool in order to rectify the fault.

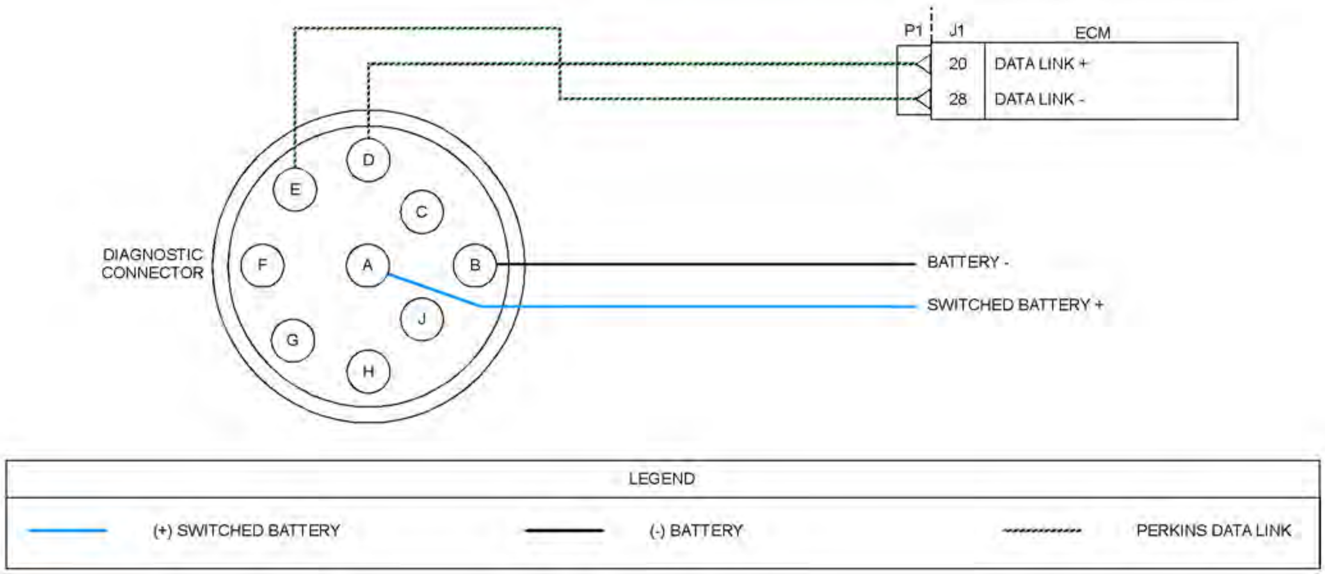


Illustration 95 g03705762

Schematic of the diagnostic connector and the data link connector for a diagnostic connector that is mounted off engine

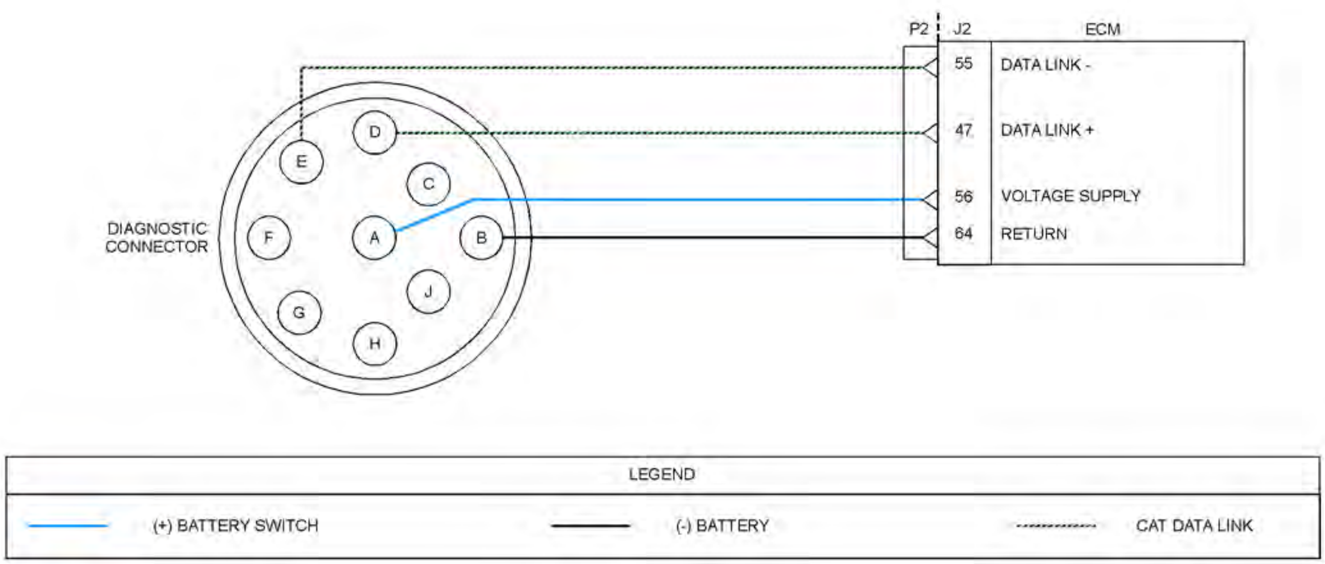


Illustration 96 g03705767

Schematic of the diagnostic connector and the data link connector for an engine mounted diagnostic connector

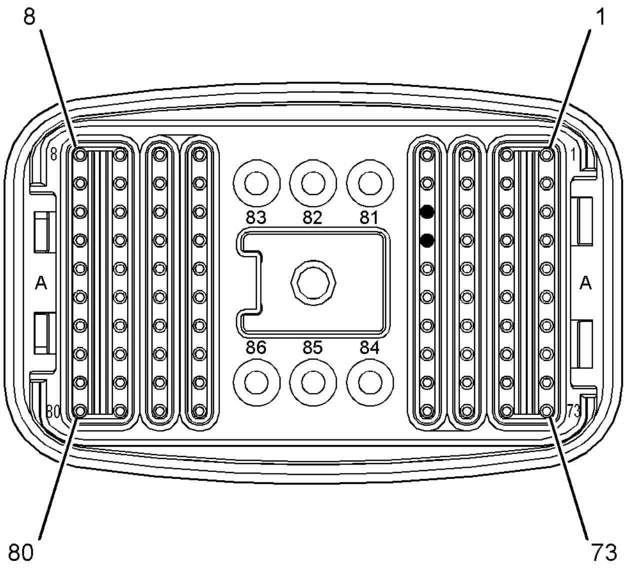


Illustration 97 g03134661

P1 pin locations for the diagnostic connector

(20) Data link +
(28) Data link -

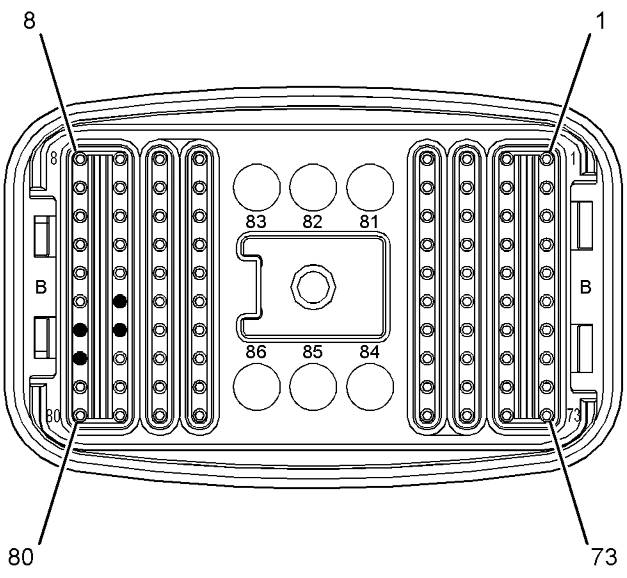


Illustration 98 g03134662

Typical view of the P2 pin locations for the diagnostic connector

(47) Data link +
(55) Data link -
(56) Voltage supply (diagnostic connector)
(64) Return (diagnostic connector)

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

Table 152

Troubleshooting Test Steps	Values	Results
1. Inspect Electrical Connectors and Wiring **A.** Turn the keyswitch to the OFF position. **B.** Inspect the connectors in the circuit for the data link. Refer to Troubleshooting, "Electrical Connectors - Inspect" for details. **C.** Perform a 45 N (10 lb) pull test on each of the wires that are associated with the CAN data link. **D.** Check the screw for the P1 and P2 ECM connectors for correct torque of 6 N·m (53 lb in). **E.** Check all of the wiring associated with the data link for abrasions and pinch points.	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:** A damaged wire or damaged connector was not found. Proceed to Test Step 2.
2. Determine the Type of Fault in the Data Link **A.** Connect the electronic service tool to the diagnostic connector that is on the engine harness or on the application. **Repair:** Turn the keyswitch to the ON position.	Power to the comms adapter	**Result:** The power lamp illuminates on the communications adapter. The communications adapter is currently receiving the correct voltage. Proceed to Test Step 5. **Result:** The power lamp is not illuminated on the communications adapter. The communications adapter is not currently receiving the correct voltage. Proceed to Test Step 3.
3. Check the Battery Voltage at the Diagnostic Connector **A.** Turn the keyswitch to the ON position. **B.** Use a multimeter in order to measure the voltage from pin A (battery+) and pin B (ground) of the diagnostic connector.	11.0 VDC and 13.5 VDC for a 12 VDC system. 22.0 VDC and 27.0 VDC for a 24 VDC system.	**Result:** The voltage is between 22.0 VDC and 27.0 VDC for a 24 V system. The voltage is between 11.0 VDC and 13.5 VDC for a 12 V system. The diagnostic connector is currently receiving the correct voltage. Proceed to Test Step 5. **Result:** The voltage is not between 22.0 VDC and 27.0 VDC for a 24 V system. The voltage is not between 11.0 VDC and 13.5 VDC for a 12 V system. The diagnostic connector is not currently receiving the correct voltage. Proceed to Test Step 4.

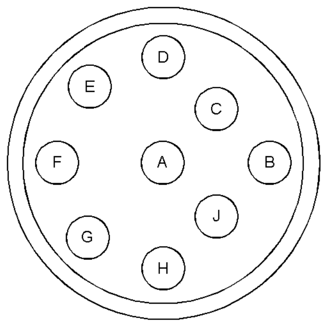


Illustration 99 g03705906

Typical view of the diagnostic connector from the wire side

(A) Switched battery +
(B) Battery ground (GND)
(D) Data link +
(E) Data link -

Table 153

Troubleshooting Test Steps	Values	Results
4. Bypass the Wiring for the Diagnostic Connector **A.** Disconnect the wires from pin A and pin B of the diagnostic connector. **Note:** If the diagnostic connector is mounted on the engine, perform Steps B to D. If the diagnostic connector is mounted off the engine, perform Step E. **B.** Disconnect the wires from P2:56 and P2:64. **C.** Fabricate a jumper wire in order to connect pin A of the diagnostic connector to P2:56. **D.** Fabricate a jumper wire in order to connect pin B of the diagnostic connector to P2:64. **E.** Fabricate a jumper wire in order to connect pin “A” of the diagnostic connector to battery+ and pin “B” to the battery-. **F.** Connect the electronic service tool to the diagnostic connector that is on the engine harness or on the application. **G.** Turn the keyswitch to the ON position. The power lamp should illuminate on the communications adapter.	Other devices are OK	**Result:** The power lamp is illuminated. The fault is in the harness. **Repair:** Repair the faulty harness or replace the faulty harness. Use the electronic service tool in order to clear all logged diagnostic codes and then verify that the repair eliminates the fault. **Result:** The power lamp is not illuminated. Proceed to Test Step 6.
5. Check the Data Link Connections **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the communications adapter from the diagnostic connector. **C.** If the diagnostic connector is installed on the application, disconnect connector P1 from the ECM. Check the resistance between P1:20 and pin “D” on the diagnostic connector. Check the resistance between P1:28 and pin “E” on the diagnostic connector. **D.** If the diagnostic connector is installed on the engine, disconnect P2 from the ECM. Check the resistance between P2:47 and pin “D” on the diagnostic connector. Check the resistance between P2:55 and pin “E” on the diagnostic connector.	Less than ten Ohms	**Result:** The resistances are less than ten Ohms. Proceed to Test Step 6. Use the electronic service tool to clear all logged diagnostic codes. Verify that the repair eliminates the fault. **Result:** At least one of the resistances is greater than ten Ohms. **Repair:** Repair the connectors and/or the harness, or replace the connectors and/or the harness. Ensure that all of the seals are correctly in place and ensure that the connectors are correctly connected. Use the electronic service tool in order to clear all logged diagnostic codes and then verify that the repair eliminates the fault.
6. Change the Electronic Service Tool Components **A.** If another electronic engine is available, connect the electronic service tool to the other engine. Ensure that the same cables are used. **B.** Turn the keyswitch to the ON position. Determine if the electronic service tool operates correctly on the other engine. **C.** If another engine is not available, obtain a replacement communications adapter and a replacement set of cables. Ensure that the cables for the electronic service tool are a complete set.	Power to the comms adapter	**Result:** A different electronic service tool works on the original engine while the engine is being tested. **Repair:** Send the faulty electronic service tool for repairs. **Result:** The original electronic service tool works on another engine. Proceed to Test Step 7.

(continued)

(Table 153, contd)

Troubleshooting Test Steps	Values	Results
D. Install the replacement communications adapter and the set of cables for the electronic service tool and connect to the diagnostic connector. **E.** Turn the keyswitch to the ON position. **F.** If changing the communications adapter or the cables allows the electronic service tool to operate correctly, perform steps G to H. **G.** Replace the components from the new set of cables with components from the original set of cables. Replace one component at a time. **H.** Apply power to the electronic service tool after each of the components is replaced. Use this method to identify the faulty component. **I.** If changing the cables does not allow the electronic service tool to operate correctly, connect another electronic service tool. **J.** Turn the keyswitch to the ON position.		

⚠ WARNING

Batteries give off flammable fumes which can explode.

To avoid injury or death, do not strike a match, cause a spark, or smoke in the vicinity of a battery.

NOTICE

Do not connect the bypass harness to the battery until the in-line fuse has been removed from the Battery + line. If the fuse is not removed before connection to the battery, a spark may result.

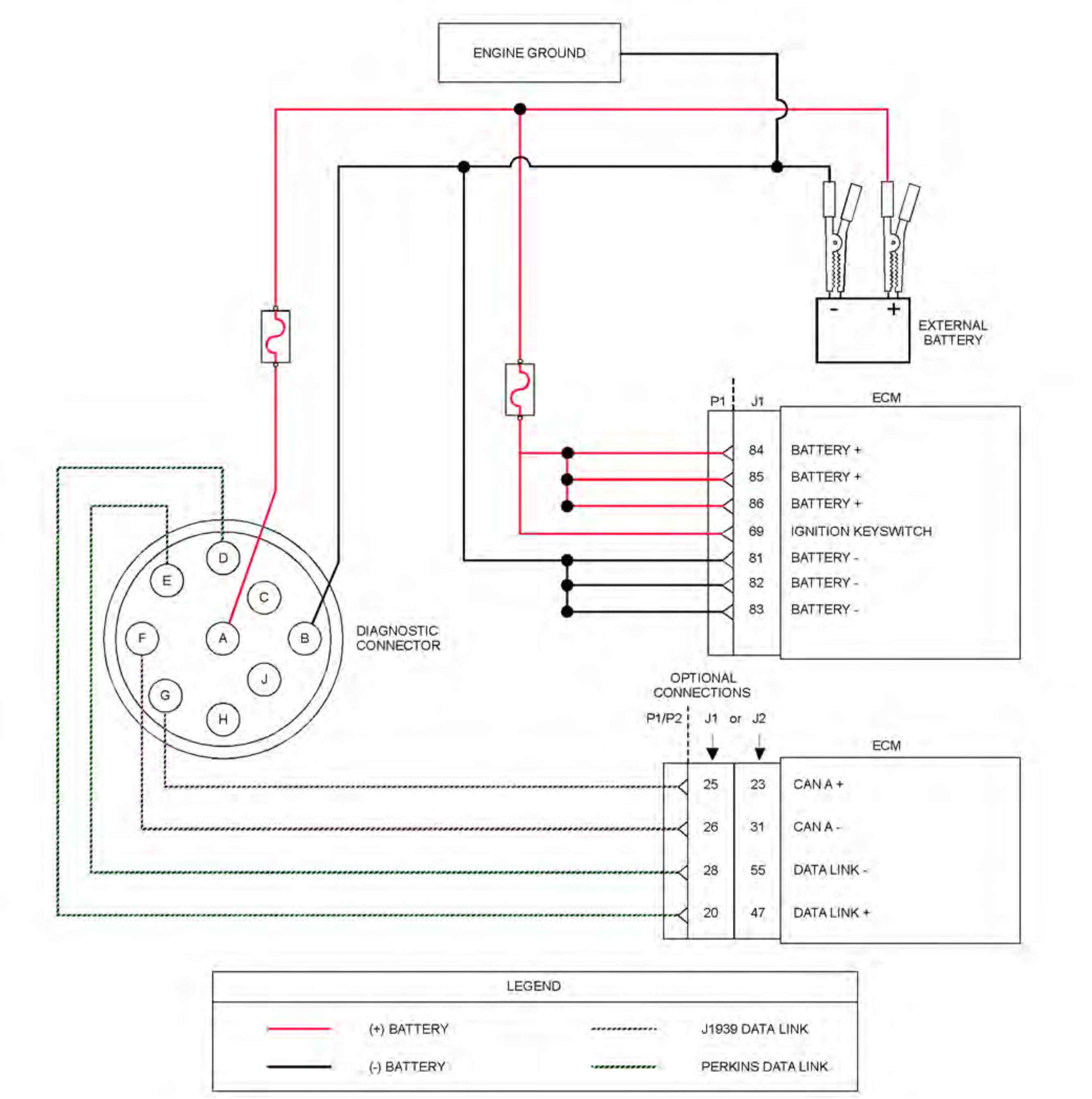


Illustration 100 g03732687

Schematic of the bypass harness connector

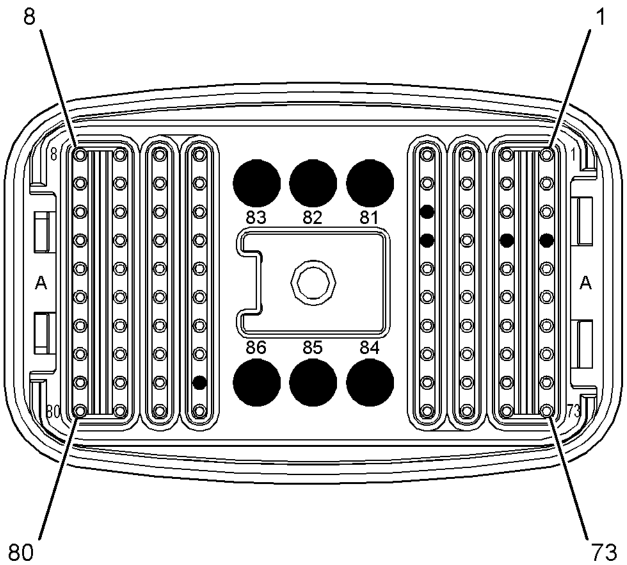


Illustration 101 g03134740

Typical view of the pin locations on connector P1 for the bypass harness

(20) Data link +
(25) J1939 (CAN) +
(26) J1939 (CAN) -
(28) Data link -
(69) Keyswitch
(81) Battery ground (GND)
(82) Battery ground (GND)
(83) Battery ground (GND)
(84) Battery +
(85) Battery +
(86) Battery +

Table 154

Troubleshooting Test Steps	Values	Results
7. Connect an Electronic Service Tool and the ECM to another Battery **Note:** Refer to Figure 100 for details of the bypass harness. **A.** Connect the battery wires from the bypass harness of the electronic service tool to a different battery that is not on the engine.	Bypass harness	**Result:** The electronic service tool is operating correctly. Refer to Troubleshooting, “Electrical Power Supply - Test”. **Result:** The electronic service tool is not operating correctly. **Repair:** Make sure that the latest flash file for the application is installed in the ECM. Refer to Troubleshooting, “ECM Software - Install”. Remove all temporary jumpers and reconnect all connectors.

If the fault is still present, contact the Dealer Solutions Network (DSN).

i06198945

Data Link Configuration Status - Test

The diagnostic code for the special instruction is logged in order to report the configuration status of the data link. The diagnostic code for the special instruction does not check the physical condition of the data link.

The following list identifies possible faults on the data link:

- Incorrect personality module code
- An invalid configuration parameter
- Incorrect module or display on the data link
- Damaged data link wiring
- Incompatible software in one of the ECMs

Use this procedure in order to troubleshoot a diagnostic code for a special instruction. 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 155

Diagnostic Trouble Codes for Data Link Configuration Status - Test		
J1939 Code	**Description**	**Notes**
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.
1231-14	J1939 Network #2 : Special Instruction	The data received from the CAN B data bus is not in the correct format. The code is logged.
1235-14	J1939 Network #3 : Special Instruction	The data received from the CAN C data bus is not in the correct format. The code is logged.
5576-14	Aftertreatment #1 Identification : Special Instruction	The data received from the aftertreatment ID module is not in the correct format. The code is logged.
5588-14	Proprietary Network #2 : Special Instruction	The data received from the DCU is incompatible. The code is logged.

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

Table 156

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. Download a "Warranty Report" from the engine ECM before performing any troubleshooting or clearing diagnostic trouble codes. C. Check for active diagnostic codes.	Associated Trouble code	**Result:** An associated -9 code is logged. Repair all associated -9 codes before continuing with this procedure. Refer to Troubleshooting, "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. 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 the Configuration Parameters A. Check the configuration parameters in order 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 4. **Result:** The configuration parameters are not programmed correctly. 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.
4. Check for Compatibility with Any Other ECM on the Data Link A. Use the as shipped information found in SIS web TMI to 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. 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).

i06834328

DEF Control Module Power - Test

This procedure covers the following diagnostic codes:

Table 157

Diagnostic Trouble Codes for the DEF Control Module Power Supply			
J1939 Code	**PDL Code**	**Code Description** (code descriptions may vary)	**Comments**
3360-3	3820-3	Catalyst Tank Controller : Voltage Above Normal	The ECM detects voltage that is above the acceptable value.
3360-4	3820-4	Catalyst Tank Controller : Voltage Below Normal	The ECM detects voltage that is below the acceptable value.
5965-5	3838-5	Aftertreatment #1 Diesel Exhaust Fluid Dosing Control Unit Relay : Current Below Normal	The ECM detects current that is below the acceptable value
5965-6	3838-6	Aftertreatment #1 Diesel Exhaust Fluid Dosing Control Unit Relay : Current Above Normal	The ECM detects current that is above the acceptable value
5966-5	3965-5	Aftertreatment #1 Diesel Exhaust Fluid Dosing Control Unit : Current Below Normal	The ECM detects current that is below the acceptable value
5966-6	3965-6	Aftertreatment #1 Diesel Exhaust Fluid Dosing Control Unit : Current Above Normal	The ECM detects current that is above the acceptable value
6309-5	3966-5	Aftertreatment #1 Diesel Exhaust Fluid Dosing Control Unit (KSW sinking dout) : Current Below Normal	The ECM detects current that is below the acceptable value
6309-6	3966-6	Aftertreatment #1 Diesel Exhaust Fluid Dosing Control Unit (KSW sinking dout) : Current Above Normal	The ECM detects current that is above the acceptable value

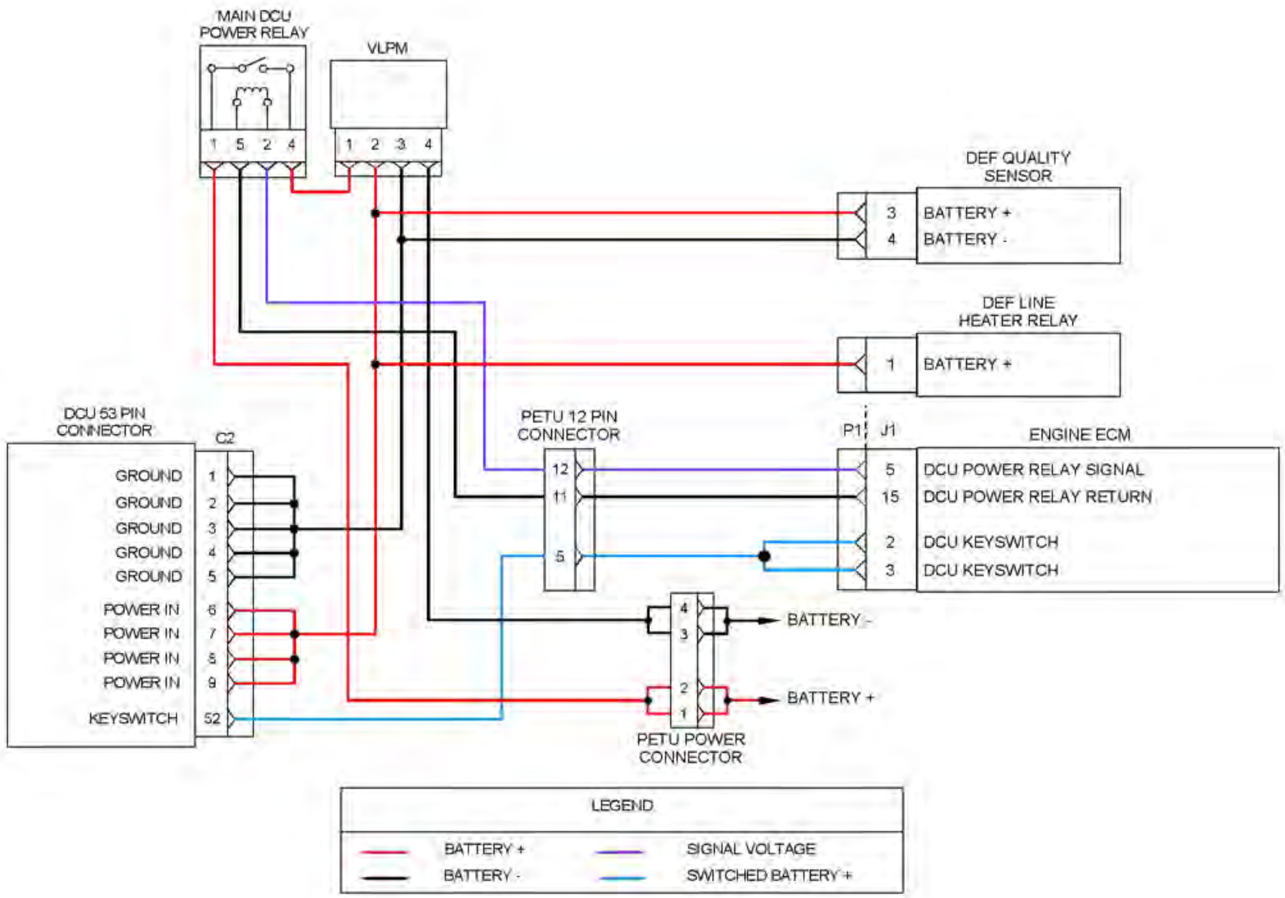


Illustration 102 g06134990

Schematic for the DCU and DEF quality sensor electrical power supply circuit

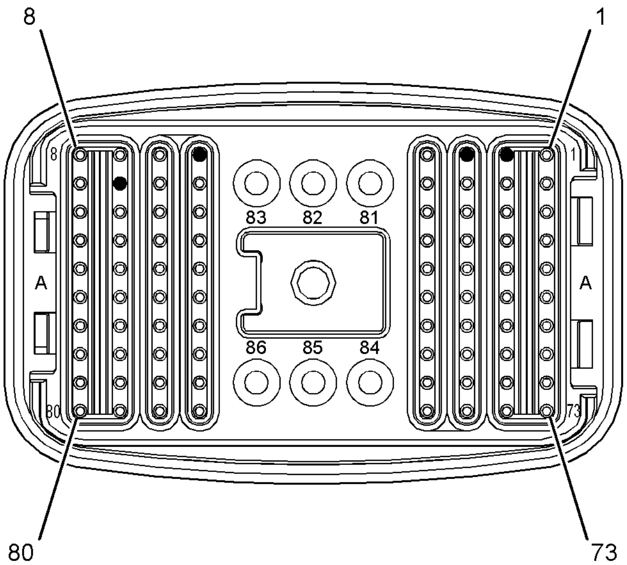


Illustration 103 g03421149

Pin locations on the P1 connector for the power supply circuit

(2) DCU keyswitch
(3) DCU keyswitch
(5) DCU power relay signal
(15) DCU power relay return

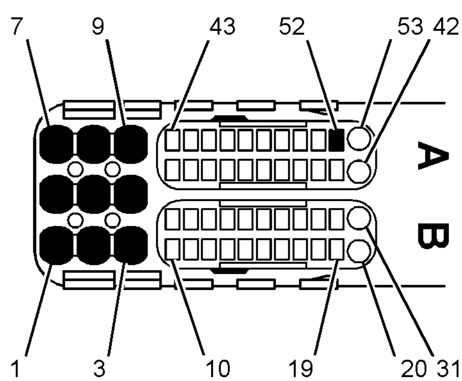


Illustration 104 g03155919

Pin locations on the DCU C2 connector for the power supply circuit

(1) Battery -
(2) Battery -
(3) Battery -
(4) Battery -
(5) Battery -
(6) Battery +
(7) Battery +
(8) Battery +
(9) Battery +
(52) Keyswitch

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

Table 158

Troubleshooting Test Steps	Value	Results
1. Inspect Electrical Connectors and Wiring **A.** Ensure that the battery disconnect switch is in the OFF position. **B.** Thoroughly inspect all connectors associated with the DEF control module power supply. **C.** Check all fuses. **D.** Perform a 45 N (10 lb) pull test on each of the wires in the connectors associated with the power supply. **E.** Check all the wiring associated with the electrical power supplies for abrasions and pinch points.	Damaged wire or connector. Blown fuse.	**Result:** A damaged wire or damaged connector was not found. The fuses are OK. Proceed to Test Step 2. **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.
2. Check for Active Diagnostic Codes **A.** Establish communication between the electronic service tool and the ECM. Refer to Troubleshooting, “Electronic Service Tools”, if necessary. **B.** Check the “Active Diagnostics” screen on the electronic service tool.	Diagnostic code	**Result:** A 3360-X or 3820-X diagnostic code is active. Proceed to Table 159 , “Troubleshooting Procedure for the DCU Power Supply” . **Result:** There is a problem with the power supply to the DEF quality sensor. Proceed to Table 159 , “Troubleshooting Procedure for the DCU Power Supply” - Test Step 7. **Result:** A 5965-5 or 3838-5 diagnostic code is active. Proceed to Table 160 , “Troubleshooting for the Main DCU Power Relay” - Test Step 1. **Result:** A 5965-6 or 3838-6 diagnostic code is active. Proceed to Table 160 , “Troubleshooting for the Main DCU Power Relay” - Test Step 4. **Result:** A 5966-5, 3965-5, 6309-5 or 3966-5 diagnostic code is active. Proceed to Table 161 , “Troubleshooting Procedure for the DCU Keyswitch Signal” - Test Step 1. **Result:** A 5966-6, 3965-6, 6309-6 or 3966-6 diagnostic code is active. Proceed to Table 161 , “Troubleshooting Procedure for the DCU Keyswitch Signal” - Test Step 4.

Table 159

Troubleshooting Procedure for the DCU Power Supply		
Troubleshooting Test Steps	**Value**	**Results**

(continued)

(Table 159, contd)

1. Check the Voltage at the PETU Power Connector **A.** Disconnect the PETU power connector. **B.** Use a suitable multimeter to take the following voltage measurements at the PETU power connector (application side). Terminal 1 to terminal 3 Terminal 2 to terminal 4	Battery voltage	**Result:** The measured voltage is equal to battery voltage. Reconnect the PETU power connector. Proceed to Test Step 2. **Result:** The measured voltage is not equal to battery voltage. **Repair:** Replace the wiring between the battery and the PETU power connector. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.
2. Check the Voltage to the DCU Power Relay **A.** Disconnect the main DCU power relay. **B.** Measure the voltage between terminal 1 on the harness connector for the relay and a suitable ground.	Battery voltage	**Result:** The measured voltage is equal to battery voltage. Reconnect the DCU power relay. Proceed to Test step 3. **Result:** The measured voltage is not equal to battery voltage. **Repair:** Replace the wiring between the PETU power connector and the DCU power relay. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.
3. Check the Voltage to the VLPM **A.** Disconnect the VLPM. **B.** Turn the keyswitch to the ON position. Do not attempt to start the engine. **C.** Measure the voltage between terminal 1 on the harness connector for the VLPM and suitable ground. **D.** Turn the keyswitch to the OFF position.	Battery voltage	**Result:** The measured voltage is equal to battery voltage. Reconnect the VLPM. Proceed to Test Step 5. **Result:** The measured voltage is not equal to battery voltage. Proceed to Test Step 4.
4. Check the Wiring Between the DCU Power Relay and the VLPM **A.** Disconnect the DCU power relay. **B.** Measure the resistance between Terminal 4 on the harness connector for the relay and terminal 1 on the harness connector for the VLPM.	Less than 2.0 Ohms	**Result:** The resistance is less than 2.0 Ohms. **Repair:** Install a replacement DCU power relay. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault. **Result:** The resistance is greater than 2.0 Ohms. **Repair:** Replace the wiring between the DCU power relay and the VLPM. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.

(continued)

(Table 159, contd)

5. Check the Voltage at the DCU Connector **A.** Disconnect the 53-pin DCU connector. **B.** Turn the keyswitch to the ON position. **C.** Use a suitable multimeter to measure the voltage between the following terminals on the harness connector for the DCU: Terminal 1 and terminal 6 Terminal 2 and terminal 7 Terminal 3 and terminal 8 Terminal 4 and terminal 9 Terminal 5 and terminal 9 **D.** Turn the keyswitch to the OFF position.	Battery voltage	**Result:** The measured voltage is equal to battery voltage. Contact the Dealer Solutions Network (DSN). **Result:** The measured voltage is not equal to battery voltage. Proceed to Test Step 6.
6. Check the Wiring Between the VLPM and the DCU **A.** Disconnect the VLPM. **B.** Use a suitable multimeter to measure the resistance between terminal 2 on the harness connector for the VLPM and the following terminals: C2:6 C2:7 C2:8 C2:9 **C.** Use a suitable multimeter to measure the resistance between terminal 3 on the harness connector for the VLPM and the following terminals: C2:1 C2:2 C2:3 C2:4 C2:5	Less than 2.0 Ohms	**Result:** The resistance is less than 2.0 Ohms. **Repair:** Install a replacement VLPM. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault. **Result:** The resistance is greater than 2.0 Ohms. **Repair:** Replace the wiring between the VLPM and the DCU. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.
7. Check the Wiring Between the VLPM and the DEF Quality Sensor **A.** Disconnect the VLPM and the DEF tank header connector. **B.** Use a suitable multimeter to measure the resistance between terminal 2 on the VLPM harness connector and terminal 3 on the DEF tank header connector. **C.** Use a suitable multimeter to measure the resistance between terminal 3 on the VLPM harness connector and terminal 4 on the DEF tank header connector.	Less than 2.0 Ohms	**Result:** The resistance is less than 2.0 Ohms. **Repair:** Install a replacement VLPM. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault. **Result:** The resistance is greater than 2.0 Ohms. **Repair:** Replace the wiring between the VLPM and the DEF tank header connector. Verify that the repair eliminates the fault.

Table 160

Troubleshooting Procedure for the Main DCU Power Relay		
Troubleshooting Test Steps	**Value**	**Results**
1. Create a Short Circuit at the DCU Power Relay Connector **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the DCU power relay. **C.** Fabricate a jumper wire. Install the jumper wire between terminal 2 and terminal 5 on the harness connector for the relay. **D.** Turn the keyswitch to the ON position. **E.** Use the electronic service tool to check for active diagnostic codes. Look for an active 5965-6 or 3838-6 diagnostic code. **F.** Turn the keyswitch to the OFF position.	Diagnostic codes	**Result:** A 5965-6 or 3838-6 diagnostic code is active with the jumper installed. **Repair:** Install a replacement DCU power relay. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault. **Result:** The 5965-5 or 3838-5 diagnostic code is still active with the jumper installed. Proceed to Test Step 2.
2. Check the Wiring Between the DCU Power Relay and the PETU 12-Pin Connector **A.** Disconnect the main DCU power relay. Disconnect the PETU 12-pin connector. **B.** Measure the resistance between terminal 2 on the harness connector for the relay and terminal 12 on the 12-pin connector. **C.** Measure the resistance between terminal 5 on the harness connector for the relay and terminal 11 on the 12-pin connector.	Less than 2.0 Ohms.	**Result:** Both the resistance measurements are less than 2.0 Ohms. Proceed to Test Step 3. **Result:** At least one of the resistance measurements is greater than 2.0 Ohms. **Repair:** Replace the wiring between the DCU power relay and the PETU 12-pin connector. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.
3. Check the Wiring Between the PETU 12-Pin Connector and the ECM **A.** Disconnect the main DCU power relay. Disconnect the P1 connector from the ECM. **B.** Measure the resistance between terminal 12 on the 12-pin connector and P1:5. **C.** Measure the resistance between terminal 11 on the 12-pin connector and P1:15.	Less than 2.0 Ohms	**Result:** Both the resistance measurements are less than 2.0 Ohms. Contact the Dealer Solutions Network (DSN). **Result:** At least one of the resistance measurements is greater than 2.0 Ohms. **Repair:** Replace the wiring between the PETU 12-pin connector and the P1 connector. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.

(continued)

(Table 160, contd)

4. Create an Open Circuit at the DCU Power Relay **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the DCU power relay. **C.** Turn the keyswitch to the ON position. Do not attempt to start the engine. **D.** Use the electronic service tool to check for active diagnostic codes. Look for an active 5965-5 or 3838-5 diagnostic code. **E.** Turn the keyswitch to the OFF position.	Diagnostic codes	**Result:** A 5965-5 or 3838-5 diagnostic code is active with the relay disconnected. **Repair:** Install a replacement DCU power relay. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault. **Result:** The 5965-6 or 3838-6 diagnostic code is still active with the relay disconnected. Proceed to Test Step 5.
5. Check the Wiring between the PETU 12-pin connector and the ECM for a Short Circuit **A.** Disconnect the P1 connector from the ECM. Disconnect the PETU 12-pin connector. **B.** Measure the resistance between P1:5 and all other terminals on the P1 connector. **C.** Measure the resistance between P1:15 and all other terminals on the P1 connector.	Greater than 100 Ohms	**Result:** All resistance measurements are greater than 100 Ohms. Proceed to Test Step 6. **Result:** At least one of the resistance measurements is less than 100 Ohms. **Repair:** Replace the wiring between the PETU 12-pin connector and the ECM. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.
6. Check the Wiring between the PETU 12-pin connector and the Main DCU Power Relay for a Short Circuit **A.** Reconnect the PETU 12-pin connector. **B.** Measure the resistance between P1:5 and all other terminals on the P1 connector. **C.** Measure the resistance between P1:15 and all other terminals on the P1 connector.	Greater than 100 Ohms	**Result:** All resistance measurements are greater than 100 Ohms. Contact the Dealer Solutions Network (DSN). **Result:** At least one of the resistance measurements is less than 100 Ohms. **Repair:** Replace the wiring between the PETU 12-pin connector and the main DCU power relay. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.

Table 161

Troubleshooting Procedure for the DCU Keyswitch Signal		
Troubleshooting Test Steps	**Value**	**Results**

(continued)

(Table 161, contd)

1. Create a Short Circuit at the DCU Connector **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the 53-pin DCU connector. **C.** Fabricate a jumper wire. Install the jumper wire between C2:52 and a suitable ground. **D.** Turn the keyswitch to the ON position. Do not attempt to start the engine. **E.** Use the electronic service tool to check for active diagnostic codes. **Note:** Other diagnostic codes will be active with the DCU connector disconnected. Disregard all other codes and only look for diagnostic codes that relate to the DCU keyswitch. **F.** Turn the keyswitch to the OFF position.	Diagnostic codes	**Result:** A 5966-6, 3965-6, 6309-6 or 3966-6 diagnostic code is active with the jumper installed. Contact the Dealer Solutions Network (DSN). **Result:** The 5966-5, 3965-5, 6309-5 or 3966-5 diagnostic code is still active with the jumper installed. Remove the jumper wire. Reconnect the DCU connector. Proceed to Test Step 2.
2. Create a Short Circuit at the 12-Pin PETU Connector **A.** Disconnect the 12-pin PETU connector. **B.** Fabricate a jumper wire. Install the jumper wire between terminal 5 on the 12-pin connector (application side) and a suitable ground. **C.** Turn the keyswitch to the ON position. **D.** Use the electronic service tool to check for active diagnostic codes. **Note:** Other diagnostic codes will be active with the DCU connector disconnected. Disregard all other codes and only look for diagnostic codes that relate to the DCU keyswitch. **E.** Turn the keyswitch to the OFF position.	Diagnostic codes	**Result:** A 5966-6, 3965-6, 6309-6 or 3966-6 diagnostic code is active with the jumper installed. **Repair:** Replace the wiring between the 12-pin PETU connector and the DCU. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault. Remove the jumper wire. Proceed to Test Step 3.
3. Check the Wiring for an Open Circuit **A.** Disconnect the P1 connector from the ECM. **B.**Measure the resistance between terminal 5 on the 12-pin PETU connector (application side) and P1:2. **C.**Measure the resistance between terminal 5 on the 12-pin PETU connector (application side) and P1:3.	Less than 2.0 Ohms	**Result:** The resistance measurements are less than 2.0 Ohms. Contact the Dealer Solutions Network (DSN). **Result:** At least one of the resistance measurements is greater than 2.0 Ohms. **Repair:** Replace the wiring between the 12-pin PETU connector and the ECM.

(continued)

(Table 161, contd)

4. Create an Open Circuit at the DCU Connector **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the 53-pin DCU connector. **C.** Turn the keyswitch to the ON position. **D.** Use the electronic service tool to check for active diagnostic codes. **Note:** Other diagnostic codes will be active with the DCU connector disconnected. Disregard all other codes and only look for diagnostic codes that relate to the DCU keyswitch. **E.** Turn the keyswitch to the OFF position.	Diagnostic codes	**Result:** A 5966-5, 3965-5, 6309-5 or 3966-5 diagnostic code is active with the DCU disconnected. Contact the Dealer Solutions Network (DSN). **Result:** The 5966-6, 3965-6, 6309-6 or 3966-6 diagnostic code is still active with the DCU disconnected. Reconnect the 53-pin DCU connector. Proceed to Test Step 5.
5. Create an Open Circuit at the 12-Pin PETU Connector **A.** Disconnect the 12-pin PETU connector. **B.** Turn the keyswitch to the ON position. **C.** Use the electronic service tool to check for active diagnostic codes. **Note:** Other diagnostic codes will be active with the DCU connector disconnected. Disregard all other codes and only look for diagnostic codes that relate to the DCU keyswitch. **D.** Turn the keyswitch to the OFF position.	Diagnostic codes	**Result:** A 5966-5, 3965-5, 6309-5 or 3966-5 diagnostic code is active with the connector disconnected. **Repair:** Replace the wiring between the DCU and the 12-pin PETU connector. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault. **Result:** The 5966-6, 3965-6, 6309-6 or 3966-6 diagnostic code is still active with the connector disconnected. Proceed to Test Step 6.
6. Check the Wiring for a Short Circuit **A.** Disconnect the P1 connector from the ECM. **B.** Measure the resistance between P1:2 and all other terminals on the P1 connector except P1:3. **C.** Measure the resistance between P1:3 and all other terminals on the P1 connector apart from P1:2.	Greater than 100 Ohms	**Result:** All resistance measurements are greater than 100 Ohms. Contact the Dealer Solutions Network (DSN). **Result:** At least one of the resistance measurements is less than 100 Ohms. **Repair:** Replace the wiring between the 12-pin DCU connector and the ECM. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.

i06194728

DEF Line Heater - Test

The Dosing Control Unit (DCU) monitors the voltage and current flow to the Diesel Exhaust Fluid (DEF) line heater relay and the heated DEF lines. Refer to Table 162 . Faults are notified to the engine Electronic Control Module (ECM) over the J1939 data bus.

The engine ECM sets a diagnostic trouble code if the current flow through a circuit is incorrect. A -5 code indicates that the current flow through the circuit is low and there is an open circuit. A -6 code indicates that the current flow through the circuit is high and there is a short in the circuit.

Table 162 lists the diagnostic codes for incorrect voltage or current flow.

Table 162

Diagnostic Trouble Codes for the DEF Line Heaters			
J1939 Code	PDL Code	Code Description	Comments
4354-5	3110-5	Aftertreatment #1 SCR Catalyst Reagent Line Heater #1 : Current Below Normal	This code indicates there is a fault in the #1 line heater circuit that is probably an open circuit. The #1 line heater is in the suction line.
4354-6	3110-6	Aftertreatment #1 SCR Catalyst Reagent Line Heater #1 : Current Above Normal	This code indicates there is a fault in the #1 line heater circuit that is probably a short circuit. The #1 line heater is in the suction line.
4354-12	3110-12	Aftertreatment #1 SCR Catalyst Reagent Line Heater #1 : Failure	This code indicates there is a fault in the #1 line heater circuit. The #1 line heater is in the suction line.
4355-5	3111-5	Aftertreatment #1 SCR Catalyst Reagent Line Heater #2 : Current Below Normal	This code indicates there is a fault in the #2 line heater circuit that is probably an open circuit. The #2 line heater is in the return line.
4355-6	3111-6	Aftertreatment #1 SCR Catalyst Reagent Line Heater #2 : Current Above Normal	This code indicates there is a fault in the #2 line heater circuit that is probably a short circuit. The #2 line heater is in the return line.
4356-5	3112-5	Aftertreatment #1 SCR Catalyst Reagent Line Heater #3 : Current Below Normal	This code indicates there is a fault in the #3 line heater circuit that is probably an open circuit. The #3 line heater is in the pressure line to the DEF injector.
4356-6	3112-6	Aftertreatment #1 SCR Catalyst Reagent Line Heater #3 : Current Above Normal	This code indicates there is a fault in the #3 line heater circuit that is probably a short circuit. The #3 line heater is in the pressure line to the DEF injector.
5491-5	3822-5	Aftertreatment 1 Diesel Exhaust Fluid Line Heater Relay: Current Below Normal	This code indicates there is a fault in the line heater relay circuit that is probably an open circuit.
5491-6	3822-6	Aftertreatment 1 Diesel Exhaust Fluid Line Heater Relay: Current Above Normal	This code indicates there is a fault in the line heater relay circuit that is probably a short circuit.
Follow the troubleshooting procedure in order to identify the root cause of the fault.			

Note: Refer to Troubleshooting, “Sensors and Electrical Connectors”for the locations of the components listed in this procedure.

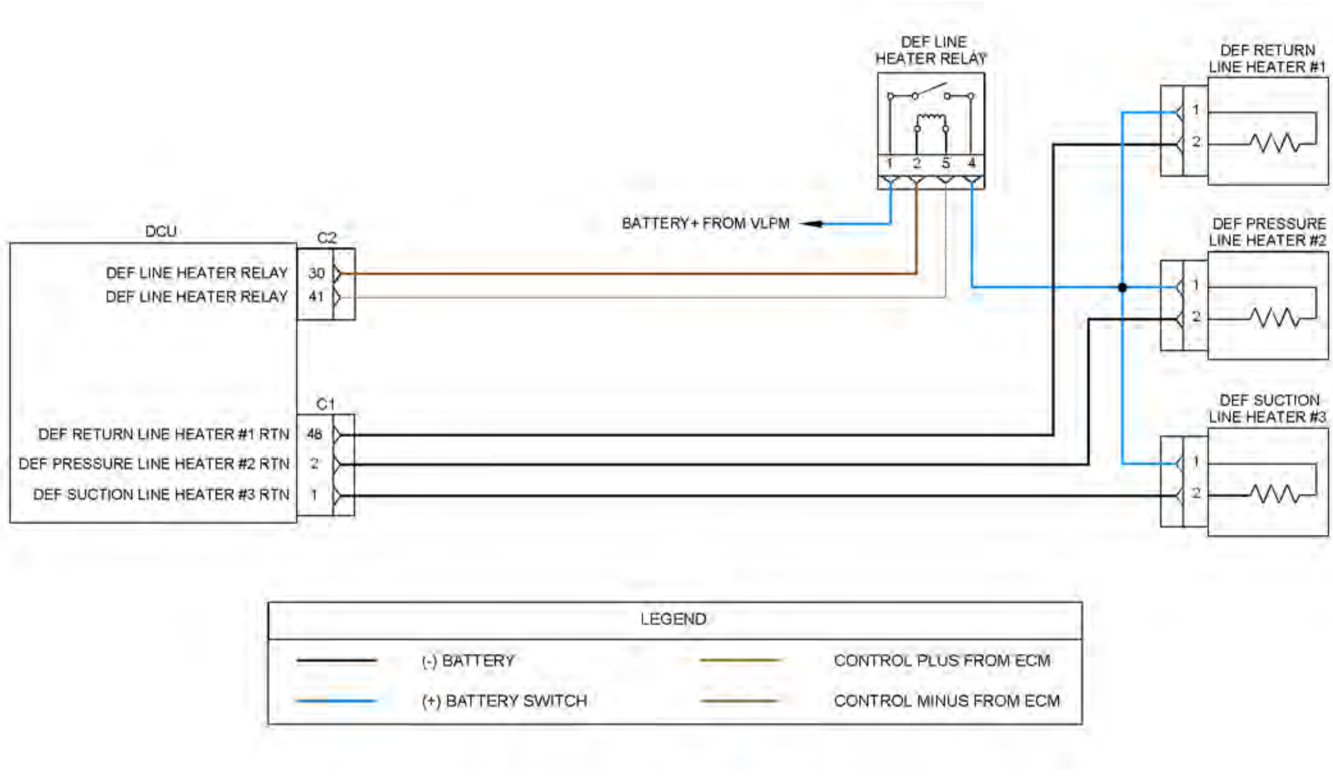


Illustration 105 g03842268

Schematic diagram of the DEF heater circuit

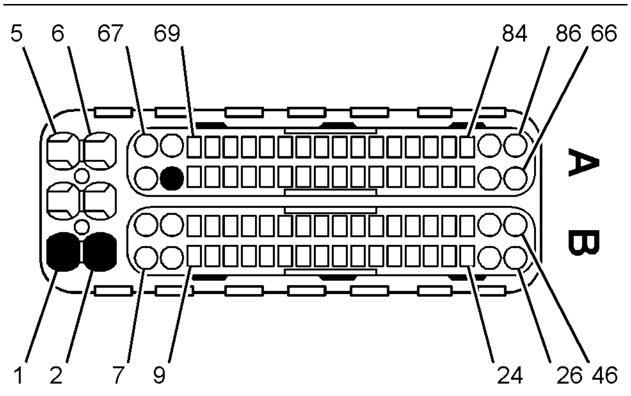


Illustration 106 g03126456

View of the pin locations for the DEF line heaters on the 86-pin (C1) connector

(1) DEF pressure line heater #3 return
(2) DEF return line heater #2 return
(48) DEF suction line heater #1 return

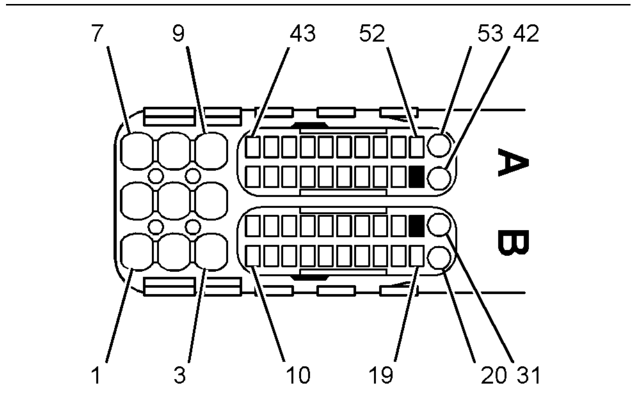


Illustration 107 g03126936

View of the pin locations for the DEF line heaters on the 53-pin (C2) connector

(30) DEF line heater relay supply
(41) DEF line heater relay return

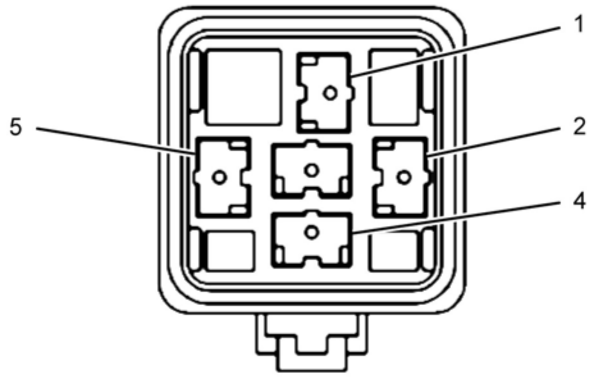


Illustration 108 g03808796

DEF heater relay socket

(1) Battery supply
(2) Relay coil supply
(4) DEF line heater supply
(5) Relay coil return

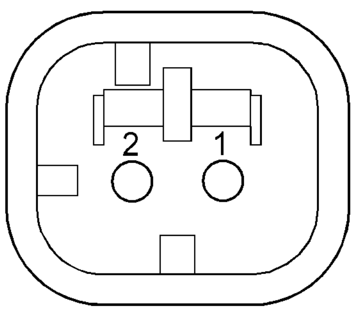


Illustration 109 g03128456

Heated DEF line connector

(1) Battery +
(2) Return

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

Table 163

Troubleshooting Test Steps	Values	Results
1. Inspect Electrical Connectors and Wiring **A.** Turn the keyswitch to the OFF position. **B.** Inspect the C1 and C2 connectors. **C.** Inspect the connectors for the DEF line heaters and the DEF line heater relay. **D.** Perform a 45 N (10 lb) pull test on each of the wires in the DCU connector, the line heaters, and the line heater relay. **E.** Check all of the wiring associated with the DEF line heaters for abrasions and pinch points.	Damaged wire or connector	**Result:** A damaged wire or damaged connector was not found. Proceed to Test Step 2. **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. Proceed to Test Step 14.
2. Determine the Diagnostic Code **A.** Establish communication between the electronic service tool and the DCU. **B.** Look for one of the codes that are listed in Table 162 .	Diagnostic Trouble Codes	**Result:** There is an active or logged 5491-5 or 3822-5 code. Proceed to Test Step 3. **Result:** There is an active or logged 5491-6 or 3822-6 code. Proceed to Test Step 5. **Result:** There is an active or logged 435x -5 or 311x-5 code. Proceed to Test Step 7. **Result:** There is an active or logged 435x-6 or 311x-6 code. Proceed to Test Step 12.
3. Create a Short Circuit at the Relay Connector **A.** Turn the keyswitch to the OFF position. Allow 2 minutes to elapse. **B.** Disconnect the connector for the DEF line heater relay. **C.** Fabricate a jumper wire and install the jumper wire between terminal 2 and terminal 5 on the harness connector for the relay. **D.** Turn the keyswitch to the ON position. **E.** Monitor the active diagnostic codes on the electronic service tool. Check for a 5491-6 or 3822-6 diagnostic code. **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:** The 5491-5 or 3822-5 diagnostic code remains active with the jumper installed. Remove the jumper wire and proceed to Test Step 4. **Result:** A 5491-6 or 3822-6 diagnostic code is active with the jumper installed. **Repair:** Replace the DEF line heater relay. Proceed to Test Step 14.

(continued)

(Table 163, contd)

Troubleshooting Test Steps	Values	Results
4. Check the Relay Wiring for an Open Circuit **A.** Disconnect the C2 connector from the DCU. **B.** Use a suitable multimeter to measure the resistance between the following points: 1. C2:30 and terminal 2 on the harness connector for the relay. 2. C2:41 and terminal 5 on the harness connector for the relay.	Less than two Ohms	**Result:** At least one of the resistance measurements is greater than two Ohms. **Repair:** Replace the wiring between the DEF line heater relay and the C2 connector on the DCU. Proceed to Test Step 14. **Result:** Both resistance measurements are less than two Ohms. **Repair:** Reconnect the relay connector and the C2 connector. Turn the keyswitch to the ON position. If the fault is still present, contact the Dealer Solutions Network (DSN).
5. Create an Open Circuit at the Relay Connector **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the connector for the DEF line heater relay. **C.** Turn the keyswitch to the ON position. **D.** Monitor the active diagnostic codes on the electronic service tool. Check for a 5491-5 or 3822-5 diagnostic code. **Wait at least 30 seconds in order for the diagnostic codes to become active.** **E.** Turn the keyswitch to the OFF position.	Open circuit recognized	**Result:** The 5491-6 or 3822-6 diagnostic code remains active with the relay disconnected. Proceed to Test Step 6. **Result:** A 5491-5 or 3822-5 diagnostic code is active with the relay disconnected. **Repair:** Replace the DEF line heater relay. Proceed to Test Step 14.
6. Check the Relay Wiring for a Short Circuit **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the C2 connector from the DCU. **C.** Use a suitable multimeter to take the following resistance measurements: C2:30 (harness side) to all other pins on the C2 harness connector. C2:41 (harness side) to all other pins on the C2 harness connector.	Greater than 100 Ohms	**Result:** At least one of the resistance measurements is less than 100 Ohms. **Repair:** Replace the wiring between the DEF line heater relay and the C2 connector on the DCU. Proceed to Test Step 14. **Result:** All resistance measurements are greater than 100 Ohms. Reconnect the relay connector and the C2 connector. Turn the keyswitch to the ON position. If the fault is still present, contact the Dealer Solutions Network (DSN).

(continued)

(Table 163, contd)

Troubleshooting Test Steps	Values	Results
7. Check for Power at DEF Line Heater Relay **A.** Turn the keyswitch to the OFF position for 2 minutes. The key-switch must be off for 2 minutes to allow the DEF pump to purge, reset the code, and reset the DCU. **B.** Remove the DEF line heater relay from the harness. **C.** Verify that the harness connector is free of debris and free of corrosion. **D.** Turn the keyswitch to the ON position. **E.** Check for battery voltage between terminal 1 of the heated line relay socket and a known good ground.	Battery voltage	**Result:** The voltage between terminal 1 and a good ground source is equal to battery voltage. Turn the keyswitch to the OFF position for 2 minutes. Proceed to Test Step 8. **Result:** The voltage between terminal 1 and a good ground source is not equal to battery voltage. **Repair:** Refer to the electrical schematic and troubleshoot the power source from the VLPM.
8. Bypass the DEF Line Heater Relay **A.** Fabricate a jumper wire and install the jumper wire between terminal 1 and terminal 4 on the harness connector for the relay. **B.** Turn the keyswitch to the ON position. **C.** Monitor the active diagnostic codes on the electronic service tool. Check for a 435X-5 or 311X-5 diagnostic code. **Wait at least 30 seconds in order for the diagnostic codes to become active.** **D.** Turn the keyswitch to the OFF position.	Diagnostic codes	**Result:** The 435X-5 or 311X-5 diagnostic code is no longer active. **Repair:** Replace the DEF line heater relay. Proceed to Test Step 14. **Result:** The 435X-5 diagnostic code is still active. **Repair:** Remove the jumper wire and reconnect the relay. Proceed to Test Step 9.
9. Check for Battery Voltage at the Line Heater Connector **A.** Turn the keyswitch to the OFF position for 2 minutes. The key-switch must be off for 2 minutes to allow the DEF pump to purge, reset the code, and reset the DCU. **B.** Disconnect the connector for the DEF line heater with active 435X-5 or 311X-5 diagnostic code. **C.** Verify that the harness connector is free of debris and free of corrosion. **D.** Turn the keyswitch to the ON position. **E.** Use the electronic service tool to perform the “DEF Heated Lines Test” . **F.** Use a suitable multimeter to measure the voltage between terminal 1 on the harness connector for the suspect line heater and a suitable ground. **G.** Use the electronic service tool to stop the “DEF Heated Lines Test” . **H.** Turn the keyswitch to the OFF position.	Battery voltage	**Result:** The voltage between terminal 1 and a good ground source is equal to battery voltage. Proceed to Test Step 10. **Result:** The voltage between terminal 1 and a good ground source is not equal to battery voltage. **Repair:** Replace the wiring between the DEF line heater relay and the suspect DEF line heater. Proceed to Test Step 14.

(continued)

(Table 163, contd)

Troubleshooting Test Steps	Values	Results
10. Create a Short Circuit at the DEF Line Heater Connector **A.** Fabricate a jumper wire. Install the jumper wire between terminal 1 and terminal 2 on the harness connector for the suspect line heater. **B.** Turn the keyswitch to the ON position. **C.** Monitor the active diagnostic codes on the electronic service tool. Check for a 435X-6 or 311X-6 diagnostic code. **Wait at least 30 seconds in order for the diagnostic codes to become active.** **D.** Turn the keyswitch to the OFF position.	Diagnostic codes	**Result:** The 435X-5 or 311X-5 diagnostic code is still active with the jumper installed. Remove the jumper and proceed to Test Step 11. **Result:** A 435X-6 or 311X-6 diagnostic code is active with the jumper installed. **Repair:** Replace the suspect DEF line heater. Proceed to Test Step 14.
11. Check the Wiring for an Open Circuit **A.** Disconnect the C1 connector from the DCU. **B.** Check the resistance between terminal 2 on the harness connector for the suspect DEF line heater and the appropriate terminal on the C1 connector (harness side). Refer to Illustration 106 .	Less than two Ohms	**Result:** The measured resistance is less than two Ohms. Contact the Dealer Solutions Network (DSN). **Result:** The measured resistance is more than two Ohms. **Repair:** Replace the wiring between the suspect DEF line heater and the C1 connector on the DCU. Proceed to Test Step 14.
12. Create an Open Circuit at the DEF Line Heater Connector **A.** Turn the keyswitch to the OFF position for 2 minutes. The keyswitch must be off for 2 minutes to allow the DEF pump to purge, reset the code, and reset the DCU. **B.** Disconnect the connector for the DEF line heater with the 435X-6 or 311X-6 diagnostic code. **C.** Turn the keyswitch to the ON position. **D.** Use the electronic service tool to perform the “DEF Heated Lines Test” . **E.** Monitor the active diagnostic codes on the electronic service tool. Check for a 435X-5 or 311X-5 diagnostic code. **Wait at least 30 seconds in order for the diagnostic codes to become active.** **F.** Use the electronic service tool to stop the “DEF Heated Lines Test” . **G.** Turn the keyswitch to the OFF position.	Diagnostic codes	**Result:** The 435X-6 or 311X-6 diagnostic code is still active with the line heater disconnected. Proceed to Test Step 13. **Result:** A 435X-5 or 311X-5 diagnostic code is active with the line heater disconnected. **Repair:** Replace the suspect line heater. Proceed to Test Step 14.

(continued)

(Table 163, contd)

Troubleshooting Test Steps	Values	Results
13. Check the Heater Wiring for a Short Circuit **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the C1 connector from the DCU. **C.** Verify that the harness connector is free of debris and free of corrosion. **D.** Measure the resistance between the suspect heater return terminal on the C1 harness connector and all other terminals on the C1 harness connector.	Greater than 100 Ohms	**Result:** All resistance measurements are greater than 100 Ohms. Contact the Dealer Solutions Network (DSN). Once any recommended repairs have been completed, proceed to Test Step 14. **Result:** At least one of the resistance measurements is less than 100 Ohms. **Repair:** Replace the wiring between the suspect DEF line heater and the DCU. Proceed to Test Step 14.
14. Perform a “DEF Heated Line Test” **A.** Establish communication between the electronic service tool and “Diesel Exhaust Fluid Controller #1” . If necessary, refer to Troubleshooting, “Electronic Service Tools”. **B.** Use the electronic service tool to perform a “DEF Heated Line - Test” .	Test passed	**Result:** The test passed and no diagnostic codes became active. Return the engine to service. **Result:** The test failed. **Repair:** Troubleshoot any diagnostic codes that became active during the test. Refer to Troubleshooting “Diagnostic Trouble Codes”. If the fault is still present, contact the Dealer Solutions Network (DSN).

i06194729

DEF Pump Motor - Test

The Dosing Control Unit (DCU) monitors and controls the Diesel Exhaust Fluid (DEF) pump via voltages, current, and PWM signals.

The DCU sets a diagnostic trouble code if an error is detected in one or more of these parameters.

A -5 code indicates that the current flow through the circuit is low and there is an open in the circuit. A -6 code indicates that the current flow through the circuit is high and there is a short in the circuit. These codes can be activated only when the DCU is sending a command to the DEF pump.

Table 164 lists the diagnostic codes for the DEF pump circuit.

Table 164

Diagnostic Trouble Codes for the DEF Pump			
J1939 Code	**PDL Code**	**Code Description (code descriptions may vary)**	**Comments**
4374-5	3118-5	Aftertreatment #1 Diesel Exhaust Fluid Pump Motor Speed : Current Below Normal	This code indicates low current to the DEF pump speed sensor. The code is logged.
4374-6	3118-6	Aftertreatment #1 Diesel Exhaust Fluid Pump Motor Speed : Current Above Normal	This code indicates high current to the DEF pump speed sensor. The code is logged.
Follow the troubleshooting procedure in order to identify the root cause of the problem.			

Table 165

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	T4000242	Break-out Connector	1
B	T4000243	Break-out Connector	1

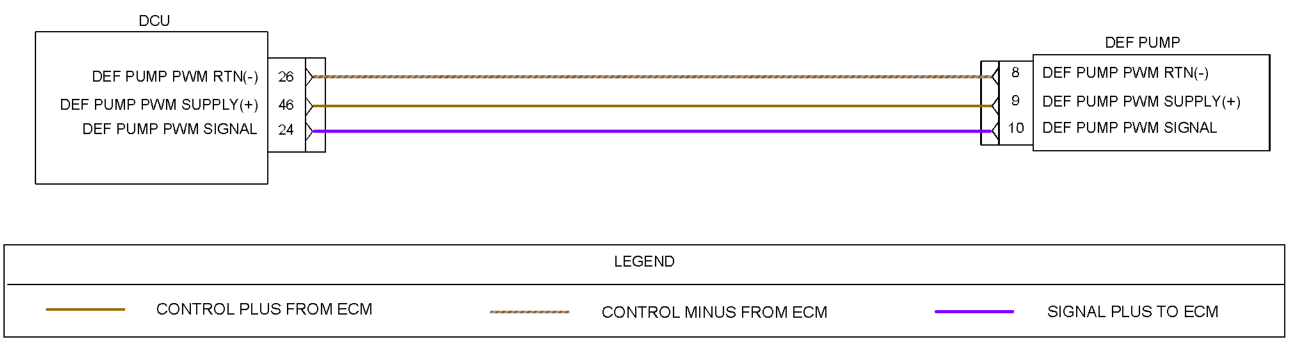


Illustration 110 g03811009

Schematic diagram for the DEF pump motor

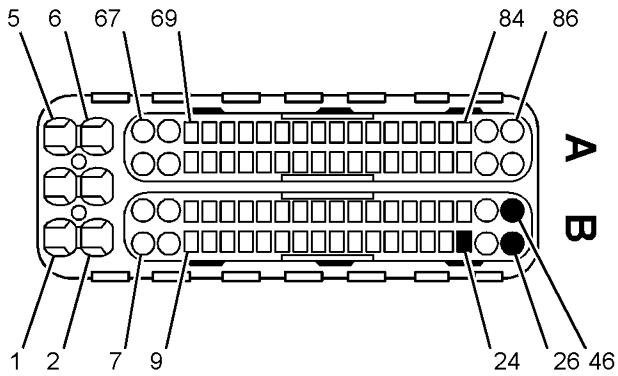


Illustration 111 g03811013

View of the pin locations for the DEF pump on the 86-pin DCU connector

(24) DEF pump signal
(26) DEF pump PWM return
(46) DEF pump PWM supply

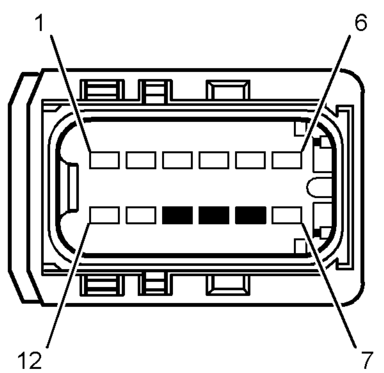


Illustration 112 g03811015

Pin location on the DEF pump connector

(8) PWM return
(9) PWM supply
(10) PWM signal

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

Table 166

Troubleshooting Test Steps	Values	Results
1. Inspect Electrical Connectors and Wiring **A.** Inspect the 86-pin DCU connector. **B.** Inspect the connector for the DEF pump. **C.** Perform a 45 N (10 lb) pull test on each of the wires in the DCU connector and the connector for the DEF pump. **D.** Check all of the wiring associated with the DEF pump for abrasions and pinch points.	Damaged wire or connector	**Result:** A damaged wire or damaged connector was not found. Proceed to Test Step 2. **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.
2. Determine the Diagnostic Code **A.** Establish communication between the electronic service tool and the engine Electronic Control Module (ECM). Refer to Troubleshooting, “Electronic Service Tools” **B.** Establish communication between the electronic service tool and the Dosing Control Unit (DCU) . **C.** Look for active or logged codes.	Diagnostic Trouble Codes	**Result:** There is an active or logged 4374-5, 3118-5, 4374-6 or 3118-6 diagnostic code. Proceed to Test Step 3.
3. Check for an Open Circuit in the Pump Electronic Tank Unit (PETU) Wiring Harness for the DEF Pump Motor Circuit **A.** Turn the keyswitch to the OFF position for 2 minutes to allow the DEF pump to purge, reset the code, and reset the DCU. **B.** Disconnect the PETU wiring harness from the DEF pump and the Diesel Exhaust Fluid Controller (DCU). **C.** Connect Tooling B to the DCU connector. Connect the Tooling A to the DEF pump connector. **Note:** The connectors must be used to prevent damage to the DCU and pump connectors. **D.** Measure the resistance between terminal 9 (PWM +) on the DEF pump connector and terminal 46 (PWM +) on the 86 pin DCU connector. **E.** Measure the resistance between terminal 8 (PWM -) on the DEF pump connector and terminal 26 (PWM -) on the 86 pin DCU connector. **F.** Measure the resistance between terminal 10 (PWM SIGNAL) on the DEF pump connector and terminal 24 (PWM SIGNAL) on the 86 pin DCU connector.	Less than five Ohms	**Result:** All resistance measurements are less than five Ohms. Proceed to Test Step 4. **Result:** At least one of the resistance measurements is greater than five Ohms. **Repair:** There is an open circuit in the harness. Repair the wiring or replace the harness. Proceed to Test Step 6.

(continued)

(Table 166, contd)

Troubleshooting Test Steps	Values	Results
4. Check for Short Circuits in the PETU Wiring Harness for the DEF Pump Motor Circuit **A.** Turn the keyswitch to the OFF position. The keyswitch must be OFF for 2 minutes to allow the DEF pump to purge, reset the code, and reset the DCU. **B.** Disconnect the PETU wiring harness from the DEF pump and the DCU. **C.** Connect Tooling B to the DCU connector. Connect Tooling A to the DEF pump connector. **Note:** The connectors must be used to prevent damage to the DCU and pump connectors. **D.** Measure the resistance between terminal 9 (PWM +) on the DEF pump connector and a known good chassis ground. **E.** Measure the resistance between terminal 8 (PWM -) on the DEF pump connector and a known good chassis ground. **F.** Measure the resistance between terminal 10 (PWM SIGNAL) on the DEF pump connector and a known good chassis ground.	Greater than 100k Ohms	**Result:** All resistance measurements are greater than 100k Ohms. Proceed to Test Step 5. **Result:** At least one of the resistance measurements is less than 100k Ohms. **Repair:** There is a short circuit in the harness. Repair the wiring or replace the harness. Proceed to Test Step 6.
5. Check for Short Circuits in the PETU Wiring Harness for the DEF Pump Motor Wiring **A.** Turn the keyswitch to the OFF position. The keyswitch must be OFF for 2 minutes to allow the DEF pump to purge, reset the code, and reset the DCU. **B.** Disconnect the PETU wiring harness from the DEF pump and the DCU. **C.** Connect Tooling B to the DCU connector. **Note:** Tooling B must be used to prevent damage to the DCU connector. **D.** Measure the resistance between terminal 46 (PWM +) and all other pins in the 86 pin DCU harness connector. **E.** Measure the resistance between terminal 26 (PWM -) and all other pins in the 86 pin DCU harness connector. **F.** Measure the resistance between terminal 24 (PWM SIGNAL) and all other pins in the 86 pin DCU harness connector.	Greater than 100k Ohms	**Result:** All resistance measurements are greater than 100k Ohms. Proceed to Test Step 6. **Result:** At least one of the resistance measurements is less than 100k Ohms. **Repair:** There is a short circuit in the harness. Repair the wiring or replace the harness. Proceed to Test Step 6.

(continued)

(Table 166, contd)

Troubleshooting Test Steps	Values	Results
6. Perform a DEF Dosing System Verification Test **A.** Turn the keyswitch to the “ON” position. Do not start the engine. **B.** Connect to the “Diesel Exhaust Fluid Controller #1 ECM” using the electronic service tool. **C.** Perform the “DEF Dosing System Verification Test” .	Diagnostic codes	**Result:** The code did not return. Return the unit to service. **Result:** The code returned. Proceed to Test Step 7.
7. Replace the DEF Pump **A.** Turn the keyswitch to the OFF position for 2 minutes. The keyswitch must be OFF for 2 minutes to allow the DEF pump to purge, reset the code, and reset the DCU. **B.** Replace the DEF pump. Refer to Disassembly and Assembly, “Diesel Exhaust Fluid Pump - Remove and Install”. **C.** Establish communication between the electronic service tool and the Diesel Exhaust Fluid Controller #1 ECM. **D.** Perform the “DEF Dosing System Verification Test” .	Diagnostic Trouble Codes	**Result:** The code returned. Contact the Dealer Solutions Network (DSN). **Result:** The code did not return. Return the unit to service.

i06194735

DEF Pump Pressure Sensor - Test

Table 167 lists the diagnostic codes for the Diesel Exhaust Fluid (DEF) pump pressure sensor circuit.

Table 167

Diagnostic Trouble Codes for the DEF Pump Pressure Sensor			
J1939 Code	**PDL Code**	**Code Description (code descriptions may vary)**	**Comments**
4334-3	3090-3	Aftertreatment #1 SCR Dosing Reagent Absolute Pressure : Voltage Above Normal	There is excessive voltage on the signal wire between the Diesel Exhaust Fluid Controller (DCU) and the DEF pump. or There is an open circuit on the supply, signal, or return wire. The code is logged.
4334-4	3090-4	Aftertreatment #1 SCR Dosing Reagent Absolute Pressure : Voltage Below Normal	There is low voltage on the signal wire between the DCU and the DEF pump pressure sensor. The code is logged.
Follow the troubleshooting procedure in order to identify the root cause of the problem.			

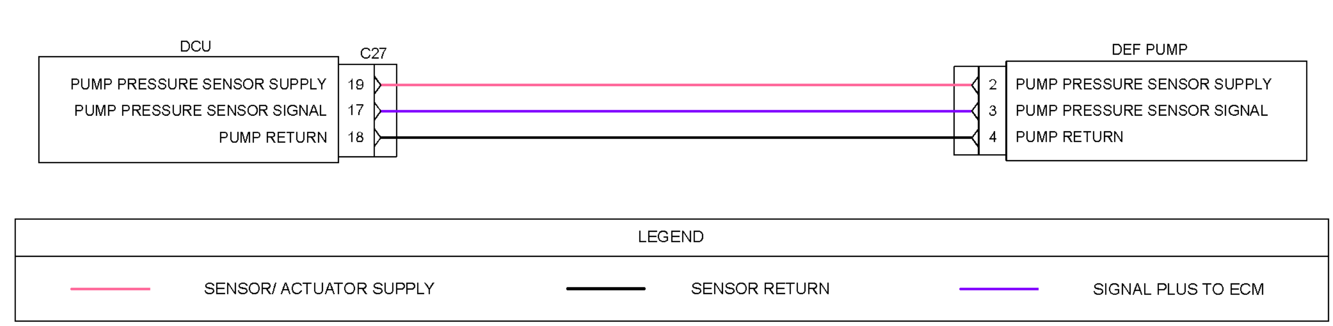


Illustration 113 g03811016

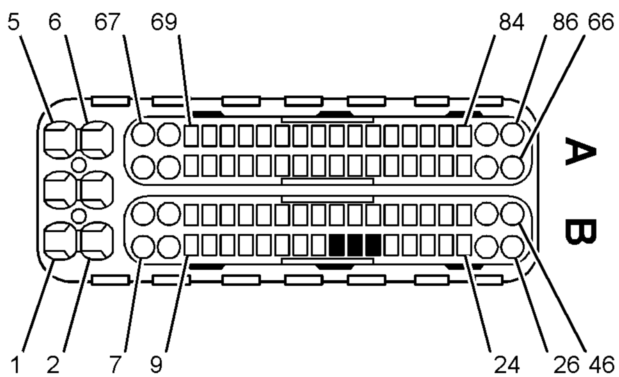


Illustration 114 g03416459

View of the pin locations for the DEF pump on the 86-pin DCU connector

(17) DEF pump pressure sensor signal
(18) DEF pump pressure sensor ground
(19) DEF pump pressure sensor 5 VDC supply

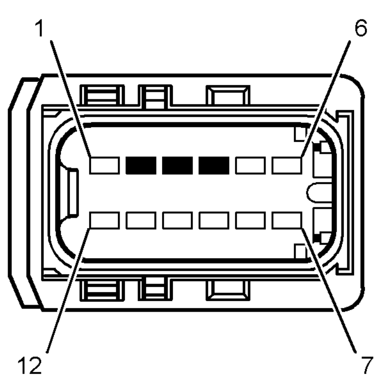


Illustration 115 g03416460

Pin location on the DEF pump connector

(2) Pressure sensor supply
(3) Pressure sensor signal
(4) Pressure sensor return

Table 168

Required Tools			
Tool	Part Number	Part Description	Qty
A	T4000242	Break-out Connector	1
B	T4000243	Break-out Connector	1

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

Table 169

Troubleshooting Test Steps	Values	Results
1. Inspect Electrical Connectors and Wiring **A.** Inspect the 86-pin DCU connector. **B.** Inspect the connector for the DEF pump. **C.** Perform a 45 N (10 lb) pull test on each of the wires in the DCU connector and the connector for the DEF pump. **D.** Check all of the wiring associated with the DEF pump for abrasions and pinch points.	Damaged wire or connector	**Result:** A damaged wire or damaged connector was not found. Proceed to Test Step 2. **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.
2. Determine the Diagnostic Code **A.** Establish communication between the electronic service tool and the engine Electronic Control Module (ECM). Refer to Troubleshooting, “Electronic Service Tools” **B.** Establish communication between the electronic service tool and the Dosing Control Unit (DCU) . **C.** Check for active or logged codes.	Diagnostic trouble codes	**Result:** There is an active or logged 4334-3, 3090-3, 4334-4 or 3090-4 diagnostic code. Proceed to Test Step 3.
3. Check for an Open Circuit in the Pump Electronic Tank Unit (PETU) Wiring Harness for the DEF Pump Pressure Sensor Circuit **A.** Turn the keyswitch to the OFF position for 2 minutes. The keyswitch must be OFF for 2 minutes to allow the DEF pump to purge, reset the code, and reset the Diesel Exhaust Fluid Controller (DCU). **B.** Disconnect the PETU wiring harness from the DEF pump and the DCU. **C.** Connect Tooling B to the DCU connector. Connect Tooling A to the DEF pump connector. **Note:** The connectors must be used to prevent damage to the DCU and DEF pump connector. **D.** Measure the resistance between terminal 2 (SUPPLY) on the DEF pump connector and terminal 19 (SUPPLY) on the 86 pin DCU connector. **E.** Measure the resistance between terminal 3 (SIGNAL) on the DEF pump connector and terminal 17 (SIGNAL) on the 86 pin DCU connector. **F.** Measure the resistance between terminal 4 (GROUND) on the DEF pump connector and terminal 18 (GROUND) on the 86 pin DCU connector.	Less than five Ohms	**Result:** All resistance measurements are less than five Ohms. Proceed to Test Step 2. **Result:** At least one of the resistance measurements is greater than five Ohms. There is an open in the harness. **Repair:** Repair the wiring or replace the harness. Verify that the fault is resolved. Proceed to Test Step 6.

(continued)

(Table 169, contd)

Troubleshooting Test Steps	Values	Results
4. Check for Short Circuits in the PETU Wiring Harness for the DEF Pump Pressure Sensor Circuit **A.** Turn the keyswitch to the “OFF” position. **B.** Disconnect the PETU wiring harness from the DEF pump and the DCU. **C.** Connect Tooling A to the DEF pump connector. **Note:** The connector must be used to prevent damage to the DEF pump connector. **D.** Measure the resistance between terminal 2 (SUPPLY) on the DEF pump connector and a known good chassis ground. **E.** Measure the resistance between terminal 3 (SIGNAL) on the DEF pump connector and a known good chassis ground. **F.** Measure the resistance between terminal 4 (GROUND) on the DEF pump connector and a known good chassis ground.	Greater than 100k Ohms	**Result:** All resistance measurements are greater than 100k Ohms. Proceed to Test Step 5. **Result:** At least one of the resistance measurements is less than 100k Ohms. There is a short circuit in the harness. **Repair:** Repair the wiring or replace the harness. Verify that the fault is resolved. Proceed to Test Step 6.
5. Check for Short Circuits in the PETU Wiring Harness for the DEF Pump Pressure Sensor Circuit **A.** Turn the keyswitch to the “OFF” position. **B.** Disconnect the PETU wiring harness from the DEF pump and the DCU. **C.** Connect Tooling B to the DCU connector. **Note:** Tooling B must be used to prevent damage to the DCU connector. **D.** Measure the resistance between terminal 19 (SUPPLY) of the DCU connector and all other pins in the 86 pin DCU harness connector. **E.** Measure the resistance between terminal 17 (SIGNAL) of the DCU connector and all other pins in the 86 pin DCU harness connector. **F.** Measure the resistance between terminal 18 (GROUND) of the DCU connector and all other pins in the 86 pin DCU harness connector.	Greater than 100k Ohms	**Result:** All of the resistance measurements are greater than 100k Ohms. A failed DEF pump has been detected. **Repair:** Replace the DEF pump. Proceed to Test Step 6. **Result:** At least one of the resistance measurements is less than 100k Ohms. There is a short circuit in the harness. **Repair:** Repair the wiring or replace the harness. Verify that the fault is resolved. Proceed to Test Step 6.
6. Perform a DEF Dosing System Verification Test **A.** Turn the keyswitch to the “ON” position. Do not start the engine. **B.** Connect the electronic service tool to the diagnostic connector. **C.** Perform the “DEF Dosing System Verification Test” .	Diagnostic codes	**Result:** The code did not return. Return the unit to service. **Result:** The code returned. Contact the Dealer Solutions Network (DSN).

i06194750

DEF Pump Sensor Supply - Test

Table 170 lists the diagnostic codes for the Diesel Exhaust Fluid (DEF) pump circuit.

Table 170

Diagnostic Trouble Codes for DEF Pump Sensor Supply			
J1939 Code	PDL Code	Code Description (code descriptions may vary)	Comments
3511-11	3482-11	Sensor Supply #3:Other Failure Mode	High or low battery voltage supply has been detected on the 5V supply to the DEF pump.
Follow the troubleshooting procedure in order to identify the root cause of the problem.			

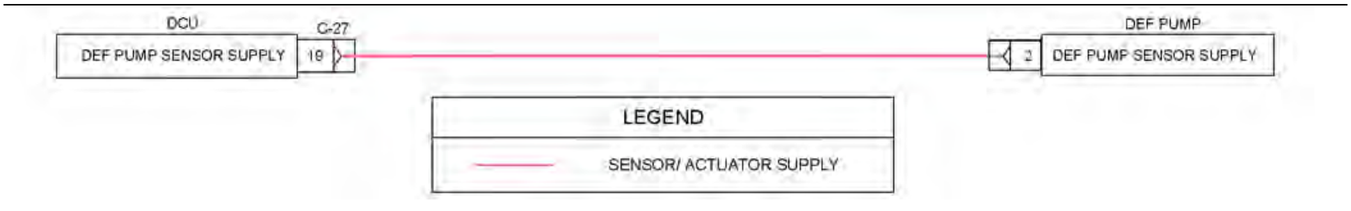


Illustration 116 g03811023

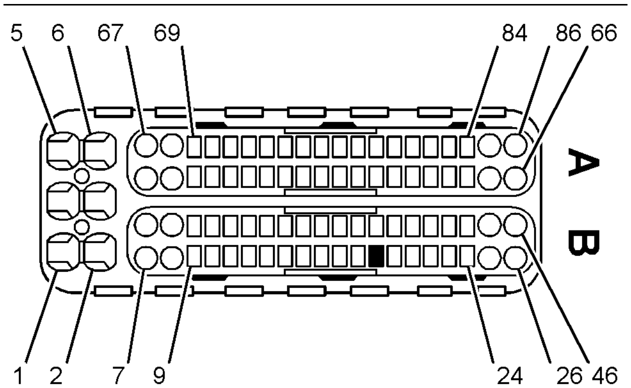


Illustration 117 g03414180

Pin location on the Dosing Control Unit (DCU) connector

(19) Diesel Exhaust Fluid (DEF) pump pressure sensor supply

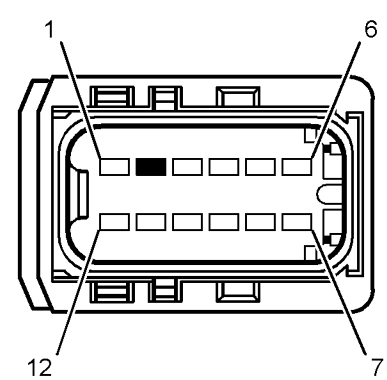


Illustration 118 g03415858

Pin location on the DEF pump connector

(2) Pressure sensor supply

Table 171

Required Tools			
Tool	Part Number	Part Description	Qty
A	T4000242	Break-out Connector	1
B	T4000243	Break-out Connector	1

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

Table 172

Troubleshooting Test Steps	Values	Results
1. Check the DEF Pump Pressure Sensor Supply Circuit for Excessive Voltage **A.** Turn the keyswitch to the OFF position for 2 minutes. The keyswitch must be OFF for 2 minutes to allow the DEF pump to purge, reset the code, and reset the Diesel Exhaust Fluid Controller (DCU). **B.** Disconnect the Pump Electronic Tank Unit (PETU) harness from the DEF pump. **C.** Verify that the harness connector is free of debris, free of corrosion, and securely connected. **D.** Turn the keyswitch ON. **E.** Measure the voltage between the 5V SUPPLY (Terminal 2) at the DEF pump connector and a known good ground source.	Supply voltage	**Result:** The voltage is greater than 5V. Proceed to Test Step 3. **Result:** The voltage is 5V or less. Proceed to Test Step 2.
2. Check the DEF Pump Pressure Sensor Supply for a Short Circuit to Ground **A.** Turn the keyswitch to the OFF position for 2 minutes. The keyswitch must be OFF for 2 minutes to allow the DEF pump to purge, reset the code, and reset the DCU. **B.** Disconnect the PETU wiring harness from the DEF pump. **C.** Disconnect the 86 pin connector from the DCU. **D.** Connect Tooling A to the DEF pump connector. **Note:** Tooling A must be used to prevent damage to the DEF pump connector. **E.** Measure the resistance between the 5V SUPPLY (Terminal 2 on the DEF pump connector) and a known good ground source.	Greater than 100k Ohms	**Result:** There was more than 100K ohms of resistance between the 5V SUPPLY and a ground source. Proceed to Test Step 4. **Result:** There was less than 100K ohms of resistance between the 5V SUPPLY and a ground source. A short circuit to ground has been detected. **Repair:** Repair or replace the wiring harness. Proceed to Test Step 4.

(continued)

(Table 172, contd)

Troubleshooting Test Steps	Values	Results
3. Check the DEF Pump Supply for a Pin-to Pin Short Circuit **A.** Turn the keyswitch to the OFF position for 2 minutes. The keyswitch must be OFF for 2 minutes to allow the DEF pump to purge, reset the code, and reset the DCU. **B.** Disconnect the PETU wiring harness from the DEF pump. **C.** Disconnect the 86 pin connector from the DCU. **D.** Connect Tooling B to the DCU connector. **Note:** Tooling B must be used to prevent damage to the DCU connector. **E.** Measure the resistance between the 5V SUPPLY (Terminal 19 at the DCU connector) and all other pins in the DCU 86 pin connector.	Greater than 100k Ohms	**Result:** There was more than 100K ohms of resistance between the 5V SUPPLY and all other pins in the DEF pump connector. Proceed to Test Step 4. **Result:** There was less than 100K ohms of resistance between the 5V Supply and all other pins in the DEF pump connector. There is a fault in the wiring harness. **Repair:** Repair or replace the wiring harness. Proceed to Test Step 4.
4. Perform a DEF Dosing System Verification Test **A.** Turn the keyswitch to the "ON" position. Do not start the engine. **B.** Connect the electronic service tool to the diagnostic connector. **C.** Perform the "DEF Dosing System Verification Test" .	Diagnostic codes	**Result:** The code did not return. Return the unit to service. **Result:** The code returned. A failed DEF pump has been detected. **Repair:** Replace the DEF pump. Perform the DEF Dosing Verification Test to verify that the fault has been eliminated. If the fault is still present, contact the Dealer Solutions Network (DSN).

i06194801

DEF Return Valve - Test

Table 173 lists the diagnostic codes for the Diesel Exhaust Fluid (DEF) pump return valve circuit.

Table 173

Diagnostic Trouble Codes for the DEF Return Valve			
J1939 Code	**PDL Code**	**Code Description (code descriptions may vary)**	**Comments**
4376-5	3862-5	Aftertreatment 1 Diesel Exhaust Fluid Return Valve : Current Below Normal	This code indicates there is problem with the DEF pump reverting valve or the Pump Electronic Tank Unit (PETU) wiring harness.
4376-6	3862-6	Aftertreatment 1 Diesel Exhaust Fluid Return Valve : Current Above Normal	This code indicates there is problem with the DEF pump reverting valve or the PETU wiring harness.
Follow the troubleshooting procedure in order to identify the root cause of the problem.			

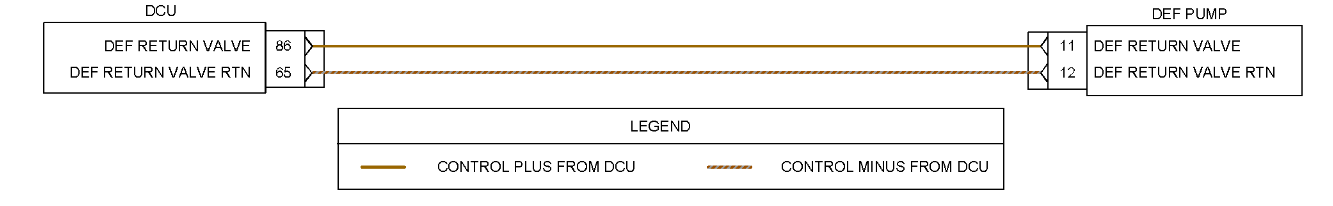


Illustration 119 g03811027

Schematic diagram for the DEF return valve circuit

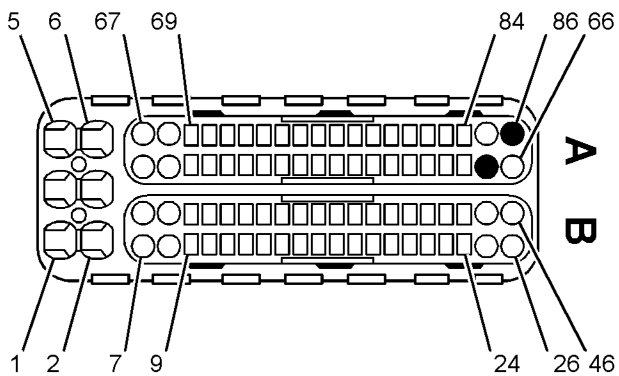


Illustration 120 g03417162

View of the pin locations for the DEF return valve on the 86-pin DCU connector

(65) DEF pump reversing valve return
(86) DEF pump reversing valve supply

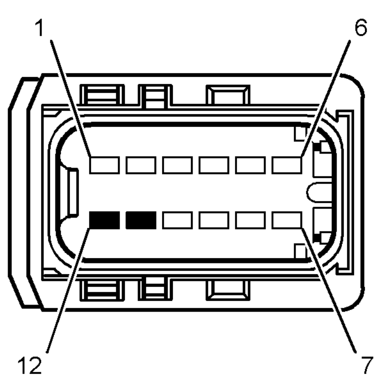


Illustration 121 g03417188

Pin locations for the DEF return valve on the DEF pump connector

(11) Reversing valve supply
(12) Reversing valve return

Table 174

Required Tools			
Tool	Part Number	Part Description	Qty
A	T4000242	Break-out Connector	1
B	T4000243	Break-out Connector	1

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

Table 175

Troubleshooting Test Steps	Values	Results
1. Inspect Electrical Connectors and Wiring **A.** Inspect the 86-pin DCU connector. **B.** Inspect the connector for the DEF pump. **C.** Perform a 45 N (10 lb) pull test on each of the wires in the DCU connector and the connector for the DEF pump. **D.** Check all of the wiring associated with the DEF pump for abrasions and pinch points.	Damaged wire or connector	**Result:** A damaged wire or damaged connector was not found. Proceed to Test Step 2. **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.
2. Determine the Diagnostic Code **A.** Establish communication between the electronic service tool and the engine Electronic Control Module (ECM). Refer to Troubleshooting, “Electronic Service Tools”. **B.** Establish communication between the electronic service tool and the Dosing Control Unit (DCU) . **C.** Check for active or logged codes.	Diagnostic trouble codes	**Result:** There is an active or logged 4376-5, 3862-5, 4376-6 or 3862-6 diagnostic code. Proceed to Test Step 3. **Result:** None of the preceding diagnostic codes are active or recently logged. Proceed to Test Step 6.
3. Check for an Open Circuit in the PETU Wiring Harness for the return Valve **A.** Turn the keyswitch to the OFF position for 2 minutes. The keyswitch must be OFF for 2 minutes to allow the DEF pump to purge, reset the code, and reset the Diesel Exhaust Fluid Controller (DCU). **B.** Disconnect the PETU wiring harness from the DEF pump and from the DCU. **C.** Connect Tooling B to the DCU connector. Connect Tooling A to the DEF pump connector. **Note:** The tooling must be used to prevent damage to the DCU and DEF pump connector. **D.** Measure the resistance between terminal 11 (return valve +) on the DEF pump connector and terminal 86 (return valve +) on the 86 pin DCU connector. **E.** Measure the resistance between terminal 12 (return valve -) on the DEF pump connector and terminal 65 (return valve -) on the 86 pin DCU connector.	Less than five Ohms	**Result:** Both resistance measurements are less than five Ohms. Proceed to Test Step 4. **Result:** At least one of the resistance measurements is greater than five Ohms. There is an open in the harness. **Repair:** Repair the wiring or replace the harness. Proceed to Test Step 6.

(continued)

(Table 175, contd)

Troubleshooting Test Steps	Values	Results
4. Check for Short Circuits in the PETU Wiring Harness for the return Valve **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the PETU wiring harness from the DEF pump. **C.** Disconnect the 86 pin connector from the DCU. **D.** Connect the Tooling A to the DEF pump connector. **Note:** Tooling A must be used to prevent damage to the DEF pump connector. **E.** Measure the resistance between terminal 11 (return valve +) on the DEF pump connector and a known good chassis ground. **F.** Measure the resistance between terminal 12 (return valve -) on the DEF pump connector and a known good chassis ground.	Greater than 100k Ohms	**Result:** Both resistance measurements are greater than 100k Ohms. Proceed to Test Step 5. **Result:** At least one of the resistance measurements is less than 100k Ohms. There is a short circuit in the harness. **Repair:** Repair the wiring or replace the harness. Proceed to Test Step 6.
5. Check for Short Circuits in the PETU Wiring Harness for the return Valve **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the PETU wiring harness from the DEF pump. **C.** Disconnect the 86 pin connector from the DCU. **D.** Connect Tooling B to the DCU connector. **Note:** Tooling B must be used to prevent damage to the DCU connector. **E.** Measure the resistance between terminal 86 (return valve +) and all other pins in the 86 pin DCU harness connector. **F.** Measure the resistance between terminal 65 (return valve -) and all other pins in the 86 pin DCU harness connector.	Greater than 100k Ohms	**Result:** All resistance measurements are greater than 100k Ohms. **Repair:** Replace the DEF pump. Refer to Disassembly and Assembly, “Diesel Exhaust Fluid Pump - Remove and Install” Proceed to Test Step 6. **Result:** At least one of the resistance measurements is less than 100k Ohms. There is a short circuit in the harness. **Repair:** Repair the wiring or replace the harness. Proceed to Test Step 6.
6. Perform a DEF Dosing System Verification Test **A.** Turn the keyswitch to the ON position. Do not start the engine. **B.** Connect the electronic service tool to the diagnostic connector. **C.** Perform the “DEF Dosing System Verification Test” .	Diagnostic codes	**Result:** The codes did not return. Return the unit to service. **Result:** The codes returned. Contact the Dealer Solutions Network (DSN).

i06194811

DEF Tank Sensor - Test

Use this procedure to troubleshoot the electrical system if a fault is suspected with the sensors. Use this procedure if any of the diagnostic codes in Table 176 are active or easily repeated.

Table 176

Diagnostic Codes Table for the DEF Tank Sensor			
J1939 Code	**PDL Code**	**Code Description (code descriptions may vary)**	**Comments**
1761-3	3130-3	Aftertreatment 1 Diesel Exhaust Fluid Tank Level : Voltage Above Normal	The ECM detects signal voltage that is not in the acceptable range. The code is logged.
1761-4	3130-4	Aftertreatment 1 Diesel Exhaust Fluid Tank Level : Voltage Below Normal	The ECM detects signal voltage that is not in the acceptable range. The code is logged.
3031-3	3134-3	Aftertreatment 1 Diesel Exhaust Fluid Tank Temperature : Voltage Above Normal	The ECM detects signal voltage that is not in the acceptable range. The code is logged.
3031-4	3134-4	Aftertreatment 1 Diesel Exhaust Fluid Tank Temperature : Voltage Below Normal	The ECM detects signal voltage that is not in the acceptable range. The code is logged.

The 5 VDC signal for the Diesel Exhaust Fluid (DEF) tank level sensor is routed to terminal 1 of the tank header unit. The 5 VDC signal for the DEF tank temperature sensor is routed to terminal 3 of the tank header unit. The sensor return is shared and is routed to terminal 2 of the tank header unit. The ECM provides short circuit protection for the internal power supply. A short circuit to the battery will not damage the internal power supply.

Note: The tank header unit houses the DEF tank temperature and the DEF tank level sensors. The sensors are not serviceable individually.

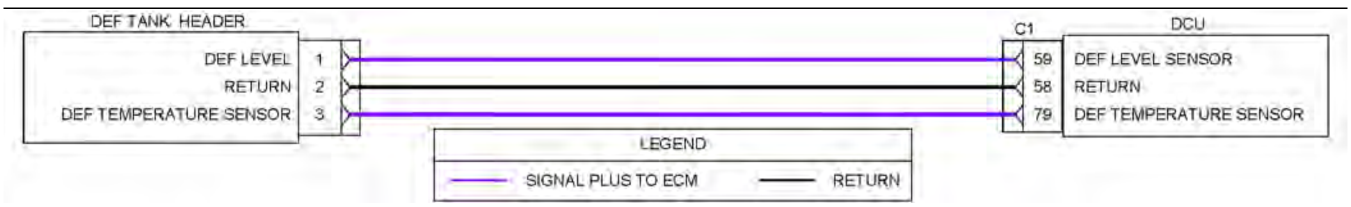


Illustration 122 g03811036

Schematic diagram for the DEF tank header

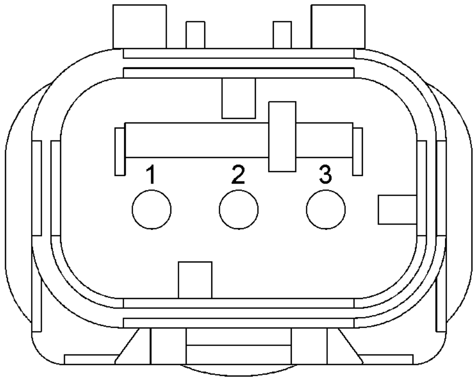


Illustration 123 g03811042

(1) DEF level signal
(2) Sensor return
(3) DEF temperature signal

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

Table 177

Troubleshooting Test Steps	Values	Results
1. Check for Diagnostic Codes **A.** Establish communication between the electronic service tool and the DEF Control Unit (DCU) . Refer to Troubleshooting, “Electronic Service Tools”, if necessary. B. Turn the keyswitch to the ON position. C. Check for “-3” or “ -4” active or logged codes.	Diagnostic code	**Result:** A -3 diagnostic code is active. Proceed to Test Step 2. **Result:** A -4 diagnostic code is active. Proceed to Test Step 3.
2. Create a Short at the Sensor Connector **A.** Verify that the harness connector is free of debris, free of corrosion and securely connected. **B.** Install a jumper wire between the appropriate signal and return wire at the sensor connector in order to create a short. Refer to Illustration 123 . **C.** Turn the keyswitch to the ON position. **D.** Monitor the diagnostic codes on the electronic service tool. Check for an active -4 diagnostic code for the suspect sensor. **E.** Turn the keyswitch to the OFF position.	Short created	**Result:** A -4 diagnostic code became active after creating the short at the sensor connector. The wiring is OK. **Repair:** Replace the DEF tank header assembly. Refer to the Disassembly and Assembly manual. Verify that the fault is resolved by cycling the keyswitch to the OFF position for 2 minutes. Turn to the keyswitch to the ON position and check for active codes. **Result:** A -4 diagnostic code does not become active for the tank header unit. **Repair:** Repair or replace the wiring harness. Verify that the fault is resolved by cycling the keyswitch to the OFF position for 2 minutes. Turn to the keyswitch to the ON position and check for active codes. If the fault is still present, contact the Dealer Solutions Network (DSN).
3. Create an Open at the Suspect Sensor Connector **A.** Disconnect the connector for the tank header unit. **B.** Turn the keyswitch to the ON position. **C.** Monitor the diagnostic codes on the electronic service tool. Check for an active -3 diagnostic code for the suspect sensor. **D.** 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. **Repair:** Replace the DEF tank header assembly. Refer to the Disassembly and Assembly manual. Verify that the fault is resolved by cycling the keyswitch to the OFF position for 2 minutes. Turn to the keyswitch to the ON position and check for active codes. **Result:** A -3 diagnostic code does not became active after disconnecting the sensor. **Repair:** Repair or replace the wiring harness. Verify that the fault is resolved by cycling the keyswitch to the OFF position for 2 minutes. Turn to the keyswitch to the ON position and check for active codes. If the fault is still present, contact the Dealer Solutions Network (DSN).

i06194814

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 178 is active or easily repeated.

Table 178

Diagnostic Trouble Codes for the Electrical Power Supply			
J1939 Code	**PDL Code**	**Code Description** (code descriptions may vary)	**Comments**
168-3	168-3	Electrical System Voltage : Voltage Above Normal	The ECM detects voltage that is above the acceptable value.
168-4	168-4	Electrical System Voltage : Voltage Below Normal	The ECM detects voltage that is below the acceptable value.
3216-5	3002-5	Aftertreatment 1 Intake NOx : Current Below Normal	The ECM detects current that is below the acceptable value
3216-6	3002-6	Aftertreatment 1 Intake NOx : Current Above Normal	The ECM detects current that is above the acceptable value
3226-5	3609-5	Aftertreatment 1 Outlet NOx : Current Below Normal	The ECM detects current that is below the acceptable value
3226-6	3609-6	Aftertreatment 1 Outlet NOx : Current Above Normal	The ECM detects current that is above the acceptable value
5758-11	3621-11	Engine Exhaust NOx Level Sensor Power Supply: Other Failure Mode	The ECM detects voltage that is outside the acceptable value.
5759-11	3619-11	Aftertreatment #1 Outlet#1 NOx Level Sensor Power Supply: Other Failure Mode	The ECM detects voltage that is outside the acceptable value.

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

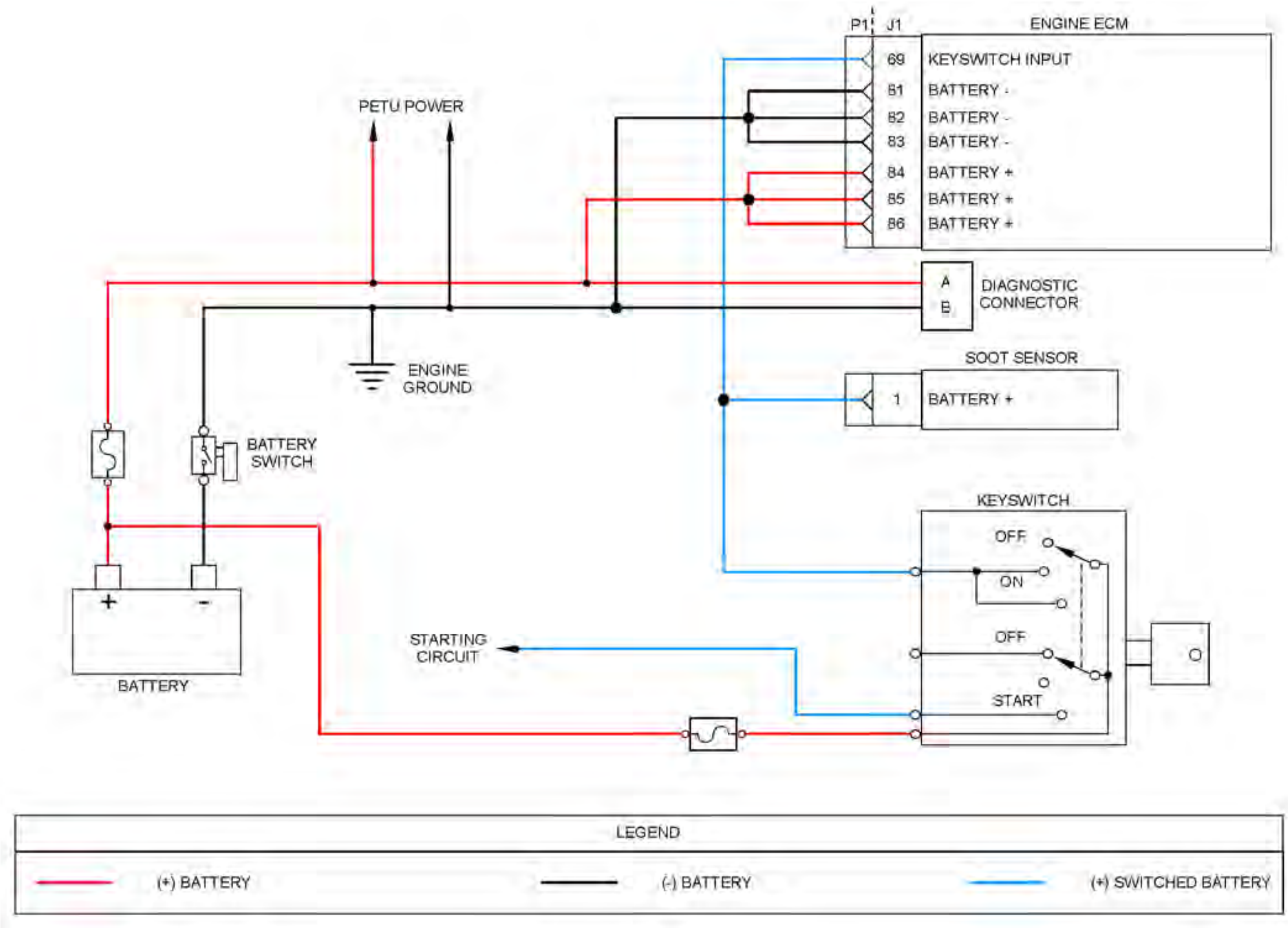


Illustration 124 g03811196

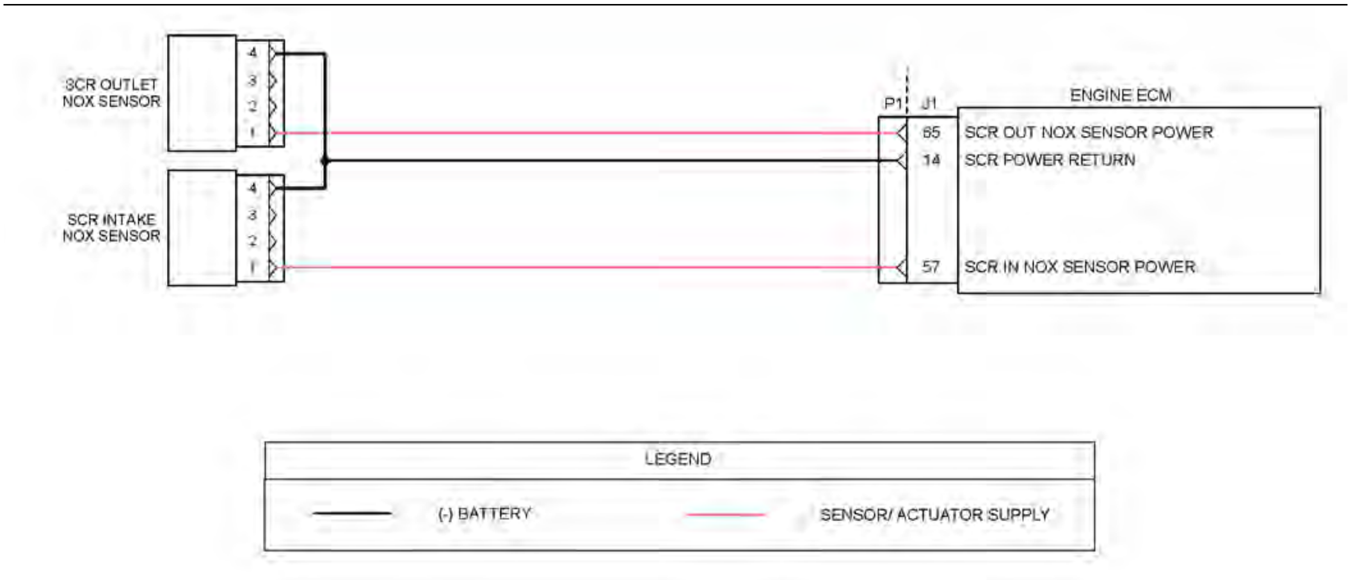


Illustration 125 g03712263

Schematic for the NOx sensor power supply circuit

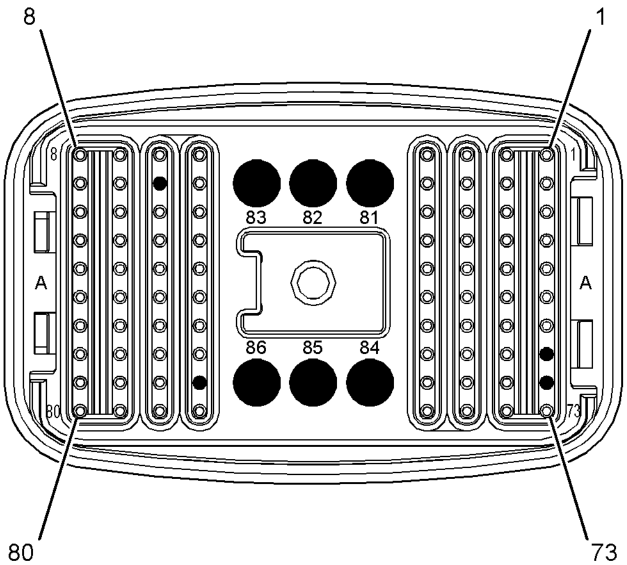


Illustration 126 g03421240

Pin locations on the P1 connector for the power supply circuit

(14) NOx sensor return
(57) SCR inlet NOx sensor power
(65) SCR outlet NOx sensor power
(69) Keyswitch input
(81) Battery -
(82) Battery -
(83) Battery -
(84) Battery +
(85) Battery +
(86) Battery +

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

Table 179

Troubleshooting Test Steps	Value	Results
1. 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 45 N (10 lb) pull test on each of the wires in the connectors associated with the electrical power supplies. **E.** Check all of the wiring associated with the electrical power supplies for abrasions and pinch points.	Damaged wire or connector. Blown fuse.	**Result:** A damaged wire or damaged connector was not found. The fuses are OK. Proceed to Test Step 2. **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.

(continued)

(Table 179, contd)

2. 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. Proceed to Test Step 3. **Result:** The charging system is not OK. There is a fault in the charging system. **Repair:** Make the necessary repairs. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.
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 for Active Diagnostic Codes **A.** Establish communication between the electronic service tool and the ECM. Refer to Troubleshooting, “Electronic Service Tools”, if necessary. **B.** Check the “Active Diagnostics” screen on the electronic service tool.	Diagnostic code	**Result:** A 168-X diagnostic code is active. Proceed to Table 180 , “Troubleshooting Procedure for the Engine ECM Power Supply” . **Result:** A 5758-11, 3621-11,5759-11, 3619-11, 3216-X, 3002-X, 3226-X, or 3609-X diagnostic code is active. Proceed to Table 181 , “Troubleshooting Procedure for the NOx Sensor Power Supplies” .

Table 180

Troubleshooting Procedure for the Engine ECM Power Supply		
Troubleshooting Test Steps	**Value**	**Results**
1. Check the Voltage at the Ignition Keyswitch Input **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the connector for the ignition keyswitch. **C.** Measure the voltage at the battery supply input to the ignition keyswitch.	Battery voltage	**Result:** The measured voltage is equal to battery voltage. Reconnect the connector for the ignition keyswitch. Proceed to Test Step 2. **Result:** The measured voltage is not equal to battery voltage. **Repair:** Replace the wiring between the battery and the input to the ignition keyswitch. Use the electronic service tool to clear all logged diagnostic codes. Verify that the repair eliminates the fault.

(continued)

(Table 180, contd)

2. Check the Keyswitch Signal Voltage **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the P1 connector from the ECM. **C.** Turn the keyswitch to the ON position. Do not attempt to start the engine. **D.** Measure the voltage between P1:69 and a suitable ground.	Battery voltage	**Result:** The measured voltage is equal to battery voltage. Proceed to Test Step 4. **Result:** The measured voltage is not equal to battery voltage. Proceed to Test Step 3.
3. Check the Wiring Between the Keyswitch and the ECM **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the connector for the ignition keyswitch. **C.** Measure the resistance between the keyswitch “ON” terminal on the harness and P1:69.	Less than two Ohms	**Result:** The resistance is less than two Ohms. **Repair:** Replace the ignition keyswitch. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault. **Result:** The resistance is greater than two Ohms. **Repair:** Replace the wiring between the ignition keyswitch and the ECM. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.
4. Check for Battery Voltage at the ECM Connector **A.** Turn the keyswitch to the ON position. **B.** Measure the resistance between the following points: P1:81 and P1:84 P1:82 and P1:85 P1:83 and P1:86	Battery voltage	**Result:** The measured voltage is equal to battery voltage. Contact the Dealer Solutions Network (DSN). **Result:** The measured voltage is not equal to battery voltage. **Repair:** Replace the wiring between the battery and the ECM. If the procedure did not correct the issue, contact the Dealer Solutions Network (DSN).

Table 181

Troubleshooting Procedure for the NOx Sensor Power Supplies		
Troubleshooting Test Steps	**Value**	**Results**

(continued)

(Table 181, contd)

1. Check the Voltage at the Sensor Connector **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the connector for the suspect NOx sensor. **C.** Turn the keyswitch to the ON position. **D.** Use the electronic service tool to switch on the override for the suspect NOx sensor. **E.** Measure the voltage between terminal 1 and terminal 4 on the harness connector for the sensor. **F.** Turn the keyswitch to the OFF position.	Battery voltage	**Result:** The measured voltage is equal to battery voltage. **Repair:** Install a replacement NOx sensor. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault. **Result:** The measured voltage is not equal to battery voltage. Proceed to Test Step 2.
2. Check the Wiring for an Open Circuit A. Disconnect the P1 connector from the ECM. B. For a 5758-11, 3621-11, 3216-X, or 3002-X diagnostic code, take the following resistance measurements: · Terminal 1 on the SCR intake NOx sensor harness connector to P1:57. · Terminal 4 on the SCR intake NOx sensor harness connector to P1:14. For a 5759-11, 3619-11, 3226-X, or 3609-X diagnostic code, take the following resistance measurements: · Terminal 1 on the SCR outlet NOx sensor harness connector to P1:65. · Terminal 4 on the SCR outlet NOx sensor harness connector to P1:14.	Less than two Ohms	**Result:** Both resistance measurements are less than two Ohms. Proceed to Test Step 3. **Result:** At least one of the resistance measurements is greater than two Ohms. **Repair:** Replace the wiring between the suspect NOx sensor and the ECM. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.
3. Check the Wiring for a Short Circuit **A.** Measure the resistance between P1:14 and all other terminals on the P1 connector. **B.** For a 5758-11, 3621-11, 3216-X, or 3002-X diagnostic code, measure the resistance between P1:57 and all other terminals on the P1 connector. **C.** For a 5759-11,3619-11, 3226-X, or 3609-X diagnostic code, measure the resistance between P1:65 and all other terminals on the P1 connector.	Greater than 100 Ohms	**Result:** All resistance measurements are greater than 100 Ohms. Contact the Dealer Solutions Network (DSN). **Result:** At least one of the resistance measurements is less than 100 Ohms. **Repair:** Replace the wiring between the suspect NOx sensor and the ECM. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault. If the procedure did not correct the issue, contact the Dealer Solutions Network (DSN).

i07731122

Ether Starting Aid - Test

Before testing the ether injection system, remove the ether canister from the system.

Use this procedure to troubleshoot the ether system or use this procedure if a diagnostic code in Table 182 is active or logged.

Table 182

Diagnostic Trouble Codes for Ether Injection			
J1939 Code	**PDL Code**	**Code Description** (code descriptions may vary)	**Comments**
626-5	2417-5	Ether Injection Control Solenoid : Current Below Normal	The Electronic Control Module (ECM) detects the following conditions: A low current condition in the output from the ECM to the solenoid for ether injection The ECM has been powered for at least 2 seconds. If equipped, the warning lamp will come on. The ECM will log the diagnostic code.
626-6	2417-6	Ether Injection Control Solenoid : Current Above Normal	The Electronic Control Module (ECM) detects the following conditions: A high current condition in the output from the ECM to the solenoid for ether injection The ECM has been powered for at least 2 seconds. If equipped, the warning lamp will come on. The ECM will log the diagnostic code.

If there is an active engine shutdown, the ether injection system is disabled.

Activation of the ether starting aid is based from a map using the coolant temperature, intake manifold temperature, and atmospheric pressure. Refer to Illustration 127 .

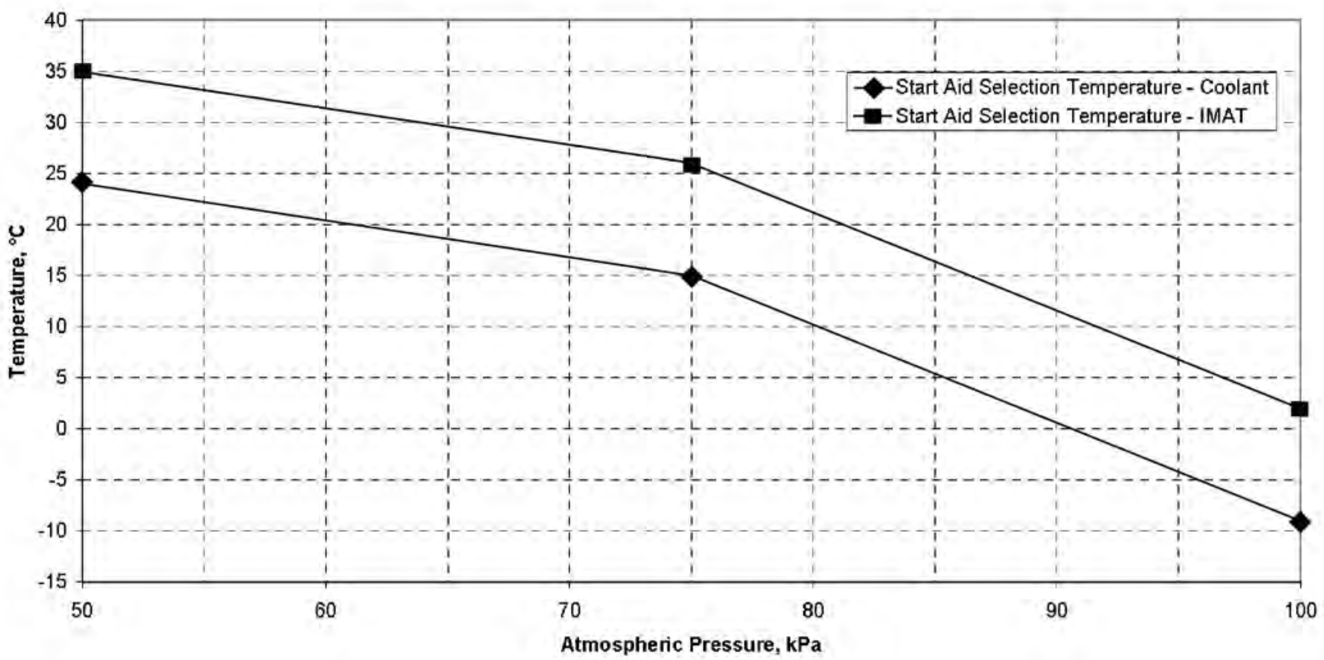


Illustration 127 g02445796

The following conditions must be met for the ether injection system to be enabled:

- Ether injection is set to “Enabled” in the ECM parameters
- Engine coolant temperature is less than the “Start Aid Selection Temperature - Coolant” . Refer to Illustration 127 .
- Intake manifold temperature is less than the “Start Aid Selection Temperature - IMAT.”
- Coolant temperature and intake manifold air temperature are within 11° C of each other.

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

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

Note: Continuous cranking with Ether that does not achieve an engine start will result in the Ether being locked out if the maximum allowed volume of Ether has been exceeded (10 x 15 second cranks).

To re-enable Ether injection, a successful start must be achieved, the engine run at low idle speed for at least 5 seconds and a minimum SCR inlet temperature of 160°C achieved for at least 5 seconds.

Table 183

Troubleshooting Test Steps	Values	Results
1. Inspect Electrical Connectors and Wiring **A.** Remove the electrical power from the ECM. **B.** Thoroughly inspect the ECM connector J1/P1. Inspect all the other connectors for the circuit. Refer to the diagnostic functional test Troubleshooting, “Electrical Connectors - Inspect”. **C.** Perform a 45 N (10 lb) pull test on each of the wires in the ECM connector that are associated with the circuit. **D.** Check the ECM connector (allen head screw) for the correct torque of 6 N·m (53 lb in). **E.** Check the harness and the wiring for abrasion and for pinch points.	Loose connection or damaged wire	**Result:** The harness and wiring are OK. Proceed to Test Step 2. **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. Proceed to Test Step 7.
2. Check for Active or Logged Diagnostic Codes **The ether canister must be removed prior to performing this procedure.** **A.** Verify that the keyswitch is in the OFF position. **B.** Remove the ether canister. **C.** Connect the electronic service tool to the diagnostic connector. **D.** Turn the keyswitch to the ON position. **E.** Check for active or logged diagnostic codes that relate to the ether injection system.	Diagnostic codes	**Result:** No diagnostic codes are present. **Repair:** There may be an intermittent fault in an electrical component between the ECM and the harness connector for the ether control. The problem may be inside an electrical connector. Refer to Troubleshooting, “Electrical Connector - Inspect”. **Result:** A 626-5 or 2417-5 code is present. Proceed to Test Step 3. **Result:** A 626-6 or 2417-6 code is present. Proceed to Test Step 5.
3. Create a Short at the Solenoid Connector **A.** Verify that the keyswitch is in the OFF position. **B.** Disconnect the harness connector from the ether solenoid. **C.** Fabricate a jumper wire and install the jumper wire between terminal 1 and terminal 2 on the harness connector for the ether solenoid. **D.** Turn the keyswitch to the ON position. **E.** Access the “Diagnostic Overrides” screen on the electronic service tool and then activate the ether injection system.	Diagnostic code	**Result:** A 626-5 or 2417-5 diagnostic code was previously active. A 626-6 or 2417-6 diagnostic code is active with the jumper installed. **Repair:** Replace the ether solenoid assembly. Proceed to Test Step 7. **Result:** The 626-5 or 2417-5 diagnostic code remains active. Proceed to Test Step 4.

(continued)

(Table 183, contd)

Troubleshooting Test Steps	Values	Results
4. Check the Wiring for an Open Circuit **A.** Verify that the keyswitch is in the OFF position. **B.** Disconnect the harness connector from the ether solenoid. **C.** Disconnect the P1 connector from the ECM. **D.** Use a multimeter to check the resistance between terminal 1 on the solenoid connector and the ether injection signal terminal on the P1 connector. **E.** Use a multimeter to check the resistance between terminal 2 on the solenoid connector and the ether injection return terminal on the P1 connector.	Less than 2.0 Ohms	**Result:** The resistance measurements are both less than 2.0 Ohms. Proceed to Test Step 7 **Result:** At least one of the resistance measurements is greater than 2.0 Ohms. **Repair:** Replace the wiring between the ether solenoid and the P1 connector. Proceed to Test Step 7
5. Create an Open Circuit at the Solenoid Connector **A.** Verify that the keyswitch is in the OFF position. **B.** Disconnect the harness connector from the ether solenoid. **C.** Turn the keyswitch to the ON position. **D.** Use the electronic service to check for active diagnostic codes. Wait at least 10 seconds for activation of the diagnostic codes. **E.** Turn the keyswitch to the OFF position.	Diagnostic codes	**Result:** A 626-6 or 2417-6 diagnostic code was previously active. A 626-5 or 2417-5 diagnostic code is active with the solenoid disconnected. **Repair:** Install a replacement ether solenoid. Proceed to Test Step 7. **Result:** The 626-6 or 2417-6 diagnostic code is still active. Proceed to Test Step 6.
6. Check the Wiring for a Short Circuit **A.** Verify that the keyswitch is in the OFF position. **B.** Disconnect the connector for the ether solenoid. Disconnect the P1 connector from the ECM. **C.** Use a suitable multimeter to measure the resistance between the following terminals: · The ether injection signal terminal on the P1 connector and all other terminals on the P1 connector. · The ether injection return terminal on the P1 connector and all other terminals on the P1 connector.	Greater than 100 Ohms	**Result:** All resistance measurements are greater than 100 Ohms. Proceed to Test Step 7. **Result:** At least one of the resistance measurements is less than 100 Ohms. **Repair:** Replace the wiring between the ether solenoid and the P1 connector. Proceed to Test Step 7.

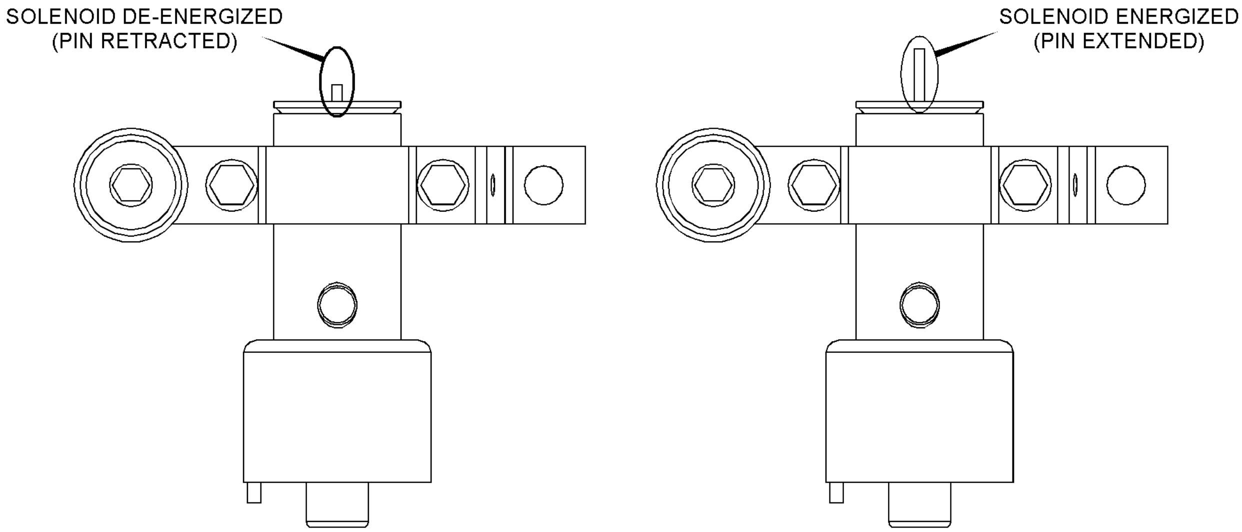


Illustration 128 g03152796

Ether solenoid pin position when energized or de-energized

Table 184

Troubleshooting Test Steps	Values	Results
7. Verify the Repair **A.** Activate the Ether Injection Override. **B.** Verify that the plunger moved up when the override was active.	Plunger movement	**Result:** The plunger moved up when the override was active. Install the ether bottle and return the unit to service. **Result:** The plunger did not move when the override was active. Contact the Dealer Solutions Network (DSN).

i07047708

Fuel Transfer Pump - Test

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

This procedure covers the following diagnostic codes:

Table 185

Diagnostic Codes for the EFLP Relay			
J1939 Code	PDL Code	Code Description (code descriptions may vary)	Comments
1075-5	3666-5	Engine Electric Lift Pump for Engine Fuel Supply : Current Below Normal	The Electronic Control Module (ECM) detects the following conditions: There are no active 168 diagnostic codes. The ECM is not attempting to power the relay. The ECM has been powered for at least 2 seconds. There is a low current condition in the EFLP 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 EFLP. The EFLP will not operate or the EFLP will operate all the time. The engine will not operate.
1075-6	3666-6	Engine Electric Lift Pump for Engine Fuel Supply : Current Above Normal	The ECM detects the following conditions: There are no active 168 diagnostic codes. The ECM is attempting to power the relay. The ECM has been powered for at least 2 seconds. There is a high current condition in the EFLP 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 EFLP. The EFLP will not operate or the EFLP will operate all the time. The engine will not operate. The ECM will continue to attempt to activate the relay. If the current is OK for 6 seconds, then the diagnostic code will be cleared.

The following background information is related to this procedure:

The EFLP 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 EFLP. If the engine is not running, the ECM will deactivate the EFLP after 2 minutes.

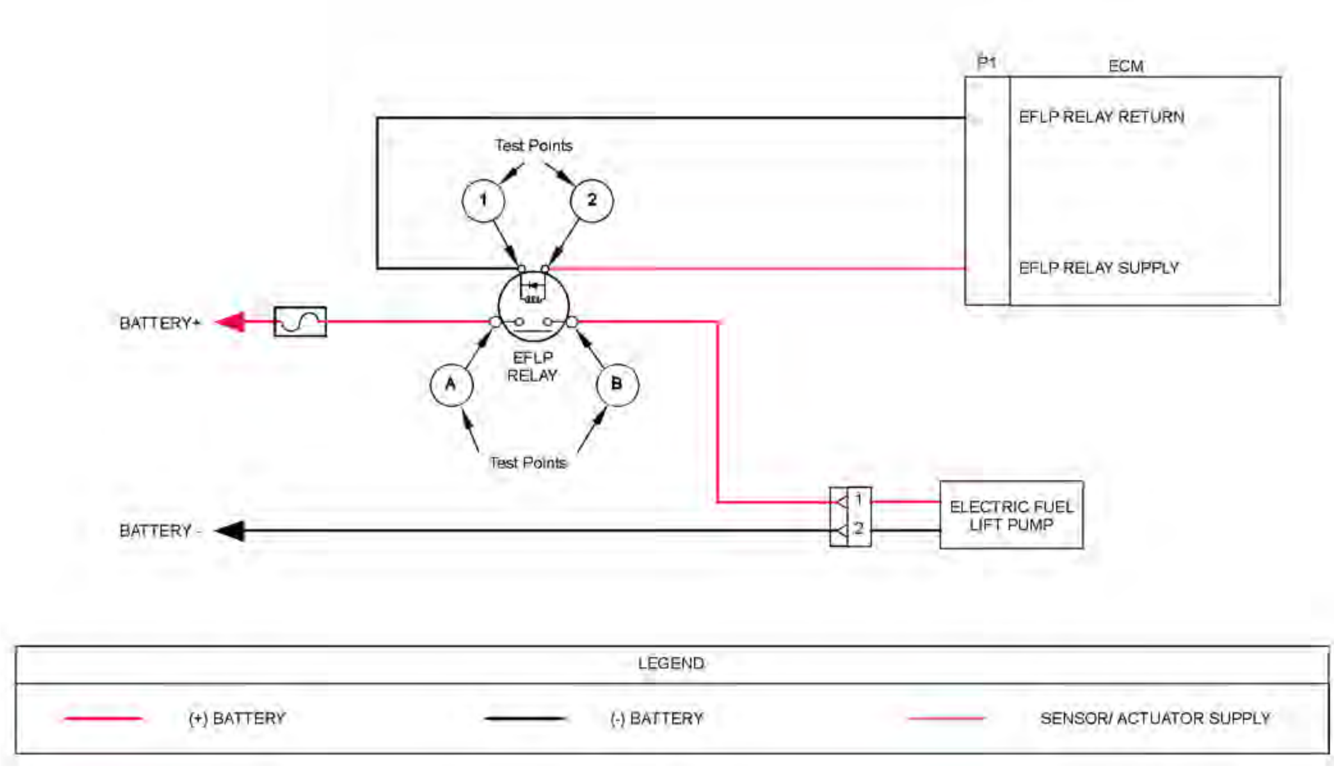


Illustration 129 g03794110

Schematic for the Electric Fuel Lift Pump (EFLP) 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 186

Troubleshooting Test Steps	Values	Results
1. Inspect Electrical Connectors and Wiring **A.** Turn the keyswitch to the OFF position. **B.** Thoroughly inspect the connectors between the EFLP relay and the engine ECM. Refer to Troubleshooting, "Electrical Connectors - Inspect" for details. **C.** Perform a 45 N (10 lb) pull test on each of the wires in the ECM connector that are associated with the EFLP relay. **D.** Check the screw for the ECM connector for the correct torque of 6 N·m (53 lb in). **E.** Check the harness and wiring for abrasion and for pinch points from the injectors 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.** 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 (EFLP) to deactivate. Make a note of any active diagnostic codes.	Diagnostic codes	**Result:** Diagnostic code 1075-5 (3666-5) is active when the EFLP is switched off. Proceed to Test Step 3. **Result:** Diagnostic code 1075-6 (3666-6) is active when the EFLP is switched on. Proceed to Test Step 5. **Result:** An active diagnostic code or a recently logged diagnostic code was not displayed. There may be a fault with the switched power circuit for the EFLP. The ECM does not monitor the status of this condition. Proceed to Test Step 7.

(continued)

(Table 186, contd)

Troubleshooting Test Steps	Values	Results
3. Create a Short Circuit at the EFLP Relay **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the harness connector for the Electric Fuel Lift Pump (EFLP) 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 EFLP relay. Refer to Illustration 129 . **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 or 3666-6 diagnostic code. **G.** Wait for at least 2 minutes for the EFLP to deactivate. Check for an active 1075-5 or 3666-5 diagnostic code. **H.** Turn the keyswitch to the OFF position. **I.** Remove the jumper. Leave the connector for the EFLP disconnected.	Open circuit	**Result:** A 1075-6 (3666-6) diagnostic code was active with the jumper installed. **Repair:** Install a replacement EFLP relay. Reconnect the connector for the EFLP 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 EFLP to deactivate. Check for active diagnostic codes. Confirm that the fault has been eliminated. **Result:** A 1075-5 (3666-5) diagnostic code is still active with the jumper installed. There is a fault in the wiring or the ECM. Proceed to Test Step 4.
4. Check the Wiring Between the ECM and the EFLP Relay for an Open Circuit **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the EFLP relay. Disconnect the J1 connector from the ECM. **C.** Measure the resistance between the following points: · EFLP relay return terminal on the J1 connector and Test Point 1 on the harness connector for the relay · EFLP relay supply terminal on the J1 connector and Test Point 2 on the harness connector for the relay.	Less than 2.0 Ohms	**Result:** At least one of the resistance measurements is greater than 2.0 Ohms. **Repair:** The fault is in the wiring between the EFLP 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:** Both resistance measurements are less than 2.0 Ohms. Contact the Dealer Solutions Network (DSN).

(continued)

(Table 186, contd)

Troubleshooting Test Steps	Values	Results
5. Create an Open Circuit at the Relay **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the harness connector for the EFLP relay. **C.** Turn the keyswitch to the ON position. Do not start the engine. Wait for at least 2 minutes for the EFLP to deactivate. **D.** Use the electronic service tool to check for an active 1075-6 or 3666-6 diagnostic code. **E.** Turn the keyswitch to the OFF position.	Short circuit	**Result:** A 1075-5 (3666-5) diagnostic code is active. There are no faults in the wiring for the EFLP. **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 EFLP to deactivate. Check for active diagnostic codes. Confirm that the fault has been eliminated. **Result:** A 1075-6 (3666-6) 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.** Disconnect the connector for the Electric Fuel Lift Pump (EFLP) relay. **E.** Measure the resistance between the "EFLP Relay Supply" terminal on the P1 connector and all other pins on the P1 connector. **F.** Measure the resistance between the "EFLP Relay Return" terminal on the P1 connector 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 EFLP 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 EFLP 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).
7. Check the Fuse **A.** Turn the keyswitch to the ON position. Wait for 5 seconds. **B.** Turn the keyswitch to the OFF position. Check the fuse for the Electric Fuel Lift Pump (EFLP). Refer to Illustration 129 .	Fuse blown	**Result:** The fuse is blown. There is a short in the circuit for the EFLP. Do not replace the fuse at this stage. Proceed to Test Step 8. **Result:** The fuse is not blown. There may be an open circuit in the circuit for the EFLP. Proceed to Test Step 8.

(continued)

(Table 186, contd)

Troubleshooting Test Steps	Values	Results
8. Check the Power Supply to the Relay Connector **A.** Disconnect the connector for the EFLP relay. **B.** Measure the voltage between Test Point A on the harness connector for the relay and a suitable ground. Refer to Illustration 129 .	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 EFLP relay. Make any necessary repairs. **Result:** Battery voltage is present at Test Point A on the harness connector. Proceed to Test Step 9.
9. Check the Power Supply to the EFLP **A.** Disconnect the connector for the EFLP. Ensure that the EFLP relay is connected. **B.** Turn the keyswitch to the ON position. **C.** Measure the voltage between terminal 1 and terminal 2 on the harness connector for the EFLP.	Battery voltage	**Result:** There is no battery voltage at the harness connector for the EFLP. **Repair:** Check all wiring between the EFLP relay and the EFLP. Make any necessary repairs. If the wiring is OK, replace the EFLP relay. **Result:** Battery voltage is present at the EFLP harness connector. If the EFLP does not activate when the keyswitch is turned to the ON position, replace the EFLP.

i06895709

Glow Plug Starting Aid - Test

This procedure covers the following diagnostic code:

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

Table 187

Diagnostic Trouble Codes For The Glow Plug Starting Aid			
J1939 Code	**PDL Code**	**Code Description (code descriptions may vary)**	**Comments**
676-5	2246-5	Engine Glow Plug Relay : Current Below Normal	The Electronic Control Module (ECM) detects the following conditions: The engine is not cranking. The ECM has been powered for at least one second. There is a low current condition (open circuit) in the glow plug start aid relay circuit for more than 2 seconds. The warning light will come on. The diagnostic code will be logged. An ECM that was previously blank will require a total of 2 hours of operation before the diagnostic code will be logged. 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	2246-6	Engine Glow Plug Relay : Current Above Normal	The Electronic Control Module (ECM) detects the following conditions: The engine is not cranking. The ECM has been powered for at least one second. There is a high current condition (short circuit) in the glow plug start aid relay circuit for more than 2 seconds. The warning light will come on. The diagnostic code will be logged. An ECM that was previously blank will require a total of 2 hours of operation before the diagnostic code will be logged. 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 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

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” . This test will assist the analysis of the cold starting aid.

Overview of the Glow Plug Start Aid Override Test

The “Glow Plug Start Aid Override” test switches on the cold starting aid when the engine is not running.

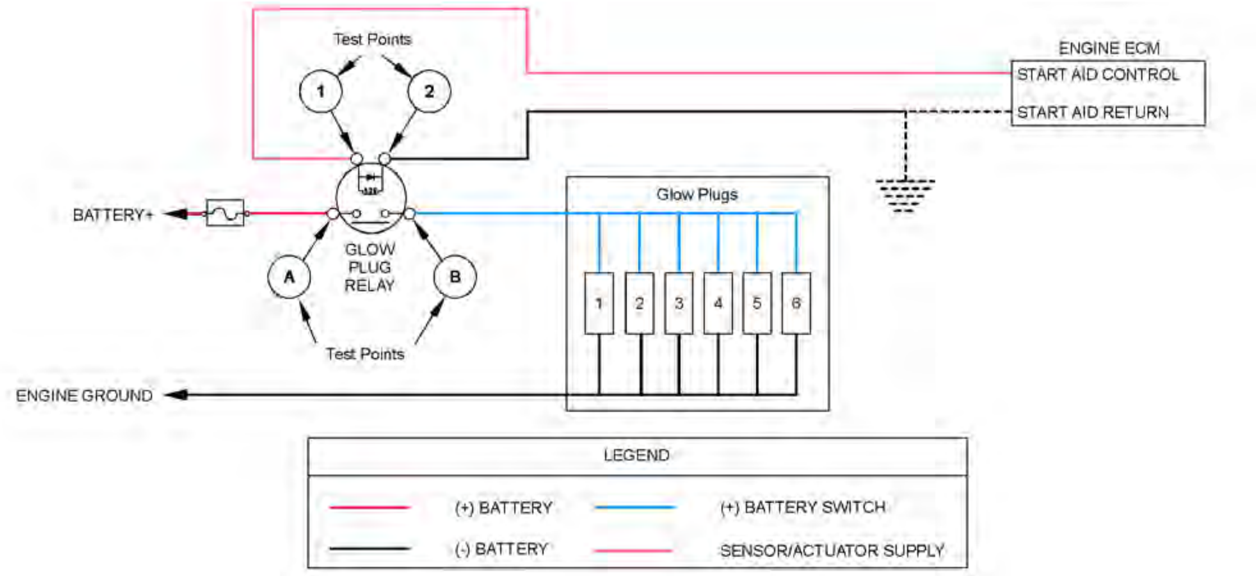


Illustration 130 g03788603

Schematic for the glow plug starting aid circuit.

Not all connectors are shown. Refer to the electrical schematic for the application.

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 188

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.** Perform a 45 N (10 lb) pull test on each of the wires in the ECM connector that are associated with the glow plug starting aid. **E.** Check the screw for the ECM connector for the correct torque of 6 N·m (53 lb in). **F.** Check the harness for abrasion and pinch points from the glow plugs 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. 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 active diagnostic codes or recently logged diagnostic codes.	Diagnostic codes	**Result:** No diagnostic codes are present. **Repair:** 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 or 2246-5 is active or recently logged. Proceed to Test Step 3. **Result:** Diagnostic code 676-6 or 2246-6 is active or recently logged. Proceed to Test Step 5.

(continued)

(Table 188, 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 130 . **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 676-5 or 2246-5 diagnostic code was previously active. A 676-6 or 2246-6 diagnostic code is active with the jumper installed. **Repair:** 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 or 2246-5 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.** Measure the resistance between Test Point 1 on the harness connector for the relay and the start aid control terminal on the P1 connector. **E.** Measure the resistance between Test Point 2 on the harness connector for the relay and the ground source. Refer to the electrical schematic for the application.	Less than 2.0 Ohms	**Result:** The resistance measurement is greater than 2.0 Ohms - the fault is in the wiring between the relay and the ECM. **Repair:** Repair the faulty wiring or replace the faulty wiring. **Result:** The resistance measurement is less than 2.0 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 676-6 or 2246-6 diagnostic code was previously active. A 676-5 or 2246-5 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 or 2246-6 diagnostic code is still active with the relay disconnected. Proceed to Test Step 6.

(continued)

(Table 188, contd)

Troubleshooting Test Steps	Values	Results
6. 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 aid control terminal on the P1 connector and all other terminals on the P1 connector.	Greater than 100 Ohms	**Result:** At least one of the resistance measurements is less than 100 Ohms - 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 100 Ohms. 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 42.0 Amps for a 12 VDC system. Approximately 15.0 Amps for a 24 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. Contact the Dealer Solutions Network (DSN).
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 Illustration 130 .	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 Illustration 130 . Make any necessary repairs. Replace the blown fuse. **Result:** The fuse is not blown. Proceed to Test Step 10.

(continued)

(Table 188, 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 130 .	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.

i07140072

Idle Validation - Test

This procedure covers the following diagnostic codes:

Table 189

Diagnostic Trouble Codes for the Idle Validation Switches			
J1939 Code	**PDL Code**	**Code Description (code descriptions may vary)**	**Comments**
558-2	1634-2	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	1635-2	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.

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 190

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:** A 558-2 (1634-2) or 2970-2 (1635-2) diagnostic code 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 190, 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 8.
4. Inspect Electrical Connectors and the Harness **A.** Inspect the P1/J1 connectors, the harness and all the connectors for the IVS. Refer to Troubleshooting, "Electrical Connectors - Inspect" for details. **B.** Perform a 45 N (10 lb) pull test on each of the wires in the ECM connector that are associated with the suspect idle validation switch. **C.** Check the screw for the ECM connector for the correct torque of 6 N·m (53 lb in). **D.** 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 190, 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, check the resistance between the IVS1 input terminal on the IVS harness connector and the “Idle Validation (IVS) 1” terminal on the P1 connector. **D.** If the fault is on IVS2, check the resistance between the IVS2 input terminal on the IVS harness connector and the “Idle Validation (IVS) 2” terminal on the P1 connector. **E.** Check the resistance between the IVS1 output terminal on the applicable IVS harness connector and the “Idle Validation Ground” terminal on the P1 connector.	Less than 2.0 Ohms	**Result:** One or more of the measured resistances is greater than 2.0 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 2.0 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.** Check the resistance between the “Idle Validation (IVS) 1” terminal on the P1 connector and all other terminals on the P1 connector. **D.** Check the resistance between the “Idle Validation (IVS) 2” terminal on the P1 connector and all other terminals on the P1 connector. **E.** Check the resistance between the “Idle Validation Ground” terminal on the P1 connector and all other terminals on the P1 connector.	Greater than 100 Ohms	**Result:** One or more of the measured resistances is less than 100 Ohms. 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 100 Ohms. Contact the Dealer Solutions Network (DSN).

(continued)

(Table 190, 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. Make a note of the “Idle Validation Max ON Threshold” parameters. **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 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.** Set the throttle 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 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 **Note:** 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. **A.** Refer to Test Step 8. “Check the IVS Calibration”. Record the raw value of the throttle signal when the idle validation	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 190, contd)

Troubleshooting Test Steps	Values	Results
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.		

i06196275

Injector Data Incorrect - Test

This procedure covers the following codes:

Table 191

Diagnostic Codes for Injector Data Incorrect			
J1939 Code	**PDL Code**	**Code Description** (code descriptions may vary)	**Comments**
651-2	1-2	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	2-2	Engine Injector Cylinder #02 : Erratic, Intermittent or Incorrect	
653-2	3-2	Engine Injector Cylinder #03 : Erratic, Intermittent or Incorrect	
654-2	4-2	Engine Injector Cylinder #04 : Erratic, Intermittent or Incorrect	
655-2	5-2	Engine Injector Cylinder #05 : Erratic, Intermittent or Incorrect	
656-2	6-2	Engine Injector Cylinder #06 : 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. 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 ECM to balance the performance of the injectors.

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

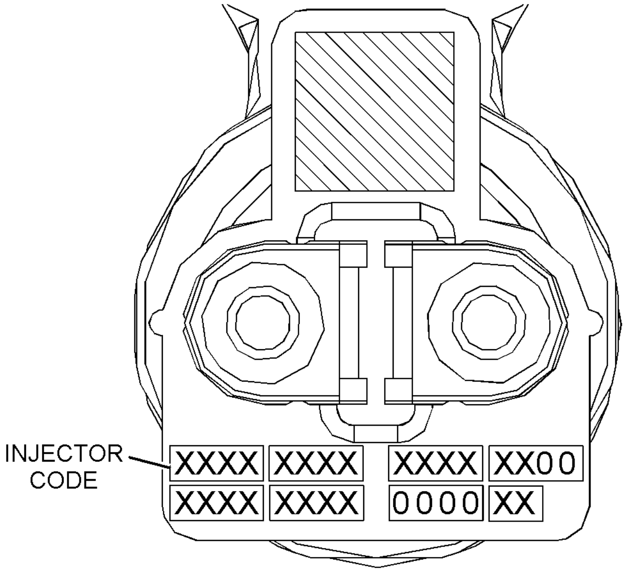


Illustration 131 g02131289

Typical code plate on an injector

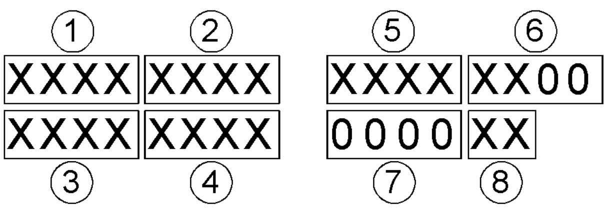


Illustration 132 g02132293

Sequence for recording the injector code

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 192

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 in order to obtain the injector codes from the ECM: · “Service” · “Calibrations” · “Injector Trim 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 code from the card. **Result:** The card with the injector code is not available. Proceed to Test Step 3.
3. Manually Program the Injector Code **A.** Remove the valve mechanism cover. Refer to Disassembly and Assembly, “Valve Mechanism Cover - Remove and Install”. **B.** Make a note of the injector code that is on the injector in any suspect cylinders. **Note:** Refer to Illustration 132 for the correct sequence for recording the injector code. **C.** 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. The injector is incorrect for the engine. **Repair:** 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 in order 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).

i06196284

Injector Solenoid - Test

This procedure covers the following diagnostic codes:

Table 193

Diagnostic Trouble Codes for Injector Solenoid			
J1939 Code	PDL Code	Code Description (code descriptions may vary)	Comments
651-5	1-5	Engine Injector Cylinder #01 : Current Below Normal	These diagnostic codes indicate an open circuit (low current) in either the solenoid or the wiring for the electronic unit injector. The Electronic Control Module (ECM) detects the following conditions: A low current condition (open circuit) for each of five consecutive attempts to operate Battery voltage above 9 VDC for 2 seconds 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	2-5	Engine Injector Cylinder #02 : Current Below Normal	
653-5	3-5	Engine Injector Cylinder #03 : Current Below Normal	
654-5	4-5	Engine Injector Cylinder #04 : Current Below Normal	
655-5	5-5	Engine Injector Cylinder #05 : Current Below Normal	
656-5	6-5	Engine Injector Cylinder #06 : Current Below Normal	
651-6	1-6	Engine Injector Cylinder #01 : Current Above Normal	These diagnostic codes indicate a short circuit (high current) in either the solenoid or the wiring for the electronic unit injector. The ECM detects the following conditions: A high current condition (short circuit) for each of five consecutive attempts to operate Battery voltage above 9 VDC for 2 seconds 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	2-6	Engine Injector Cylinder #02 : Current Above Normal	
653-6	3-6	Engine Injector Cylinder #03 : Current Above Normal	
654-6	4-6	Engine Injector Cylinder #04 : Current Above Normal	

(continued)

(Table 193, contd)

Diagnostic Trouble Codes for Injector Solenoid			
J1939 Code	PDL Code	Code Description (code descriptions may vary)	Comments
655-6	5-6	Engine Injector Cylinder #05 : Current Above Normal	
656-6	6-6	Engine Injector Cylinder #06 : Current Above Normal	
Follow the troubleshooting procedure in order 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).

The engine has 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” .

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.

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 194

Troubleshooting Test Steps	Values	Results
1. 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 45 N (10 lb) pull test on each of the wires in the ECM connector that are associated with injector solenoids. **D.** Check the screw for the ECM connector for the correct torque of 6 N·m (53 lb in). **E.** Check the harness and wiring for abrasion and for pinch points from the injectors 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 of 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. 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.** Connect the electronic service tool to the diagnostic connector. **E.** Turn the keyswitch to the ON position. **F.** Access the “Injector Solenoid Test” by accessing the following display screens in order: · “Diagnostics” · “Diagnostic Tests” · “Injector Solenoid Test” **G.** Activate the test. **Note:** Do not confuse the “Injector Solenoid Test” with the “Cylinder Cutout Test” . The “Cylinder Cutout Test” is used to shut off fuel to a specific cylinder while the engine is running. The “Injector Solenoid Test” is used 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 at this time. 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 3. **Result:** “SHORT” Note the cylinders that indicate “SHORT” . Proceed to Test Step 4.

(continued)

(Table 194, contd)

Troubleshooting Test Steps	Values	Results
3. Check the Harness between the ECM and the Cylinder Head for an Open Circuit **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 from the cylinder head. **C.** Fabricate a jumper wire 100 mm (4 inch) long with terminals on both ends of the wire. **D.** Insert one end of the jumper wire into the terminal for the supply to the suspect injector. Insert the other end of the jumper wire into the terminal for the return circuit 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. Proceed to Test Step 5. **Result:** The electronic service tool does not display “SHORT” for the cylinder with the jumper wire. Proceed to Test Step 6.
4. Check the Harness between the ECM and the Cylinder Head for a Short Circuit **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 from the cylinder head. **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 and the cylinder that shares the same connector. Proceed to Test Step 5. **Result:** The electronic service tool does not display “OPEN” for the suspect cylinder. Proceed to Test Step 6.

(continued)

(Table 194, contd)

Troubleshooting Test Steps	Values	Results
5. Exchange the Injector Harness Under the Valve Mechanism Cover **A.** Turn the keyswitch to the OFF position. A strong electrical shock hazard is present if the keyswitch is not turned OFF. **B.** Remove the valve mechanism cover. Refer to Disassembly and Assembly, “Valve Mechanism Cover - Remove and Install” for the correct procedure. **C.** Disconnect the connector for the suspect injector from the cylinder head. Disconnect the connector from the adjacent pair of injectors. **D.** Exchange the two internal harnesses. Refer to Disassembly and Assembly, “Electronic Unit Injector - Remove” and refer to Disassembly and Assembly, “Electronic Unit Injector - Install” for the correct procedure. **E.** Turn the keyswitch to the ON position. **F.** Perform the “Injector Solenoid Test” at least two times. **G.** Restore the wiring to the normal positions.	Fault moves to another injector	**Result:** Exchanging the harnesses causes the fault to move to another injector. There is a fault with the suspect injector harness under the valve mechanism cover. **Repair:** Repair the suspect injector harness or replace the suspect injector harness under the valve mechanism cover. Use the electronic service tool in order to clear all logged diagnostic codes and then verify that the repair eliminates the fault. **Result:** The fault remains on the same injector when the harness is exchanged. The injector may be faulty. **Repair:** Replace the faulty injector. Refer to Disassembly and Assembly, “Electronic Unit Injector - Remove” and Disassembly and Assembly, “Electronic Unit Injector - Install”. Perform the “Injector Solenoid Test” . Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.
6. Check the Wiring to the Cylinder Head for an Open Circuit **A.** Turn the keyswitch to the OFF position. A strong electrical shock hazard is present if the keyswitch is not turned OFF. **B.** Disconnect connector P2 from the ECM. **C.** Thoroughly inspect the P2 connector. Refer to Troubleshooting, “Electrical Connectors - Inspect”. **D.** Disconnect the connector for the suspect injector from the cylinder head. **E.** Use a multimeter to check the resistance between the terminals on the suspect cylinder head connector and the terminals on P2. **F.** Install the removed connectors.	Less than two Ohms	**Result:** One or more of the measured resistances is greater than two Ohms. The fault is in the wiring between the ECM and the cylinder head 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 resistances for the suspect injector wiring are less than two Ohms. Proceed to Test Step 7.
7. Check the Wiring to the Cylinder Head for a Short Circuit **A.** Turn the keyswitch to the OFF position. A strong electrical shock hazard is present if the keyswitch is not turned OFF. **B.** Disconnect connector P2 from the ECM. **C.** Thoroughly inspect the P2 connector. Refer to Troubleshooting, “Electrical Connectors - Inspect”.	Greater than 100 Ohms	**Result:** At least one of the resistance measurements is less than 100 Ohms. 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 100 Ohms.

(continued)

(Table 194, contd)

Troubleshooting Test Steps	Values	Results
D. Disconnect the connector for the suspect injector from the cylinder head. **E.** Check the resistance between the terminals for the suspect injector on P2 and all other terminals on P2. **F.** Install the removed connectors.		Contact the Dealer Solutions Network (DSN).

i06196285

Mode Selection - Test

This procedure covers the following diagnostic code:

Table 195

Diagnostic Trouble Code for the Mode Selection Switch			
J1939 Code	**PDL Code**	**Code Description (code descriptions may vary)**	**Comments**
2882-2	1743-2	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 in order 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 196

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 or 1743-2 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 197

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 45 N (10 lb) pull test on each of the wires in the P1 connector that are associated with the mode selector switches. **D.** Check the screw for the ECM connector for the correct torque of 6 N·m (53 lb in). **E.** 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 of 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 197, 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 for a 12 V system At least 22 VDC for a 24 V system	**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 two Ohms	**Result:** One of the measured resistances is greater than two Ohms - The fault is in the wiring between the suspect mode switch and P1:36. **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 two 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 100 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 100 Ohms. There is a fault in the ECM. Contact the Dealer Solutions Network (DSN).

i07905912

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 198

Diagnostic Codes for the Motorized Valves			
J1939 Code	PDL Code	Code Description (code descriptions may vary)	Comments
649-5	3512-5	Engine Exhaust Back Pressure Regulator Control Command : Current Below Normal	The ECM detects the following conditions: A low current condition in the output for the exhaust back pressure regulator for 2 seconds 168 diagnostic codes are not active. The ECM has been powered for at least 2 seconds. If equipped, the warning lamp will come on. The ECM will log the diagnostic code.
649-6	3512-6	Engine Exhaust Back Pressure Regulator Control Command : Current Above Normal	The ECM detects the following conditions: A high current condition in the output for the exhaust back pressure regulator for 2 seconds The ECM has been powered for at least 2 seconds. If equipped, the warning lamp will come on. The ECM will log the diagnostic code.
649-7	E1263 (2)	Engine Exhaust Back Pressure Regulator Control Command : Not Responding to Command	The ECM detects the following conditions: The signal from the exhaust back pressure regulator 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 exhaust back pressure regulator position sensor. The ECM has been powered for at least 2 seconds. If equipped, the warning lamp will come on. The ECM will log the diagnostic code.
2791 -5	3405-5	Engine Exhaust Gas Recirculation (EGR) Valve Control : Current Below Normal	The ECM detects the following conditions: A low current condition in the output for the NOx Reduction System (NRS) valve (EGR valve) for 2 seconds 168 diagnostic codes are not active. The ECM has been powered for at least 2 seconds. If equipped, the warning lamp will come on. The ECM will log the diagnostic code.

(continued)

(Table 198, contd)

Diagnostic Codes for the Motorized Valves			
J1939 Code	PDL Code	Code Description (code descriptions may vary)	Comments
2791-6	3405-6	EGR Valve Control : Current Above Normal	The ECM detects the following conditions: A high current condition in the output for the NRS valve (EGR valve) for 2 seconds The ECM has been powered for at least 2 seconds. If equipped, the warning lamp will come on. The ECM will log the diagnostic code.
2791-7	E1121 (2)	EGR Valve Control Not Responding to Command	The ECM detects the following conditions: The signal from the NRS 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 NRS valve position sensor. The ECM has been powered for at least 2 seconds. If equipped, the warning lamp will come on. The ECM will log the diagnostic code.

The following background information is related to this procedure:

NRS valve (EGR valve)

The NRS valve (EGR 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.

Exhaust Back Pressure Regulator

The Exhaust Back Pressure Regulator (EBPR) is used to promote regeneration of the Diesel Particulate Filter (DPF). When the soot level in the DPF is high, the ECM commands the EBPR to close. As the EBPR closes, the increased back pressure causes the engine to increase fuel flow. The increased fuel flow raises the exhaust gas temperature and therefore accelerates the regeneration process in the DPF.

As the soot level in the DPF reduces, the ECM commands the EBPR to open, reducing the exhaust back pressure to a normal level.

The EBPR is also used on engines with no DPF to assist deposit management.

The position of the EBPR is calculated by the software that is contained in the ECM. The EBPR is controlled by a PWM signal from the ECM.

Air System Motor Valves Verification Test

The Air System Motor Valve Verification Test will identify whether the EGR valve, and the EBPR are working correctly. This test must be run when the engine speed is zero and the battery voltage is within an acceptable range. For a 12VDC system, the service test must only be executed if the battery voltage is between 9VDC and 16VDC. For a 24VDC system, the battery voltage must be between 18VDC and 32VDC. If the battery voltage is outside of these ranges at any time, the test must be aborted. The test will also be aborted if a position sensor diagnostic, a motor short diagnostic, or a motor open circuit diagnostic become active.

If at any point during the test the engine speed is not zero, the test will abort. The test moves the valves to various positions and then 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 EGR valve. If a test threshold is exceeded or any related diagnostics become active, the test will abort and generate an error identifier.

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

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

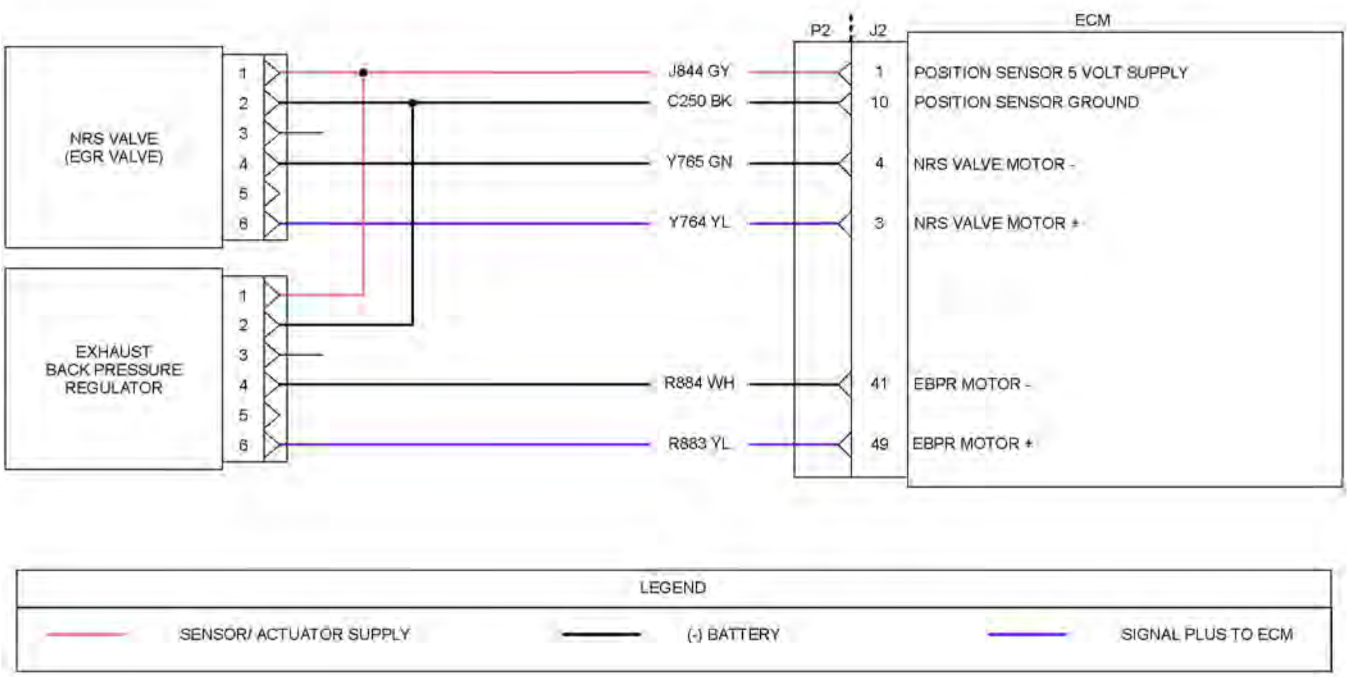


Illustration 133 g06194085

Table 199

Troubleshooting Test Steps	Values	Results
1. Inspect Electrical Connectors and Wiring **A.** Turn the keyswitch to the OFF position. **B.** Thoroughly inspect the connectors for the motorized valves. Refer to Troubleshooting, “Electrical Connectors - Inspect” for details. **C.** Perform a 45 N (10 lb) pull test on each of the wires in the ECM connector that are associated with the motorized valves. **D.** Check the screw for the ECM connector for the correct torque of 6 N·m (53 lb in). **E.** Check the harness and wiring for abrasion and for pinch points from the motorized valves 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 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.	Diagnostic codes	**Result:** An XXXX-5 diagnostic code is active or recently logged for one or more of the motorized valves. Proceed to Test Step 4. **Result:** An XXXX-6 diagnostic code is active or recently logged for one or more of the motorized valves.

(continued)

(Table 199, contd)

Troubleshooting Test Steps	Values	Results
D. Monitor the electronic service tool for active diagnostic codes and/or logged diagnostic codes.		Proceed to Test Step 6. **Result:** An XXXX-7 or EXXXX-2 code is active or recently logged for one or more of the motorized valves. Proceed to Test Step 3. **Result:** No diagnostic codes are active or logged. **Repair:** For intermittent faults, refer to Troubleshooting, “Electrical Connectors - Inspect”. If no intermittent faults are found, return the unit to service.
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. **E.** Turn the keyswitch to the OFF position.	4.84 to 5.16 VDC	**Result:** The voltage from the terminal for the 5 VDC supply to the sensor common terminal measures 4.84 to 5.16 VDC. **Repair:** Reconnect the suspect valve. Operate the engine for enough time to allow the engine to reach normal operating temperature. The suspect valve may be not responding due to frozen condensation. Use the electronic service tool to run the “Air System Motor Valves Verification Test” . If the fault is cleared, return the engine to service. If the -7, E1263 (2), or E1121 (2) code is still active, replace the suspect valve. Refer to Disassembly and Assembly for more information. Use the electronic service tool to clear all logged diagnostic codes. Use the electronic service tool to run the “Air System Motor Valve Verification Test” and verify that the repair eliminates the fault. **Result:** The sensor supply voltage is out of the nominal range. A 3509-X, 262-X, 3510-X, or 2131-X diagnostic code is active. The fault is in the 5 VDC supply wire or the ground wire in the engine harness. **Repair:** Repair the faulty wiring or replace the faulty harness. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.

(continued)

(Table 199, contd)

Troubleshooting Test Steps	Values	Results
4. Create a Short Circuit at the Valve Connector **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the connector for the suspect valve. **C.** Fabricate a jumper wire that is 150 mm (6 inch) long. **D.** Install the jumper between the motor + and motor - pins on the connector for the suspect valve to create a short circuit. **E.** Turn the keyswitch to the ON position. Check for active diagnostic codes on the electronic service tool. **F.** Remove the jumper wire from the connector for the motorized valve.	Open circuit	**Result:** Diagnostic code XXXX-6 is active when the jumper wire is installed. Diagnostic code XXXX-5 is active with the jumper removed. **Repair:** Reconnect the valve. 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 XXXX-5 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. Use the electronic service tool to run the “Air System Motor Valve Verification Test” and verify that the repair eliminates the fault. **Result:** A 649-5, 3512-5, 2791-5, or 3405-5 diagnostic code is still active with the jumper installed. Proceed to Test Step 5.
5. Check the Wiring for an Open Circuit **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the P2 connector and the connector for the suspect valve. **C.** For the EBPR, check the resistance between terminal 4 on the valve connector and P2:41. **D.** For the EBPR, check the resistance between terminal 6 on the valve connector and P2:49. **E.** For the NRS valve, check the resistance between terminal 4 on the valve connector and P2:4. **F.** For the NRS valve, use a multimeter to check the resistance between terminal 6 on the valve connector and P2:3. **G.** Reconnect the connectors.	Open circuit	**Result:** All measured resistances are less than 2 Ohms. There is a fault in the ECM. **Repair:** Make sure that the latest flash file for the application is installed in the ECM. Refer to Troubleshooting, “ECM Software - Install”. Contact the Dealer Solutions Network (DSN). **Result:** One or more of the measured resistances is greater than 2 Ohms. There is a fault in the wiring. **Repair:** Repair the valve connector or replace the wiring harness. Use the electronic service tool to clear all logged diagnostic codes and then verify that the repair eliminates the fault.

(continued)

(Table 199, contd)

Troubleshooting Test Steps	Values	Results
6. Create an Open Circuit at the Valve Connector **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the connector for the suspect valve to create an open circuit. **C.** 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.	Motorized valve	**Result:** An XXXX-5 diagnostic code is now active. There is a short in the valve. **Repair:** Reconnect the valve. 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 XXXX-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. Use the electronic service tool to run the “Air System Motor Valve Verification Test” and verify that the repair eliminates the fault. **Result:** There is still a 649-6, 3512-6, 2791-6, or 3405-6 diagnostic code. Proceed to Test Step 7.
7. Check the Wiring for a Short Circuit **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the P2 connector and the connector for the suspect valve. **C.** For the EBPR, check the resistance between P2:41 and all other terminals on the P2 connector. **D.** For the EBPR, check the resistance between P2:49 and all other terminals on the P2 connector. **E.** For the NRS valve, check the resistance between the P2:4 and all other terminals on the P2 connector. **F.** For the NRS valve, check the resistance between P2:3 and all other terminals on the P2 connector. **G.** Reconnect the connectors.	Greater than 1k Ohm	**Result:** All measured resistances are greater than 1k Ohm. There is a fault in the ECM. **Repair:** Make sure that the latest flash file for the application is installed in the ECM. Refer to Troubleshooting, “ECM Software - Install”. Contact the Dealer Solutions Network (DSN). **Result:** One or more of the measured resistances is less than 100 Ohms. There is a fault in the wiring. **Repair:** Repair the valve connector or replace the wiring harness. Use the electronic service tool to clear all logged diagnostic codes and then verify that the repair eliminates the fault. If the fault has not been eliminated, contact the Dealer Solutions Network (DSN).

i06836186

NOx Sensor - Test

The ECM is monitoring the NOx level being reported by the sensors. If the NOx value is not steady when the engine speed/fueling is steady, the codes listed below will log. If the NOx value is steady when the engine speed/load is changing, the codes listed below will log.

Table 200 lists the diagnostic codes for the NOx sensors.

Table 200

Diagnostic Trouble Codes for the NOx Sensors			
J1939 Code	**PDL Code**	**Code Description (code descriptions may vary)**	**Comments**
3216-7	E1431 (2)	Aftertreatment #1 Intake NOx : Not Responding Properly	The engine out NOx level is not responding as expected. The code is logged.
3226-7	E1432 (2)	Aftertreatment #1 Outlet NOx : Not Responding Properly	The tailpipe out NOx level is not responding as expected. The code is logged.
Follow the troubleshooting procedure to identify the root cause of the problem.			

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 201

Troubleshooting Test Steps	Values	Results
1. Check the Diesel Exhaust Fluid (DEF) Quality **A.** Measure the DEF quality. Refer to Systems Operation, Testing, and Adjusting, “Diesel Exhaust Fluid Quality - Test” for the correct procedure.	DEF Quality	**Result:** The DEF is not contaminated and the concentration is not within the acceptable range. **Repair:** Drain the DEF from the tank. Refill the tank with DEF that meets ISO 22241 quality standards. Proceed to Test Step 3. **Result:** The DEF is not contaminated and the concentration is within the acceptable range. Proceed to Test Step 2. **Result:** The DEF is contaminated. **Repair:** Contact the Dealer Solutions Network (DSN) for further information.
2. Perform a DEF Dosing System Accuracy Test **A**. Perform a “DEF Dosing System Accuracy Test” . Refer to Systems Operation, Testing, and Adjusting, “Aftertreatment SCR System Dosing - Test” for the correct procedure.	DEF dosing system accuracy test	**Result:** The amount of DEF collected is within specification. **Repair:** Install the DEF injector. Refer to Disassembly and Assembly, DEF Injector and Mounting - Remove and Install. Proceed to Test Step 4. **Result:** The amount of DEF collected is below specification. Proceed to Test Step 3. **Result:** The amount of DEF collected is above specification. A failed DEF injector has been detected. **Repair:** Replace the DEF injector. Refer to the Disassembly and Assembly manual for the correct procedure. Proceed to Test Step 4.
3. Check the DEF Pressure Line **A.** Turn the keyswitch to the OFF position. Allow 2 minutes to elapse before proceeding. **B.** Visually inspect the lines for leaks or damage. **C.** Remove the DEF pressure line between the DEF pump and the DEF injector. Refer to the Disassembly and Assembly manual for the correct procedure. **D.** Inspect the DEF pressure line for obstructions. Flush the line with water or low-pressure air, if necessary. Possible obstructions are ice, DEF deposits, or debris.	Restrictions, obstructions, or leaks	**Result:** There are restrictions or leaks in the lines. **Repair:** Remove the restrictions or replace the pressure line. Proceed to Test Step 4. **Result:** There are no restrictions or leaks in the lines. **Repair:** Proceed to Troubleshooting, “DEF Pressure is Low”.

(continued)

(Table 201, contd)

Troubleshooting Test Steps	Values	Results
4. Perform an “Aftertreatment System Functional Test” **A.** Connect the electronic service tool to the diagnostic connector. **B.** Perform a “Aftertreatment System Functional Test” .	Successful completion of test	**Result:** The test completed successfully. Return the unit to service. **Result:** The test did not complete successfully. Proceed to Test Step 5.
5. Check for an Engine Misfire **A.** Connect the electronic service tool to the diagnostic connector. **B.** Use the electronic service tool to perform a “Cylinder Cutout Test” .	Misfire	**Result:** A misfire was detected. **Repair:** Replace or repair the failed component or components. Proceed to Test Step 7. **Result:** A misfire was not detected. Proceed to Test Step 6.
6. Check the Exhaust System for Leaks **A.** Check the entire exhaust system for leaks.	Exhaust leaks	**Result:** No exhaust leaks were identified. **Repair:** For a 3216-7 or E1431 (2) code, replace the intake NOx sensor. **Repair:** For a 3226-7 or E1432 (2) code, replace the outlet NOx sensor. Proceed to Test Step 7. **Result:** Exhaust leaks were identified. **Repair:** Repair the exhaust leaks. Proceed to Test Step 7.
7. 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 1.0 L (1.05669 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 1.0 L (1.05669 qt). Proceed to Test Step 8.

(continued)

(Table 201, contd)

Troubleshooting Test Steps	Values	Results
8. 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. Proceed to Test Step 9. **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).
9. Perform the “Aftertreatment System Functional Test” **A.** Connect the electronic service tool to the diagnostic connector. **B.** Use the electronic service tool to perform the “Aftertreatment System Functional Test” .	Successful completion of test	**Result:** The test completed successfully. Return the unit to service. **Result:** The test did not complete successfully. Contact the Dealer Solutions Network (DSN).

i06196293

Power Take-Off - Test

Note: This procedure only applies to engines equipped with Power Take-Off (PTO) switches.

Use this procedure under the following circumstances:

- The correct supply voltage to the PTO switches is suspect.
- Operation of the PTO switches is suspect.

Note: Some applications may only have one PTO switch.

The PTO switches provide the operator with the ability to select the desired engine speed. Engine speed will decrease with increasing load. The PTO switches can be used to control the engine speed.

The engine has the following options of set speed control:

- Single speed
- No speed (no PTO control)

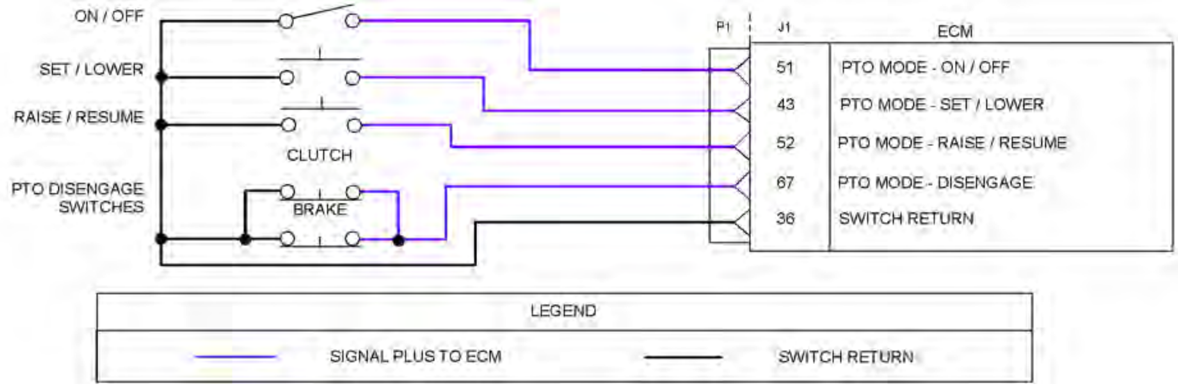


Illustration 134 g03820426

Schematic for the PTO switches

Table 202

Troubleshooting Test Steps	Values	Results
1. Inspect Electrical Connectors and Wiring **A.** Turn the keyswitch to the OFF position. **B.** Thoroughly inspect the J1/P1 connectors on the Electronic Control Module (ECM), the switch connections and battery connections. Refer to Troubleshooting, “Electrical Connectors - Inspect” for details. **C.** Perform a 45 N (10 lb) pull test on each of the wires in the switch connector and the ECM connector that are associated with the fault. Refer to Illustration 134 . **D.** Check the screw for the ECM connector for the correct torque of 6 N·m (53 lb in). **E.** Check the harness for corrosion, abrasion, and pinch points from the PTO mode 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 of 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 “PTO Mode Switches” on the Electronic Service Tool **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.** Observe the status of the PTO mode switch on the electronic service tool while cycling the PTO ON/OFF switch. **E.** Use the electronic service tool in order to observe the status of the PTO mode switch while cycling the PTO Set/Lower switch. **F.** Use the electronic service tool in order to observe the status of the PTO mode switch while cycling the PTO Raise/Resume switch.	Switch status changes from “OPEN” to “CLOSED”	**Result:** The switch status changes on the electronic service tool as the PTO 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 PTO switches are cycled. Proceed to Test Step 3.
3. Check the Status of the PTO Mode Disengage Switches **A.** Use the electronic service tool in order to observe the switch status while the PTO mode disengage switches are operated OFF and ON. **Note:** The PTO mode - Disengage switches usually function by the operation of the brake, clutch, or the operator switch. These switches should be operated separately for this test.	Switch status changes from “ENGAGED” to “DISENGAGED”	**Result:** The PTO mode - Disengage switch operates correctly. Use the electronic service tool to clear all logged diagnostic codes. Return the engine to service. **Result:** The PTO mode - Disengage switch does not operate correctly. Proceed to Test Step 4.

(continued)

(Table 202, contd)

Troubleshooting Test Steps	Values	Results
4. Check the Suspect PTO Switch **A.** Turn the keyswitch to the OFF position. **B.** Remove the two wires from the suspect switch. Use a suitable jumper in order to join the two wires together. **C.** Turn the keyswitch to the ON position. **D.** Monitor the status screen on the electronic service tool while the jumper wire is being disconnected and reconnected.	Switch status changes when jumper is installed	**Result:** When the jumper wire is connected, the status of the PTO mode switches is “CLOSED” . When the jumper wire is disconnected, the status of the PTO mode switches is “OPEN” - The fault is in the switch. **Repair:** Replace the switch. Use the electronic service tool in order to clear all logged diagnostic codes and then verify that the repair has eliminated the problem. **Result:** When the jumper wire is connected, the status of the PTO mode switches is “OPEN” or when the jumper wire is disconnected the status of the PTO mode switches is “CLOSED” . Proceed to Test Step 5.
5. Measure the Resistance of the Cables at the ECM **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the suspect switch. **C.** Disconnect the P1 connector from the ECM. **D.** Measure the resistance between P1:36 and the appropriate pin on the P1 connector for the suspect switch. Refer to Illustration 134 . **E.** Repeat the procedure for each of the PTO mode switches.	Less than two Ohms with switch ON. Greater than 1k Ohm with switch off.	**Result:** The measured resistance is more than two Ohms with the switch ON. The measured resistance is less than 1k Ohm with the switch OFF. There is a fault with the wires between the suspect 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:** The measured resistance is less than two Ohms with the switch ON. The measured resistance is more than 1k Ohm with the switch OFF. Contact the Dealer Solutions Network (DSN).

i06196300

Relay - Test
(ECM Power Relay)

This procedure covers the following diagnostic codes:

Table 203

Diagnostic Trouble Codes for the ECM Power Relay			
J1939 Code	**PDL Code**	**Code Description (code descriptions may vary)**	**Comments**
2634-5	3467-5	Power Relay : Current Below Normal	The Electronic Control Module (ECM) detects a low current condition (open circuit) in the ECM power relay control circuit.
2634-6	3467-6	Power Relay : Current Above Normal	The Electronic Control Module (ECM) detects a high current condition (short circuit) in the ECM power relay control circuit.
Follow the troubleshooting procedure in order 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 204

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 ECM power relay. Refer to Troubleshooting, “Electrical Connector - Inspect” for details. **C.** Perform a 45 N (10 lb) pull test on each of the wires in the ECM connector that are associated with the ECM power relay. **D.** Check the screw for the ECM connector for the correct torque of 6 N·m (53 lb in). **E.** Check the harness for abrasion and pinch points from the ECM power 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 of 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 2634-5 or 3467-5 is active or recently logged. Proceed to Test Step 3. **Result:** Diagnostic code 2634-6 or 3467-6 is active or recently logged. Proceed to Test Step 6.
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. At least 22 VDC for a 24 VDC system.	**Result:** The voltage is not within the expected range. **Repair:** Repair or replace the battery supply wiring to the ECM power 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.

(continued)

(Table 204, contd)

Troubleshooting Test Steps	Values	Results
4. Create a Short Circuit at the Relay Connector **A.** Turn the keyswitch to the OFF position. **B.** Remove the ECM power relay. **C.** Fabricate a jumper wire. Install the jumper wire between terminal 1 and terminal 2 on the harness connector for the ECM power 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 2634-6 or 3467-6 diagnostic code is active with the jumper installed. **Repair:** Install a replacement ECM power relay. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault. **Result:** The 2634-5 or 3467-5 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 ECM power relay and the “ECM Power Relay Control” terminal on the P1 connector. **E.** Measure the resistance between Terminal 2 on the harness connector for the ECM power relay and ground.	Less than five Ohms	**Result:** At least one of the resistance measurements is greater than five Ohms - the fault is in the wiring for the ECM power relay control circuit. **Repair:** Repair the faulty wiring or replace the faulty wiring. **Result:** Both resistance measurements are less than five Ohms. Contact the Dealer Solutions Network (DSN).

(continued)

(Table 204, 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 ECM power 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 2634-5 or 3467-5 diagnostic code is active with the relay disconnected. **Repair:** Install a replacement ECM power relay. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault. **Result:** The 2634-6 or 3467-6 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 “ECM Power Relay Control” terminal and all other terminals on the P1 connector.	Greater than one k Ohm	**Result:** At least one of the resistance measurements is less than one 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 one k Ohm. Contact the Dealer Solutions Network (DSN).

i07048547

Relay - Test
(Start Relay)

This procedure covers the following diagnostic codes:

Table 205

Diagnostic Trouble Codes for the Start Relay			
J1939 Code	**PDL Code**	**Code Description (code descriptions may vary)**	**Comments**
677-5	444-5	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	444-6	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 206

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 45 N (10 lb) pull test on each of the wires in the ECM connector that are associated with the start relay. **D.** Check the screw for the ECM connector for the correct torque of 6 N·m (53 lb in). **E.** 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 (444-5) is active or recently logged. Proceed to Test Step 3. **Result:** Diagnostic code 677-6 (444-6) is active or recently logged. Proceed to Test Step 6.
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. At least 22 VDC for a 24 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.

(continued)

(Table 206, contd)

Troubleshooting Test Steps	Values	Results
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 (444-6) 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 (444-5) 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.	Less than 5.0 Ohms	**Result:** At least one of the resistance measurements is greater than 5.0 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 5.0 Ohms. Contact the Dealer Solutions Network (DSN).

(continued)

(Table 206, 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 (444-5) 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 (444-6) 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).

i06196301

Sensor Calibration Required - Test

The Electronic Control Module (ECM) performs calibrations of pressure sensors automatically. Use this procedure if the diagnostic code in Table 207 is active or easily repeated.

Table 207

Diagnostic Codes Table for Sensor Calibration			
J1939 Code	**PDL Code**	**Code Description** (code descriptions may vary)	**Comments**
411-13	3387-13	Engine Exhaust Gas Recirculation Differential Pressure : Out of Calibration	The ECM detects the following conditions: The NRS 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 be derated. The code is logged.

(continued)

(Table 207, contd)

3358-13	3385-13	Engine Exhaust Gas Recirculation Inlet Pressure : Out of Calibration	The ECM detects the following conditions: The offset between the NRS inlet pressure and the barometric pressure is outside the acceptable range during initialization check. The offset between the NRS inlet pressure and the barometric pressure is outside the acceptable range during sensor calibration when the engine is not running. The warning lamp will come on and the engine will derate. The code is logged.
3563-13	1785-13	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.

During normal operation, each pressure sensor outputs a signal voltage that accurately represents the pressure that is sensed by the sensor. However, certain circuit conditions can cause a signal voltage to become inaccurate.

During each key on event of at least 2 seconds, the Electronic Control Module (ECM) evaluates the signal voltage from each pressure sensor. The ECM compares each signal voltage to a reference voltage. The reference voltage that is used depends on the sensor.

If a signal voltage is close to the reference voltage, the ECM will internally adjust the signal voltage. The internal adjustment causes the pressure value for the sensor to be correct. This process is called automatic sensor calibration.

If a signal voltage is not close to the reference voltage, the ECM will not internally adjust the signal voltage. The ECM will set a fault code that indicates there is a problem with the signal voltage.

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 208

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. Download the "Product Summary Report" from the engine ECM before performing any troubleshooting or clearing diagnostic trouble codes. **D.** Use the electronic service tool to check that coolant temperature, intake manifold air temperature, and NRS 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 in order 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 in order 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. If there are logged diagnostic codes for the intake manifold pressure sensor, the fault may be intermittent. **Repair:** Refer to Troubleshooting, "Electrical Connectors - Inspect" in order to identify intermittent faults. **Result:** One or more of the temperature sensors is reading less than 5° C (41° F). Proceed to Test Step 4. **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:** 3358-13 or 3385-13**and** 3563-13 or 1785-13 diagnostic codes are active. Proceed to Test Step 5. **Result:** There is an active 3358-13, 3385-13, 3563-13 or 1785-13 diagnostic code for only one sensor. Proceed to Test Step 6. There is an active 411-13 or 3387-13 diagnostic code. Proceed to Test Step 2.
2. Check the Signal Wire for a Short Circuit **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the P2 connector and disconnect the connector from the suspect sensor. **C.** Check the resistance between the applicable signal terminal on the P2 connector and all other terminals on the P2 connector.	Greater than 100 Ohms	**Result:** At least one of the resistance measurements is less than 100 Ohms. The fault is in the engine harness. **Repair:** Repair the faulty connector or replace the faulty harness. Use the electronic service tool to verify that the repair eliminates the fault. **Result:** All resistance measurements are greater than 100 Ohms. Proceed to Test Step 3.

(continued)

(Table 208, contd)

Troubleshooting Test Steps	Values	Results
3. Create a Short Circuit at the Sensor Connector **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the connector for the suspect sensor. **C.** Fabricate a jumper wire that is 150 mm (6 inch) long. Crimp a terminal to both ends of the wire. **D.** Use the jumper to connect the sensor signal terminal to the sensor ground terminal on the harness connector for the suspect sensor. **E.** Turn the keyswitch to the ON position. Do not start the engine. **F.** Access the “Active Diagnostic Codes” screen on the electronic service tool and check for an active XXXX-4 diagnostic code for the suspect sensor. **G.** Remove the jumper. Reconnect the sensor.	Diagnostic codes	**Result:** An XXXX-4 diagnostic code became active with the jumper installed. The sensor may be faulty. **Repair:** Temporarily connect a new sensor to the harness, but do not install the new sensor in the engine. Use the electronic service tool in order to verify that the repair eliminates the fault and then permanently install the new sensor. Use the electronic service tool in order to clear all logged diagnostic codes and verify that the repair eliminates the fault. **Result:** The XXXX-4 diagnostic code did not become active when the jumper is installed. Proceed to Test Step 4.
4. 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) for the duration of 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, intake manifold air temperature, and NRS 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. The fault was caused by ice in the system that has now been thawed. Return the unit to service **Result:** Both 3563-13 or 1785-13 **and** 3358-13 or 3385-13 codes are active or logged. Proceed to Test Step 5. **Result:** A single -13 code is active or logged. Proceed to Test Step 6.
5. Check the Barometric Pressure Sensor **A.** Turn the keyswitch to the OFF position. **B.** Install a new barometric pressure sensor. **C.** 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.	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:** Either a 3563-13, 1785-13, 3358-13, or 3386-13 code is active. Proceed to Test Step 6.

(continued)

(Table 208, contd)

Troubleshooting Test Steps	Values	Results
D. Monitor the status parameter for the suspect sensor on the electronic service tool.		

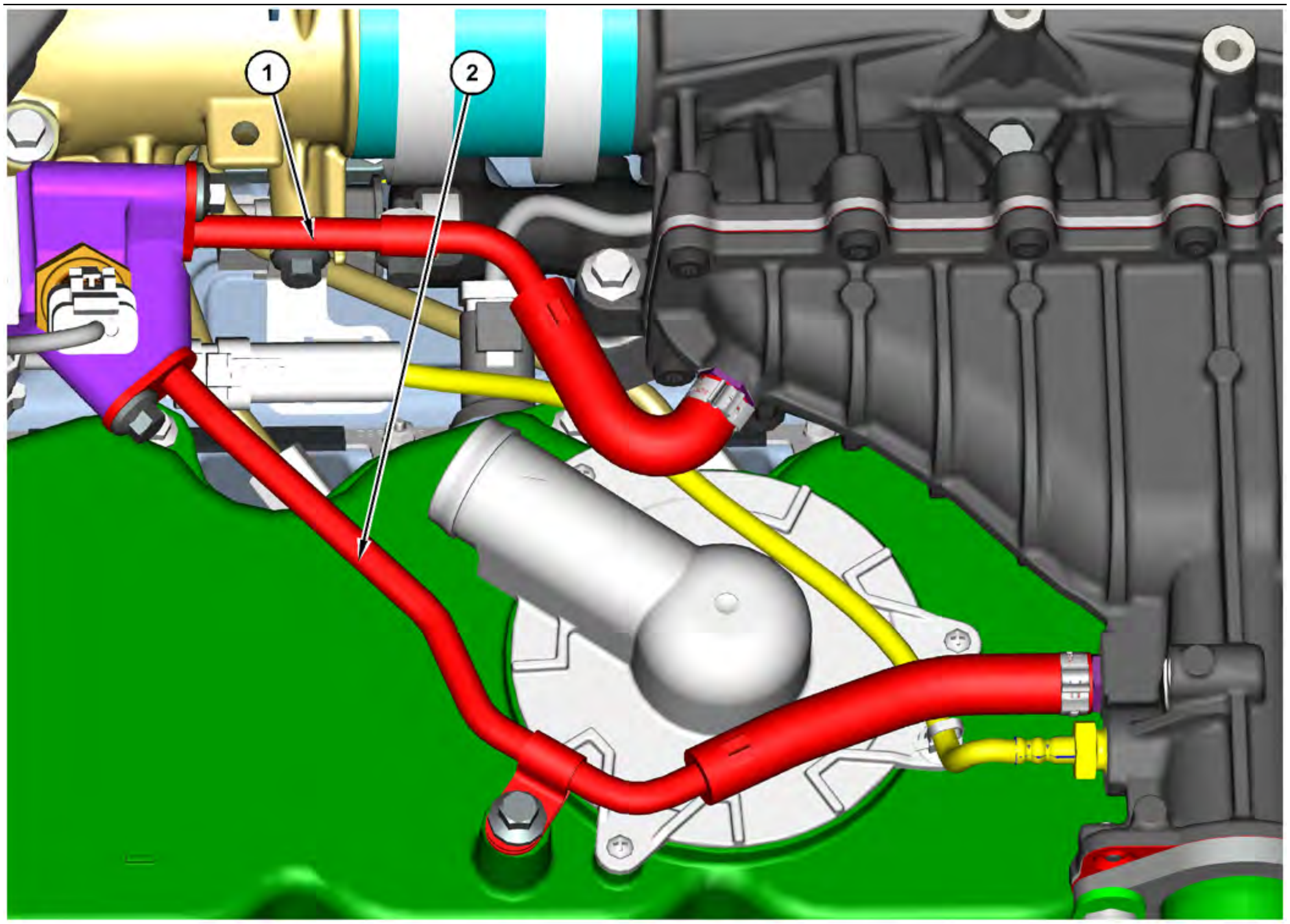


Illustration 135 g03791820

(1) Pipe for the NRS differential pressure sensor

(2) Pipe for the NRS inlet pressure sensor and the NRS differential pressure sensor

Table 209

Troubleshooting Test Steps	Values	Results
6. 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 **Repair:** 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 5. **Result:** There is no active -13 code. Check that the sensor pipes are free of blockages or restrictions. Refer to Illustration 135 . If necessary, remove the pipes and clear any blockage with an air line that is set at a maximum pressure of 200 kPa (29 psi). If the blockage is cleared, reinstall the pipes. If the blockage cannot be cleared or there is a restriction, replace the pipe. Install the sensor. Refer to Disassembly & Assembly for the correct installation procedure. Turn the keyswitch to the ON position. Run the engine at idle speed for 5 minutes. Turn the keyswitch to the OFF position. Ensure ECM is fully powered-down. Turn the keyswitch to the ON position. Do not start the engine. Wait for 10 seconds. Confirm code is not active. Use the electronic service tool to clear all logged codes. If the fault is still present, contact the Dealer Solutions Network (DSN).

i07731065

Sensor (Data Link Type) - Test

Use this procedure to troubleshoot the electrical system if a fault is suspected with the CAN C data link . Also use this procedure if a diagnostic code in Table 210 is active or easily repeated.

Table 210

Diagnostic Trouble Codes for the Data Link Sensors			
J1939 Code	PDL Code	Code Description (code descriptions may vary)	Comments
3216-11	3655-11	Aftertreatment #1 Intake NOx : Other Failure Mode	The NOx sensor cannot reach the correct operating temperature in the defined time period
3216-12	3655-12	Aftertreatment #1 Intake NOx : Failure	The data received from the NOx sensor is out of range. The code is logged. The warning lamp is illuminated.
3226-11	3609-11	Aftertreatment #1 Outlet NOx : Other Failure Mode	The NOx sensor cannot reach the correct operating temperature in the defined time period
3226-12	3609-12	Aftertreatment #1 Outlet NOx : Failure	The data received from the NOx sensor is out of range. The code is logged. The warning lamp is illuminated.
3360-12	3820-12	Catalyst Tank Controller : Failure	The data received from the DCU is out of range. The code is logged. The warning lamp is illuminated.
3516-2 (2017- Engines Onwards)	3100-2	Aftertreatment #1 DEF Concentration: Erratic, Intermittent, or Incorrect	The DEF quality sensor is unable to read the DEF concentration due to an optical path obstruction. The code is logged. The warning lamp is illuminated.
3516-12 (2017- Engines Onwards)	3100-12	Aftertreatment #1 DEF Concentration: Failure	The DEF quality sensor has failed. 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.

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 211

Troubleshooting Test Steps	Values	Results
1. Check the Connectors **A.** Turn the keyswitch to the ON position. **B.** Connect the electronic service tool to the diagnostic connector. **C.** Record all active and logged codes. **D.** Turn the keyswitch to the OFF position. **E.** Allow the system to completely power down before disconnecting connectors. **F.** Thoroughly inspect the connectors that are associated with the data link sensor circuits. Verify that the connectors are free of debris, free of corrosion, and securely connected.	Connectors	**Result:** The connectors were connected properly and did not have corrosion or moisture. If an XXXX-11 code is active or logged, proceed to Test Step 2. If a 3360-12 or 3820-12 code is active or logged, proceed to Test Step 3. If a 3216-12, 3655-12, 3226-12, or 3609-12 code is active or logged, replace the applicable NOx sensor. Proceed to Test Step 5. If a 3516-2 (3100-2) code is active or logged, proceed to Test Step 4. If a 3516-12 (3100-12) code is active or logged, replace the DEF tank header. Refer to Disassembly and Assembly, Manifold (DEF Heater) - Remove and Install. **Result:** The connectors were not connected properly or the connectors did have corrosion or moisture. **Repair:** Repair the connectors and/or the wiring. Replace parts, if necessary. **The DCU connector is not serviceable**. Verify that the fault is resolved.
2. Check the Voltage to the Suspect Sensor. **A.** Disconnect the suspect sensor from the wiring harness. **B.** Turn the keyswitch to the ON position. **C.** Measure the voltage between battery “SUPPLY” and “RETURN” on the wiring harness connector of the suspect sensor.	Battery voltage	**Result:** The measured voltage is equal to battery voltage. **Repair:** Replace the failed NOx sensor. Proceed to Test Step 5. **Result:** The measured voltage is not equal to battery voltage. **Repair:** There is a fault in the power supply wiring. Check the power supply to the suspect sensor. Proceed to Test Step 5.
3. Override the Power to the DCU **A.** Turn the keyswitch to the ON position. **B.** Use the electronic service tool to perform the “Aftertreatment #1 DEF Dosing Control Module Key Switch Line Override” . **C.** Check for active diagnostic codes.	Test completed successfully	**Result:** The override completed successfully and a 3360-12 or 3820-12 code is no longer active. Return the unit to service. **Result:** The override did not complete successfully and a 3360-12 or 3820-12 code is still active. Contact the Dealer Solutions Network (DSN). After completing any recommended repairs, proceed to Test Step 5.

(continued)

(Table 211, contd)

Troubleshooting Test Steps	Values	Results
4. Inspect the DEF Quality Sensor **A.** Remove the DEF tank header from the DEF tank. Refer to Disassembly and Assembly, Manifold (DEF Heater) - Remove and Install. **B.** Inspect the DEF tank and the DEF tank header filter for debris. **C.** Inspect the DEF quality sensors for visible debris. Refer to Systems Operation, Testing and Adjusting, Diesel Exhaust Fluid Tank - Flush.	DEF quality sensor	**Result:** Debris was found in the DEF Tank, DEF tank header filter or on the DEF quality sensors. **Repair:** Drain and flush the DEF Tank, and replace all DEF filters. Refer to Systems Operation, Testing and Adjusting, Diesel Exhaust Fluid Tank - Flush. Proceed to Test Step 5. **Result:** No debris was found in the DEF Tank, DEF tank header filter or on the DEF quality sensor or a DEF quality sensor is damaged. **Repair:** Drain and flush the DEF Tank, and replace the DEF Tank Header assembly. Fill the tank with DEF that meets ISO 22241 quality standards. Proceed to Test Step 5.
5. Perform the Aftertreatment System Functional Test. **A.** Turn the keyswitch to the ON position. **B.** Start the engine. **C.** Connect the electronic service tool to the diagnostic connector. **D.** Perform the “Aftertreatment System Functional Test” .	Test completed successfully	**Result:** The test passed and no diagnostic codes became active. Return the unit to service. **Result:** A fault came active. **Repair:** Troubleshoot the fault that became active during the “Aftertreatment System Functional Test” . If the fault is still present, contact the Dealer Solutions Network (DSN).

i07398407

Sensor Signal (Analog, Active - Test (Sensors on the J1 ECM Connector)

This test procedure is used for the following active sensors:

- Air filter restriction sensor

This procedure covers the following diagnostic codes:

Table 212

Diagnostic Codes for the Active Analog Sensors			
J1939 Code	**PDL Code**	**Code Description (Code descriptions may vary)**	**Comments**
1176-3	2738-3	Turbocharger #1 Compressor Inlet Pressure Sensor : Voltage Above Normal	The ECM detects the following conditions: The signal voltage for the low-pressure turbocharger compressor inlet pressure sensor is more than 4.8 VDC. The ECM has been powered for at least 0.24 seconds. The ECM will log the diagnostic code.
1176-4	2738-4	Turbocharger #1 Compressor Inlet Pressure Sensor : Voltage Below Normal	The ECM detects the following conditions: The signal voltage for the low-pressure turbocharger compressor inlet pressure sensor is less than 0.2 VDC. The ECM has been powered for at least 0.24 seconds. The ECM will log the diagnostic code.
Follow the troubleshooting procedure to identify the root cause of the fault.			

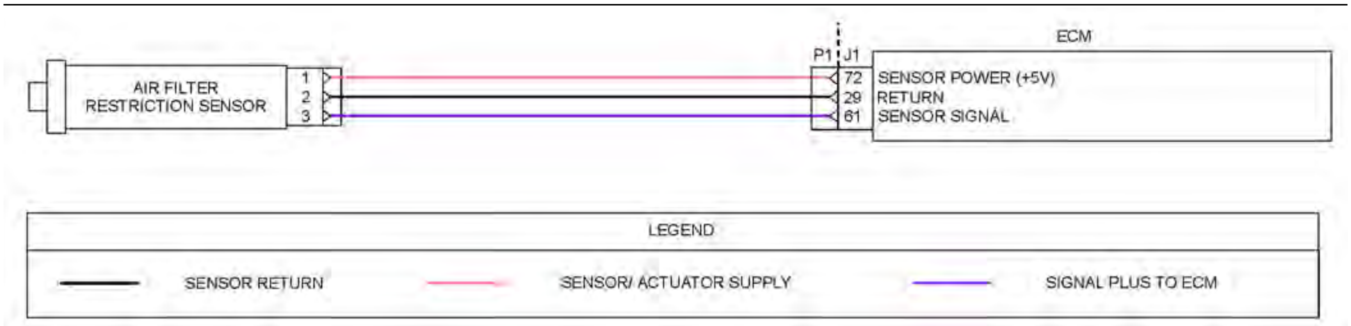


Illustration 136 g06308612

Schematic for the sensors on the J1 ECM connector

Table 213

Troubleshooting Test Steps	Values	Results
1. Inspect Electrical Connectors and Wiring **A.** Thoroughly inspect the terminal connections on the P1/J1 ECM connectors and the engine pressure sensors. Refer to Troubleshooting, “Electrical Connectors - Inspect”. **B.** Perform a 45 N (10 lb) pull test on each of the wires in the ECM connector and the sensor connectors that are associated with the active diagnostic code. **C.** Check the screw for the ECM connector for the correct torque of 6 N·m (53 lb in). **D.** Check the harness for corrosion, abrasion, and pinch points from the engine pressure sensors 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 212 are active. **E.** Turn the keyswitch to the OFF position.	Diagnostic codes	**Result:** There are no active diagnostic codes for the active sensors. If there are logged diagnostic codes for the active sensors, the fault may be intermittent. **Repair:** Refer to Troubleshooting, “Electrical Connectors - Inspect” to identify intermittent faults. **Result:** A diagnostic code is active for one or more of the active sensors. 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 connector for the suspect sensor. **C.** Turn the keyswitch to the ON position. Do not start the engine. **D.** Measure the voltage between the sensor supply terminal and the ground terminal on the harness connector for the suspect sensor. **E.** Turn the keyswitch to the OFF position. **F.** Reconnect the sensor.	4.8 VDC to 5.2 VDC	**Result:** The voltage measurement is not within the expected range. The fault is in the supply wire or the ground wire in the engine wiring harness. **Repair:** Repair the faulty wiring or replace the faulty wiring. Use the electronic service tool to clear all logged diagnostic codes. Return the engine to service. **Result:** The voltage measurement is within the expected range. The correct supply voltage is reaching the sensor. Proceed to Test Step 4.

(continued)

(Table 213, contd)

Troubleshooting Test Steps	Values	Results
4. 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 -4 diagnostic code is active for one or more of the active sensors. Proceed to Test Step 5. **Result:** A -3 diagnostic code is active for one or more of the active sensors. Proceed to Test Step 7.
5. Create An Open Circuit at the Sensor Connector **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the connector for the 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 Code” screen. Check for a -3 diagnostic code.	Diagnostic codes	**Result:** A -4 diagnostic code was active before disconnecting the sensor. A -3 diagnostic code became active after disconnecting the sensor - the sensor is faulty. **Repair:** Temporarily connect a new sensor to the harness, but do not install the new sensor in the engine. Use the electronic service tool to verify that the repair eliminates the fault and then permanently install the new 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. Proceed to Test Step 6.

(continued)

(Table 213, contd)

Troubleshooting Test Steps	Values	Results
6. Check the Signal Wire for a Short Circuit **A.** If the fault is related to the DPF intake temperature sensor, perform the following procedure: Disconnect the P1 connector. Inspect the P1/J1 connector. Refer to Troubleshooting, “Electrical Connectors - Inspect”. Measure the resistance between P1:62 all other terminals on the P1 connector. **B.** If the fault is related to the SCR intake temperature sensor, perform the following procedure: Disconnect the P1 connector. Inspect the P1/J1 connector. Refer to Troubleshooting, “Electrical Connectors - Inspect”. Measure the resistance between P1:63 all other terminals on the P1 connector. **C.** If the fault is related to the air filter restriction sensor, perform the following procedure: Disconnect the P1 connector. Inspect the P1/J1 connector. Refer to Troubleshooting, “Electrical Connectors - Inspect”. Measure the resistance between P1:61 all other terminals on the P1 connector.	Greater than 100 Ohms	**Result:** At least one of the resistance measurements is less than 100 Ohms - The fault is in the engine harness. **Repair:** Repair the faulty connector or replace the faulty harness. Use the electronic service tool to verify that the repair eliminates the fault. **Result:** All resistance measurements are greater than 100 Ohms. Contact the Dealer Solutions Network (DSN).
7. Create a Short Circuit at the Sensor Connector **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the connector for the suspect sensor. **C.** Fabricate a jumper wire that is 150 mm (6 inch) long. Crimp a terminal to both ends of the wire. **D.** Use the jumper to connect the sensor signal terminal to the sensor ground terminal on the harness connector for the suspect sensor. **E.** Turn the keyswitch to the ON position. Do not start the engine. **F.** Access the “Active Diagnostic Codes” screen on the electronic service tool and check for an active -4 diagnostic code for the suspect sensor. **G.** Remove the jumper. Reconnect the sensor.	Diagnostic codes	**Result:** A -3 diagnostic code was active before installing the jumper. A -4 diagnostic code became active with the jumper installed. The sensor may be faulty. **Repair:** Temporarily connect a new sensor to the harness, but do not install the new sensor in the engine. Use the electronic service tool to verify that the repair eliminates the fault and then permanently install the new 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 when the jumper is installed. Proceed to Test Step 8.

(continued)

(Table 213, contd)

Troubleshooting Test Steps	Values	Results
8. Check the Signal Wire for an Open Circuit **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the P1 connector and disconnect the connector from the suspect sensor. **C.** For the DPF intake temperature sensor, measure the resistance between P1:62 and terminal 3 on the harness connector for the sensor. **D.** For the SCR intake temperature sensor, measure the resistance between P1:63 and terminal 4 on the harness connector for the sensor. **E.** For the air filter restriction sensor, measure the resistance between P1:61 and terminal 3 on the harness connector for the sensor.	Less than 2 Ohms.	**Result:** The resistance measurement is greater than 2 Ohms - The fault is in the engine harness. **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).

i07731073

Sensor Signal (Analog, Active - Test
(Sensors on the J2 ECM Connector)

This procedure covers the following diagnostic codes:

Table 214

Diagnostic Codes for the Active Analog Sensors			
J1939 Code	PDL Code	Code Description (code descriptions may vary)	Comments
100-3	100-3	Engine Oil Pressure : Voltage Above Normal	The Electronic Control Module (ECM) detects the following conditions: The signal voltage from the engine oil pressure sensor is greater than 4.8 VDC for more than 8 seconds. The warning lamp will come on. The ECM will log the diagnostic code. The ECM will set data for engine oil pressure to the default value. The default engine oil pressure is 600 kPa (87 psi). The electronic service tool will display "Voltage Above Normal" on the status screens.
100-4	100-4	Engine Oil Pressure : Voltage Below Normal	The ECM detects the following conditions: The signal voltage from the engine oil pressure sensor is less than 0.2 VDC for more than 8 seconds. The ECM has been powered for at least 2 seconds. The warning lamp will come on. The ECM will log the diagnostic code. The ECM will set data for the engine oil pressure to the default value. The default engine oil pressure is 600 kPa (87 psi). The electronic service tool will display "Voltage Below Normal" on the status screens.
108-3	3528-3	Barometric Pressure : Voltage Above Normal	The ECM detects the following conditions: The signal voltage for the barometric pressure sensor is greater than 4.8 VDC for at least 8 seconds. The warning lamp will come on. The ECM will log the diagnostic code.
108-4	3528-4	Barometric Pressure : Voltage Below Normal	The ECM detects the following conditions: The signal voltage for the barometric pressure sensor is less than 0.2 VDC for at least 8 seconds. The warning lamp will come on. The ECM will log the diagnostic code.
157-3	1797-3	Engine Injector Metering Rail #1 Pressure : Voltage Above Normal	The ECM detects the following conditions: The signal voltage for the fuel rail pressure sensor is more than 4.7 VDC for 0.6 seconds. The warning lamp will flash. The ECM will log the diagnostic code. The electronic service tool will display "70000 kPa" next to "Desired Fuel Rail Pressure" and "Actual Fuel Rail Pressure" on the status screens. The engine will be derated.

(continued)

(Table 214, contd)

Diagnostic Codes for the Active Analog Sensors			
J1939 Code	PDL Code	Code Description (code descriptions may vary)	Comments
157-4	1797-4	Engine Injector Metering Rail #1 Pressure : Voltage Below Normal	The ECM detects the following conditions: The signal voltage for the fuel rail pressure sensor is less than 0.67 VDC for 0.6 seconds. The warning lamp will flash. The ECM will log the diagnostic code. The electronic service tool will display “70000 kPa” next to “Desired Fuel Rail Pressure” and “Actual Fuel Rail Pressure” on the status screens. The engine will be derated.
157-12	1797-12	Engine Injector Metering Rail #1 Pressure : Failure	The ECM detects that the fuel rail pressure sensor has an in-range failure. The warning lamp will flash. The code is logged.
411-2	3387-2	Engine Exhaust Gas Recirculation Differential Pressure : Erratic, Intermittent, or Incorrect	The ECM detects the following conditions: The signal voltage for the NOx Reduction System (NRS) differential pressure sensor is not stable. The ECM has been powered for at least 0.24 seconds. The warning light will come on. The ECM will log the diagnostic code.
411-3	3387-3	Engine Exhaust Gas Recirculation Differential Pressure : Voltage Above Normal	The ECM detects the following conditions: The signal voltage for the NOx Reduction System (NRS) differential pressure sensor is more than 4.8 VDC. The ECM has been powered for at least 0.24 seconds. The warning light will come on. The ECM will log the diagnostic code.
411-4	3387-4	Engine Exhaust Gas Recirculation Differential Pressure : Voltage Below Normal	The ECM detects the following conditions: The signal voltage for the NRS differential pressure sensor is less than 0.2 VDC. The ECM has been powered for at least 0.24 seconds. The warning light will come on. The ECM will log the diagnostic code.
3358-3	3385-3	Engine Exhaust Gas Recirculation Inlet Pressure : Voltage Above Normal	The ECM detects the following conditions: The signal voltage from the NRS inlet pressure sensor is more than 4.8 VDC for 0.12 seconds. The ECM has been powered for 2 seconds. The warning light will come on. The ECM will log the diagnostic code. The ECM will set data for the NRS inlet pressure to the default value. The default value for the NRS inlet pressure is 250 kPa (36.3 psi).

(continued)

(Table 214, contd)

Diagnostic Codes for the Active Analog Sensors			
J1939 Code	PDL Code	Code Description (code descriptions may vary)	Comments
3358-4	3385-4	Engine Exhaust Gas Recirculation Inlet Pressure : Voltage Below Normal	The ECM detects the following conditions: The signal voltage for the NRS inlet pressure sensor is less than 0.2 VDC for 0.12 seconds. The ECM has been powered for 2 seconds. The warning light will come on. The ECM will log the diagnostic code. The ECM will set data for the NRS inlet pressure to the default value. The default value for the NRS inlet pressure is 250 kPa (36.3 psi).
3563-3	1785-3	Engine Intake Manifold #1 Absolute Pressure : Voltage Above Normal	The ECM detects the following conditions: The signal voltage from the intake manifold pressure sensor is above 4.8 VDC for at least 8 seconds. The ECM has been powered for 2 seconds. The warning light will come on. The ECM will log the diagnostic code. The data for the intake manifold pressure will be set to a maximum valid pressure for 2 seconds. The ECM will then flag the intake manifold pressure as being invalid. A default value is then used for the intake manifold pressure. The current for the wastegate regulator will be set to a default value while this code is active. This condition will cause the engine to have poor acceleration. The default setting will prevent any overpressure in the intake manifold which could be caused by an overspeed of the turbocharger.
3563-4	1785-4	Engine Intake Manifold #1 Absolute Pressure : Voltage Below Normal	The ECM detects the following conditions: The signal voltage from the intake manifold pressure sensor is less than 0.2 VDC for at least 8 seconds. The ECM has been powered for 2 seconds. The warning light will come on. The ECM will log the diagnostic code. The data for the intake manifold pressure will be set to a maximum valid pressure for 2 seconds. The ECM will then flag the intake manifold pressure as being invalid. A default value is then used for intake manifold pressure. The current for the wastegate regulator will be set to a default value while this code is active. This condition will cause the engine to have poor acceleration. The default setting will prevent any overpressure in the intake manifold which could be caused by an overspeed of the turbocharger.
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 or 262 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 ECM supplies 5 VDC to terminal “3” of the fuel rail pressure sensor connector and to terminal “1” of all other active sensor connectors. The sensor common from the ECM connector goes to terminal “1” of the connector for the fuel rail pressure sensor. The sensor common from the ECM connector goes to terminal “2” of all other active sensor connectors. The sensor supply is output short circuit protected. A short circuit to the battery will not damage the circuit inside the ECM.

The 8 VDC sensor supply provides power to the exhaust outlet temperature sensor. The ECM supplies 8 VDC to terminal “1” of the exhaust outlet temperature sensor connector. The sensor common from the ECM connector goes to terminal “2” of the connector for the exhaust outlet temperature sensor. 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.

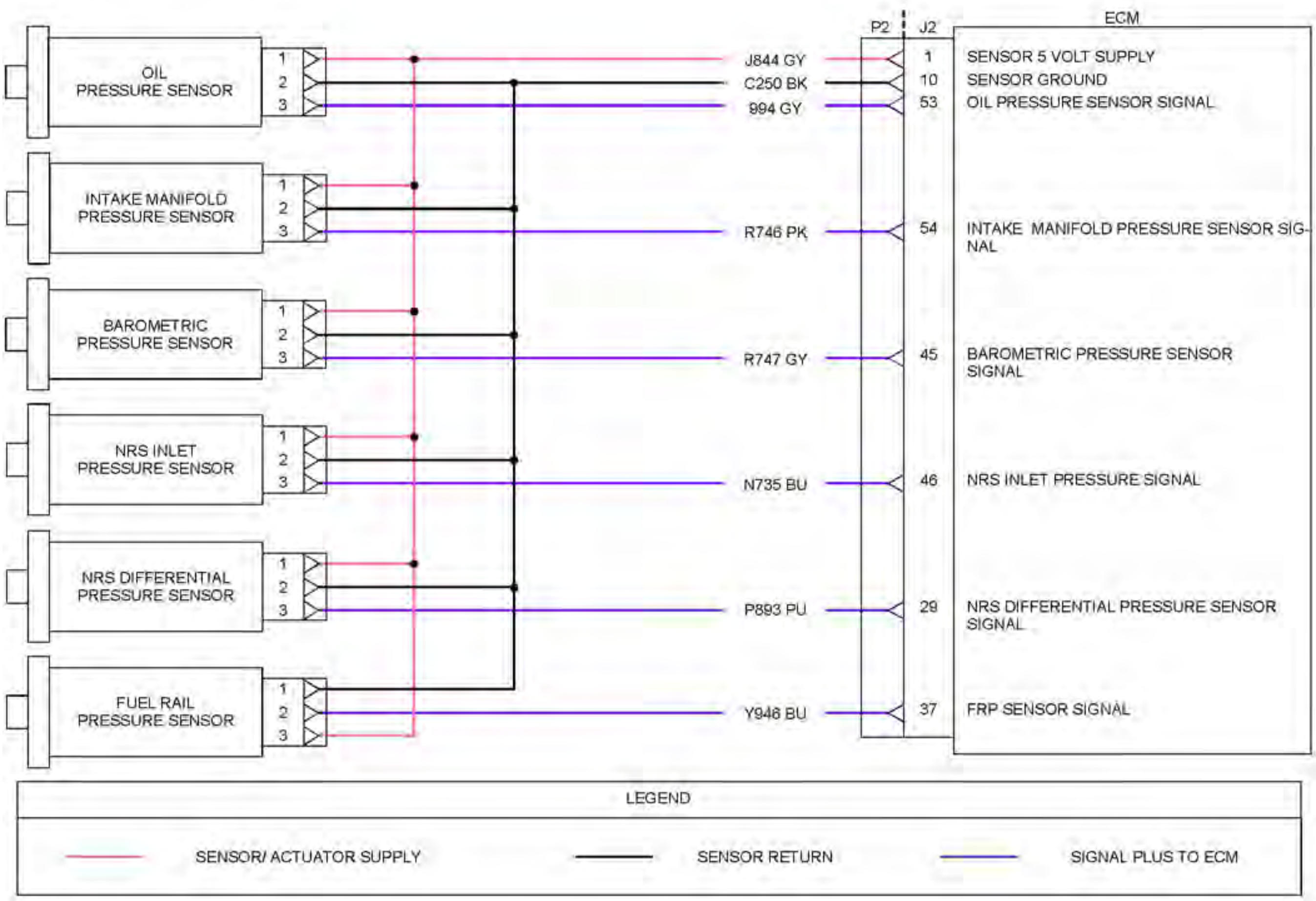


Illustration 137 g06308935

Schematic for the active sensors on the ECM J2 connector

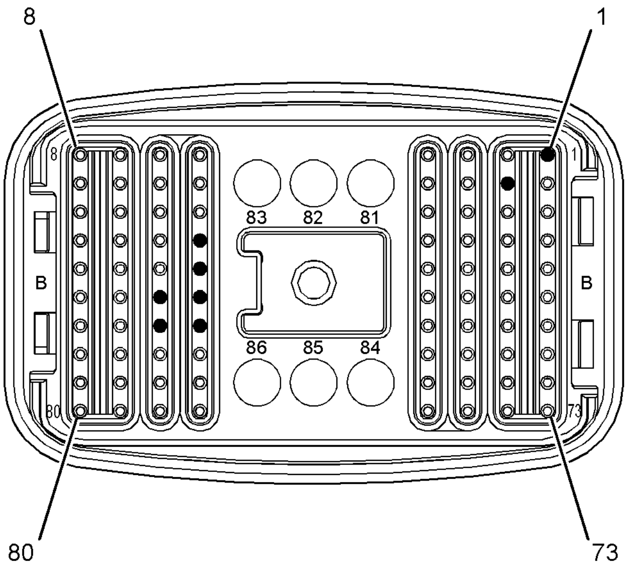


Illustration 138 g06308941

Pin locations on the P2 connector for the active sensors

(1) 5 VDC supply
(10) Sensor ground
(29) NRS differential pressure sensor signal
(37) Fuel rail pressure sensor signal
(45) Barometric pressure sensor signal
(46) NRS inlet pressure sensor signal
(53) Oil pressure sensor signal
(54) Intake manifold pressure sensor signal

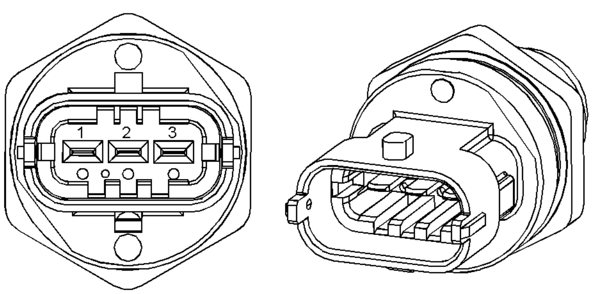


Illustration 139 g03374231

Fuel rail pressure sensor

(1) Ground
(2) Signal
(3) 5 VDC Supply

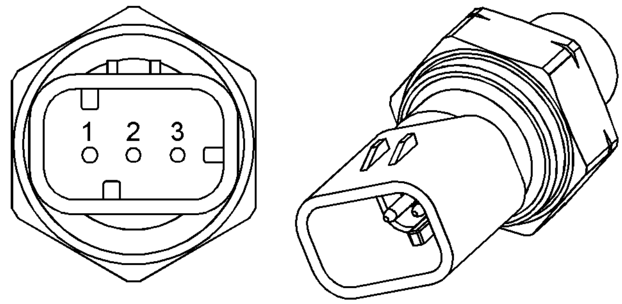


Illustration 140 g01170310

Typical example of an engine pressure sensor

(1) 5 VDC Supply
(2) Ground
(3) Signal

Table 215

Troubleshooting Test Steps	Values	Results
1. Inspect Electrical Connectors and Wiring **A.** Thoroughly inspect the terminal connections on the P2/J2 ECM connectors and the engine pressure sensors. Refer to Troubleshooting, “Electrical Connectors - Inspect”. **B.** Perform a 45 N (10 lb) pull test on each of the wires in the ECM connector and the sensor connectors that are associated with the active diagnostic code. **C.** Check the screw for the ECM connector for the correct torque of 6 N·m (53 lb in). **D.** Check the harness for corrosion, abrasion, and pinch points from the engine pressure sensors 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 214 are active. **E.** Turn the keyswitch to the OFF position.	Diagnostic codes	**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 214 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 connector for the suspect sensor. **C.** Turn the keyswitch to the ON position. Do not start the engine. **D.** Measure the voltage between the supply terminal and the ground terminal on the harness connector for the suspect sensor. The voltage measurement should be 5.0 ± 0.2 VDC. **E.** Turn the keyswitch to the OFF position. **F.** Reconnect the sensor.	4.8 VDC to 5.2 VDC	**Result:** The voltage measurement is not within the expected range. The fault is in the supply wire or the ground wire in the engine wiring harness. **Repair:** Repair the faulty wiring or replace the faulty wiring. Use the electronic service tool to clear all logged diagnostic codes. Return the engine to service. **Result:** The voltage measurement is within the expected range - The correct supply voltage is reaching the sensor. Proceed to Test Step 4.

(continued)

(Table 215, contd)

Troubleshooting Test Steps	Values	Results
4. 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:** If this code is active when the engine is cranking but not starting, use the electronic service tool to check the speed/timing sensor status on the “Engine Starting” screen. If the status of the speed/timing sensors is “Not Detected” , refer to Troubleshooting, Speed/Timing - Test to diagnose the speed/ timing sensor fault. If the speed/timing sensor circuit is OK, replace the fuel rail pressure sensor. Refer to Disassembly and Assembly for the correct procedure. **Result:** A 411-2 diagnostic code is active. Proceed to Test Step 5. **Result:** An XXXX-3 diagnostic code is active for one or more of the active sensors. Proceed to Test Step 7. **Result:** An XXXX-4 diagnostic code is active for one or more of the active sensors. Proceed to Test Step 6.
5. Diagnose a 411-2 Code **A.** Remove the exhaust inlet pipe and the exhaust outlet pipe from the NRS cooler. Refer to Disassembly and Assembly, Exhaust Cooler (NRS) - Remove and Install. **B.** Inspect the inlet port and the outlet port of the NRS cooler for excessive fouling with condensate and/or soot. **Note:** A light coating of soot is normal. There must be no evidence of wet or shiny condensate fouling or excessive soot deposits that cover most of the internal tubes.	Short created	**Result:** The NRS cooler has excessive fouling. Replace the NRS cooler. Refer to Disassembly and Assembly, Exhaust Cooler (NRS) - Remove and Install. Verify that the problem is resolved. If the fault is still present, contact the Dealer Solutions Network (DSN). **Result:** The NRS cooler does not have excessive fouling. Install a replacement NRS differential pressure sensor. Refer to Disassembly and Assembly, Pressure Sensor (Cooled Exhaust Gas) - Remove and Install. Verify that the problem is resolved. If the fault is still present, contact the Dealer Solutions Network (DSN).

(continued)

(Table 215, contd)

Troubleshooting Test Steps	Values	Results
6. Create An Open Circuit at the Sensor Connector **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the connector for the 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 Code” screen. Check for a -3 diagnostic code.	Diagnostic codes	**Result:** A -4 diagnostic code was active before disconnecting the sensor. A -3 diagnostic code became active after disconnecting the sensor. The sensor is faulty. **Repair:** Temporarily connect a new sensor to the harness, but do not install the new sensor in the engine. Use the electronic service tool to verify that the repair eliminates the fault and then permanently install the new 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. Proceed to Test Step 8.
7. Create a Short Circuit at the Sensor Connector **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the connector for the suspect sensor. **C.** Fabricate a jumper wire that is 150 mm (6 inch) long. Crimp a terminal to both ends of the wire. **D.** Use the jumper to connect the sensor signal terminal to the sensor ground terminal on the harness connector for the suspect sensor. **E.** Turn the keyswitch to the ON position. Do not start the engine. **F.** Access the “Active Diagnostic Codes” screen on the electronic service tool and check for an active -4 diagnostic code for the suspect sensor. **G.** Remove the jumper. Reconnect the sensor.	Diagnostic codes	**Result:** A -3 diagnostic code was active before installing the jumper. A -4 diagnostic code became active with the jumper installed. The sensor may be faulty. **Repair:** Temporarily connect a new sensor to the harness, but do not install the new sensor in the engine. Use the electronic service tool to verify that the repair eliminates the fault and then permanently install the new 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 when the jumper is installed. Proceed to Test Step 8.
8. 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	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.

(continued)

(Table 215, contd)

Troubleshooting Test Steps	Values	Results
5. Improper routing of wiring **6.** Damaged insulation		**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

i06196460

Sensor Signal (Analog, Passive) - Test

This procedure covers the following diagnostic codes:

Table 216

Diagnostic Trouble Codes for Analog Passive Sensors			
J1939 Code	**PDL Code**	**Code Description (code descriptions may vary)**	**Comments**
105-3	172-3	Intake Manifold Air Temperature Sensor : Voltage Above Normal	The Electronic Control Module (ECM) detects the following conditions: The signal voltage from the intake manifold air temperature sensor is greater than 4.95 VDC for more than 8 seconds. Engine coolant temperature is above −10 °C (15.0 °F). The ECM will use the default value of 70 °C (158 °F) for the intake manifold air temperature. “Voltage High” will be displayed next to the status for “Intake Manifold Air Temperature” on the electronic service tool. The engine may show the following symptoms: Poor stability Poor cold running Poor acceleration under load White smoke
105-4	172-4	Intake Manifold Air Temperature Sensor : Voltage Below Normal	The ECM detects the following conditions: The signal voltage from the intake manifold air temperature sensor is less than 0.2 VDC for more than 8 seconds. The ECM will use the default value of 70 °C (158°F) for the intake manifold air temperature. “Voltage Low” will be displayed next to the status for “Intake Manifold Air Temperature” on the electronic service tool. The engine may show the following symptoms: Poor stability Poor cold running Poor acceleration under load White smoke

(continued)

(Table 216, contd)

Diagnostic Trouble Codes for Analog Passive Sensors			
J1939 Code	**PDL Code**	**Code Description (code descriptions may vary)**	**Comments**
110-3	110-3	Engine Coolant Temperature Sensor : Voltage Above Normal	The ECM detects the following conditions: The signal voltage from the engine coolant temperature sensor is greater than 4.95 VDC for more than 8 seconds. An active diagnostic code will be generated after 8 seconds. The ECM will default to 90 °C (194 °F) for engine coolant temperature. “Voltage Above Normal” will be displayed next to the status for “Engine Coolant Temperature” on the electronic service tool. The engine may show the following symptoms: Poor stability Poor cold running White smoke
110-4	110-4	Engine Coolant Temperature Sensor : Voltage Below Normal	The ECM detects the following conditions: The signal voltage from the engine coolant temperature sensor is less than 0.2 VDC for more than 8 seconds. An active diagnostic code will be generated after 8 seconds. The diagnostic code will be logged if the engine has been operating for more than 7 minutes. The ECM will default to 90 °C (194 °F) for engine coolant temperature. “Voltage Below Normal” will be displayed next to the status for “Engine Coolant Temperature” on the electronic service tool. The engine may show the following symptoms: Poor stability Poor cold running White smoke
172-3	2526-3	Air Inlet Temperature Sensor : Voltage Above Normal	The ECM detects the following conditions: The signal voltage from the air inlet temperature sensor is greater than 4.95 VDC for at least 8 seconds.
172-4	2526-4	Air Inlet Temperature Sensor : Voltage Below Normal	The ECM detects the following conditions: The signal voltage from the air inlet temperature sensor is less than 0.2 VDC for at least 8 seconds.
174-3	174-3	Fuel Temperature Sensor : Voltage Above Normal	The ECM detects the following conditions: The signal voltage from the fuel temperature sensor is greater than 4.95 VDC for more than 8 seconds. The ECM will default to 40° C (104° F) for fuel temperature. “Voltage Above Normal” will be displayed next to the status for “Engine Fuel Temperature” on the electronic service tool.
174-4	174-4	Fuel Temperature Sensor : Voltage Below Normal	The ECM detects the following conditions: The signal voltage from the fuel temperature sensor is less than 0.2 VDC for more than 8 seconds. The ECM will default to 40° C (104° F) for fuel temperature. “Voltage Below Normal” will be displayed next to the status for “Engine Fuel Temperature” on the electronic service tool.

(continued)

(Table 216, contd)

Diagnostic Trouble Codes for Analog Passive Sensors			
J1939 Code	PDL Code	Code Description (code descriptions may vary)	Comments
412-3	3386-3	EGR Temperature Sensor : Voltage Above Normal	The ECM detects the following conditions: The signal voltage from the Nox Reduction System (NRS) temperature sensor is greater than 4.975 VDC for more than 8 seconds.
412-4	3386-4	EGR Temperature Sensor : Voltage Below Normal	The ECM detects the following conditions: The signal voltage from the NRS temperature sensor is less than 0.2 VDC for more than 8 seconds.
441-3	600-3	Auxiliary Temperature #1 : Voltage Above Normal	The ECM detects the following conditions: The signal voltage from the hydraulic oil temperature sensor is greater than 4.975 VDC for more than 8 seconds.
441-4	600-4	Auxiliary Temperature #1 : Voltage Below Normal	The ECM detects the following conditions: The signal voltage from the hydraulic oil temperature sensor is less than 0.2 VDC for more than 8 seconds.
2630-3	3372-3	Engine Charge Air Cooler Outlet Temperature : Voltage Above Normal (If equipped)	The ECM detects the following conditions: The signal voltage from the ATAAC outlet temperature sensor is greater than 4.95 VDC for more than 8 seconds. An active diagnostic code will be generated after 8 seconds. The diagnostic code will be logged if the engine has been operating for more than 7 minutes. "Voltage Above Normal" will be displayed next to the status for "ATAAC Temperature" on the electronic service tool.
2630-4	3372-4	Engine Charge Air Cooler Outlet Temperature : Voltage Below Normal (If equipped)	The ECM detects the following conditions: The signal voltage from the ATAAC outlet temperature sensor is less than 0.2 VDC for more than 8 seconds. An active diagnostic code will be generated after 8 seconds. The diagnostic code will be logged if the engine has been operating for more than 7 minutes. "Voltage Below Normal" will be displayed next to the status for "ATAAC Temperature" on the electronic service tool.
7441-3	4648-3	Aftertreatment #1 Ambient Air Temperature : Voltage Above Normal (If equipped)	The ECM detects the following conditions: The signal voltage from the aftertreatment ambient air temperature sensor is greater than 4.95 VDC for more than 8 seconds. An active diagnostic code will be generated after 8 seconds. The diagnostic code will be logged if the engine has been operating for more than 7 minutes. "Voltage Above Normal" will be displayed next to the status for "Aftertreatment Ambient Air Temperature" on the electronic service tool.

(continued)

(Table 216, contd)

Diagnostic Trouble Codes for Analog Passive Sensors			
J1939 Code	**PDL Code**	**Code Description (code descriptions may vary)**	**Comments**
7441-4	4648-4	Aftertreatment #1 Ambient Air Temperature : Voltage Below Normal (If equipped)	The ECM detects the following conditions: The signal voltage from the aftertreatment ambient air temperature sensor is less than 0.2 VDC for more than 8 seconds. An active diagnostic code will be generated after 8 seconds. The diagnostic code will be logged if the engine has been operating for more than 7 minutes. "Voltage Below Normal" will be displayed next to the status for "Aftertreatment Ambient Air Temperature" on the electronic service tool.
Follow the troubleshooting procedure in order 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:

- Coolant temperature sensor
- Intake manifold air temperature sensor
- Fuel temperature sensor
- Air inlet temperature sensor
- ATAAC outlet temperature sensor
- NRS inlet temperature sensor
- Auxiliary (hydraulic oil) temperature sensor (if equipped)
- Aftertreatment ambient air temperature sensor (if equipped)

The following background information is related to this procedure:

The troubleshooting procedures for the diagnostic codes of each temperature sensor are identical. The temperature sensors 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 P2/J2 connector or the P1/J1 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 in order 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 (XXX-3) is generated for the sensor.

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.

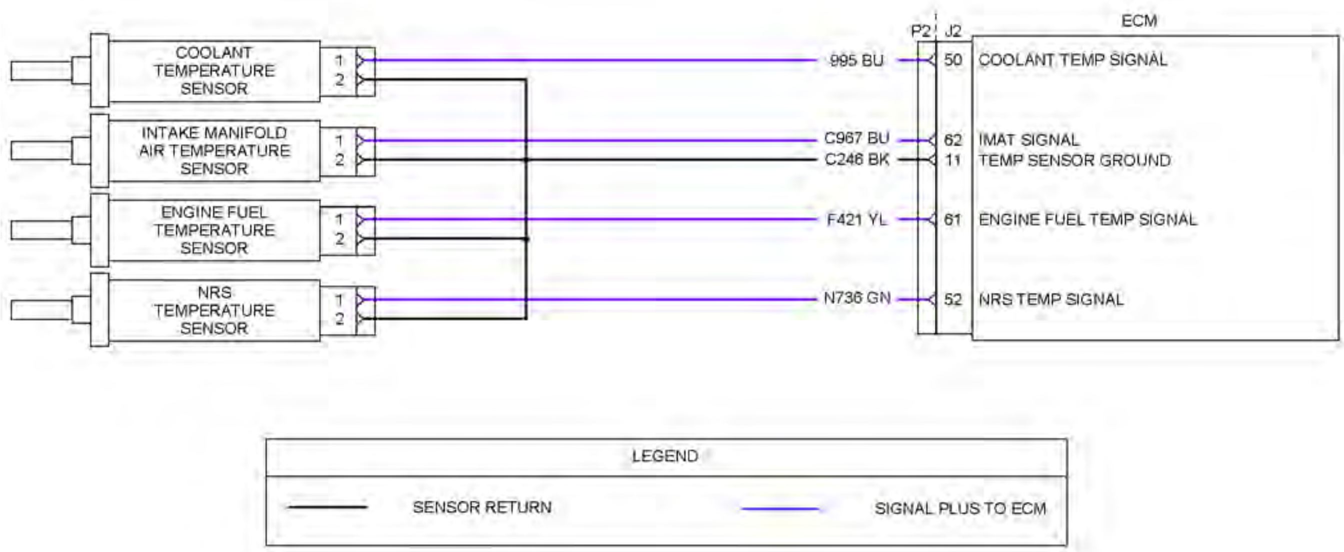


Illustration 141 g03812153

Schematic for passive engine temperature sensors on the P2 connector

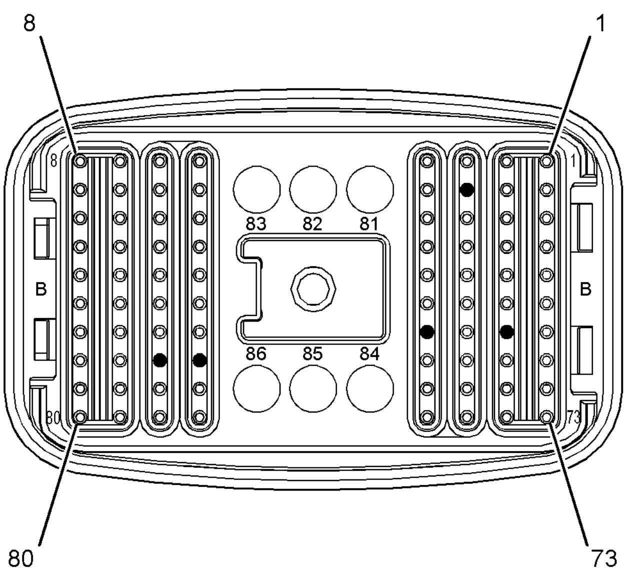


Illustration 142 g03146858

P2 pin locations for the temperature sensors

(11) Sensor ground
(50) Coolant temperature sensor signal
(52) NRS temperature sensor signal
(61) Fuel temperature sensor signal
(62) Intake manifold air temperature sensor signal

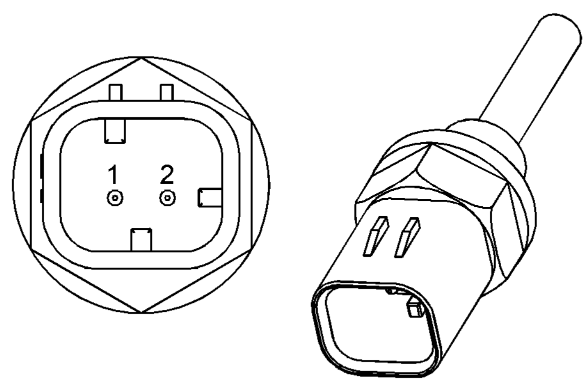


Illustration 143 g01170313

Typical view of an engine temperature sensor

(1) Signal
(2) Ground

For sensors that are connected to the P1/J1 connector, refer to the electrical schematic for the application.

For sensors that are connected to the P2/J2 connector, refer to Illustration 141 .

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

Table 217

Troubleshooting Test Steps	Values	Results
1. Inspect Electrical Connectors and Wiring **A.** Thoroughly inspect the terminal connections on the ECM connectors and the engine temperature sensors. Refer to Troubleshooting, "Electrical Connectors - Inspect". **B.** Perform a 45 N (10 lb) pull test on each of the wires in the ECM connector and the sensor connectors that are associated with the active diagnostic code. **C.** Check the screw for the ECM connector for the correct torque of 6 N·m (53 lb in). **D.** Check the harness for corrosion, abrasion, and pinch points from the engine temperature sensors 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 of 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 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:** An XXXX-4 diagnostic code is active for one or more of the temperature sensors at this time. Proceed to Test Step 3. **Result:** An XXXX-3 diagnostic code is active for one or more of the temperature sensors at this time. Proceed to Test Step 5.
3. Create An Open Circuit at the Sensor Connector **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the connector for the sensor with the XXXX-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 Code" screen. Check for an XXXX-3 diagnostic code.	Open circuit	**Result:** An XXXX-4 diagnostic code was active before disconnecting the sensor. An XXXX-3 diagnostic code became active after disconnecting the sensor. The sensor is faulty. **Repair:** Temporarily connect a new sensor to the harness, but do not install the new sensor in the engine. Use the electronic service tool in order to verify that the repair eliminates the fault and then permanently install the new sensor. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault. **Result:** The XXXX-4 diagnostic code is still active. Proceed to Test Step 4.

(continued)

(Table 217, contd)

Troubleshooting Test Steps	Values	Results
4. Check the Signal Wire for a Short Circuit **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the P1 or P2 connector, as applicable, and disconnect the connector from the suspect sensor. **C.** Check the resistance between the applicable signal terminal on the P1/P2 connector and all other terminals on the P1/P2 connector. For sensors on the P1 connector, refer to the electrical schematic for the machine. For sensors on the P2 connector, refer to Illustration 141 .	Greater than 100 Ohms	**Result:** At least one of the resistance measurements is less than 100 Ohms. The fault is in the engine harness. **Repair:** Repair the faulty connector or replace the faulty harness. Use the electronic service tool to verify that the repair eliminates the fault. **Result:** All resistance measurements are greater than 100 Ohms. Contact the Dealer Solutions Network (DSN).
5. Create a Short Circuit at the Sensor Connector **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the connector for the suspect sensor. **C.** Fabricate a jumper wire that is 150 mm (6 inch) long. Crimp a terminal to both ends of the wire. **D.** Use the jumper to connect the sensor signal terminal to the sensor ground terminal on the harness connector for the suspect sensor. **E.** Turn the keyswitch to the ON position. Do not start the engine. **F.** Access the “Active Diagnostic Codes” screen on the electronic service tool and check for an active XXXX-4 diagnostic code for the suspect sensor. **G.** Remove the jumper. Reconnect the sensor.	Short circuit	**Result:** An XXXX-3 diagnostic code was active before installing the jumper. An XXXX-4 diagnostic code became active with the jumper installed - the sensor may be faulty. **Repair:** Temporarily connect a new sensor to the harness, but do not install the new sensor in the engine. Use the electronic service tool in order to verify that the repair eliminates the fault and then permanently install the new sensor. Use the electronic service tool in order to clear all logged diagnostic codes and verify that the repair eliminates the fault. **Result:** The XXXX-3 diagnostic code remains active when the jumper is installed. Proceed to Test Step 6.
6. Check the Signal Wire for an Open Circuit **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the P1 or P2connector as applicable and disconnect the connector from the suspect sensor. **C.** Check the resistance between the applicable signal terminal on the sensor connector and the applicable terminal on the P1/P2 connector. For sensors on the P1 connector, refer to the electrical schematic for the machine. For sensors on the P2 connector, refer to Illustration 141 .	Less than two Ohms.	**Result:** The resistance measurement is greater than two Ohms. The fault is in the engine harness. **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 two Ohms. Contact the Dealer Solutions Network (DSN).

i07730214

Sensor Signal (PWM) - Test

This procedure covers the following diagnostic codes:

Table 218

Diagnostic Codes for the Active Analog Sensors			
J1939 Code	PDL Code	Code Description (code descriptions may vary)	Comments
1184-3	3782-3	Engine Turbocharger #1 Turbine Outlet Temperature : Voltage Above Normal	The ECM detects the following conditions: The signal for the turbocharger outlet temperature sensor is greater than the upper diagnostic limit. The warning light will come on. The ECM will log the diagnostic code. The engine will be derated.
1184-4	3782-4	Engine Turbocharger #1 Turbine Outlet Temperature : Voltage Below Normal	The ECM detects the following conditions: The signal for the turbocharger outlet temperature sensor is less than the lower diagnostic limit. The warning light will come on. The ECM will log the diagnostic code. The engine will be derated.
1184-8	3782-8	Engine Turbocharger #1 Turbine Outlet Temperature : Abnormal Frequency, Pulse Width, or Period	The ECM detects the following conditions: The signal for the turbocharger outlet temperature sensor is not within the normal operating range. The warning light will come on. The ECM will log the diagnostic code. The engine will be derated.
3242-3	2452-3	DPF #1 Intake Temperature Sensor : Voltage Above Normal	The ECM detects the following conditions: The signal from the DPF intake temperature sensor is greater than the upper diagnostic limit. If equipped, the warning lamp will come on. The ECM will log the diagnostic code. The engine will be derated.
3242-4	2452-4	DPF #1 Intake Temperature Sensor : Voltage Below Normal	The Electronic Control Module (ECM) detects the following conditions: The signal from the DPF intake temperature sensor is less than the lower diagnostic limit. If equipped, the warning lamp will come on. The ECM will log the diagnostic code. The engine will be derated.
3242-8	2452-8	DPF #1 Intake Temperature Sensor : Abnormal Frequency, Pulse Width, or Period	The ECM detects the following conditions: The signal from the DPF intake temperature sensor is not within the normal operating range. If equipped, the warning lamp will come on. The ECM will log the diagnostic code. The engine will be derated.
4360-3	3105-3	Aftertreatment #1 SCR Catalyst Intake Gas Temperature Sensor : Voltage Above Normal	The Electronic Control Module (ECM) detects the following conditions: The signal from the SCR intake temperature sensor is greater than the upper diagnostic limit. If equipped, the warning lamp will come on. The ECM will log the diagnostic code. The engine will be derated.

(continued)

(Table 218, contd)

Diagnostic Codes for the Active Analog Sensors			
J1939 Code	PDL Code	Code Description (code descriptions may vary)	Comments
4360-4	3105-4	Aftertreatment #1 SCR Catalyst Intake Gas Temperature Sensor : Voltage Below Normal	The Electronic Control Module (ECM) detects the following conditions: The signal from the SCR intake temperature sensor is less than the lower diagnostic limit. If equipped, the warning lamp will come on. The ECM will log the diagnostic code. The engine will be derated.
4360-8	3105-8	Aftertreatment #1 SCR Catalyst Intake Gas Temperature Sensor : Abnormal Frequency, Pulse Width, or Period	The ECM detects the following conditions: The signal voltage from the SCR intake temperature sensor is not within the normal operating range. If equipped, the warning lamp will come on. The ECM will log the diagnostic code. The engine will be derated.
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 678 or 41 codes.
- There are no active 168 codes.

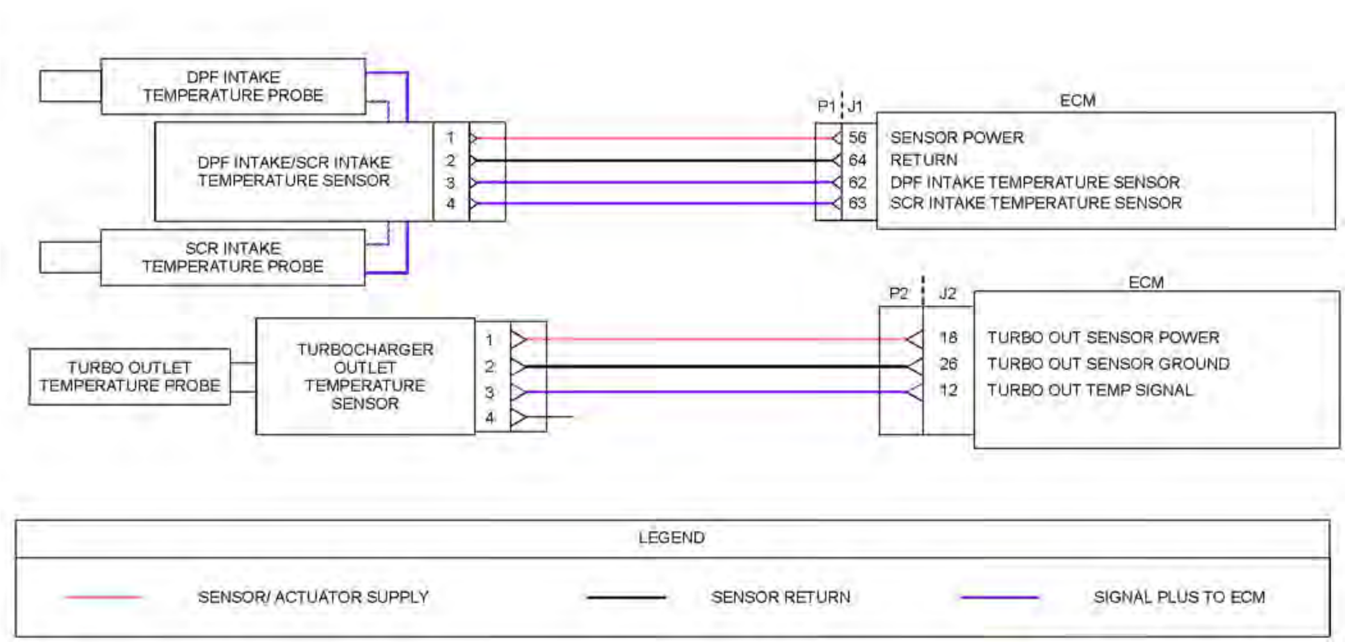


Illustration 144
g06382099

Schematic diagram for the PWM sensors

Table 219

Troubleshooting Test Steps	Values	Results
1. Inspect Electrical Connectors and Wiring **A.** Thoroughly inspect the terminal connections on the P2/J2 and P1/J1 ECM connectors and the PWM sensors. Refer to Troubleshooting, "Electrical Connectors - Inspect". **B.** Perform a 45 N (10 lb) pull test on each of the wires in the ECM connector and the sensor connectors that are associated with the active diagnostic code. **C.** Check the screw for the ECM connector for the correct torque of 6 N·m (53 lb in). **D.** Check the harness for corrosion, abrasion, and pinch points from the sensors 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 218 are active. **E.** Turn the keyswitch to the OFF position.	Diagnostic codes	**Result:** There are no active diagnostic codes for the PWM sensors. **Repair:** If there are logged diagnostic codes for the PWM 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 218 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 connector for the suspect sensor. **C.** Turn the keyswitch to the ON position. Do not start the engine. **D.** Measure the voltage between the supply terminal and the ground terminal on the harness connector for the suspect sensor. The voltage measurement should be battery voltage. **E.** Turn the keyswitch to the OFF position. **F.** Reconnect the sensor.	Between 7.5 V and 8.5 V for an 8 V system Between 11 V and 13 V for a 12 V system Between 22 V and 26 V for a 24 V system	**Result:** The voltage measurement is not within the expected range. The fault is in the supply wire or the ground wire in the engine wiring harness. **Repair:** Repair the faulty wiring or replace the faulty wiring. Use the electronic service tool to clear all logged diagnostic codes. Return the engine to service. **Result:** The voltage measurement is within the expected range - The correct supply voltage is reaching the sensor. Proceed to Test Step 4.

(continued)

(Table 219, contd)

Troubleshooting Test Steps	Values	Results
4. 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 -8, or diagnostic code is active for one or more of the PWM sensors. **Repair:** Replace the suspect sensor. Use the electronic service tool to clear all logged diagnostic codes. Return the unit to service. **Result:** A -4 diagnostic code is active for one or more of the PWM sensors. Proceed to Test Step 5. **Result:** A -3 diagnostic code is active for one or more of the PWM sensors. Proceed to Test Step 7.
5. Create An Open Circuit at the Sensor Connector **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the connector for the 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 Code” screen. Check for a -3 diagnostic code.	Diagnostic codes	**Result:** A -4 diagnostic code was active before disconnecting the sensor. A -3 diagnostic code became active after disconnecting the sensor. The sensor is faulty. **Repair:** Temporarily connect a new sensor to the harness, but do not install the new sensor in the engine. Use the electronic service tool to verify that the repair eliminates the fault and then permanently install the new 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. Proceed to Test Step 6.
6. Check the Signal Wire for a Short Circuit **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the P2/P1 connector and disconnect the connector from the suspect sensor. **C.** Check for resistance between the applicable signal terminal on the P2/P1 connector and all other terminals on the P2/P1 connector. Refer to Illustration 144 .	Greater than 100 Ohms	**Result:** At least one of the resistance measurements is less than 100 Ohms. The fault is in the engine harness. **Repair:** Repair the faulty connector or replace the faulty harness. Use the electronic service tool to verify that the repair eliminates the fault. **Result:** All resistance measurements are greater than 100 Ohms. Contact the Dealer Solutions Network (DSN).

(continued)

(Table 219, 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 connector for the suspect sensor. **C.** Fabricate a jumper wire that is 150 mm (6 inch) long. Crimp a terminal to both ends of the wire. **D.** Use the jumper to connect the sensor signal terminal to the sensor ground terminal on the harness connector for the suspect sensor. **E.** Turn the keyswitch to the ON position. Do not start the engine. **F.** Access the “Active Diagnostic Codes” screen on the electronic service tool and check for an active -4 diagnostic code for the suspect sensor. **G.** Remove the jumper. Reconnect the sensor.	Diagnostic codes	**Result:** A -3 diagnostic code was active before installing the jumper. An -4 diagnostic code became active with the jumper installed. The sensor may be faulty. **Repair:** Temporarily connect a new sensor to the harness, but do not install the new sensor in the engine. Use the electronic service tool to verify that the repair eliminates the fault and then permanently install the new 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 when the jumper is installed. Proceed to Test Step 8.
8. Check the Signal Wire for an Open Circuit **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the P2 connector and disconnect the connector from the suspect sensor. **C.** Check for resistance between the applicable signal terminal on the sensor connector and the applicable terminal on the P2 connector. Refer to Illustration 144 .	Less than 2 Ohms.	**Result:** The resistance measurement is greater than 2 Ohms. The fault is in the engine harness. **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).

i06851668

Sensor Supply - Test

This procedure covers the following diagnostic codes:

Table 220

Diagnostic Trouble Codes for Sensor Supplies			
J1939 Code	**PDL Code**	**Code Description (code descriptions may vary)**	**Comments**
678-3	41-3	ECU 8 Volts DC Supply : Voltage Above Normal	The ECM detects the following conditions: The 8 VDC supply is more than 8.8 VDC for more than one second. The ECM has been powered for more than 3 seconds. Diagnostic code 168-4 is not active. The ECM will log the diagnostic code and the warning lamp will illuminate while this diagnostic code is active. The engine may be limited to low idle.
678-4	41-4	ECU 8 Volts DC Supply : Voltage Below Normal	The ECM detects the following conditions: The 8 VDC supply is less than 7.2 VDC for more than one second. The ECM has been powered for more than 3 seconds. Diagnostic code 168-4 is not active. The ECM will log the diagnostic code and the warning lamp will illuminate while this diagnostic code is active. The engine may be limited to low idle. An active diagnostic code may not cause any noticeable effect on engine response unless the voltage drops below 6.5 VDC.
3509-3	262-3	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 one second. The ECM has been powered for at least 3 seconds. Diagnostic code 168-4 is not active. 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	2131-3	Sensor Supply Voltage 2 : Voltage Above Normal	
3509-4	262-4	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 one second. The ECM has been powered for at least 3 seconds. Diagnostic code 168-4 is not active. 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	2131-4	Sensor Supply Voltage 2 : Voltage Below Normal	

Note: A 678-XX or 41-XX diagnostic code indicates a fault in the 8 VDC circuit on the J1/P1 connector. A 3509-XX or 262-XX diagnostic code indicates a fault in the 5 VDC circuit on the J2/P2 connector. A 3510-XX or 2131-XX diagnostic code indicates a fault in the 5 VDC circuit on the J1/P1 connector.

The following background information is related to this procedure:

The ECM supplies regulated +5 VDC to the following sensors on P2:1:

- Barometric pressure sensor
- Intake manifold air pressure sensor
- Fuel pressure sensor
- Engine oil pressure sensor
- NRS intake pressure sensor
- NRS differential pressure sensor
- NRS valve position sensor
- Exhaust Back Pressure Regulator (EBPR) position sensor

The ECM supplies regulated +5 VDC to the analog throttle position sensors (if equipped) and the aftertreatment ID module on P1:72.

The ECM supplies regulated +8 VDC to the following sensors on P1:56:

- DPF in /SCR in temperature sensor
- Digital throttle position sensors (if equipped)
- Coolant level sensor (if equipped)
- Fuel/water separator level sensor (if equipped)

A diagnostic code can be caused by the following conditions:

- An open circuit in the harness
- A short circuit in the harness
- A short circuit to a voltage that is higher than 5.16 VDC
- A faulty sensor
- A faulty ECM

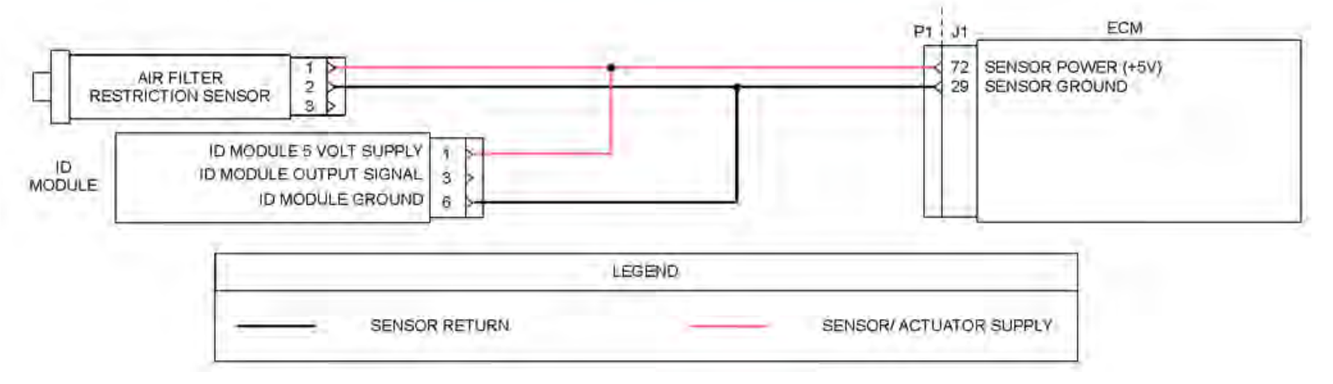


Illustration 145 g03812157

Schematic for the 5 VDC supply on P1:72

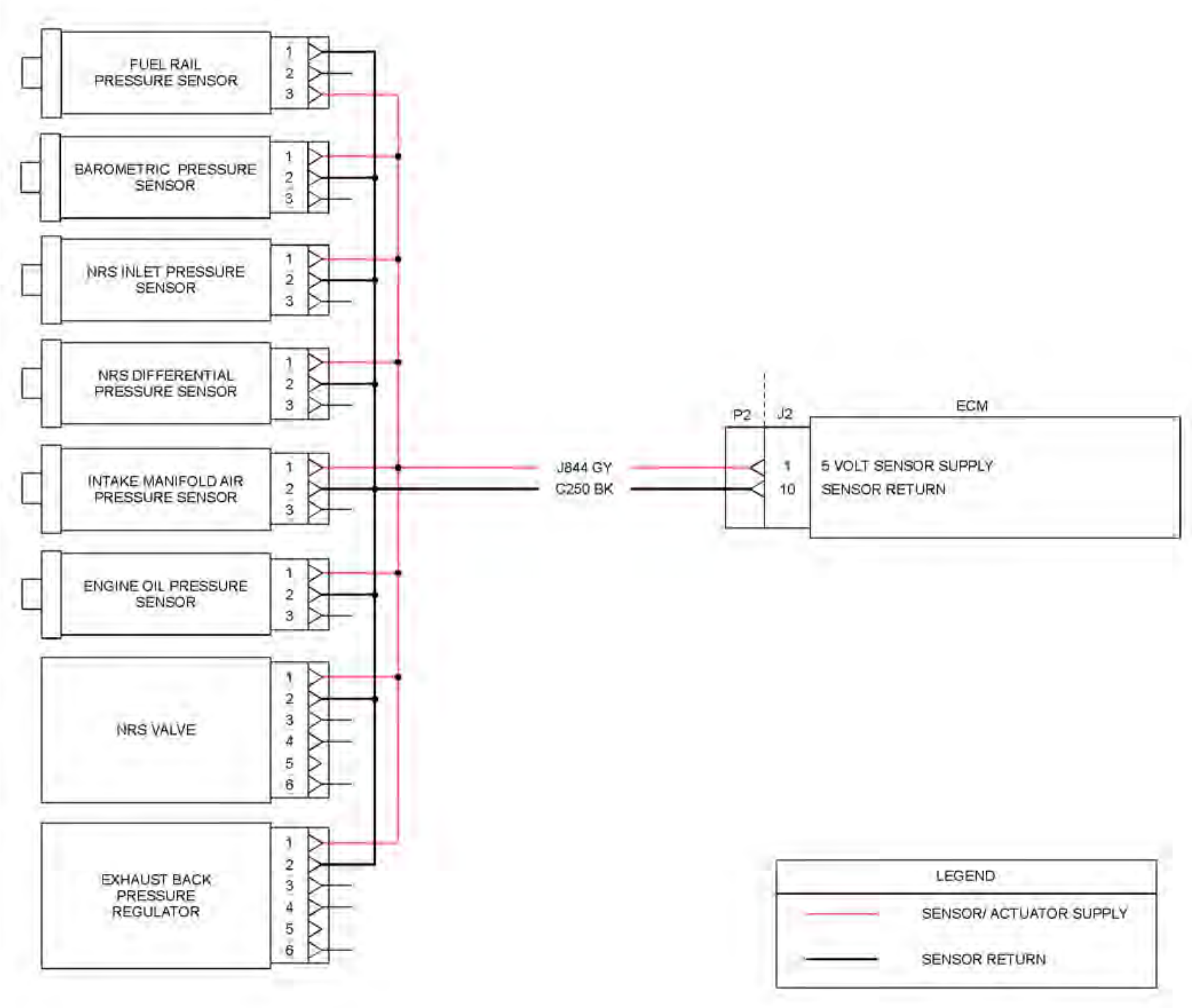


Illustration 146 g03812159

Schematic for the 5 VDC supply on P2:1

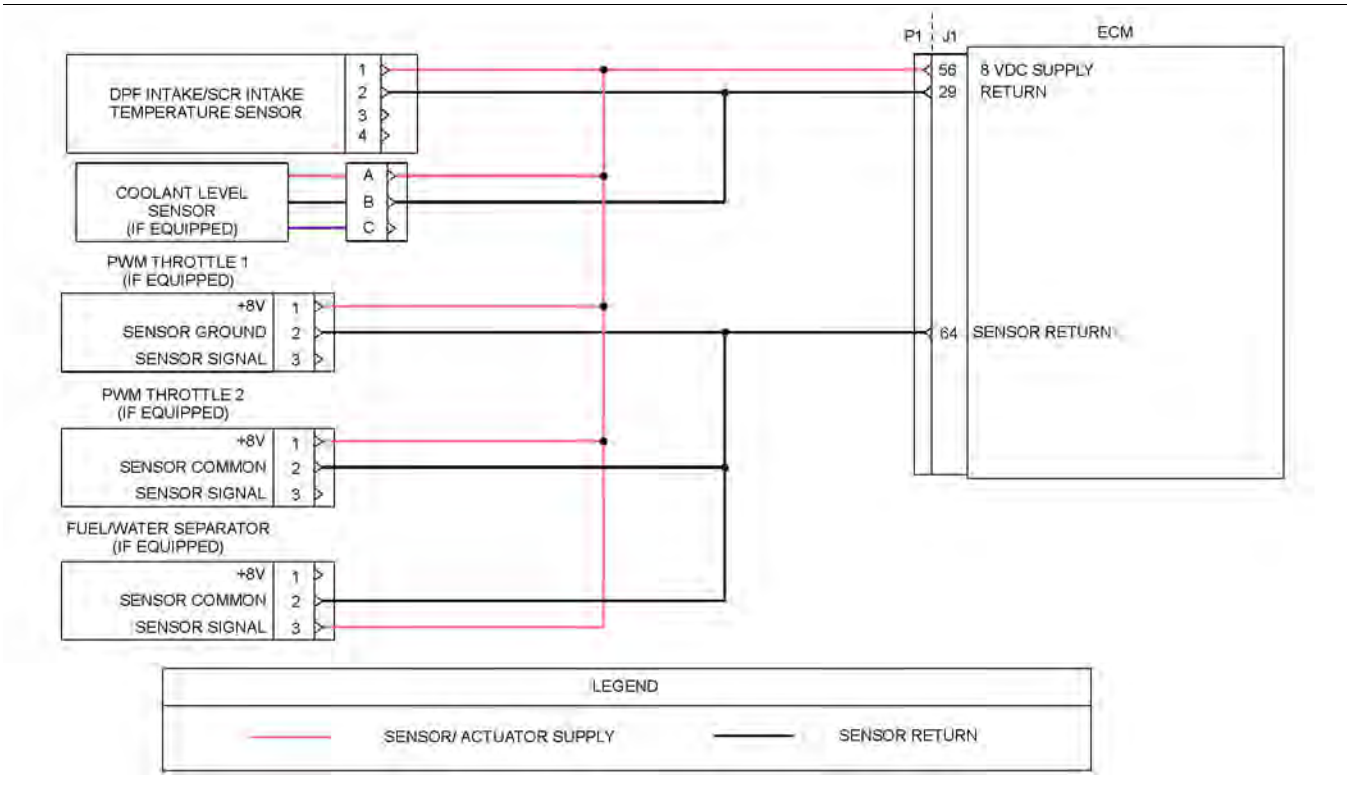


Illustration 147 g06141724

Schematic for the 8 VDC supply on P1:56

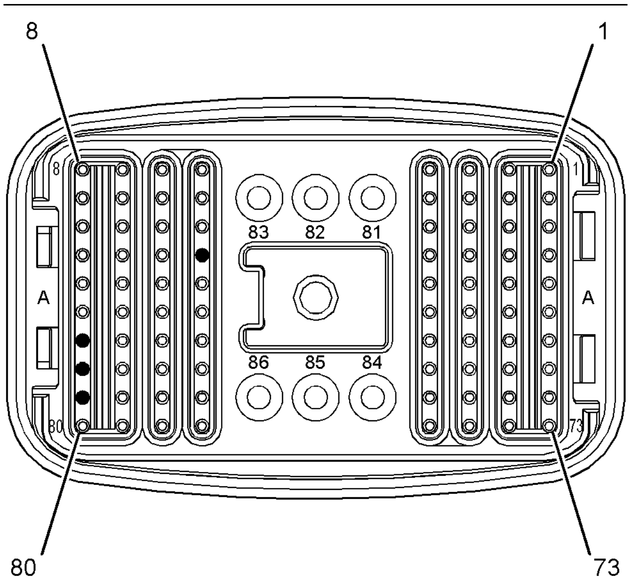


Illustration 148 g03812163

P1 pin location for the sensor supply

(29) Ground
(56) 8 VDC supply
(64) Ground
(72) 5 VDC supply

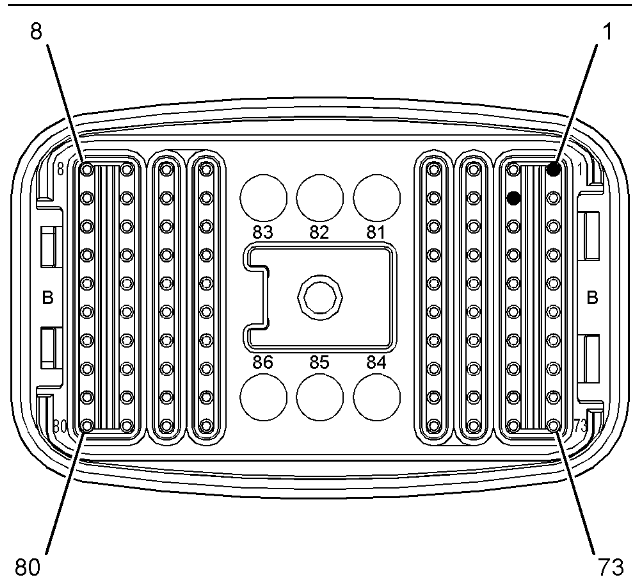


Illustration 149 g03812164

Typical example of the pin locations for the 5 VDC supply on the P2 connector

(1) 5 VDC supply
(10) Ground

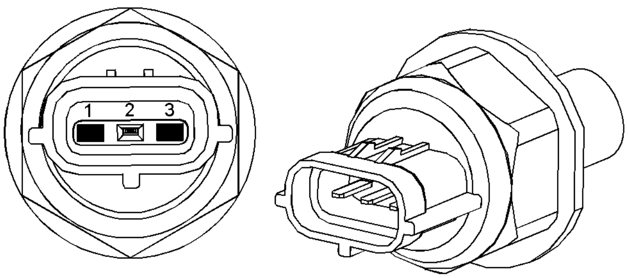


Illustration 150 g02315513

Typical example of the fuel rail pressure sensor

(1) Sensor ground
(3) 5 VDC supply

Note: The position of the terminal for the voltage supply on the fuel rail pressure sensor is different to all other engine pressure sensors.

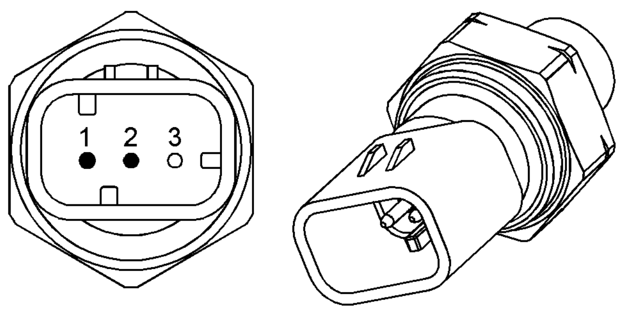


Illustration 151 g02315514

Typical example of an engine pressure sensor

(1) 5 VDC supply
(2) Sensor ground

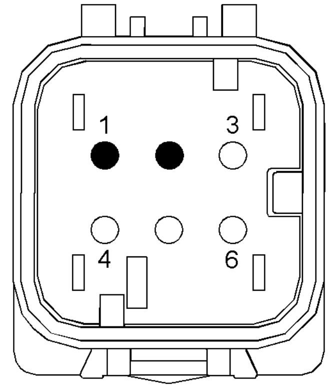


Illustration 152 g02315534

Typical example of the connector for the NRS valve

(1) 5 VDC supply
(2) Sensor ground

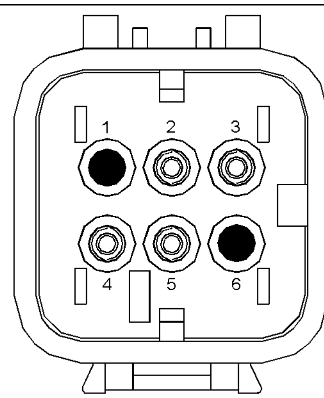


Illustration 153 g02315537

Typical example of the connector for the aftertreatment identification module

(1) 5 VDC supply
(6) Ground

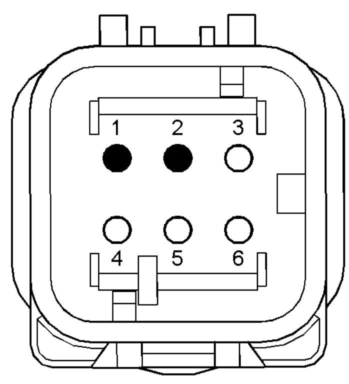


Illustration 154 g03130436

Typical example of the connector for the Exhaust Back Pressure Regulator (EBPR)

(1) 5 VDC supply
(2) Ground

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

Table 221

Troubleshooting Test Steps	Values	Results
1. Check for Connector Damage **A.** Turn the keyswitch to the OFF position. **B.** Check the connectors and the harness for the following faults: · Damage · Abrasion · Corrosion · Incorrect attachment **C.** Refer to Troubleshooting, “Electrical Connectors - Inspect”. **D.** Perform a 45 N (10 lb) pull test on each of the wires in the harness that are associated with the throttle position sensors. Check the wire connectors for all the sensors on the sensor supply circuits. **E.** Check the screws for the ECM connectors for the correct torque of 6 N·m (53 lb in).	Connector fault	**Result:** Found damage, abrasion, corrosion, or incorrect attachment. **Repair:** Repair the connectors or the harness and/or replace the connectors or the harness. Use the electronic service tool to clear all logged diagnostic codes and then verify that the repair eliminates the fault. **Result:** No faults found. 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. **C.** Use the electronic service tool to monitor the diagnostic codes. Wait at least 15 seconds in order for the diagnostic codes to become active. Check and record any active diagnostic codes.	Diagnostic codes	**Result:** One or more of the diagnostic codes listed in Table 220 is active or recently logged. Proceed to Test Step 3. **Result:** None of the previous diagnostic codes are active. The fault may be intermittent. Proceed to Test Step 7.

(continued)

(Table 221, contd)

Troubleshooting Test Steps	Values	Results
3. Disconnect the Sensors One at a Time **A.** Turn the keyswitch to the OFF position. **B.** For a 3509-X or 262-X diagnostic code, disconnect the sensors on the 5 VDC supply circuit on the J2/P2 connector one at a time. Refer to Illustration 146 . Wait for 30 seconds after each sensor is disconnected. Use the electronic service tool to monitor the diagnostic codes. For a 3510-X or 2131-X diagnostic code, disconnect the analog throttle position sensors (if equipped) one at a time. Also, disconnect the aftertreatment ID module and any other sensors that are connected to the 5 VDC supply on the P1 connector. Refer to Illustration 145 . Wait for 30 seconds after each sensor is disconnected. Use the electronic service tool to monitor the diagnostic codes. For a 678-X or 41-X diagnostic code, disconnect the digital throttle position sensors (if equipped) one at a time. Also, disconnect any other sensors that are connected to the 8 VDC supply on the P1 connector. Refer to Illustration 147 . Wait for 30 seconds after each sensor is disconnected. Use the electronic service tool to monitor the diagnostic codes. **Note:** The sensor supply diagnostic will become inactive when the sensor that caused the diagnostic code is disconnected. **C.** Ensure that all the sensors on the suspect sensor supply circuit are disconnected.	Diagnostic code inactive	**Result:** The 3509, 262, 3510 or 2131 diagnostic code is inactive when all the sensors are disconnected. **Repair:** Replace the suspect sensor. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault. **Result:** A 3509 or 262 diagnostic code is still active. Proceed to Test Step 4. **Result:** A 3510, 2131, 678 or 41 diagnostic code is still active. Proceed to Test Step 5.
4. Disconnect the ECM Connector **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the P2 connector from the ECM. Thoroughly inspect the P2/J2 connectors for corrosion and/or damaged seals. Repair if necessary. **C.** Turn the keyswitch to the ON position. **D.** Use the electronic service tool to check for active diagnostic codes. **Note:** With the P2 connector disconnected, diagnostic codes will be active for all the engine sensors. Disregard all other codes and look for a 3509-X or 262-X diagnostic code only. **E.** Turn the keyswitch to the OFF position.	Diagnostic code inactive	**Result:** The 3509 or 262 diagnostic code is no longer active. **Repair:** Replace the engine wiring harness. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault. **Result:** The 3509 or 262 diagnostic code is still active with the P2 connector disconnected. Contact the Dealer Solutions Network (DSN).

(continued)

(Table 221, contd)

Troubleshooting Test Steps	Values	Results
5. Check the Wiring for an Open Circuit or High Resistance **A.** Disconnect any sensors that are connected to the suspect sensor supply circuit. Disconnect the P1 connector from the ECM. **B.** Thoroughly inspect the P1/J1 connectors for corrosion and/or damaged seals. Repair if necessary. **C.** Measure the resistance of the following wires for each sensor: · The sensor supply wire from the sensor to the P1 connector · The sensor ground wire from the sensor to the P1 connector	Less than 2.0 Ohms	**Result:** At least one of the resistance measurements is greater than 2.0 Ohms. **Repair:** Replace the wiring with the high resistance. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault. **Result:** All resistance measurements are less than 2.0 Ohms. Proceed to Test Step 6.
6. Check the Wiring for a Short Circuit **A.** Measure the following resistances: · P1:72 and all other terminals on the P1 connector · P1:56 and all other terminals on the P1 connector · P1:64 and all other terminals on the P1 connector	Greater than 100 Ohms	**Result:** At least one of the resistance measurements is less than 100 Ohms. **Repair:** Replace the wiring between the sensor and the P1 connector. 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 100 Ohms. Contact the Dealer Solutions Network (DSN).
7. 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.	No faults	**Result:** No intermittent faults were found. The harness and connectors appear to be OK. Return the engine to service. **Result:** At least one intermittent fault was indicated. **Repair:** Repair or replace the harness or connector. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault.

i06196489

Shutdown (Ground Level - Test

Use this procedure to troubleshoot the ground level shutdown switch or the following diagnostic codes:

Table 222

Diagnostic Trouble Codes for the Ground Level Shutdown Switch			
J1939 Code	**PDL Code**	**Code Description** (code descriptions may vary)	**Comments**
4215-3	267-3	Remote Shutdown Input voltage above normal	The Electronic Control Module (ECM) detects the following condition: Both contacts from the ground level shutdown switch are in the open state.
4215-4	267-4	Remote Shutdown Input voltage below normal	The Electronic Control Module (ECM) detects the following conditions: Both contacts from the ground level shutdown switch are in the closed state.

The ground level shutdown switch allows the engine to be shut down from ground level. When the switch is moved to the STOP position, the engine shuts down. The ECM remains powered. The ground level shutdown switch must be in the RUN position and the power to the ECM must be cycled before the engine can restart.

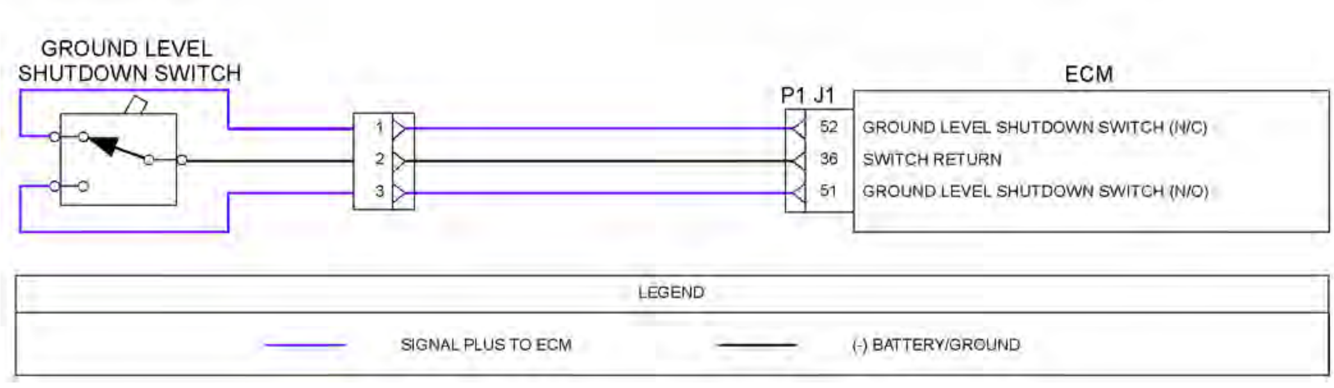


Illustration 155 g03812170

Schematic for the ground level shutdown switch

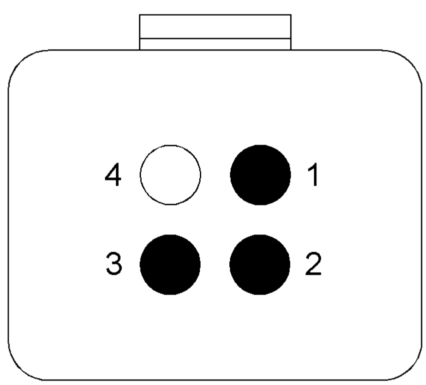


Illustration 156 g03812171

Ground level shutdown switch connector

(1) Ground level shutdown switch (N/O)
(2) Switch ground
(3) Ground level shutdown switch (N/C)

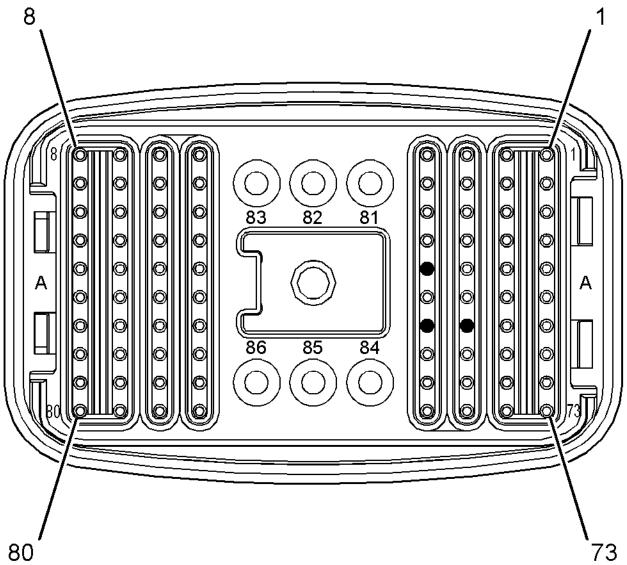


Illustration 157 g03812172

Pin locations on the P1 connector for the ground level shutdown switch.

(36) Ground level shutdown switch return
(51) Ground level shutdown switch (N/O)
(52) Ground level shutdown switch (N/C)

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

Table 223

Troubleshooting Test Steps	Values	Results
1. Inspect Electrical Connectors and Wiring **A.** Thoroughly inspect the terminal connections on the P1 ECM connector and the switch connector. Refer to Troubleshooting, "Electrical Connector - Inspect". **B.** Perform a 45 N (10 lb) pull test on each of the wires in the ECM connector and the ground level shutdown switch connector.. **C.** Check the screw for the ECM connector for the correct torque of 6 N·m (53 lb in). **D.** Check the harness for corrosion, abrasion, and pinch points from the solenoids 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 of 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.** Place the ground level shutdown switch in the RUN position. **D.** Turn the keyswitch to the ON position. Wait at least 20 seconds for activation of the diagnostic codes. **E.** Verify if any of the diagnostic codes that are listed in Table 222 are active. **F.** Turn the keyswitch to the OFF position.	Diagnostic codes	**Result:** No diagnostic codes are active or logged. **Repair:** The switch is operating normally. There may be an intermittent fault in the wiring harness or in a connector. Check the wiring harness and the connectors for an intermittent electrical fault. Refer to Troubleshooting, "Electrical Connector - Inspect". **Result:** A 4215-3 or 267-3 diagnostic is active. Proceed to Test Step 3. **Result:** A 4215-4 or 267-4 diagnostic is active. Proceed to Test Step 5.
3. Create a Short Circuit at the Shutdown Switch Connector **A.** Turn the keyswitch to the OFF position. **B.** Fabricate a jumper wire. Install the jumper wire between terminal 1 and terminal 2 on the harness connector for the shutdown switch. **C.** Turn the keyswitch to the ON position. **D.** Use the electronic service tool to check for an active 4215-3 or 267-3 diagnostic code. **E.** Turn the keyswitch to the OFF position. Remove the jumper wire.	Diagnostic code	**Result:** The 4215-3 or 267-3 diagnostic code is no longer active with the jumper installed. **Repair:** Install a replacement ground level shutdown switch. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault. **Result:** The 4215-3 or 267-3 diagnostic code is still active with the jumper installed. Proceed to Test Step 4.

(continued)

(Table 223, contd)

Troubleshooting Test Steps	Values	Results
4. Check the (N/C) Wiring for an Open Circuit **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the harness connector for the ground level shutdown switch. Disconnect the P1 connector from the ECM. **C.** Measure the resistance between terminal 1 on the shutdown switch harness connector and P1:52.	Less than five Ohms	**Result:** The measured resistance is greater than five Ohms. The fault is in the wiring between the ground level shutdown switch and the P1 ECM 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 five Ohms. Contact the Dealer Solutions Network (DSN).
5. Create an Open Circuit at the Shutdown Switch Harness Connector **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the harness connector for the ground level shutdown switch. **C.** Turn the keyswitch to the ON position. **D.** Use the electronic service tool to check for an active 4215-3 or 267-3 diagnostic code.	Diagnostic code	**Result:** A 4215-3 or 267-3 diagnostic code is active with the switch disconnected. **Repair:** Install a replacement ground level shutdown switch. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault. **Result:** There are no active 4215 or 267 diagnostic codes with the switch disconnected. Proceed to Test Step 6.
6. Check the (N/O) Wiring for a Short Circuit **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the harness connector for the ground level shutdown switch. Disconnect the P1 connector from the ECM. **C.** Check the resistance between P1:51 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 ground level shutdown switch and the P1 connector. **Repair:** Repair the faulty wiring or replace the faulty wiring. **Result:** All resistance measurements are greater than 1.0 k Ohm. Contact the Dealer Solutions Network (DSN).

i06196766

Solenoid Valve - Test
(Solenoid Valves that Connect to the Engine ECM)

This procedure covers the following diagnostic codes:

Table 224

Diagnostic Codes for the Solenoid Valves			
J1939 Code	PDL Code	Code Description (code descriptions may vary)	Comments
1076-5	18-5	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 ECM has been powered for at least 0.25 seconds. The warning lamp will come on. The ECM will log the diagnostic code. This diagnostic code detects a fault in the circuit for the fuel pump solenoid.
1076-6	18-6	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 ECM has been powered for at least 0.25 seconds. The warning lamp will come on. The ECM will log the diagnostic code. This diagnostic code detects a fault in the circuit for the fuel pump solenoid. This fault is most likely to be caused by a high side short to ground or a low side short to power.
1188-5	526-5	Engine Turbocharger 1 Wastegate Drive : Current Below Normal	The ECM detects the following conditions: A low current condition in the output from the ECM to the solenoid for the wastegate regulator. There are no active 168 diagnostic codes. The ECM has been powered for at least 2 seconds. The warning lamp will come on once the diagnostic code has been active for 30 seconds. The diagnostic code will be logged. The engine will be derated while this diagnostic code is active. After the engine derate has been activated, the electronic service tool will indicate “Turbo Protection Derate Active” . This diagnostic code detects a fault in the wastegate regulator that is most likely to be an open circuit.

(continued)

(Table 224, contd)

Diagnostic Codes for the Solenoid Valves			
J1939 Code	PDL Code	Code Description (code descriptions may vary)	Comments
1188-6	526-6	Engine Turbocharger 1 Wastegate Drive : Current Above Normal	The ECM detects the following conditions: A high current condition in the output from the ECM to the solenoid in the wastegate regulator There are no active 168 diagnostic codes. The ECM has been powered for at least 2 seconds. The warning lamp will come on once the diagnostic code has been active for 30 seconds. The diagnostic code will be logged. The engine will be derated while this diagnostic code is active. After the engine derate has been activated, the electronic service tool will indicate “Turbo Protection Derate Active” . This diagnostic code detects a fault in the circuit for the wastegate regulator. This fault is most likely to be caused by a high side short to ground or a low side short to power.
Follow the troubleshooting procedure in order to identify the root cause of the fault.			

The following background information is related to this procedure:

Electronically Controlled Wastegate

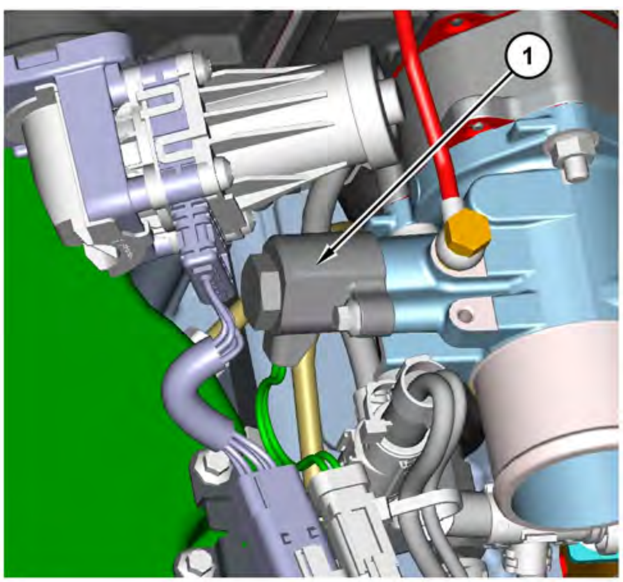


Illustration 158 g03795243

The engine has a turbocharger with an electronically controlled wastegate (1). Typically, the wastegate is a mechanical valve that is used in the turbocharger in order to regulate the intake manifold pressure to a set value.

The control system for the electronically controlled wastegate precisely regulates the intake manifold pressure by using a wastegate regulator to control the wastegate.

The required intake manifold pressure is calculated by the software that is contained in the ECM. The ECM uses the wastegate regulator to control the wastegate in order to provide the precise value of intake manifold pressure. The solenoid in the wastegate regulator is controlled by a PWM signal from the ECM.

Suction Control Valve for the High-Pressure Fuel Pump

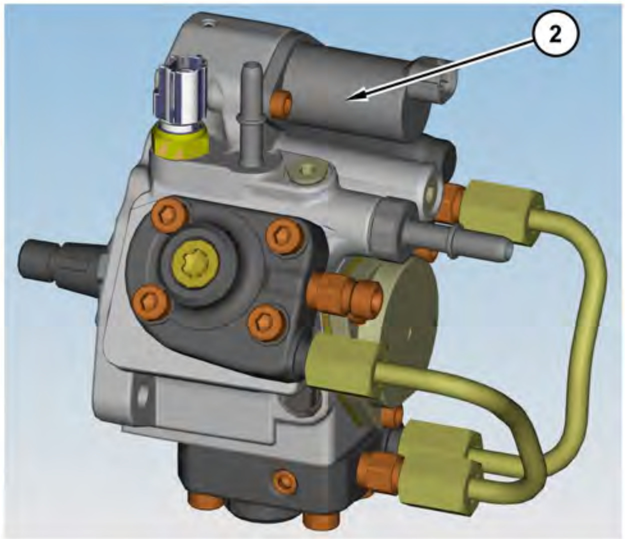


Illustration 159 g03795285

The high-pressure fuel pump is equipped with a suction control valve (2). The suction 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.

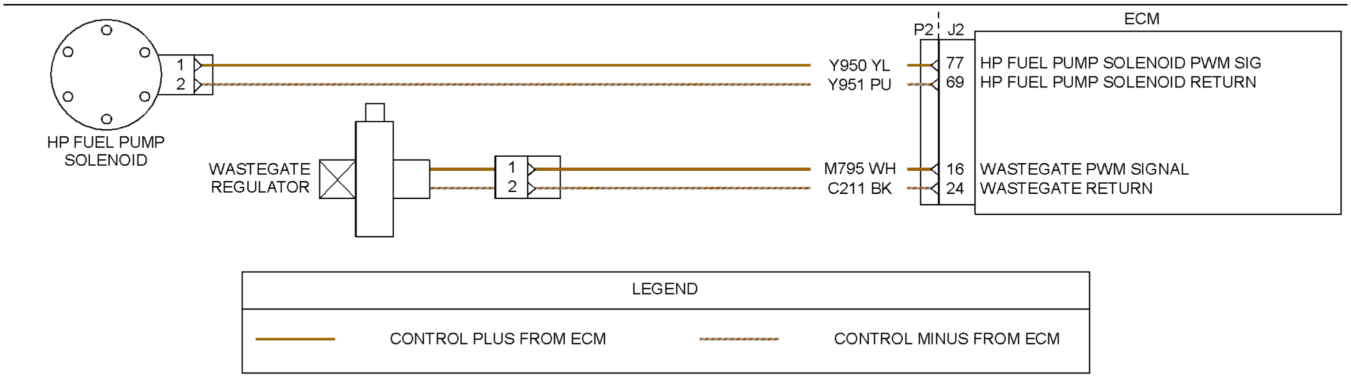


Illustration 160 g03812182

Schematic for the solenoid valves connected to the engine ECM

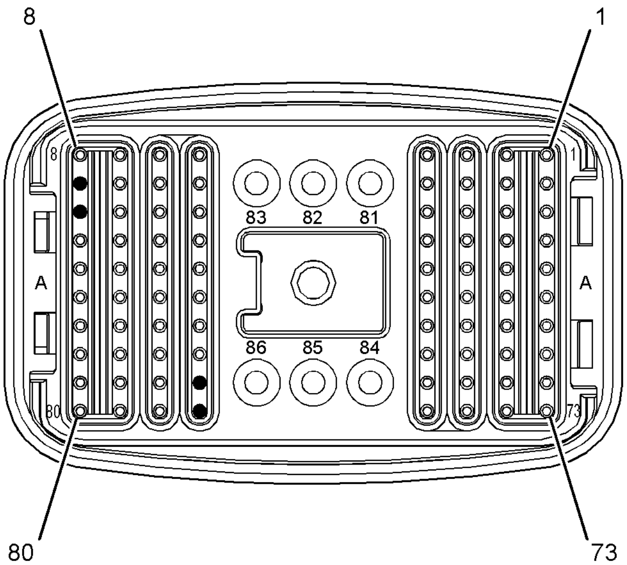


Illustration 161 g03812187

Pin locations on the P2 connector for the solenoid valves

(16) Wastegate regulator PWM signal
(24) Wastegate regulator return
(69) High pressure fuel pump suction control valve return
(77) High pressure fuel pump suction control valve PWM signal

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

Table 225

Troubleshooting Test Steps	Values	Results
1. Inspect Electrical Connectors and Wiring **A.** Thoroughly inspect the terminal connections on the P2/J2 ECM connector and the solenoids. Refer to Troubleshooting, “Electrical Connectors - Inspect”. **B.** Perform a 45 N (10 lb) pull test on each of the wires in the ECM connector and the solenoid connectors that are associated with the active diagnostic code. **C.** Check the screw for the ECM connector for the correct torque of 6 N·m (53 lb in). **D.** Check the harness for corrosion, abrasion, and pinch points from the solenoids 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 of 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 20 seconds for activation of the diagnostic codes. **D.** Verify if any of the diagnostic codes that are listed in Table 224 are active. **E.** Turn the keyswitch to the OFF position.	Diagnostic codes	**Result:** An XXXX-5 diagnostic code is active. Proceed to Test Step 3. **Result:** An XXXX-6 diagnostic is active. Proceed to Test Step 5.
3. Create a Short Circuit at the Harness Connector for the Solenoid **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the connector for the suspect solenoid. **C.** Fabricate a jumper wire that is 150 mm (6 inch) long. **D.** Install the wire between the two pins on the harness connector for the suspect solenoid in order to create a short circuit. **E.** Turn the keyswitch to the ON position. Wait for 10 seconds. Check for active diagnostic codes on the electronic service tool. **F.** Remove the jumper wire from the connector for the solenoid valve.	Open circuit	**Result:** An XXXX-5 diagnostic code was active before installing the jumper. An XXXX-6 diagnostic code is active when the jumper is installed. There is a fault in the solenoid. **Repair:** Temporarily connect a replacement for the suspect valve to the harness. Turn the keyswitch to the ON position. Use the electronic service tool in order to check for active diagnostic codes. Wait at least 30 seconds in order for the codes to be displayed. If the fault is eliminated, reconnect the suspect valve. If the fault returns, permanently install the replacement valve. Refer to Disassembly and Assembly for the correct procedure. **Result:** An XXXX-5 diagnostic code is still active with the jumper installed. Proceed to Test Step 4.

(continued)

(Table 225, 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 P2 connector and the connector for the suspect valve. **C.** Check the resistance between the signal terminal on P2 and the signal terminal on the valve connector. Refer to Illustration 160 . **D.** Check the resistance between the return terminal on P2 and the return terminal on the valve connector. Refer to Illustration 160 . **E.** Reconnect the connectors.	Less than two Ohms	**Result:** One of the measured resistances is greater than two Ohms. There is a fault in the engine wiring harness **Repair:** Repair the engine wiring harness or replace the engine wiring harness. 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 two Ohms. Contact the Dealer Solutions Network (DSN).
5. Create an Open Circuit at the Solenoid **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the connector for the suspect solenoid valve. **C.** Turn the keyswitch to the ON position. Wait for 10 seconds. Check for active diagnostic codes on the electronic service tool.	Short circuit	**Result:** An XXXX-6 diagnostic code was active before disconnecting the valve. An XXXX-5 diagnostic code is active with the valve disconnected. **Repair:** Temporarily connect a replacement for the suspect valve to the harness. Turn the keyswitch to the ON position. Use the electronic service tool in order to check for active diagnostic codes. Wait at least 30 seconds in order for the codes to be displayed. If the fault is eliminated, reconnect the suspect valve. If the fault returns, permanently install the replacement valve. Refer to Disassembly and Assembly for the correct procedure. **Result:** An XXXX-6 diagnostic code is still active with the valve disconnected. Proceed to Test Step 6.
6. Check the Wiring for a Short Circuit **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the P2 connector and the connector for the suspect valve. **C.** Check the resistance between the suspect signal terminal on P2 all other terminals on P2. Refer to Illustration 161 . **D.** Check the resistance between the suspect return terminal on P2 and all other terminals on P2. Refer to Illustration 161 . **E.** Reconnect the connectors.	Greater than 100 Ohms	**Result:** At least one of the resistance measurements is less than 100 Ohms. The fault is in the engine harness. **Repair:** Repair the faulty harness or replace the faulty harness. Use the electronic service tool to verify that the repair eliminates the fault. **Result:** All resistance measurements are greater than 100 Ohms. Contact the Dealer Solutions Network (DSN).

i06835429

Solenoid Valve - Test
(Solenoid Valves that Connect to the Dosing Control Unit (DCU))

This procedure covers the following diagnostic codes:

Table 226

Diagnostic Codes for the Solenoid Valves			
J1939 Code	**PDL Code**	**Code Description (code descriptions may vary)**	**Comments**
3361-5	3821-5	Aftertreatment #1 DEF Dosing Unit : Current Below Normal	The ECM detects the following conditions: A low current condition in the output from the DCU to the solenoid in the DEF injector There are no active 168 diagnostic codes. The ECM has been powered for at least 2 seconds. The warning lamp will come on once the diagnostic code has been active for 30 seconds. The diagnostic code will be logged. The engine will be derated while this diagnostic code is active. This diagnostic code detects a fault in the circuit for the DEF injector that is most likely to be an open circuit.
3361-6	3821-6	Aftertreatment #1 DEF Dosing Unit : Current Above Normal	The ECM detects the following conditions: A high current condition in the output from the DCU to the solenoid in the DEF injector. There are no active 168 diagnostic codes. The ECM has been powered for at least 2 seconds. The warning lamp will come on once the diagnostic code has been active for 30 seconds. The diagnostic code will be logged. The engine will be derated while this diagnostic code is active. This diagnostic code detects a fault in the circuit for the DEF injector. This fault is most likely to be caused by a high side short to ground or a low side short to power.
3363-5	3126-5	Aftertreatment #1 DEF Tank Heater : Current Below Normal	The ECM detects the following conditions: A low current condition in the output from the DCU to the solenoid in the coolant diverter valve. There are no active 168 diagnostic codes. The ECM has been powered for at least 2 seconds. The warning lamp will come on once the diagnostic code has been active for 30 seconds. The diagnostic code will be logged. The engine will be derated while this diagnostic code is active. This diagnostic code detects a fault in the circuit for the coolant diverter valve that is most likely to be an open circuit.

(continued)

(Table 226, contd)

Diagnostic Codes for the Solenoid Valves			
J1939 Code	PDL Code	Code Description (code descriptions may vary)	Comments
3363-6	3126-6	Aftertreatment #1 DEF Tank Heater : Current Above Normal	The ECM detects the following conditions: A high current condition in the output from the DCU to the solenoid in the coolant diverter valve. There are no active 168 diagnostic codes. The ECM has been powered for at least 2 seconds. The warning lamp will come on once the diagnostic code has been active for 30 seconds. The diagnostic code will be logged. The engine will be derated while this diagnostic code is active. This diagnostic code detects a fault in the circuit for the coolant diverter valve. This fault is most likely to be caused by a high side short to ground or a low side short to power.
Follow the troubleshooting procedure to identify the root cause of the fault.			

The following background information is related to this procedure:

Coolant Diverter Valve

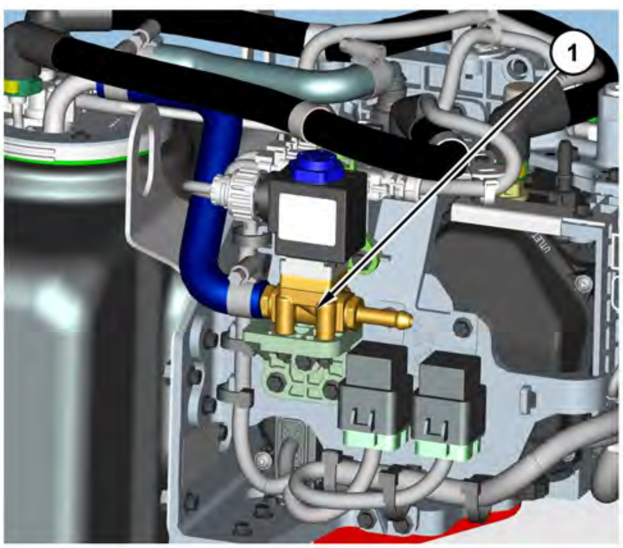


Illustration 162 g03795580

Coolant diverter valve

The coolant diverter valve controls the flow of coolant to the heater in the Diesel Exhaust Fluid (DEF) tank. When required, the valve is opened to allow hot coolant to circulate through the DEF tank. This flow allows the coolant to heat the DEF to a useable temperature.

DEF Injector

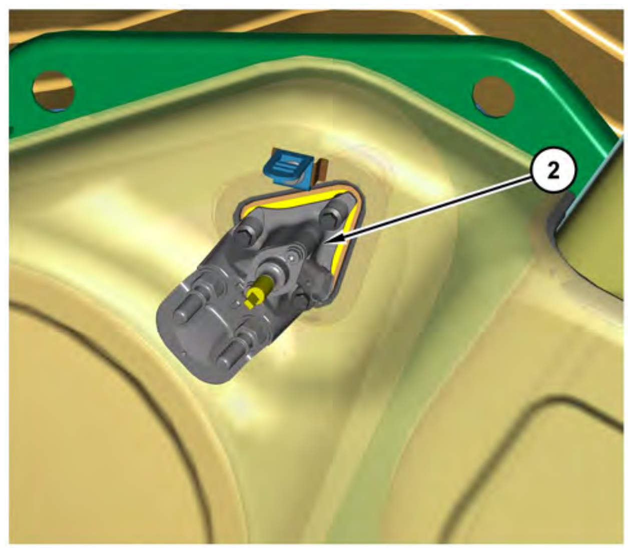


Illustration 163 g03795581

DEF injector

The DEF injector controls the flow of DEF into the exhaust stream in the Integrated Clean Emissions Module (IGCEM). The DEF injector is controlled by the Dosing Control Unit (DCU).

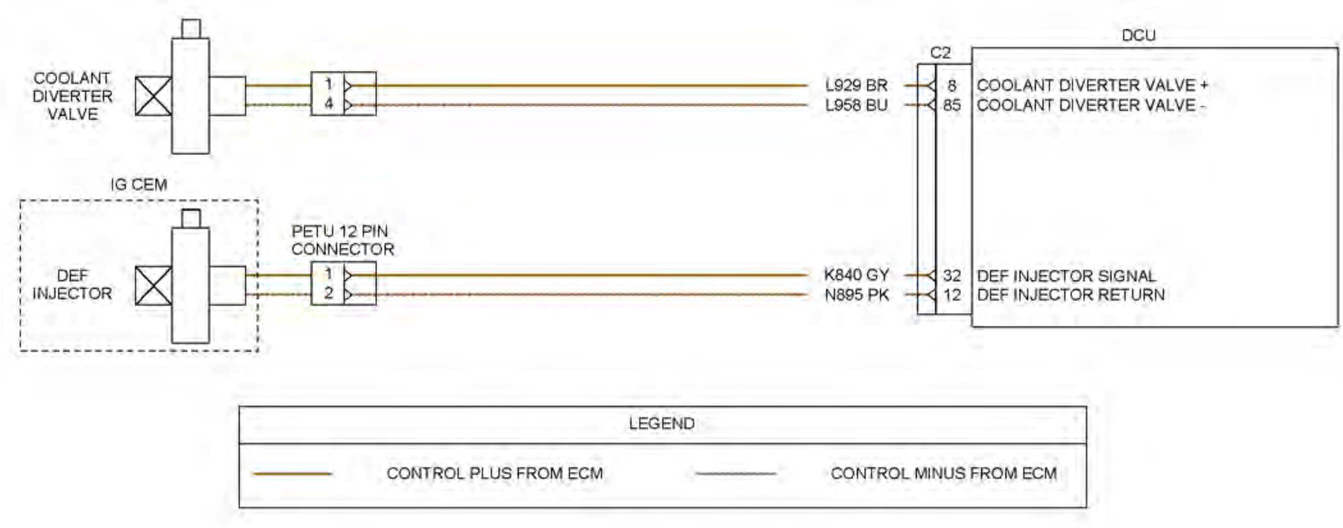


Illustration 164 g03812218

Schematic for the solenoid valves

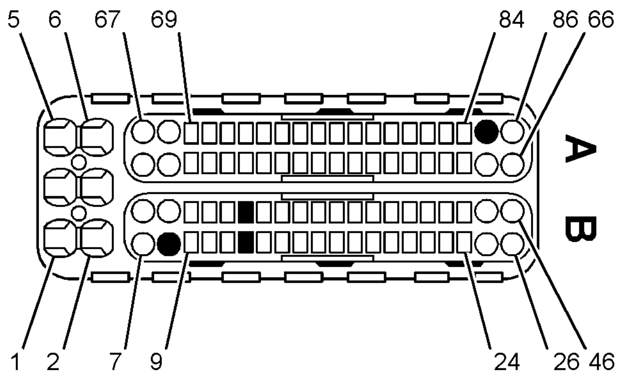


Illustration 165 g03812227

Pin locations on the C2 DCU connector for the solenoid valves

(8) Coolant diverter valve +
(12) DEF injector return
(32) DEF injector signal
(85) Coolant diverter valve -

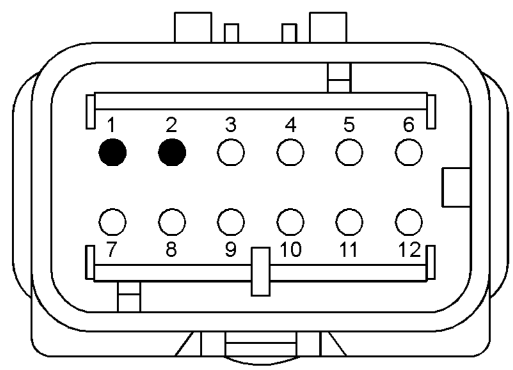


Illustration 166 g03812230

Pin locations on the 12-pin DCU connector for the PETU

(1) DEF injector signal
(2) DEF injector return

Table 227

Component	Controller	Electrical Checkout
DEF Injector	Dosing Control Unit (DCU)	**DEF Dosing System Verification Test :** Initiate the DEF Dosing System Verification test in the electronic service tool to activate the injector circuit.
Coolant Diverter Valve	Dosing Control Unit (DCU)	**DEF Coolant Diverter Valve Solenoid Override :** Turn the keyswitch to the OFF position for 2 minutes. The keyswitch must be off for 2 minutes to allow the DEF pump to purge, to reset the code, and to reset the DCU. Turn the keyswitch to the ON position. Initiate the DEF Coolant Diverter Valve Solenoid Override in the electronic service tool to activate the coolant diverter valve circuit.

Table 228

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	T40-0241	Probe - Female	2
B	T40-0240	Probe - Male	2
C	T40-1591	Probe - Female	2

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

Table 229

Troubleshooting Test Steps	Values	Results
1. Inspect Electrical Connectors and Wiring **A.** Thoroughly inspect the 12-pin connector for the PETU and the C1 DCU connector. Refer to Troubleshooting, "Electrical Connectors - Inspect" for details. **B.** Thoroughly inspect the connector for the suspect solenoid valve. Refer to Troubleshooting, "Electrical Connectors - Inspect" for details. **C.** Perform a 45 N (10 lb) pull test on each of the wires in the 12-pin connector for the PETU, the C2 DCU connector, and the solenoid connectors that are associated with the active diagnostic code. **D.** Check the harness for corrosion, abrasion, and pinch points from the solenoids 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 20 seconds for activation of the diagnostic codes. **D.** Verify if any of the diagnostic codes that are listed in Table 226 are active. **E.** Turn the keyswitch to the OFF position.	Diagnostic codes	**Result:** A 3363-5 or 3126-5 diagnostic code is active. Proceed to Test Step 3. **Result:** A 3363-6 or 3126-6 diagnostic code is active. Proceed to Test Step 4. **Result:** A 3361-5, 3821-5 , 3361-6 or 3821-6 diagnostic code is active. Proceed to Test Step 5.
3. Check the Wiring for an Open Circuit **A.** Verify that the harness connector is free of debris, free of corrosion and securely connected. **B.** Disconnect the solenoid from the applicable harness. **C.** Connect a jumper wire between the terminals of the harness connector for the suspect coil. The coil is replaced with a short circuit. **D.** Perform the appropriate electrical checkout. Refer to Table 227 .	Wiring	**Result :** A -5 code became active during the electrical checkout. There is an open circuit in the wiring between the coil and the applicable ECM connector. **Repair :** Repair the connectors and/or the wiring. Turn the keyswitch to the OFF position for 2 minutes. The keyswitch must be off for 2 minutes to allow the DEF pump to purge, the code to reset, and the DCU to reset. Verify that the original fault is resolved. If the fault is still present, contact the Dealer Solutions Network (DSN). **Result :** A -6 code is activated during the electrical checkout. The DCU detected the jumper wire. There is a fault in the solenoid. **Repair :** Replace the solenoid. Perform the electrical checkout again to verify that the fault is resolved.

(continued)

(Table 229, contd)

Troubleshooting Test Steps	Values	Results
4. Check the Wiring for a Short Circuit **A.** Disconnect the solenoid from the applicable harness. **B.** Perform the appropriate electrical checkout. Refer to Table 227 .	Wiring	**Result :** A -6 code became active during the electrical checkout. The DCU did not detect the open circuit. There is a short circuit in the wiring between the coil and the applicable ECM connector. **Repair :** Repair the connectors and/or the wiring. Turn the keyswitch to the OFF position for 2 minutes. The keyswitch must be off for 2 minutes to allow the DEF pump to purge, the code to reset, and the DCU to reset. Perform the electrical checkout again to verify that the fault is resolved. If the fault is still present, contact the Dealer Solutions Network (DSN). **Result :** A -5 code is activated during the electrical checkout. The applicable ECM detected the open circuit. There is a fault in the solenoid. **Repair :** Replace the solenoid. Turn the keyswitch to the OFF position for 2 minutes. The keyswitch must be off for 2 minutes to allow the DEF pump to purge, the code to reset, and the DCU to reset. Perform the electrical checkout again to verify that the fault is resolved.
5. Measure the Resistance of the Injector **A.** Turn the keyswitch to the OFF position. Allow 2 minutes to elapse before proceeding. **B.** Disconnect the DEF injector from the applicable harness. **C.** Inspect the connector for damage or debris. **D.** Connect Tooling (A) to the DEF injector. The tooling must be used to prevent damage to the DEF injector connector. **E.** Measure the resistance of the DEF injector.	10 to 20 Ohms	**Result :** The resistance of the injector measured between 10 Ω and 20 Ω. Proceed to Test Step 6. **Result :** The resistance of the injector did not measure between 10 Ω and 20 Ω. A failed DEF injector has been detected. **Repair :** Replace the injector. Refer to the Disassembly and Assembly manual for the correct procedure. Use the electronic service tool to perform a DEF Dosing System Verification test. This test will verify that the fault is resolved.

(continued)

(Table 229, contd)

Troubleshooting Test Steps	Values	Results
6. Check for a Short Circuit in the Wiring Harness **A.** Disconnect the injector from the harness. **B.** Connect Tooling (B) to the DEF injector harness connector. The tooling must be used to prevent damage to the DEF injector connector. **C.** Measure the resistance between the DEF injector positive wire and the DEF injector negative wire at the DEF injector harness connector. **D.** Measure the resistance between the DEF injector positive wire and a good ground. **E.** Measure the resistance between the DEF injector negative wire and a good ground. The resistance should be greater than 1kΩ.	Greater than 1k Ohms	**Result :** The resistance of the DEF injector wiring harness measured greater than 1k Ω. Proceed to Test Step 7. **Result :** The resistance of the DEF injector wiring harness measured less than 1k Ω. There is a short circuit in the wiring harness between the DEF injector connector and the DCU or there is an external short to ground. **Repair :** Repair or replace the wiring harness. Use the electronic service tool to perform a DEF Dosing System Verification test. This test will verify that the fault is resolved.
7. Check for an Open Circuit in the Wiring Harness **A**. Disconnect the injector from the harness. **B.** Disconnect the PETU wiring harness from the DCU. **C.** Connect Tooling (B) to the DEF injector harness connector. The tooling must be used to prevent damage to the DEF injector connector. **D.** Connect Tooling (C) to terminal 12. Connect one Tooling (C) to terminal 32 on the 86-pin DCU connector. The tooling must be used to prevent damage to the DCU connectors. **E.** Measure the resistance between terminal 1 on the DEF injector connector and terminal 32 on the 86-pin DCU connector. **F.** Measure the resistance between terminal 2 on the DEF injector connector and terminal 12 on the 86-pin DCU connector.	Less than 10 Ohms	**Result:** There is more than 10 Ω of resistance on any one of the DEF injector circuit wires. There is an open in the harness. **Repair :** Repair the wiring or replace the harness. Use the electronic service tool to perform a DEF Dosing System Verification test. This test will verify that the fault is resolved. **Result:** There is less than 10 Ω of resistance on any one of the DEF injector circuit wires. The harness is OK. Contact the Dealer Solutions Network (DSN).

i06167053

Soot Sensor - Test

Use this procedure to troubleshoot a fault with the soot sensor. Also, use this procedure if the diagnostic code in Table 230 is active or easily repeated.

Table 230

Diagnostic Codes Table for Soot Sensor

(continued)

(Table 230, contd)

J1939 Code	PDL Code	Code Description (code descriptions may vary)	Comments
4783-3	3397-3	DPF #1 Mean Soot Signal : Voltage Above Normal	The Electronic Control Module (ECM) detects the following conditions: The signal voltage for the soot sensor is greater than 32 VDC for 60 seconds. The warning lamp will come on. The ECM will log the diagnostic code. The EBPR may close as a precaution.
4783-4	3397-4	DPF #1 Mean Soot Signal : Voltage Below Normal	The Electronic Control Module (ECM) detects the following conditions: The signal voltage for the soot sensor is less than 9 VDC for 60 seconds. The warning lamp will come on. The ECM will log the diagnostic code. The EBPR may close as a precaution.
4783-12	3397-12	DPF #1 Mean Soot Signal : Failure	The ECM detects the following conditions: The soot sensor has failed. The warning lamp will come on and the ECM will log the diagnostic code.
4783-21	3397-21	DPF #1 Mean Soot Signal : Data Drifted Low	The ECM detects the following conditions: The soot sensor has not received a valid signal from the soot antenna for at least 60 seconds. The warning lamp will come on and the ECM will log the diagnostic code.

Table 231

Required Tools			
Tool	Part Number	Part Description	Qty
A	T400025	Attenuator	1

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

- The ECM has been powered for at least 60 seconds.
- There are no active 168 codes.

The following background information is related to this procedure:

The soot sensor is powered from the switched battery voltage. A signal is sent by the soot sensor to one soot antenna. The signal that is received by the other antenna is sent back to the soot sensor. The signal is attenuated by the soot in the Diesel Particulate Filter (DPF). The soot sensor calculates the soot load in the DPF by measuring the attenuation of the signal.

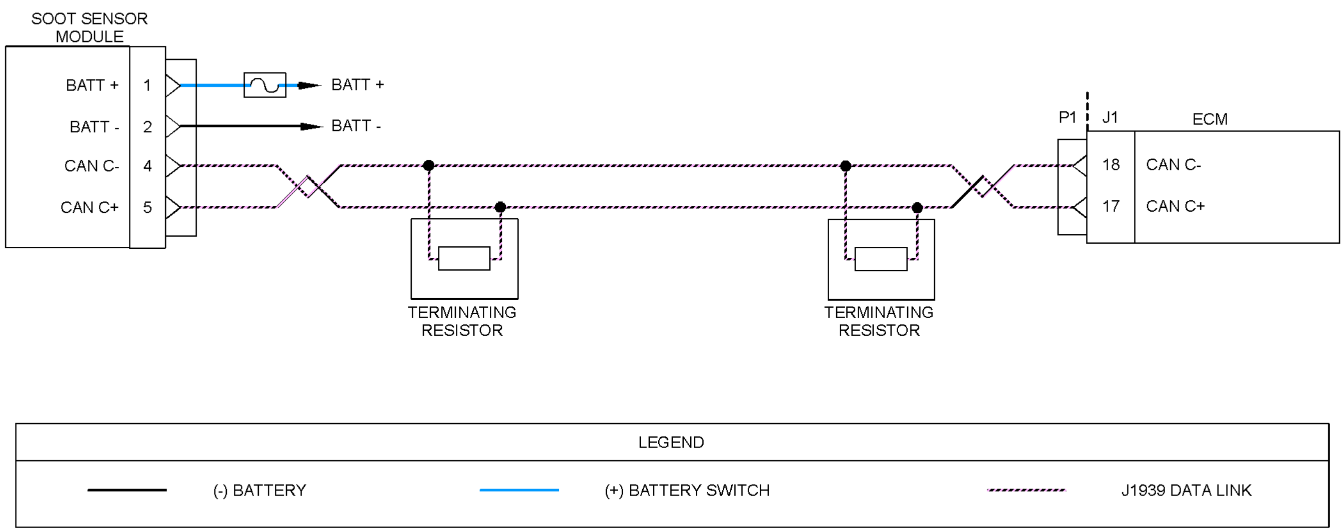


Illustration 167 g03812262

Schematic diagram for the soot sensor circuit

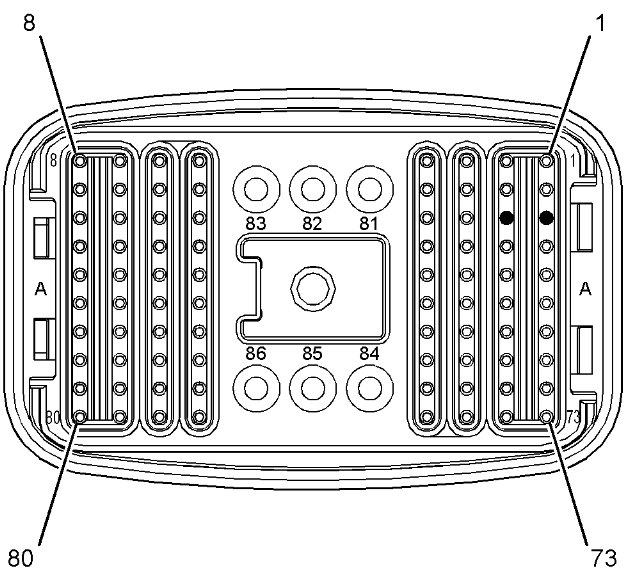


Illustration 168 g03812265

View of the pin locations on the P1 connector for the soot sensor

(17) CAN C +
(18) CAN C -

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

Table 232

Troubleshooting Test Steps	Values	Results
1. Inspect Electrical Connectors and Wiring **A.** Turn the keyswitch to the OFF position. **B.** Inspect the connectors for the speed/timing sensors. Refer to Troubleshooting, "Electrical Connectors - Inspect". **C.** Perform a 45 N (10 lb) pull test on each of the wires in the suspect sensor connector and the sensor connections at the ECM. **D.** Check the screw for the ECM connector for the correct torque of 6 N·m (53 lb in). **E.** Check the ground connection on the ECM for abrasions and pinch points. **F.** Check the harness for abrasion and pinch points from the suspect sensor to the ECM. **G.** Check that the suspect sensor is installed correctly. Check that the suspect sensor is fully seated into the engine.	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 of 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. **Repair:** There may be an intermittent fault. Use the electronic service tool to perform a Wiggle Test. If no fault is identified If no fault is identified, 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. **D.** Use the electronic service tool in order to monitor active diagnostic codes or recently logged diagnostic codes. Look for an active or logged code. **E.** Turn the keyswitch to the OFF position.	Diagnostic codes	**Result:** Diagnostic code 4783-3 or 3397-3 is active. Proceed to Test Step 3. **Result:** Diagnostic code 4783-4 or 3397-4 is active. Proceed to Test Step 4. **Result:** Diagnostic code 4783-12 or 3397-12 is active. Proceed to Test Step 5. **Result:** Diagnostic code 4783-21 or 3397-21 is active. Proceed to Test Step 6.
3. Check for a High Voltage at the Soot Sensor **A.** Turn the keyswitch to the ON position. **B.** Measure the voltage across pins 1 and 2 on the soot sensor connector. **C.** Turn the keyswitch to the OFF position.	Greater than 32 VDC	**Result:** The supply voltage is within the acceptable range for the soot sensor. Return the unit to service **Result:** The supply voltage is above the acceptable range for the soot sensor. **Repair:** Investigate the cause of the high voltage. Refer to Systems Operation, Testing and Adjusting, "Charging System - Inspect".

(continued)

(Table 232, contd)

Troubleshooting Test Steps	Values	Results
4. Check for a Low Voltage at the Soot Sensor **A.** Turn the keyswitch to the ON position. **B.** Measure the voltage across pins 1 and 2 on the soot sensor. **C.** Turn the keyswitch to the OFF position.	Less than 9 VDC	**Result:** The supply voltage is within the acceptable range for the soot sensor. Return the unit to service. **Result:** The supply voltage is below the acceptable range for the soot sensor. **Repair:** Make sure that any in-line fuses are intact. Replace any blown fuses. Check that the supply voltage is adequate. Refer to Systems Operation, Testing and Adjusting, "Charging System - Inspect". If the supply voltage is satisfactory, inspect the wiring and the connectors. Refer to Troubleshooting, "Electrical Power Supply - Test".
5. Diagnostic Code 4783-12 or 3397-12 is Active **A.** If diagnostic code 4783-12 or 3397-12 is active, the soot sensor has a fault.	Faulty sensor	**Result:** Diagnostic code 4783-12 or 3397-12 is active. There is a fault in the soot sensor. **Repair:** Replace the soot sensor.
6. Check the Soot Antennas **Note:** If diagnostic code 4783-21 or 3397-21 is active, the soot sensor is not receiving a signal from the soot antennas. **Note:** If any corrective action is performed, allow a period of 60 seconds for the diagnostic code to disappear. **A.** Inspect the coaxial cable. Check each connection for dirt or water ingress. All connectors must be clean and dry before connections are made. Verify that all of the connectors are securely connected. **B.** Torque all coaxial connectors to 1.2 N·m (10.6 lb in). **C.** After 60 seconds, check for diagnostic code 4783-21 or 3397-21. **D.** If diagnostic code 4783-21 or 3397-21 is still active, continue with this procedure. **E.** Disconnect the coaxial cables from the antennas. **F.** Connect the ends of the coaxial cables to Tooling (A). **G.** Perform the "DPF Soot Loading Sensor Functional Test" on the electronic service tool by selecting the following menus: · "Diagnostics" · "Diagnostic Tests" · "DPF Soot Loading Sensor Functional Test" **H.** Disconnect the coaxial cables from the attenuator.	Faulty soot antenna	**Result:** The "DPF Soot Loading Sensor Functional Test" is successful. The fault is in a soot antenna. **Repair:** Remove the two soot antennas from the DPF. Refer to Disassembly and Assembly, "Soot Antenna - Remove and Install". Inspect the soot antennas for damaged or bent probes. Replace a damaged antenna. If no damage is found, replace both antennas. Install the two soot antennas. Refer to Disassembly and Assembly, "Soot Antenna - Remove and Install". Ensure that the antenna connectors are tightened to a torque of 1.2 N·m (10.6 lb in). After 60 seconds, confirm that diagnostic code 4783-21 or 3397-21 is no longer active. **Result:** The "DPF Soot Loading Sensor Functional Test" is not successful. The fault is in the soot sensor or a coaxial cable. **Repair:** Replace the soot sensor. Ensure that the antenna connectors are tightened to a torque of 1.2 N·m (10.6 lb in). Repeat the "DPF Soot Loading Sensor Functional Test" and confirm that the test is successful. If the fault has not been eliminated, contact the Dealer Solutions Network (DSN).

i06198372

Speed Control (Analog) - Test

This procedure covers the following diagnostic codes:

Table 233

<table>
<tr><th colspan="4">Diagnostic Trouble Codes for Analog Throttles</th></tr>
<tr><th>J1939 Code</th><th>PDL Code</th><th>Code Description
(code descriptions may vary)</th><th>Comments</th></tr>
<tr><td>91-3</td><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 (262) 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>774-3</td><td>Accelerator Pedal Position 2: Voltage Above Normal</td></tr>
<tr><td>91-4</td><td>91-4</td><td>Accelerator Pedal Position 1 : Voltage Below Normal</td><td rowspan="2">The ECM detects one of the following conditions:
The ECM has been powered for 3 seconds.
Diagnostic code 168-4 is not active.
3510 (2131) 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.</td></tr>
<tr><td>29-4</td><td>774-4</td><td>Accelerator Pedal Position 2: Voltage Below Normal</td></tr>
<tr><td colspan="4">Follow the troubleshooting procedure in order to identify the root cause of the fault.</td></tr>
</table>

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 in order 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.

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 234

Troubleshooting Test Steps	Values	Results
1. Inspect Electrical Connectors and Wiring **A.** Thoroughly inspect the terminal connections on the P1/J1 ECM connector and the analog throttle position sensors. Refer to Troubleshooting, "Electrical Connector - Inspect". **B.** Perform a 45 N (10 lb) pull test on each of the wires in the ECM connector and the analog throttle position sensor connectors that are associated with the active diagnostic code. **C.** Check the screw for the ECM connector for the correct torque of 6 N·m (53 lb in). **D.** Check the harness for corrosion, abrasion, and pinch points from the analog throttle position sensors 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 of 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 233 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 233 is active. Proceed to Test Step 5.

(continued)

(Table 234, contd)

Troubleshooting Test Steps	Values	Results
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.
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 in order 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.

(continued)

(Table 234, contd)

Troubleshooting Test Steps	Values	Results
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 233 . 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 9. **Result:** There are no active diagnostic codes for the throttle position sensors - The fault may be intermittent. **Repair:** Refer to Troubleshooting, “Electrical Connector - Inspect”.
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 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. **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 two Ohms	**Result:** The resistance measurement is greater than two 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 two Ohms. Contact the Dealer Solutions Network (DSN).

(continued)

(Table 234, contd)

Troubleshooting Test Steps	Values	Results
9. 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 10.
10. 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 100 Ohms	**Result:** At least one of the resistance measurements is less than 100 Ohms - 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 100 Ohms. Contact the Dealer Solutions Network (DSN).

i06198381

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 235

Diagnostic Trouble Codes for the Digital Throttles			
J1939 Code	**PDL Code**	**Code Description (code descriptions may vary)**	**Comments**
29-3	774-3	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. There are no active 678 or 41 codes. 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	774-4	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. There are no active 678 or 41 codes. 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	774-8	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, 774-3, 29-4, and 774-4 are not active. There are no active 678 or 41 codes. 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	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. There are no active 678 or 41 codes. 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 235, contd)

Diagnostic Trouble Codes for the Digital Throttles			
J1939 Code	**PDL Code**	**Code Description (code descriptions may vary)**	**Comments**
91-4	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. There are no active 678 or 41 codes. 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	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. There are no active 678 or 41 codes. 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 in order 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 236

Troubleshooting Test Steps	Values	Results
1. Inspect Electrical Connectors and Wiring **A.** Thoroughly inspect the terminal connections on the P1/J1 ECM connector and the PWM throttle position sensors. Refer to Troubleshooting, “Electrical Connector - Inspect”. **B.** Perform a 45 N (10 lb) pull test on each of the wires in the ECM connector and the PWM throttle position sensor connector. **C.** Check the screw for the ECM connector for the correct torque of 6 N·m (53 lb in). **D.** 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 of 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 235 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 235 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” in order to identify intermittent faults. If the fault is still present, proceed to Test Step 3.

(continued)

(Table 236, 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 in order 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 in order 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 236, 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 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. **D.** Install the jumper wire between P1 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 236, 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.		

i06167060

Speed/Timing - Test

This procedure covers the following diagnostic codes:

Table 237

Diagnostic Codes for the Speed/Timing Sensors			
J1939 Code	**PDL Code**	**Code Description (code descriptions may vary)**	**Comments**
190-8	190-8	Engine Speed : Abnormal Frequency, Pulse Width, or Period	The Electronic Control Module (ECM) detects the following conditions: An intermittent loss of signal or a complete loss of signal from the primary speed/timing sensor for 2 seconds The engine has been running for more than 3 seconds. 3512 or 3483 diagnostic trouble codes are not active. The warning light will come on and the diagnostic code will be logged. The ECM will use the signal from the secondary speed/timing sensor. The engine will be derated. If the signal from the secondary speed/timing sensor is also lost, the engine will shut down.
723-8	342-8	Engine Speed Sensor #2 : Abnormal Frequency, Pulse Width or Period	The Electronic Control Module (ECM) detects the following conditions: A loss of signal from the secondary speed/timing sensor for 2 seconds while the signal from the primary speed/timing sensor remained valid The engine has been running for more than 3 seconds. 3512 or 3483 diagnostic trouble codes are not active. The warning lamp will come on and the diagnostic code will be logged. The loss of signal from the secondary speed/timing sensor will prevent the engine from starting.

(continued)

(Table 237, contd)

Diagnostic Codes for the Speed/Timing Sensors			
J1939 Code	**PDL Code**	**Code Description (code descriptions may vary)**	**Comments**
637-11	261-11	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. Diagnostic code 190-8 is not active. 3512 or 3483 diagnostic trouble codes are not active. The warning light will come on. This code will not be logged.
3512-3	3483-3	Sensor Supply Voltage 4 : Voltage Above Normal	The ECM detects the following conditions: The 8 VDC supply is more than 8.8 VDC for more than one second. The ECM has been powered for more than 3 seconds. Diagnostic code 168-4 is not active. The ECM will log the diagnostic code and the warning lamp will illuminate while this diagnostic code is active. The engine may be limited to low idle.
3512-4	3483-4	Sensor Supply Voltage 4 : Voltage Below Normal	The ECM detects the following conditions: The 8 VDC supply is less than 7.2 VDC for more than one second. The ECM has been powered for more than 3 seconds. Diagnostic code 168-4 is not active. The ECM will log the diagnostic code and the warning lamp will illuminate while this diagnostic code is active. The engine may be limited to low idle. An active diagnostic code may not cause any noticeable effect on engine response unless the voltage drops below 6.5 VDC.
Follow the troubleshooting procedure in order to identify the root cause of the fault.			

Use this procedure when the engine will not start and the electronic service tool indicates a faulty sensor by displaying “Not Detected” against the faulty sensor on the “No Start Parameter” screen.

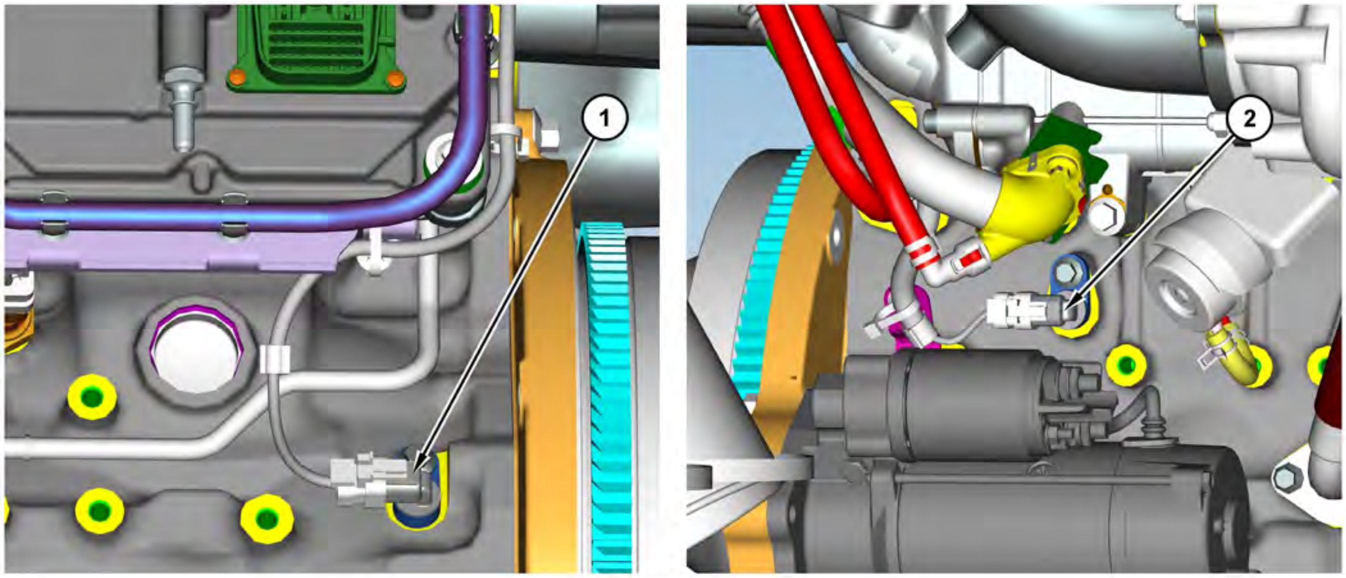


Illustration 169 g03796519

Typical examples of the sensor locations

(1) Primary speed/timing sensor (2) Secondary speed/timing sensor

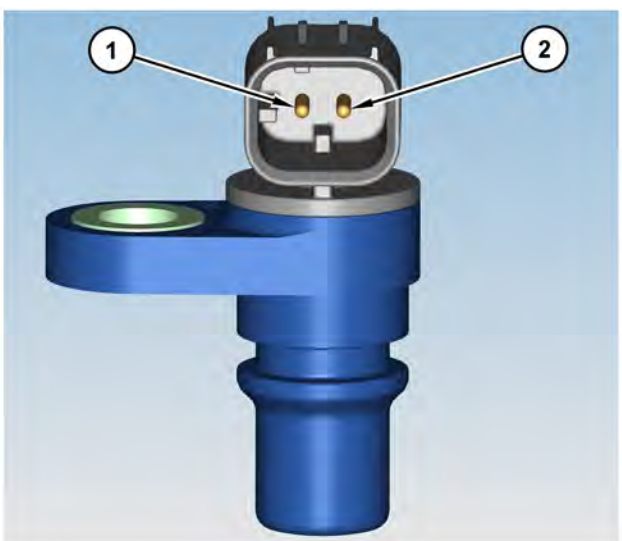


Illustration 170 g03796527

Speed/timing sensor

(1) 8 VDC Supply
(2) Signal

The engine uses two engine speed/timing sensors. The primary speed/timing sensor is located on the left-hand side of the cylinder block close to the flywheel housing. The primary speed/timing sensor generates a signal by detecting the movement of the teeth that are located on the crankshaft timing ring. The signal that is generated by the speed/timing sensor is transmitted to the ECM. The ECM uses the signal from the speed/timing sensor to calculate the position of the crankshaft. The signal is also used to determine the engine speed.

The secondary speed/timing sensor is located on the right-hand side of the cylinder block toward the rear of the engine. The secondary speed/timing sensor generates a signal that is related to the camshaft position. The secondary speed/timing sensor detects the movement of the teeth on the timing ring for the camshaft. The signal that is generated by the speed/timing sensor is transmitted to the ECM. The ECM calculates the speed and the rotational position of the engine by using the signal. The secondary speed/timing sensor is required for starting purposes.

During normal operation, the secondary speed/timing sensor is used to determine the cycle that the engine is on. When the timing has been established, the primary speed/timing sensor is then used to determine the engine speed and the angular position.

The loss of signal to the primary sensor and/or the secondary sensor will result in one of the following faults:

- The engine will continue to run when only one sensor signal is present from either the primary sensor or the secondary sensor.

- Loss of signal both sensors during operation of the engine will cause fuel injection to be terminated and the engine will stop.

The primary sensor and the secondary sensor are interchangeable components. If a sensor is suspect, the sensors can be exchanged in order to eliminate a fault. If a secondary sensor is suspect and a replacement secondary sensor is not available, then the primary sensor and the secondary sensor can be exchanged. This exchange will allow testing to determine if the secondary sensor is faulty.

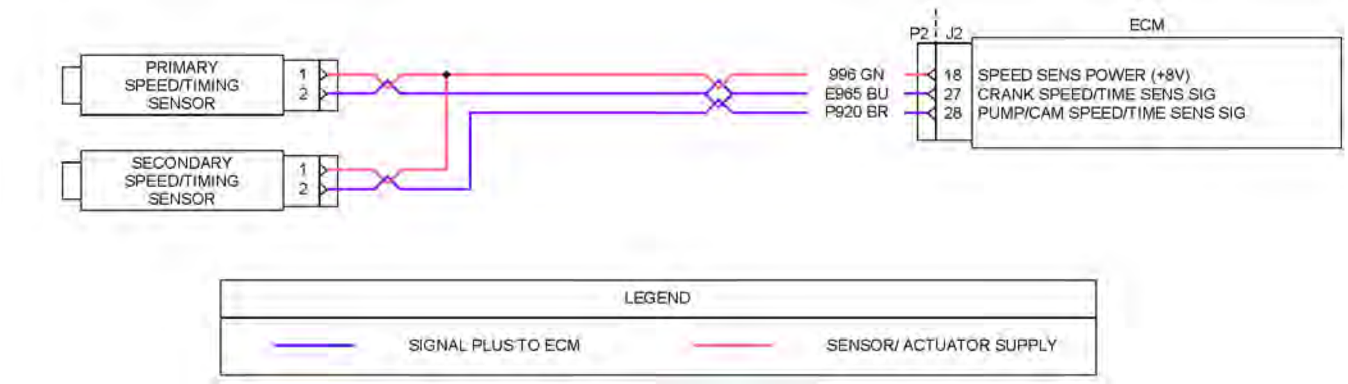


Illustration 171 g03812318

Schematic for the speed/timing sensors

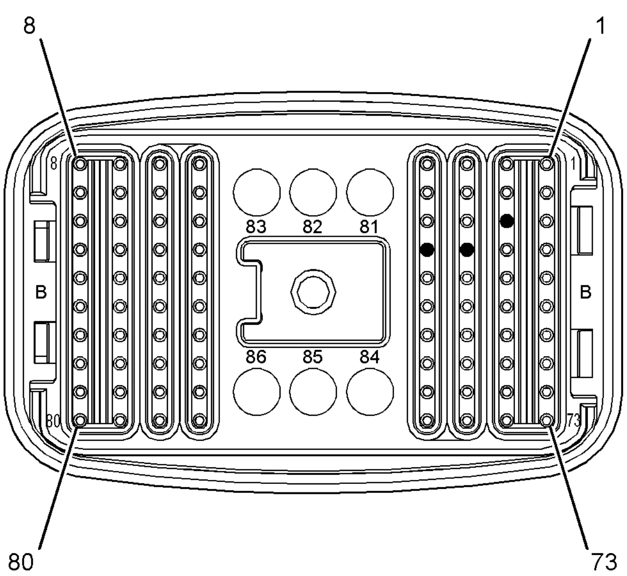


Illustration 172 g03812322

Pin locations for the speed/timing sensor on the P2 connector

(18) Supply for the speed/timing sensor (8 VDC)
(27) Signal for the primary speed/timing sensor
(28) Signal for the secondary speed/timing sensor

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

Table 238

Troubleshooting Test Steps	Values	Results
1. Inspect Electrical Connectors and Wiring **A.** Turn the keyswitch to the OFF position. **B.** Inspect the connectors for the speed/timing sensors. Refer to Troubleshooting, "Electrical Connectors - Inspect". **C.** Perform a 45 N (10 lb) pull test on each of the wires in the suspect sensor connector and the sensor connections at the ECM. **D.** Check the screw for the ECM connector for the correct torque of 6 N·m (53 lb in). **E.** Check the ground connection on the ECM for abrasions and pinch points. **F.** Check the harness for abrasion and pinch points from the suspect sensor to the ECM. **G.** Check that the suspect sensor is installed correctly. Check that the suspect sensor is fully seated into the engine.	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 of 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.** Use the electronic service tool in order to monitor active diagnostic codes or recently logged diagnostic codes. **E.** Turn the keyswitch to the OFF position.	Diagnostic codes	**Result:** Diagnostic code 637-11 or 261-11 is active or recently logged. Proceed to Test Step 3. **Result:** Diagnostic code 190-8, 723-8, or 342-8 is active or recently logged. Proceed to Test Step 5. **Result:** Diagnostic code 3512-3, 3483-3, 3512-4 or 3483-4 is active or recently logged. Proceed to Test Step 9.
3. Inspect the Sensors **A.** Ensure that the speed/timing sensors are correctly seated in 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 or 261-11 diagnostic code is still active.	Faulty sensor	**Result:** A 637-11 or 261-11 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 or 261-11 diagnostic code is still active. Proceed to Test Step 4.

(continued)

(Table 238, contd)

Troubleshooting Test Steps	Values	Results
4. Check the Crankshaft Timing Ring and the Timing Ring on the Camshaft **A.** Remove the primary speed/timing sensor and the secondary speed/timing sensor. Refer to Disassembly and Assembly, “Crankshaft Position Sensor - Remove and Install” or refer to Disassembly and Assembly, “Camshaft Position Sensor - Remove and Install”. **B.** Use a flashlight in order to check the timing ring on the camshaft through the camshaft timing hole for damage. **C.** Use a flashlight in order to check the crankshaft timing ring for damaged teeth or missing teeth. Ensure that the crankshaft timing ring has not been displaced from the crankshaft.	Loose timing ring or damaged teeth	**Result:** Fault identified with the crankshaft timing ring or the timing ring on the camshaft. **Repair:** If necessary, replace the camshaft. Refer to Disassembly and Assembly, “Camshaft - Remove” and refer to Disassembly and Assembly, “Camshaft - Install”. If necessary, replace the crankshaft timing ring. Refer to Disassembly and Assembly, “Crankshaft Timing Ring - Remove and Install”. Use the electronic service tool in order to clear all logged diagnostic codes and then verify that the repair has eliminated the fault. **Result:** No faults found. Repeat this procedure from Test Step 3.
5. Measure the Supply Voltage at the Sensor Connector **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the speed/timing sensor with the active diagnostic code. **C.** Turn the keyswitch to the ON position. **D.** Measure the voltage from terminal 1 on the sensor connector to engine ground.	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 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 correct. Proceed to Test Step 6.

(continued)

(Table 238, contd)

Troubleshooting Test Steps	Values	Results
6. Exchange the Sensors **A.** Turn the keyswitch to the OFF position. **B.** Exchange the primary speed/timing sensor with the secondary speed/timing sensor. Refer to Disassembly and Assembly, “Crankshaft Position Sensor - Remove and Install” and refer to Disassembly and Assembly, “Camshaft Position Sensor - Remove and Install”. **C.** Turn the keyswitch to the ON position. **D.** Start the engine. **E.** Use the electronic service tool to check for active diagnostic codes. Wait for 30 seconds in order for diagnostic codes to become active.	A 190-8 diagnostic code was previously active. A 723-8, or 342-8 diagnostic code is now active. OR A 723-8, or 342-8 diagnostic code was previously active. A 190-8 diagnostic code is now active.	**Result:** The active diagnostic code is now for the other speed/timing sensor. **Repair:** Turn the keyswitch to the OFF position. Disconnect the suspect sensor and remove the suspect sensor from the engine. Install a replacement sensor. Refer to Disassembly and Assembly, “Crankshaft Position Sensor - Remove and Install” or refer to Disassembly and Assembly, “Camshaft Position Sensor - Remove and Install”. Turn the keyswitch to the ON position and start the engine. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault. **Result:** The diagnostic code that was previously active is still active. Proceed to Test Step 7.
7. Check the Signal Wire for an Open Circuit **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the P2 connector. Disconnect the connector for the suspect speed/timing sensor. **C.** Check the resistance between terminal 2 on the harness connector for the sensor and the appropriate terminal on the P2 connector. Refer to Illustration 171 .	Less than two Ohms	**Result:** The resistance is greater than two Ohms - There is an open circuit or high resistance in the 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 is less than two Ohms. Proceed to Test Step 8.
8. Check the Signal Wire for a Short Circuit **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the P2 connector. Disconnect the connector for the suspect speed/timing sensor. **C.** Check the resistance between the suspect sensor signal terminal and all other terminals on the P2 connector. Refer to Illustration 172 .	Greater than 100 Ohms	**Result:** At least one of the resistance measurements is less than 100 Ohms. 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:** All resistance measurements are greater than 100 Ohms. Proceed to Test Step 9.

(continued)

(Table 238, contd)

Troubleshooting Test Steps	Values	Results
9. Disconnect the Sensors One at a Time **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the engine speed/timing sensors one at a time. Wait 30 seconds after each sensor is disconnected. Use the electronic service tool to monitor the diagnostic codes. **Note:** The 3512-X or 3483-X diagnostic code will become inactive when the sensor that caused the 8 VDC diagnostic code is disconnected.	Diagnostic code	**Result:** The 3512-X or 3483-X diagnostic code is not active when all of the sensors are disconnected. **Repair:** Replace the suspect sensor. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault. **Result:** The 3512-X or 3483-X diagnostic code is still active. Proceed to Test Step 10.
10. Check the 8 VDC Supply from the ECM **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the P2 connector from the ECM. **C.** Turn the keyswitch to the ON position. **D.** Measure the voltage from J2:18 on the ECM to a suitable ground.	7.5 to 8.5 VDC	**Result:** The 8 VDC supply voltage from the ECM is within specification. The fault is in the harness. **Repair:** Repair the faulty connectors or replace the harness. Reconnect all sensor and ECM connectors. Ensure that all of the seals are correctly in place. Ensure that all connectors are correctly coupled. Use the electronic service tool to clear all logged diagnostic codes and verify that the repair eliminates the fault. **Result:** The 8 VDC supply voltage from the ECM is outside the specified limits. Contact the Dealer Solutions Network (DSN).

i06198345

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 239 .

Table 239

Diagnostic Code for the Air Filter Restriction Switch			
J1939 Code	**PDL Code**	**Code Description (code descriptions may vary)**	**Comments**
107-3	582-3	Engine Air Filter 1 Differential Pressure : Voltage Above Normal	This code indicates a fault in the circuit for the air filter restriction switch. The air filter restriction circuit is open or shorted for at least 1 second while the engine is not running. The open or short circuit depends on the configuration of the switch.

Tables 240 and 241 contains the normal engine conditions and switch states for the air filter restrictions switch.

Table 240

Normally Open Air Filter Restriction Switch	
Engine Condition	**Switch State**
Not running	Open
Running	Closed

Table 241

Normally Closed Air Filter Restriction Switch	
Engine Condition	**Switch State**
Not running	Closed
Running	Open

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 242

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” .	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 or 582-3 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 or 582-3 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 or 582-3 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 or 582-3 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).

i06198353

Switch Circuits - Test
(Multiposition Throttle Switch)

This procedure covers the following diagnostic codes:

Table 243

Diagnostic Trouble Codes for Throttle Switch			
J1939 Code	**PDL Code**	**Code Description (code descriptions may vary)**	**Comments**
29-2	774-2	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	91-2	Accelerator Pedal Position 1 : Erratic, Intermittent or Incorrect	
Follow the troubleshooting procedure in order 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 244

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 45 N (10 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 screw for the ECM connector for the correct torque of 6 N·m (53 lb in). **E.** Check the ground connection on the ECM for abrasions and pinch points. **F.** 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 of 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” in order 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 244, 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 two Ohms	**Result:** At least one of the resistance measurements is greater than two 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 in order to clear all logged diagnostic codes and then verify that the repair has eliminated the fault. **Result:** All resistance measurements are less than two 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 100 Ohms	**Result:** At least one of the resistance measurements is less than 100 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 100 Ohms. Contact the Dealer Solutions Network (DSN).

i06177722

Valve Position - Test

This procedure covers the following diagnostic codes:

Table 245

Diagnostic Codes for the Valve Position Sensors			
J1939 Code	PDL Code	Code Description (code descriptions may vary)	Comments
27-3	3407-3	EGR #1 Valve Position : Voltage Above Normal	The Electronic Control Module (ECM) detects the following conditions: The signal voltage from the position sensor on the NOx Reduction System (NRS) valve is greater than 4.8 VDC for 0.1 seconds. The warning lamp will come on. The ECM will log the diagnostic code. The NRS valve will be fully closed while the code is active. The engine will be derated.
27-4	3407-4	EGR #1 Valve Position : Voltage Below Normal	The ECM detects the following conditions: The signal voltage from the NRS valve position sensor is less than 0.2 VDC for 0.1 seconds. The warning lamp will come on. The ECM will log the diagnostic code. The NRS valve will be fully closed while the code is active. The engine will be derated.
5625-3	3513-3	Engine Exhaust Back Pressure Regulator Position : Voltage Above Normal	The ECM detects the following conditions: The signal voltage from the position sensor on the exhaust back pressure regulator is greater than 4.8 VDC for 0.1 seconds. The warning lamp will come on. The ECM will log the diagnostic code. The engine exhaust back pressure regulator will be fully open while the code is active. The engine will be derated.
5625-4	3513-4	Engine Exhaust Back Pressure Regulator Position : Voltage Below Normal	The ECM detects the following conditions: The signal voltage from the position sensor on the exhaust back pressure regulator is less than 0.2 VDC for 0.1 seconds. The warning lamp will come on. The ECM will log the diagnostic code. The exhaust back pressure regulator will be fully open while the code is active. The engine will be derated.
Follow the troubleshooting procedure in order to identify the root cause of the fault.			

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

- The ECM has been powered for at least 2 seconds.
- There are no active 168 codes.
- There are no active 3509 or 262 codes.

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

- NRS valve
- Exhaust back pressure regulator

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 ECM supplies 5.0 VDC to terminal “1” of both valve connectors. The sensor common from the ECM connector goes to terminal “2” of both valve connectors. 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 terminal “3” of both valves is supplied to the appropriate terminal at the 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 in order 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.

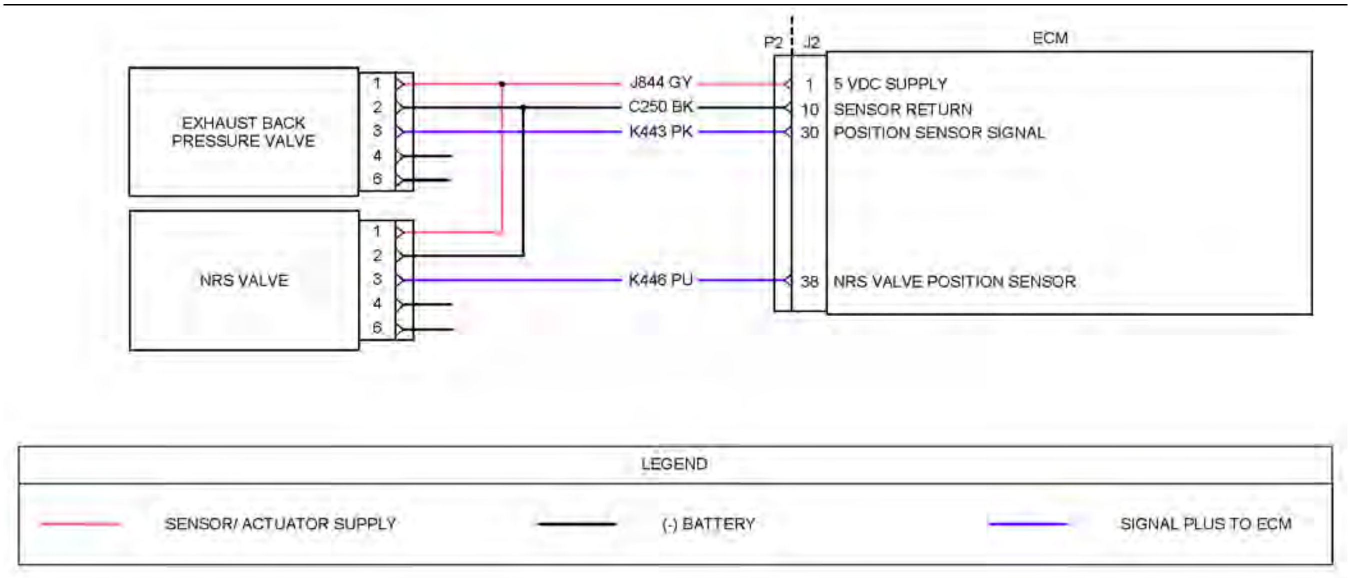


Illustration 173 g03812374

Schematic diagram for the valve position sensors

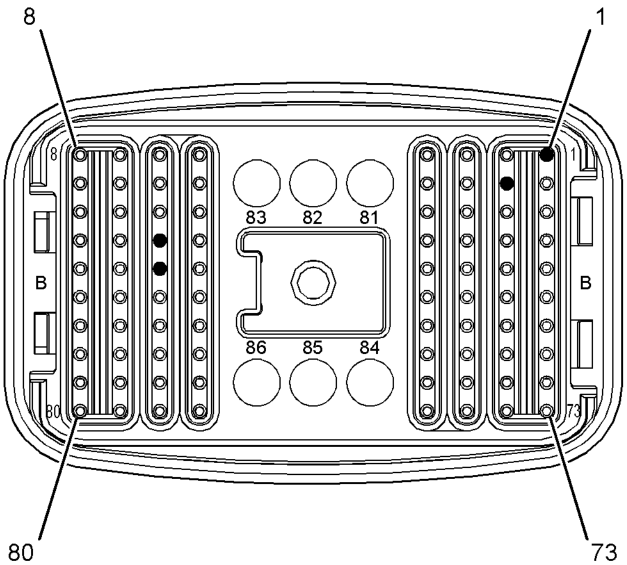


Illustration 174 g03812375

Pin locations on the P2 connector for the valve position sensors

(1) Valve position sensor 5 VDC supply
(10) Valve position sensors ground
(30) Combustion air valve position sensor signal
(38) NRS valve position sensor signal

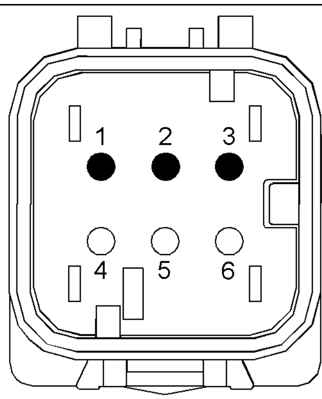


Illustration 175 g03177615

Connector for the NRS valve

(1) 5 VDC supply
(2) Position sensor ground
(3) Position sensor signal

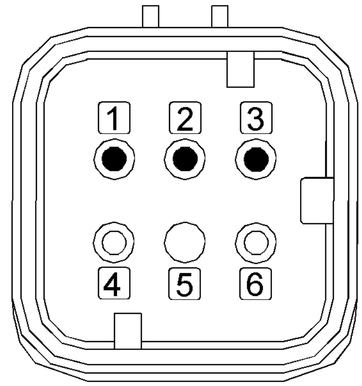


Illustration 176 g03177636

Connector for the exhaust back pressure regulator

(1) 5 VDC supply
(2) Position sensor ground
(3) Position sensor signal

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

Table 246

Troubleshooting Test Steps	Values	Results
1. Inspect Electrical Connectors and Wiring **A.** Turn the keyswitch to the OFF position. **B.** Inspect the connectors for the valve position sensors. Refer to Troubleshooting, “Electrical Connectors - Inspect”. **C.** Perform a 45 N (10 lb) pull test on each of the wires in the suspect sensor connector and the sensor connections at the ECM. **D.** Check the screw for the J2 ECM connector for the correct torque of 6 N·m (53 lb in). **E.** Check the ground connection on the ECM for abrasions and pinch points. **F.** 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 of 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.** Use the electronic service tool in order to monitor active diagnostic codes or recently logged diagnostic codes. **E.** Turn the keyswitch to the OFF position.	Diagnostic codes	**Result:** One or more of the preceding diagnostic codes are active or recently logged. Proceed to Test Step 3. **Result:** None of the preceding diagnostic codes are active or recently logged. **Repair:** The fault may be intermittent. Refer to Troubleshooting, “Electrical Connectors - Inspect”. Perform a “Wiggle Test” by using the electronic service tool in order to identify intermittent connections.
3. Measure the Supply Voltage at the Valve Connector **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the suspect valve from the harness. **C.** Turn the keyswitch to the ON position. **D.** Measure the voltage between terminals 1 and 2 at the connector for the valve. **E.** Reconnect the valve to the harness.	4.84 to 5.16 VDC	**Result:** The sensor supply voltage is out of the nominal range. The fault is in the engine harness between the valve connector and the ECM. **Repair:** Repair the faulty valve 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 sensor supply voltage is correct. Proceed to Test Step 4.

(continued)

(Table 246, contd)

Troubleshooting Test Steps	Values	Results
4. Verify that the Diagnostic Code is Still 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:** An XXXX-4 diagnostic code is active at this time. Proceed to Test Step 5. **Result:** An XXXX-3 diagnostic code is active at this time. Proceed to Test Step 7. **Result:** No diagnostic codes are active at this time. An intermittent fault may exist. **Repair:** Use the electronic service tool to perform a “Wiggle Test” . If faults are indicated, then go to the appropriate procedure.
5. 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 XXXX-4 diagnostic code. **C.** Remove the wire for the position sensor signal from the harness connector for the valve. **D.** Reconnect the connector for the valve. **E.** Turn the keyswitch to the ON position. Wait for at least 10 seconds for activation of the diagnostic codes. **F.** Use the electronic service tool to check the “Active Diagnostic Code” screen. Check for an XXXX-3 diagnostic code. **G.** Turn the keyswitch to the OFF position.	Open circuit	**Result:** An XXXX-4 diagnostic code was active before removing the signal wire. An XXXX-3 diagnostic code became active after removing the signal wire. **Repair:** Disconnect the connector for the valve. Reconnect the signal wire for the position sensor. Reconnect the connector for the valve. Turn the keyswitch to the ON position. Use the electronic service tool to check for active diagnostic codes. If the XXXX-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 verify that the repair eliminates the fault. **Result:** There is still an XXXX-4 diagnostic code active with the signal wire removed. The valve position sensor is OK. **Repair:** Return all wires to the original configuration. Proceed to Test Step 6.

(continued)

(Table 246, contd)

Troubleshooting Test Steps	Values	Results
6. Check the Harness for a Short Circuit **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the P2 ECM connector and the connector for the suspect valve. **C.** For a suspect NRS valve position sensor, measure the resistance between P2:38 and all other terminals on P2. **D.** For a suspect EBPR position sensor, measure the resistance between P2:30 and all other terminals on P2. **E.** Install the removed connectors.	Greater than 100 Ohms	**Result:** The measured resistance is less than 100 Ohms. There is a short circuit in the harness. **Repair:** Repair the valve connector or replace the harness. 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 100 Ohms. Contact the Dealer Solutions Network (DSN).
7. 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 XXXX-3 diagnostic code. **C.** Fabricate a jumper wire that is 150 mm (6 inch) long. **D.** Insert one end of the jumper wire into terminal 3 on the harness connector for the suspect valve. Insert the other end of the jumper into terminal 2. **E.** Turn the keyswitch to the ON position. **F.** Access the “Active Diagnostic Codes” screen on the electronic service tool and check for an active XXXX-4 diagnostic code for the suspect sensor. **G.** Remove the jumper.	Less than two Ohms	**Result:** An XXXX-3 diagnostic code was active before the jumper was installed. An XXXX-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 XXXX-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 verify that the repair eliminates the fault. **Result:** An XXXX-3 diagnostic code remains active when the jumper is installed. The valve is OK. Proceed to Test Step 8.
8. Check the Wiring Harness for an Open Circuit **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the P2 ECM connector and the connector for the suspect valve. **C.** For a suspect NRS valve, check the resistance between terminal 3 on the valve connector and P2:38. **D.** For a suspect exhaust back pressure regulator, check the resistance between terminal 3 on the valve connector and P2:30. **E.** Install the removed connectors.	Less than two Ohms	**Result:** The measured resistance is greater than two Ohms. There is an open circuit in the harness. **Repair:** Repair the valve connector or replace the harness. 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 two Ohms. Contact the Dealer Solutions Network (DSN).

i07907488

Water in Fuel - Test

For a 97-15 or 97-16 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 247

Diagnostic Trouble Code for the Water-in-Fuel Sensor			
J1939 Code	**PDL code**	**Code Description (code descriptions may vary**	**Comments**
97-3	3547-3	Water In Fuel Indicator : Voltage Above Normal	The ECM detects the following conditions: An open circuit in the Water-In-Fuel (WIF) sensor circuit. The ECM has been powered for less than 5 seconds. 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 45 seconds, a 97-15 (E232-1) diagnostic code will become active. If the signal remains constant for 1 hour, a 97-16 (E232-2) diagnostic code will become active. These diagnostic codes can also be caused by a short in the WIF sensor circuit.

Water-in-Fuel Sensor Self Check

When the ignition keyswitch is turned to the ON position, the switch in the WIF sensor will close for 5 seconds. If the ECM does not detect a signal from the WIF sensor during this period, a 97–3 (3547-3) diagnostic code will become active.

Table 248

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 the P1/J1 ECM connector. Refer to Troubleshooting, "Electrical Connectors - Inspect". **C.** Perform a 45 N (10 lb) pull test on each of the wires that are associated with the WIF sensor. **D.** Check the screw for the ECM connector for the correct torque of 6 N·m (53 lb in). **E.** Check the harness for abrasions, for pinch points, and for corrosion.	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 (E232 (1)) or 97-16 (E232 (2)) diagnostic code is active. Refer to Troubleshooting, "Fuel Contains Water" before continuing with this procedure. Proceed to Test Step 3. **Result:** A 97-3 (3547-3) diagnostic code is active. Proceed to Test Step 3.
3. Check the Supply Voltage at the Sensor Connector **Note:** Refer to the Electrical Schematic for the application to determine the sensor supply voltage. **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 VDC and 13 VDC for a 12 VDC system. Between 22 VDC and 26 VDC for a 24 VDC system. Between 7.5 VDC and 8.5 VDC for an 8 VDC supply	**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 248, 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 (3547-3) diagnostic code is active. Proceed to Test Step 5. **Result:** A 97-15 (E232 (1)) diagnostic code is active. Proceed to Test Step 7. **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 OFF position. **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.** Turn the keyswitch to the ON position. Wait for at least 1 minute. **F.** Monitor the active diagnostic code screen on the electronic service tool. Check and record any active diagnostic codes.	Open circuit	**Result:** A 97-3 (3547-3) diagnostic code was active before installing the jumper. A 97-15 (E232 (1)) 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 (3547-3) diagnostic code with the jumper installed. The sensor is OK. Proceed to Test Step 6.
6. Check the Harness for an Open Circuit **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the connector for the water-in-fuel sensor and P1 connector. **C.** Use a multimeter to check the resistance of the sensor signal wiring between the sensor connector and the P1 connector. **Note:** Refer to the Electrical Schematic for the application for the correct terminals. **D.** Install the removed connectors.	Less than 2 Ohms.	**Result:** The measured resistances are greater than 2 Ohms. There is an open circuit in the harness. **Repair:** Repair the sensor connector or replace the harness. 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. There may be a short circuit in the harness. Proceed to Test Step 7.

(continued)

(Table 248, contd)

Troubleshooting Test Steps	Values	Results
7. Create an Open Circuit at the Sensor Connector **A.** Turn the keyswitch to the OFF position. **B.** Disconnect the WIF sensor from the harness. **C.** Turn the keyswitch to the ON position. **D.** Monitor the active diagnostic code screen on the electronic service tool. Check and record any active diagnostic codes.	Short circuit	**Result:** A 97-15 (E232 (1)) diagnostic code is active with the WIF sensor connected. A 97-3 (3547-3) 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 (E232(1)) diagnostic code is still active with the WIF sensor disconnected. The WIF sensor is OK. Proceed to Test Step 8.
8. 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. **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 100 Ohms	**Result:** The measured resistances are less than 100 Ohms. There is a short in the harness. **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 measured resistance is greater than 100 Ohms. There is a fault in the ECM. Contact the Dealer Solutions Network (DSN).

Service

i07905913

Service Tool Features

Note: With the release of Tier 4 Final engines, additional emissions control system components have been added to the engine to reduce the NOx output. The addition of these components requires two Electronic Control Modules (ECMs) for the engine and aftertreatment systems to operate. 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.

In the electronic service tool, select the engine ECM or the Dosing Control Unit (DCU) as appropriate for the required override.

Override Parameters Listed in the Engine ECM Menu

Aftertreatment #1 Intake NOx Level Sensor Power Supply Override

This override can be used during troubleshooting to reset the SCR intake NOx sensor without having to cycle key power to the Engine ECM.

Aftertreatment #1 Outlet #1 NOx Level Sensor Power Supply Override

This override can be used during troubleshooting to reset the SCR Outlet NOx Sensor without having to cycle key power to the Engine ECM.

Aftertreatment #1 DEF Dosing Control Module Key Switch Line

This override resets the Dosing Control Unit (DCU) without having to cycle key power to the other ECM's. The reset ensures that the DCU completes a purge cycle, resets any active codes, and shuts down correctly.

This test turns off the key switch power from the engine ECM to the DCU for approximately 2 minutes. Once the DCU has successfully powered down and reset, the key switch power supply will be turned back on. The DCU will then be operational.

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.

Engine Shutdown Lamp

This override provides the facility to test the electrical circuit for the Engine Shutdown Lamp. The override commands the Engine Shutdown Lamp on.

Ether Starting Aid Override

This override is used to confirm the correct operation of the ether system. Remove the ether canister from the system before testing the ether injection system. Refer to Troubleshooting, “Ether Starting Aid - Test”. The override requires that engine speed must be zero. The override will be unavailable for a short duration if glow plugs are active.

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. The override will be unavailable for a short duration if ether injection is active.

Override Parameters Listed in the Diesel Exhaust Fluid Controller (DCU) Menu

DEF Coolant Diverter Valve Solenoid Override

The override is used to check the solenoid and diverter valve harness. This override will open the coolant diverter valve, allowing coolant to flow through the Pump, Electronics, and Tank Unit (PETU) . This test can be used to verify that the coolant diverter valve is working correctly.

This override will only enable with the engine running at idle prior to the DEF system priming to operating pressure.

DEF Dosing Injector Override

This override allows the user to test the electrical circuit for the DEF injector. The override commands the DEF injector to open. This override only operates when there is no engine speed.

System Troubleshooting Settings

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

In the electronic service tool, select the engine ECM or the Dosing Control Unit (DCU) as appropriate for the required override.

System Troubleshooting Settings Listed in the Engine ECM Menu

Engine Emissions Operator Inducement Service Mode Override

The override is used by service technicians to stop the inducement counter and disable engine restrictions due to inducement in order to perform troubleshooting. Once the override is activated, the operator can navigate to other functions in the electronic service tool.

Factory passwords are required to perform this override as the engine will be operating outside of the emissions window.

Injector 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 of the active diagnostic codes.

In the electronic service tool, select the engine ECM or the Dosing Control Unit (DCU) as appropriate.

Select the “Diagnostics” tab.

Select the “Active Diagnostic Codes” tab.

Tab Functions At Bottom of Screen

Reset All

This tab will reset all of the active codes.

Troubleshoot Code

This tab is currently not available for Tier 4 engines. Refer to Troubleshooting, “Diagnostic Trouble Codes” for further information.

Troubleshoot Symptom

This tab is currently not available for Tier 4 engines. Refer to Troubleshooting, “Diagnostic Trouble Codes” for further information.

Logged Diagnostic Codes

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

In the electronic service tool, select the engine ECM or the Dosing Control Unit (DCU) as appropriate.

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 currently not available for Tier 4 engines. Refer to Troubleshooting, “Diagnostic Trouble Codes” for further information.

Troubleshoot Symptom

This tab is currently not available for Tier 4 engines. Refer to Troubleshooting, “Diagnostic Trouble Codes” for further information.

Active Event Codes

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

In the electronic service tool, select the engine ECM or the Dosing Control Unit (DCU) as appropriate.

Select the “Diagnostics” tab.

Select the “Events” tab.

Tab Function At Bottom of Screen

Reset All

This tab will reset all of 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 of the logged event codes.

In the electronic service tool, select the engine ECM or the Dosing Control Unit (DCU) as appropriate.

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 currently not available for Tier 4 engines. Refer to Troubleshooting, “Diagnostic Trouble Codes” for further information.

Troubleshoot Symptom

This tab is currently not available for Tier 4 engines. Refer to Troubleshooting, “Diagnostic Trouble Codes” for further information.

Diagnostic Tests

Electronic service tool diagnostic tests are listed below.

In the electronic service tool, select the engine ECM or the Dosing Control Unit (DCU) as appropriate.

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. In order to start the test, select the “Start” button. The automatic test will continually cycle through the injectors until the “Stop” button is selected.

There is 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 cut out. The cylinder cutout test is useful when troubleshooting poor engine performance or a suspected injector failure

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 on one injector or multiple injectors at once. This function provides a way to identify misfiring cylinders when the engine is running.

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.

DPF Soot Loading Sensor Functional Test

This test is used to determine if the mean soot level and standard deviation are within range.

Fuel Rail Pressure Relief Valve Test

The purpose of this test is check that the opening pressure for the pressure relief valve is above 220 MPa (31900 psi). The engine speed is automatically increased above a minimum threshold when this test is run and then the rail pressure is increased to 220 MPa (31900 psi). After a short time, the rail pressure is reduced to normal.

Fuel Rail Pressure Test

The purpose of this test is 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 220 MPa (31900 psi) and held at this pressure for a time. The rail pressure is then reduced to normal. 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 Exhaust Back Pressure Regulator (EBPR) in order to establish a desired cylinder head pressure differential. If the target pressure differential is not achieved, an error identifier will be displayed, indicating that the EGR intake pressure is not responding.

If the pressure differential 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.

Air System Motor Valves Verification Test

The Air System Motor Valve Verification Test will identify whether the EGR valve, and the EBPR are working correctly. This test must be run when the engine speed is zero and the battery voltage is within an acceptable range. For a 12VDC system, the service test must only be executed if the battery voltage is between 9VDC and 16VDC. For a 24VDC system, the battery voltage must be between 18VDC and 32VDC. If the battery voltage is outside of these ranges at any time, the test must be aborted. The test will actively check position sensor diagnostics, motor short diagnostic and motor open circuit diagnostic and will abort if any of these become active..

If at any point during the test the engine speed is not zero, the test will abort. The test moves the valves to various positions and then checks the position sensor within each valve to confirm that the valve has responded correctly. Providing no electrical diagnostics are active, the test will calibrate the EBPR maximum position and EGR valve minimum position. Each valve will be tested in turn, starting with the EGR valve. If a test threshold is exceeded or any related diagnostics become active, the test will abort and generate an error identifier.

Aftertreatment System Functional 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 verify that the SCR System is functioning correctly. The EBPR and elevated engine speed are used to increase the exhaust gas temperature. The higher temperature allows the NOx sensors and SCR system to control active DEF dosing.

When the NOx sensors are ready for use, the sensors control DEF dosing and check that the NOx conversion efficiency meets the test target value.

The following conditions must be met for the test to start:

- Coolant at the minimum required temperature
- DEF at the minimum required temperature
- Exhaust gas at the minimum required temperature
- Sufficient DEF in the tank
- No related active diagnostic codes

- Engine speed and load in the required range

Once the target SCR inlet temperature has been achieved and the NOx conversion level has been met, the test will complete successfully.

If a related diagnostic code is generated during the test, the test will be aborted.

If the test times out with no active codes and NOx conversion test criteria is not met, a low NOx conversion error identifier is logged.

If certain DCU faults are active, the test will cycle power to the DCU in an attempt to clear these faults before continuing the test.

If an active low DEF concentration event or low NOx conversion ratio event is present, the test will be modified. This mode will request that DEF dosing be reduced to a minimum in order to remove all stored ammonia in the catalyst. The test will then attempt to clear the NOx conversion and DEF concentration events in an abbreviated time period. If the events are cleared, the test will complete successfully. If the events are still active, the test will fail after a timeout period.

Manual HC 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 in order to clean the SCR system so that acceptable NOx conversion is maintained. The test checks that HC dosing raises the SCR 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 of the following criteria are met:

- The engine is running
- Coolant at the minimum required temperature
- No active diagnostic codes

The test will initially use the EBPR to increase the DOC intake temperature. When the target DOC inlet temperature is reached, HC dosing will begin and the initial temperature rise across the DOC is assessed. If the temperature rise is insufficient, the EBPR will be used to raise the DOC intake temperature further. If the required temperature rise is achieved, HC dosing will increase until the DPF intake temperature reaches approximately 475° C (887° F). If the target temperature is achieved, HC dosing continues until the SCR intake temperature reaches 475° C (887° F). If the target SCR intake temperature is achieved, the test will end successfully.

Diagnostic Tests Listed in the Diesel Exhaust Fluid Controller #1 Menu

DEF Dosing System Purge Test

This test verifies that the DEF purging process is working correctly by purging the DEF pump and lines.

This service test is used to purge the DEF system. This test turns on the DEF pump and opens the reversing valve, causing the DEF to be pumped from the injector back into the tank. Purging allows the system to de-pressurize and empty prior to repair work.

DEF Dosing System Accuracy Test

This test is used to measure the amount of DEF that the SCR dosing system is delivering. The test can also be used to confirm that there is an acceptable spray pattern from the DEF Injector.

Note: The DEF injector must be removed from the exhaust system during this test and placed in an appropriate container. Failure to do so could result in issues with the SCR system operation. Refer to Systems Operation, Testing, and Adjusting, “Aftertreatment SCR System Dosing Test”.

This test turns on the DEF pump and opens the DEF injector. The DEF injector atomizes the DEF and the spray pattern must be uniform in order for the SCR system to work correctly. Once the test completes, the system will purge and the amount of DEF in the container must be confirmed to meet the specification.

DEF Heated Lines Test

This test checks the electrical circuit integrity by activating the line heaters. The test is used to validate a repair made to any of the heated line circuits.

This test turns on all of the line heaters. The test will cycle the line heaters on and off for 5 minutes. After 5 minutes, the test will turn off. This test is used to check the line heater circuit for faults.

DEF Dosing System Verification Test

This test primes the dosing system. The test is used to ensure that the DEF pump is able to build adequate pressure.

This test turns on the DEF pump for 5 minutes. During this time, the DEF pump will pressurize the entire DEF dosing system. The DEF injector will remain closed in order to maintain a constant pressure within the dosing system. The DEF pump will purge the system at the end of the test.

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 of 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. The calibration must only be performed 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.

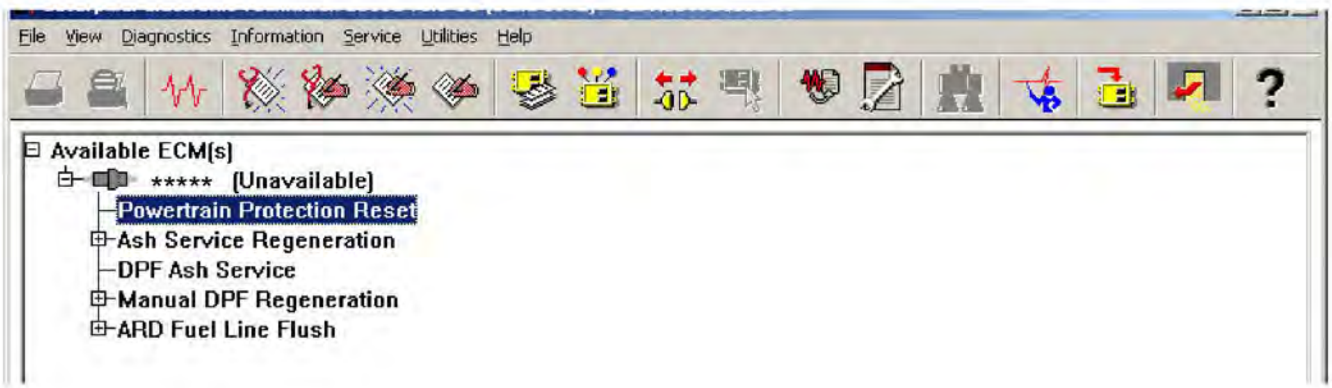


Illustration 177 g03826879

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

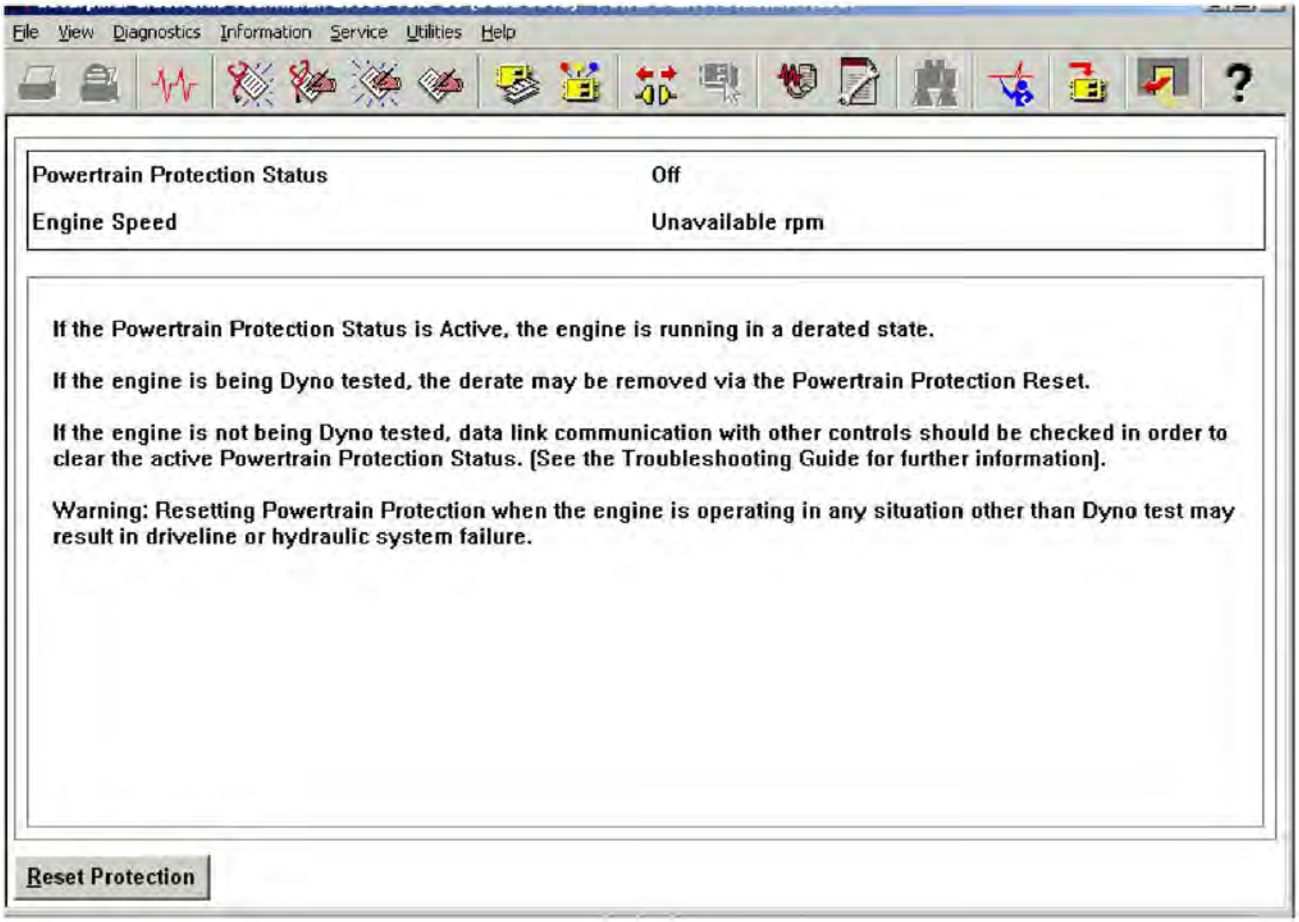


Illustration 178 g03826882

5. Select “Reset Protection” .

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

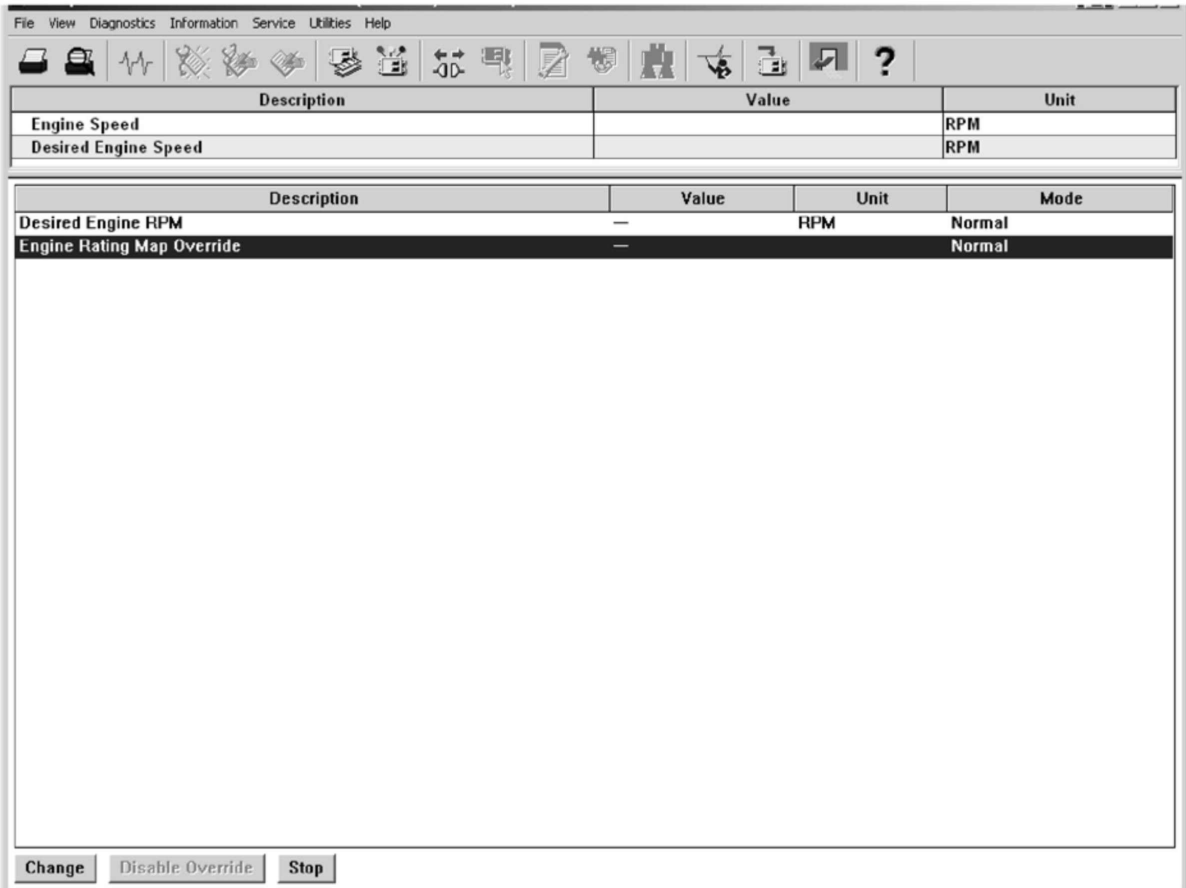


Illustration 179 g03826884

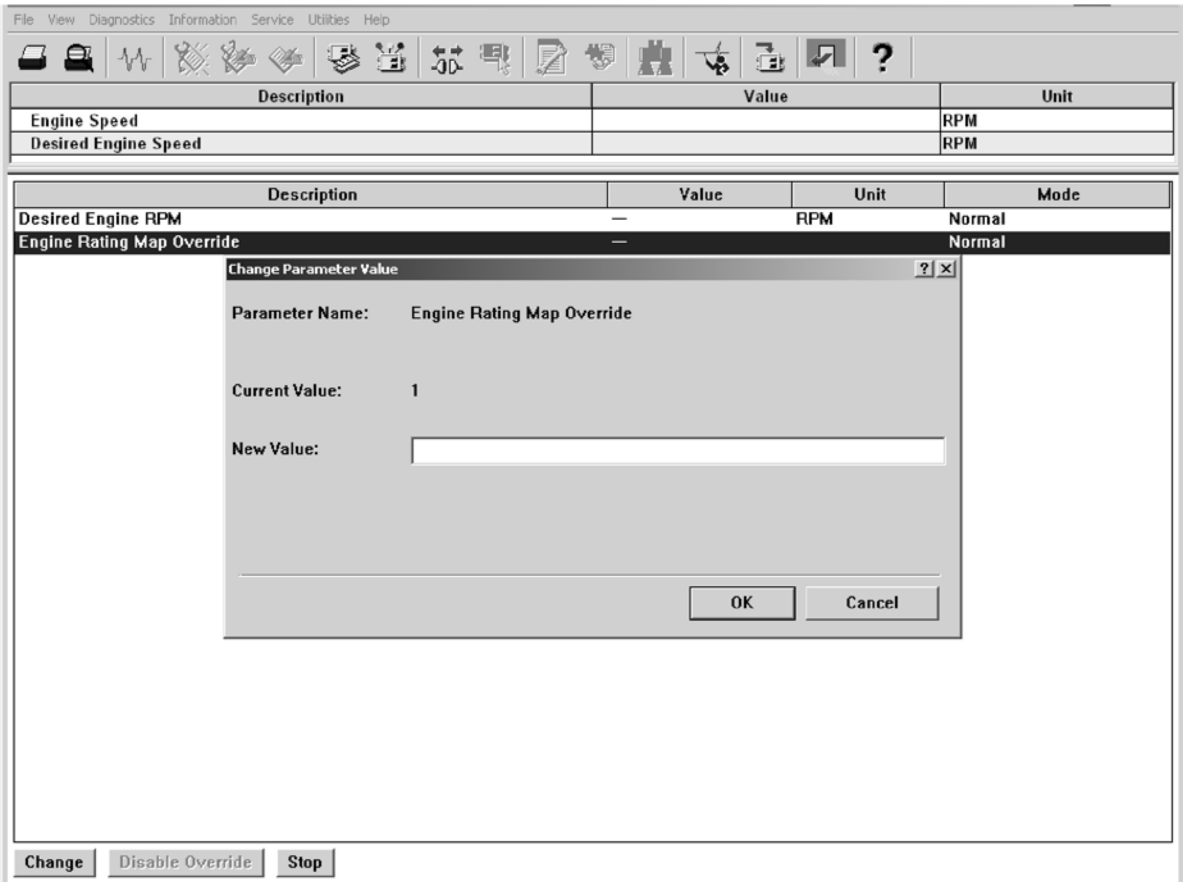


Illustration 180 g03826886

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 SCR system. The test is performed at elevated temperatures so that acceptable NOx conversion is maintained. 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

An EBPR check is performed by the service test before starting the regeneration process.

If an EBPR issue is present, the procedure will abort and an error identifier will be generated.

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 EBPR to reduce the soot load. The procedure will target a desulfation-specific desired cylinder head pressure differential. The procedure waits for several seconds before taking an average of the measured pressure differential. If the target is not met, an error identifier will be displayed, indicating EGR intake pressure is not responding.

If the pressure differential check passes, the procedure 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 assesses whether the system can generate the required SCR intake temperature. This temperature is required to remove any urea or sulfur from the aftertreatment. A higher DOC intake temperature than normal is targeted to ensure that light-off occurs the first time.

If the 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 of approximately 475° C (887° F).

If this part of the procedure is successful, HC dosing will continue until the required SCR intake temperature of 475° C (887° F) is achieved. The procedure then maintains this temperature for a set time in order to remove sulfur and/or urea deposits from the SCR catalyst.

Manual DPF Regeneration

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 performed under the following conditions:

- There are no related active diagnostic codes
- The engine must be running
- The engine must be under minimum load
- Coolant must be at a minimum required temperature

If the required conditions are not maintained throughout the test, error identifiers will be displayed.

Once the pre-conditions are met, the EBPR will start to close until a target cylinder head pressure differential is achieved. If the target is not met, an error identifier will be displayed to indicate that EGR intake pressure is not responding. If the target pressure is achieved, the test will wait for the temperature to stabilize. The test will then check if the DPF intake temperature is above a minimum threshold. If the minimum temperature is not achieved, an error identifier will be displayed to indicate that DPF intake temperature is too low.

Once the system verification steps are complete, the test will monitor the soot load. If the soot has already reduced below the required level, the test will pass successfully. If the soot has not dropped below the required level, the test will monitor the soot reduction rate. If the rate is too slow, the test will send an error identifier. If the soot reduction rate is acceptable, the test will continue until the target soot level is achieved.

Aftertreatment Sulfation 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 test must be performed under the following conditions:

- There are no related active diagnostic codes
- The engine must be running
- Engine speed must be sufficient for desulfation to occur
- The engine must be under minimum load
- Coolant must be at a minimum required temperature

If engine speed is not within the required range during warm-up, the option to continue will be offered. If the test continues, a minimum coolant temperature must be achieved. If the target parameters are not met, error identifiers will be displayed.

Once the pre-conditions are met, the EBPR will start to close until a target cylinder head pressure differential is achieved. If the target is not met, an error identifier will be displayed to indicate that EGR intake pressure is not responding. If the target pressure is achieved, the test will wait for the temperature to stabilize. The test will then check if the DPF intake temperature is above a minimum threshold. If the minimum temperature is not achieved, an error identifier will be displayed to indicate that DPF intake temperature is too low.

Once the system verification steps are complete, the test will continue to run for a set time in order to desulfate the DPF. This test will run for up to an hour and a percent complete signal will be displayed to indicate progress.

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.

A hot shutdown can damage the aftertreatment or SCR system.

A cold shutdown can damage the SCR dosing system.

Low Temperature Regeneration History

Connect to the electronic service tool.

Select the Engine ECM.

Select the Information tab.

Select History.

Select Low Temperature Regeneration History.

The ECM logs timestamp and engine data at the start and end of a low temperature regeneration. Data can be viewed via the electronic service tool to analyze the process when low temperature regeneration occurs.

Snapshots

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

Snapshots provide data in the electronic service tool for approximately 9.5 seconds before and 3.5 seconds after the time a diagnostic trouble code was recorded.

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

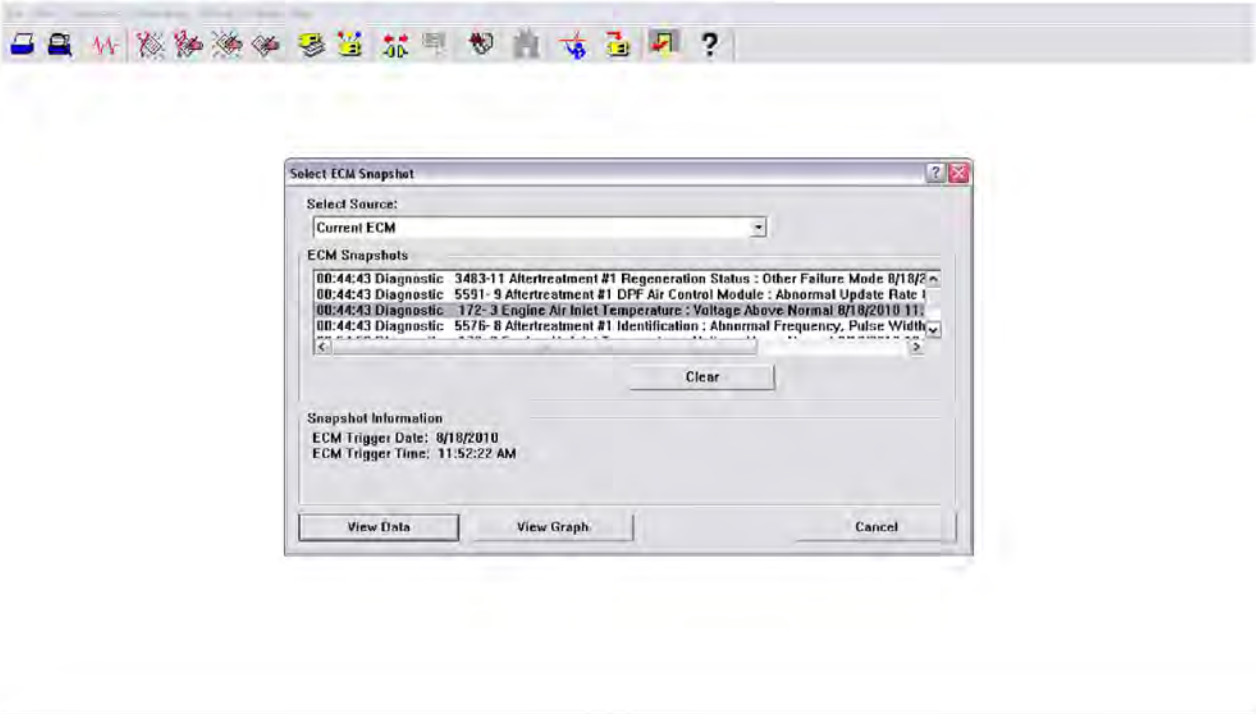


Illustration 181 g03826898

2. Select the diagnostic trouble code to be viewed.
Select “View Data” .

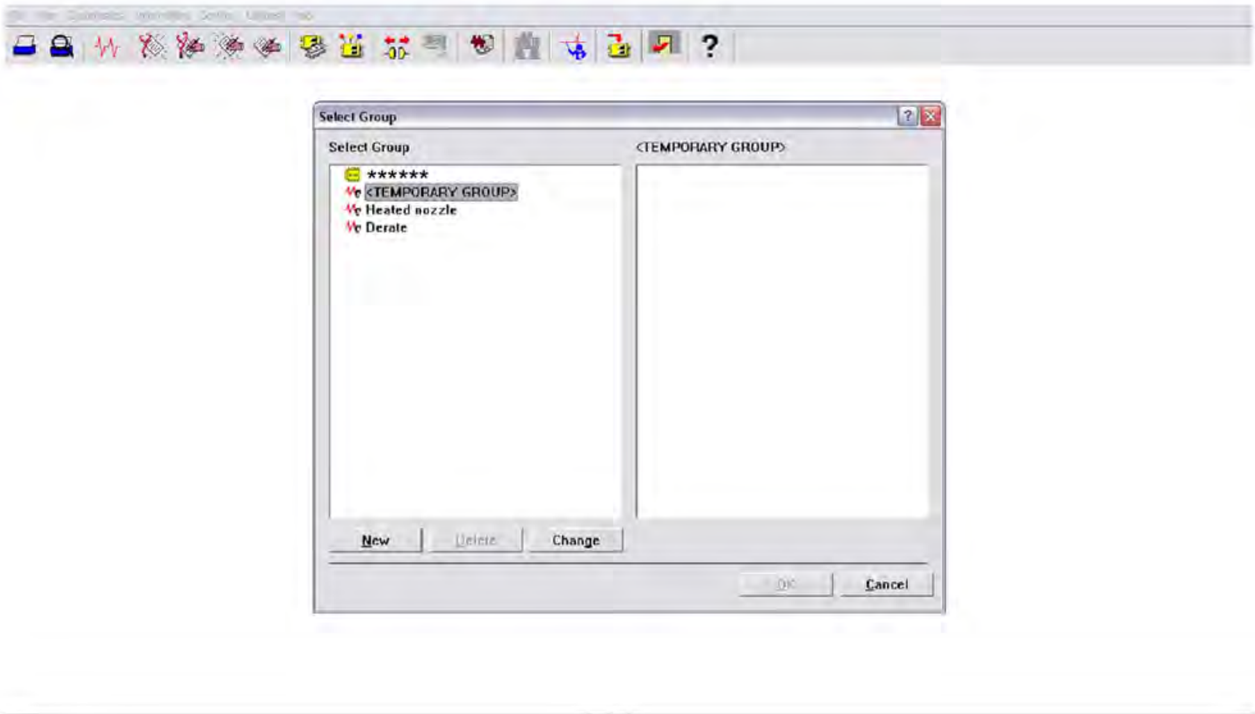


Illustration 182 g03826900

3. Select a group or select “Temporary Group”

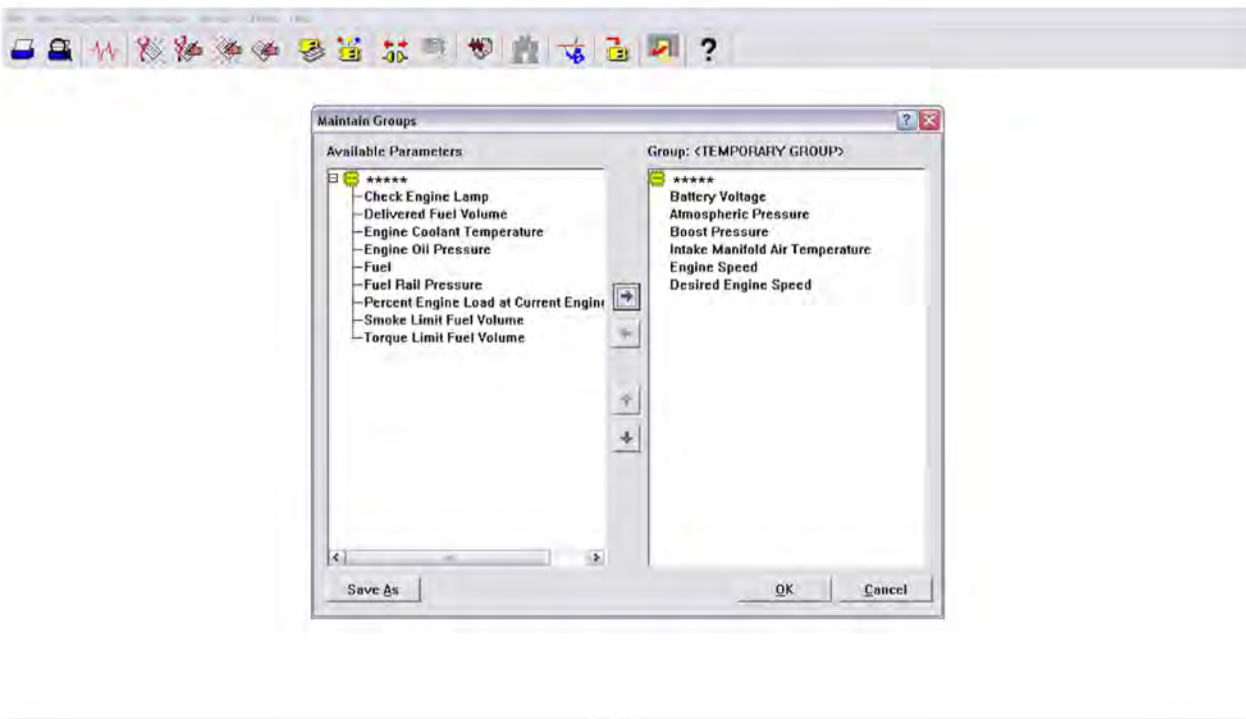


Illustration 183 g03826902

4. Select the channels to view and add the channels to the group. Select “OK” .

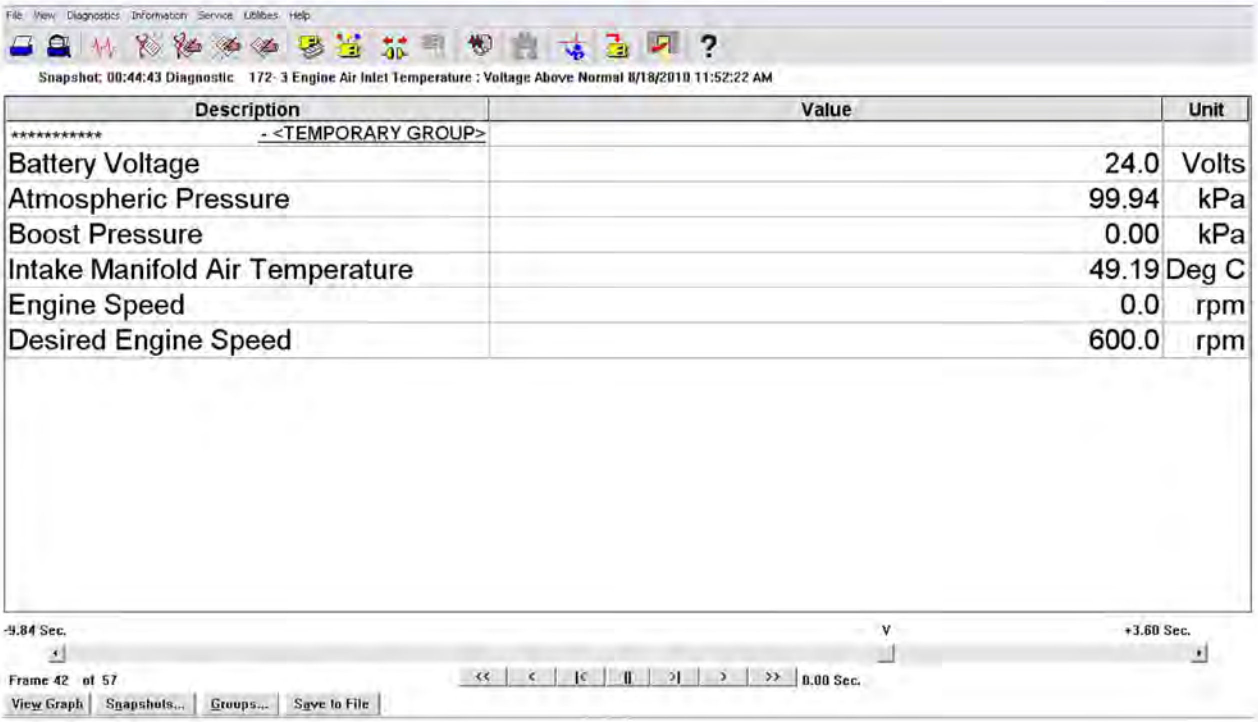


Illustration 184 g03826904

5. The sliding time bar indicates when the diagnostic trouble code was recorded. Data can be viewed 9.5 seconds before and 3.5 seconds after the time the code was recorded.

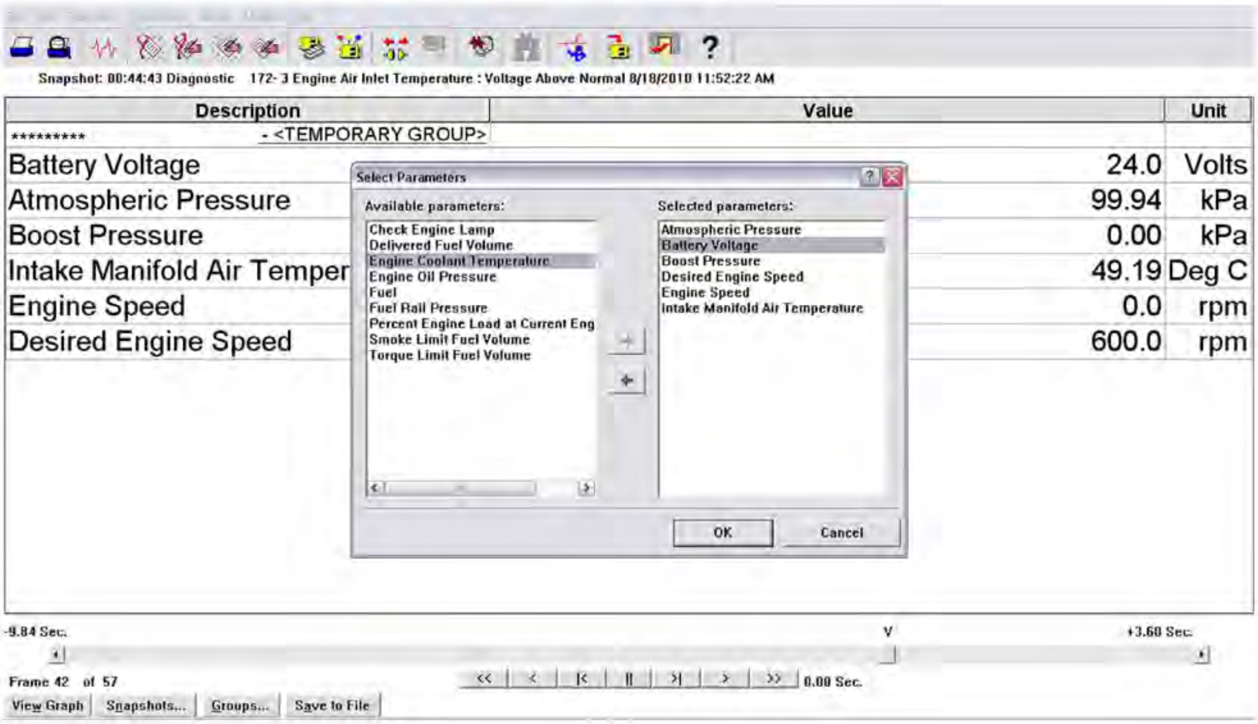


Illustration 185 g03826906

6. Select the “View Graph” tab for graphic illustrations. Select the channels to be viewed and then select “OK” .

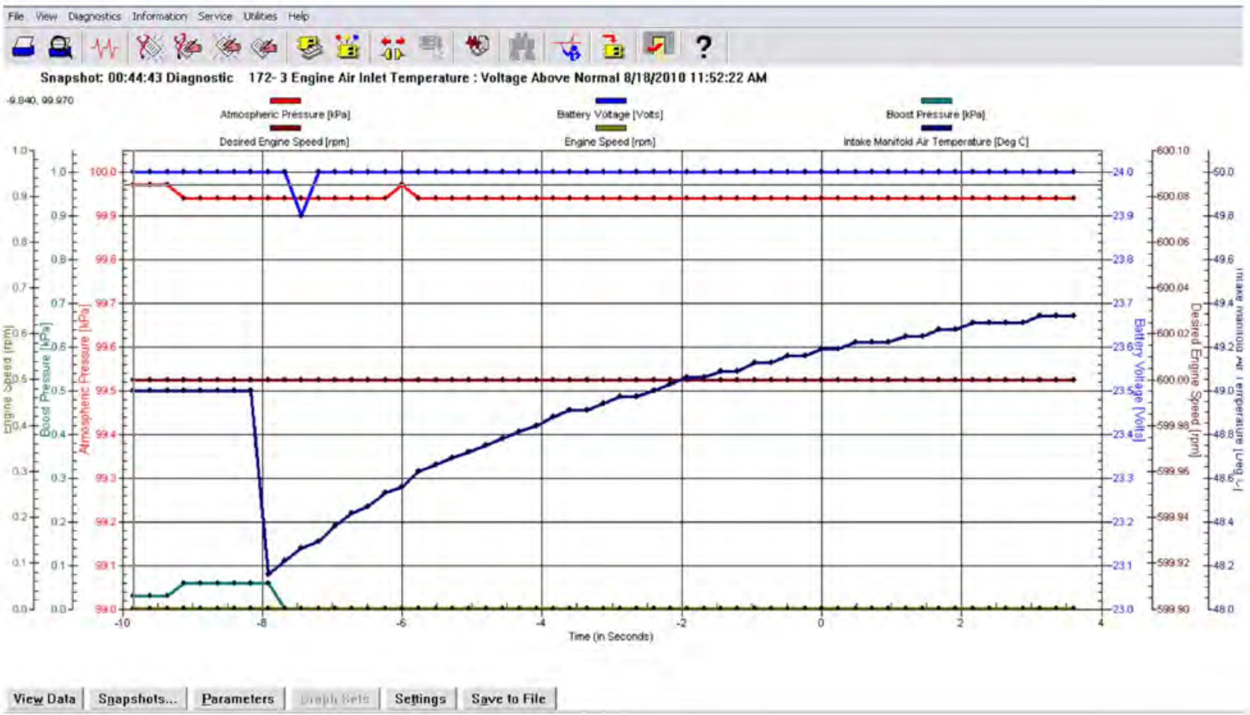


Illustration 186 g03826908

Histogram Screens

Tab Functions At Bottom of Screen

Histograms

This tab pulls up the histogram menu.

Clear

This tab is currently not available for Tier 4 engines.

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

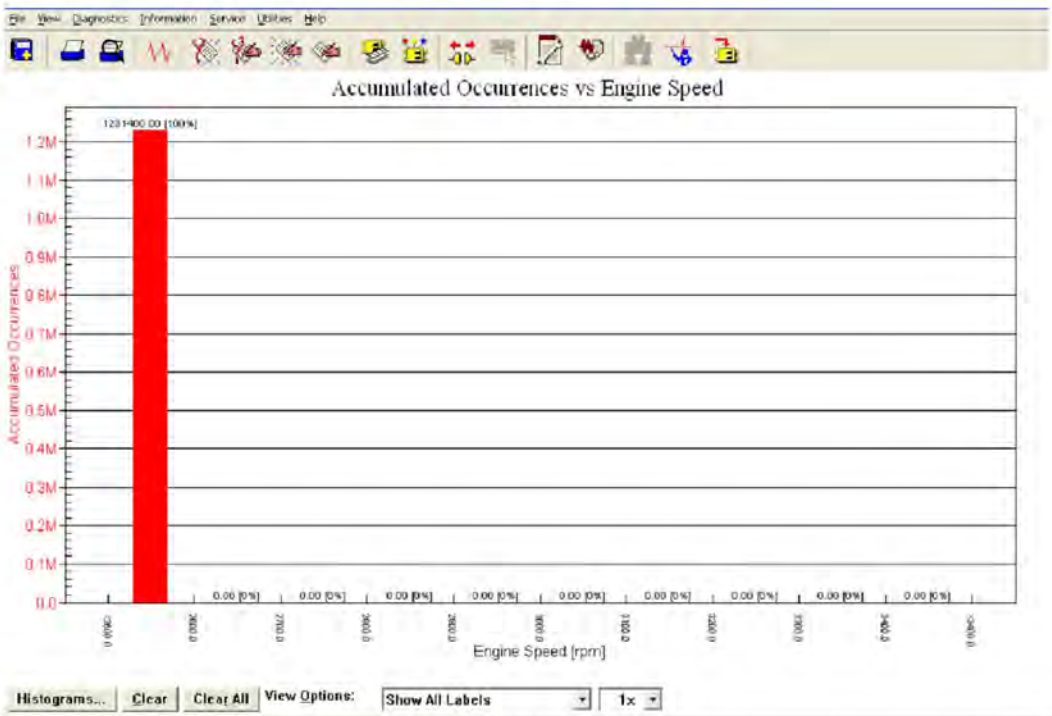


Illustration 187 g03826913

The total amount of occurrences.

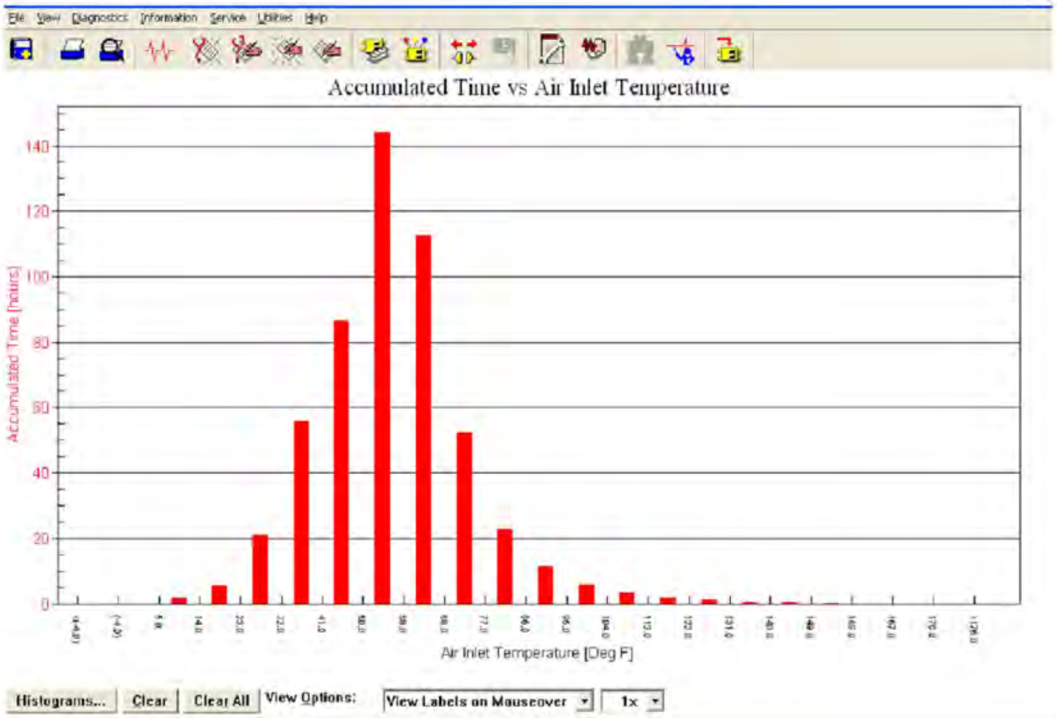


Illustration 188 g03826916

The amount of engine hours operated at indicated inlet temperature.

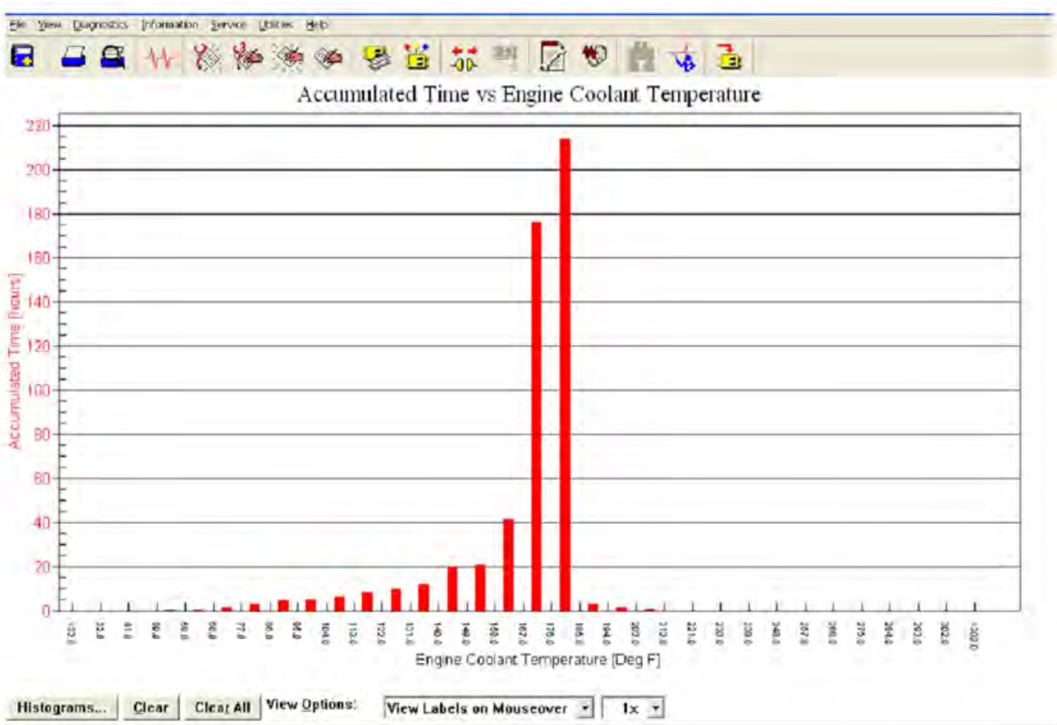


Illustration 189 g03826917

The amount of engine hours operated at indicated coolant temperature.

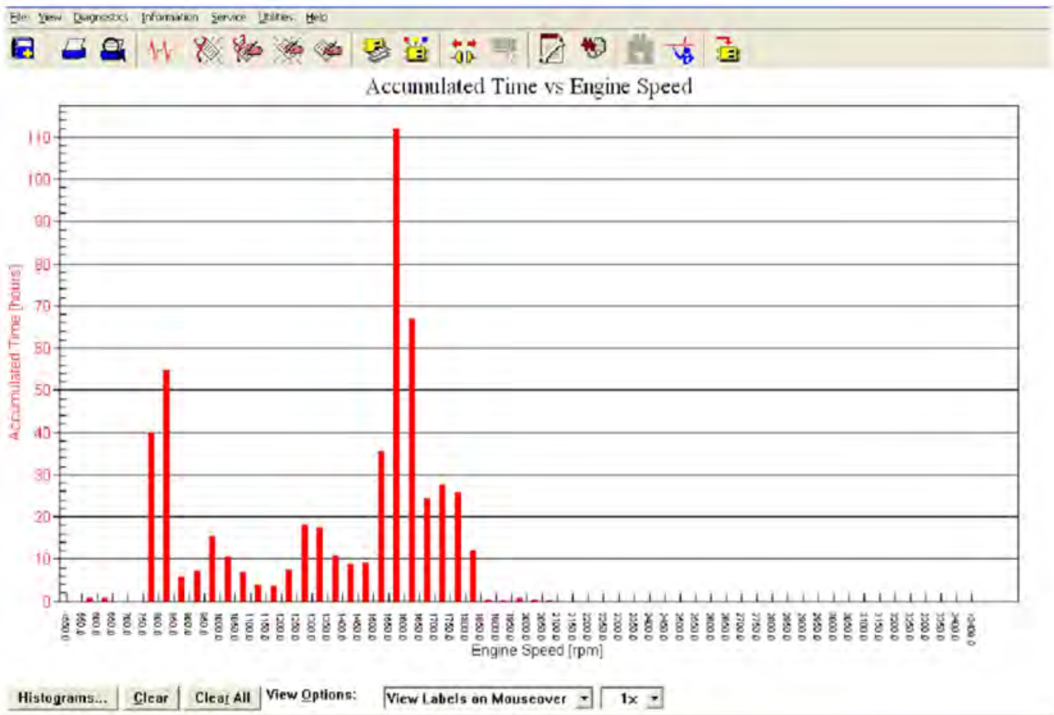


Illustration 190 g03826918

The amount of engine hours operated at indicated engine speed.

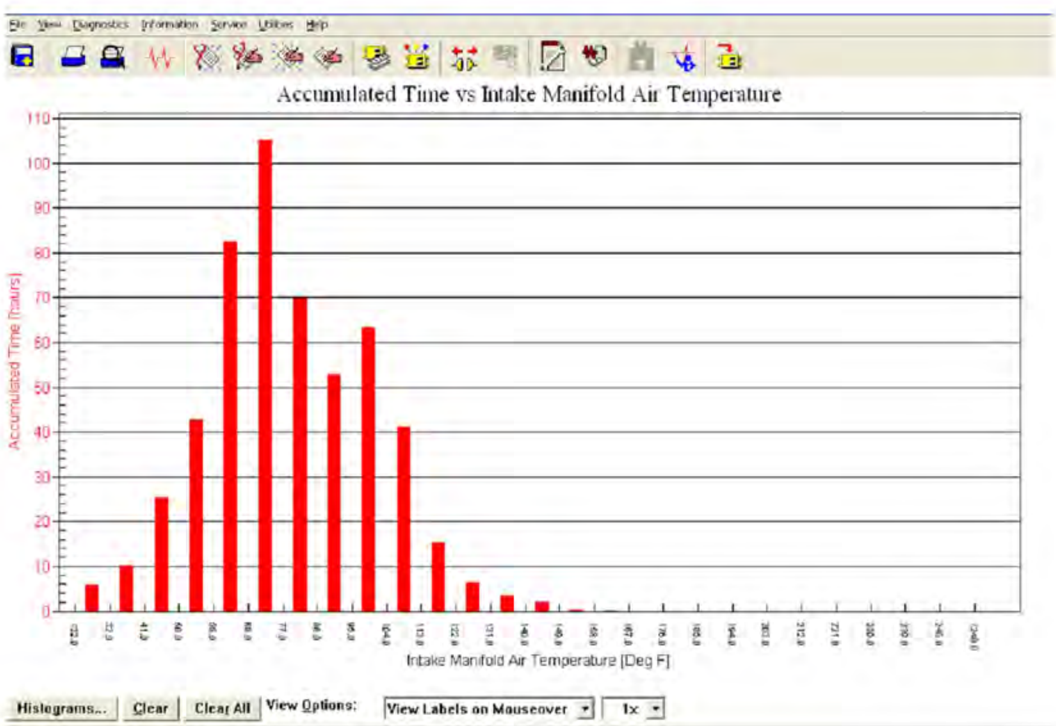


Illustration 191 g03826920

The amount of engine hours operated at indicated intake manifold air temperature.

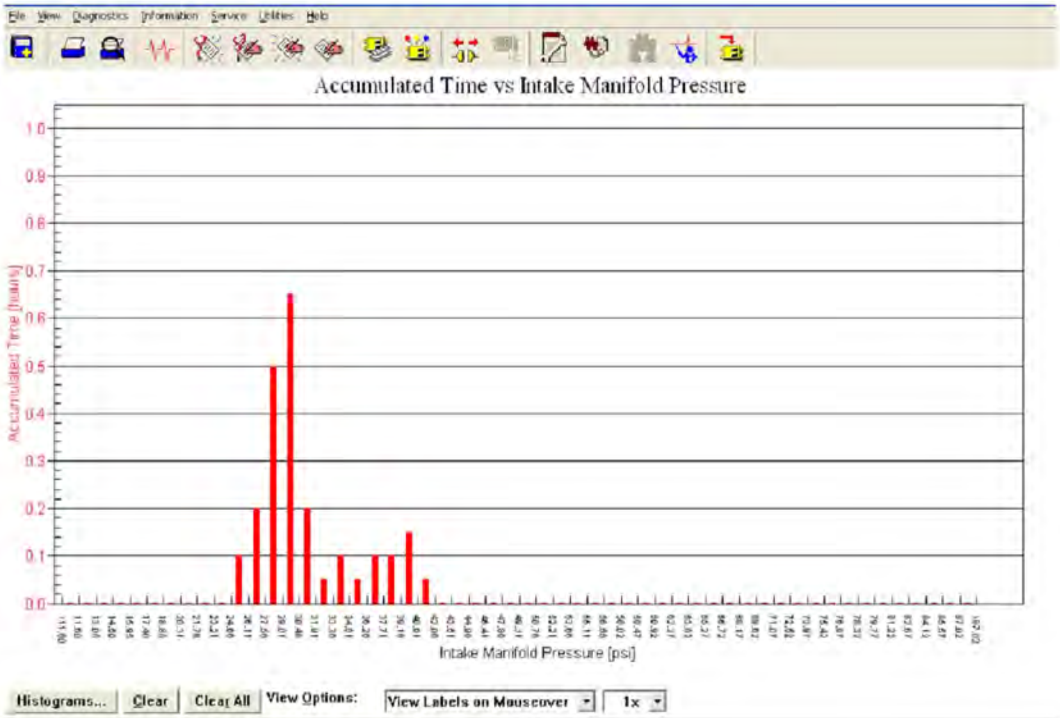
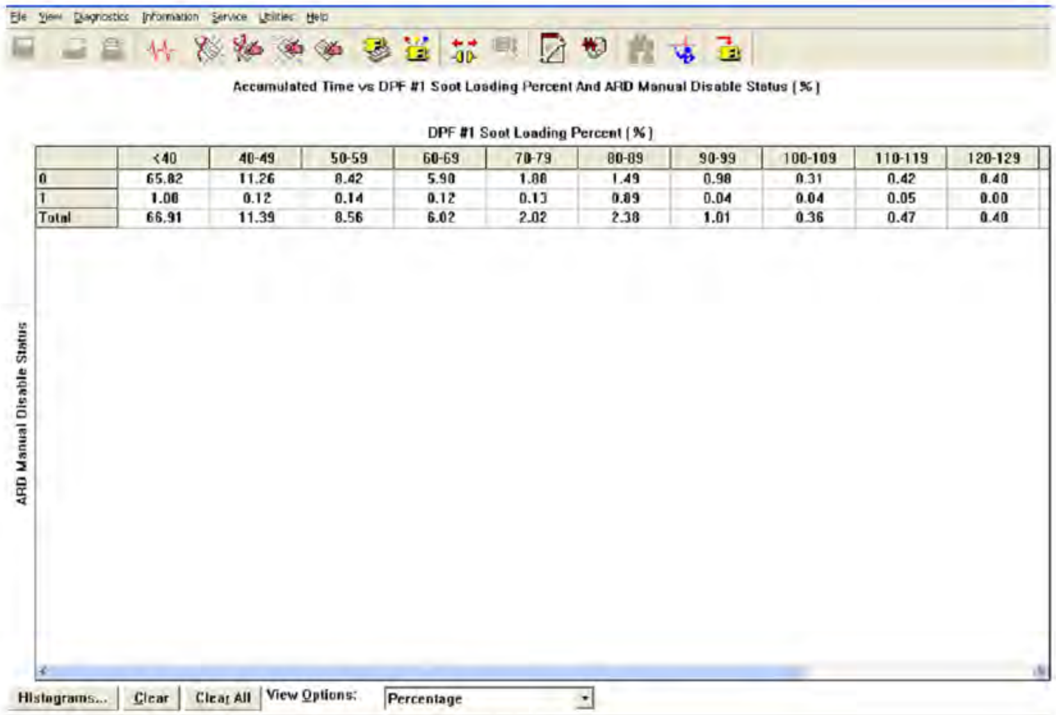


Illustration 192 g03826921

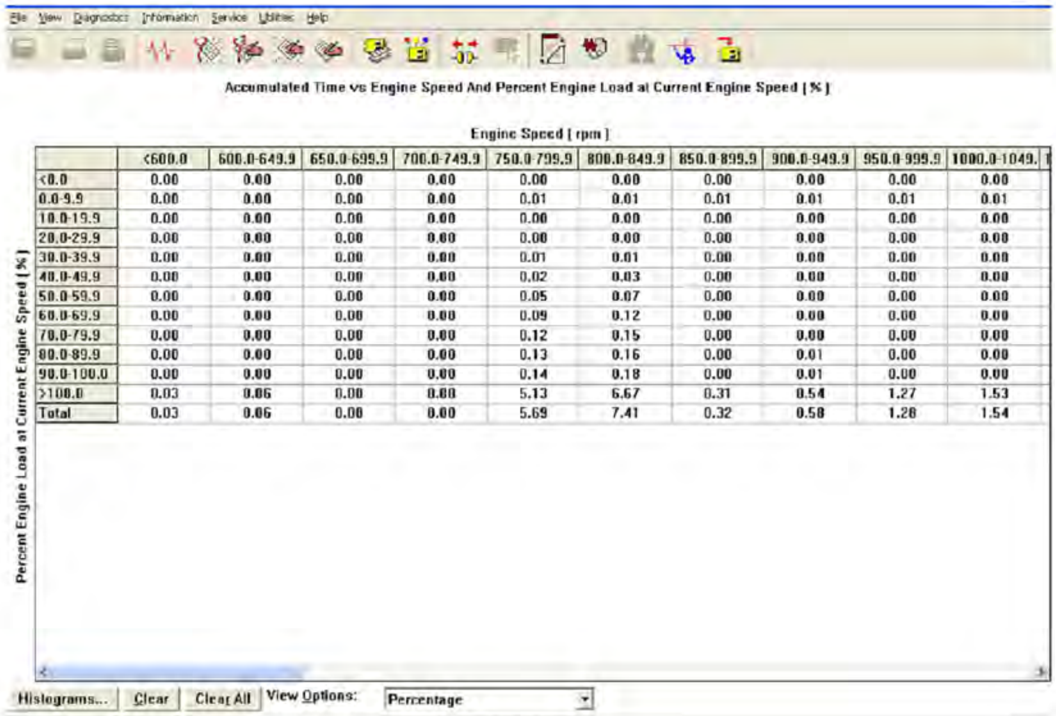
The amount of engine hours operated at indicated intake manifold pressure.



	<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 193 g03826922

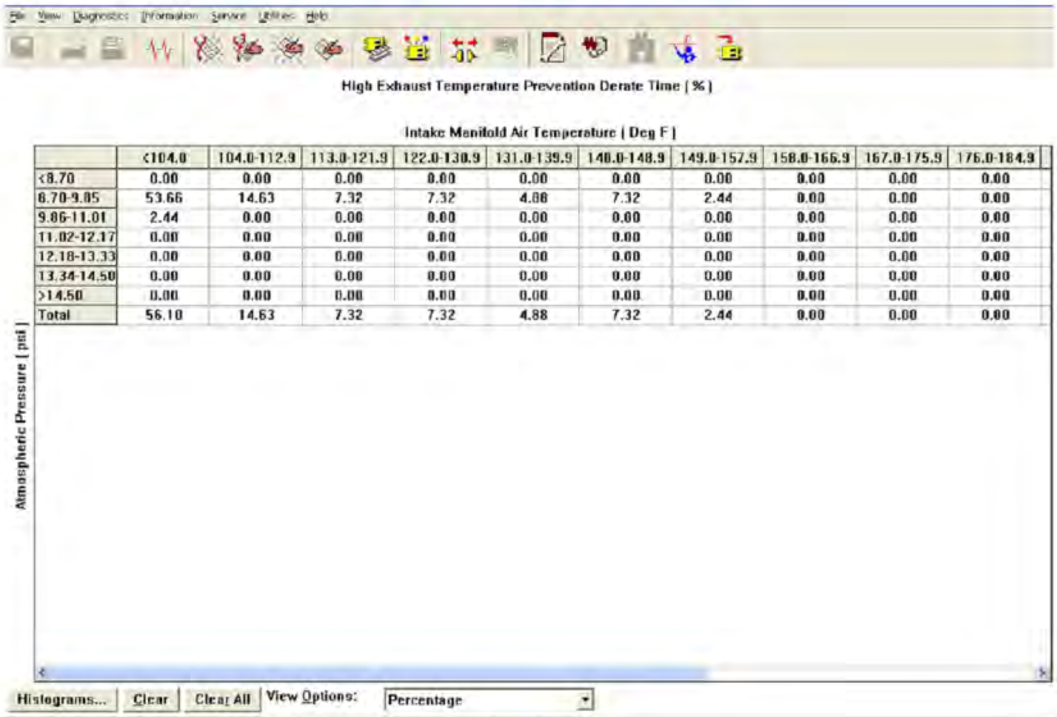
This screen is used to help understand the operator use of the disable switch and at what soot load the regenerations take place. Manual disable status 0 = regenerations allowed due to switch position. Manual disable status 1= regenerations not allowed due to switch position.



	<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 194 g03826923

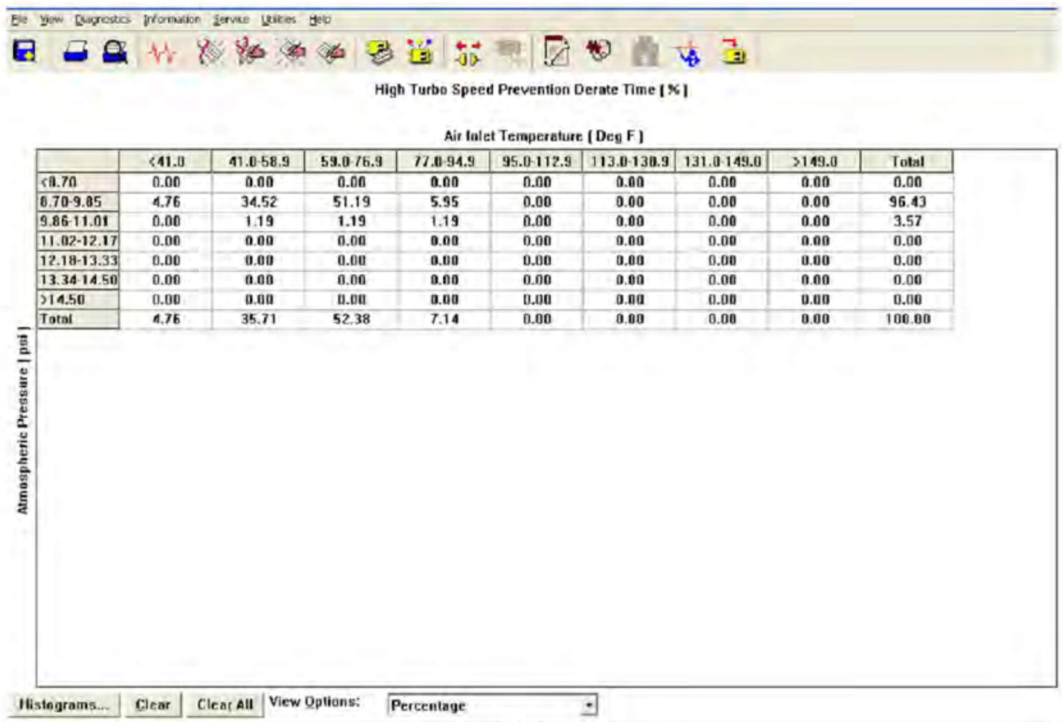
This screen is used to illustrate load percentage at the current engine speed. This screen can be helpful in understanding how the engine is being used. The screen can also be used for comparison between similar machines and/or operators.



	<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 195 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 in order 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 196 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.

DPF Soot Load Reset

Connect to the electronic service tool.

Select the engine ECM.

Select the “Service” tab.

This function allows the soot load value to be reset. This function must only be used when a new or clean DPF is installed.

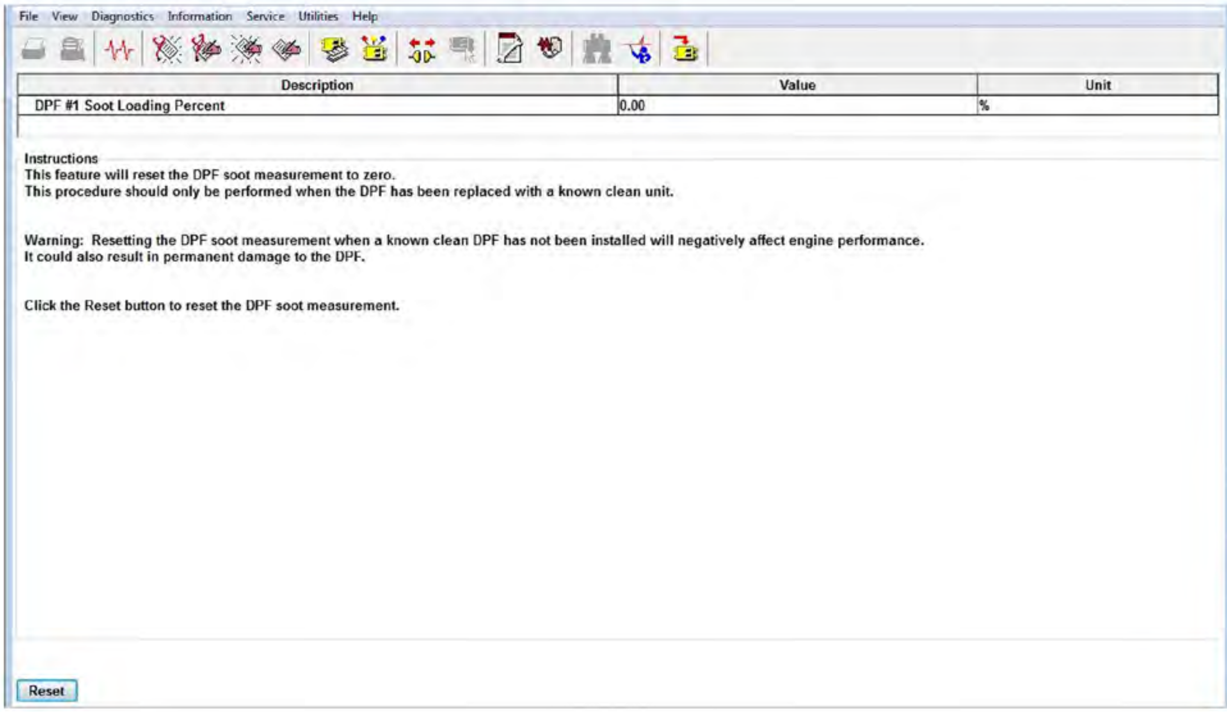


Illustration 197 g03826931

Initial screen for "DPF Soot Load Reset"

Illustration 198 g03826939

Warning screen

The screen will display the current soot load. When the "Reset" button is selected, a warning is displayed. The warning must be accepted before the process can continue.

When the soot load has reset, the screen will display a soot load of 0% and a "Reset was successful" message will be displayed.

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
- Analogue 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 249

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 analogue throttle. This switch is used to confirm that the throttle pedal has been physically moved, before reacting to the analogue 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.

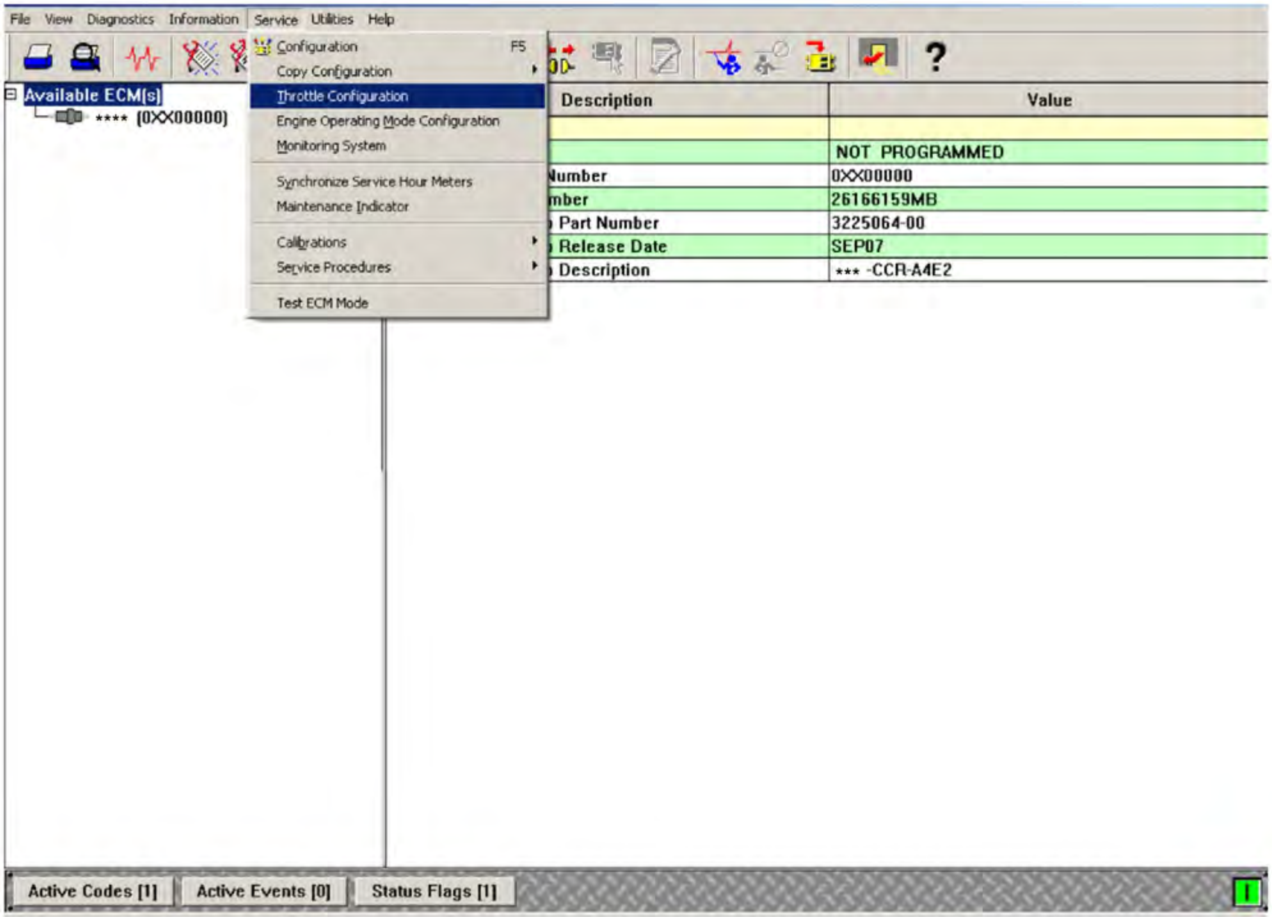


Illustration 199 g03826943

Screen 1

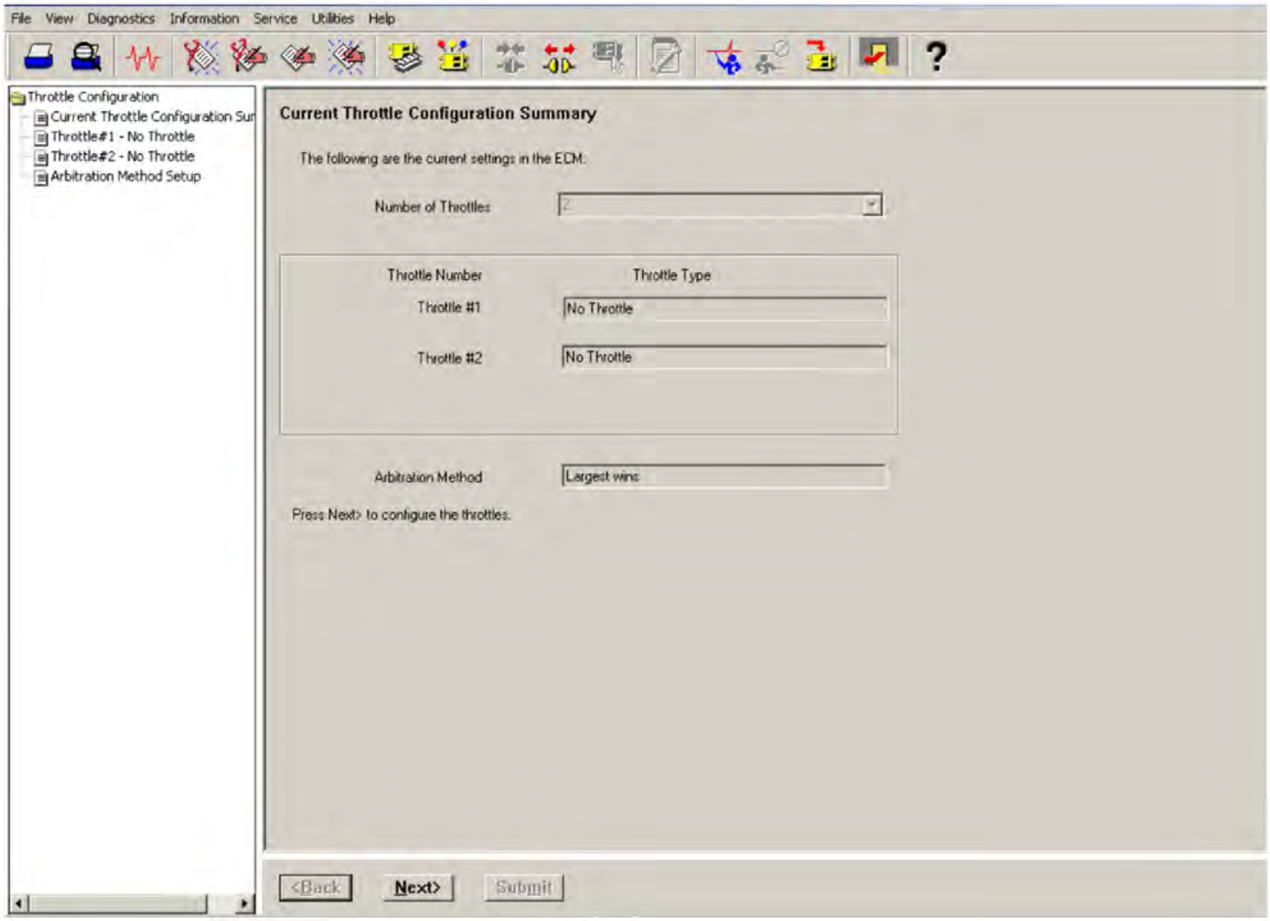


Illustration 200 g03826947

Screen 2

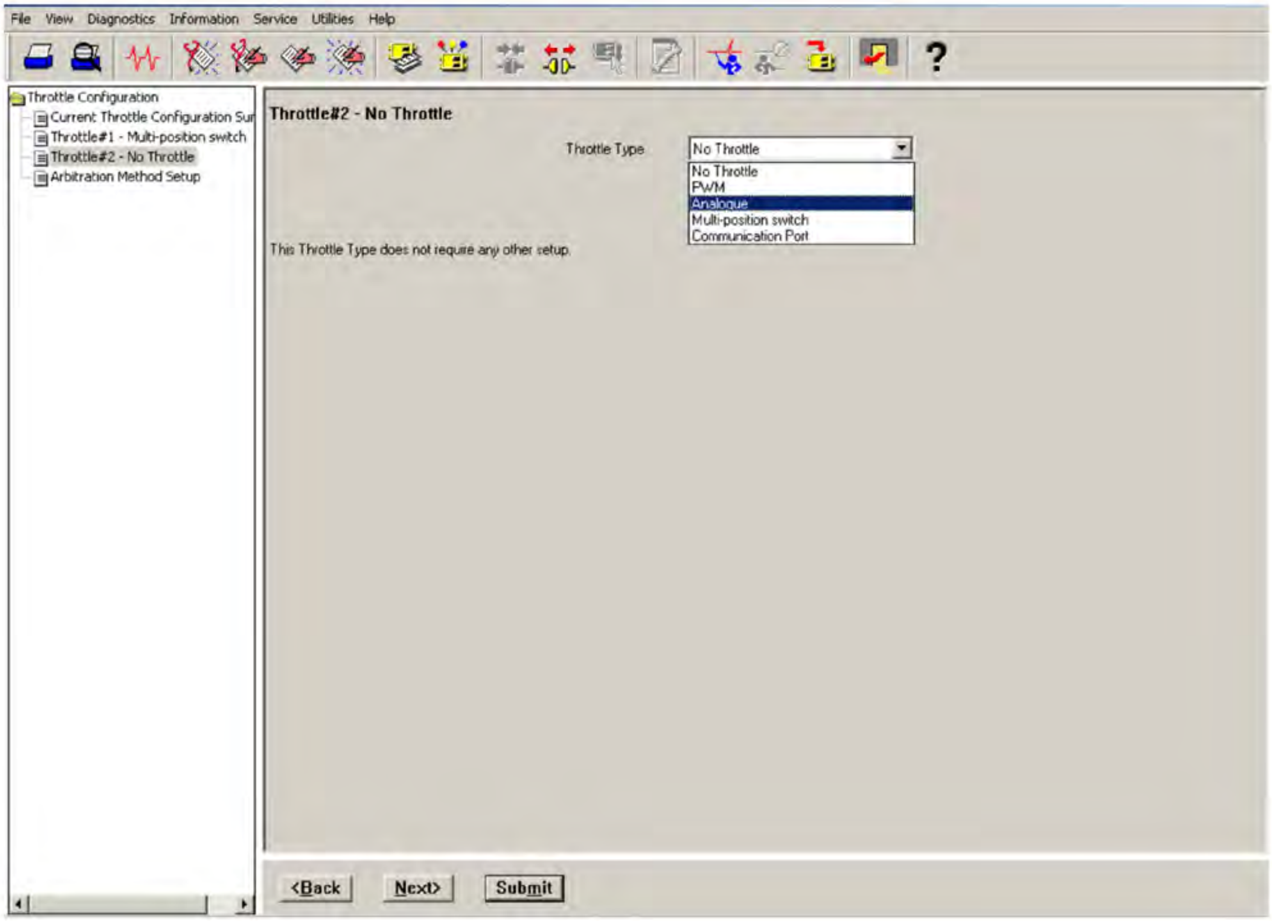


Illustration 201 g03826949

Screen 3

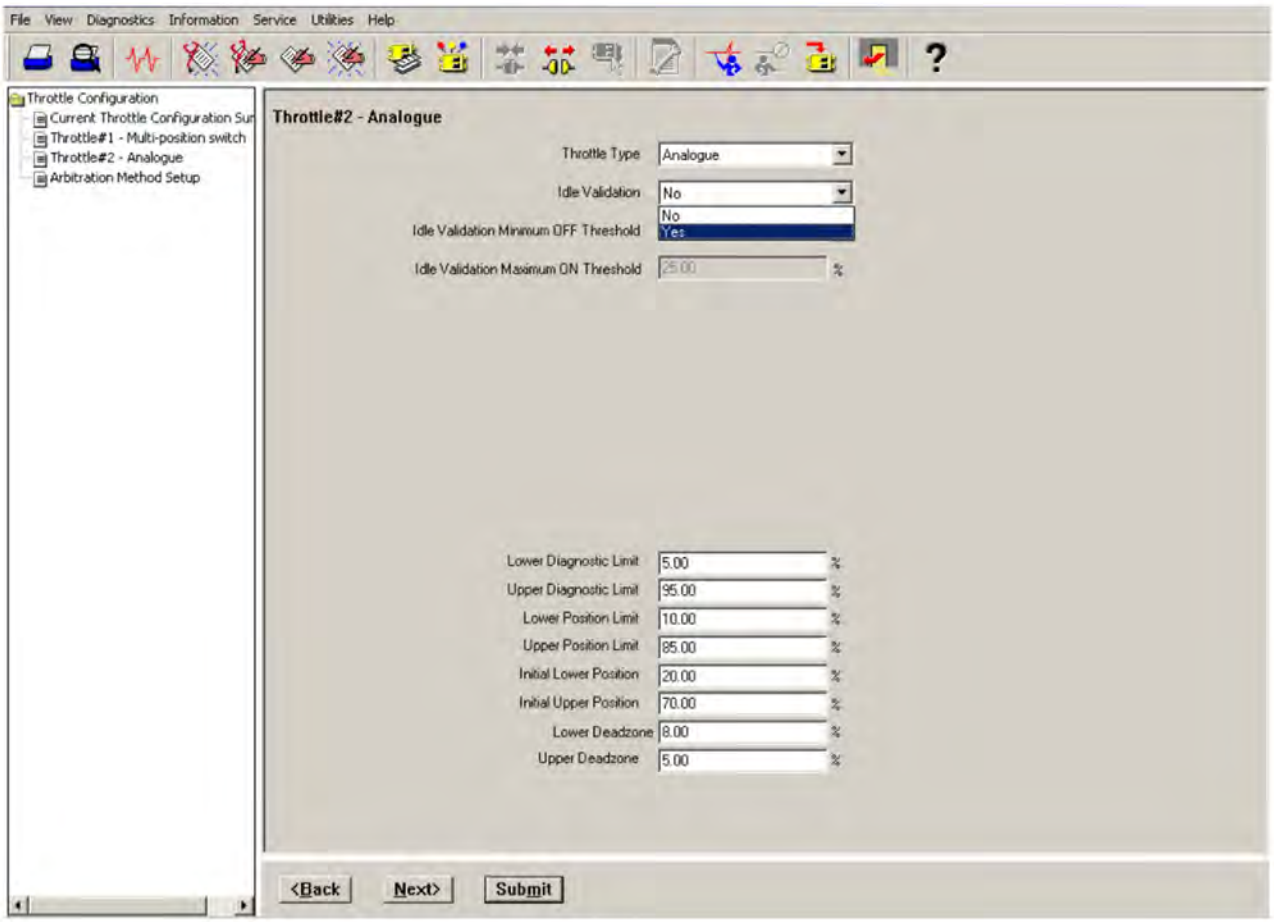


Illustration 202 g03826950

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.

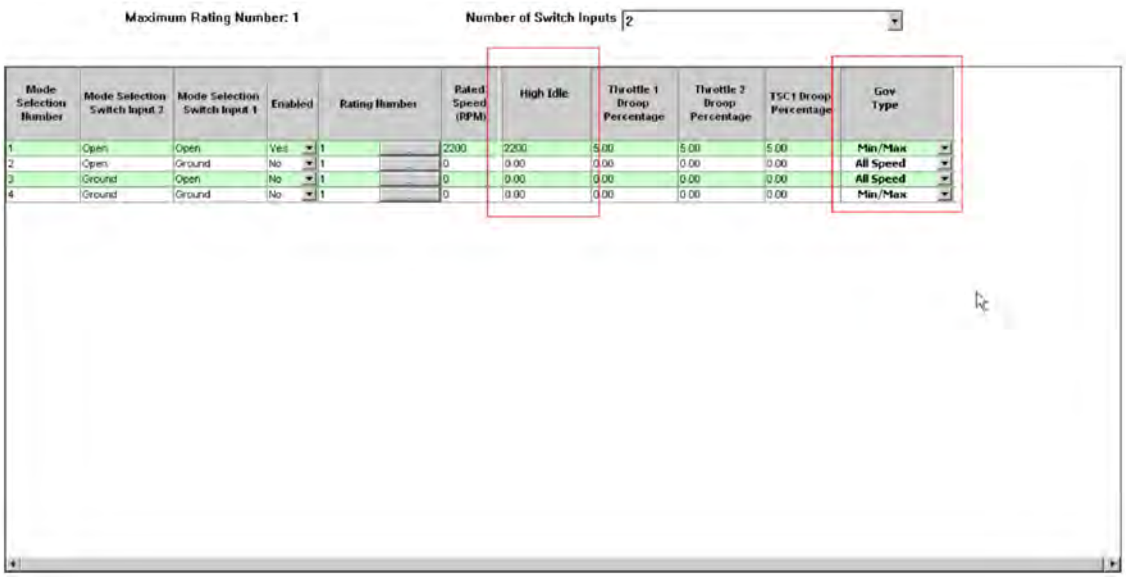


Illustration 203 g03422567

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.

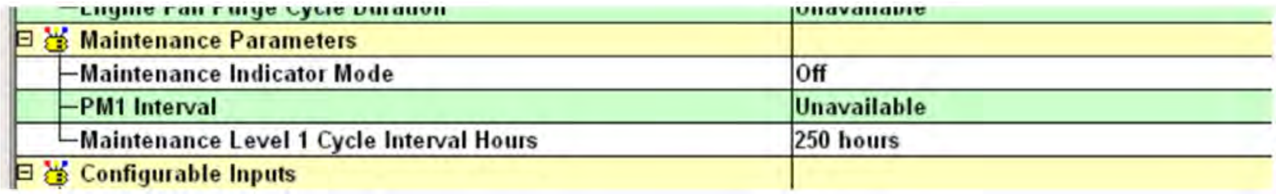


Illustration 204 g03422642

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.

i06198441

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 250

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 250, 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.
DPF Soot Loading Sensor Functional Test		
$0002	Active Diagnostic Present	Resolve any active diagnostic codes. Refer to the appropriate troubleshooting procedure.
$1011	Engine Running	Engine speed must be zero.
$105F	Test Timed Out Not all conditions were met in order for the test to complete	Restart DPF Soot Loading Functional test.
$115B	Diesel Particulate Filter soot Loading Sensor Data incorrect	Contact the Dealer Solutions Network (DSN) as a soot sensor replacement is recommended.
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.

(continued)

(Table 250, contd)

Service Error Identifiers	Description	Troubleshooting
$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 to be less than 80 MPa (11600 psi). 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.
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	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 to be less than 80 MPa (11600 psi). 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.
Aftertreatment Regeneration System Test		

(continued)

(Table 250, contd)

Service Error Identifiers	Description	Troubleshooting
$0002	Active Diagnostic Present	Resolve any active diagnostic codes. Refer to the appropriate troubleshooting procedure.
$10D0	Engine Has Not Been Running Long Enough	Allow engine to idle for 2 minutes and restart the Aftertreatment Regeneration System Test.
$1164	Engine Speed / Load Incorrect	Bring engine to idle and remove load and re-start the Aftertreatment Regeneration System Test. The test will try to take control of engine speed to elevate idle to required position for duration of test.
$1168	Engine Exhaust Back Pressure Too High	The observed exhaust back pressure when testing the EBPR is too high. Look for associ-ated EBPR diagnostics. Run the Air System Motor Valves Verification Test to check correct operation of the EBPR.
$1169	Engine Exhaust Back Pressure Too Low	The observed exhaust back pressure when testing the EBPR is too low. Look for associ-ated EBPR diagnostics. Look for exhaust sys-tem leaks. Run the Air System Motor Valves Verification Test to check correct operation of the EBPR.
$112C	Particulate Filter Intake Temperature Too Low	The system detects the DPF inlet temperature not being high enough to allow successful DPF desulfation. Refer to Troubleshooting, “Diesel Particulate Filter Intake Temperature Is Low”. Check for exhaust leaks then restart the Aftertreatment Regeneration System Test.
$116F	Engine Exhaust Gas Recirculation Valve Not Responding to Command	Bring engine to idle and remove load. The cur-rent operating load could be too high to allow the NRS valve to close. Look for associated NRS valve diagnostics. Run the Air System Motor Valves Verification Test to check correct operation of the NRS valve.
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 be-tween 9 VDC and 16 VDC. For a 24 VDC sys-tem, 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.
$1070	Battery Voltage Too Low	For a 12 VDC system, the service test must only be executed if the battery voltage is be-tween 9 VDC and 16 VDC. For a 24 VDC sys-tem, 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 250, contd)

Service Error Identifiers	Description	Troubleshooting
$1164	Engine Speed/Load Incorrect	The test must be run with keyswitch ON only, Stop Engine leaving ECM powered and re-start 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.
$1170	Engine Exhaust Back Pressure Regulator Not Responding to Command	Engine NRS valve is not responding to a command
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 and the EBPR to be used. 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.
$112C	Particulate Filter Intake Temperature Too Low	The SCR system cannot dose due to the DPF inlet temperature not being high enough to allow DEF dosing to initiate. Check for exhaust leaks and restart the Aftertreatment System Functional Test.
$115C	Regeneration is Active	HC dosing is currently 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.
$11A8	Aftertreatment SCR Catalyst Conversion Efficiency Too Low	The SCR system NOx conversion is too low to perform the test. Refer to Troubleshooting, “NOx Conversion is Low”.
$11A9	Aftertreatment Outlet NH3 Too High	There is too much NH3 in the exhaust. Perform the “Manual HC Dosing Capability Test” to raise the exhaust temperature and reduce the NH3 storage.

(continued)

(Table 250, contd)

Service Error Identifiers	Description	Troubleshooting
$11AA	Aftertreatment Diesel Exhaust Fluid Temperature Too Low	The temperature of the DEF is too low. Operate the engine to raise the DEF Temperature.
$11B5	Aftertreatment #1 NOx Level Sensors Not Ready	The NOx sensors have not reached the correct temperature to start reading the NOx level.
$11B9	Aftertreatment #1 SCR Catalyst Intake Gas Temperature Too Low	The SCR system cannot dose due to the SCR inlet temperature not being high enough to allow DEF dosing to initiate. Restart the Aftertreatment System Functional Test.
$11BB	Aftertreatment Diesel Exhaust Fluid Level Too Low	The DEF tank level is too low. Fill the DEF tank and restart the Aftertreatment System Functional Test.
$11C2	Aftertreatment SCR System in Warmup Mode	The temperature of the exhaust system is not high enough to perform the test. Operate the engine to raise the exhaust temperatures. Restart the Aftertreatment System Functional Test.
$11C3	Aftertreatment SCR System Not Able to Prime	The SCR dosing system cannot prime. Refer to Troubleshooting, “DEF Pressure is Low”.
Manual HC Dosing Capability Test		
$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.
$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 and/or the EBPR to elevate exhaust back pressure to increase exhaust temperature. 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 aged so not enough heat is being generated for the amount of HC dosing fuel being injected. The DOC may be sulfated. Run the “Aftertreatment Recovery Procedure” .
$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

(continued)

(Table 250, contd)

Service Error Identifiers	Description	Troubleshooting
$11BA	Aftertreatment SCR System Not Ready to Dose	The SCR system needs to dose a small amount of DEF during HC dosing. The DEF dosing is to protect the DEF injector tip from getting damaged at high temperature. The SCR system is not working properly. Check for associated SCR system diagnostic codes and follow relevant troubleshooting procedures.
$1168	Engine Exhaust Back Pressure Too High	The observed exhaust back pressure when testing the EBPR is too high. Look for associated EBPR diagnostic codes. Run the “Air System Motor Valves Verification Test” to check the correct operation of the EBPR.
$1169	Engine Exhaust Back Pressure Too Low	The observed exhaust back pressure when testing the EBPR is too low. Look for associated EBPR diagnostic codes. Check for exhaust system leaks. Run the “Air System Motor Valves Verification Test” to check the correct operation of the EBPR.
$1130	Aftertreatment Failed to Ignite	The DOC may be aged so not enough heat is being generated for the amount of HC dosing fuel being injected. The DOC may be sulfated. Run the “Aftertreatment Recovery Procedure” .
$11B9	Aftertreatment #1 SCR Catalyst Intake Gas Temperature Too Low	The HC dosing procedure is generating the correct heat rise. However, a significant amount of this heat is being lost before the exhaust gas reaches the SCR. Check for signs of exhaust leaks in the CEM between the DOC and the SCR.
High Pressure Fuel Pump Calibration		
$0002	Active Diagnostic Present	Resolve any active diagnostic codes. Refer to the appropriate troubleshooting procedure. 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: Crankshaft speed/timing. Camshaft 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: Pressure relief valve activation. Fuel leakage. Rail pressure event. Battery supply diagnostic is active.
$10A7	Coolant Temperature Too Low	Coolant temperature is less than the trip point

(continued)

(Table 250, contd)

Service Error Identifiers	Description	Troubleshooting
$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	The rail pressure is unstable. Changing the engine operating condition may allow successful pump learn. If still unsuccessful, follow the troubleshooting guide to determine the cause is in the low-pressure system or the high-pressure system.
$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.
$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.
$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.

(continued)

(Table 250, contd)

Service Error Identifiers	Description	Troubleshooting
$11BA	Aftertreatment SCR System Not Ready to Dose	The SCR system needs to dose a small amount of DEF during HC dosing to protect the DEF injector tip from damage at high temperatures. The SCR system is not working properly. Identify associated SCR system diagnostic codes and follow relevant troubleshooting procedures.
$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.
$1108	Excessive Engine RPM Change	Lower the engine speed to idle. The test will try to take speed control to put engine in acceptable speed and load range. Restart the Aftertreatment Recovery Procedure.
$10F5	Excessive Change in Engine Load	Lower the engine speed to idle and remove the load. The test will try to take speed control to put engine in acceptable speed and load range. 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 Sensor measurement. However, observed soot load is not reducing. Contact the Dealer Solutions Network (DSN) for further advice.
$10CB	Engine Load Too High	Bring engine to idle and remove load. The current operating load is too high to allow NRS valve to close and EBPR to operate. Restart the Aftertreatment Recovery Procedure.
$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.
$1168	Engine Exhaust Back Pressure Too High	The observed exhaust back pressure when testing the EBPR is too high. Identify associated EBPR diagnostics. Run the “Air System Motor Valves Verification Test” to check correct operation of the EBPR.

(continued)

(Table 250, contd)

Service Error Identifiers	Description	Troubleshooting
$1169	Engine Exhaust Back Pressure Too Low	The observed exhaust back pressure when testing the EBPR is too low. Identify associated EBPR diagnostics. Check for exhaust system leaks. Run the “Air System Motor Valves Verification Test” to check correct operation of the EBPR.
$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.
$11B9	Aftertreatment SCR Catalyst Intake Gas Temperature Too Low	Although the procedure is generating the correct heat rise, some of this heat is being lost before the exhaust gas reaches the SCR. Check for evidence of exhaust leaks in the CEM between the DOC and the SCR.
Manual DPF Regeneration		
$0002	Active Diagnostic Present	Resolve any active diagnostic codes. Refer to the appropriate troubleshooting procedure.
$10D0	Engine Has Not Been Running Long Enough	Allow engine to idle for 2 minutes and restart the Manual DPF Regeneration 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 Manual DPF Regeneration 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 Manual DPF Regeneration Procedure.
$112C	Particulate Filter Intake Temperature Too Low	The system detects the DPF inlet temperature is too low to allow successful DPF desulfation. Refer to Troubleshooting, “Diesel Particulate Filter Intake Temperature Is Low”. Check for exhaust leaks and then restart the Manual DPF Regeneration Procedure.
$1164	Engine Speed / Load Incorrect	Bring the engine to idle and remove load and then restart the Manual DPF Regeneration Procedure. The test will try to take control of engine speed to elevate idle to required position for duration of test.
$1168	Engine Exhaust Back Pressure Too High	The observed exhaust back pressure when testing the EBPR is too high. Look for associated EBPR diagnostics. Run the “Air System Motor Valves Verification Test” to check correct operation of the EBPR.

(continued)

(Table 250, contd)

Service Error Identifiers	Description	Troubleshooting
$1169	Engine Exhaust Back Pressure Too Low	The observed exhaust back pressure when testing the EBPR is too low. Look for associated EBPR diagnostics. Check for exhaust system leaks. Run the “Air System Motor Valves Verification Test” to check correct operation of the EBPR.
$116F	Engine Exhaust Gas Recirculation Valve Not Responding to Command	Bring the engine to idle and remove load. The current operating load may be too high to allow the NRS valve to close. Check for associated NRS valve diagnostics. Run the “Air System Motor Valves Verification Test” to check correct operation of the NRS valve.
$1172	Diesel Particulate Filter Soot Loading Too Low	The soot level in the DPF is not high enough to warrant running a regeneration. At low soot levels, the rate of regeneration is extremely slow negating the value of the test.
$1173	Diesel Particulate Filter Regeneration Rate Too Low	The procedure is running in optimum conditions for DPF soot regeneration with no issues with soot sensor measurement. However, observed soot load is not reducing. Contact the Dealer Solutions Network (DSN) for further advice.
Aftertreatment Sulfation Recovery Procedure		
$0002	Active Diagnostic Present	Resolve any active diagnostic codes. Refer to the appropriate troubleshooting procedure.
$10CB	Engine Load Too High	Bring the engine to idle and remove load. Current operating load is too high to allow the NRS valve to close and EBPR to operate. Restart the Aftertreatment Sulfation Recovery Procedure.
$10D0	Engine Has Not Been Running Long Enough	Allow the engine to idle for 2 minutes and then restart the Aftertreatment Sulfation 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 Sulfation 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 Sulfation Recovery Procedure.
$112C	Particulate Filter Intake Temperature Too Low	The DPF inlet temperature is too low to allow successful DPF desulfation. Refer to Troubleshooting, “Diesel Particulate Filter Intake Temperature Is Low” and check for exhaust leaks. Restart the Aftertreatment Sulfation Recovery Procedure.
$1164	Engine Speed / Load Incorrect	Bring the engine to idle and remove load and then restart the Aftertreatment Sulfation Recovery Procedure. The test will try to take control of engine speed to elevate idle to required position for duration of test.

(continued)

(Table 250, contd)

Service Error Identifiers	Description	Troubleshooting
$1168	Engine Exhaust Back Pressure Too High	The observed exhaust back pressure when testing the EBPR is too high. Identify any associated EBPR diagnostics. Run the “Air System Motor Valves Verification Test” to check correct operation of the EBPR.
$1169	Engine Exhaust Back Pressure Too Low	The observed exhaust back pressure when testing the EBPR is too low. Identify any associated EBPR diagnostics. Check for exhaust system leaks. Run the “Air System Motor Valves Verification Test” to check correct operation of the EBPR.
$116F	Engine Exhaust Gas Recirculation Valve Not Responding to Command	Bring the engine to idle and remove load. The current operating load may be too high to allow the NRS valve to close. Check for associated NRS valve diagnostics. Run the “Air System Motor Valves Verification Test” to check correct operation of the NRS valve.

i06071165

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.

i06177728

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 in order 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 in order to restore customer passwords. Factory passwords are also required in order to reset customer passwords.

Set Configuration parameters – Factory passwords are required in order to modify specific configuration parameters. Refer to Troubleshooting, “Configuration Parameters” for details that are related to the parameters for your application.

If factory passwords are needed in order 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 in order to clear the code from ECM memory. For example, factory passwords must be obtained in order 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.

i06177736

Electronic Service Tool Does Not Communicate

Use this procedure to solve communication problems between the electronic service tool and the Electronic Control Module (ECM). The electronic service tool must communicate with the ECM on the Perkins data link and the J1939 data link.

Indicators on the communication adapter indicate that communication is occurring on a particular data link. The “J1939 / DeviceNet” indicator indicates that the communication adapter is communicating on the J1939 data link. The “J1708” indicator indicates that the communication adapter is communicating on the Perkins data link. The electronic service tool displays a message during the connection if the electronic service tool cannot communicate on both data links.

The following conditions can cause a communication problem:

- Incorrect communication adapter
- Incorrect version of the electronic service tool
- Incorrect firmware in the communication adapter
- Incorrect configuration of the electronic service tool
- A fault in the electrical power to the communication adapter
- A fault in the electrical power to the engine ECM
- A fault in the wiring for a data link
- A fault in the electrical cables between the PC and the machine

Table 251

Troubleshooting Test Steps	Values	Results
1. Determine the Fault **A.** If an indicator other than the “POWER” indicator is illuminated when the electronic service tool is not communicating with an ECM, disconnect and reconnect the communication adapter.	Communication problem	**Result:** Both indicators on the communication adapter are not flashing. Proceed to Test Step 2. **Result:** The electronic service tool indicates that the engine is serviced on both links. Proceed to Test Step 2. **Result:** The electronic service tool displays a message that indicates the firmware in the communication adapter does not support communication on both data links. Proceed to Test Step 3. **Result:** The electronic service tool displays an Error “ #142 The interface hardware is not responding” message. Proceed to Test Step 3. **Result:** The electronic service tool indicates that the electronic service tool cannot find an exact match for the software version in the ECM. **Repair:** Update the electronic service tool to the latest available version. **Result:** The power indicator is not illuminated. Proceed to Test Step 5.
2. Verify that the Correct Communication Adapter is Being Used **A.** A 27610164 TIPSS Adaptor Kit must be used to communicate. **B.** Determine the communication adapter that is being used.	Communication Adapter	**Result:** An incorrect communication adapter is being used. **Repair:** Connect a correct communication adapter. Refer to Troubleshooting, “Electronic Service Tools”, if necessary. Attempt to establish communication. Continue with this procedure if the communication adapter does not communicate on both data links. **Result:** A correct communication adapter is being used. However, the “Power” indicator is not illuminated. Proceed to Test Step 5. **Result:** A correct communication adapter is being used. The “Power” indicator is illuminated. Proceed to Test Step 4.

(continued)

(Table 251, contd)

Troubleshooting Test Steps	Values	Results
3. Check the Version of the Firmware for the Communication Adapter The version of the firmware for the communication adapter must be "1.18.47" or higher. **A.** Electronically disconnect the electronic service tool. Verify that the "power" indicator on the communication adapter is illuminated. **B.** Click on the "Utilities" menu. **C.** Click on the "Comm Adapter III Toolkit" menu. **D.** Wait for the tool kit to open. Then, click the "Utilities" menu. **E.** Click "Reprogram CA3" . **F.** Select the latest ".apf" file from the list. **G.** Click "OK" . Then, click "Begin Flash" . **H.** Wait for the "Flashes Completed Successfully" message to appear. **I.** Click "Toolkit" . Verify that the "Software Release Version" is "1.18.47" or higher. **J.** Attempt to connect the electronic service tool.	Firmware	**Result:** The electronic service tool communicates on both data links. The problem is resolved. **Result:** The electronic service tool does not communicate on both data links. Proceed to Test Step 4.
4. Check that the Electronic Service Tool is Configured Correctly The electronic service tool must be configured correctly in order to communicate on both data links. **A.** Click on the "Utilities" menu. **B.** Click on the "Preferences" menu. **C.** Select the "Communications" tab. **D.** Verify that "Comm Adapter III (RP120)" is selected. If "Comm Adapter III (RP120)" is not an option for selection, the version of the electronic service tool is incorrect. Version "2013B" or higher must be used. Update the version of the electronic service tool and then perform this Test Step again. **E.** Verify that the port is correct. **F.** Verify that the "Enable Dual Data Link Service" option is checked. **G.** Click "OK" . The electronic service tool must reconnect in order for any changes to be used. **H.** If changes are made to any of the settings for communications, electronically disconnect the electronic service tool . Electronically connect the electronic service tool. Attempt to establish communication. Observe the indicators on the communication adapter. A "limited support" warning should not be displayed. The "J1939 / DeviceNet" and "PDL" indicators should be flashing. The indicator indicates that the electronic service tool is communicating on both data links.	Configured Correctly	**Result:** The electronic service tool communicates on both data links. The problem is resolved. **Result:** The electronic service tool does not communicate on both data links. The "POWER" indicator is not illuminated. Proceed to Test Step 5. **Result:** The electronic service tool does not communicate on both data links. The "POWER" indicator is illuminated. Proceed to Test Step 6.

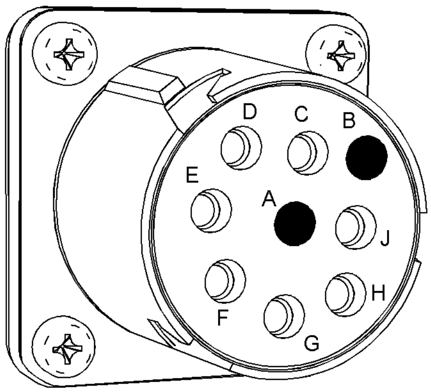


Illustration 205 g02061279

Power terminals at the service tool connector

(Terminal A) +Battery
(Terminal B) −Battery

Table 252

Troubleshooting Test Steps	Values	Results
5. Check the Electrical Power to the Communication Adapter **A.** Check for battery voltage at the diagnostic connector.	Electrical Power	**Result:** Battery voltage is not present at the diagnostic connector. **Repair:** Inspect the vehicles wiring and fuses. Determine the cause of the missing voltage. Make the necessary repairs. Attempt to establish communication after the electrical power is at the service tool connector. If the service tool does not communicate on both data links, proceed to Test Step 6. **Result:** The electronic service tool indicates that the engine is serviced on both links. **Repair:** Verify that the cable between the diagnostic connector and the communication adapter is OK. If necessary, replace the cable. **Repair:** Replace the communication adapter if the following conditions are true: **1.** There is power at the cables “DATA LINK” connector. **2.** The communication adapters “POWER” indicator is not illuminated.
6. Check the Electrical Power to the ECM **A.** Verify that the keyswitch is ON. **B.** Check the voltage between the “Battery+” terminals and the “Battery-” terminals on the P1 ECM connector. **C.** Check the voltage between the “Keyswitch” terminal and a “Battery-” terminal on the P1 ECM connector.	Electrical Power	**Result:** Battery voltage is missing from a P1 terminal. **Repair:** Inspect the vehicles wiring and fuses. Determine the cause of the missing voltage. Make the necessary repairs. Attempt to establish communication after the electrical power is at all of the appropriate P1 terminals. Continue with this procedure, if necessary. **Result:** Battery voltage is present at all of the appropriate P1 terminals. Contact the Dealer Solutions Network (DSN).

i07031107

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 253

Codes That Clear With Each Key Cycle			
J1939 Code	**PDL Code**	**Customer Action**	**Clearing Conditions**
102-16	E1044 (2)	Cycle key OFF for 2 minutes and then run engine per Clearing Conditions	Engine Speed >1400/1500 RPM
102-18	E1045 (2)	Cycle key OFF for 2 minutes and then run engine per Clearing Conditions	Engine Speed >1400/1500 RPM
105-3	172-3	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
105-4	172-4	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
110-0	E361 (3)	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
110-3	110-3	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
110-4	110-4	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
110-15	E361 (1)	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
110-16	E361 (2)	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
157-3	1797-3	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
157-4	1797-4	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
157-16	E396 (2)	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
157-18	E398 (2)	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
168-3	168-3	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
168-4	168-4	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
174-16	E363 (2)	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
649-5	3512-5	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
649-6	3512-6	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
649-7	E1263 (2)	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
651-2	1-2	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
651-5	1-5	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)

(continued)

(Table 253, contd)

Codes That Clear With Each Key Cycle			
J1939 Code	PDL Code	Customer Action	Clearing Conditions
651-6	1-6	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
652-2	2-2	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
652-5	2-5	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
652-6	2-6	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
653-2	3-2	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
653-5	3-5	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
653-6	3-6	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
654-2	4-2	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
654-5	4-5	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
654-6	4-6	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
655-2	5-2	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
655-5	5-5	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
655-6	5-6	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
656-2	6-2	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
656-5	6-5	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
656-6	6-6	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
1184-3	3782-3	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
1184-4	3782-4	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
1184-8	3782-8	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
1188-5	526-5	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
1188-6	526-6	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
1239-0	E499 (3)	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
2791-6	3405-6	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
2791-7	E1121 (2)	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
3242-3	2452-3	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
3242-4	2452-4	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
3242-8	2452-8	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
3358-3	3385-3	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
3358-4	3385-4	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
3358-13	3385-13	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
3563-3	1785-3	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
3563-4	1785-4	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
3563-13	1785-13	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)

(continued)

(Table 253, contd)

Codes That Clear With Each Key Cycle			
J1939 Code	PDL Code	Customer Action	Clearing Conditions
4360-17	E947 (1)	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
4765-17	E1530 (1)	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
5571-0	E1264 (2)	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
5625-3	3513-3	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
5625-4	3513-4	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)
7440-31	E1645 (1)	Cycle key OFF for 2 minutes, then turn key ON	Circuit Check (Auto)

Table 254

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.

i06071355

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 the following worksheets:

- Parameters Worksheet

- Configuration Parameters

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.

i06177741

ECM Software - Install

Use this procedure to troubleshoot the electrical system if the diagnostic code in Table 255 is active.

Table 255

Diagnostic Trouble Code for ECM Software			
J1939 Code	PDL Code	Code Description (code descriptions may vary)	Comments
631-2	253-2	Calibration Module : Erratic, Intermittent, or Incorrect	The flash file is for a different engine family or for a different engine application. The engine will not start. Clearing this diagnostic code requires factory passwords. The personality module code must be reset to zero.

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 in order 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 in order to select the part number of the flash file that will be programmed into the ECM.

c. When the correct flash file is selected, press the “Open” button.

d. Verify that the “File Values” match the application. If the “File Values” do not match the application, search for the correct flash file.

e. When the correct flash file is selected, press the “Begin Flash” button.

f. The electronic service tool will indicate when flash programming has been successfully completed.

6. 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 in order to determine the parameters that require programming. Look under the “Tattletale” column. All of 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 on the “Cancel” button in order 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 or 268-2 diagnostic trouble code is displayed after flash programming, a required parameter is missing. Program the missing parameter.

i06177745

ECM - Replace

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Dispose of all fluids according to local regulations and mandates.

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

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 in order 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 in order 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 in order 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 10b.

Note: Record any Logged Faults and Events for your records.

3. Record the following parameters:

- Record all of the parameters on the "Configuration" screen.
- Record all of the parameters on the "Throttle Configuration" screen.
- Record all of 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.

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.

i06198549

DEF Pump - Replace

Table 256 lists the diagnostic codes for the Diesel Exhaust Fluid (DEF) pump.

Table 256

Diagnostic Trouble Codes for the DEF Pump			
J1939 Code	**PDL Code**	**Code Description (code descriptions may vary)**	**Comments**
4337-8	3096-8	Aftertreatment #1 SCR Dosing Reagent Temperature : Abnormal Frequency, Pulse Width, or Period	The Diesel Exhaust Fluid Controller (DCU) detects an abnormal temperature signal from the pump. The code is logged.
4374-8	3118-8	Aftertreatment #1 Diesel Exhaust Fluid Pump Motor Speed : Abnormal Frequency, Pulse Width, or Period	The DCU detects an abnormal motor speed signal from the pump. The code is logged.
4376-7	3862-7	Aftertreatment #1 DEF Return Valve : Not Responding Properly	The DCU detects that the return valve is not responding properly. The code is logged.
5798-2	3096-2	Aftertreatment #1 DEF Dosing Unit Heater Temperature : Erratic, Intermittent, or Incorrect	The DCU detects that the DEF pump temperature is implausible when compared to the ambient air temperature.
Follow the troubleshooting procedure in order to identify the root cause of the problem.			

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 257

Troubleshooting Test Steps	Values	Results
1. Inspect the Harness Connector at the DEF Pump **A.** Turn the keyswitch to the OFF position for 2 minutes. The keyswitch must be OFF for 2 minutes to allow the DEF pump to purge, reset the code, and reset the DCU. **B.** Disconnect the DEF pump electrical connector. **C.** Inspect the connector terminals for DEF contamination or corrosion.	DEF pump connector	**Result:** The DEF pump connector was free of DEF contamination or corrosion. Proceed to Test Step 2. **Result:** The DEF pump connector was not free of DEF contamination or corrosion. **Repair:** Replace the PETU wiring harness. Proceed to Test Step 2.
2. Replace the DEF Pump **A.** Turn the keyswitch to the OFF position for 2 minutes. The keyswitch must be OFF for 2 minutes to allow the DEF pump to purge, reset the code, and reset the DCU. **B.** Replace the DEF pump. Refer to Disassembly and Assembly, “Diesel Exhaust Fluid Pump - Remove and Install” for the correct procedure. **C.** Establish communication between the electronic service tool and the DCU. **D.** Perform the “DEF Dosing System Verification Test” in order to pressurize and prime the system. **E.** Visually inspect all DEF lines from the tank to the DEF injector for leakage.	Leakage	**Result:** The lines are not leaking. Proceed to Test Step 3. **Result:** The lines are leaking. **Repair:** Make the necessary repairs and repeat the “DEF Dosing System Verification Test” . Proceed to Test Step 3.
3. Perform an “Aftertreatment System Functional Test” **A.** Turn the keyswitch to the ON position. **B.** Establish communication between the electronic service tool and the engine ECM. **C.** Perform an “Aftertreatment System Functional Test” .	Aftertreatment System Functional Test	**Result:** The “Aftertreatment System Functional Test” was successful and the code cleared. Return the unit to service. **Result:** The “Aftertreatment System Functional Test” was not successful and additional codes were logged. Troubleshoot the additional codes, Refer to Troubleshooting for the correct procedure. If the fault is still present, contact the Dealer Solutions Network (DSN).

i06574499

Electrical Connectors - Inspect

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, “ECM Harness Connector Terminals” 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.

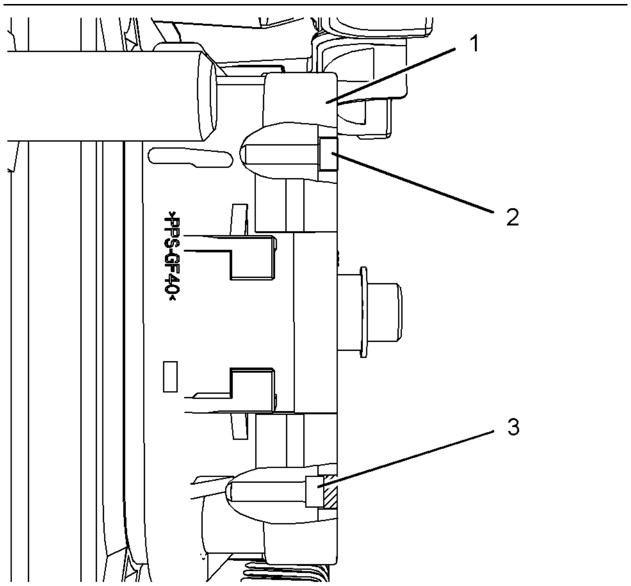


Illustration 206 g01131276

Diagram for the installation of a connector plug (typical example)

(1) ECM connector
(2) Correctly inserted plug
(3) Incorrectly inserted plug

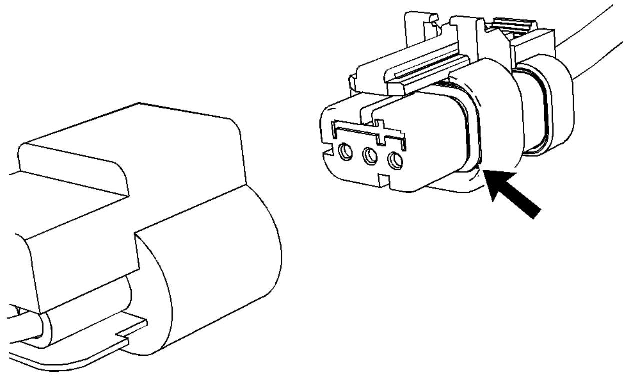


Illustration 207 g01131019

Seal for a three-pin connector (typical example)

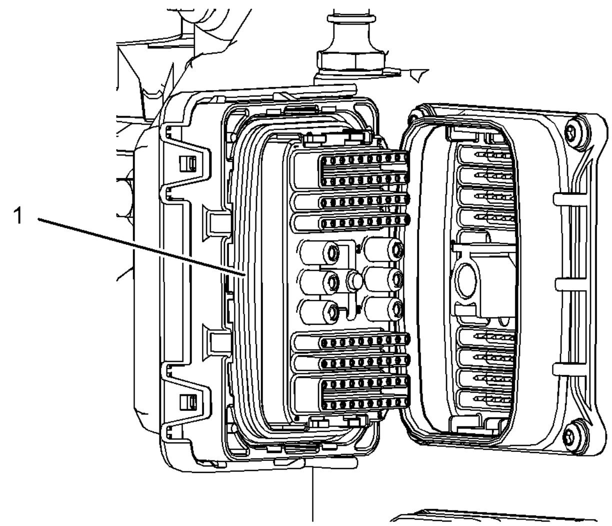


Illustration 208 g03137420

(1) Seal for ECM connector

Table 258

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. Refer to Illustration 206 . **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. **E.** Check the connectors for white deposits. White deposits may indicate that the connector has been contaminated with Diesel Exhaust Fluid (DEF). DEF may corrode the copper wire in the wiring harness.	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.

(continued)

(Table 258, contd)

Troubleshooting Test Steps	Values	Results
3. Inspect the Connector Terminals **Note:** The ECM connectors cannot be repaired. If damage is found on an ECM connector, the harness must be replaced. **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.	Terminals are aligned and undamaged	**Result:** The terminals of the connector are damaged. **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.

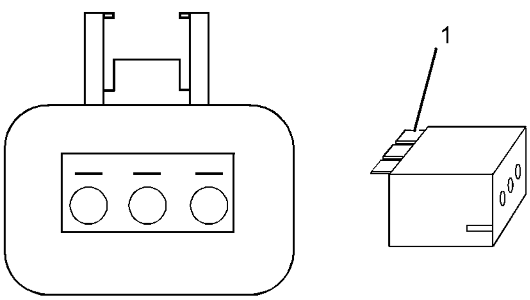


Illustration 209 g01802454

A typical example of the lock wedge.

(1) Lock wedge

Table 259

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 45 N (10 lb) pull test on each wire. Each terminal and each connector should easily withstand 45 N (10 lb) of tension and each wire should remain in the connector body. This test checks whether the wire was 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 45 N (10 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. Check the Screws on the ECM Connectors **A.** Visually inspect the screws for the ECM connectors. Ensure that the threads on each screw are not damaged. **B.** Connect the ECM connectors. **C.** Use a 7 mm screw to retain each of the ECM connectors. **D.** Tighten the two screws for the ECM connector to the correct torque of 6.0 N·m (53 lb in).	The ECM connectors are secure.	**Result:** The screws for the ECM connectors are damaged or a threaded hole in the ECM is damaged. **Repair:** Repair the connectors or replace the connectors or screws, as required. If a threaded hole in the ECM is damaged, replace the ECM. Use the electronic service tool to clear all logged diagnostic codes and then verify that the repair eliminates the fault. **Result:** The ECM connectors are secured. Proceed to Test Step 7.
7. 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.

i07693101

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.

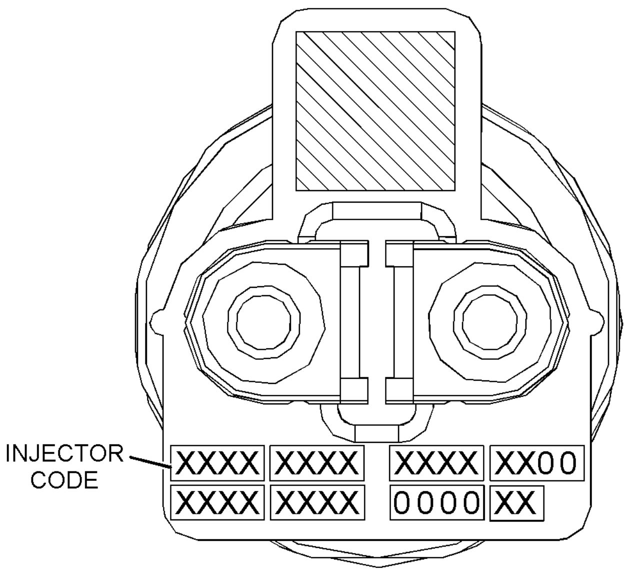


Illustration 210 g02854936

Label with the injector code

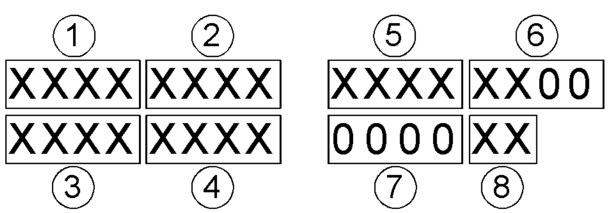


Illustration 211 g02132457

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 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.

i07433030

SCR Inducement Emergency Override

Table 260

Diagnostic Trouble Codes for SCR Inducement Emergency Override			
J1939 Code	**PDL Code**	**Code Description (code descriptions may vary)**	**Comments**
7343–31	E1598 (2)	SCR Inducement Override Re-newal Required	This code indicates that the Inducement Override has been activated. The code is logged.
Follow the troubleshooting procedure to identify the root cause of the fault.			

When an emergency situation occurs, initial activation of the override is allowed without input from Caterpillar ™. Prior to activation, the operator will be notified of the following on display : “**EMERGENCY USE ONLY. SEE OWNERS MANUAL. PENALTIES APPLY FOR MISUSE**” .

Upon activation, the check engine, and action lamps will also illuminate to alert the operator that the override is active. A code will also become active indicating that the engine emission operator inducement emergency override is active. The code will remain active until the override is reset. The override must be paused by the operator if the emergency ends before the 120 hours of override operation has expired. While paused, the equipment will be subject to inducements (derates). The override may be reactivated if an emergency situation returns. After 120 hours of override use the override will expire, and the equipment will be subject to inducements. Upon activation, the check engine and action lamps will continue to be illuminated until the override is reset. If the override has expired, the dealer will need to reset the override to use the override again. The code indicating that the engine emission operator inducement emergency override is active, will be cleared when the override is reset. Resetting the override is the only way to clear the code.

The override needs to be reset by an authorized dealer or distributor through the electronic service tool whenever the override has expired. The override cannot be used again until the override is reset. The warning lamp will continue to be illuminated until the override is reset. The override may be reset at any point after the initial activation.

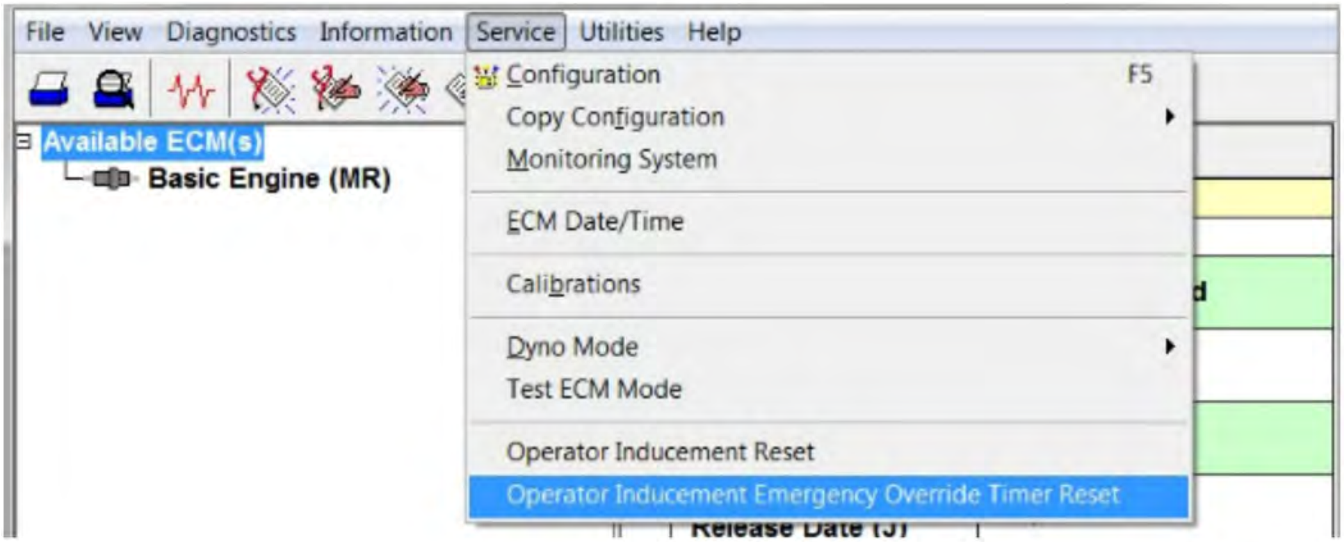


Illustration 212 g06241919

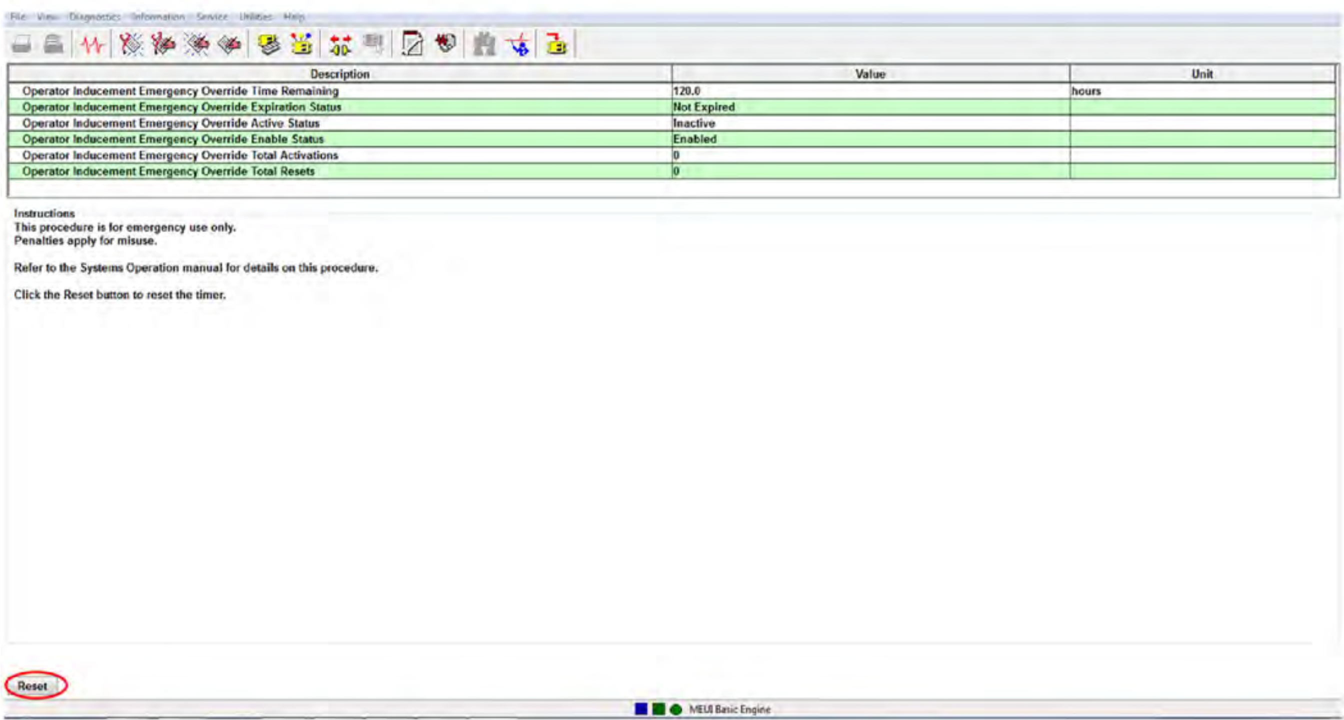


Illustration 213 g06241920

Table 261

Troubleshooting Test Steps	Values	Results
1. Reset the Operator Inducement Emergency Override **A.** Connect the electronic service tool to the diagnostic connector. **B.** Under the “Service Tab” , navigate to “Operator Inducement Emergency Override Timer Reset” . **C.** Click the “Reset” button at the bottom of the screen.	Reset	**Result:** The Emergency Inducement Operator Override Reset was performed. Return the unit to service.

Index