DIAGNOSTIC MANUAL

N13 Engine with SCR

Navistar, Inc.

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Foreword

Navistar, Inc. is committed to continuous research and development to improve products and introduce technological advances. Procedures, specifications, and parts defined in published technical service literature may be altered.

NOTE: Photo illustrations identify specific parts or assemblies that support text and procedures; other areas in a photo illustration may not be exact.

This manual includes necessary information and specifications for technicians to maintain Navistar® diesel engines. See vehicle manuals and Technical Service Information (TSI) bulletins for additional information.

Technical Service Literature

Navistar® N13 with SCR *Engine Operation and Maintenance Manual*

Navistar® N13 with SCR *Engine Service Manual*

Navistar® N13 with SCR Engine and Aftertreatment Wiring Schematic Form

Technical Service Literature is revised periodically. If a technical publication is ordered, the latest revision will be supplied.

NOTE: To order technical service literature, contact your International dealer.

Service Diagnosis

Service diagnosis is an investigative procedure that must be followed to find and correct an engine application problem or an engine problem.

If the problem is engine application, see specific vehicle manuals for further diagnostic information.

If the problem is the engine, see specific *Engine Diagnostic Manual* for further diagnostic information.

Prerequisites for Effective Diagnosis

- Availability of gauges and diagnostic test equipment
- Availability of current information for engine application and engine systems
- Knowledge of the principles of operation for engine application and engine systems
- Knowledge to understand and do procedures in diagnostic and service publications

Technical Service Literature required for Effective Diagnosis

- *Engine Service Manual*
- *Engine Diagnostic Manual*
- Diagnostics Forms
- Engine Wiring Schematic Form
- Service Bulletins

Safety Information

This manual provides general and specific maintenance procedures essential for reliable engine operation and your safety. Since many variations in procedures, tools, and service parts are involved, advice for all possible safety conditions and hazards cannot be stated.

Read safety instructions before doing any service and test procedures for the engine or vehicle. See related application manuals for more information.

Disregard for Safety Instructions, Warnings, Cautions, and Notes in this manual can lead to injury, death or damage to the engine or vehicle.

Safety Terminology

Three terms are used to stress your safety and safe operation of the engine: Warning, Caution, and Note

Warning: A warning describes actions necessary to prevent or eliminate conditions, hazards, and unsafe practices that can cause personal injury or death.

Caution: A caution describes actions necessary to prevent or eliminate conditions that can cause damage to the engine or vehicle.

Note: A note describes actions necessary for correct, efficient engine operation.

Safety Instructions

Work Area

- Keep work area clean, dry, and organized.
- Keep tools and parts off the floor.
- Make sure the work area is ventilated and well lit.
- Make sure a First Aid Kit is available.

Safety Equipment

- Use correct lifting devices.
- Use safety blocks and stands.

Protective Measures

- Wear protective safety glasses and shoes.
- Wear correct hearing protection.
- Wear cotton work clothing.
- Wear sleeved heat protective gloves.
- Do not wear rings, watches or other jewelry.
- Restrain long hair.

Vehicle

- Make sure the vehicle is in neutral, the parking brake is set, and the wheels are blocked before servicing engine.

- Clear the area before starting the engine.

Engine

- The engine should be operated or serviced only by qualified individuals.
- Provide necessary ventilation when operating engine in a closed area.
- Keep combustible material away from engine exhaust system and exhaust manifolds.
- Install all shields, guards, and access covers before operating engine.
- Do not run engine with unprotected air inlets or exhaust openings. If unavoidable for service reasons, put protective screens over all openings before servicing engine.
- Shut engine off and relieve all pressure in the system before removing panels, housing covers, and caps.
- If an engine is not safe to operate, tag the engine and ignition key.

Fire Prevention

- Make sure charged fire extinguishers are in the work area.

NOTE: Check the classification of each fire extinguisher to ensure that the following fire types can be extinguished.

1. Type A — Wood, paper, textiles, and rubbish
2. Type B — Flammable liquids
3. Type C — Electrical equipment

Batteries

- Always disconnect the main negative battery cable first.
- Always connect the main negative battery cable last.
- Avoid leaning over batteries.
- Protect your eyes.
- Do not expose batteries to open flames or sparks.
- Do not smoke in workplace.

Compressed Air

- Use an OSHA approved blow gun rated at 30 psi.(207 kPa)
- Limit shop air pressure to 30 psi (207 kPa).
- Wear safety glasses or goggles.
- Wear hearing protection.
- Use shielding to protect others in the work area.
- Do not direct compressed air at body or clothing.

Tools

- Make sure all tools are in good condition.
- Make sure all standard electrical tools are grounded.

- Check for frayed power cords before using power tools.

Fluids Under Pressure

- Use extreme caution when working on systems under pressure.
- Follow approved procedures only.

Fuel

- Do not over fill the fuel tank. Over fill creates a fire hazard.
- Do not smoke in the work area.
- Do not refuel the tank when the engine is running.

Removal of Tools, Parts, and Equipment

- Reinstall all safety guards, shields, and covers after servicing the engine.
- Make sure all tools, parts, and service equipment are removed from the engine and vehicle after all work is done.

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SCR Component Locator

SCR Switchback Assembly

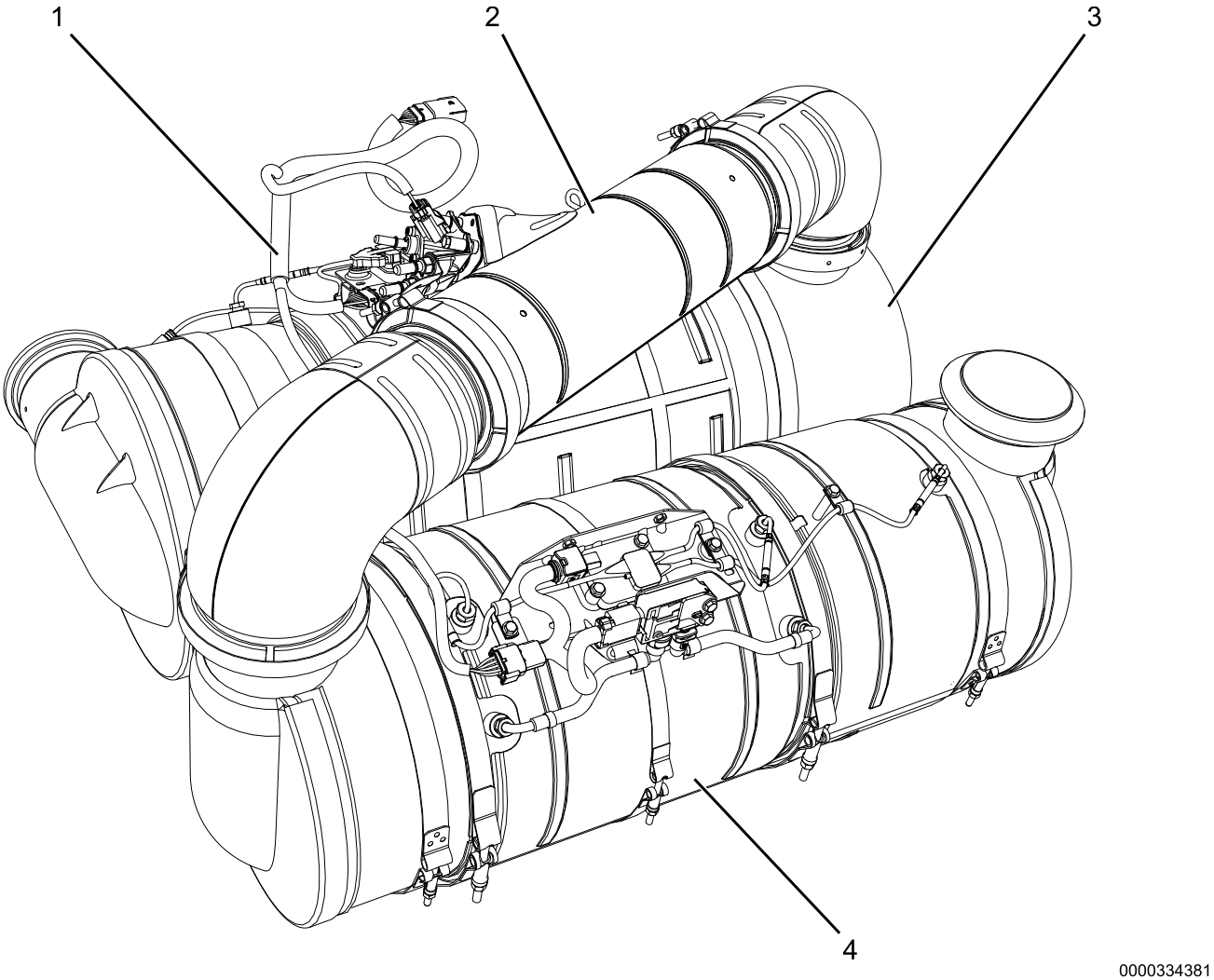

Figure 1 SCR Switchback Assembly

1. Exhaust Jumper Harness
2. Decomposition Reactor Tube
3. Selective Catalyst Reduction (SCR) assembly
4. Diesel Particular Filter (DPF) assembly

DPF Components

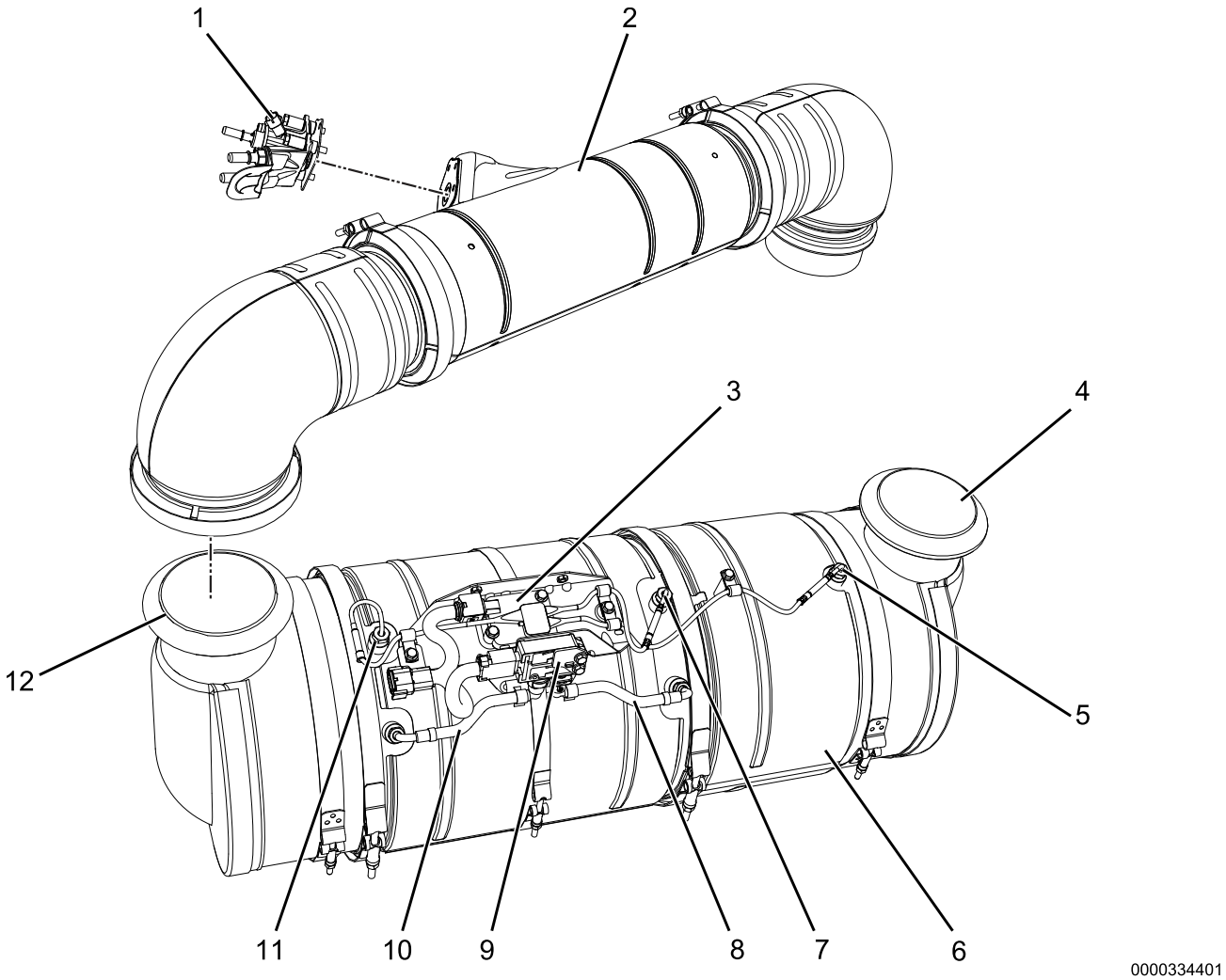

Figure 2 DPF Components

1. Diesel Exhaust Fluid Doser Valve (DEFDV)
2. Decomposition Reactor Tube
3. Diesel Oxidation Catalyst (DOC) / DPF Diesel Particulate Filter (DPF) Temperature sensor module
4. DOC Intake
5. Diesel Oxidation Catalyst Intake Temperature (DOCIT) sensor
6. Diesel Particulate Filter (DPF) assembly
7. Diesel Particulate Filter Inlet Temperature (DPFIT) sensor
8. High Pressure Tube
9. Diesel Particulate Filter Differential Pressure (DPFDP) / outlet pressure sensor module
10. Low Pressure Tube
11. Diesel Particulate Filter Outlet Temperature (DPFOT) sensor
12. DPF Outlet

SCR Components

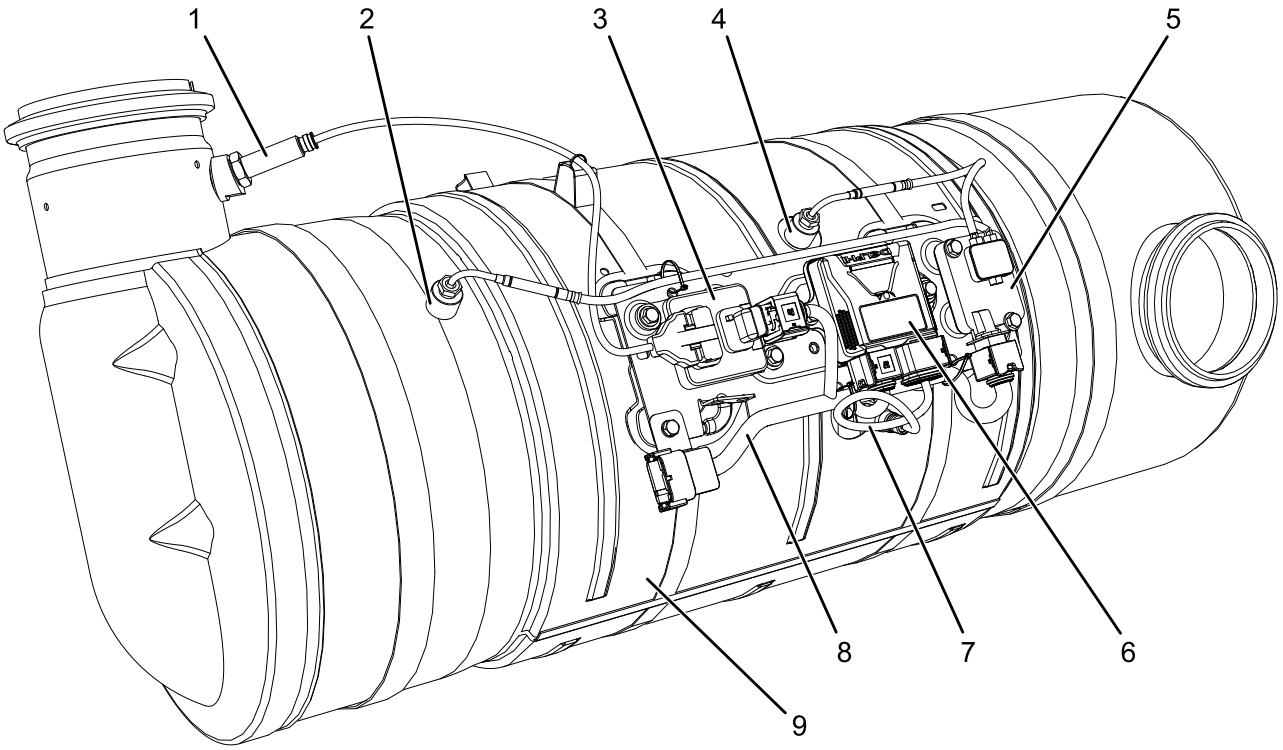

Figure 3 SCR Components

1. NOx Out sensor
2. Selective Catalyst Reduction Outlet Temperature (SCROT) sensor
3. NOx Sensor Module
4. Selective Catalyst Reduction Inlet Temperature (SCRIT) sensor
5. Selective Catalyst Reduction (SCR) temperature sensor module
6. Ammonia (NH3) sensor module
7. Ammonia (NH3) sensor
8. SCR sensor jumper harness
9. Selective Catalyst Reduction (SCR) assembly

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Engine Identification

Engine Serial Number

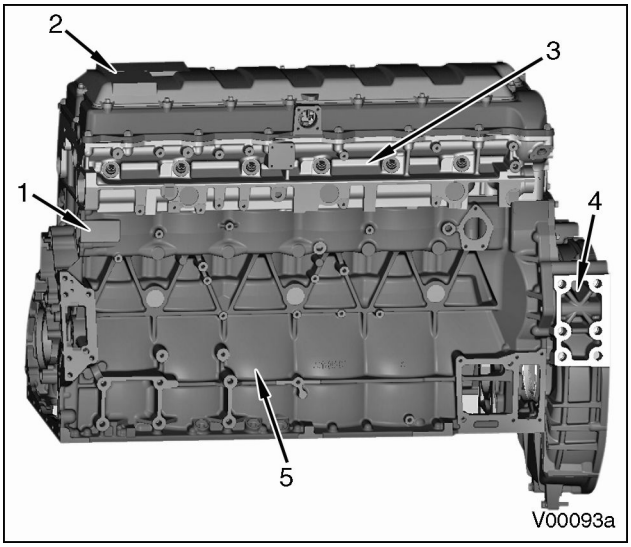

Figure 4 Engine serial number

1. Engine Serial Number (ESN) location
2. Engine emission label
3. Cylinder head
4. Flywheel housing
5. Crankcase

The Engine Serial Number (ESN) is located on the front of the crankcase (left side), below the cylinder head.

Engine Serial Number Examples

Navistar® N13: 126HM2YXXXXXXX

Engine Serial Number Codes

126 – N13 with SCR engines
H – Diesel, turbocharged, Charge Air Cooler (CAC), and electronically controlled
M2 – Motor truck
Y – Huntsville, Alabama
7 digit suffix – Engine serial number sequence

Engine Emission Label

0000054345

Figure 5 2010 U.S. Environmental Protection Agency (EPA) exhaust emission label (example)

The U.S. Environmental Protection Agency (EPA) exhaust emission label is on top of the valve cover (front left side). The EPA label typically includes the following:

- Model year
- Engine family, model, and displacement
- Advertised brake horsepower and torque rating
- Emission family and control systems
- Valve lash specifications
- Engine Serial Number (ESN)
- EPA, Onboard Diagnostics (OBD), EURO, and reserved fields for specific applications

Engine Accessory Labels and Identification Plates

The following engine accessories may have manufacturer's labels or identification plates:

- Aftertreatment Control Module (ACM)
- Aftertreatment Purge Air Valve (AFTPAV)
- Air compressor
- Air conditioning compressor
- Alternator
- Cooling fan clutch
- Diesel Oxidation Catalyst (DOC)
- Diesel Particulate Filter (DPF)
- Engine Control Module (ECM)
- High Pressure (HP) fuel pump
- Power steering pump
- Selective Catalyst Reduction (SCR) catalyst
- Starter motor
- Turbochargers

Engine Specifications

Navistar® N13 Diesel Engine	
Engine Configuration	4 stroke, inline six cylinder diesel
Advertised brake horsepower @ rpm	
• Navistar® N13	See EPA exhaust emission label
Peak torque @ rpm	
• Navistar® N13	See EPA exhaust emission label
Displacement	
• Navistar® N13	12.4 L (758 in³)
Compression ratio	
• Navistar® N13	17.0:1
Stroke	
• Navistar® N13	166 mm (6.54 in)
Bore (sleeve diameter)	
• Navistar® N13	126 mm (4.96 in)
Total engine weight (dry weight without trim or accessories)	
• Navistar® N13	1087 kgs (2392 lbs)

Firing order	1-5-3-6-2-4
Engine rotation direction (facing flywheel)	Counterclockwise
Aspiration	Dual turbocharged and charge air cooled
Combustion system	Direct injection turbocharged
Fuel system	High-pressure common rail
Lube system capacity (including filter)	40 L (42 qts)
• Navistar® N13	
Lube system capacity (overhaul only, with filter)	44 L (46 qts)
• Navistar® N13	
Engine oil pressure at operating temperature with SAE 15W-40 oil	
• Low idle	69 kPa (10 psi) min.
• High idle	276 - 483 kPa (40 - 70 psi)
Idle speed (no load)	600 rpm, nominal
Thermostat operating temperature	
• Primary	83°C - 95°C (181°F - 203°F)
• Secondary	87°C - 102°C (189°F - 216°F)

Heavy Duty On Board Diagnostics (HD-OBD)

The EPA has added new regulations for 2010 to reduce heavy duty vehicle emissions. The HD-OBD system is designed specifically for electronically controlled heavy duty engines. The goal for HD-OBD regulation is to keep engine emissions in specification for as long as a given vehicle is in use.

HD-OBD is legislated to be implemented in three phases:

- 2010: First engine for each Original Equipment Manufacture (OEM) becomes fully certified.
  - The lead engine is determined by a legislated equation based on projected sales volume & useful life of the engine.
  - For Navistar®, this is the EPA 2010® N13 engine.
- 2013: One engine in each engine family becomes fully certified.
  - This will be the largest step of the three phases.
- 2016: All engines must be fully HD-OBD certified.

The HD-OBD system continuously monitors for proper engine operation, and will alert the vehicle operator to emission-related faults using the Malfunction Indicator Lamp (MIL).

The MIL is installed in the Electronic Instrument Cluster. When a detected emissions fault occurs, the MIL will be illuminated. Diagnostic information is also stored in the Engine Control Module (ECM), and may be accessed by the technician for diagnosis and repair of the malfunction. Diagnostic information is accessed by connecting the Electronic Service Tool (EST) to the in-cab Diagnostic Connector.

Engine Description

The Navistar® N13 diesel engine is designed for increased durability, reliability, and ease of maintenance.

The cylinder head has four valves per cylinder for increased airflow. The overhead valve train includes rocker arms and valve bridges to operate the four valves. The fuel injector is centrally located between the four valves, directing fuel over the piston for improved performance and reduced emissions.

The overhead camshaft is supported by seven bearings in the cylinder head. The camshaft gear is driven from the rear of the engine. The overhead valve train includes roller rocker arms and dual valves that open, using a valve bridge.

Navistar® N13 engines use one-piece steel pistons. All pistons use an offset piston axis and centered combustion bowls. Crown markings show correct piston orientation in the crankcase.

The one-piece crankcase uses replaceable wet cylinder liners that are sealed by dual crevice seals.

The crankshaft has seven main bearings with fore and aft thrust controlled at the sixth bearing. One fractured cap connecting rod is attached at each crankshaft journal. The piston pin moves freely inside the connecting rod and piston. Piston pin retaining rings secure the piston pin in the piston. The rear oil seal carrier is part of the flywheel housing.

A gerotor lube oil pump is mounted behind the front cover and is driven by the crankshaft. Pressurized oil is supplied to various engine components. All Navistar® N13 engines also use an engine oil cooler and a cartridge-style engine oil filter, which are installed in the engine lube oil module.

The low-pressure fuel pump draws fuel from the fuel tank(s) through a chassis mounted filter/water separator. The low-pressure fuel pump provides fuel for the engine mounted fuel module. Conditioned low-pressure fuel is supplied from the engine mounted fuel module to the high-pressure fuel pump, Inlet Air Heater fuel solenoid, and the AFT fuel doser module.

The high-pressure fuel system is a direct fuel injected common-rail system. The common-rail includes a high-pressure fuel pump, two fuel rail supply lines, fuel rail, six fuel injectors, and pressure relief valve.

The fuel injectors are installed in the cylinder head under the valve cover and are electronically actuated by the ECM.

Navistar® N13 engines use a dual stage, fixed geometry turbocharger assembly. Each stage includes a Charge Air Cooler (CAC). The High Pressure (HP) turbocharger includes a pneumatically operated wastegate. The Low Pressure Charge Air Cooler (LPCAC) is mounted on the lower right side of the engine, and uses the engine cooling system to regulate charge air temperatures. The High Pressure Charge Air Cooler (HPCAC) is mounted in front of the engine cooling package. The HPCAC is an air-to-air type cooler, and requires no connections to the engine's cooling system.

The Exhaust Gas Recirculation (EGR) system circulates cooled exhaust into the air inlet duct. The dual stage EGR cooler provides regulated cooling of the EGR gases before entering the air inlet duct. This cools the combustion process, and reduces Nitrogen Oxides (NO_x) emissions.

The open crankcase breather system uses a centrifugal Crankcase Oil Separator (CCOS) to return oil mist to the crankcase, and vent the cleaned crankcase gasses to the atmosphere. The CCOS is part of the oil module. The breather system has been redesigned, and uses no crankcase breather filter or external piping. Blowby gases enter the CCOS through the side of the crankcase.

The Inlet Air Heater system warms the incoming air supply during engine cranking and several minutes after cold engine start up to help reduce emissions.

The Navistar® Engine Brake by Jacobs® is optional for Navistar® N13 engine displacements. The engine brake is a compression release system that provides additional vehicle braking performance. The operator can control the engine brake for different operating conditions.

Optional Equipment

Optional cold climate features available are an oil pan heater and a coolant heater. Both heaters use an electric element to warm engine fluids in cold weather.

The oil pan heater warms engine oil to ensure optimum oil flow to engine components.

The coolant heater warms the engine coolant surrounding the cylinders. Warmed engine coolant increases fuel economy and aids start-up in cold weather.

Chassis Mounted Equipment

- The chassis mounted fuel filter/water separator removes a majority of the water and foreign particles that may enter the fuel system from the supply tank(s). This filter works with the engine mounted fuel module to eliminate foreign matter and moisture from the fuel before entering the fuel injection system.
- The Low Temperature Radiator (LTR) regulates the temperature of the LPCAC and the low-temperature stage of the EGR cooler. The LTR is mounted in front of the radiator cooling package, and requires connections to the engine cooling system.
- The HPCAC lowers temperature after the air is compressed by the turbochargers, and has no connections to the engine cooling system. The HPCAC is an air-to-air cooler. The HPCAC is mounted in front of the radiator cooling package.

- The Diesel Oxidation Catalyst (DOC) oxidizes hydrocarbons and carbon monoxide, provides heat for exhaust system warm-up, aids in temperature management for the Diesel Particulate Filter (DPF), and oxidizes NO into NO_2 for passive DPF regeneration. The DOC is monitored by the Aftertreatment Control Module (ACM) using one Diesel Oxidation Catalyst Inlet Temperature (DOCIT) sensor positioned at the DOC inlet, and one Diesel Particulate Filter Inlet Temperature (DPFIT) sensor positioned at the DPF inlet.
- The DPF temporarily stores carbon-based particulates, oxidizes stored particulates, stores non-combustible ash, and provides required exhaust back pressure for proper engine performance. The DPF is monitored by the ACM using the DOC / DPF temperature sensor module installed on the DPF, and the Diesel Particulate Filter Differential Pressure (DPFDP) / outlet pressure sensor installed on or near the DPF.
- The Selective Catalyst Reduction (SCR) catalyst oxidizes Nitrogen Oxides (NOx) into Nitrogen gas and water. The SCR catalyst is monitored by the ACM using a NOx IN sensor module installed after the HP turbocharger outlet pipe, and a NOx OUT sensor module installed after the outlet of the SCR catalyst. An ammonia (NH_3) sensor provides feedback to the ACM related to Diesel Exhaust Fluid (DEF) injection into the SCR catalyst.

Air Management System

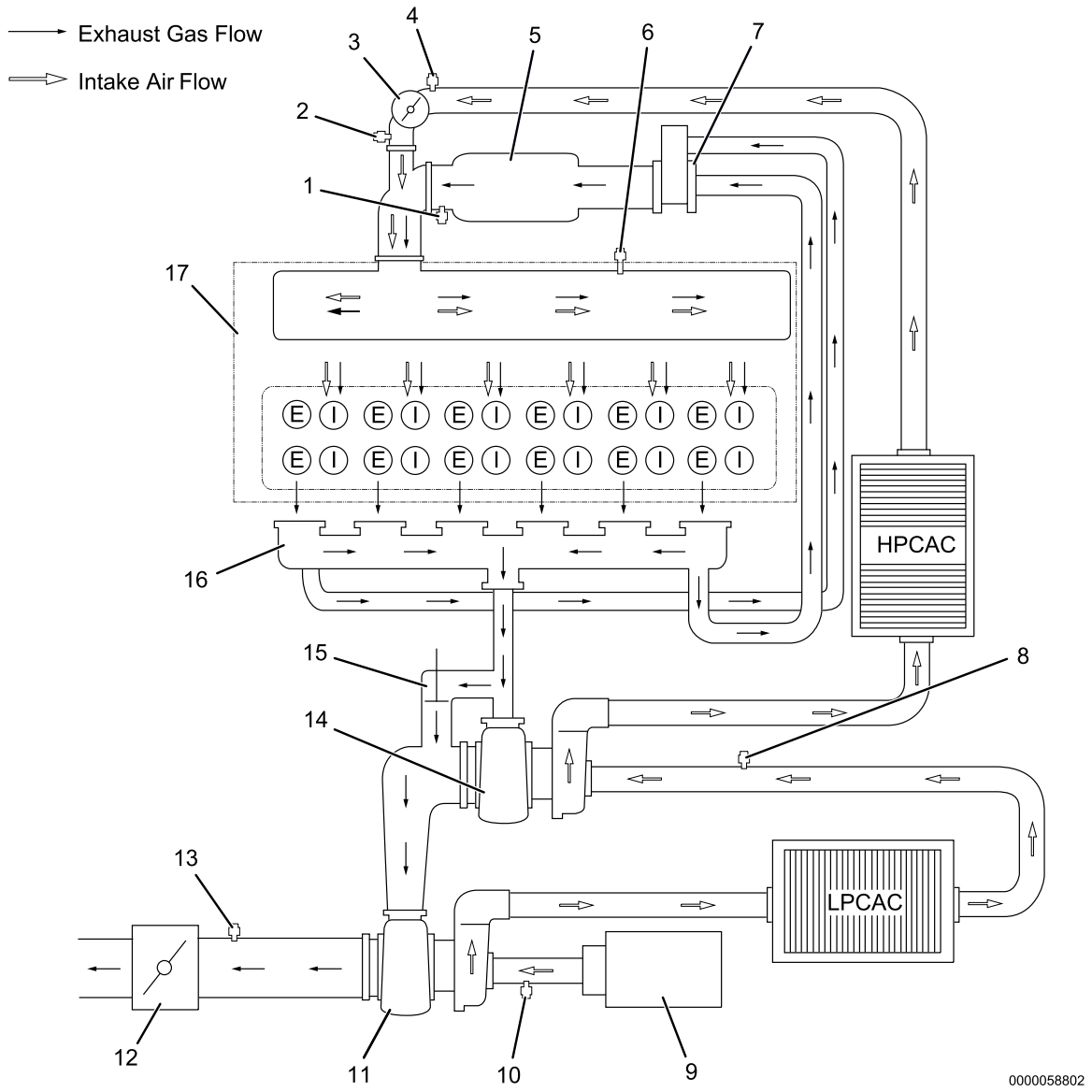

Figure 6 Air Management System

1. Exhaust Gas Recirculation Temperature (EGRT) sensor
2. Intake Manifold Pressure (IMP) sensor
3. Engine Throttle Valve (ETV)
4. Charge Air Cooler Outlet Temperature (CACOT) Sensor
5. EGR cooler
6. Intake Manifold Temperature (IMT) sensor
7. EGR valve
8. Turbocharger 2 Compressor Inlet Sensor (TC2IS)
9. Air filter housing
10. Humidity Sensor (HS) / Inlet Air Temperature (IAT) sensor
11. Low Pressure (LP) turbocharger
12. Exhaust Back Pressure Valve (EBPV)
13. Oxygen Sensor (O_2S)
14. High Pressure (HP) turbocharger
15. HP turbocharger wastegate
16. Exhaust manifold
17. Cylinder head

Airflow

Air flows through the air filter assembly and enters the Low-Pressure (LP) turbocharger. The LP turbocharger increases air pressure and temperature before entering the Low Pressure Charge Air Cooler (LPCAC). Cooled and compressed air then flows from the LPCAC into the High Pressure (HP) turbocharger (compressor inlet). Hot and highly compressed air flows from the HP turbocharger (compressor outlet) into the High Pressure Charge Air Cooler (HPCAC) where it is cooled, and into the intake throttle duct, and continues through the Engine Throttle Valve (ETV). The HP and LP turbochargers can increase pressures up to 345 kPa (50 psi).

If the Exhaust Gas Recirculation Valve (EGRV) is open, exhaust gases pass through the EGR cooler and into the intake throttle duct where it is mixed with filtered air. This mixture flows into the intake manifold, and then the cylinder head. The intake manifold is an integral part of the cylinder head casting.

During cold weather, the Inlet Air Heater system activates the heater element, vaporizing and igniting small quantities of fuel into the air inlet duct.

After combustion, exhaust gases exit through the cylinder head exhaust valves and ports. The exhaust gas is forced through the exhaust manifold where, depending on EGRV position, it is split between the EGR system and the exit path through the HP turbocharger, LP turbocharger, and Exhaust Back Pressure Valve (EBPV).

The EBPV is operated by the Air Control Valve (ACV), a pneumatic actuator. When the ACV is applied, the EBPV restricts flow and increases exhaust back pressure. Operation of the EBPV is controlled by the ECM using the ACV and the Turbocharger 1 Turbine Outlet Pressure (TC1TOP) sensor. When the EBPV is opened, exhaust back pressure is released.

Exhaust gases exiting the engine flow through the EBPV, then through the vehicle Aftertreatment (AFT) system, and out the exhaust tail pipe.

Turbochargers

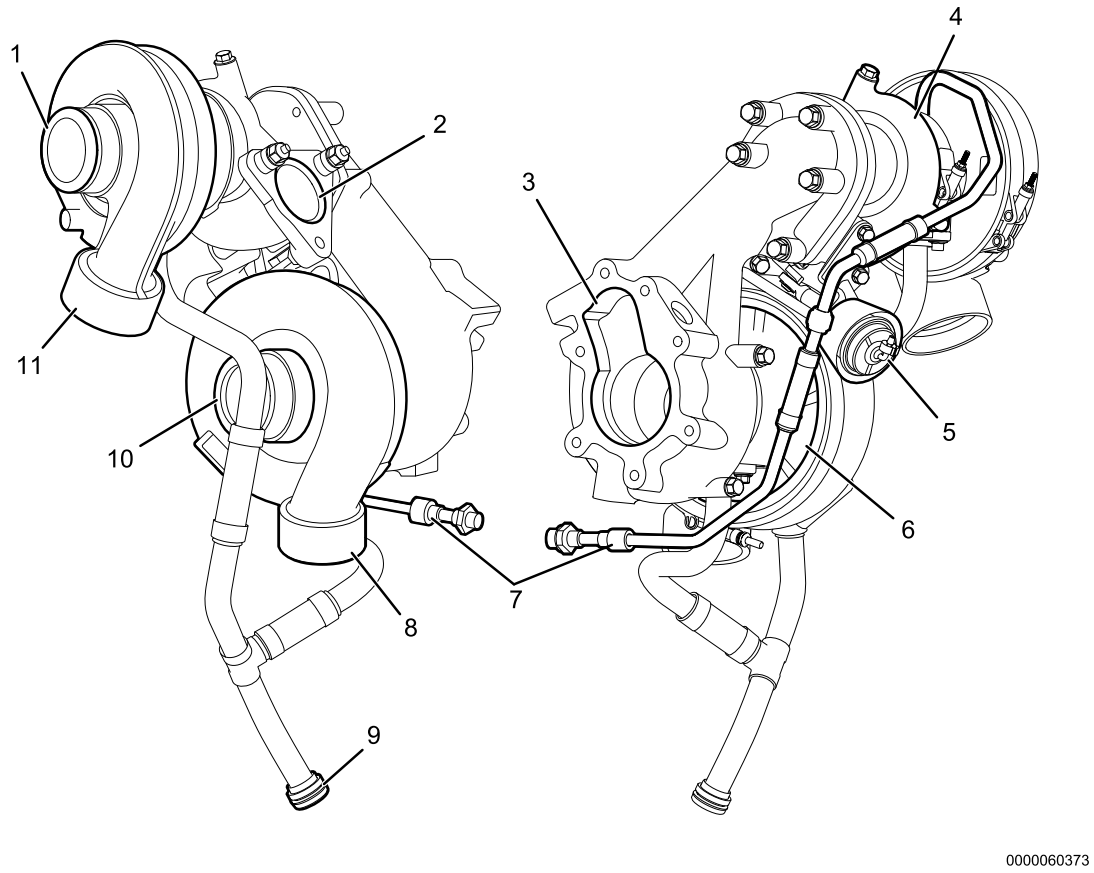

Figure 7 High and Low Pressure Turbocharger Components – Inner and Outer views

1. High Pressure (HP) turbocharger compressor inlet
2. HP turbocharger turbine inlet
3. LP turbocharger turbine outlet
4. HP turbocharger
5. HP turbocharger wastegate actuator
6. Low Pressure (LP) turbocharger
7. Turbocharger oil supply tube
8. LP turbocharger compressor outlet
9. Oil return tube
10. LP turbocharger compressor inlet
11. HP turbocharger compressor outlet

Navistar® N13 engines are equipped with a pneumatically regulated two-stage turbocharger system. The High Pressure (HP) and Low Pressure (LP) turbochargers are installed in parallel on the right side of the engine.

Intake air flow: Filtered air enters the LP compressor, where it is compressed and directed to the Low Pressure Charge Air Cooler (LPCAC). Cooled compressed air then enters the HP compressor, where it is further compressed and directed into the High Pressure Charge Air Cooler (HPCAC). Compressed air then goes through the Engine Throttle Valve (ETV) and the intake throttle duct. This system provides high charge air pressure to improve engine performance and to help reduce emissions.

Exhaust gas flow: The HP turbocharger is connected to the exhaust manifold through the HP turbine inlet. Exhaust gases exit the HP turbine outlet and are directed to the LP turbine inlet. The HP turbocharger is equipped with a wastegate, which is controlled by a pneumatic actuator. The HP turbocharger wastegate is used to regulate boost by controlling the amount of exhaust gas that bypasses the turbine of the turbocharger.

When boost demand is low, the wastegate is opened, allowing part of the exhaust gas flow to bypass the HP turbine.

Control system signals associated with the HP and LP turbochargers have been renamed for 2010.

All signals related to the LP turbocharger are designated as Turbocharger 1 (TC1) signals, and are identified below:

- Turbocharger 1 Turbine Outlet Pressure (TC1TOP)

All signals associated with the HP turbocharger are designated as Turbocharger 2 (TC2), and are identified below:

- Turbocharger 2 Wastegate Control (TC2WC)
- Turbocharger 2 Compressor Inlet Sensor (TC2CIS)

Air Control Valve (ACV)

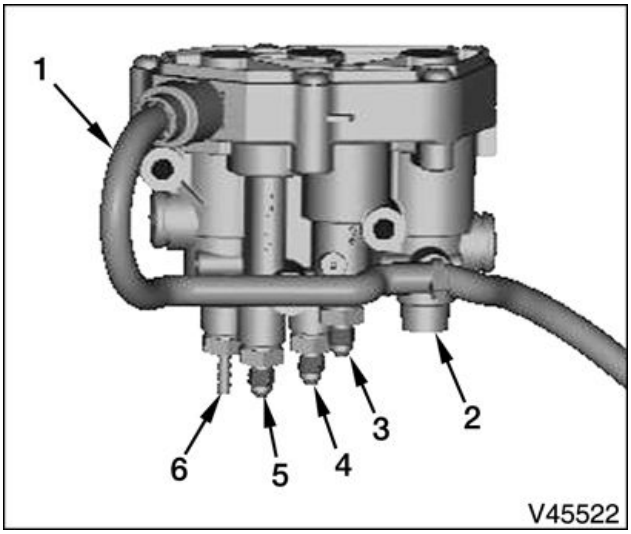

Figure 8 Air Control Valve (ACV) Connections

1. Pigtail harness (to engine sensor harness connector)
2. Plug
3. Vehicle air supply port
4. Exhaust Back Pressure Valve (EBPV) control port
5. Turbocharger 1 Turbine Outlet Pressure (TC1TOP) sensor port
6. High Pressure (HP) turbocharger wastegate control port

The ACV assembly contains the High Pressure (HP) turbocharger wastegate control port, the Exhaust Back Pressure Valve (EBPV) control port, and the Turbocharger 1 Turbine Outlet Pressure (TC1TOP) port. Although these components are integral to the ACV, each circuit is controlled by the Engine Control Module (ECM). The ACV controls compressed air for each control valve. The air supply port is connected to the vehicle's air system.

The ECM provides a Pulse Width Modulated (PWM) signal for operation of the wastegate control valve. With no PWM signal, the control valve is closed, and vehicle no air is supplied to the wastegate actuator.

When an increase in the boost is required, the ECM supplies PWM voltage to close the control valve. This reduces air pressure to the wastegate actuator causing the wastegate to close and vent air pressure, results in

increased boost. The limit values of the PWM signals are between approximately 9%, corresponding to a fully opened air control valve, and 100% corresponding to a closed air control valve.

The TC1TOP sensor and EBPV control valve are in the ACV. The EBPV control valve is also operated by the ECM using PWM, and the TC1TOP sensor is monitored by the ECM. The EBPV control valve operates the EBPV actuator.

Boost Control

The wastegate control valve, in the ACV, provides for operation of a pneumatic wastegate actuator for the HP turbocharger. Boost is controlled for HP turbocharger, by signals sent from the ECM to the ACV. In normal operation the wastegate is actuated by the ACV using vehicle compressed air, regulated to 43 psi (296 kPa). Positioning of the wastegate by the ACV is based on boost pressure and temperature signals monitored by the ECM.

Because of the ability to generate very high charge air pressure levels and to avoid Charge Air Cooler (CAC) overloading, the wastegate actuator for the HP turbocharger is also spring loaded. When boost levels increase above specification, boost pressure alone will open the wastegate, and the exhaust gases will bypass the HP turbocharger. Exhaust back pressure is constantly monitored by the ECM using TC1TOP. The TC1TOP sensor is part of the ACV, and is connected to the exhaust system by a steel line.

Low Pressure Charge Air Cooler (LPCAC)

The LPCAC is installed between the High Pressure (HP) and Low Pressure (LP) turbochargers, and is mounted to the lower right side of the engine. The LPCAC air inlet is connected to the LP turbocharger compressor outlet, and uses engine coolant to regulate the LP charge air temperature. The LPCAC air outlet is connected to the compressor inlet of the HP turbocharger.

High Pressure Charge Air Cooler (HPCAC)

The HPCAC is installed between the HP turbocharger and the intake throttle duct. The HPCAC air inlet is connected to the HP compressor outlet, and uses ambient airflow entering the front of the vehicle to reduce the charge air temperature. The HPCAC air outlet is connected to the intake throttle duct.

Intake Manifold Pressure (IMP) Sensor

Monitors charge air pressure entering the intake throttle duct and provides information used for boost and EGR control.

The IMP provides an analog voltage output to the Engine Control Module (ECM) which is proportional to pressure applied to an internal diaphragm in the sensor. The IMP sensor is connected to the ECM by the Reference Voltage (VREF), signal, and ground wires. A transfer function in the ECM software converts the analog voltage to a pressure value which is then used by software strategies.

Intake Manifold Temperature (IMT) Sensor

This sensor monitors charge air temperature entering the intake throttle duct. The temperature measured is an input to the engine coolant control strategy. It also is used for evaluation of on-board diagnostics to ensure proper functionality of the charge air cooling system.

This temperature sensor is a thermistor and has two connections to the Engine Control Module (ECM). A thermistor varies resistance as temperature changes. When interfaced to the ECM circuitry, a change in sensor

resistance results in a voltage change internal to the ECM. A transfer function contained in the ECM software translates the measured voltage to a temperature value.

The ECM continuously monitors the voltage resulting from the thermistor's changing resistance. High and low diagnostic voltage thresholds are evaluated to ensure that the output voltage is within a valid range.

Turbocharger 2 Compressor Inlet Sensor (TC2IS)

This sensor is a dual function sensor that detects pressure and temperature of the charge air entering the High Pressure (HP) compressor. It is installed in the piping between the Low Pressure (LP) compressor outlet and the HP compressor inlet. This sensor is used for evaluation by on-board diagnostics to ensure proper functionality of the charge air cooling system.

This sensor consists of a thermistor which varies resistance as temperature changes. When interfaced to the Engine Control Module (ECM) circuitry, a change in sensor resistance results in a voltage change internal to the ECM. An internal diaphragm which deflects due to pressure changes results in an analog voltage output to the ECM which is proportional to the pressure. Transfer functions contained in the ECM software translate the measured voltages into a temperature and a pressure value.

The ECM continuously monitors the voltages resulting from changes in both the temperature and pressure. High and low diagnostic voltage thresholds are evaluated to ensure output voltage is within a valid range.

Exhaust Gas Recirculation (EGR) System

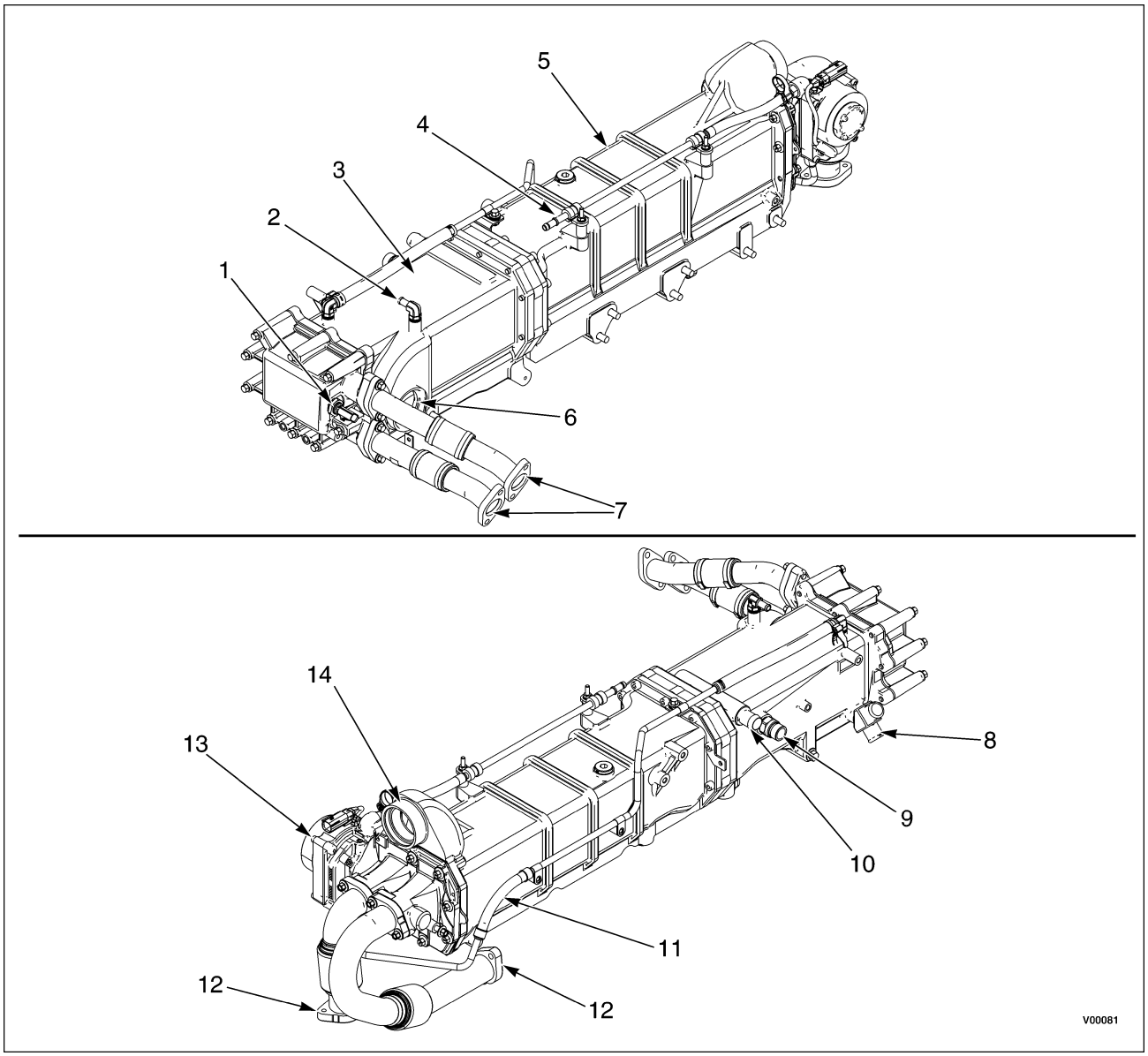

Figure 9 EGR system components

1. EGRT sensor
2. EGR cooler air bleed (to deaeration tank)
3. EGR cooler (low-temperature stage)
4. EGRV coolant return line (to deaeration tank)
5. High temperature EGR cooler
6. Intake Manifold Temperature (IMT)
7. EGR cooler outlet tube (2) (gases)
8. Low temperature EGR cooler inlet (coolant)
9. Engine Coolant Temperature 2 (ECT2) sensor
10. Low temperature EGR cooler outlet (coolant)
11. EGRV coolant supply line
12. EGR cooler inlet tubes (gases)
13. EGRV
14. EGR cooler inlet (coolant)

EGR System Overview

The EGR system reduces NO_x engine emissions by introducing inert cooled exhaust gas into the air inlet duct. NO_x forms during a reaction between nitrogen and oxygen at high-temperatures during combustion.

The Engine Control Module (ECM) monitors signals from the Charge Air Cooler Outlet Temperature (CACOT) sensor, Oxygen sensor (O_2S), Engine Coolant Temperature 1 (ECT1) sensor, EGRT sensor to control the EGR system.

EGR is switched Off (EGRV closed) if any of the following conditions are present:

- Engine coolant temperature less than 10°C (50°F) will close the EGR valve
- Intake manifold temperatures less than 7°C (45°F) will close the EGR valve
- During engine brake operation

EGR Flow

Hot exhaust gas from the exhaust manifold flows through the EGR inlet tubes to the Exhaust Gas Recirculation Valve (EGRV). When EGR is commanded, the EGRV opens and allows exhaust gas to enter the EGR cooler. Exhaust gas flows through the EGR cooler, is cooled and then flows through the EGR outlet tubes, and into the intake throttle duct where it is mixed with filtered air.

EGR System Control

The EGR system consists of the EGRV, Engine Throttle Valve (ETV), and Oxygen Sensor (O_2S). The EGRV contains a Pulse Width Modulated (PWM) controlled valve and Exhaust Gas Recirculation Position (EGRP) sensor.

The EGRV is installed at the rear of the EGR cooler, on the right side of engine valve cover. The EGRV limits exhaust gas flow into the EGR cooler.

The ECM commands the EGRV to move and hold position. The EGRP sensor, installed inside the EGRV, monitors and provides an EGRV position signal to the ECM.

The O_2S is installed in the exhaust, in front of the aftertreatment fuel injector. The O_2S has a heater element that heats the sensor to its normal operating temperature of 780°C (1436°F). During initial engine warm-up, the O_2S heater element is activated only after engine coolant reaches 40°C (104°F) and the exhaust gas temperature DOCIT sensor exceeds 100°C (212°F) for more than 30 seconds.

EGRV Control

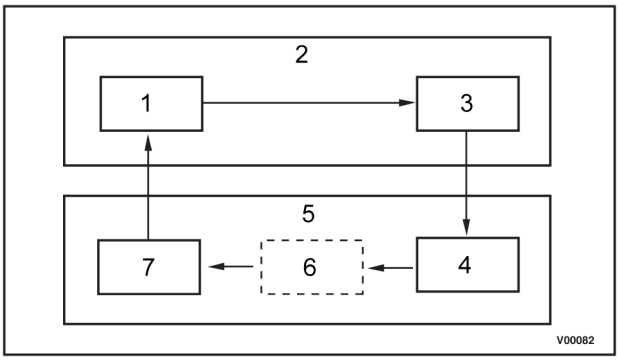

Figure 10 EGRV position control

1. EGR position monitored by ECM
2. Engine Control Module (ECM)
3. ECM commands EGR to desired position
4. EGRV to desired position
5. EGRV
6. EGRV position matches ECM command
7. EGR position sent to ECM

The EGRV has an integrated position sensor, and provides feedback to the ECM indicating EGRV position.

EGR – Open Loop

During engine warm-up and before the Oxygen Sensor (O_2S) reaches normal operating temperature, the Exhaust Gas Recirculation (EGR) system operates in open loop. In open loop, the EGR system is controlled by the ECM based on the charge air temperature, engine coolant temperature, engine speed, and load conditions.

EGR – Closed Loop

After the O_2S reaches operating temperature, the EGR system switches to closed loop operation. In closed loop, the EGR system is controlled by the ECM based on coolant temperature and O2S readings.

EGR Flow Cooling

The EGR system includes a two-stage EGR cooler, and Coolant Control Valve (CCV) to allow the Engine Control Module (ECM) to regulate EGR cooler temperatures. The ECM monitors intake manifold temperature through the Exhaust Gas Recirculation Temperature 1 (EGRT1) sensor and the CCV regulates coolant flow through the Low Temperature Radiator (LTR). Refer to Engine Cooling System (page 55) in this section for more information.

Aftertreatment (AFT) System

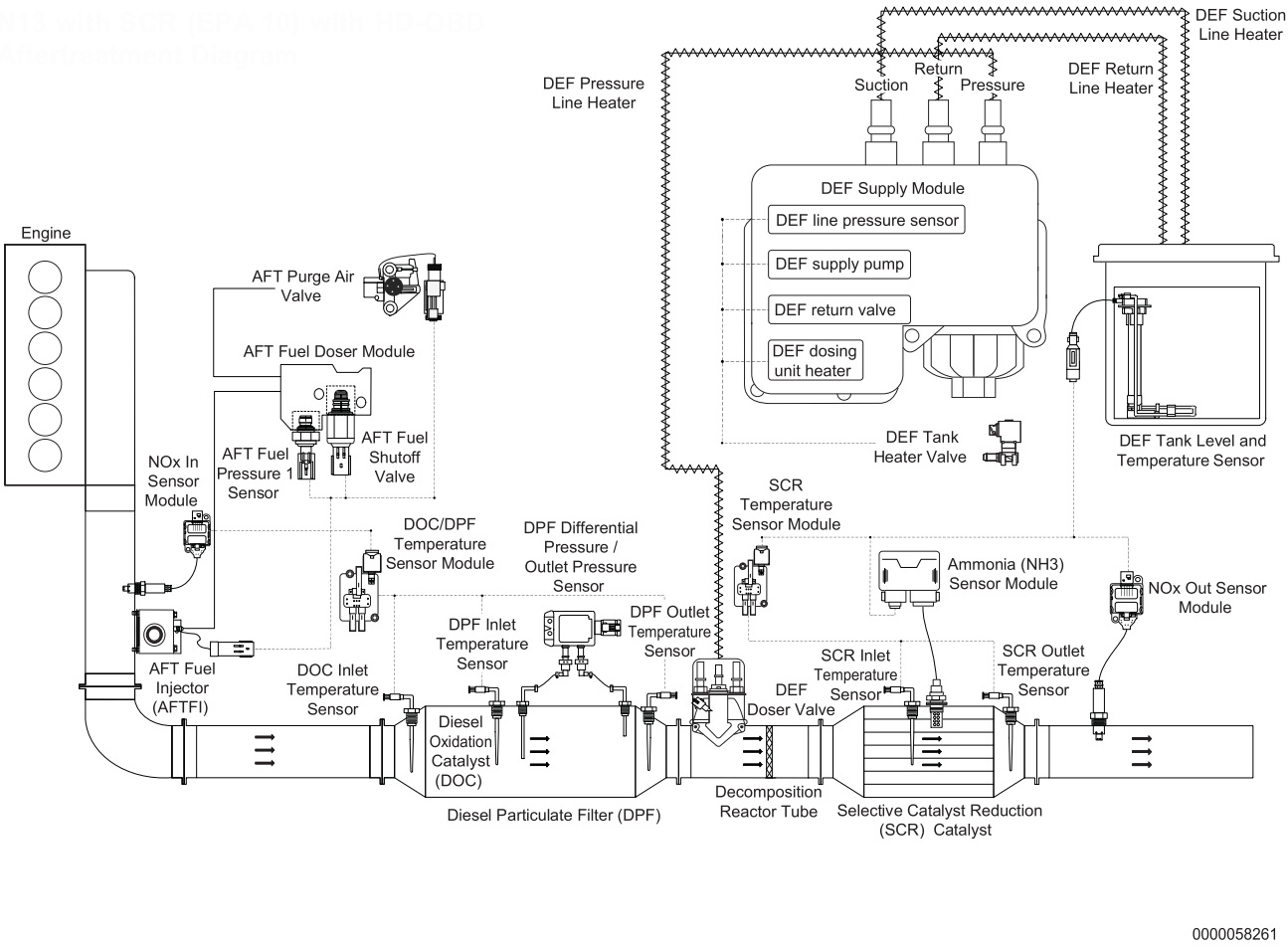

Figure 11 Functional Diagram of AFT system

The AFT system, part of the larger exhaust system, processes engine exhaust to meet emission requirements. The AFT system traps particulate matter (soot) and prevents it from leaving the tailpipe, and reduces Nitrogen Oxides (NOx).

The AFT system performs the following functions:

- Monitors exhaust gas temperatures DOC In, DPF In, DPF Out, SCRIT, SCROT temperature, and Diesel Particulate Filter (DPF) delta pressure. It controls engine operating parameters for emission control and failure recognition.
- May cancel regeneration in the event of catalyst or sensor failure
- Monitors the level of soot accumulation in the DPF
- Initiates regeneration automatically when DPF is full with soot and controls engine operating parameters to increase temperature to have successful regeneration
- Maintains vehicle and engine performance during regeneration
- Monitors NOx levels in the exhaust

- Initiates Diesel Exhaust Fluid (DEF) dosing automatically when NOx levels are above a pre-calibrated threshold
- Monitors and adjusts DEF dosing per Ammonia (NH_3) sensor feedback

Decomposition Reactor Tube

The decomposition reactor tube does the following:

- Converts DEF to ammonia and CO2
- Uses an internal mixer to ensure even evaporation of DEF into the exhaust stream

Diesel Particulate Filter (DPF)

The DPF does the following:

- Captures and temporarily stores carbon-based particulates in a filter
- Allows for oxidation (regeneration) of stored particulates once loading gets to a particular level (restriction)
- Provides the required exhaust back pressure drop for engine performance
- Stores non-combustible ash

Diesel Oxidation Catalyst (DOC)

The DOC does the following:

- Oxidizes hydrocarbons and carbon monoxide (CO) in exhaust stream
- Provides heat for exhaust system warm-up
- Aids in system temperature management for the DPF

Selective Catalyst Reduction (SCR) Catalyst

The SCR catalyst does the following:

- Completes the breakdown of DEF into ammonia and CO2
- Converts ammonia and NOx to Nitrogen gas and water

Aftertreatment (AFT) System Conditions and Responses

The operator is alerted of system status either audibly or with instrument panel indicators. Automatic or manual regeneration is required when levels of soot exceed acceptable limits. For additional information, see the applicable vehicle Operator's Manual and the vehicle visor placard.

Diesel Exhaust Fluid (DEF) Injection

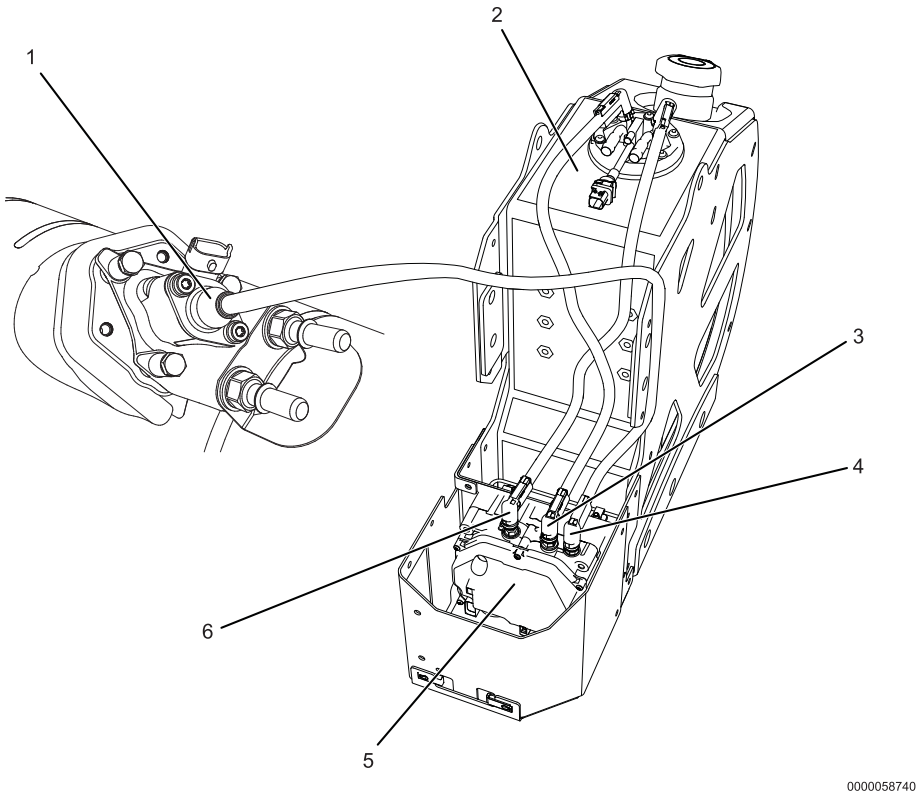

Figure 12 Diesel Exhaust Fluid (DEF) Injection Components

1. Diesel Exhaust Fluid Doser Valve (DEFDV)
2. DEF tank
3. DEF supply module return line
4. DEF supply module pressure line
5. DEF supply module
6. DEF suction line

Diesel Exhaust Fluid (DEF) injection is required when Nitrogen Oxides (NOx) levels exceed acceptable limits.

The Aftertreatment Control Module (ACM) determines when DEF injection is required by monitoring signals from the Nitrogen Oxides (NOx) IN sensor module, NOx OUT sensor module, and Ammonia (NH_3) sensor.

When NOx levels are too high, the ACM commands the DEF supply pump ON, allowing DEF to be drawn from DEF tank, through the suction line, and to the DEF supply module. DEF then exits the supply module and travels to the Diesel Exhaust Fluid Doser Valve (DEFDV) through the pressure line. The ACM then commands the DEFDV ON allowing DEF to be sprayed into the aftertreatment system.

Aftertreatment Fuel Injection

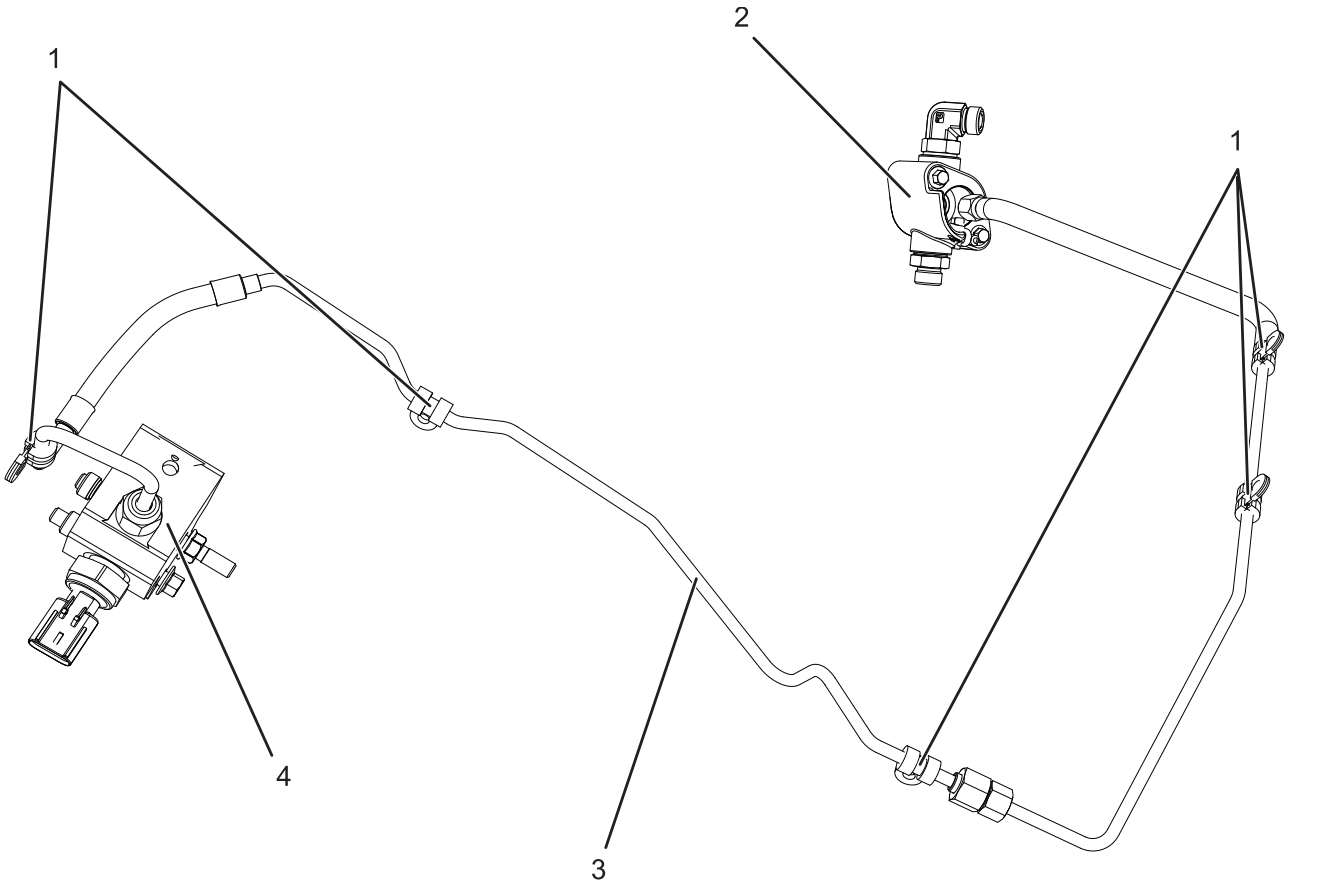

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Figure 13 Aftertreatment Fuel Injection Components (Top View)

1. Fuel line retainers (rear and left side of engine block)
2. Aftertreatment Fuel Injector (AFTFI)
3. AFTFI fuel pressure line
4. AFT fuel doser module

The AFT fuel doser module injects fuel into the exhaust system to increase temperature of the Diesel Oxidation Catalyst (DOC), and is necessary for Diesel Particulate Filter (DPF) regeneration. AFT fuel doser module is controlled by the Aftertreatment Control Module (ACM). The ACM receives signals from the Aftertreatment Fuel Pressure 1 (AFTFP1) sensor (installed in the AFT fuel doser module), and control operation when aftertreatment fuel injection (regeneration) is required. The ACM also controls the Aftertreatment Fuel Shutoff Valve (AFTFSV) (installed in the AFT fuel doser module) which controls the volume of fuel sent to the AFTFI.

AFT Fuel Doser Module Injection

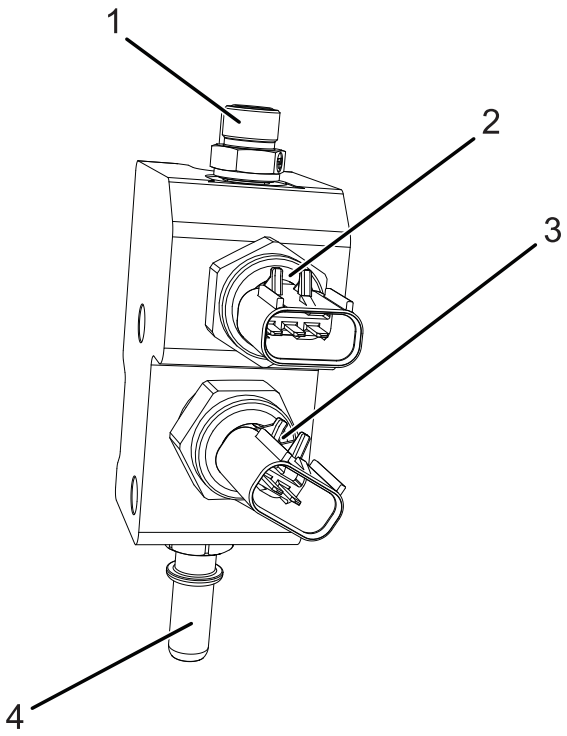

Figure 14 AFT Fuel Doser Module (Left Side View)

1. Fuel outlet port to Aftertreatment Fuel Injector (AFTFI)
2. Aftertreatment Fuel Pressure 1 (AFTFP1) sensor
3. Aftertreatment Fuel Shutoff Valve (AFTFSV)
4. Fuel supply from fuel filter assembly

The AFT fuel doser module is connected to the clean side of the low-pressure fuel system, and provides a metered amount of fuel to the Aftertreatment Fuel Injector (AFTFI). The AFT fuel doser module provides pressurized fuel injection pulses to the AFTFI. The AFTFI is a solenoid type injector, and will only inject fuel when commanded ON by the Aftertreatment Control Module (ACM). The AFT fuel doser module is installed on the left side of the engine, to the rear of the fuel module.

The AFTFP1 sensor monitors fuel pressure in the AFT fuel doser module, and provides constant feedback to the ACM.

Aftertreatment Fuel Injector (AFTFI)

The AFTFI is installed on the right side of the engine, in the exhaust pipe after the exhaust Oxygen Sensor (O_2S).

Pressurized fuel is supplied to the AFTFI thru the AFT fuel doser module using the Aftertreatment Fuel Shutoff Valve (AFTFSV). When conditions required for regeneration are met, the ACM commands the AFTFSV ON, allowing pressurized fuel to reach the AFTFI.

To protect the AFTFI internal components, continuous engine coolant flow through the AFTFI is maintained by external coolant supply and return lines.

Crankcase Oil Separator

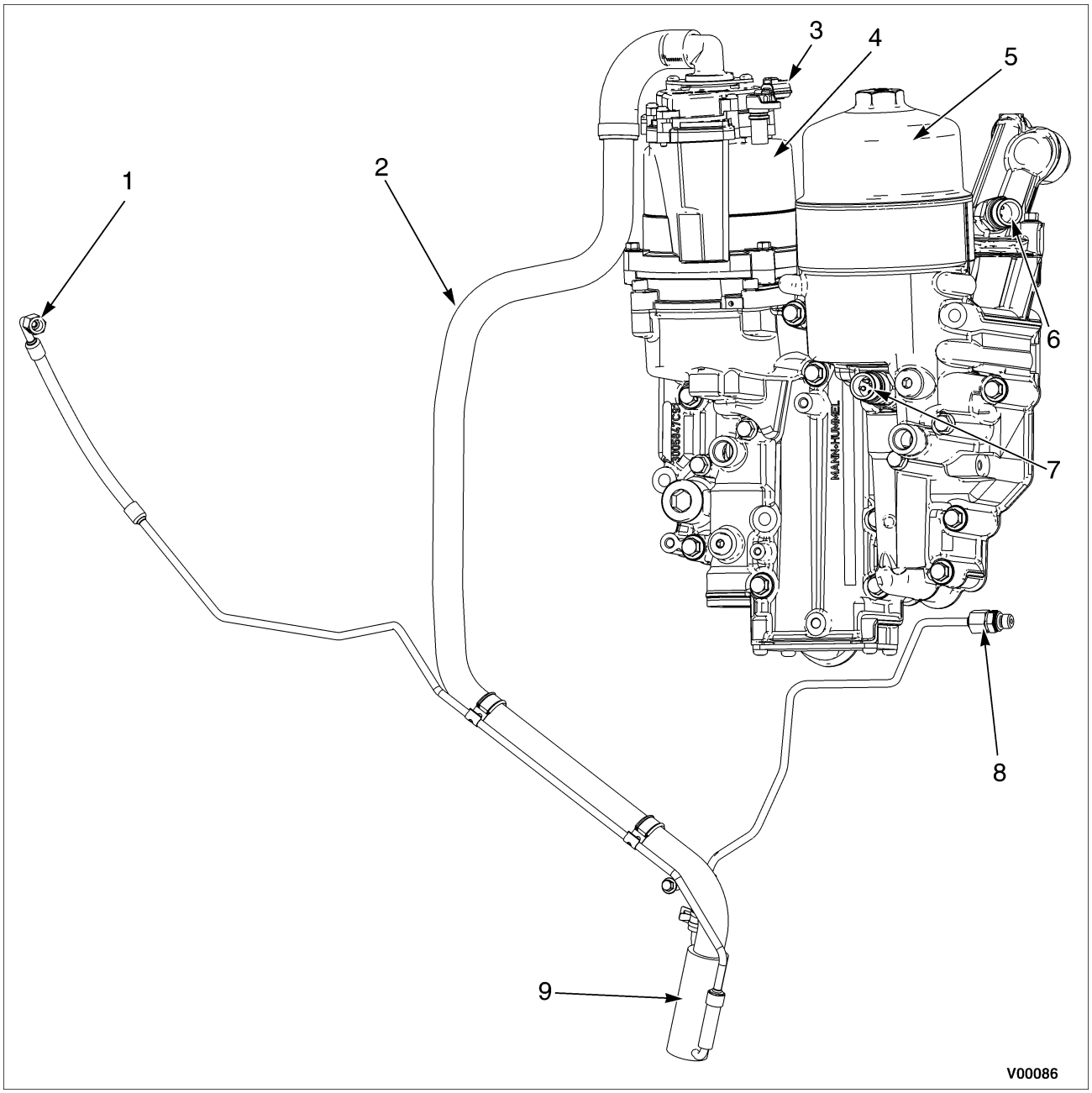

Figure 15 Oil Module with Crankcase Oil Separator

1. Coolant supply line
2. CCOS vent tube
3. Crankcase Oil Separator Speed (CCOSS) sensor
4. Crankcase Centrifuge Oil Separator (CCOS)
5. Oil filter access cap
6. Engine Oil Temperature (EOT) sensor
7. Engine Oil Pressure (EOP) sensor
8. Coolant return line
9. CCOS ventilation tube heater

Crankcase ventilation is provided using the CCOS. Excess crankcase vapors are filtered by the CCOS, and are then vented to the atmosphere.

A centrifugal oil separator, driven by engine oil pressure, separates and directs oil mist to the side of the CCOS housing. The separated oil drains from the oil separator, through the crankcase, and into the oil pan. The oil separator is an integral part of the oil module.

Fuel Management System

Fuel System Components

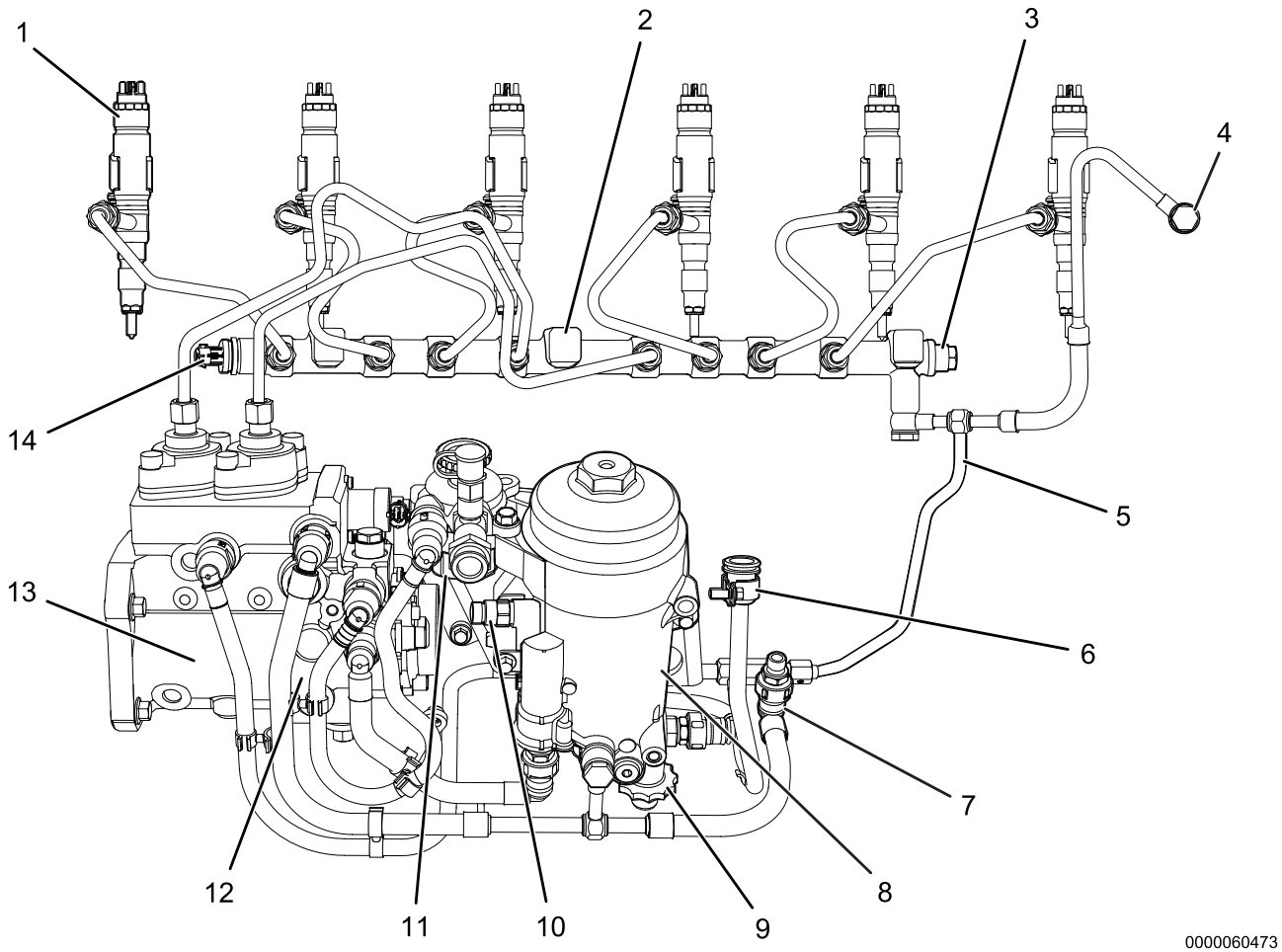

Figure 16 Fuel system

1. (Fuel) Injector (6)
2. Fuel Rail
3. Fuel rail pressure limiting valve
4. Fuel return from cylinder head
5. Fuel return line
6. Engine fuel return connection (to chassis filter)
7. Fuel supply to AFT fuel doser module
8. Fuel filter housing assembly
9. Fuel filter drain screw
10. Fuel Delivery Pressure (FDP) sensor
11. Fuel primer pump assembly
12. Low Pressure (LP) fuel pump
13. High Pressure (HP) fuel pump
14. Fuel Rail Pressure (FRP) sensor

Navistar® N13 engines are equipped with a high-pressure common rail fuel injection system which provides pressurized fuel to the fuel injectors for optimal fuel atomization in the combustion chamber.

Excess fuel is returned to the chassis mounted filter separator, before returning to the fuel tank.

The fuel system is controlled by the Engine Control Module (ECM), various sensors, and the Fuel Pressure Control Valve (FPCV) installed in the HP fuel pump.

Fuel Flow

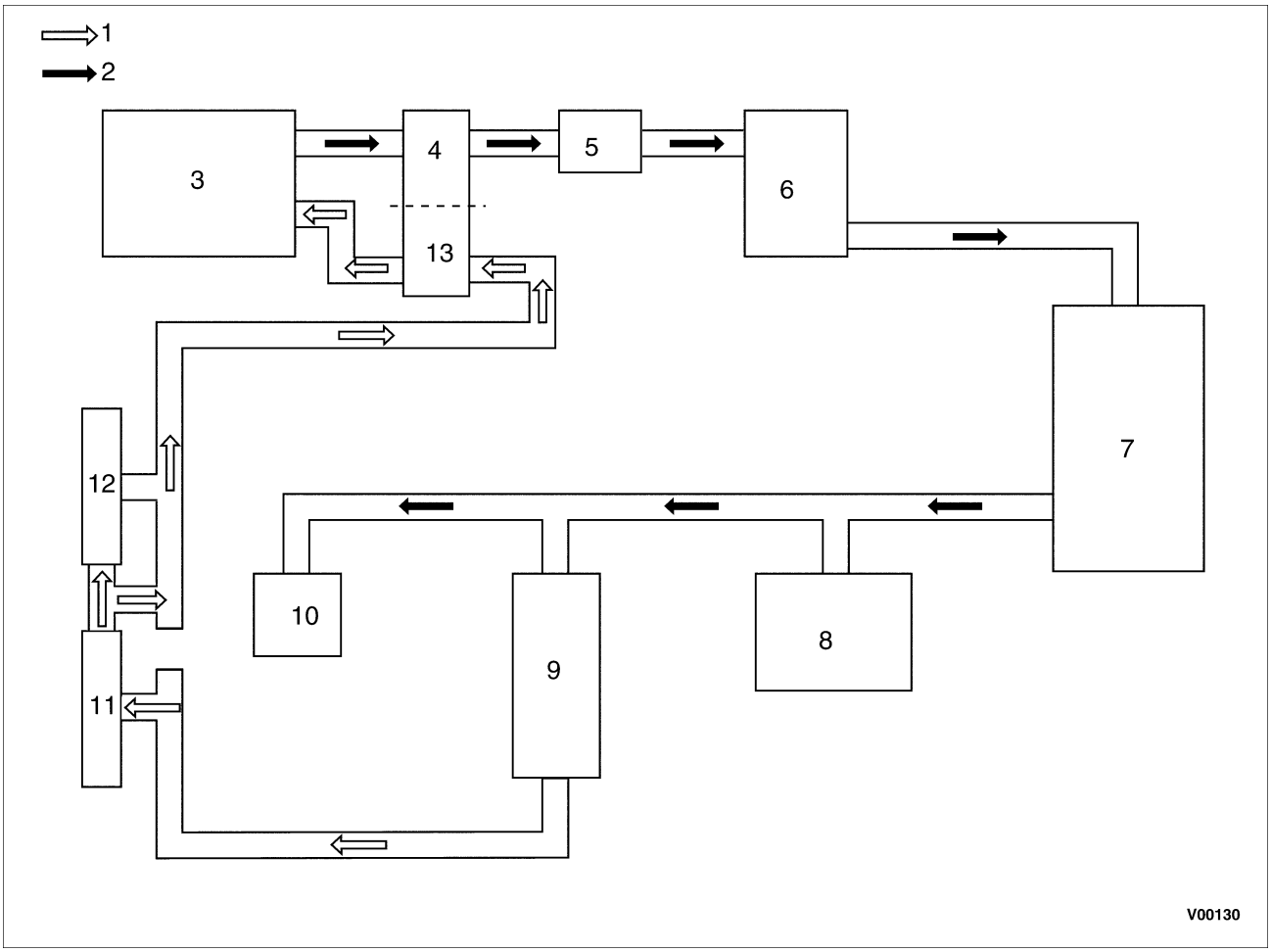

Figure 17 Fuel supply flow diagram

1. Fuel Return
2. Fuel supply
3. Fuel tank
4. Chassis mounted fuel filter/water separator (Top portion)
5. Fuel primer pump assembly with fuel strainer element
6. Low Pressure (LP) fuel pump
7. Fuel filter housing assembly (engine mounted)
8. AFT fuel doser module
9. High Pressure (HP) fuel pump
10. Inlet Air Heater Fuel Solenoid (IAHFS)
11. Fuel rail
12. Fuel injectors
13. Chassis mounted fuel filter/water separator (bottom portion)

Fuel is pumped from the tank, through the chassis mounted fuel filter/water separator using the Low Pressure (LP) fuel pump. Fuel is pumped from the LP fuel pump to the engine mounted fuel filter assembly, before being supplied to the High Pressure (HP) fuel pump. The HP fuel pump supplies high-pressure fuel to the fuel rail, which feeds the fuel injectors through individual tubes. The LP fuel pump and HP fuel pump are assembled as one gear driven unit, and are serviced as an assembly.

Low Pressure Fuel System

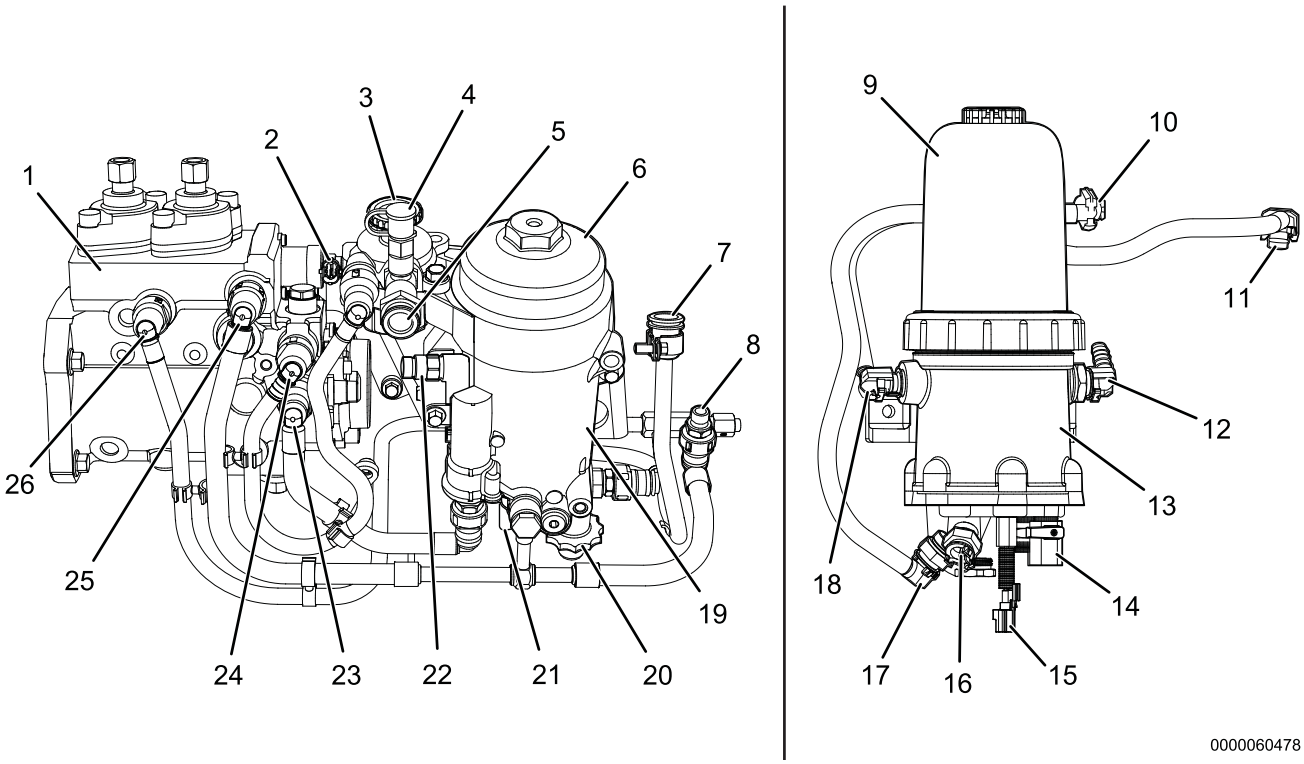

Figure 18 Low Pressure (LP) fuel system

1. High Pressure (HP) fuel pump
2. Fuel Pressure Control Valve (FPCV)
3. Fuel primer pump assembly w/ fuel strainer element
4. Fuel pressure test port
5. Engine fuel supply connection
6. Engine mounted secondary fuel filter access
7. Engine fuel return connection
8. Fuel supply to AFT fuel doser module
9. Chassis mounted primary fuel filter access
10. Fuel supply to engine
11. Fuel return from engine
12. Fuel supply from tank
13. Chassis mounted fuel filter/water separator
14. Fuel Heater
15. Water In Fuel (WIF) sensor
16. Fuel return to tank
17. Fuel return from engine
18. Fuel supply to engine
19. Fuel filter housing assembly (engine mounted)
20. Fuel filter drain screw
21. Inlet air heater port
22. Fuel Delivery Pressure (FDP) sensor
23. LP fuel pump outlet
24. LP fuel pump inlet
25. HP fuel pump inlet
26. HP fuel pump return

The LP fuel pump pumps fuel from the tank through the chassis mounted fuel filter/water separator, fuel strainer element, and engine filter element, then to the high-pressure fuel system, inlet air heater system, and AFT fuel doser module.

In addition to providing high-pressure fuel to the injectors, the fuel system provides filtered low-pressure fuel to the downstream injection and Inlet air heater systems.

Chassis Mounted Filter/Water Separator

The chassis mounted filter/water separator removes debris and water from the fuel before it enters the fuel primer pump and low-pressure fuel pump. The chassis mounted filter/water separator includes a Water In Fuel (WIF) sensor and optional fuel heater.

Fuel Primer Pump Assembly

During fuel system priming, fuel is drawn from the tank through the chassis mounted filter/water separator by the fuel primer pump assembly. The fuel primer pump assembly has an integrated fuel strainer element that can be cleaned. The fuel primer pump assembly is manually operated, and is used to prime the low-pressure fuel system anytime the fuel system has been emptied. The primer pump provides unrestricted fuel flow to the low-pressure pump during normal engine operation.

Low Pressure (LP) Fuel Pump

The LP fuel pump and the High Pressure (HP) fuel pump are one assembly. Fuel is drawn through the fuel primer pump assembly and into the LP fuel pump. The LP pump supplies fuel to the fuel filter housing assembly at pressures varying between approximately 85 psi (586 kPa) at idle, and 120 psi (827 kPa) at rated speed. The LP fuel pump has an internal pressure regulator that relieves the fuel pressure internally if the pressure exceeds 189 psi (1300 kPa).

Fuel Filter Assembly

The fuel filter assembly is installed on the left side of the engine and has a disposable filter element. A Fuel Delivery Pressure (FDP) sensor is installed on the front side of the fuel filter assembly, which measures fuel pressure between the LP fuel pump and the filter element. The fuel filter assembly also has a drain screw that allows water and dirt to be drained periodically. Because water may accumulate inside the fuel filter assembly, use the drain screw to drain water per maintenance schedule in the *Engine Operation and Maintenance Manual*. An additional function of the fuel filter assembly is fuel system self-deaeration. The air separated from fuel is pushed back into the fuel tanks through the return line. The fuel filter assembly also provides filtered fuel to the AFT fuel doser module and inlet air heater system. An orifice regulator is integrated into the fuel filter assembly, and regulates the fuel pressure for the inlet air heater system to approximately 10 psi (70 kPa).

High Pressure Fuel System

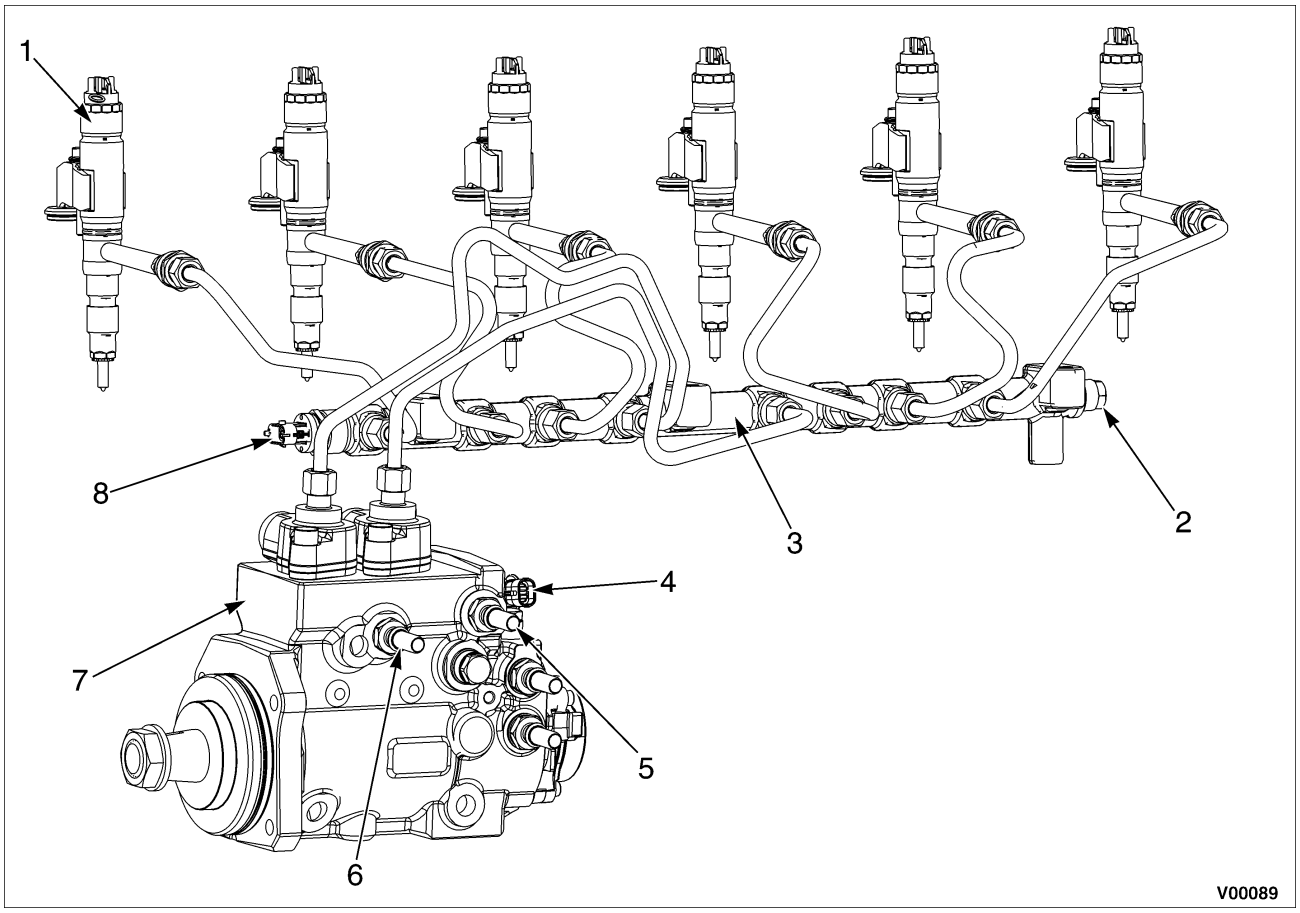

Figure 19 High Pressure (HP) fuel system

1. (Fuel) Injector (6)
2. Rail pressure limiting valve
3. Fuel rail
4. Fuel Pressure Control Valve (FPCV)
5. Fuel inlet - HP fuel pump
6. Fuel return - HP fuel pump
7. HP fuel pump
8. Fuel Rail Pressure (FRP) sensor

Pressurization and injection are separate in the common rail injection system. Optimal fuel injection pressure is generated by the high-pressure pump at any engine speed. High-pressure fuel quantity from the high-pressure pump is controlled by the FPCV. Injection timing and quantity are calculated in the Engine Control Module (ECM) and implemented by solenoid valve controlled injectors. The use of solenoid valve controlled injectors allows three injections per cycle.

The first injection is used to reduce combustion noise and emissions by introducing a small amount of fuel into the cylinder, preventing a rapid rise in cylinder pressure when combustion begins. The second injection is the main injection. This injection allows high-temperatures to be maintained during combustion, but not long enough to allow generation of large soot amounts. The third injection is done during the power stroke to maximize cylinder temperature and reduce engine soot generation.

The high-pressure fuel system consists of the high-pressure pump with integrated Fuel Pressure Control Valve (FPCV), pressure pipe rail, high-pressure fuel lines, injectors, FRP sensor, and rail pressure limiting valve.

High Pressure (HP) Pump

The HP pump supplies the necessary quantity of HP fuel for all operating engine modes. The HP pump is gear driven and is fuel lubricated. Fuel from the LP fuel pump is forced through the fuel module assembly, and into the HP pump. The flow of fuel to the suction chamber of the HP pump is controlled by the FPCV, in order to control HP fuel output.

Fuel Pressure Control Valve (FPCV)

The FPCV is a variable position actuator installed on the suction side of the high-pressure pump and controls the output fuel pressure. The Engine Control Module (ECM) sends a Pulse Width Modulated (PWM) signal to control the FPCV. A 100% duty cycle PWM signal corresponds to minimum fuel pressure delivery, while a 0% duty cycle PWM corresponds to maximum fuel pressure delivery.

Fuel Rail

The fuel rail is a HP fuel storage unit. The storage volume of the fuel rail is designed to reduce pressure pulses caused by the HP pump and injectors, and to maintain constant fuel pressure even when large fuel quantities are injected into the cylinders. Connection between the fuel rail and injectors are made through two individual injection lines.

Fuel Rail Pressure (FRP) Sensor

The FRP sensor is a variable resistance sensor that monitors fuel pressure in the High Pressure (HP) fuel rail. The FRP sensor is mounted in the front of the fuel rail, on the left side of the engine.

Rail Pressure Limiting Valve

The rail pressure limiting valve maintains fuel pressure inside the fuel rail below approximately 37,700 psi (260,000 kPa). If HP fuel pump output exceeds specification the rail pressure limiting valve opens and fuel flows into the fuel return line. With the pressure limiting valve open, fuel pressure in the high-pressure fuel rail drops to approximately 15,950 psi (110,000 kPa).

Fuel Injectors

Navistar® N13 engines are equipped with electronically controlled fuel injectors. During engine operation, injectors are supplied with high-pressure fuel, and the injector solenoid valves open up to three times per combustion cycle. The injectors are positioned vertically in the center of the cylinder head and are held in place by clamps. The seal between the injectors and the combustion chamber consists of a copper washer on the tip of each injector.

Inlet Air Heater System

Inlet Air Heater System Components

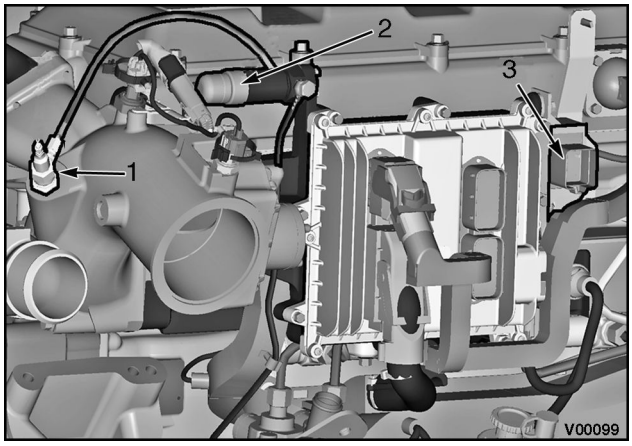

Figure 20 Inlet Air Heater System

1. Inlet Air Heater Fuel Igniter (IAHFI)
2. Inlet Air Heater Fuel Solenoid (IAHFS) valve
3. Inlet Air Heater Relay (IAHR)

Inlet Air Heater Fuel Igniter (IAHFI)

The Inlet Air Heater system rapidly activates the heater element, vaporizing and igniting small quantities of fuel into the air inlet duct.

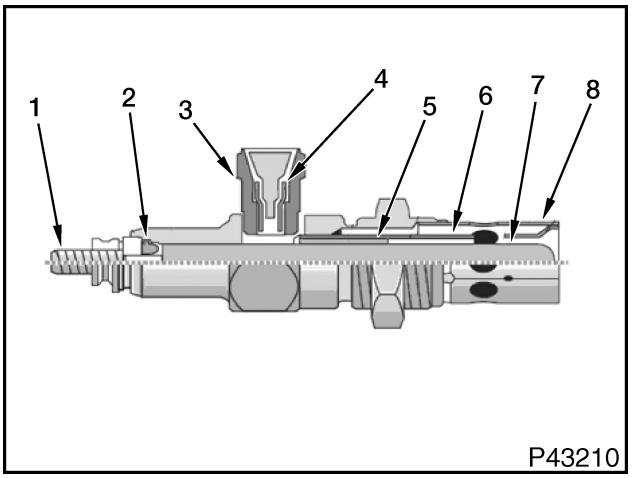

Figure 21 Inlet Air Heater Fuel Igniter (partial cut away view)

1. Electrical connection
2. Insulation
3. IAHFI fuel line connection
4. Metering device
5. Vaporizer filter
6. Vaporizer tube
7. Heater element
8. Protective sleeve

The IAHFI has an internal fuel metering device, vaporizer filter, vaporizer tube, heater element, and a protective sleeve. The protective sleeve has holes that allow enough air to pass through the IAHFI to enable fuel vaporization and combustion.

The IAHFI is installed on the left front side of the engine, in the intake throttle duct.

Inlet Air Heater Relay (IAHR)

The IAHR is installed on the left side of the engine at the rear of the Engine Control Module (ECM). The IAHR provides voltage to the IAHFI, and is controlled by the ECM.

Inlet Air Heater Fuel Solenoid (IAHFS) Valve

The IAHFS valve is installed on the left side of the engine and is controlled by the ECM. The IAHFS valve is supplied with low-pressure fuel regulated from the fuel filter assembly.

When the ECM provides battery voltage to the IAHFS valve, the solenoid opens and allows fuel to flow to the IAHFI through the IAHFI fuel line.

Inlet Air Heater System Operation

The Inlet Air Heater system operates only in temperatures lower than 10°C (50°F).

When the truck operator turns the ignition switch to ON, the wait-to-start lamp in the instrument cluster illuminates. Based on the temperature readings from the Engine Coolant Temperature (ECT) sensors, the ECM activates the IAHR heater element. The IAHR then energizes the IAHFI for approximately 35 seconds.

Once the IAHFI is heated to approximately 1000°C (1832°F), the wait-to-start lamp starts to flash and the operator can crank the engine. When the engine is rotating, the IAHFS valve opens and allows fuel to enter the IAHFI. Inside the IAHFI, fuel passes through the vaporizer tube. The vaporized fuel then mixes with in coming air and ignites in contact with the heater element.

With the engine running, the IAHFI remains energized and fuel continues to be injected, and the wait-to-start lamp continues to flash for a maximum of four minutes. When the wait-to-start lamp stops flashing, the IAHFI and the IAHFS valve are deactivated. If the operator accelerates while the wait-to-start lamp is flashing, the Inlet Air Heater system will shutdown.

Oil Flow System

Oil Flow and Components

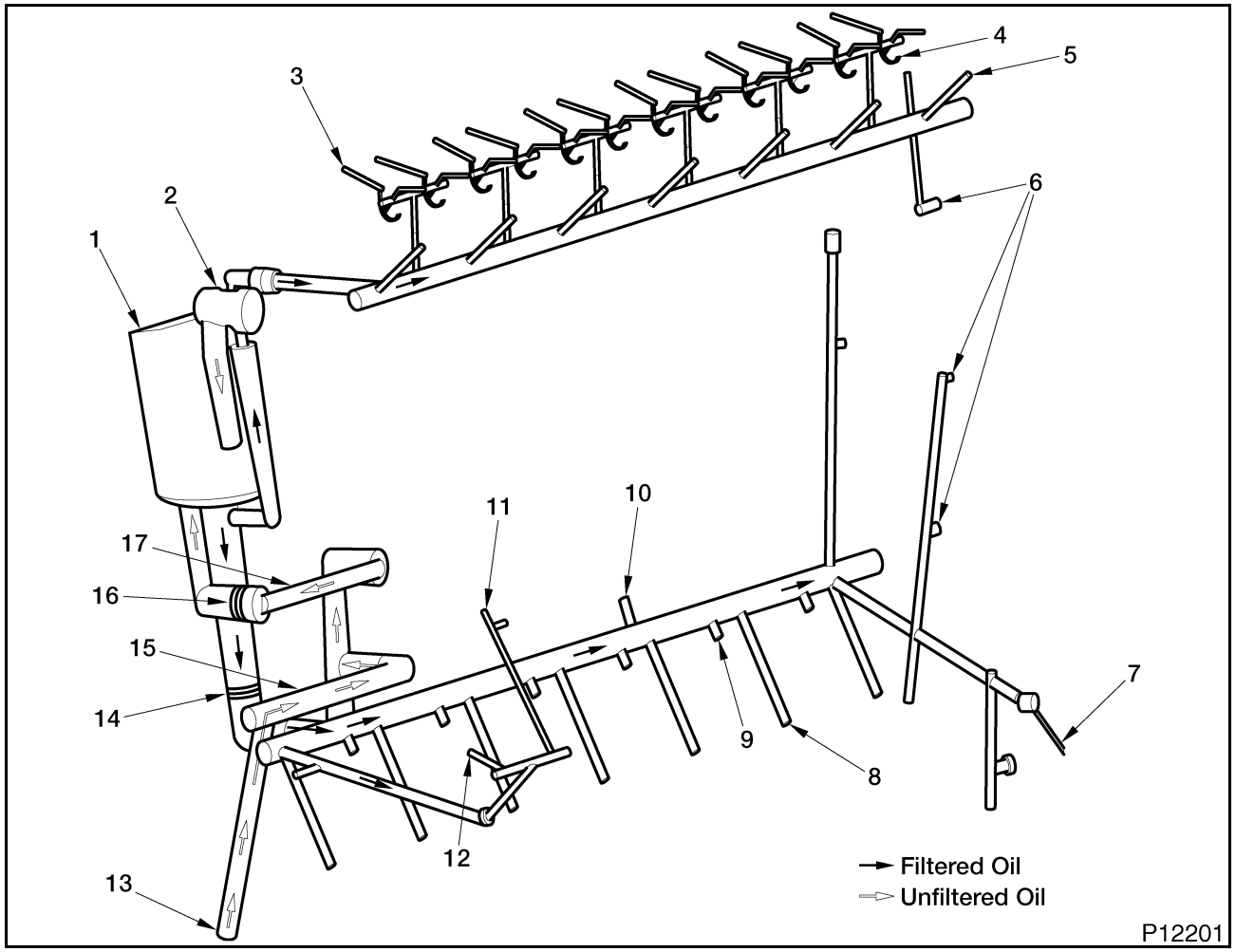

Figure 22 Oil flow

1. Oil filter element
2. Oil return from cylinder head
3. Oil supply to exhaust valve bridge
4. Oil supply to rocker gear
5. Oil supply to camshaft bearings
6. Oil supply to intermediate gears
7. Oil supply to air compressor
8. Oil supply to crankshaft main bearings
9. Oil supply to piston oil sprayer nozzles
10. Oil supply to turbochargers
11. Oil supply to drive housing
12. Oil supply to front cover
13. Oil pump output
14. Oil pressure relief valve
15. Oil supply to oil module
16. Oil return shutoff valve
17. Oil cooler

Unfiltered oil is drawn from the oil pan through the pickup tube and front cover passage by the crankshaft driven gerotor pump. Pressurized oil is moved through a vertical crankcase passage and into the oil module.

Inside the oil module, unfiltered oil flows through plates in the oil cooler heat exchanger. Engine coolant flows around the plates to cool the surrounding oil. An oil return shutoff valve installed at the exit from the oil cooler prevents oil from draining through the oil pump and back into the oil pan when the engine is stopped. If oil

pressure coming out of the oil pump is too high, a pressure relief valve allows excess oil to return through the crankcase into the oil pan before entering the oil cooler.

Oil that exits the oil cooler flows through a return shutoff valve that prevents the oil from draining back into the oil pan. From the return shutoff valve, oil enters the oil filter element and flows from the outside to the inside of the filter element to remove debris. When the filter is restricted, an oil filter bypass valve opens and allows oil to bypass the filter so engine lubrication is maintained. If oil pressure inside the oil filter element is too high, an oil pressure relief valve, installed at the bottom of the oil filter element housing, allows the excess oil to return to the oil pan.

After passing through the oil filter element, oil flow is directed to the cylinder head and crankcase.

Clean oil enters the cylinder head through an external flange elbow connected to the oil module. Inside the cylinder head, oil flows through passages to lubricate the camshaft bearings, rocker arms, exhaust valve bridges, and cylinder intermediate gear.

Clean oil enters the crankcase from the oil module to lubricate the crankshaft, high-pressure pump, air compressor, intermediate gears, and turbochargers. The crankshaft has cross-drillings that direct oil to the connecting rods.

Oil sprayer nozzles direct cooled oil to the bottom of the piston crowns.

The turbochargers are lubricated with filtered oil from an external supply tube that connects the main oil gallery from the crankcase to the center housing of each turbocharger. Oil drains back to the oil pan through the low and high-pressure turbocharger oil return pipes connected to the crankcase.

A service oil drain valve, installed at the bottom of the filter element cavity, opens automatically when the filter element is lifted for replacement, and allows the oil from the oil filter element cavity to drain into the oil pan.

Oil is also supplied to the Navistar® Engine Brake housings (under valve cover) through specially designed rocker mounting bolts.

Crankcase Oil Separator

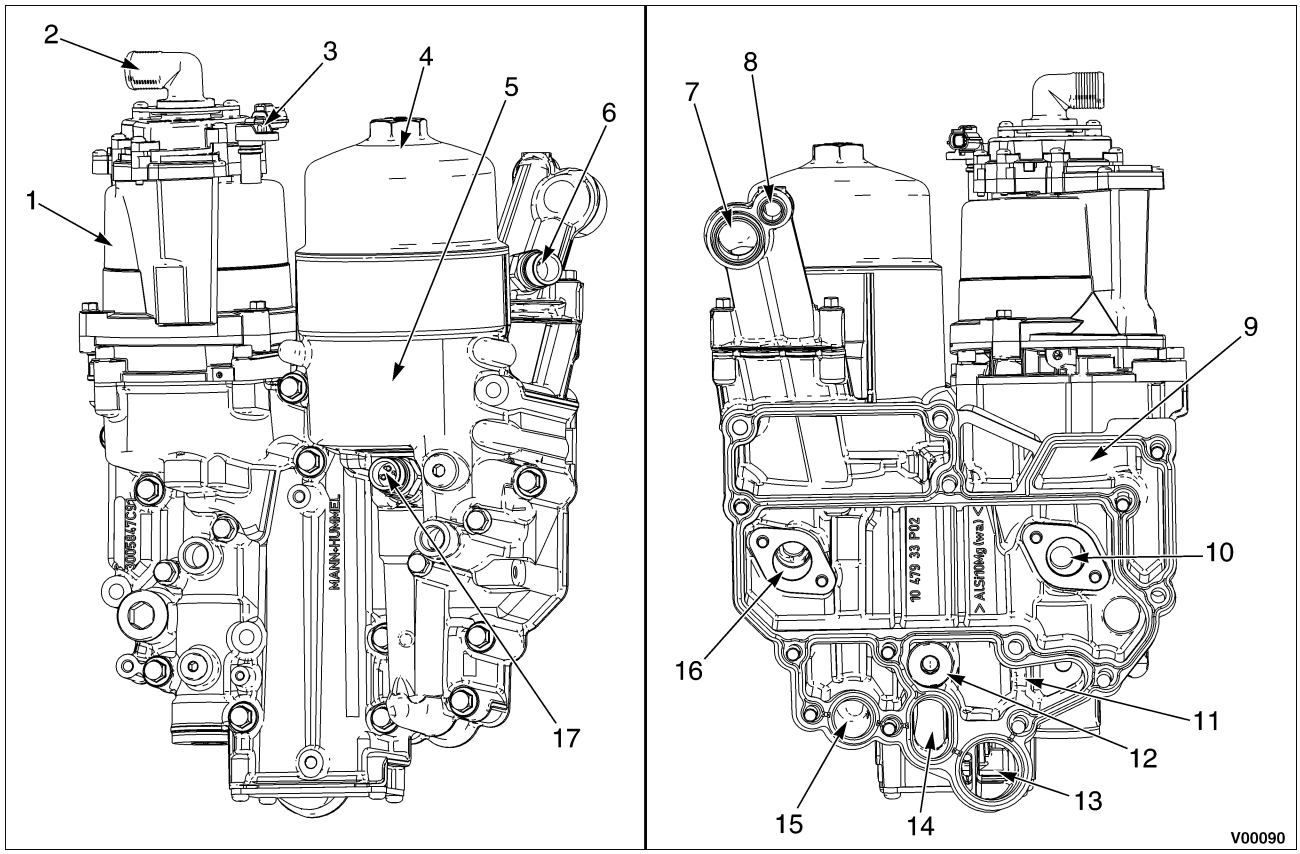

Figure 23 Oil module with crankcase oil separator assembly (inner and outer views)

1. Crankcase Oil Separator (CCOS)
2. CCOS vent outlet
3. Crankcase Oil Separator Speed (CCOSS) sensor
4. Filter cover
5. Oil filter assembly
6. Engine Oil Temperature (EOT) sensor
7. Oil return from cylinder head
8. Oil supply to cylinder head
9. Crankcase gas inlet
10. Oil cooler inlet
11. Oil supply from oil pump
12. Regulator
13. CCOS oil return
14. Oil module pressure relief port
15. Oil out to crankcase
16. Oil cooler outlet to crankcase
17. Engine Oil Pressure (EOP) sensor

The oil module contains a canister style filter, oil cooler, EOP and EOT sensors, a pressure relief valve, an oil filter bypass valve, and an oil return shutoff valve. The oil module also collects, and directs crankcase emissions to the CCOS. The oil that separates from the crankcase emissions, before it reaches the CCOS, is drained back into the oil pan through the oil return port.

Remote Mounted Centrifugal Oil Filter (Optional)

The remote mounted centrifugal oil filter is used to remove particulates from engine oil, reducing wear and extending engine oil change intervals. During operation, dirty oil enters the oil supply port to a regulator valve. When engine oil pressure exceeds approximately 248 kPa (36 psi), the regulator valve opens, and oil enters the centrifugal element through the center hollow spindle. Inside the element, centrifugal acceleration separates contaminants from oil. Contaminants accumulate on the serviceable rotor surface as a solid cake. Clean oil

exits through opposing twin nozzles that power the centrifuge and returns to the crankcase from the oil level control base. Oil level is managed by the oil float. When the oil float raises, compressed air enters the system to force oil back to the crankcase. When the oil float drops, the air supply port is closed.

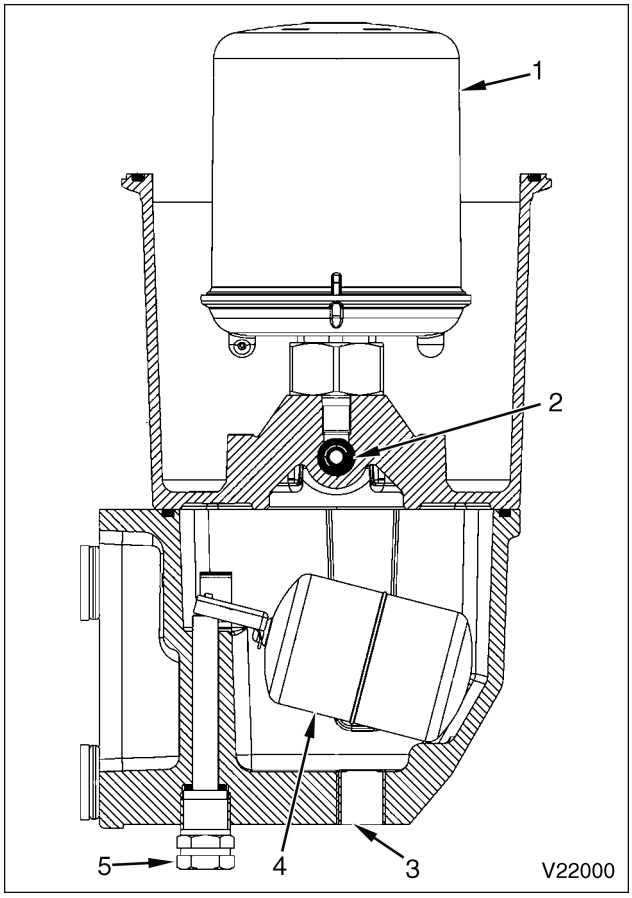

Figure 24 Remote Mounted Centrifugal Oil Filter

1. Serviceable rotor
2. Oil supply port (regulator valve)
3. Oil return port
4. Oil float
5. Air supply port (regulator valve)

Engine Cooling System

Cooling System Flow

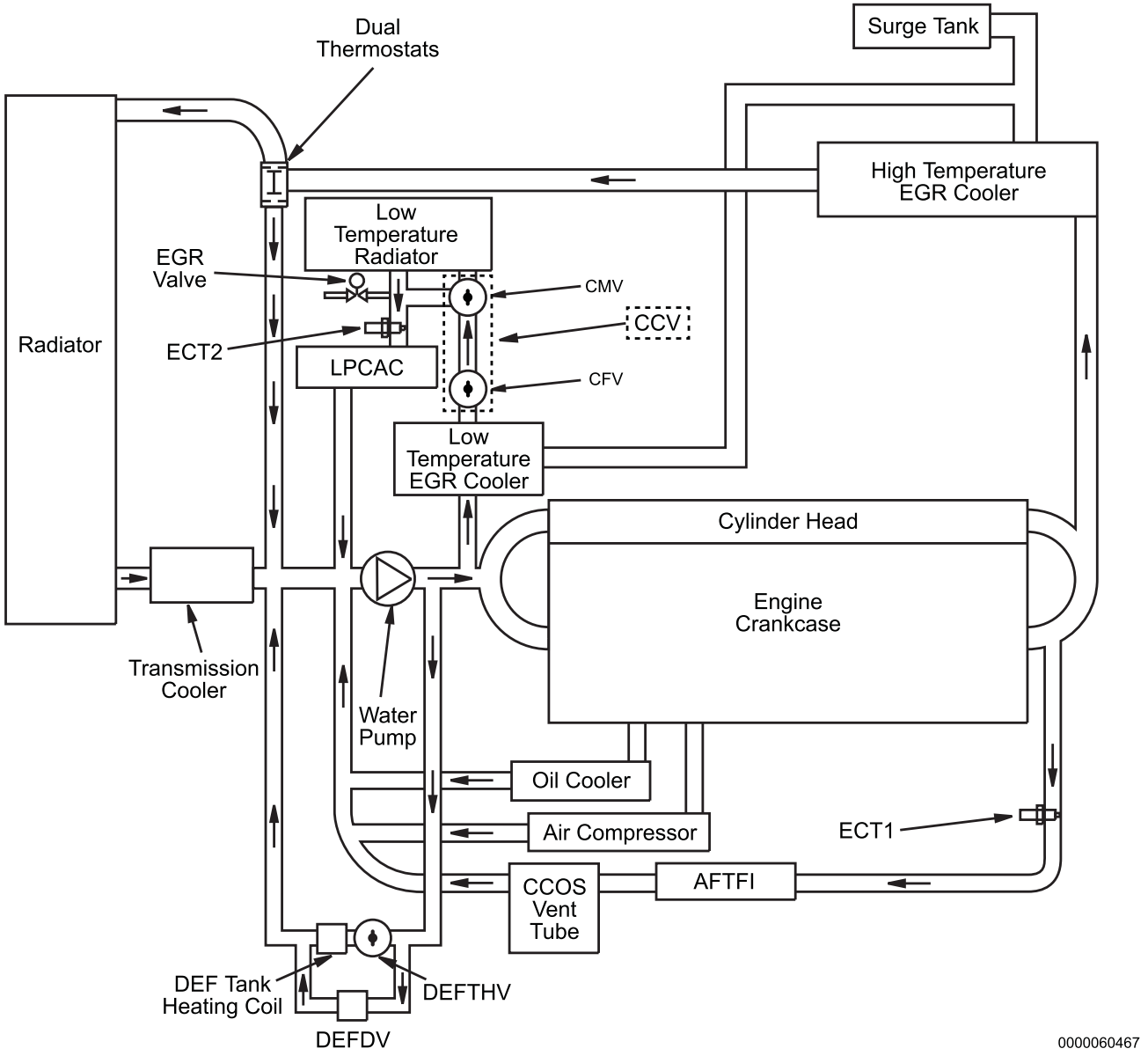

Figure 25 Cooling system flow

The water pump is installed on the water distribution housing and draws coolant from the radiator through the coolant inlet.

Navistar® N13 engines have no coolant passages between the crankcase and cylinder head through the cylinder head gasket. This eliminates the possibility of coolant leaks at the cylinder head gasket. Coolant in and out of the crankcase and cylinder head is directed through external passages. Coolant flows through the crankcase and cylinder head from front to rear. This coolant flows around the cylinder liners and combustion chambers to absorb heat from combustion.

Coolant exiting the crankcase and cylinder head at the rear of the engine is directed through an external coolant pipe to the high-temperature stage of the Exhaust Gas Recirculation (EGR) cooler. Coolant passes between the EGR cooler plates, travels parallel to the exhaust flow, through a transfer passage in the left side of the low-temperature EGR cooler, into the EGR cooler return manifold, and into the thermostat housing. A deaeration port on top of the high-temperature EGR cooler directs coolant and trapped air to the coolant deareation tank.

Coolant from the water pump also flows through the low-temperature EGR Cooler and then through the Low Pressure Charge Air Cooler (LPCAC) to regulate charge air temperature. Flow through the low-temperature EGR cooler/charge air cooler is controlled by the Coolant Mixer Valve (CMV) and Coolant Flow Valve (CFV). Depending on the coolant flow, CMV sends coolant through the low-temperature EGR Cooler, or bypass indirectly to the LPCAC, after going through the Low Temperature Radiator (LTR) installed in front of the main coolant radiator. When charge air temperature is too low, CMV bypasses the LTR and directs all the coolant through the Charge Air Cooler (CAC). When charge air temperature increases, the CMV directs a percentage of coolant to the LTR before it enters the CAC to cool the charge air. If the engine coolant temperature is too high, CMV sends all of the coolant flow through the LTR and through the LPCAC to help cool the engine faster.

Both CMV and CFV are controlled by the Engine Control Module (ECM) based on signals from the Engine Coolant Temperature 1 (ECT1) sensor, ECT2 sensor, Intake Manifold Pressure (IMP), and Inlet Air Temperature (IAT) sensors.

Coolant flow to the radiator is controlled by two thermostats. When the thermostats are closed, coolant flowing out of the EGR cooler is directed through a bypass port inside the front cover into the water pump. When the thermostats are open the bypass port is blocked, and coolant is directed from the engine into the radiator.

Coolant passes through the radiator and is cooled by air flowing through the radiator from ram air and operation of the coolant fan. The coolant returns to the engine first through the transmission cooler, then through the engine coolant inlet elbow.

The air compressor is cooled with coolant supplied by a hose from the left side of the crankcase. Coolant passes through the air compressor cylinder head and returns through a coolant return line to the engine crankcase.

The oil module receives coolant from a passage in the crankcase. Coolant passes between the oil cooler plates and returns back to the water pump suction passage.

The Diesel Exhaust Doser Valve (DEFDV) and DEF Tank Heater Valve (DEFTHC) receive coolant from a supply line running from the lower radiator hose. When DEF tank temperature is too low, the Aftertreatment Control Module (ACM) commands the DEFTHC ON allowing coolant to pass through the DEF tank heating coil. Coolant from the DEF tank heating coil and DEFDV then returns to the water pump inlet through a coolant return line.

Thermostat Operation

Navistar® N13 engines are fitted with two thermostats in a common housing to ensure sufficient coolant flow in all operating conditions. The thermostat housing is installed on top of the water distribution housing.

The thermostat housing assembly has two outlets. One directs coolant to the radiator when the engine is at operating temperature. The second outlet directs coolant to the water pump until the engine reaches operating temperature. The thermostats begin to open at approximately 83°C (181°F) and are fully open at 91°C (196°F).

When engine coolant is below approximately 83°C (181°F), the thermostats are closed, blocking coolant flow to the radiator.

When coolant temperature reaches opening temperature, the thermostats open allowing some coolant to flow to the radiator. When coolant temperature exceeds approximately 91°C (196°F), the lower seat blocks the bypass port directing full coolant flow to the radiator.

Coolant Control Valve (CCV) assembly operation

The CCV is installed on the upper right side of the water distribution housing and controls coolant flow to the Charge Air Coolers (CAC)s.

The CCV has two separate solenoid actuated valves. The Coolant Mixer Valve (CMV) and the Coolant Flow Valve (CFV) are part of the CCV assembly and cannot be serviced separately. The CMV and CFV solenoids are controlled by two separate Pulse Width Modulated (PWM) signals from the Engine Control Module (ECM). The PWM signal duty cycles vary between 0% and 100% depending on coolant and charge air temperature.

Coolant Flow Valve (CFV)

The CFV is installed on the lower side of the CCV and controls coolant flow through the Low Pressure Charge Air Cooler (LPCAC). The CFV will close to reduce coolant flow through the LPCAC when the engine is operating at high speeds.

Coolant Mixer Valve (CMV)

The CMV is installed on the upper side of the CCV and controls coolant flow through the Low Temperature Radiator (LTR). When charge air and coolant temperature coming out of the LPCAC is low, the CMV directs coolant through a LTR bypass into the LPCAC. This helps the engine reach normal operating temperature faster. If charge air and coolant temperature coming out of the LPCAC is high, the CMV directs coolant flow through the LTR. This prevents overheating the LPCAC, which can result in LPCAC failure.

Engine Brake System

Engine Brake Control System Components

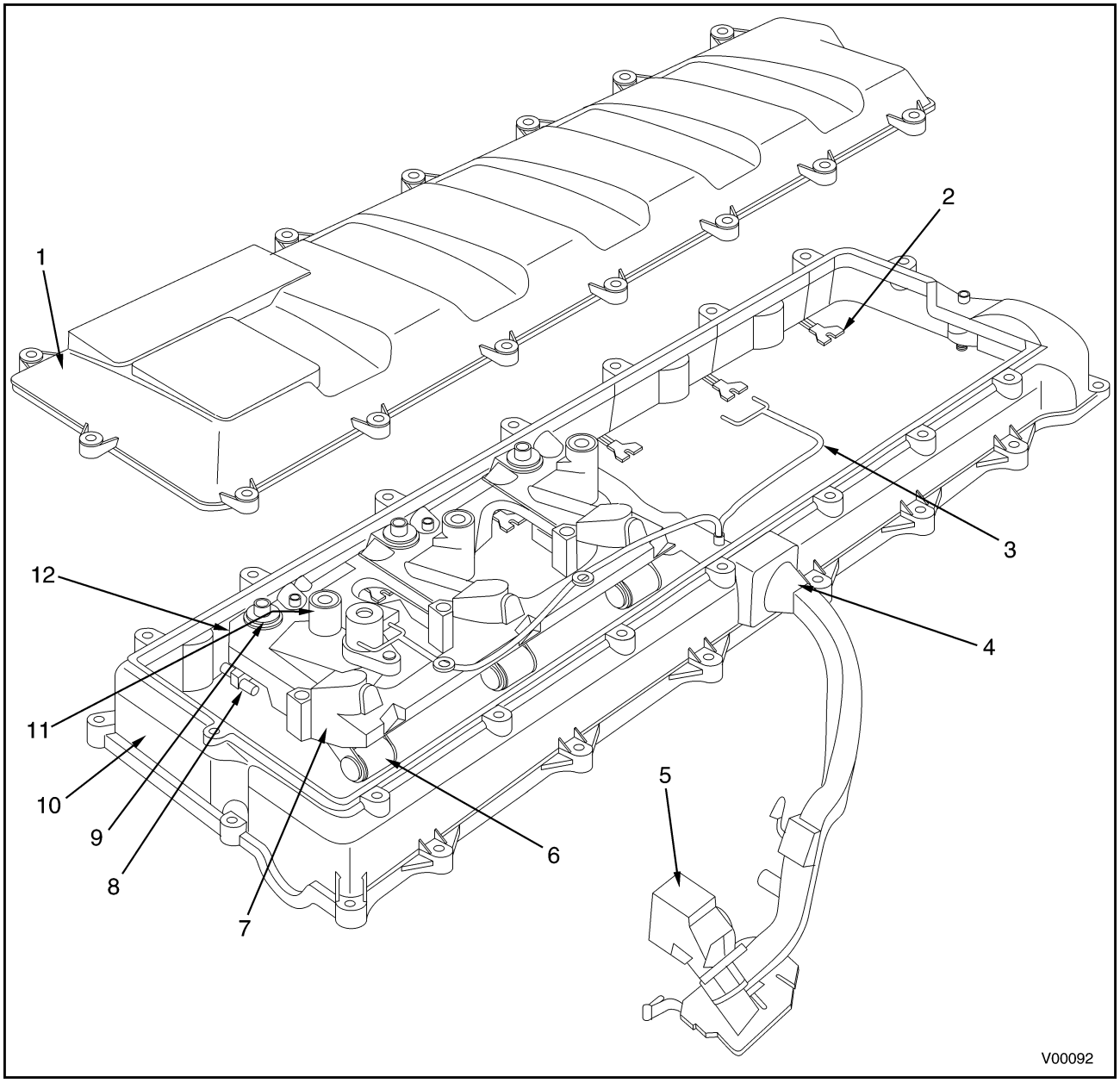

Figure 26 Engine brake control system components

1. Upper valve cover
2. Injector harness connector
3. Engine brake solenoid harness connector lead (2)
4. Pass through harness
5. ECM E1 connector
6. Master piston roller assembly (3 each housing)
7. Engine brake master piston (within housing)
8. Exhaust valve bridge
9. Engine brake slave piston
10. Valve cover base
11. Engine brake solenoid (1 each housing)
12. Engine brake housing assembly (2)

Engine Brake System Description

The Navistar® Engine Brake by Jacobs® braking system is standard equipment on the ProStar® and optional equipment on the TranStar® and WorkStar® for Navistar®N13 engines. The braking system is a hydro-mechanical device that mounts under the engine's valve cover. It turns your power-producing diesel engine into a power-absorbing air compressor.

Here's how: when the driver releases the accelerator pedal, the forward momentum of the truck continues to turn the drivetrain and engine. The pistons continue to move up and down. Once activated, the engine brake opens the exhaust valves near the peak of the compression stroke, releasing the highly compressed air through the exhaust systems. Little energy is returned to the piston, and as the cycle repeats, the energy of the truck's forward motion is now directed toward motoring the diesel engine, thus reducing the forward motion causing the truck to slow down.

Engine Brake System Operation

The engine brake system consists of two hydraulic braking housings, activated using two Engine Control Module (ECM) actuated brake solenoids, and an exhaust bridge (pin). The engine brake depends on engine oil for operation; minimum oil temperature for retarder activation is approximately 40°C (104°F).

Engine brake operation is automatic after the operator turns it On using the On / Off switch. When the clutch is engaged and the throttle is not depressed, the engine brake is automatically activated.

NOTE: The operator can select various engine brake retarding levels by pressing a HIGH/MEDIUM/LOW switch.

Activation occurs through the following steps:

1. Engine oil pressure fills the housing passages up to the solenoid.
2. Activation of the engine brake is communicated by the ECM using the J1939 Controller Area Network (CAN) data link. When activated, the energized solenoid valve permits engine lube oil to flow under pressure through the control valve to both the master piston and slave piston circuits.
3. Oil pressure causes the master piston roller assembly to move down, picking up the motion of the cam (dedicated braking lobe) pushing the piston back into the housing creating high-pressure oil.
4. High-pressure oil flows back through the master piston, slave piston and control valve circuits.
5. The check ball in the control valve seats, trapping oil in the circuit creating a high-pressure link between the slave piston and master piston.
6. Once the high-pressure link is created, the master piston follows the cam profile causing the slave piston to move down, momentarily opening exhaust valve (single valve opening), while the engine piston is near its top dead center position, releasing compressed cylinder air to the exhaust manifold.
7. Compressed air escapes to atmosphere completing compression braking cycle.

NOTE:

1. The Navistar® Engine Brake by Jacobs® will disengage during Anti-lock Brake System (ABS) braking.
2. Will interact with the vehicle cruise control for smooth operation during engine braking
3. Will interact with the Eaton UltraShift® Transmission for smooth up-shifts under fueling conditions

Electronic Control System

Electronic Control System Components

Navistar®N13 engines are equipped with two control modules, the Engine Control Module (ECM), and the Aftertreatment Control Module (ACM).

Operation and Function

The ECM and ACM monitor and control engine and aftertreatment system operation to ensure maximum performance and adherence to emissions standards. The ECM and ACM, perform the following functions:

- Provide reference voltage (VREF)
- Condition input signals
- Process and store control strategies
- Control actuators

Reference Voltage (VREF)

The ECM and ACM supply 5 volt VREF signals to various input sensors in the electronic control system. By comparing the 5 volt VREF signal sent to the sensors with their respective returned signals, the ECM and ACM determine pressures, positions, and other variables important to engine, aftertreatment, and vehicle functions.

Signal Conditioner

Signal conditioning circuitry in the ECM and ACM convert analog signals to digital signals, squares up sine wave signals, and amplifies low intensity signals.

Microprocessor

The microprocessor, installed inside the ECM and ACM, process stored operating instructions (control strategies) and value tables (calibration parameters). The microprocessor compares stored instructions and values with conditioned input values to determine the correct strategy for all engine operations.

Diagnostic strategies are also programmed into the ECM and ACM. Some strategies monitor inputs continuously and command the necessary outputs for correct performance of the engine and aftertreatment.

Diagnostic Trouble Codes

Diagnostic Trouble Codes (DTCs) are stored by the ECM if inputs or conditions do not comply with expected values. Diagnostic fault codes are communicated using the Suspect Parameter Number (SPN) and Failure Mode Indicator (FMI) identifiers, and are accessed using an electronic service tool with ServiceMaxx™ diagnostic software or other J1939 and J1708 RP1210B compliant interface device.

Microprocessor Memory

The ECM and ACM microprocessors includes Read Only Memory (ROM) and Random Access Memory (RAM).

Read Only Memory (ROM)

ROM stores permanent information for calibration tables and operating strategies. Permanently stored information cannot be changed or lost when the ignition switch is turned to OFF or when power to the control modules is interrupted. ROM includes the following:

- Vehicle configuration, modes of operation, and options
- Engine Family Rating Code (EFRC)
- Engine warning and protection modes

Random Access Memory (RAM)

RAM stores temporary information for current engine conditions. Temporary information in RAM is lost when the ignition switch is turned to OFF or power to control module is interrupted. RAM information includes the following:

- Engine temperature
- Engine rpm
- Accelerator pedal position

Actuator Control

The Engine Control Module (ECM) and Aftertreatment Control Module (ACM) control actuators by applying a low level signal (low-side driver) or a high level signal (high-side driver). When switched on, both drivers complete a ground or power circuit to an actuator.

Actuators are controlled in one of the following ways, depending upon type of actuator:

- Duty cycle (percent time On / Off)
- Pulse Width Modulated (PWM)
- Switched On or Off

Actuators

The ECM controls engine operation with the following:

- Coolant Control Valve (CCV)
- Exhaust Back Pressure Valve (EBPV)
- Exhaust Gas Recirculation Valve (EGRV)
- Air Control Valve (ACV)
- Inlet Air Heater Relay (IAHR)
- Inlet Air Heater Fuel Solenoid (IAHFS) valve
- Engine Throttle Valve (ETV)
- Fuel Pressure Control Valve (FPCV)
- Intake Air Heater Fuel Ignitor (IAHFI) relay

The ACM controls aftertreatment system operation with the following:

- Aftertreatment Fuel Shutoff Valve (AFTFSV)
- Aftertreatment Purge Air Valve (AFTPAV)
- Diesel Exhaust Fluid Dosing Unit Heater (DEFDUH)
- Diesel Exhaust Fluid Doser Valve (DEFDV)
- Diesel Exhaust Fluid Line Heater Relay (DEFLHR)
- Diesel Exhaust Fluid Pressure Line Heater (DEFPLH)
- Diesel Exhaust Fluid Return Line Heater (DEFRLH)
- Diesel Exhaust Fluid Return Valve (DEFRV)
- Diesel Exhaust Fluid Suction Line Heater (DEFSLH)
- Diesel Exhaust Fluid Supply Pump (DEFSP) and Temperature Sensor
- Diesel Exhaust Fluid Tank Heater Valve (DEFTHC)
- Diesel Exhaust Fluid Unit Heater Relay (DEFUHR)

Coolant Control Valve (CCV)

The Coolant Mixer Valve (CMV) and Coolant Flow Valve (CFV) are a combined solenoid assembly that regulates coolant flow and temperature through the Low Pressure Charge Air Cooler (LPCAC) and the low-temp EGR cooler. The CMV and CFV are housed in the CCV assembly.

The CFV controls the rate of coolant flow through the CAC, and the CMV regulates the temperature of the coolant, by directing coolant either through the Low Temperature Radiator (LTR) or through an internal bypass. Both valves are controlled by the Engine Control Module (ECM).

The CCV is installed on the water distribution housing.

Exhaust Back Pressure Valve (EBPV) Control

The EBPV is controlled using the Air Control Valve (ACV) assembly. The ACV assembly contains the EBPV control valve, and the Turbocharger 1 Turbine Outlet Pressure (TC1TOP) sensor. Both are used by the ECM to control EBPV operation.

The EBPV regulates air pressure applied to the EBPV pneumatic actuator. The pneumatic cylinder actuates the valve (in the exhaust system) in response to commands by the ECM.

The EBPV actuator is mounted on the right side of the engine, after the turbocharger exhaust connection.

Exhaust Gas Recirculation (EGR) Valve

The EGRV is mounted on the rear of the EGR cooler, on top of the engine. The EGRV assembly receives the desired valve position from the ECM. The EGRV regulates the flow of exhaust gases through the EGR system.

Air Control Valve (ACV)

The ACV contains solenoids used for control of the High Pressure (HP) turbocharger wastegate and EBPV. It also contains the TC1TOP sensor.

ACV solenoids are controlled through pulse width modulated signals sent by the ECM.

The ACV is installed on the right side of the engine, near the center of the EGR cooler.

Inlet Air Heater Relay (IAHR)

The Inlet Air Heater system warms incoming air supply up to four minutes for cold engine emissions reduction.

The Engine Control Module (ECM) is programmed to energize the Inlet Air Heater Fuel Igniter (IAHFI) heater element through the Inlet Air Heater Relay (IAHR) while monitoring engine coolant temperature, air inlet temperature, engine oil temperature, and atmospheric pressure.

The IAHR delivers battery voltage to the heater element for a set time, depending on engine coolant temperature and altitude. The ground circuit is supplied from the battery ground. The relay is controlled by switching on a voltage source from the ECM, and is installed to the rear of the ECM.

Inlet Air Heater Fuel Solenoid (IAHFS) Valve

The IAHFS valve controls fuel flow to the IAHFI during Inlet Air Heater operation.

When Inlet Air Heater is required, the ECM provides voltage to open the IAHFS valve.

The IAHFS valve is mounted on the intake throttle duct, on the top left side of the engine.

Engine Throttle Valve (ETV)

The ETV controls the flow of fresh air (boosted and cooled) into the engine's air intake path through the Charge Air Cooler (CAC) to help heat the exhaust aftertreatment during regeneration, and to when heavy Exhaust Gas Recirculation (EGR) is requested. The electronic portion of the ETV contains a microprocessor that monitors valve position, electronic chamber temperature, controls the electric motor, and reports diagnostic faults to the ECM. The ETV changes position in response to ECM signals.

The ETV is integrated into the intake throttle duct, on the top left side of the engine.

Fuel Pressure Control Valve (FPCV)

The FPCV is a variable position actuator that controls fuel flow to the suction side of the high-pressure fuel pump.

The FPCV changes valve position through pulse width modulated signals from the ECM.

The FPCV is mounted on the upper side of the high-pressure pump. The FPCV and fuel pump are serviced as an assembly.

Aftertreatment Fuel Shutoff Valve (AFTFSV)

The AFTFSV is used to control fuel flow to the Aftertreatment Fuel Injector (AFTFI). The AFTFSV is controlled through an On-Off signal sent by the Aftertreatment Control Module (ACM). The AFTFSV is installed in the AFT fuel doser module, located to the rear of the fuel filter assembly, on the left side of the engine.

Aftertreatment Purge Air Valve (AFTPAV)

The AFTPAV is used to purge the AFTFI of fuel after active regeneration of the aftertreatment system. When purging is needed, the Aftertreatment Control Module (ACM) commands the AFTPAV ON, and AFTFI open. This allows pressurized air from the vehicle air tanks, to flow through the AFTPAV, AFT fuel doser module, and out the AFTFI.

The AFTPAV is mounted on the left side of the engine, behind the AFT fuel doser module.

Diesel Exhaust Fluid Dosing Unit Heater (DEFDUH)

The DEFDUH is used to maintain proper DEF temperature in the DEF supply module.

The ACM is programmed to energize the DEFDUH through the Diesel Exhaust Fluid Unit Heater Relay (DEFUHR) when DEF supply module temperature is too low.

Diesel Exhaust Fluid Doser Valve (DEFDV)

The DEFDV is a solenoid assembly controlled by the Aftertreatment Control Module (ACM). When the ACM commands DEF dosing, it opens the doser valve and allows DEF to be sprayed into the exhaust stream.

Diesel Exhaust Fluid Line Heater Relay (DEFLHR)

The DEF line heaters are used to maintain proper DEF temperature to avoid DEF freezing. When DEF temperature is too low. The ACM commands the DEFLHR ON, sending power to the DEF line heaters.

The DEFLHR is installed in the Power Distribution Module (PDM), behind the DEF tank.

Diesel Exhaust Fluid Pressure Line Heater (DEFPLH)

The DEFPLH is used to maintain proper DEF temperature in the DEF supply module pressure line.

The DEFPLH is wrapped around the pressure line between the DEF supply module and DEFDV.

Diesel Exhaust Fluid Return Line Heater (DEFRLH)

The DEFRLH is used to maintain proper DEF temperature in the DEF supply module return line.

The DEFRLH is wrapped around the return line between the DEF supply module and DEF tank.

Diesel Exhaust Fluid Return Valve (DEFRV)

The DEFRV is switched On or Off by the ACM.

The DEFRV regulates the flow of DEF exiting the DEF supply module. When purging is needed, the ACM will turn the DEFRV ON, and returns DEF in the lines to the tank.

The DEFRV is part of the DEF supply module, and is not serviceable individually.

Diesel Exhaust Fluid Suction Line Heater (DEFSLH)

The DEFSLH is used to maintain proper DEF temperature in the DEF supply module suction line.

The DEFSLH is wrapped around the suction line between the DEF supply module and DEF tank.

Diesel Exhaust Fluid Supply Pump (DEFSP) and Temperature Sensor

The DEFSP is controlled using a Pulse Width Modulated (PWM) signal from the ACM.

The DEF supply module has an internal temperature sensor used to monitor DEFSP temperature.

The DEFSP is part of the DEF supply module, and is not serviceable individually.

Diesel Exhaust Fluid Tank Heater Valve (DEFTHC)

The DEFTHC controls coolant flow to the DEF tank. When DEF temperature is low, the ACM commands the DEFTHC open, allowing coolant flow to warm the DEF tank.

The DEFTHC is typically mounted to the vehicle frame.

Diesel Exhaust Fluid Unit Heater Relay (DEFUHR)

The DEFUHR aids in defrosting the DEF supply module. When DEF temperature is too low, the ACM energizes the heater element inside the DEF supply module through the DEFUHR.

Engine and Vehicle Sensors

Thermistor Sensors

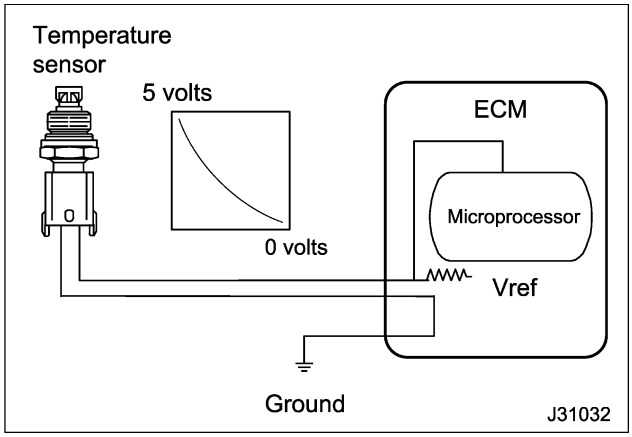

Figure 27 Thermistor

A thermistor sensor changes electrical resistance with changes in temperature. As temperature changes at the thermistor, voltage at the ECM or ACM will change accordingly. Thermistors work with the control module to produce a voltage signal proportional to temperature values.

A thermistor sensor has two electrical connectors, signal return and ground. The output of a thermistor sensor is a non-linear analog signal.

Thermistor type sensors include the following:

- Aftertreatment temperature sensors
- Engine coolant temp sensors
- Engine Oil Temperature (EOT) sensor
- Turbocharger 2 Compressor Inlet Sensor (TC2CIS)
- Charge Air Cooler Outlet Temperature (CACOT) sensor
- Intake Manifold Temperature (IMT) sensor
- EGR (cooler) Temperature (EGRT) sensor
- Ambient Air Temperature (AAT) sensor

Aftertreatment Temperature Sensors

Temperature sensors used in the Aftertreatment System include the following:

- Diesel Exhaust Fluid Tank Level and Temperature (DEFTLT) sensor
- DOC / DPF temperature sensor module
    - Diesel Oxidation Catalyst Inlet Temperature (DOCIT) sensor
    - Diesel Particulate Filter Inlet Temperature (DPFIT) sensor
    - Diesel Particulate Filter Outlet Temperature (DPFOT) sensor

- SCR temperature sensor module
  - Selective Catalyst Reduction Inlet Temperature (SCRIT) sensor
  - Selective Catalyst Reduction Outlet Temperature (SCROT) sensor

Diesel Exhaust Fluid Tank Level and Temperature (DEFTLT) Sensor Module

The DEFTLT sensor module is a combination sensor that monitors DEF tank level and temperature, and communicates to the Aftertreatment Control Module (ACM) through J1939 Controller Area Network (CAN) communication.

The DEFTLT sensor module is installed inside the DEF tank.

Diesel Oxidation Catalyst (DOC) / Diesel Particulate Filter (DPF) Temperature Sensor Module

The DOC / DPF temperature sensor module monitors aftertreatment DPF and DOC temperature. The DOC / DPF temperature sensor module monitors signals from the DOC Inlet Temperature (DOCIT), DPF Inlet Temperature (DPFIT), and DPF Outlet Temperature (DPFOT) sensors, and communicates these signals to the Aftertreatment Control Module (ACM) through J1939 Controller Area Network (CAN) communication.

The DOCIT, DPFIT, and DPFOT sensors are not serviceable individually, and are part of the DOC / DPF temperature sensor module.

Selective Catalyst Reduction (SCR) Temperature Sensor Module

The SCR temperature sensor module monitors aftertreatment SCR catalyst temperature. The SCR temperature sensor module monitors signals from the SCR Inlet Temperature (SCRIT) sensor, and SCR Outlet Temperature (SCROT) sensor, and communicates these signals to the ACM through J1939 Controller Area Network (CAN) communication.

The SCRIT sensor and SCROT sensor are not serviceable individually, and are part of the SCR temperature sensor module.

Engine Coolant Temperature (ECT) Sensors

The ECT1 and ECT2 sensors are thermistor-type sensors that detect engine coolant temperature.

The ECT1 signal is monitored by the ECM for operation of the instrument panel temperature gauge, coolant temperature compensation, charge air temperature control, EGR system control, optional Engine Warning Protection System (EWPS), and the wait to start lamp. The ECM uses ECT1 sensor input as a backup, if EOT sensor values are out of range.

The ECT1 sensor is installed in the underside of the EGR coolant crossover manifold, at the back of the engine. The ECT2 sensor is installed in the low-temperature stage of the EGR cooler, on the right side of the engine.

Engine Oil Temperature (EOT) Sensor

The EOT sensor is a thermistor sensor that detects engine oil temperature. The EOT sensor is installed in the side oil module flange, behind the oil filter cover, on the right side of the engine.

Turbocharger 2 Compressor Inlet Sensor (TC2CIS)

The TC2CIS sensor includes a thermistor sensor that monitors the temperature of charge air entering the High Pressure (HP) turbocharger. This sensor also monitors boost pressure for the Low Pressure (LP) turbocharger.

The TC2CIS sensor is monitored by the Engine Control Module (ECM), and is used for calculating fuel delivery and controlling turbocharger wastegate operation.

The TC2CIS is installed in the piping between the LP compressor outlet and the HP compressor inlet.

Charge Air Cooler Outlet Temp (CACOT) Sensor

The CACOT sensor is a thermistor sensor that monitors the temperature of charge air entering the intake air duct.

The CACOT signal is monitored by the ECM.

The CACOT sensor is installed on the intake air duct, before the Engine Throttle Valve (ETV).

Intake Manifold Temperature (IMT) Sensor

The IMT sensor is a thermistor sensor that monitors temperature.

The IMT sensor is installed in the intake side of the cylinder head, on the left side of the engine.

Exhaust Gas Recirculation Temperature (EGRT) Sensor

The EGRT sensor is a thermistor sensor that detects the exhaust gas temperature entering the EGR cooler.

The EGRT signal is monitored by the ECM.

The EGRT sensor is installed in the front of the low temp EGR cooler on the left side.

Ambient Air Temperature (AAT) Sensor

The AAT sensor is a thermistor sensor that detects the temperature of ambient air.

The AAT signal is monitored by the ECM.

The AAT sensor is installed in various places depending on the vehicle.

Variable Capacitance Sensors

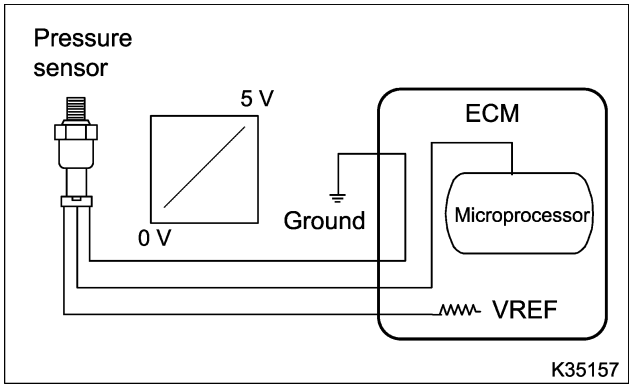

Figure 28 Variable capacitance sensor example

Variable capacitance sensors measure pressure. The pressure measured is applied to a ceramic material. The pressure forces the ceramic material closer to a thin metal disk. This action changes the capacitance of the sensor.

The sensor is connected to the control module through the VREF, signal, and signal ground wires.

The sensor receives the VREF and returns an analog signal voltage to the Engine Control Module (ECM) or Aftertreatment Control Module (ACM). The ECM or ACM compares the voltage with pre-programmed values to determine pressure.

Variable capacitance sensors include the following:

- Aftertreatment Fuel Pressure 1 (AFTFP1)
- Diesel Exhaust Fluid Line Pressure (DEFLP) sensor
- Diesel Particulate Filter Differential Pressure (DPFDP) / outlet pressure sensor
- Fuel Delivery Pressure (FDP) sensor
- Engine Oil Pressure (EOP) sensor
- Fuel Rail Pressure (FRP) sensor
- Intake Manifold Pressure (IMP) sensor
- Turbocharger 1 Turbine Outlet Pressure (TC1TOP) sensor

Aftertreatment Fuel Pressure 1 (AFTFP1) Sensor

The AFTFP1 sensor is a variable capacitance sensor that the ACM uses to monitor fuel pressure into the aftertreatment system.

The AFTFP1 sensor is installed in the AFT fuel doser module, to the rear of the fuel filter assembly.

Diesel Exhaust Fluid Line Pressure (DEFLP) Sensor

The DEFLP sensor is a variable capacitance sensor that measures DEF pressure from the DEF Supply Pump (DEFSP).

The DEFLP sensor provides feedback to the ACM for the DEF dosing system.

The DEFLP sensor is not serviceable individually and is part of the DEF supply module.

Diesel Particulate Filter Differential Pressure (DPFDP) / Outlet Pressure Sensor

The DPFDP / outlet pressure sensor provides a feedback signal to the ACM indicating the pressure difference between the inlet and outlet of the DPF.

The DPFDP / outlet pressure sensor is a differential pressure sensor with two tap-offs installed at the DPF. A tap-off is installed before and after the DPF.

Fuel Delivery Pressure (FDP) Sensor

The FDP sensor is a variable capacitance sensor that measures fuel supply pressure.

The FDP sensor provides feedback to the ECM for the low-pressure fuel system.

The FDP sensor is installed in the front of the fuel filter assembly on the left side of the engine.

Engine Oil Pressure (EOP) Sensor

The EOP sensor is a variable capacitance sensor that detects engine oil pressure.

The EOP signal is monitored by the ECM for operation of the instrument panel pressure gauge and optional Engine Warning and Protection System (EWPS).

The EOP sensor is installed in the oil module, on the right side of the engine.

Fuel Rail Pressure (FRP) Sensor

The FRP sensor is a variable capacitance sensor that monitors fuel pressure in the high-pressure fuel rail.

The FRP sensor measures fuel pressure just before injection.

The FRP sensor is mounted in the front of the fuel rail on the left side of the engine.

Intake Manifold Pressure (IMP) Sensor

The IMP sensor is a variable capacitance sensor that monitors the pressure of charge air entering the intake air duct.

The IMP signal is monitored by the ECM for control of the EGR system and turbocharger wastegates.

The IMP sensor is installed in the intake air duct, after the Engine Throttle Valve (ETV).

Turbocharger 1 Turbine Outlet Pressure (TC1TOP)

The TC1TOP sensor is a variable capacitance sensor that monitors exhaust back pressure.

The sensor measures back pressure in the exhaust system. A tap for the TC1TOP is installed in the exhaust, between the low-pressure turbocharger and Exhaust Back Pressure Valve (EBPV).

The TC1TOP sensor is installed in the Air Control Valve (ACV), on the right side of the engine.

Magnetic Pickup Sensors

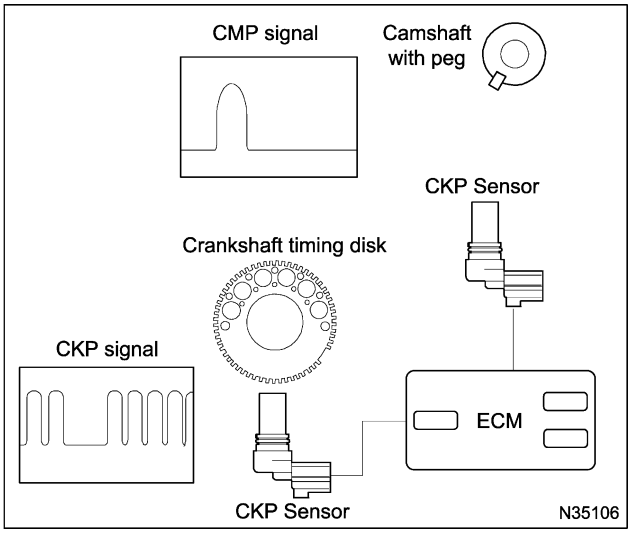

Figure 29 Magnetic pickup sensor examples

A magnetic pickup sensor contains a permanent magnet core that is surrounded by a coil of wire. The sensor generates a voltage signal through the collapse of a magnetic field created by a moving metal trigger. The movement of the trigger then creates Alternate Current (AC) voltage in the sensor coil.

Magnetic pickup sensors used include the following:

- CKP sensor
- CMP sensor
- VSS
- CCOSS sensor

Crankshaft Position (CKP) Sensor

The CKP sensor is a magnetic pickup sensor that indicates crankshaft speed and position.

The CKP sensor sends a pulsed signal to the Engine Control Module (ECM) as the crankshaft turns. The CKP sensor reacts to holes drilled into the flywheel adjacent to the ring gear. For crankshaft position reference, teeth 59 and 60 are missing. By comparing the CKP signal with the CMP signal, the ECM calculates engine rpm and timing requirements.

The CKP sensor is installed in the top left of the flywheel housing.

Camshaft Position (CMP) Sensor

The CMP sensor is a magnetic pickup sensor that indicates camshaft speed and position.

The CMP sensor sends a pulsed signal to the ECM as a toothed wheel on the camshaft rotates past the CMP sensor. The ECM calculates camshaft speed and position from CMP signal frequency.

The CMP sensor is installed in the left rear of the cylinder head.

Vehicle Speed Sensor (VSS)

The VSS provides the ECM with transmission tail shaft speed by sensing the rotation of a 16-tooth gear on the rear of the transmission. The detected sine wave signal (AC) received by the ECM, is used with tire size and axle ratio to calculate vehicle speed. The VSS is installed on the left side of the transmission housing for automatic transmissions, or at rear of the transmission housing for manual transmissions.

Crankcase Oil Separator Speed (CCOSS) sensor

The CCOSS sensor sends the ECM information about the speed of the crankcase oil separator internal components. The detected sine wave signal (AC) received by the ECM is used to monitor operation of the cyclonic oil separator, installed inside the breather assembly on the engine oil filter assembly.

Potentiometer Sensors

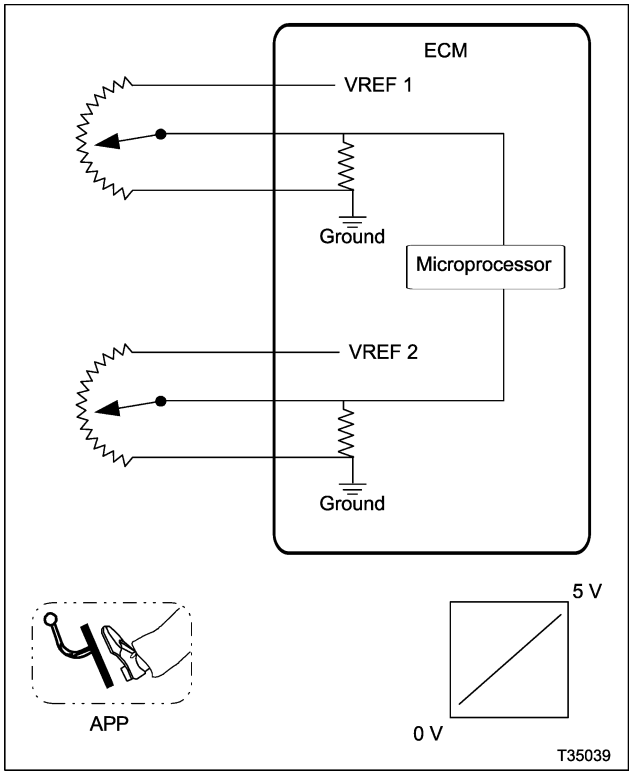

Figure 30 Potentiometer example

A potentiometer is a variable voltage divider that senses the position of a mechanical component. A reference voltage is applied to one end of the potentiometer. Mechanical rotary or linear motion moves the wiper along the resistance material, changing voltage at each point along the resistive material. Voltage is proportional to the amount of mechanical movement.

The engine has two potentiometers, both contained in the Accelerator Pedal Position (APP) Sensor.

Accelerator Pedal Position (APP)

The APP provides the ECM with a dual feedback signal (dual linear analog voltages) that indicate the operator's demand for power. The APP contains two potentiometers, and provides two individual signals (APP1 and APP2) to the ECM. The APP is installed in the cab on the accelerator pedal assembly.

Switches

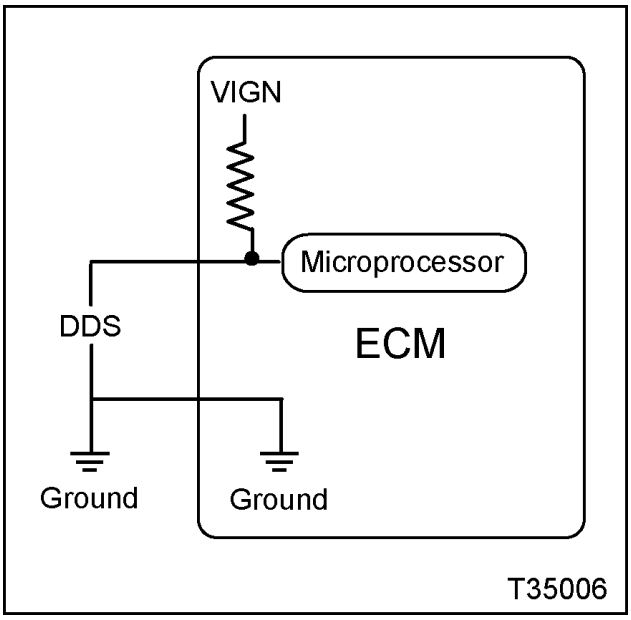

Figure 31 Switch example

Switch sensors indicate position, level, or status. They operate open or closed, regulating the flow of current. A switch sensor can be a voltage input switch or a grounding switch. A voltage input switch supplies the control module with a voltage when it is closed. A grounding switch grounds the circuit when closed, causing a zero voltage signal. Grounding switches are usually installed in series with a current limiting resistor.

Switches include the following:

- Driveline Disengagement Switch (DDS)
- Engine Coolant Level (ECL)
- Oil Level Sensor (OLS)

Driveline Disengagement Switch (DDS)

The DDS determines if a vehicle is in gear. For manual transmissions, the clutch switch serves as the DDS. For automatic transmissions, the neutral indicator switch functions as the DDS. The DDS signal is sent to the Body Controller (BC) and transmitted on the J1939 Controller Area Network (CAN) datalink to the engine ECM.

Engine Coolant Level (ECL) Switch

The ECL switch is part of the Engine Warning and Protection System (EWPS). The ECL switch is installed on the deaeration tank. When the magnetic switch is open, the tank is considered full of coolant.

If engine coolant is low, the switch closes and the red ENGINE lamp on the instrument panel is illuminated.

Oil Level Sensor (OLS)

The OLS is part of the EWPS. The OLS is installed in the engine oil pan. The OLS measures the volume of oil in the oil pan and broadcast the percentage volume over J1939 Controller Area Network (CAN).

If the level of engine lube oil is low, the red ENGINE lamp on the instrument panel is illuminated.

Additional Sensors

Ammonia (NH_3) Sensor Module

The NH_3 sensor module is used to control DEF dosing by monitoring ammonia levels at the Selective Catalyst Reduction (SCR) catalyst.

The NH_3 sensor module monitors the NH_3 sensor signal, and communicates this signal to the Aftertreatment Control Module (ACM).

The NH_3 sensor is not serviceable individually, and is part of the NH_3 sensor module.

Humidity Sensor (HS)

The HS measures the moisture content of filtered air entering the intake system.

Using HS input, the Engine Control Module (ECM) will make adjustments to prevent condensation of airborne water particles (moisture). The HS also houses the IAT sensor, which is used by the ECM for calculating fuel delivery.

Nitrogen Oxides (NOx) IN Sensor Module

The Nitrogen Oxides (NOx) IN sensor module is a smart device used to measure the NOx emissions at the intake of the aftertreatment system. The NOx IN sensor module performs internal diagnostics and reports malfunctions back to the ACM using the J1939 CAN data link.

The NOx IN sensor is not serviceable individually, and is part of the NOx IN sensor module.

Nitrogen Oxides (NOx) OUT Sensor Module

The Nitrogen Oxides (NOx) OUT sensor module is a smart device used to measure NOx emissions at the outlet of the SCR catalyst. The NOx OUT sensor module performs internal diagnostics and reports malfunctions back to the ACM using the J1939 CAN data link.

The NOx OUT sensor is permanently attached to the NOx control module. They are not serviceable independently and it is a single component.

Oxygen Sensor (O_2S)

The O_2S monitors oxygen levels in the exhaust.

O_2S input is used by the ECM to control EGR flow to a specified ratio by monitoring the level of unused oxygen in the exhaust stream.

The O_2S compares oxygen levels in the exhaust stream with oxygen levels in the outside air. The sensor generates an analog voltage and is monitored by the ECM. The level of voltage generated by the O2S corresponds to the oxygen levels in the exhaust stream.

The O2S is installed in the turbocharger exhaust pipe, after the Exhaust Back Pressure Valve (EBPV).

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Standard Electronic Control Features

NOTE: For additional feature operation, and parameter information, use the Navistar® 13 Engine Feature Documentation found on the Body Builder Website Link within Navistar® Service Portal. This includes parameter details of description, possible values, whether or not it is customer programmable, and recommended settings.

Aftertreatment (AFT) System

The AFT system, part of the larger exhaust system, processes engine exhaust so that it meets tailpipe emission requirements. The AFT system traps particulate matter (soot) and prevents it from leaving the tailpipe. The trapped particulate matter is then rendered to ash by heating the exhaust and injecting fuel through a process called regeneration. Regeneration reduces the frequency of AFT system maintenance without adversely affecting emissions.

For additional information, see Aftertreatment (AFT) System in the “Engine Systems” section of this manual.

Cold Ambient Protection (CAP)

CAP protects the engine from damage caused by prolonged idle at no load condition during cold weather.

CAP maintains engine coolant temperature by increasing engine rpm. CAP also improves cab warm-up.

CAP is standard on trucks without an Idle Shutdown Timer (IST).

Coolant Temperature Compensation (CTC)

NOTE: CTC is disabled in emergency vehicles and school buses that require 100 percent power on demand.

CTC reduces fuel delivery if the engine coolant temperature is above cooling system specifications.

Before standard engine warning or optional warning/protection systems engage, the ECM begins reducing fuel delivery when engine coolant temperature reaches approximately 107°C (225°F). A rapid fuel reduction of 15 percent is achieved when engine coolant temperature reaches approximately 110°C (230°F).

Data Plate

The ECM stores data to help identify the vehicle and engine components. The data plate feature is used to display text data descriptions in order to assist with reports and make data tracking easier.

The parameters associated with this feature only need to be modified when a related component is replaced, and can only be updated through your authorized dealer.

Electronic Speedometer and Tachometer

The engine control system calibrates vehicle speed up to 157 pulses per mile. The calculated vehicle speed is a function of transmission tail shaft speed, number of teeth on the tail shaft, rear axle ratio, and tire revolutions per mile. Use the Electronic Service Tool (EST) with ServiceMaxx™ software to program new speed calibrations into the ECM.

The tachometer signal is generated by the ECM by computing the signals from the Camshaft Position (CMP) sensor and the Crankshaft Position (CKP) sensor. The calculated engine speed is then sent to the instrument cluster through the J1939 CAN Data Link.

Engine Crank Inhibit (ECI)

The ECI will not allow the starting motor to engage when the engine is running and the drivetrain is engaged.

The ECI will not allow the starting motor to engage with the engine running if the key is turned to START while the clutch pedal is pressed.

Engine Electronic Governor Control

The governor controls engine rpm within a safe and stable operating range.

The low idle governor prevents engine rpm from dropping below a stable speed to prevent stalling when various loads are demanded on the engine.

The high idle governor prevents engine rpm from going above a safe speed that would cause engine damage.

Engine Fan Control (EFC)

The engine fan control feature is designed to allow configuration of the engine for various fan control features on a particular vehicle application.

The primary purpose of the engine fan is to allow the engine to run at its regulated operating temperature increasing engine performance. It is also used to assist in cooling the refrigerant in the A/C condenser. Factory set parameters within the ECM provide engine fan control based on the fan type installed in the vehicle. Choosing whether the fan is engaged during engine speed control, commonly referred to as PTO, operation is a customer programmable parameter. For additional information, see EFC (Engine Fan Control) in the “Electronic Control Systems Diagnostics” section of this manual.

Event Logging System

The event logging system records vehicle operation above the maximum speed setting (overspeed) and engine operation above maximum rpm (overspeed), coolant temperature out of operational range, low coolant level, or low oil pressure. The readings for the odometer and hourmeter are stored in the ECM memory at the time of an event and can be retrieved using the EST.

Fast Idle Advance

The ECM monitors the Engine Coolant Temperature (ECT) sensor. If the engine coolant temperature is below 10 °C (50 °F), the ECM activates the fast idle advance.

Fast idle advance increases engine idle speed to 700 rpm for a period of up to 100 seconds to assist in faster warm-up to operating temperature. This occurs by the ECM monitoring the engine coolant temperature and adjusting the fuel injector operation accordingly.

Low idle speed is resumed when engine coolant temperature reaches temperatures above 10 °C (50 °F), or the 100 second period times out.

Inlet Air Heater Assist

The Inlet Air Heater (IAH) feature improves engine start-up in cold weather. The Engine Control Module (ECM) controls the IAH Relay and monitors the Engine Oil Temperature (EOT), Inlet Air Temperature (IAT) and Engine Coolant Temperature 2 (ECT2) sensors. When the key is turned to the ON position, the ECM monitors the ECT2 and IAT sensors. If either sensor is below 11°C (52°F), the ECM enables the IAHR. The IAHR energizes the IAH Fuel Igniter (IAHFI). When the IAHFI reaches the proper operating temperature, the wait to start lamp flashes. As the engine is cranked, the ECM energizes the IAH Fuel Solenoid (IAHFS) valve, introducing fuel into the IAHFI, which ignites and warms the air being drawn into the engine. Do not accelerate the engine until the wait to start lamp goes out.

For additional information, see Inlet Air Heater System in the “Engine Systems” section of this manual.

IST (Idle Shutdown Timer) System (Clean Low Idle)

IST (Clean Low Idle)

The Idle Shutdown Timer (IST) ("Clean Low Idle") allows the ECM to shut down the engine during extended idle. When parking brake is set, the idle time can be programmed up to 5 minutes. When parking brake is released, the idle time can be programmed up to 15 minutes. During service, the idle time can be programmed up to 60 minutes. The ECM deactivates the IST when the PTO is active.

Thirty seconds before engine shutdown, the IST engine lamp illuminates. This continues until the engine shuts down or the low idle shutdown timer is reset. Idle time is measured from the last clutch or APP. The engine must be out of gear for the IST to work. Engine shutdown time resets for one or more of the following conditions:

- Engine speed is not at idle speed.
- Vehicle movement or a Vehicle Speed Sensor (VSS) fault is detected.
- DPF Regeneration is enabled (Any REGEN State).
- Accelerator pedal movement or an Accelerator Pedal Position (APP) fault is detected.
- Engine coolant operating temperature is below 16 °C (60 °F).
- Brake pedal movement or a brake switch fault is detected.
- Parking brake transition is detected.
- Clutch pedal is pressed or clutch pedal switch fault is detected (manual transmissions, if equipped with a clutch switch).
- Shift selector is moved from neutral (automatic transmissions).
- If the IST is enabled, the CAP will not function.

IST (Idle Shutdown Timer) System (Federal - Optional)

IST (Federal - Optional) Sensor Circuit Operation

The optional Idle Shutdown Timer (IST) allows the ECM to shut down the engine during extended idle. Idle time can be programmed from 5 to 120 minutes. The ECM can be programmed to deactivate the IST when the Power Takeoff (PTO) is active.

- Engine speed is not at idle speed (600 rpm).
- Vehicle movement or a Vehicle Speed Sensor (VSS) fault is detected.
- Manual DPF Regeneration is enabled.
- Accelerator pedal movement or an Accelerator Pedal Position (APP) fault is detected.
- Engine coolant operating temperature is below 60 °C (140 °F).
- Ambient temperature below 16° C (60 °F) or above 44 °C (110 °F).
- Brake pedal movement or a brake switch fault is detected.
- Parking brake transition is detected.
- Clutch pedal is pressed or clutch pedal switch fault is detected (manual transmissions, if equipped with a clutch switch).
- Shift selector is moved from neutral (automatic transmissions).
- If the IST is enabled, the CAP will not function.

J1939 Datalink

The vehicle is equipped with an SAE standard J1939 CAN datalink:

- The J1939 datalink is used for diagnostics and calibration communications for the Engine Control Module (ECM and ACM).
- The J1939 datalink is used for communications between the ECM, Electronic Gauge Cluster (EGC), and Body Controller (BC).

The J1939 datalink is accessed through the cab diagnostic connector pins C and D. The datalink provides communication between the ECM and the Electronic Service Tool (EST).

The J1939 datalink supports:

- Transmission of engine parameter data
- Transmission and clearing of Diagnostic Trouble Codes (DTCs)
- Diagnostics and troubleshooting
- Programming engine and vehicle features
- Programming calibrations and strategies

- Inter-module communications between the:
  - Engine Control Module (ECM)
  - Body Controller (BC)
  - Electronic Gauge Cluster (EGC)
  - Automatic Transmission Controller
  - Electronic Service Tool (EST)

For additional information, see J1939 Datalink in the “Electronic Control Systems Diagnostics” section in this manual.

Password Protection

The ECM allows the vehicle to be configured to help the owner optimize fuel economy and reliability. The password protection feature provides protection to prevent unauthorized users from changing parameter values in the ECM. With the password set, the service tool will prompt for the current password and will not allow any parameter to be changed until that password is entered. The password parameter is customer programmable.

Service Diagnostics

The EST provides diagnostic information using the J1939 Controller Area Network (CAN) datalink.

Faults from sensors, actuators, electronic components, and engine systems are detected by the ECM. The faults are accessed by the EST through the Diagnostic Connector, and are displayed as Diagnostic Trouble Codes (DTCs) on the EST. Effective engine diagnostics require and rely on DTCs.

Trip Reporting

The trip reporting feature is designed to monitor, collect, and store engine related operational information. This information can be downloaded and organized into useful reports using a service tool. Trip reporting operational data is recorded in two ways; non-resettable cumulative data, which consists of running totals, and resettable trip data, which consists of data collected since the last trip reset.

Vehicle Setup

The vehicle setup feature consists of various parameters within the ECM, which are based on the vehicle configuration. Most parameters are pre-programmed by the original equipment manufacturer (OEM) and will not require any adjustment for the life of the vehicle.

Optional Electronic Control Features

NOTE: For additional feature operation, and parameter information, use the Navistar® N13 Engine Feature Documentation found on the Body Builder Website Link within Navistar® Service Portal. This includes parameter details of description, possible values, whether or not it is customer programmable, and recommended settings.

Cruise Control

Cruise Control is a well-known feature that offers driving comfort by providing a method for an operator to set and maintain a constant vehicle speed without using the accelerator pedal. It is especially useful when the operator is required to drive on highways at a constant speed for many miles.

This cruise control feature is unique due to a parameter, which allows the cruise control set speed to be maintained in the ECM memory. Additional programming flexibility is included to allow a trade-off to be made between performance and fuel economy.

Driver Reward

The driver reward feature is designed to give the operator incentives for driving more efficiently. The feature accomplishes this by measuring the driver's habits based on fuel economy, time at idle, or both.

The rewards include higher maximum vehicle speed and higher cruise control speed limit. Lower maximum vehicle speed or cruise control speed limits may result as a penalty for failing to meet the standards.

Customer programmable parameters within the ECM provide driver reward related options that can be adjusted to suit the customer's needs.

Navistar® Engine Brake

The engine brake feature is a hydro-mechanical device designed to help decelerate the vehicle by providing additional engine load. It mounts under the engine valve cover and turns your power-producing diesel engine into a power-absorbing air compressor. This will reduce brake wear in vehicles which require frequent braking. This feature assumes the vehicle is equipped with a factory installed engine brake system; otherwise there may be engine components, additional switches, harnesses, and software modifications which may also be required.

Programmable parameters within the ECM provide engine brake related options that can be adjusted to suit the customer's needs. Choosing whether the engine brake is activated by pressing the service brake pedal or by releasing the accelerator pedal is one example. For a detailed feature description, see Engine Brake System in the "Engine Systems" section of this manual.

Engine Warning Protection System (EWPS)

NOTE: Emergency vehicles are not equipped with EWPS.

The Engine Warning and Protection System (EWPS) feature is designed to protect the engine from damage by monitoring critical engine data such as the engine speed, temperature, oil pressure, and coolant level. The EWPS feature will alert the operator by using a combination of visual and audible warnings if critical engine parameters are exceeded. Depending on the severity of the problem, there may be a reduction in power associated with the visual warnings. EWPS also visually alerts the operator with an amber warning lamp if the vehicle speed exceeds a threshold. The vehicle overspeed incidents are logged and can be downloaded into a report. Refer to the "Trip Reporting" feature for more information.

Customer programmable parameters within the ECM provide EWPS related options that can be adjusted to suit the customer's needs. For example the customer may choose that the EWPS feature activate a flashing red lamp and audible warning 30 seconds before engine shut down, to provide an additional level of engine protection.

Gear Down Protection (GDP)

The Gear Down Protection (GDP) feature is designed to encourage the driver to operate in the engine's most efficient range for fuel economy. This is done by limiting the vehicle speed until the driver shifts into a higher gear. This encourages the driver to upshift to the next highest gear, and helps to maintain the engine's most efficient speed range for fuel economy.

There are several customer programmable parameters for this feature.

Idle Shutdown Timer (IST)

The idle shutdown timer is used to limit the amount of engine idle time by automatically shutting down the engine after a pre-programmed time has expired. Programmable parameters within the ECM determine the time and conditions required before the engine shuts down. Some customer programmable parameters provide idle shutdown related options that can be adjusted to suit the customer's needs.

Thirty seconds before engine shutdown occurs, there will be an amber lamp illuminated in the instrument panel (if equipped) and an audible warning will sound. This will continue until the engine shuts down or the idle shutdown timer is reset. This feature shuts down the engine, but the vehicle electrical system and accessories will remain active until the key switch is turned off.

Progressive Shift

The progressive shift feature is designed to limit the engine speed to encourage the driver to up-shift early, which in turn improves fuel economy. This feature provides engine speed limit parameters optimized for each transmission gear, to encourage the use of the higher gears during cruise control and low engine load operations.

Customer programmable parameters within the ECM provide progressive shift related options that can be adjusted to suit the customer’s needs.

Power Take Off (PTO) - In Cab

The engine speed control feature, commonly referred to as “PTO”, provides a method for an operator to set and maintain a constant engine speed without using the accelerator pedal. It is commonly used for powering auxiliary devices.

The in-cab engine speed control feature provides three conditions under which the operator may select PTO speeds:

- Stationary Preset - Permits the operator to select up to six preset speeds while the vehicle is stationary
- Stationary Variable Speed - Permits the operator to select any engine speed within the PTO boundaries
- Mobile Variable Speed - Permits the operator to select a desired variable speed for moving or stationary PTO operations

Customer programmable parameters within the ECM provide in-cab engine speed control related options that can be adjusted to suit the customer's needs. Choosing whether the operator is allowed to increase the engine speed using the accelerator pedal without disengaging the PTO is one example.

Power Take Off (PTO) - Remote

When control over engine speed is required from outside the vehicle’s cab, remote mounted switches must be used to turn on PTO engine speed control and select the desired engine speed. This functionality is referred to as Remote Engine Speed Control (RESC). The engine speed can be ramped up and down with RESC similar

to the way the in cab PTO feature works; however, the RESC feature includes two additional switches (remote preset & remote variable), which allow the operator to choose the mode of engine speed control operation.

Customer programmable parameters within the ECM provide RESC related options that can be adjusted to suit the customer's needs. Choosing whether a remote throttle pedal is used for PTO operation is one example.

Service Interval

The service interval feature is designed to provide a visual reminder to the operator of service interval information such as, oil change interval has expired, and that routine maintenance procedures should be performed. The term “interval” in this case is used to describe the distance, time, or fuel used between the last maintenance performed on the vehicle and the next maintenance, which is due.

Customer programmable parameters within the ECM provide options that can be adjusted to suit the customer’s needs. For example, the engine hours, fuel used, and vehicle distance can be used individually or in combination to determine the service interval.

It is essential that operators are trained to know the maintenance schedules and instructions regarding the operation and reset functionality of the service interval for the feature to be effective. Refer to Integral Digital Display in Section 3 – Instruments, Indicators, and Switches of the Navistar® 11 and 13 *Engine Operation and Maintenance Manual* for more information.

Traction Control

Traction control is a system that identifies when a wheel is spinning faster than the other wheels during acceleration.

When a traction control condition occurs, a datalink message is sent to the ECM to limit fuel for the purpose of reducing engine torque.

Vehicles must have a transmission and an Anti-lock Brake System (ABS) that supports traction control.

Up-Shift Indicator

The up-shift indicator feature provides an indication to the operator that the transmission should be shifted into a higher gear. This helps to maintain the engine’s most efficient speed range for fuel economy.

The feature is commonly used on manual transmissions and automated manuals in manual mode.

Road Speed Limiter

Road Speed Limiter (RSL) is a feature with customer programmable parameters designed to regulate the maximum vehicle speed as controlled by the accelerator pedal.

The following additional features are available with RSL:

- **Adjustable RSL:** Provides a customer programmable secondary vehicle speed limit, lower than the limit provided by RSL, useful for spreader applications and construction, etc.
- **RSL Override:** Raises the vehicle speed limit provided by the RSL feature to a customer programmable speed when the driver identifies a "passing situation."
- **RSL Anti-Tampering:** Customer selectable option, which checks whether the vehicle speed signal (VSS) input is valid or if it has been subject to tampering.

These options can be enabled by programmable parameters within the ECM.

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Session Files

A Session file is a window into the Engine Control Module (ECM). Sessions can display vehicle and engine information, such as; module calibration, sensor signals, and actuator command signals. Special engine and vehicle features can also be programmed using these sessions.

ServiceMaxx™ software has many default sessions, that load automatically when running any Service Bay Test or Service Tool Procedure. Users are not limited to any default session. Users are able to build their own session and save or load it at anytime. See the *ServiceMaxx™ Users Guide* for details.

ServiceMaxx™ software has a few added sessions that do not load automatically, but can be selected from the Sessions drop-down menu. These sessions are available to help diagnose common systems, and program special features.

- Hard Start No Start
- Performance
- Programming

Diagnostic Trouble Code (DTC)

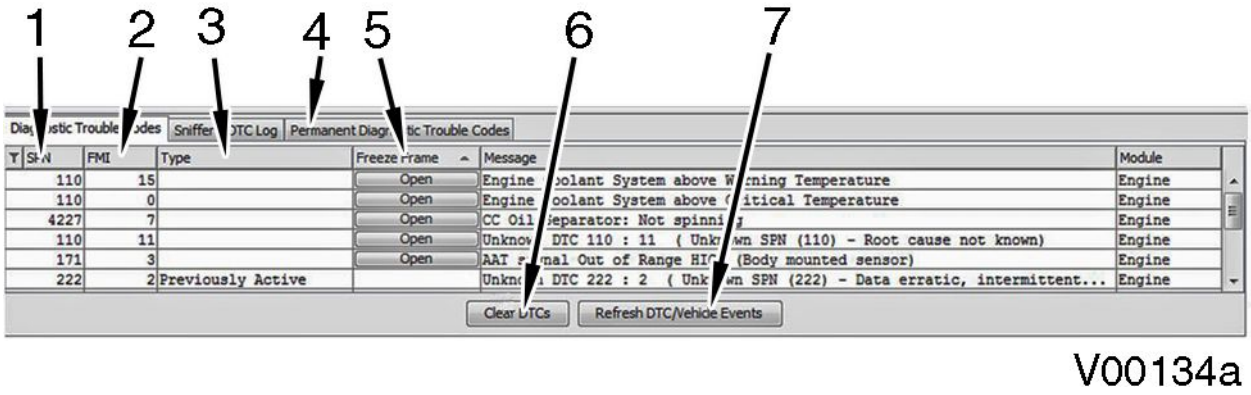

Figure 32 ServiceMaxx – DTC window

1. Suspect Parameter Number (SPN)
2. Failure Mode Indicator (FMI)
3. Fault Code Type
4. Permanent Diagnostic Trouble Codes tab
5. Freeze Frame
6. Clear DTCs button
7. Refresh DTC/Vehicle Events button

Suspect Parameter Number (SPN)

Identifies component or system causing the fault.

Failure Mode Indicator (FMI)

Identifies fault or condition effecting the component or system.

Pending

Pending SPN / FMI are possible faults that were detected on the first drive cycle.

Active

SPN / FMI that was detected on a second consecutive drive cycle.

Previously Active

Historical SPN / FMI that may be caused by intermittent signals, or an operating condition, which is not currently present.

Freeze Frame Data

Snapshot of influencing signals at the time the code was set. This can help diagnose hard to duplicate failures. Freeze Frame Data is cleared as soon as the SPN / FMI is cleared.

ECM Programmable Features

Many features can be programmed into the Engine Control Module (ECM) to fit many different applications. To make programming changes using ServiceMaxx™ software, load the Programming session. See the Body Builder website for further details.

Connecting EST with ServiceMaxx™ Software to Engine

To connect the Electronic Service Tool (EST) with ServiceMaxx™ software to the engine, the NAVCoM, NAVLink, or generic Interface cable (RP1210B compliant supporting J1939 and J1708) must be connected between the EST and vehicle diagnostic connector. The diagnostic connector is located inside the vehicle cab, above the clutch pedal.

Tests

KOEO Tests

Key On Engine Off (KOEO) tests can be selected in the Tests drop-down menu under KOEO Tests.

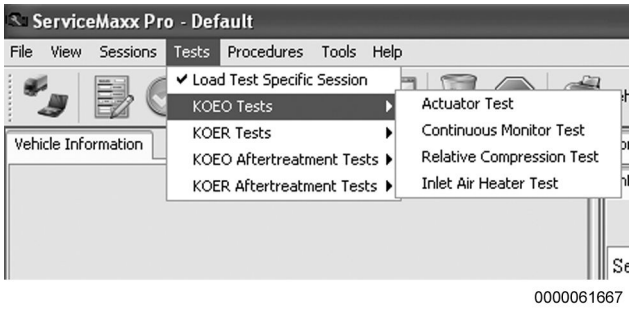

Figure 33 ServiceMaxx™ Tests – KOEO Tests

Actuator Test

Enables technicians to cycle selected actuator high and low and, if available, command given duty cycle percent. A technician can then use a Digital Multimeter (DMM) to measure changes in voltage, duty cycle, or visually monitor actuator movement while the actuator is commanded.

Continuous Monitor (Wiggle) Test

NOTE: Run the Continuous Monitor Test while monitoring sensor voltages. Wiggle the wiring harness and connections while looking for signal spikes.

Helps detect intermittent circuit faults. During this test, signals are continuously monitored and faults are logged. This test provides a graphical view of signals and allows the technician to detect intermittent spiking or momentary loss of signal. Perform this test while manipulating / wiggling connectors, wiring, and harnesses of the suspected faulty component or circuit.

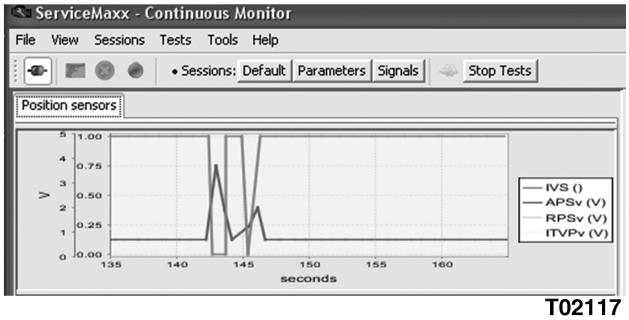

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Figure 34 Continuous Monitor Test – Faulty Signal

Relative Compression Test

NOTE: The Relative Compression Test must be run before running the Cylinder Cutout Test.

Measures cylinder balance based on the compression stroke of each cylinder.

This test helps determine cylinder integrity. The Engine Control Module (ECM) measures time for each piston to travel upward during the compression stroke. Timing is based on information from the Camshaft Position (CMP) sensor and Crankshaft Position (CKP) sensor. A cylinder with low compression allows the piston to travel faster during the compression stroke.

Test results are displayed by either numerical text or graphical display. If there are no mechanical problems with the engine, the numbers or graphs displayed should be approximately the same value or height. A smaller number or lower level graph would indicate a problem with that cylinder.

Inlet Air Heater Test

Gives technicians the ability to command the inlet air heater system to run. Follow on screen instructions when running ServiceMaxx™ software procedures.

KOER Tests

Key On Engine Running (KOER) tests can be selected in the Tests drop-down menu.

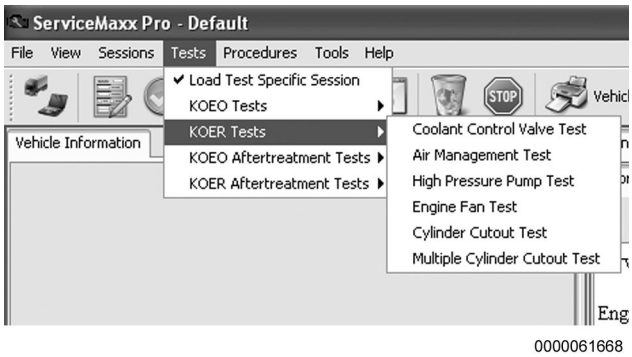


Figure 35 ServiceMaxx™ Tests – KOER Tests

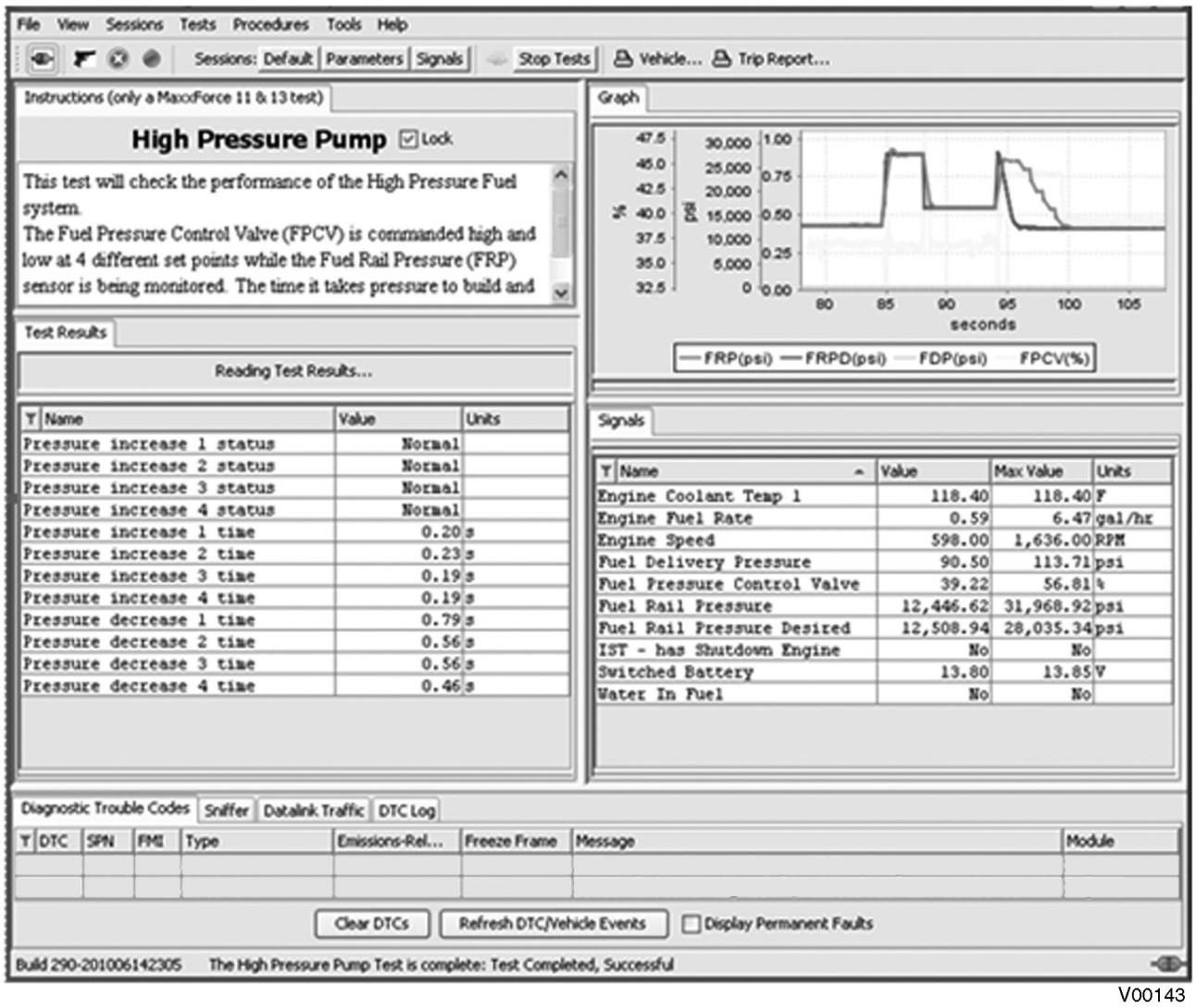
Air Management Test

The Air Management Test validates operation and performance of the Exhaust Gas Recirculation (EGR) valve, Turbocharger 2 Wastegate Control (TC2WC) valve, and Exhaust Backpressure Valve (EBPV), based on Intake Manifold Pressure (IMP). This test is unable to validate the performance of the turbocharger, due to the amount of engine load required.

High Pressure Pump Test

The High Pressure Pump Test validates performance of the high-pressure fuel system. This test accelerates the engine in four steps while commanding higher fuel rail pressure on each step. When the test is complete, the Engine Control Module (ECM) sends the test results to the Electronic Service Tool (EST).

Using an Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests > KOER Tests > High Pressure Pump Test.



T	Name	Value	Units
	Pressure increase 1 status	Normal	
	Pressure increase 2 status	Normal	
	Pressure increase 3 status	Normal	
	Pressure increase 4 status	Normal	
	Pressure increase 1 time	0.20	s
	Pressure increase 2 time	0.23	s
	Pressure increase 3 time	0.19	s
	Pressure increase 4 time	0.19	s
	Pressure decrease 1 time	0.79	s
	Pressure decrease 2 time	0.56	s
	Pressure decrease 3 time	0.56	s
	Pressure decrease 4 time	0.46	s

T	Name	Value	Max Value	Units
	Engine Coolant Temp 1	118.40	118.40	F
	Engine Fuel Rate	0.59	6.47	gal/hr
	Engine Speed	598.00	1,636.00	RPM
	Fuel Delivery Pressure	90.50	113.71	psi
	Fuel Pressure Control Valve	39.22	56.81	%
	Fuel Rail Pressure	12,446.62	31,968.92	psi
	Fuel Rail Pressure Desired	12,508.94	28,035.34	psi
	IST - has Shutdown Engine	No	No	
	Switched Battery	13.80	13.85	V
	Water In Fuel	No	No	

T	DTC	SPN	FMI	Type	Emissions-Rel...	Freeze Frame	Message	Module

V00143

Figure 36 High Pressure Pump Test

Engine Fan Test

Commands the engine fan to different states and operating speeds to help diagnose fan failures. The viscous engine fan takes minutes to respond to changes in the commanded speed.

Cylinder Cutout Test

Isolates a low contributing cylinder due to an injector, or injector circuit fault.

Before starting the Cylinder Cutout Test, do the following:

1. Run Relative Compression Test.
    - If Relative Compression Test results indicate low balanced cylinder(s), there is no need to run the Cylinder Cutout Test. Repair mechanical fault.
2. Verify fuel system pressure is not below specification and fuel is not aerated.

Multi-Cylinder Cutout Test

Helps determine an over- or under-performing cylinder. This test monitors engine load while disabling one or more cylinders at a time in a pre-determined sequence. The results of each combination are collected and used in calculating the result.

NOTE: Before starting the Multi-Cylinder Cutout Test, coolant temperature should be above 160°F and engine load should be stable (Example: A/C, PTO, and Engine Fan should not be cycling on and off throughout the test).

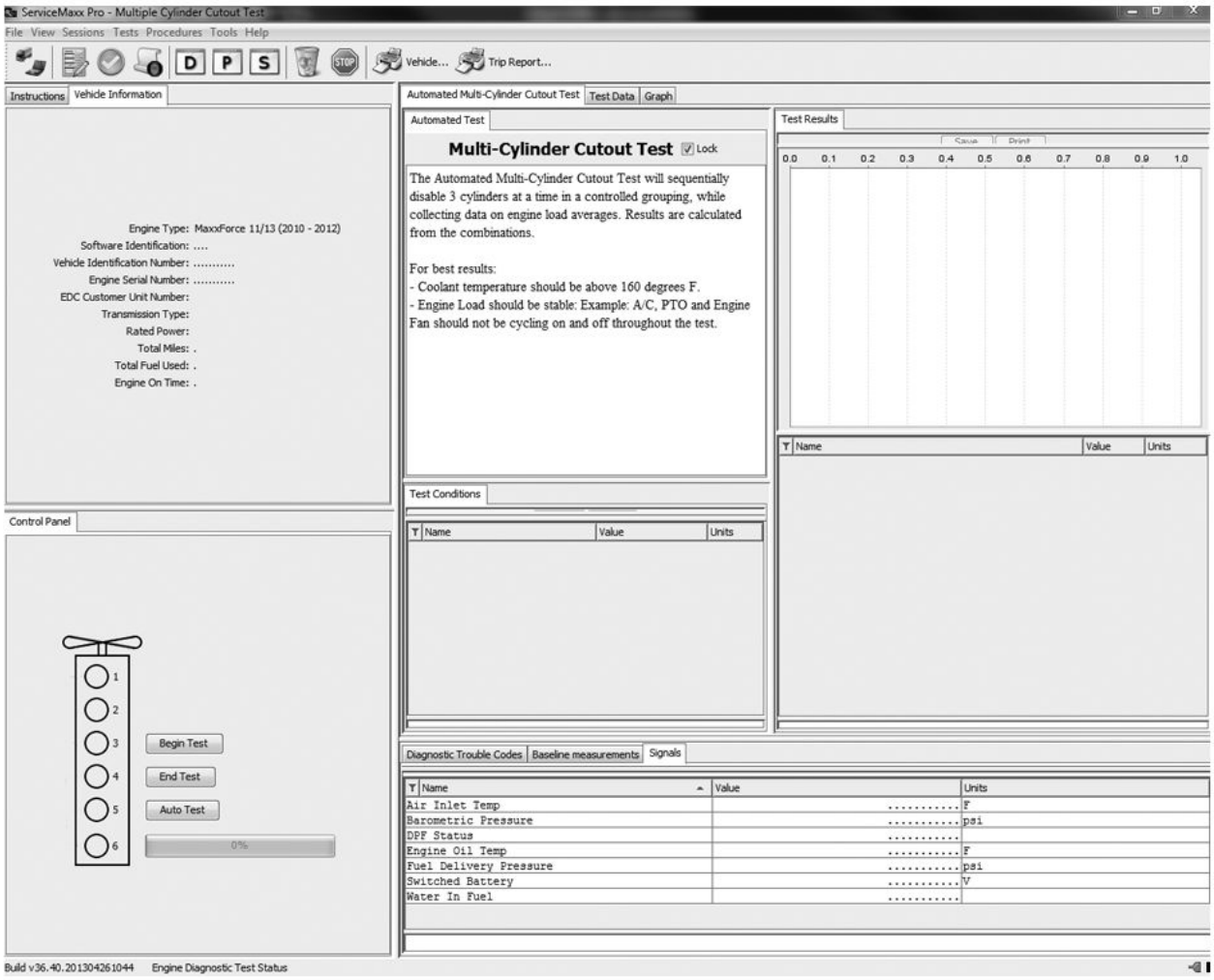


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Figure 37 Multi-Cylinder Cutout Test

Hot Run Sensor Comparison Test

Purpose

Check for failed aftertreatment system temperature sensor.

Tools Required

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

NOTE: This test is not dependent on engine temperature.

1. Turn ignition switch to ON position.
2. Connect Electronic Service Tool (EST) with ServiceMaxx™ software to vehicle's diagnostic connector.

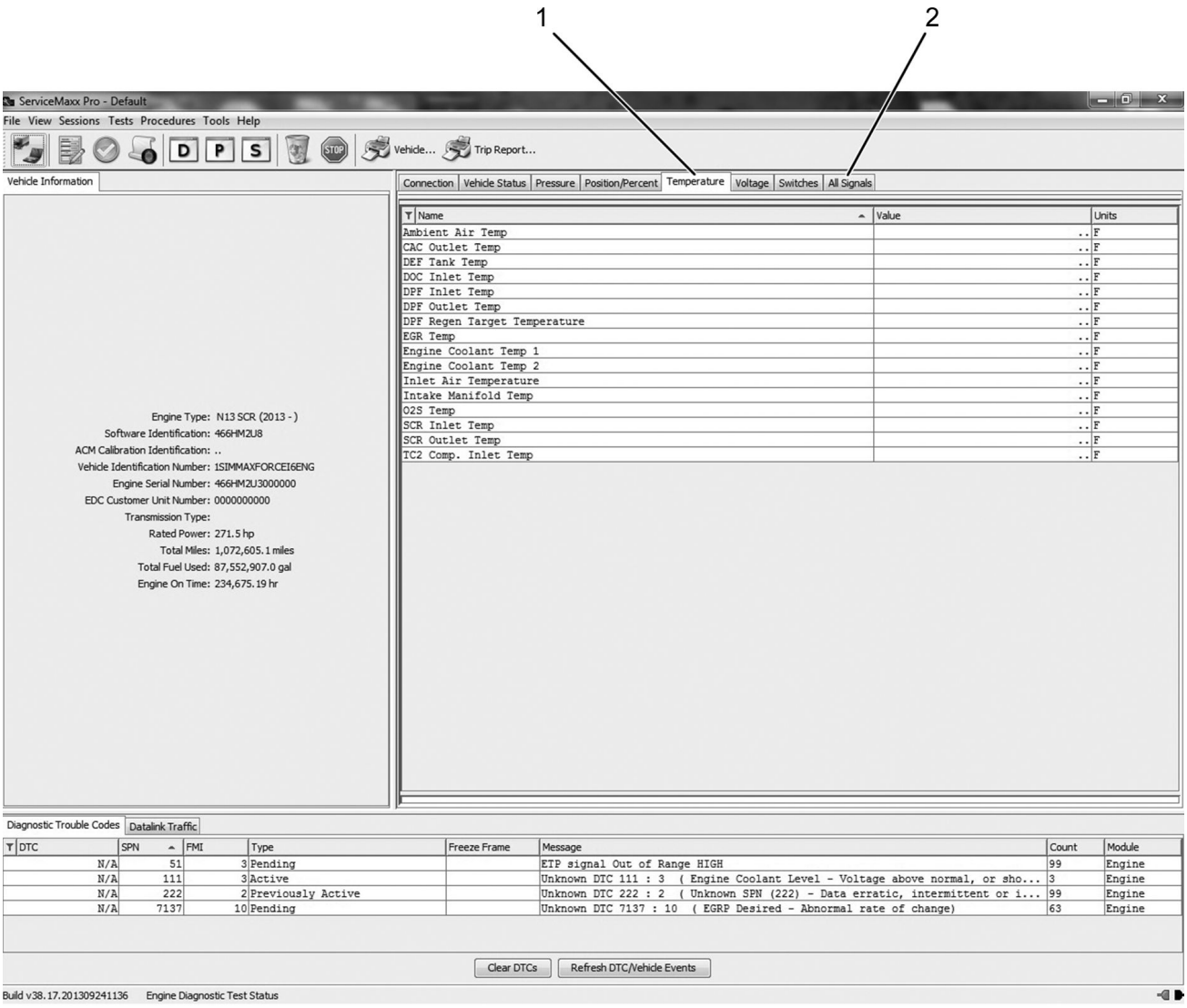

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Figure 38 Default Session

1. Temperature tab
2. All Signals tab

3. Go to Default Session: Sessions > Default > Temperature tab.

⚠ WARNING: To prevent personal injury or death, shift transmission to park or neutral, set parking brake, and block wheels before doing diagnostic or service procedures.

4. Start and run engine at 1400 - 1500 rpm for 10 minutes.
5. Monitor the following signals in the All Signals tab:

   Compare the following three signals:

   - DOC Inlet Temp

- DPF Inlet Temp
- DPF Outlet Temp

After 10 minutes, if any of these three aftertreatment temperature sensors are not within 77°F (25°C) of each other, diagnose appropriate sensor and / or circuit (see Electronic Control Systems Diagnostics).

Compare the following two signals:

- SCR Inlet Temp
- SCR Outlet Temp

After 10 minutes, if either of the two SCR temperature sensors are not within 77°F (25°C) of each other, diagnose appropriate sensor and / or circuit (see Electronic Control Systems Diagnostics).

Coolant Control Valve Test

Use this test to validate the performance of the coolant control valves and cooler. The Coolant Mixer Valve controlled to 95% will bypass the low temperature radiator. Controlling the valve to 5% will cool the coolant going to the EGR Cooler.

Run engine up to normal operating temperature.

- With either valve at (95%) ECT1 and ECT2 should be within 5 degree F of each other.
- With Coolant Mixer Valve at (5%) ECT2 and TC2CIT should cool 30 degree F lower than ECT1.

KOEO Aftertreatment Tests

DEF Doser Pump Override Test Initial Checks

Validates performance of the Diesel Exhaust Fluid (DEF) dosing system, based on the amount of DEF flow for a fixed amount of time. This test will inject 100 ml of DEF in 6 minutes.

Tools Required

- Coolant Management Tool KL5007NAV
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)
- Diesel Exhaust Fluid Doser Valve (DEFDV) Spray Test Kit 18-559-01
- Graduated cylinder
- Plastic container
- Air and Fuel Cap and Plug Kit ZTSE4891

1. Check Diesel Exhaust Fluid (DEF) tank, DEF supply module, and DEF Doser Valve (DEFDV) lines and connections for: cracks and pitting; loose, leaking, or damaged connections; and restrictions.

   If the DEF tank, DEF supply module, or DEFDV lines and connections are damaged or restricted, repair or replace the failed component, line, or connection.

2. Check DEF quality. Obtain a sample of DEF. Visually inspect for contamination, and use DEF Refractometer 5025 to test urea concentration of DEF.

If DEF is contaminated or urea concentration is not between 30 – 34 percent, drain the DEF tank, flush with distilled water, and fill with new and / or known good DEF.

DEFDV Removal and Preparatory Steps

WARNING: To prevent personal injury or death, allow engine to cool before removing components.

WARNING: To prevent personal injury or death, avoid contact with Diesel Exhaust Fluid (DEF) / urea. Do not get DEF in eyes. In case of eye contact, immediately flush eyes with large amounts of water for a minimum of 15 minutes. Do not swallow. If DEF is ingested, contact a physician immediately.

WARNING: To prevent personal injury or death, do the following when removing radiator or deaeration cap:

- **Allow engine to cool for 15 minutes or more.**
- **Wrap a thick cloth around radiator cap or deaeration cap.**
- **Loosen cap slowly a quarter to half turn counterclockwise to vent pressure.**
- **Continue to turn cap counterclockwise to remove.**

NOTE: Low battery voltage can cause dosing volume to be low. Verify batteries are fully charged before beginning this test.

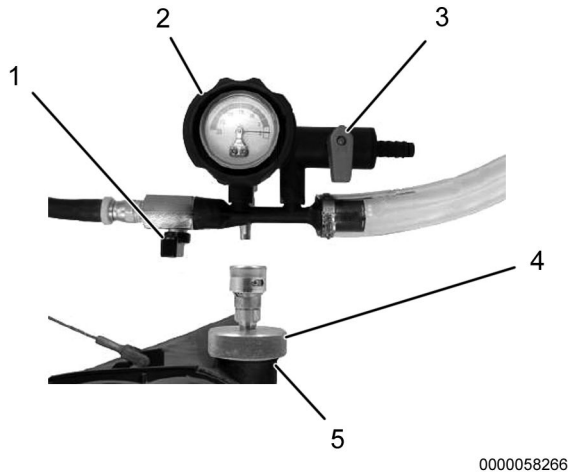

Figure 39 Coolant Management Tool Connections

1. Air valve (closed)
2. Vacuum Module
3. BLUE vent valve
4. Cap Adapter
5. Deaeration tank

1. Remove deaeration tank cap and install Cap Adapter KL5004NAV (Figure 39) (Item 4) onto the deaeration tank (Figure 39) (Item 5).

2. Connect Vacuum Module KL5005NAV (Figure 39) (Item 2) to Cap Adapter.
3. Verify both valves on the vacuum module are in the closed position, and attach clean dry shop air.

Figure 40 Air Valve (Open)

1. Air valve (open)

4. Open air valve (Figure 40) (Item 1) on Vacuum Module, and allow 20 to 25 in. Hg to be drawn on the cooling system.

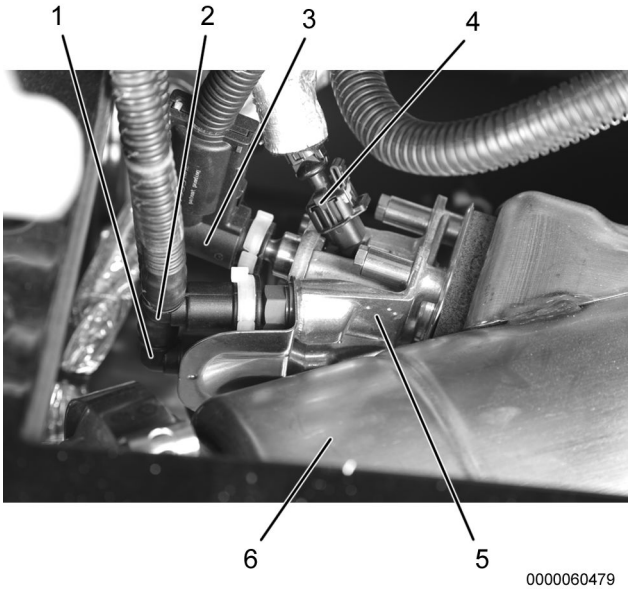

Figure 41 DEFDV Connection Locations

1. Coolant return line
2. Coolant supply line
3. Diesel Exhaust Fluid Doser Valve (DEFDV) pressure line
4. DEFDV connector
5. DEFDV
6. Decomposition reactor tube

WARNING: To prevent personal injury or death, wear safety glasses with side shields.

5. Use compressed air to remove any debris trapped in the gaps between the Diesel Exhaust Fluid Doser Valve (DEFDV) (Figure 41) (Item 5) and the decomposition reactor tube (Figure 41) (Item 6).
6. Clean any white deposits from DEF on the DEFDV pressure line (Figure 41) (Item 3) connection with a shop towel soaked in warm water.
7. Disconnect DEFDV coolant supply line (Figure 41) (Item 2) and coolant return line (Figure 41) (Item 1) at DEFDV.

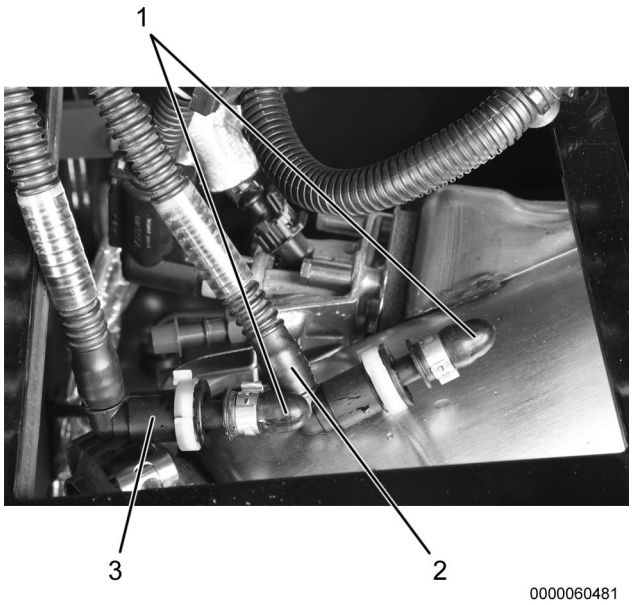

Figure 42 DEFDV Coolant Line Plugs Installed

1. DEFDV Coolant Line Plugs (2)
2. Coolant supply line
3. Coolant return line

8. Install two DEFDV Coolant Line Plugs 18-559-01-02 (Figure 42) (Item 1) onto DEFDV coolant supply and return line.
9. Open BLUE vent valve on the Vacuum Module (Figure 39) (Item 2) to release vacuum on the cooling system.

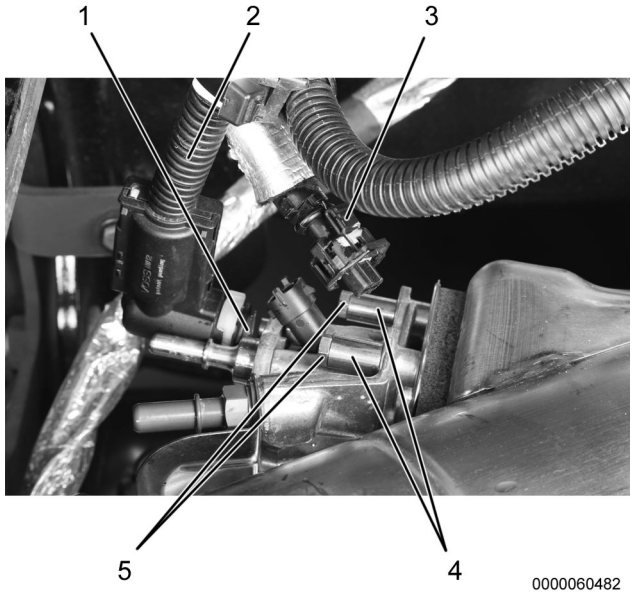

Figure 43 DEFDV Pressure Line Plugged and Connector Disconnected

1. DEFDV pressure line plug
2. DEFDV pressure line
3. DEFDV connector
4. DEFDV spacers
5. DEFDV mounting bolts (3)

10. Place a plastic container under the DEFDV to catch Diesel Exhaust Fluid (DEF).

CAUTION: Do Not disconnect vehicle batteries, DEF supply module 12–way connector, or any DEF lines until the DEF dosing system has completed the purge cycle. Wait at least five minutes after Key OFF for the DEF dosing system to complete the purge cycle.

11. Disconnect DEFDV pressure line (Figure 43) (Item 2) and install DEFDV pressure line plug to prevent debris from entering system using Air and Fuel Cap and Plug Kit ZTSE4891.
12. Disconnect DEFDV connector (Figure 43) (Item 3).
13. Remove three DEFDV mounting bolts (Figure 43) (Item 5) and spacers (Figure 43) (Item 4).
14. Remove DEFDV and gasket from decomposition reactor tube. Discard gasket.

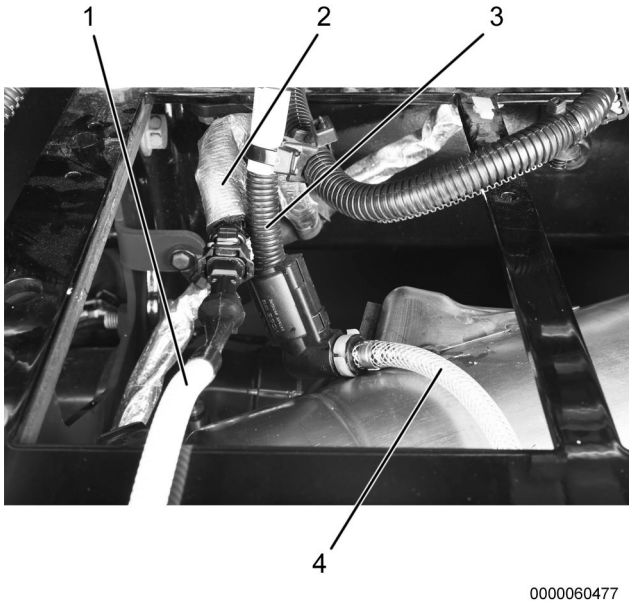

Figure 44 DEFDV Pressure Line and Harness Extensions Connected

1. DEFDV Harness Extension
2. Vehicle harness
3. DEFDV pressure line
4. DEFDV Pressure Line Extension

15. Connect DEFDV Pressure Line Extension 18-559-01-03 (Figure 44) (Item 4) between DEFDV pressure line and DEFDV.
16. Connect DEFDV Harness Extension 18-559-01-01 (Figure 44) (Item 1) between vehicle harness and DEFDV connector.
17. Place DEFDV into a clear graduated cylinder, large enough to contain the DEFDV, and marked in milliliters (ml) or ounces (oz).
18. Cover the DEFDV and graduated cylinder so DEF spray is contained.

DEF Doser Pump Override Test

NOTE: Verify DEF tank is full before beginning procedure.

1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests > KOEO Aftertreatment Tests > DEF Doser Pump Override Test.

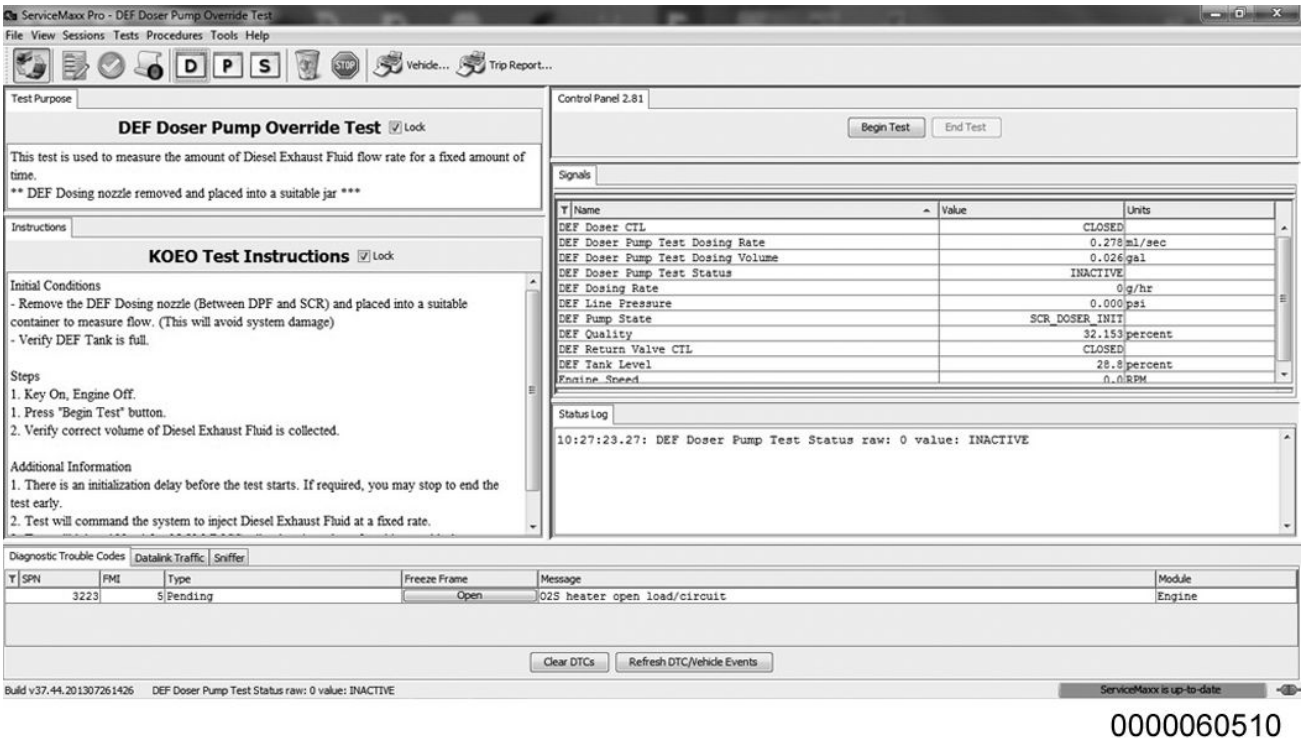

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Figure 45 DEF Doser Pump Override Test

2. Select Begin Test.

   NOTE: When test starts, the DEF dosing system will first prime the Diesel Exhaust Fluid Doser Valve (DEFDV). The DEFDV will open intermittently to purge air from the system. This will cause some DEF to be sprayed from the DEFDV (normal operation).

3. While test is running, monitor DEFDV spray pattern.

   NOTE: DEFDV spray pattern should be a fine mist. If larger drops, dripping, or a non-symmetrical spray pattern is present, stop the test and clean the DEFDV tip (see Exhaust System Service Manual). After cleaning is completed, restart DEF Doser Pump Override test.

4. After test is complete, measure DEF in graduated cylinder. DEF collected should be between 85 ml and 115 ml.

5. Perform steps 1 through 4 three times. If results are not within specification, inspect DEF supply module filter for contamination and debris.

   - If one or more of the test results is below 85 ml, clean the DEFDV (see Exhaust System Service Manual).
   - If one or more of the test results is above 115 ml, replace the DEFDV.
   - If test results vary above and below specification, replace the DEFDV.

NOTE: Inspect collected sample for contamination or debris.

DEFDV Installation and Finishing Steps

1. Remove Diesel Exhaust Fluid Doser Valve (DEFDV) from graduated cylinder and dispose of DEF according to local regulations.
2. Clean any components coated with DEF with a shop towel soaked in warm water.
3. Disconnect DEFDV Harness Extension 18-559-01-01 from DEFDV.
4. Disconnect DEFDV Pressure Line Extension 18-559-01-03 from DEFDV.
5. Install new DEFDV gasket onto bottom of DEFDV with metallic side facing DEFDV.

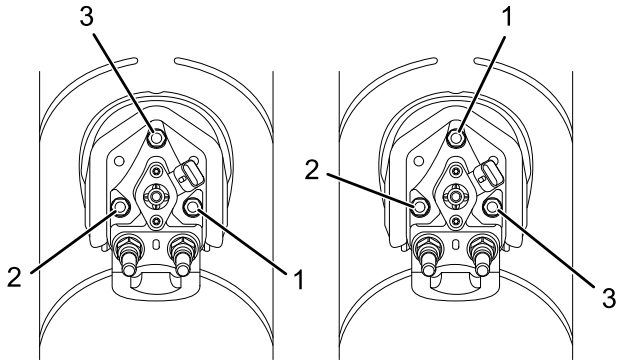

Figure 46 DEFDV Mounting Bolts Tightening Sequence

6. Install DEFDV, three DEFDV mounting bolts, and spacers onto decomposition reactor tube. Tighten three DEFDV mounting bolts by hand first using DEFDV Mounting Bolts Tightening Sequence (Figure 46)shown on the left. Then tighten to 80 lb·in (9 N·m) in the DEFDV Mounting Bolts Tightening Sequence (Figure 46) shown on the right.
7. With Vacuum Module KL5005NAV installed, open air valve on Vacuum Module, and allow 20 to 25 in. Hg to be drawn on the cooling system.
8. Remove DEFDV Coolant Line Plugs 18-559-01-02 from coolant supply and return line.
9. Connect DEFDV coolant supply and return line at the DEFDV.
10. Connect DEFDV pressure line to DEFDV.
11. Connect vehicle wiring harness lead to DEFDV connector.

DEF Supply Module Flush

DEF supply module flushing should be performed when the DEF supply module is suspected of being the cause of a fault.

CAUTION: Do Not disconnect vehicle batteries, DEF supply module 12–way connector, or any DEF lines until the DEF dosing system has completed the purge cycle. Wait at least five minutes after Key OFF for the DEF dosing system to complete the purge cycle.

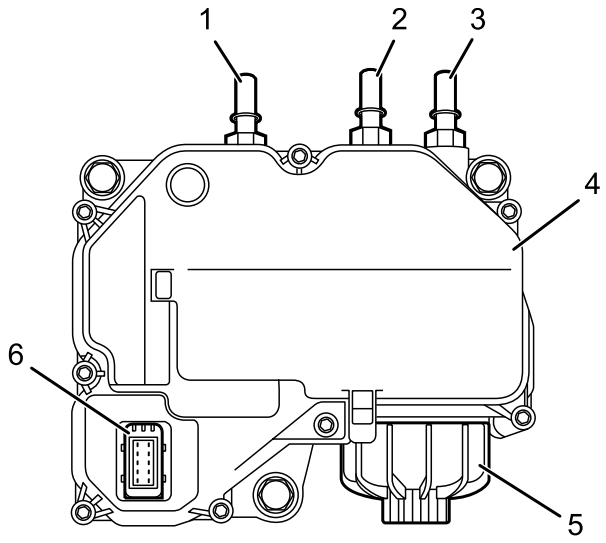

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Figure 47 DEF Supply Module

1. DEF supply module suction line fitting
2. DEF supply module return line fitting
3. DEF supply module pressure line fitting
4. DEF supply module housing
5. DEF supply module filter cap
6. DEF supply module 12–way connector

NOTE: If the DEF supply module is being removed for service, install protective caps on the 12–way electrical connector and fluid fittings.

Step	Action	Decision
1	Check Diesel Exhaust Fluid (DEF) supply module housing (Figure 47) (Item 4) for cracks or leaks. Is DEF supply module housing in good condition and Not leaking?	Yes: Go to step 2. No: Replace DEF supply module.

NOTE: The DEF supply module is not internally serviceable. Do not open the case.

Step	Action	Decision
2	Inspect connections at DEF supply module. Key OFF, disconnect DEF supply module 12-way connector (Figure 47) (Item 6). Check DEF supply module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DEF supply module connector, harness, and terminals clean and undamaged?	Yes: Go to step 3. No: Repair connector, harness, or terminal damage.

Step	Action	Decision
3	Inspect DEF supply module filter cap (Figure 47) (Item 5) and fluid fittings for white DEF deposits. Is the DEF supply module filter cap free of white deposits?	Yes: Go to step 4. No: Clean the leak areas with warm water and a soft bristled brush. Go to step 4.

CAUTION: Do not immerse the DEF supply module in any kind of solution. Do not wash with any detergents.

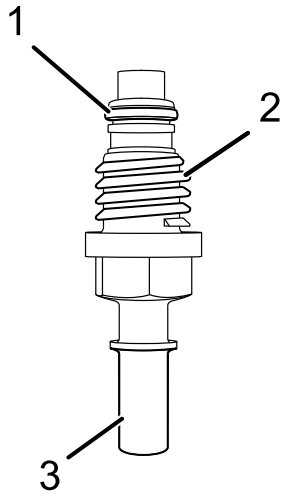

Figure 48 DEF Supply Module Fluid Fitting

1. DEF supply module fluid fitting o-ring
2. DEF supply module fluid fitting threads
3. DEF supply module fluid fitting

Step	Action	Decision
~~5~~4	Inspect DEF supply module fluid fittings (Figure 47) (Items 1, 2, 3). Remove DEF supply module fluid fittings. Inspect fittings (Figure 48) (Item 3) for cracks or other damage. Are DEF supply module fluid fittings in good condition?	Yes: Go to step ~~6~~ 5. No: Obtain new DEF supply module fluid fitting(s). Go to step 6.

Step	Action	Decision
~~6~~5	Inspect DEF supply module suction fitting for debris. Using a rubber-tipped blow gun, blow air through the threaded side of the fitting onto a sheet of paper. Inspect the paper for debris that has been blown out. Was any debris blown out of the suction fitting?	Yes: Inspect the DEF tank and tank filter for debris and contamination. Replace DEF and DEF tank filter as necessary. Obtain new DEF supply module suction fitting. Go to step 7. No: Go to step ~~7~~6.

Step	Action	Decision
~~7~~6	Inspect the DEF supply module pressure and return fittings for debris. • Using a rubber-tipped blow gun, blow air through the threaded side of the return line fitting onto a sheet of paper. Inspect the paper for debris that has been blown out. • Using a rubber-tipped blow gun, blow air through the Non-threaded side of the pressure line fitting onto a sheet of paper. Inspect the paper for debris that has been blown out. Was any debris blown out of the fittings?	Yes: Replace the DEF supply module fluid fitting(s) that had debris. Go to step ~~8~~7. No: Go to step ~~8~~7.

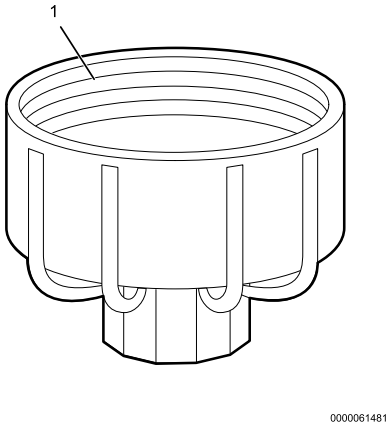

Figure 49 DEF Supply Module Filter Cap Inspection Point

1. DEF supply module filter cap

Step	Action	Decision
~~8~~7	Remove and Inspect DEF supply module filter cap (Figure 49) (Item 1) for cracks or damage Is the DEF supply module filter cap free of cracks and damage?	Yes: Go to step ~~9~~8. No: Replace the DEF supply module filter cap. Go to step ~~9~~8.

Step	Action	Decision
~~9~~8	Check DEF quality. Obtain a sample of DEF. Visually inspect for contamination, and use DEF Refractometer 5025 to test urea concentration of DEF fluid. Is urea concentration between 30 - 34 percent and Not contaminated?	Yes: Go to step ~~10~~9. No: Drain the DEF tank, flush with distilled water, and fill with new and / or known good DEF. Go to step ~~10~~9.

Step	Action	Decision
~~10~~9	Re-install DEF supply module fluid fittings using new o-rings and torque to 40 in lb (4.5 nm). **CAUTION:** Do Not use lubricant on the DEF supply module fluid fitting threads or o-rings Fill DEF supply module cleaner bottle 18-200-01-01 with water and connect to the supply module inlet connector. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests > KOEO Aftertreatment Tests > DEF Doser Pump Override Test. Select Begin Test. Squeeze the DEF supply module cleaner bottle to push water into the DEF supply module, until the supply module draws water on its' own. Does the DEF supply module draw water from the bottle (maximum 3 minutes)?	Yes: Go to step 1~~1~~0. No: Replace DEF supply module.

Step	Action	Decision
1~~1~~0	Install new DEF supply module filter. Tighten DEF supply module filter cap to 177 in. lb. (20 Nm) Reinstall DEF lines. Perform DEFDV Spray Test (page 98). Is 85–115 ml of DEF dispensed?	Yes: DEF supply module cleaning is complete. No: Replace DEF supply module.

KOER Aftertreatment Tests

Key On Engine Running (KOER) Aftertreatment Tests can be selected in the Tests drop-down menu.

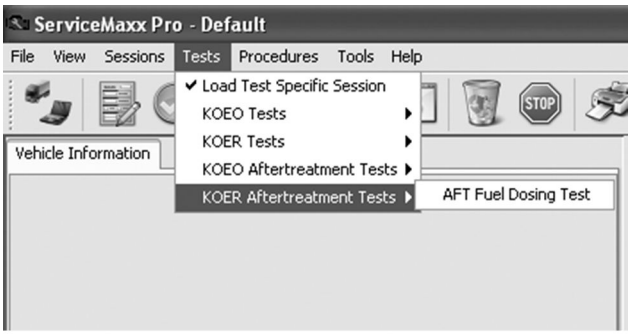

Figure 50 ServiceMaxx – KOEO Aftertreatment Tests

AFT Fuel Dosing Test

Validates performance of the Aftertreatment (AFT) fuel dosing system by measuring how much fuel comes out of the Aftertreatment Fuel Injector (AFTFI) in approximately 2 minutes 30 seconds while the AFTFI and Aftertreatment Fuel Shutoff Valve (AFTFSV) are commanded Open. The AFT Fuel Dosing Test has three different modes:

- AFT Dosing System Test
- AFT Fuel Injector Leak Test
- AFT Fuel Shutoff Valve Leak Test

Tools Required

- Coolant Management Tool KL5007NAV
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)
- Aftertreatment Injector Test Kit 12-559-01
- Graduated Cylinder
- Air and Fuel Cap and Plug Kit ZTSE4891

Preparatory Steps

WARNING: To prevent personal injury or death, allow engine to cool before removing components.

WARNING: To prevent personal injury or death, do the following when removing the radiator cap or deaeration cap:

- Allow engine to cool for 15 minutes or more.
- Wrap a thick cloth around radiator cap or deaeration cap.
- Loosen cap slowly a quarter to half turn counterclockwise to vent pressure.
- Pause for a moment to avoid being scalded by steam.
- Continue to turn the cap counterclockwise to remove.

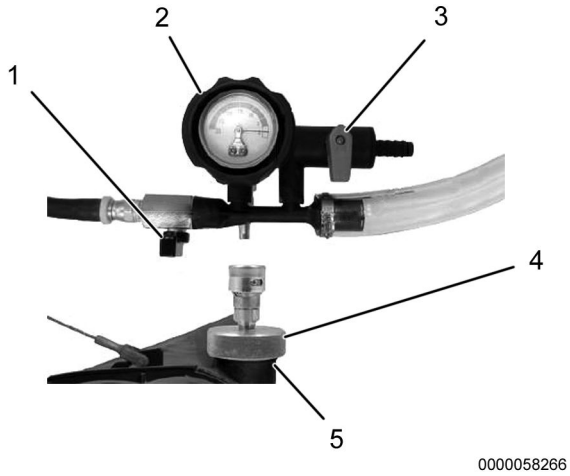

Figure 51 Coolant Management Tool Connections

1. Air valve (closed)
2. Vacuum Module
3. BLUE vent valve
4. Cap Adapter
5. Deaeration tank

WARNING: To prevent personal injury or death, wear safety glasses with side shields.

1. Remove deaeration tank cap and install Cap Adapter KL5004NAV (Figure 51) (Item 4) onto the deaeration tank (Figure 51) (Item 5).
2. Connect Vacuum Module KL5005NAV (Figure 51) (Item 2) to Cap Adapter.
3. Verify both valves on the Vacuum Module are in the closed position, and attach clean dry shop air.

Figure 52 Air Valve (Open)

1. Air valve (open)

4. Open air valve (Figure 52) (Item 1) on Vacuum Module, and allow 20 to 25 in. Hg to be drawn on the cooling system.

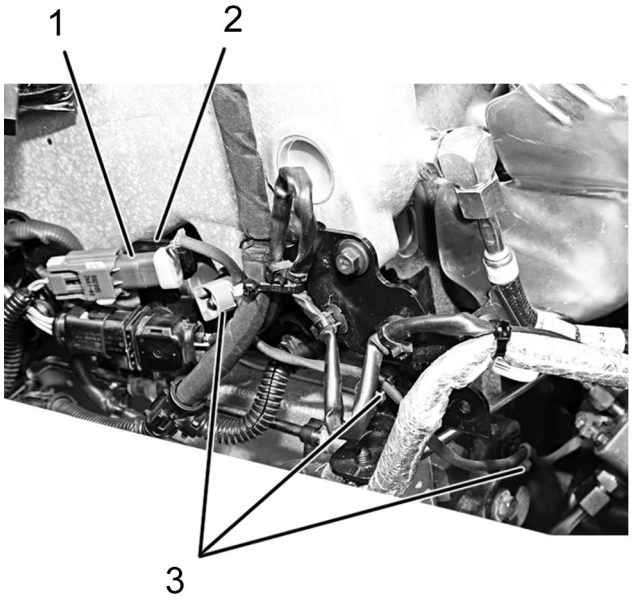

Figure 53 AFTFI Harness and Connections

1. Aftertreatment Fuel Injector (AFTFI) connector
2. AFTFI connector mounting bracket
3. AFTFI harness fasteners (3)

5. Press release tab to disconnect wiring harness lead from AFTFI connector (Figure 53) (Item 1).
6. Disconnect AFTFI connector from AFTFI connector mounting bracket (Figure 53) (Item 2).
7. Disconnect three AFTFI harness fasteners (Figure 53) (Item 3).

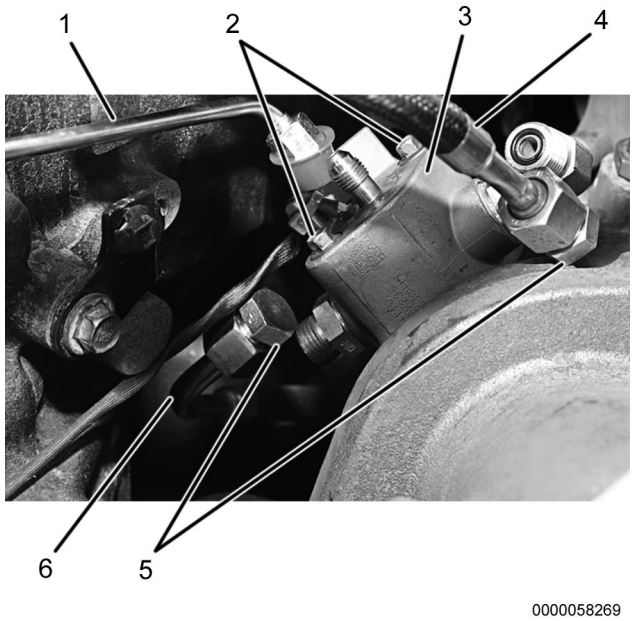

Figure 54 AFTFI Connections (Disconnected)

1. Fuel supply line
2. AFTFI M6 mounting bolts (2)
3. Aftertreatment Fuel Injector (AFTFI)
4. Coolant supply line
5. AFTFI Coolant Line Plugs (2)
6. Coolant return line

8. Disconnect AFTFI fuel supply line (Figure 54) (Item 1) from AFTFI, and use Air and Fuel Cap and Plug Kit ZTSE4891 to cap line. Discard O-rings.
9. Disconnect AFTFI coolant supply line (Figure 54) (Item 4) and coolant return line (Figure 54) (Item 6) at the AFTFI. Discard O-rings.
10. Install two AFTFI Coolant Line Plugs (Figure 54) (Item 5) onto coolant supply and return line.
11. Open the BLUE vent valve (Figure 39) (Item 3) on the Vacuum Module to release vacuum on the cooling system.
12. Remove two AFTFI M6 mounting bolts (Figure 54) (Item 2).
13. Remove AFTFI as an assembly from turbocharger exhaust outlet pipe. Discard metal gasket and fibrous insulator.

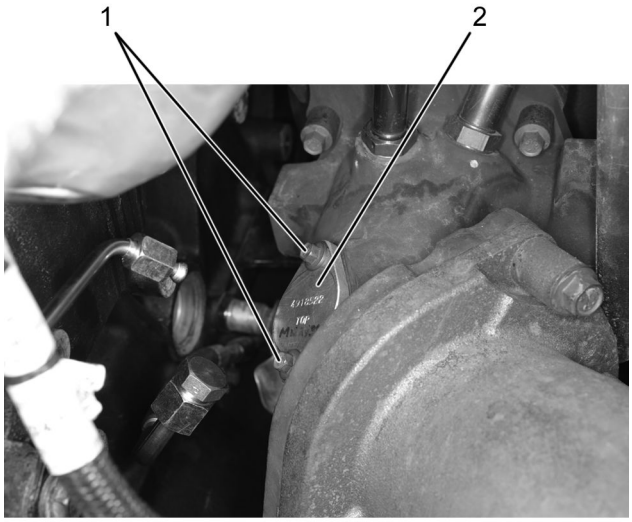

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Figure 55 AFTFI Block Off Plate and Bolts

1. AFTFI Block Off Plate Bolt (2)
2. AFTFI Block Off Plate

14. Install AFTFI Block Off Plate 12-559-01-05 (Figure 55) (Item 2) onto turbocharger exhaust outlet pipe using two AFTFI Block Off Plate Bolts 12-55-01-04 (Figure 55) (Item 1).

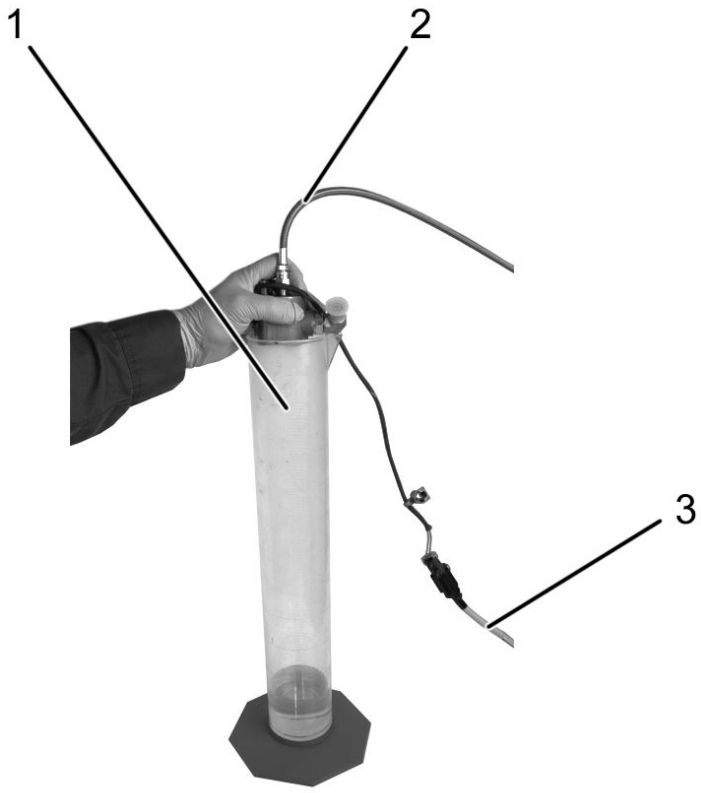


Figure 56 AFTFI In Graduated Cylinder

1. Graduated cylinder
2. AFTFI Fuel Supply Extension Line 12-559-01
3. AFTFI Harness Extension 12-559-01-06

15. Connect AFTFI Fuel Supply Extension Line 12-559-01 (Figure 56) (Item 2) between AFTFI fuel supply line and AFTFI.
16. Connect AFTFI Harness Extension 12-559-01-06 (Figure 56) (Item 3) between vehicle harness and AFTFI connector.
17. Place AFTFI into a clear graduated cylinder (Figure 56) (Item 1), large enough to contain the AFTFI, and marked in milliliters.
18. Cover the AFTFI and graduated cylinder so fuel spray is contained.

AFT Dosing System Test

Determines the amount of fuel dispensed from the Aftertreatment Fuel Injector (AFTFI). The test will open the AFTFI and Aftertreatment Fuel Shutoff Valve (AFTFSV), and inject 225 to 500 ml of fuel within 2 minutes 30 seconds.

1. Do Preparatory Steps (page 111).
2. Start the engine and allow it to reach operating temperature.
3. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Test > KOER Aftertreatment Tests > AFT Fuel Dosing Test.

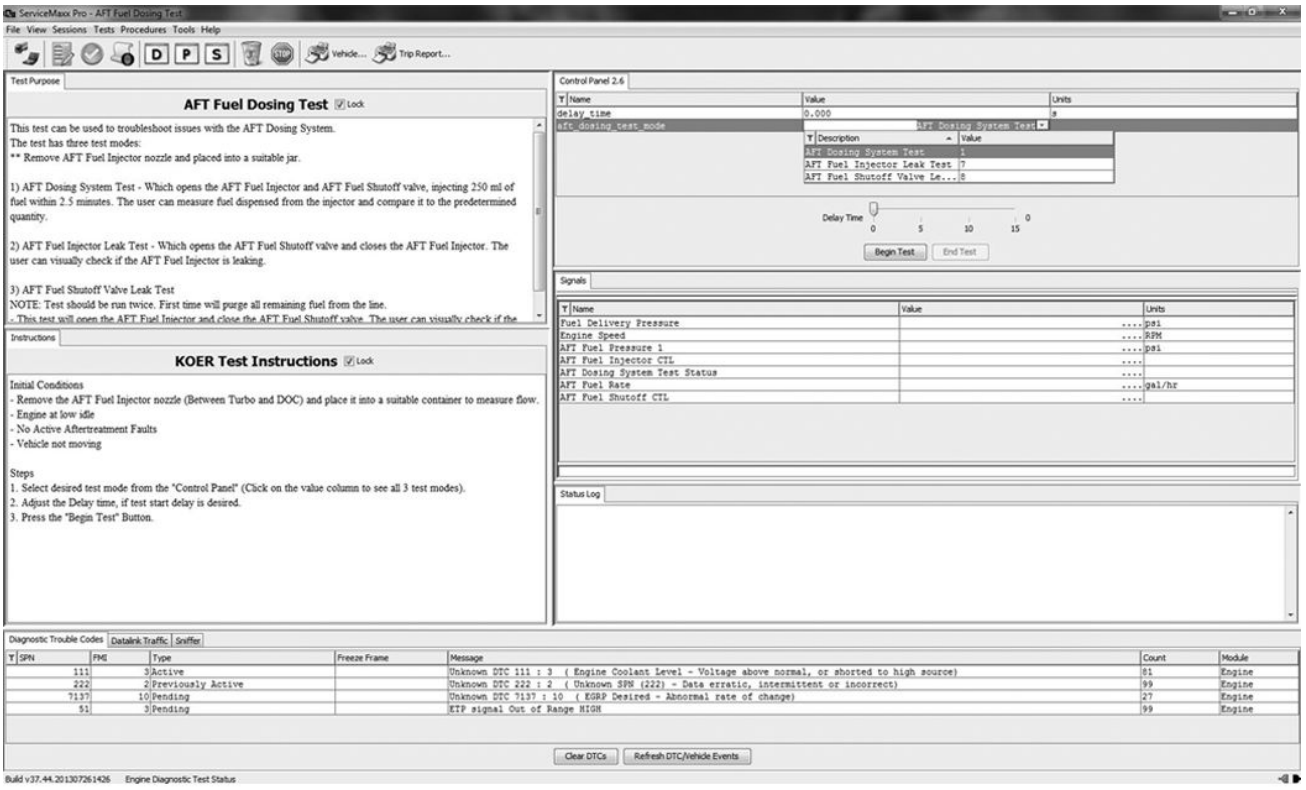


Figure 57 AFT Dosing System Test

4. Under Value heading, select AFT Dosing System Test.

WARNING: To prevent personal injury or death, wear safety glasses with side shields.

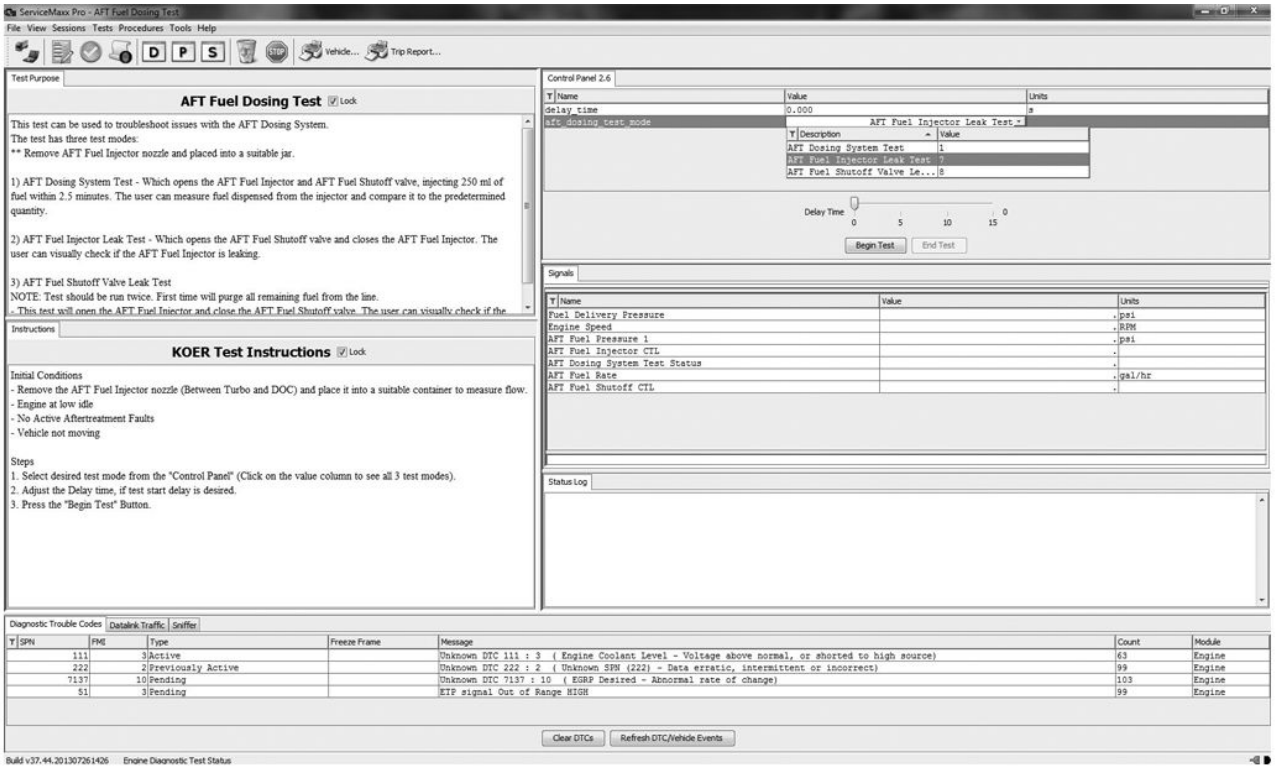
5. Set the desired Delay Time and select Begin Test.
6. Do steps 3 thru 5 three times, and average the test results. Average amount of fuel collected per test should be between 225 and 500 ml. If fuel collected is within specification, clean and install AFTFI. If fuel collected is not within specification, clean AFTFI and perform AFT Dosing System Test a second time. If average amount of fuel collected is still below specifications, replace AFTFI.

   NOTE: Clean AFTFI after this step regardless of test results.

AFT Fuel Injector Leak Test

Helps to determine if the Aftertreatment Fuel Injector (AFTFI) is leaking. This test will open the Aftertreatment Fuel Shutoff Valve (AFTFSV), and close the AFTFI.

1. Do Preparatory Steps (page 111).
2. Start the engine and allow it to reach operating temperature.
3. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Test > KOER Aftertreatment Tests > AFT Fuel Dosing Test.



0000060475

Figure 58 AFT Fuel Injector Leak Test

4. Under Value heading, select AFT Fuel Injector Leak Test.

WARNING: To prevent personal injury or death, wear safety glasses with side shields.

5. Set the desired Delay Time and select Begin Test.
6. After test is completed, record results. If more than 5 ml of fuel is collected, replace AFTFI.

AFT Fuel Shutoff Valve Leak Test

Helps determine if the Aftertreatment Fuel Shutoff Valve (AFTFSV) is leaking. This test should be run twice consecutively. The first time to purge all remaining fuel from the Aftertreatment Fuel Injector (AFTFI) supply line. This test will open the AFTFI and close the AFTFSV.

1. Do Preparatory Steps (page 111).
2. Start engine and allow it to reach operating temperature.
3. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Test > KOER Aftertreatment Tests > AFT Fuel Dosing Test.

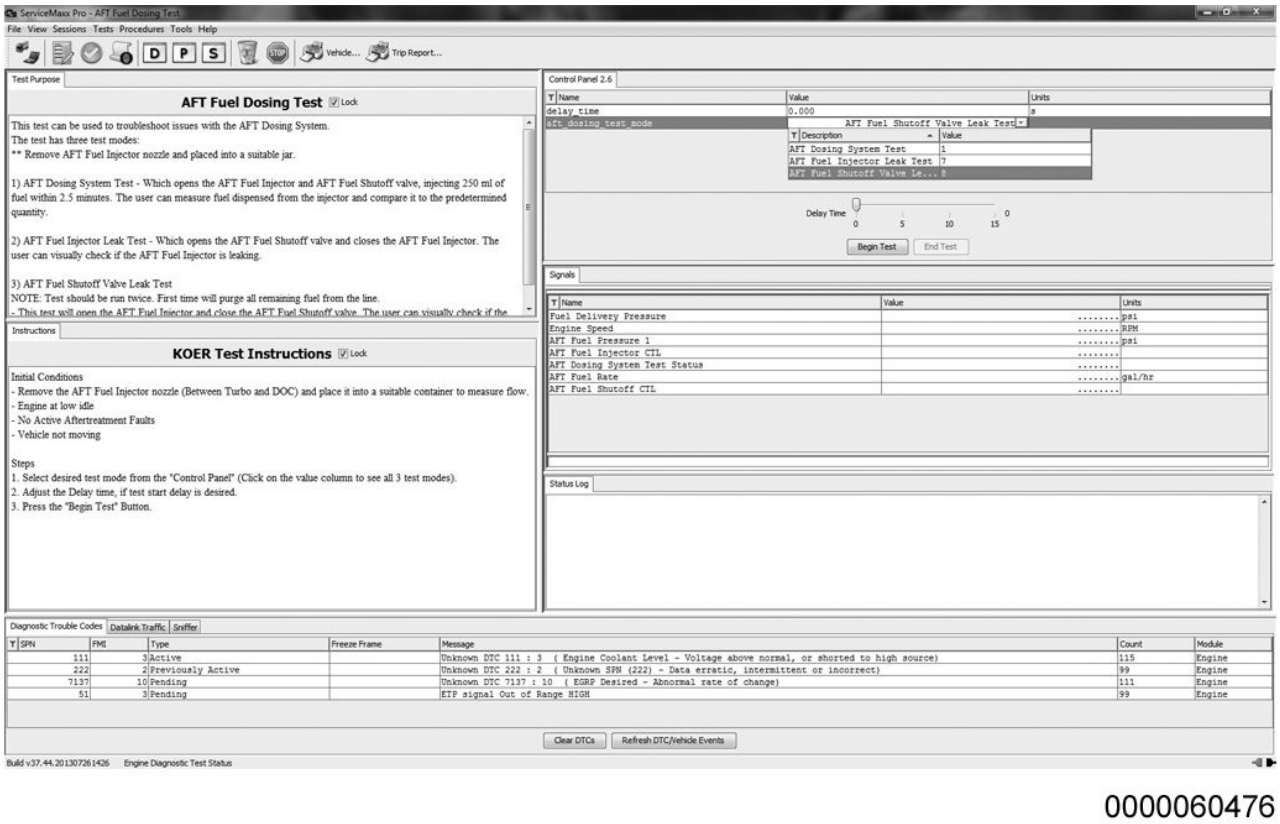


Figure 59 AFT Fuel Shutoff Valve Leak Test

4. Under Value heading, select AFT Fuel Shutoff Valve Leak Test.

WARNING: To prevent personal injury or death, wear safety glasses with side shields.

5. Set the desired Delay Time and select Begin Test.
6. After test is completed, record results. If more than 5 ml of fuel is collected, replace the AFTFSV.

AFTFI Installation and Finishing Steps

1. Remove Aftertreatment Fuel Injector (AFTFI) from graduated cylinder and dispose of collected fuel properly.
2. Disconnect AFTFI Harness Extension 12-559-01-06 from AFTFI.

3. Disconnect AFTFI Fuel Supply Extension Line 12-559-01 to AFTFI.
4. Remove AFTFI Block Off Plate 12-559-01-05 from turbocharger exhaust outlet pipe by removing two AFTFI Block Off Plate Bolts 12-559-01-04.
5. Install new fibrous insulator and metal gasket onto AFTFI.
6. Install AFTFI and two AFTFI M6 mounting bolts onto turbocharger exhaust outlet pipe. Tighten two AFTFI M6 mounting bolts to 80 lb·in (9 N·m).
7. With Vacuum Module KL5005NAV installed, open air valve on vacuum module, and allow 20 to 25 in. Hg to be drawn on the cooling system.
8. Remove AFTFI Coolant Line Plugs from coolant supply and return line.
9. Install new O-rings, and connect AFTFI coolant supply and return line at the AFTFI.
10. Install new O-rings, connect AFTFI fuel supply line to AFTFI.
11. Connect three AFTFI harness fasteners.
12. Connect AFTFI connector to AFTFI connector mounting bracket.
13. Connect wiring harness lead to Aftertreatment Fuel Injector (AFTFI) connector.

Procedures

These procedures are not Tests, but special Engine Control Module (ECM) controls that allow the technician to perform specific procedures.

KOEO Procedures

Key On Engine Off (KOEO) Procedures can be selected in the Procedures drop-down menu.

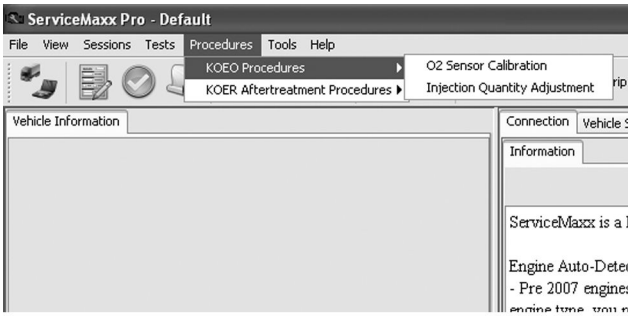


Figure 60 ServiceMaxx – KOEO Procedures

Oxygen (O2) Sensor Calibration

Calibrates the Engine Control Module (ECM) to the Oxygen Sensor (O_2S). Do this procedure after replacing the O2 sensor.

O_2S Calibration Procedure – Using ServiceMaxx™ Software

Verify there are no O_2S OPEN or short circuits before sensor replacement.

NOTE: Remove O_2S from exhaust system before running O_2 Sensor Calibration procedure.

1. Connect O_2S to engine harness. Leave sensor outside the exhaust system.
2. Turn ignition switch to ON, engine OFF.
3. Start ServiceMaxx™ software.
4. Run O_2 Sensor Calibration procedure.
5. After Calibration is complete, install O_2S in exhaust system.

Injector Quantity Adjustment

Injector Quantity Adjustment (IQA) is a function that injects the correct amount of fuel for each individual injector, throughout the operating range of the engine. Injector mechanical tolerances, high flow to low flow, can be evenly balanced with ECM calibration. Each injector has an encrypted label and must be programmed into the ECM, whenever an injector has been replaced. IQA can be programmed using the Injector Quantity Adjustment procedure.

KOER Aftertreatment Procedures

Key On Engine Running (KOER) Aftertreatment Procedures can be selected in the Procedures drop-down menu.

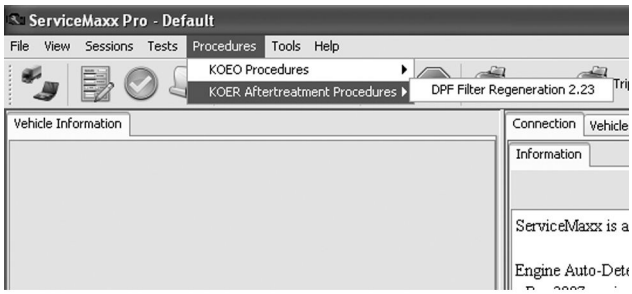


Figure 61 ServiceMaxx – KOER Aftertreatment Procedures

DPF Regeneration

The DPF Regeneration increases engine speed to measure pressure differential across the Diesel Particulate Filter (DPF). This includes running a complete Parked Regen.

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Low Power No MIL

Low Power No MIL

Description

Any complaint for low power, engine de-rate, or engine shutdown often with no service engine light (MIL). The diagnostics will require the CCV (Coolant Control Valve) and LTR (Low Temperature Radiator) to be inspected. This issue can also be very difficult to duplicate without a loaded trailer or hills to pull.

Diagnose and repair all other engine related fault codes before performing below diagnostics. This is only intended to repair low power issues with no service engine light.

The CCV consists of CMV (Coolant Mixer Valve) and CFV (Coolant Flow Valve) and is located on front of engine, upper right side.

Symptoms

- Engine De-Rate with no warning lights in cluster
- Warning Lamps in Cluster
- Fan Engages before Programmed Temperature (Fan On Temp)

Possible Diagnostic Trouble Codes

SPN	FMI	Condition
1173	16	TC2CIT Signal Above Desired (Interstage CAC Under Cooling) (page 431)
27	0	Pin-EGRP Fault: Over Temperature (page 1018)
4076	0	ECT2 Above Critical (EWPS Programmable Limit) (page 1050)
4076	15	ECT2 Above Warning (EWPS Programmable Limit) (page 1050)

Overview

GOVERNMENT REGULATION: Engine fluids (oil, fuel, and coolant) may be a hazard to human health and the environment. Handle all fluids and other contaminated materials (e.g. filters, rags) in accordance with applicable regulations. Recycle or dispose of engine fluids, filters, and other contaminated materials according to applicable regulations.

WARNING: To prevent personal injury or death, make sure the engine has cooled before removing components.

WARNING: To prevent personal injury or death, do not let engine fluids stay on your skin. Clean skin and nails using hand cleaner and wash with soap and water. Wash or discard clothing and rags contaminated with engine fluids.

Step	Action
1	**Symptom Verification / Data Acquisition** Using EST, go to Sessions > Performance. Find an open stretch of road in order to perform Lug Down Test. When driving conditions are safe, select record snapshot icon from toolbar, and perform. **NOTE:** Engine must be at operating temperature before taking snapshot. Lug Down procedure below: 1. Select a suitable high range gear (Example: In a 10 speed gearbox, select the 8th speed). 2. Allow engine speed to drop to 1000 rpm. 3. Press accelerator pedal fully to floor, and accelerate to rated engine speed. After Lug Down Test is complete continue with a 2 minute cruise at 1500 rpm at highway speeds so coolant temps can be reviewed later. To be viewed later. Continue to Step 2.

Step	Action	Decision
2	**Fuel Rail Pressure Verification** Check for low fuel rail pressure. Using EST with ServiceMaxx™ software, use playback feature and graph the following signal values from Lug Down Test: Signal Values • Engine Speed • Fuel Rail Pressure (FRP) • Fuel Rail Pressure Desired (FRPD) Compare snapshot to Graph 3 (page 132) and associated Graph Analysis Is FRP signal operating as per Graph 3 Graph Analysis (page 132)?	Yes: Go to Step 3. No: Diagnose and repair low fuel rail pressure (page 217). After repairs are complete, go to step 1 and recheck.

Step	Action	Decision
3	**TC1 Turbine Outlet Pressure Verification** Verify aftertreatment system is free of restrictions. Using EST, use playback feature and graph the following signal values from Lug Down Test: Signal Values: • Engine Speed • Turbocharger 1 Turbine Outlet Pressure (TC1TOP) Compare snapshot to Graph 4 (page 133) and associated Graph Analysis Is TC1TOP signal operating as per Graph 4 Graph Analysis (page 133)?	Yes: Go to step 4. No: Repair TC1TOP (page 1399) issue. After repairs are complete, go to step 1 and recheck..

Step	Action	Decision
4	**TC1 Turbine Outlet Pressure Verification** Check for an Intake Manifold Pressure (IMP) issue. Use playback feature in ServiceMaxx™, and graph the following signal values from Lug Down Test: Signal Values: • Engine Speed • Intake Manifold Pressure (IMP) • Accelerator Pedal Position 1 (APP1) • Vehicle Speed Compare snapshot to Graph 5 (page 134) and associated Graph Analysis. Is IMP operating as per Graph 5 Graph Analysis (page 134)?	Yes: Go to Step 5. No: Diagnose and repair IMP (page 1130) issue. After repairs are complete, go to step 1 and recheck.

Step	Action	Decision
5	**Cooling package Inspection** Check cooling system package for external plugging. Especially check for debris packed between the cooling system components. (Bug screen, A/C Condenser, HP CAC, LTR, and radiator) Is Cooling Package free of debris?	Yes: Continue to Step 6. No: Clean and Retest

Step	Action	Decision
6	**LTR Internal Flow** Remove inlet and outlet of LTR. Using a garden hose at inlet, make sure flow coming out of LTR is consistent with flow going in. Is LTR flowing properly?	Yes: Replace the CCV. No: Replace LTR. Add Phosphate conditioner p/n 2611268C1 in cooling system when replacing LTR.

Graph 1: Plugged LTR

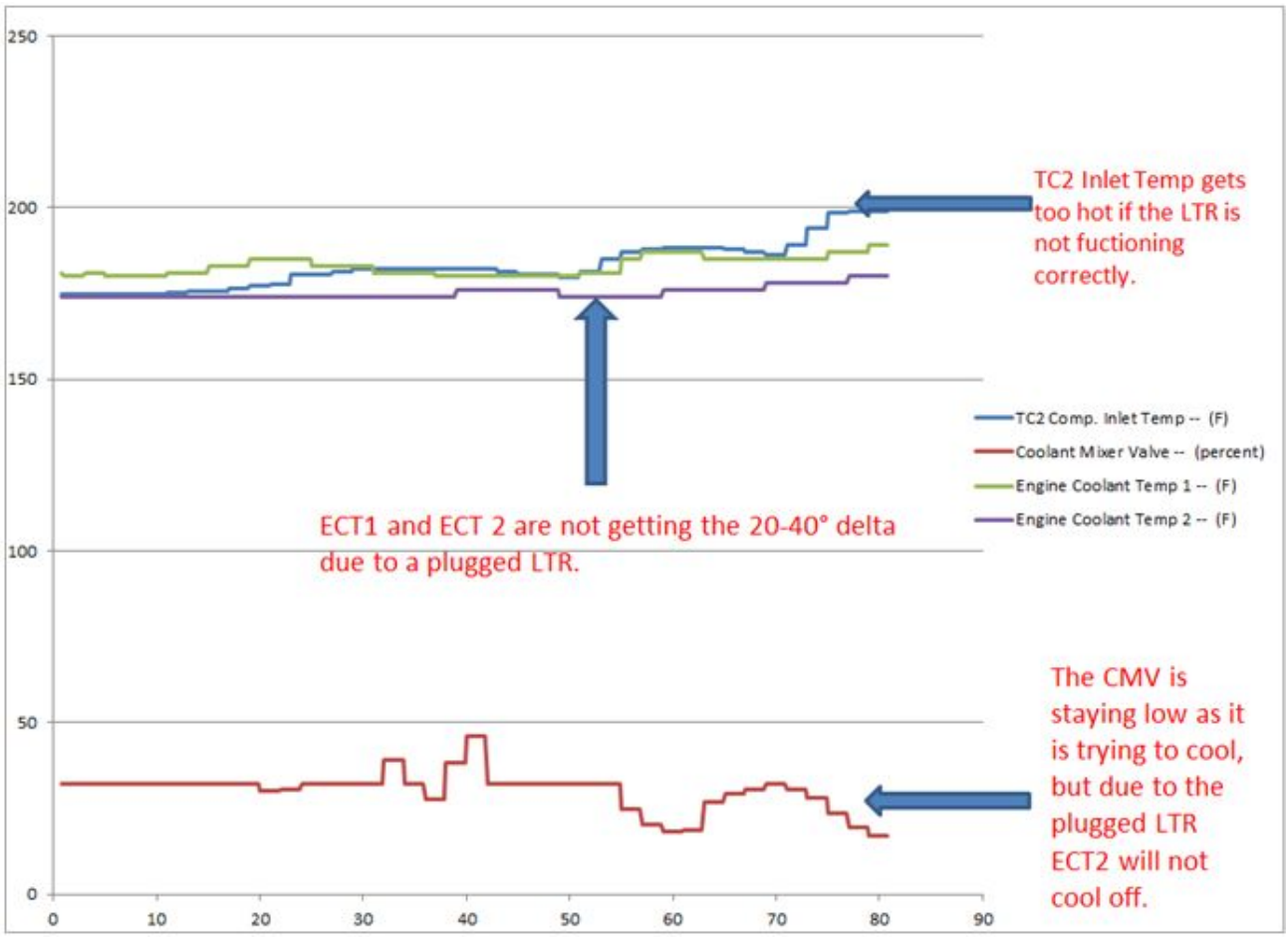


Figure 62 Snapshot of Plugged LTR

Graph 2: Good LTR

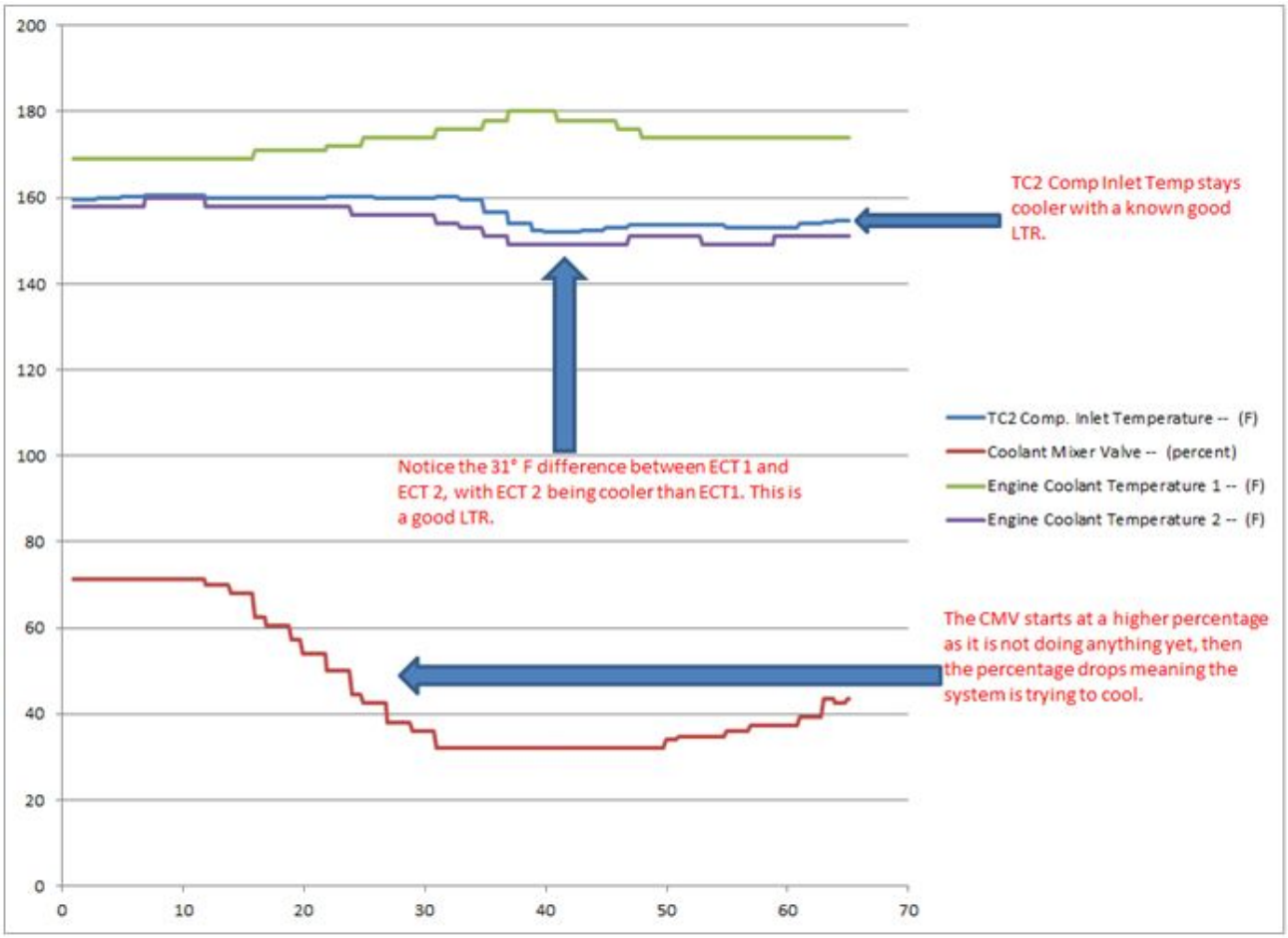


Figure 63 Snapshot of a Clean LTR

Graph 3: Lug Down Test (Engine Speed, FRP and FRPD

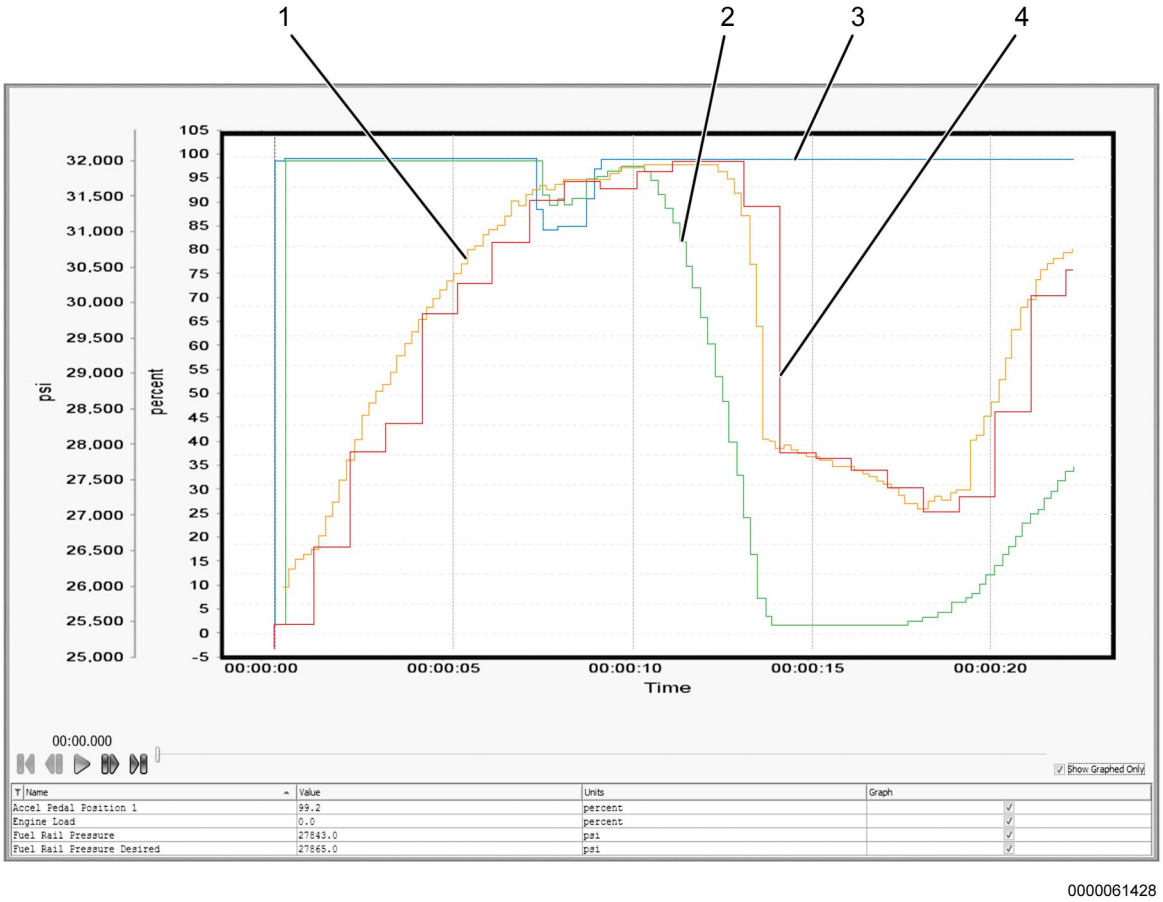


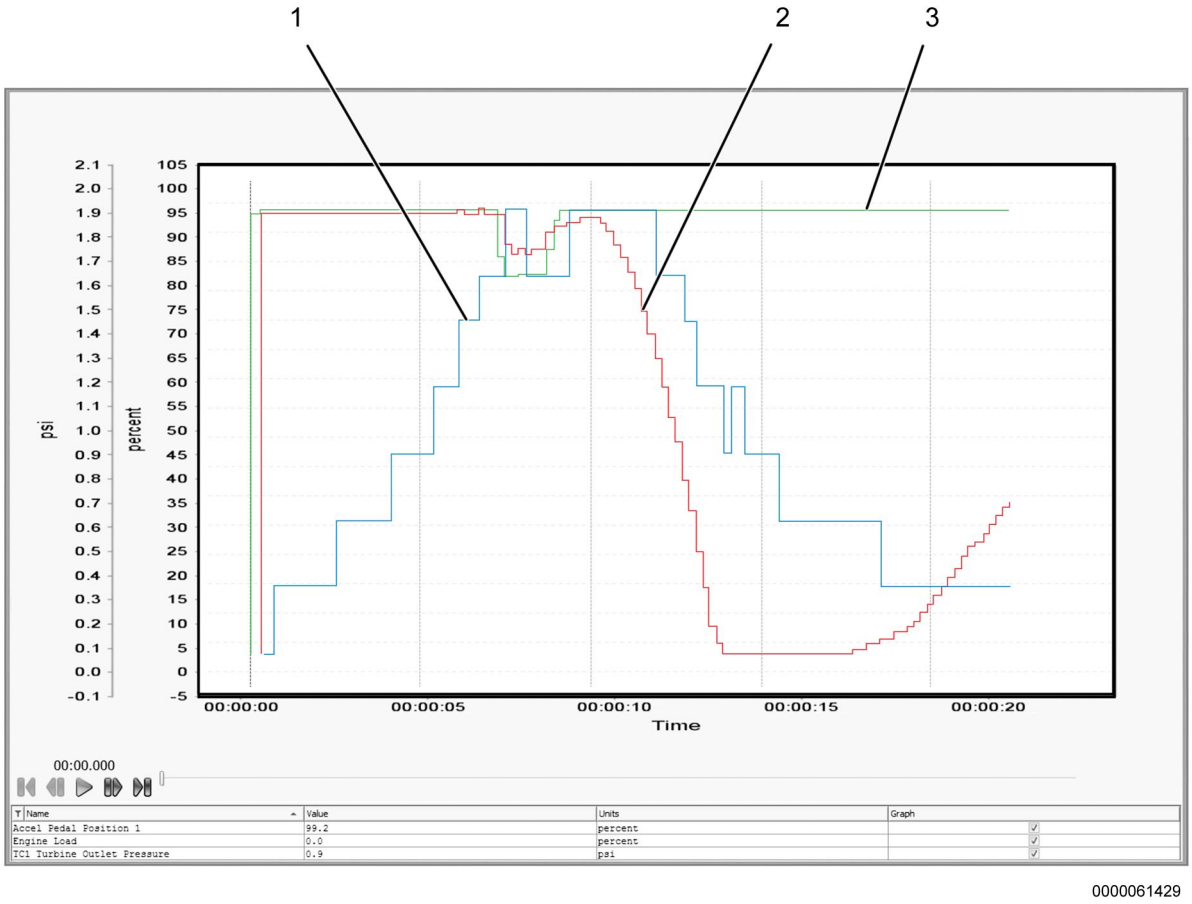
Figure 64 Lug Down Test Graph

1. Fuel Rail Pressure Desired (FRPD) (psi) [Orange]
2. Engine Load (percent) [Green]
3. Accelerator Pedal Position 1 (APP1) (percent) [Blue]
4. Fuel Rail Pressure (FRP) (psi) [Red]

Graph Analysis

This graph shows a fuel management system operating as designed. This test does not give pass or fail results. It only allows the user to validate Fuel Rail Pressure (FRP) and Fuel Rail Pressure Desired (FRPD) signal values under load. As engine rpm increases, Fuel Rail Pressure (FRP) should steadily increase. Low FRP will cause low Intake Manifold Pressure (IMP). Diagnose low FRP concerns before diagnosing low IMP concerns.

Graph 4: Lug Down Test (Engine Speed and TC1TOP)



0000061429

Figure 65 Lug Down Test Graph

1. Turbocharger 1 Turbine Outlet Pressure (TC1TOP) (psi) [Blue]
2. Engine Load (percent) [Red]
3. Accelerator Pedal Position 1 (APP1) (percent) [Green]

Graph Analysis

This graph shows an exhaust aftertreatment system operating as designed (unrestricted). This test does not give pass or fail results. It only allows the user to validate Turbocharger 1 Turbine Outlet Pressure (TC1TOP) signal value under load. High TC1TOP will cause low Intake Manifold Pressure (IMP). Diagnose high TC1TOPconcerns before diagnosing low IMP concerns.

Actions:

1. Verify TC1TOP signal value is less than 5 psi (34 kPa) during Lug Down Test.

Analyze Lug Down test Signal Values only during engine acceleration, and not deceleration or shifting.

Graph 5: Lug Down Test (Engine Speed, APP1, Vehicle Speed and IMP)

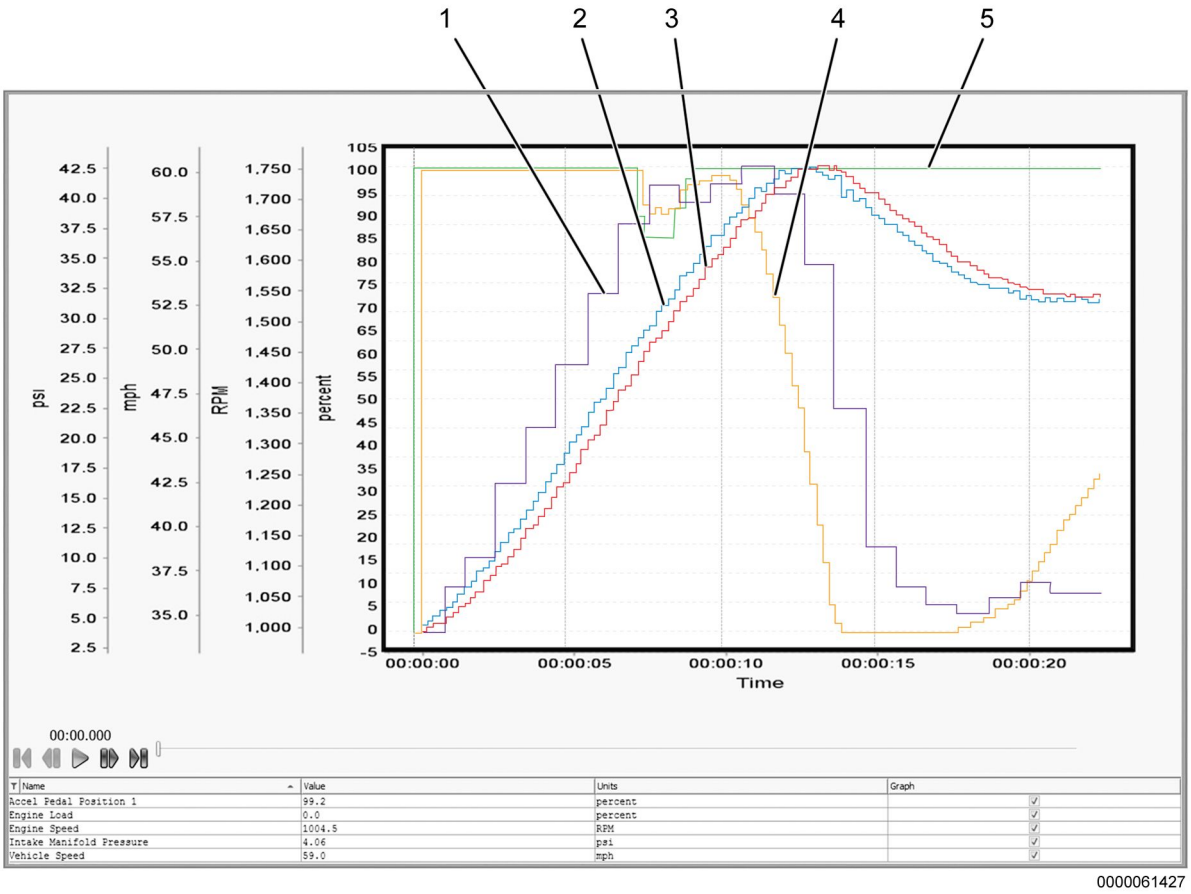


Figure 66 Lug Down Test Graph

1. Intake Manifold Pressure (IMP) (psi) [Purple]
2. Engine Speed (rpm) [Blue]
3. Vehicle Speed (mph) [Red]
4. Engine Load (percent) [Orange]
5. Accelerator Pedal Position 1 (APP1) (percent) [Green]

Graph Analysis

This graph shows the Intake Manifold Pressure (IMP) signal value responding as designed. This test does not give pass or fail results. It only allows the user to validate IMP signal value under load. Engine power band is typically between 1300 to 1700 rpm with peak power occurring around 1600 rpm. Anything outside of this power band drops boost and power significantly. Accelerator Pedal Position 1 (APP1) signal value must be 99.6% to successfully reach peak boost during this test. Low IMP can be the result of low Fuel Rail Pressure (FRP), or high Turbocharger 1 Turbine Outlet Pressure (TC1TOP). Diagnose low FRP concerns first, high TC1TOP concerns second, and low IMP concerns third.

Signal(s) to Watch

In ServiceMaxx go to the "Tests" tab, click on "KOER Tests", then select "Coolant Control Valve Test" The test only runs a few seconds so you will need to push the start button 15-20 times with the engine at operating temperature to see the ECT1 and ECT2 temps start to react.

Coolant System

GOVERNMENT REGULATION: Engine fluids (oil, fuel, and coolant) may be a hazard to human health and the environment. Handle all fluids and other contaminated materials (e.g., filters rags) in accordance with applicable regulations. Recycle or dispose of engine fluids, filters, and other contaminated materials according to applicable regulations.

Coolant Loss

Symptom

Consistent need to refill deaeration tank and active or previously active DTCs related to the cooling system.

Tools

- ZTSE4891 – Plastic Plug/Cap Kit
- KL5007NAV – Coolant Management Tool
- ZTSE2384 – Radiator Pressure Testing Kit
- Coolant Cap Pressure Testing Kit – 09-040-01
- KL20060NAV – EGR Cooler Leak detection Kit
- 12-892-01 – EGR Cooler Alignment Tool
- 12-892-03 – EGR Cooler Lifting Bracket
- ZTSE6042 – Kit, Charge Air Cooler Test

GOVERNMENT REGULATION:

Government Regulation: Engine fluids (oil, fuel, and coolant) may be a hazard to human health and the environment. Handle all fluids and other contaminated materials (e.g., filters rags) in accordance with applicable regulations. Recycle or dispose of engine fluids, filters, and other contaminated materials according to applicable regulations.

WARNING: To prevent personal injury or death, make sure the engine has cooled before removing components.

WARNING: To prevent personal injury or death, do not let engine fluids stay on your skin. Clean skin and nails using hand cleaner and wash with soap and water. Wash or discard clothing and rags contaminated with engine fluids.

Before beginning, it is important to review a few areas of the vehicle, to prevent unnecessary repair. Each of the following can manifest in "consumption" or low coolant level.

i. Is AFC 12917 open?

ii. Was the vehicle recently in for a repair in which the cooling system was not properly filled (air pockets)?

iii. Was the vehicle recently repaired and the fault code not successfully cleared?

iv. Is the operator aware of the proper filling procedure (overfill)?

If the coolant leak path is known (white smoke from exhaust, coolant in oil samples, etc) proceed to the respective steps, noted below. Otherwise, continue with Step 1.

- Step 1 - External Leaks
- Coolant Leak to Exhaust (page 143)
- Coolant Leak to Intake (page 144)
- Coolant Leak to Engine Oil (page 148)
- Coolant Over-Temperature (page 150)
- Coolant Overflow (page 138)

WARNING: To prevent personal injury or death, do the following when removing the radiator cap or deaeration cap:

- Allow engine to cool for 15 minutes or more.
- Wrap a thick cloth around radiator cap or deaeration cap.
- Loosen cap slowly a quarter to half turn counterclockwise to vent pressure.
- Pause for a moment to avoid being scalded by steam.
- Continue to turn the cap counterclockwise to remove.

Diagnostic Procedure

Step	Action	Decision
1	Visually inspect all components and hoses for external coolant leaks. • Remove deaeration tank cap. • Install Radiator Pressure Testing Kit ZTSE2384 with Surge Tank Cap Adaptor on deaeration tank. • Pressurize cooling system to 117 kPa (17 psi) for a minimum of 15 minutes. Are any external coolant leaks visible?	Yes: Repair as necessary. Restore the engine to operational condition and retest cooling system. No: Go to step 2.

Step	Action	Decision
2	Remove deaeration tank cap. Pressurize cap to its rated pressure. • Remove deaeration tank cap • Connect Radiator Pressure Testing Kit ZTSE2384 with Surge Tank Cap Adapter to deaeration cap • Pressurize deaeration cap to rated pressure Does the deaeration cap hold its rated pressure?	Yes: Go to Step 3. No: Replace deaeration cap. Restore the engine to operational condition and retest cooling system.

Step	Action	Decision
3	Inspect Cooling System pressure loss. • With the Radiator Pressure Testing Kit ZTSE2384 with Surge Tank Cap Adaptor already installed on deaeration tank. Pressurize cooling system to 117 kPa (17 psi) for a minimum of 15 minutes. Does the cooling system decrease in pressure after 15 minutes?	Yes: Go to step 6. No: Reinstall deaeration tank cap. Go to step 4.

Step	Action	Decision
4	Start engine. With engine at operating temperature and operating at high idle speed, inspect for coolant overflow out of deaeration tank. • Top off the deaeration tank with coolant prior to running this test (If necessary). Is coolant overflowing out of the deaeration tank?	Yes: Go to Coolant Overflow (page 138) symptom based diagnostics. No: Go to step 5.

Step	Action	Decision
5	Verify Engine Overheat/Over Temperature • Do not run the vehicle on a Dyno to try and duplicate an overheat/over temperature concern. This will give false results due to the lack of air flow across the engine. Does the vehicle have an overheat/Over Temperature concern?	Yes: Go to Coolant Over Temperature (page 150) symptom based diagnostics. No: Go to step 6.

Step	Action	Decision
6	Inspect for coolant in the exhaust. • Install Radiator Pressure Testing Kit ZTSE2384 with Surge Tank Cap Adaptor on deaeration tank. • Pressurize cooling system to 117 kPa (17 psi) for a minimum of 15 minutes. • Disconnect exhaust pipe at PRE-DOC and inspect for coolant Is coolant visible in the exhaust system?	Ye: Go to Coolant in the Exhaust (page 143) symptom based diagnostics. No: Go to step 7.

Step	Action	Decision
7	Inspect for coolant and/or white coolant residue in charge air intake. • Disconnect CAC pipe at ETV housing. • Inspect CAC pipe for visual signs of white coolant residue • Inspect the ETV Housing for visual signs of coolant. Is coolant and/or white coolant residue present in intake?	Yes: Go to Coolant in Intake (page 144) symptom based diagnostics. No: Go to step 8.

Step	Action	Decision
8	Inspect for visible evidence of coolant on the engine oil level gauge (dipstick). • Remove and inspect the engine oil dipstick for visible evidence of contamination. • Oil contaminated with coolant generally causes the oil to thicken and coagulate, giving the oil a light gray sludgy appearance. Does the lube oil show signs of visible contamination?	Yes: Go to Coolant in Engine Oil (page 148) symptom based diagnostics. No: Restore the engine to operational condition and retest cooling system.

Coolant Overflow

Overview

Diagnose coolant over flowing from the deaeration tank.

— Red light under temperature gauge

— Low coolant warning on Message Center

Possible Causes

- Failed air compressor
- Failed EGR cooler
- Cracked cylinder liner

- Failed cylinder head

Tools

- ZTSE4891 – Plastic Plug/Cap Kit
- ZTSE2384 – Radiator Pressure Testing Kit
- 09-040-01 – Coolant Cap Pressure Testing Kit
- KL5007NAV – Coolant Management Tool
- KL20060NAV – EGR Cooler Leak Detection Kit
- 12-892-01 – EGR Cooler Alignment Tool
- 12-892-03 – EGR Cooler Lifting Bracket
- ZTSE6042 – Kit, Charge Air Cooler Test
- 09-889-01 – Combustion in Cooling System Tester Kit

GOVERNMENT REGULATION: GOVERNMENT REGULATION: Engine fluids (oil, fuel, and coolant) may be a hazard to human health and the environment. Handle all fluids and other contaminated materials (e.g., filters rags) in accordance with applicable regulations. Recycle or dispose of engine fluids, filters, and other contaminated materials according to applicable regulations.

WARNING: To prevent personal injury or death, make sure the engine has cooled before removing components.

WARNING: To prevent personal injury or death, do not let engine fluids stay on your skin. Clean skin and nails using hand cleaner and wash with soap and water. Wash or discard clothing and rags contaminated with engine fluids.

Diagnostic Procedure

Step	Action	Decision
1	Symptom verification • When recreating overflow, watch for engine overheating. Does the vehicle overheat?	Yes: Go to step 2. No: Go to step 3.

Step	Action	Decision
2	Symptom verification • When recreating Overflow concern verify which concern occurs first Does Overflow condition occur before over temperature?	Yes: Go to step 3. No: Go to Coolant Over-Temperature (page 150) diagnostics.

Step	Action	Decision
3	Air Compressor Test Perform Air compressor Isolation test to verify that the Air compressor is not aerating the coolant. 1. Run the Engine 2. When Overflow condition is present perform next step 3. Pull and prop open the drain valves on the air tanks After pulling and propping the drain valves open on the air tanks with the engine running. Does engine coolant continue to overflow from the deaeration tank with the drain valves open?	Yes: Go to Step 4 No: Correct issue with Air Compressor and Retest

Step	Action	Decision
4	Pressure test Low Temperature (LT) and High Temperature (HT) Exhaust Gas Recirculation (EGR) Cooler. Using KL 20060 NAV EGR Cooler Leak Detection Test Kit, Pressure test EGR Cooler following the Installation, and testing Instructions in TL2900004 Is there a leak present in either of the EGR Cooler sections?	Yes: Go to step 5 No: Go to step 6

Step	Action	Decision
5	Verify which section of the EGR Cooler is leaking. **NOTE:** See IK1201113, or IK1201100 for EGR Cooler SRT codes and warranty replacement guidelines. Which section of the EGR Cooler is leaking?	HT EGR Cooler : Replace HT EGR Cooler Core, See IK1201113, if condition is still present go to Step 6 LT EGR Cooler : Replace LT EGR Cooler Core, See IK1201100. If condition still present go to Step 6 Both HT and LT : Follow the individual instructions above. Neither procedure interferes with the other so there's no set order of repair.

Step	Action	Decision
6	Cylinder Liner/Cylinder Head Inspection Remove cylinder head for inspection (see *Engine Service Manual starting on page 409)* 1. Bar engine over to put each cylinder at BDC 2. Visually inspect for coolant staining and coolant to identify suspect cylinder 3. Check for pinholes and cracks in the liner 4. Repeat for the remaining cylinders. Are cylinder liners free of coolant leaks and coolant staining?	Yes: Go to step 7. No : Replace affected liners, reassemble, and retest for condition. **NOTE:** If replacing any liners be sure to inspect the piston cooling jet for obstructions

Step	Action	Decision
7	Measure Cylinder Liner Protrusion on each cylinder Perform Cylinder Sleeve Protrusion Procedure in *Engine Service Manual* page 497: Check cylinder sleeve protrusion above the crankcase deck as follows: 1. Install Sleeve Protrusion Hold Down Clamps (page 504) using four included bolts. Torque bolts to special torque (page 503). 2. Place dial indicator with magnetic base (page 504) on crankcase deck surface. 3. Position dial indicator tip on crankcase deck adjacent to cylinder sleeve flange. Zero dial indicator. 4. Carefully pivot dial indicator until tip is resting on cylinder sleeve flange. Record reading. 5. Measure cylinder sleeve protrusion at three locations evenly spaced around the cylinder sleeve Spec : 0.050 - 0.085 mm (0.0019 - 0.0033 in) Is cylinder liner protrusion within specification on all cylinders?	Yes: Go to step 9 No: Go to step 8

Step	Action	Decision
8	Cylinder liner protrusion diagnostic. Swap liners on cylinder(s) with incorrect protrusion measurement and known good liner on other cylinder. **NOTE:** When Reinstalling Piston/Connecting Rod Assembly be sure that Piston(s) are oriented correctly and being put back in the correct cylinder. Is the liner free of defects/issues?	Yes: Replace affected liner(s) **NOTE:** If replacing any liners be sure to inspect the piston cooling jet for obstructions No: Counterbore issue present - Contact your Supervisor.

Step	Action	Decision
9	Liner damage diagnostic Remove all liners, and visually inspect inside and out for pinholes, cracks, and damage **NOTE:** When Reinstalling Piston/Connecting Rod Assembly be sure that Piston(s) and connecting rod caps are oriented correctly and being put back in the correct cylinder. Is the liner free of defects/issues?	Yes: Replace cylinder head and retest No: Replace affected liner(s) **NOTE:** If replacing any liners be sure to inspect the piston cooling jet for obstructions

Coolant Leak to Exhaust

Overview

Diagnose cause of coolant in the exhaust.

Symptoms

These may be detected externally or internally. See the following list of symptoms for identification of coolant leaks to the exhaust:

- Coolant smell in exhaust
- Coolant leaking from exhaust
- White Smoke

GOVERNMENT REGULATION: GOVERNMENT REGULATION: Engine fluids (oil, fuel, and coolant) may be a hazard to human health and the environment. Handle all fluids and other contaminated materials (e.g., filters rags) in accordance with applicable regulations. Recycle or dispose of engine fluids, filters, and other contaminated materials according to applicable regulations.

WARNING: To prevent personal injury or death, make sure the engine has cooled before removing components.

WARNING: To prevent personal injury or death, do not let engine fluids stay on your skin. Clean skin and nails using hand cleaner and wash with soap and water. Wash or discard clothing and rags contaminated with engine fluids.

Possible Causes

- Failed EGR cooler

Tools

- ZTSE4891 – Plastic Plug/Cap Kit
- ZTSE2384 – Radiator Pressure Testing Kit
- 09-040-01 – Coolant Cap Pressure Testing Kit
- KL5007NAV – Coolant Management Tool
- KL20060NAV – EGR Cooler Leak Detection Kit
- 12-892-01 – EGR Cooler Alignment Tool
- 12-892-03 – EGR Cooler Lifting Bracket
- ZTSE6042 – Kit, Charge Air Cooler Test
- 09-889-01 – Combustion in Cooling System Tester Kit

NOTE: Follow the oxygen sensor diagnostic procedure found in IK1201065 for any failure that results in coolant in the exhaust system. The coolant has potential to contaminate the sensor.

Diagnostic Procedure

Step	Action	Decision
1	Pressure test Low Temp (LT) and High Temp (HT) EGR cooler, on engine. • Using KL20060 NAV EGR Cooler Leak Detection Test Kit, pressure test the EGR Cooler following the instructions in TL2900004. Is there a leak present in either of the EGR Cooler sections?	Yes: Go to Step 2 No: Restore the engine to operational condition and retest cooling system

Step	Action	Decision
2	Verify which section of the EGR Cooler is leaking. Which section of the EGR Cooler is leaking?	HT EGR Cooler: Replace HT EGR Cooler core, see IK1201113, then go to step 3 LT EGR Cooler: Replace LT EGR Cooler core, see IK1201100. Repair complete. Both LT and HT: Follow the individual instructions above. Neither procedure interferes with the other, so there's no set order of repair.

Step	Action	Decision
3	Change the engine oil, filter and soot centrifuge oil filter (if equipped).	Repair complete

Coolant Leak to Intake

Overview

Diagnose cause of coolant in the intake.

Symptoms

- Visible coolant and/or white coolant residue in intake piping

GOVERNMENT REGULATION: GOVERNMENT REGULATION: Engine fluids (oil, fuel, and coolant) may be a hazard to human health and the environment. Handle all fluids and other contaminated materials (e.g., filters rags) in accordance with applicable regulations. Recycle or dispose of engine fluids, filters, and other contaminated materials according to applicable regulations.

WARNING: To prevent personal injury or death, make sure the engine has cooled before removing components.

WARNING: To prevent personal injury or death, do not let engine fluids stay on your skin. Clean skin and nails using hand cleaner and wash with soap and water. Wash or discard clothing and rags contaminated with engine fluids.

Possible Causes

- Failed EGR cooler
- Failed High Pressure Turbocharger air inlet duct
- Failed Low Pressure Charge Air Cooler (LPCAC)

Tools

- ZTSE4891 – Plastic Plug/Cap Kit
- ZTSE2384 – Radiator Pressure Testing Kit
- 09-040-01 – Coolant Cap Pressure Testing Kit
- KL5007NAV – Coolant Management Tool
- KL20060NAV – EGR Cooler Leak Detection Kit
- 12-892-01 – EGR Cooler Alignment Tool
- 12-892-03 – EGR Cooler Lifting Bracket
- ZTSE6042 – Kit, Charge Air Cooler Test

Diagnostic Procedure

Step	Action	Decision
1	Inspect for coolant or white coolant residue in ETV Housing or CAC pipe. • Disconnect CAC pipe from Engine Throttle Valve housing. Inspect for wet coolant coming out of the EGR Cooler outlet tubes and inspect for white coolant residue in the CAC pipe. **NOTE:** There may only be white coolant residue in the CAC pipe and the HPCAC if the HP turbocharger air inlet duct or the LPCAC are causing the coolant consumption concern Where is coolant or coolant residue present?	ETV Housing/EGR Cooler outlet tubes: Go to step 2 CAC Pipe/HPCAC: Go to step 5

Step	Action	Decision
2	Pressure test Low Temp (LT) and High Temp (HT) EGR cooler, on engine. • Using KL 20060 NAV - EGR Cooler Leak Detection Test Kit, pressure test EGR cooler following the procedure in TL2900004. Is there a leak present in either of the EGR Cooler sections?	Yes: Go to step 3. No: Restore the engine to operational condition and retest cooling system.

Step	Action	Decision
3	Verify which section of the EGR Cooler is leaking. Which section of the EGR Cooler is leaking?	HT EGR Cooler: Replace HT EGR Cooler core, see IK1201113, then go to step 4.
		LT EGR Cooler: Replace LT EGR Cooler core, see IK1201100. Repair complete
		Both LT and HT: Follow the individual instructions above. Neither procedure interferes with the other, so there's no set order of repair. Then go to step 4.

Step	Action	Decision
4	Change the engine oil, filter and soot centrifuge oil filter (if equipped).	Repair complete

Step	Action	Decision
5	Inspect for coolant or coolant residue in HP turbocharger air inlet duct and LPCAC.	HP Turbo Air Inlet Duct: Go to step 6
	• Remove HP turbocharger center section with HP turbocharger air inlet duct. See service manual for procedure. Where is coolant or coolant residue present?	LPCAC: Go to step 7

Figure 67 Porous HP turbocharger air inlet duct leaking coolant into intake.

Step	Action	Decision
6	Visually inspect HP turbocharger air inlet duct (Figure 67) for signs of engine coolant and/or coolant residue. • Inspect for coolant seeping through the casting (porosity). Is the HP turbocharger air inlet duct leaking?	Yes: Replace HP turbocharger air inlet duct following the procedure in the Engine Service Manual. Repair complete.
		No: Go to step 7

Step	Action	Decision
7	Pressure test LPCAC • Remove LPCAC following the Engine Service Manual. Using ZTSE6042 pressure test the LPCAC on bench. Is the LPCAC leaking?	Yes: Replace the LPCAC following the procedure in the Engine Service Manual. Repair complete.
		No: Restore the engine to operational condition and retest cooling system. Repair complete.

Coolant Leak to Engine Oil

Symptom

Engine oil with a light gray and sludgy appearance. The crankcase may also be overfilled.

Possible Causes

- Failed EGR cooler
- Cracked cylinder liner
- Failed cylinder Head rear gear train freeze plug
- Failed air compressor
- Cracked oil cooler housing
- Missing / damaged oil cooler gaskets
- Missing / damaged oil filter module gasket
- Missing mounting bolts for the oil filter module to the crankcase

Tools

- ZTSE4891 – Plastic Plug / Cap Kit
- ZTSE2384 – Radiator Pressure Testing Kit
- 09–040–01 – Coolant Cap Pressure Testing Kit
- KL5007NAV – Coolant Management Tool
- KL20060NAV – EGR Cooler Leak Detection Test Kit
- 12–892–01 – EGR Cooler Alignment Tool
- 12–892–03 – EGR Cooler Lifting Bracket
- ZTSE6042 – Kit, Charge Air Cooler Test

Diagnostic Procedure

Step	Action	Decision
1	**Check engine oil for proper level and visible contamination** • Oil Contaminated with coolant generally causes oil to thicken and coagulate, giving oil a light gray sludgy appearance. Does the engine oil show signs of visual contamination?	Yes: Go to Step 2. No: Take an oil sample for analysis. Restore engine to operational condition and retest cooling system.

Step	Action	Decision
2	**Pressure test Low Temp (LT) and High Temp (HT) EGR cooler, on engine.** • Using KL 20060 NAV - EGR Cooler Leak Detection Test Kit, pressure test EGR cooler following the procedure in TL2900004. Is there a leak present in either of the EGR Cooler sections?	Yes: Go to Step 3. No: Reinstall removed components, go to Step 4.

Step	Action	Decision
3	**Verify which section of the EGR Cooler is leaking.** Which Section of the EGR Cooler is leaking?	HT EGR Cooler: Replace HT EGR Cooler core, see IK1201113, then go to step 8. LT EGR Cooler: Replace LT EGR Cooler core, see IK1201100. Repair complete. Both LT and HT: Follow the individual instructions above. Neither procedure interferes with the other, so there's no set order of repair.

Step	Action	Decision
4	**Remove oil pan following procedures in the Engine Service Manual. Inspect the inside of the crankcase for evidence of coolant leakage.** • Remove deareation tank cap. • Install Radiator Pressure Testing Kit ZTSE2384 with Surge Tank Cap Adaptor on deaeration tank. • Pressurize cooling system to 117 kPa (17 psi) for a minimum of 15 minutes. Is coolant leakage present inside the crankcase?	Yes: Go to Step 5. No: Restore the engine to operational condition and retest cooling system.

Step	Action	Decision
5	**Identify where the coolant leakage in the crankcase originates. (Cylinder Liners or Rear Gear Train)** • Inspect for coolant at bottom edge of cylinder liners. • Inspect for coolant evident at the rear gear train area. What area does the coolant leakage originate from?	Cylinder Liners: Go to Step 7. Rear Gear Train Area: Inspect cylinder head freeze plugs for leaking coolant. Repair as necessary. Go to Step 8. Neither Area: Go to Step 6.

Step	Action	Decision
6	**Identify where the coolant leakage in the crankcase originates. (Air Compressor or Oil Cooler)** • Inspect for coolant evident at the Air Compressor drain. • Inspect for coolant evident at the Oil Cooler drain. What area does the coolant leakage originate from?	Air Compressor Drain: Replace Air Compressor. Go to Step 8. Oil Cooler Drain: Check for leaking oil cooler module gasket as per *Engine Service Manual*. Repair as necessary. Go to Step 8. Neither Area: Restore the engine to operational condition and retest cooling system.

Step	Action	Decision
7	**Inspect lower edges of cylinder liners for coolant leaks.** • Note cylinder number(s) where coolant leakage is identified. IIs coolant leakage present between cylinder liner and crankcase?	Yes: Replace failed cylinder liner o-ring(s). Go to Step 8. No: Go to Coolant Overflow (page 138) Symptom diagnostic section in the Engine Diagnostic Manual for further testing.

Step	Action	Decision
7	**Change the engine oil, filter and soot cartridge oil filter (if equipped)**	Repair Complete.

Coolant Over-Temperature

Overview

Diagnose cause of engine overheat

Symptom

• Engine Overheating

- Red Light on under temperature gauge

Possible Causes

- Cooling Package Debris clogging
- Damaged Fan Belt
- Accessory Belt Tensioner Failure
- Inoperative/slipping Fan Clutch
- Damaged Water Pump Impeller
- Stuck Closed Thermostats

Tools

- ZTSE4891 – Plastic Plug/Cap Kit
- ZTSE2384 – Radiator Pressure Testing Kit
- 09-040-01 – Coolant Cap Pressure Testing Kit
- KL5007NAV – Coolant Management Tool
- KL20060NAV – EGR Cooler Leak Detection Kit
- 12-892-01 – EGR Cooler Alignment Tool
- 12-892-03 – EGR Cooler Lifting Bracket
- ZTSE6042 – Kit, Charge Air Cooler Test
- 09-889-01 – Combustion in Cooling System Tester Kit

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WARNING: To prevent personal injury or death, make sure the engine has cooled before removing components.

WARNING: To prevent personal injury or death, do not let engine fluids stay on your skin. Clean skin and nails using hand cleaner and wash with soap and water. Wash or discard clothing and rags contaminated with engine fluids.

Diagnostic Procedure

Step	Action	Decision
1	Debris Check • Check for blockages/excessive debris to areas between radiators and other cooling package coolers. Was significant blockage/debris found?	Yes: Clean cooling package, and retest No: Go to step 2

Step	Action	Decision
2	Cooling System Component Inspection • Inspect Cooling fan blade, shroud, accessory drive belt(s), accessory drive belt tensioner(s), and radiator for damage Was any damage found with these components?	Yes: Repair damage, and retest No: Go to step 3

Step	Action	Decision
3	Cooling System Flow Test Run Engine, and observe radiator and aeration lines for coolant flow. • Check for Flow in the Surge tank. Is there coolant circulating in the Reservoir/Surge tank?	Yes: Go to step 4 No: Go to step 7

Step	Action	Decision
4	Fan Clutch Operation Verification Follow : IK0900094 Horton V Master Ultra (Stratis) Viscous Fan Hub Diagnostics and Troubleshooting guide. **NOTE:** See IK0900094 for warranty submission and SRT details. Does the Vehicle Still overheat after following IK0900094?	Yes: Go to step 5 No: Reassemble vehicle to operating condition, and retest

Step	Action	Decision
5	Thermostat(s) inspection/HT Plugging and test Verify Cooling System Flow by checking hose temperatures. 1. Bring engine up to operating temperature 2. Using EST with ServiceMaxx™ monitor, and record ECT 1 Sensor Signal 3. Utilizing a Infrared Thermometer target Upper Radiator Hose, and record reading 4. Calculate difference At operating temperature does the upper radiator hose have a similar temperature to ECT 1 within 25 degrees F?	Yes: Go to step 6 No: Replace Thermostats and retest

Step	Action	Decision
6	Internal Radiator Blockage Inspection 1. Bring engine to operating temperature, with engine at high idle 2. Utilizing a Infrared Thermometer target Upper Radiator Hose, and record reading 3. Utilizing a Infrared Thermometer target the Lower Radiator Hose, and record reading 4. Calculate the difference Is the Lower Radiator Hose temperature within 40-60 degrees of the Upper Radiator Hose Temperature?	Yes: Go to step 7 No: Clean/Replace Radiator due to internal restriction, and retest

Step	Action	Decision
7	Water Pump/Manifold Inspection 1. Remove four M8 x 16 bolts and water pump pulley. 2. Remove M8 x 130, M8 x 150 and seven M8 x 40 bolts. 3. Remove water pump assembly. **CAUTION:** To prevent damage do not drop water pump impeller, or hit impeller with hard objects. Is there any damage to the Water Pump?	Yes: Replace Water Pump and retest No: Go to step 8

Step	Action	Decision
8	Water Distribution Housing Inspection • **If severe cavitation is present on the Water Distribution Housing see: TSI 10-12-04R** Is there any damage/cavitation to the Water Distribution Housing?	Yes: Replace Water Distribution Housing, and retest No: Reassemble vehicle to operating condition, and contact your supervisor.

Cooling System Components

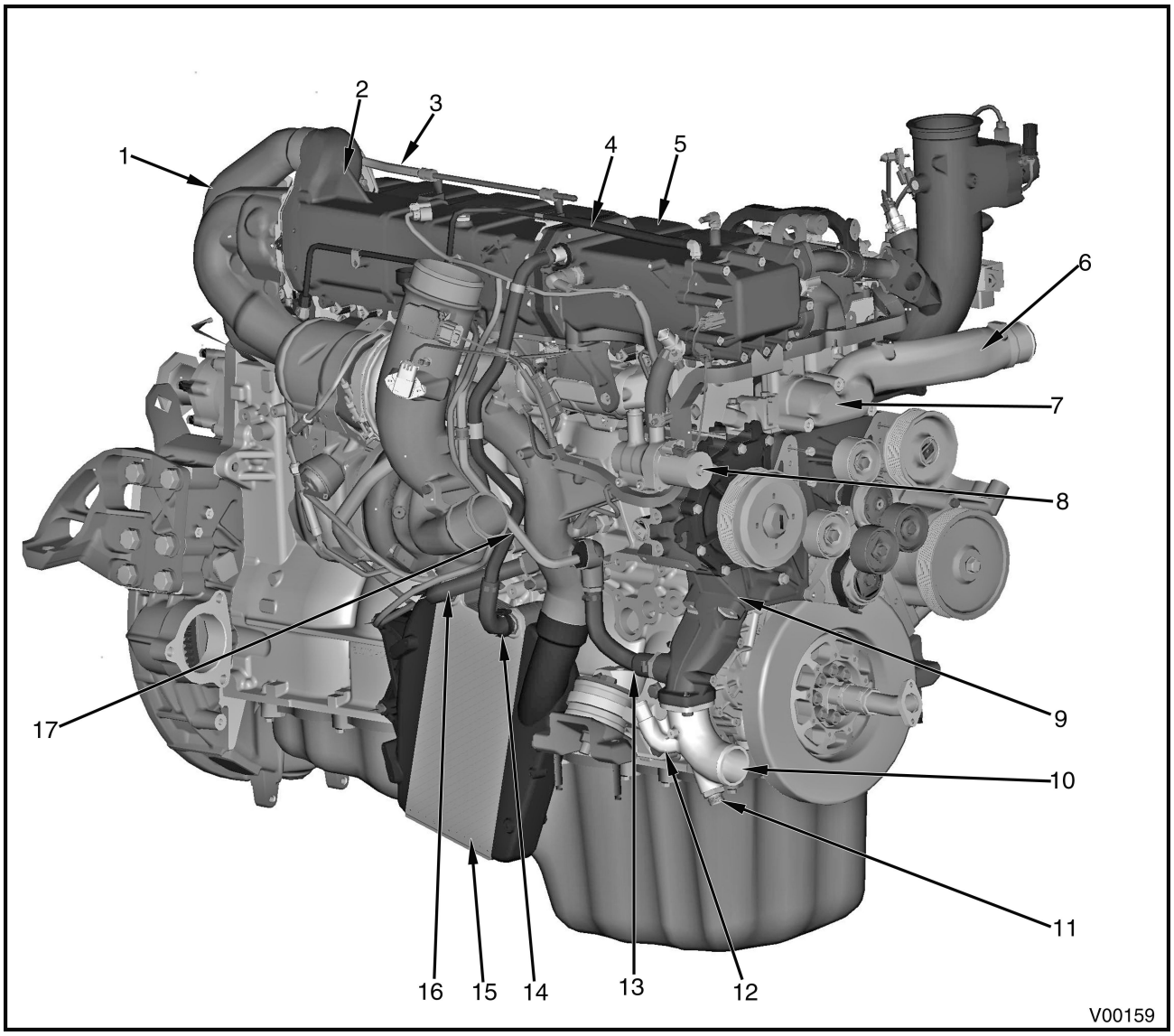

Figure 68 Cooling System Components

1. Coolant manifold
2. High-temperature EGR cooler
3. EGR coolant return
4. EGR coolant supply
5. Low-temperature EGR cooler
6. Coolant manifold outlet
7. Dual thermostats
8. CMV and CFV
9. Water Pump
10. Water inlet
11. Heater coolant
12. Surge tank line connector
13. LTR coolant return line
14. LTR coolant supply line
15. LPCAC
16. LTR coolant return line
17. Coolant return (cab heater)

Cooling System Flow

The water pump is located on the distributor case and draws coolant from the radiator through the coolant inlet at the lower right side of the distributor case. The engines have no coolant passages between the crankcase and cylinder head through the cylinder head gasket. This design eliminates the possibility of coolant leaks at the cylinder head gasket. Coolant in and out of the crankcase and cylinder head is directed through external passages. Coolant flows through the crankcase and cylinder head from front to rear. This coolant flows around the cylinder liners and combustion chambers to absorb heat from combustion.

Coolant exiting the crankcase and cylinder head at the rear of the engine is directed through an external coolant elbow to the Exhaust Gas Recirculation (EGR) module. Coolant passes between the EGR cooler plates, travels parallel to the exhaust flow, and exits into the distributor case. A deaeration port on the top of the EGR module directs coolant and trapped air towards the coolant surge tank.

Coolant from the pump also flows through the air to air and the Low Pressure Charge Air Cooler (LPCAC) to regulate the charge air temperature. Coolant flow through the charge air coolers is controlled by the Coolant Mixer Valve (CMV) and Coolant Flow Valve (CFV). Depending on the coolant temperature, CMV sends coolant through the LPCAC, or indirectly to the LPCAC, after going through the Low Temperature Radiator (LTR) located in front of the main coolant radiator. When the charge air temperature is too low, CMV bypasses the LTR and directs all the coolant through the LPCAC. When the charge air temperature increases, CMV directs a percentage of the coolant to the LTR before it enters the LPCAC to cool the charge air. If the engine coolant temperature is too high, CMV sends all of the coolant flow through the LTR and through the LPCAC to help cool the engine faster.

Both coolant valves are controlled by the Engine Control Module (ECM) based on signals from the Engine Coolant Temperature 1 (ECT1) sensor, ECT2 sensor, and the Intake Manifold Pressure/Turbocharger 2 Compressor Inlet Sensor (IMP/TC2CIS) sensors. The ECT1 sensor is located in the underside of the EGR coolant crossover manifold, at the back of engine.

Coolant flow to the radiator is controlled by two thermostats. When the thermostats are closed, coolant flowing out of the EGR cooler is directed through a bypass port inside the front cover into the water pump. When the thermostats are open, the bypass port is blocked, and coolant is directed from the engine into the radiator.

Coolant passes through the radiator and is cooled by air flowing through the radiator from ram air and operation of the coolant fan. The coolant returns to the engine through the inlet elbow.

The air compressor is cooled with coolant supplied by a hose from the left side of the crankcase. Coolant passes through the air compressor cylinder head and returns through a passage inside the crankcase to the distributor case.

The oil module receives coolant from a passage in the crankcase. Coolant passes between the oil cooler plates and returns back to the water pump suction passage located in the front cover.

Thermostat Operation

The engines are fitted with two thermostats in a common housing to ensure sufficient coolant flow in all operating conditions. The thermostats are located at the top of the distributor case.

The thermostat housing assembly has two outlets. One directs coolant to the radiator when the engine is at operating temperature. The second outlet directs coolant to the water pump until the engine reaches operating temperature. The thermostats begin to open at 83 °C (181 °F) and are fully open at 91 °C (196 °F).

When engine coolant is below the 83 °C (181 °F), the thermostats are closed, blocking coolant flow to the radiator. Coolant is forced to flow through a bypass port back to the water pump.

When coolant temperature reaches the opening temperature of 83 °C (181 °F), the thermostats open allowing some coolant to flow to the radiator. When coolant temperature exceeds 91 °C (196 °F), the lower seat blocks the bypass port directing full coolant flow to the radiator.

Coolant Control Valve (CCV) Assembly and Coolant Mixer Valve (CMV) Operation

The CCV assembly is installed on the upper right side of the distributor housing. The CCV has two separate solenoid actuated valves; CMV, and CFV. The CMV and the CFV are part of the CCV assembly and cannot be serviced separately. CFV controls the coolant flow through the CACOTs while the CMV controls the coolant flow through the LTR. The CMV and CFV solenoids are controlled by two separate Pulse Width Modulated (PWM) signals from the ECM. The PWM signal duty cycles vary between 0% and 100% depending on the coolant and charge air temperature. The CMV is installed on the upper side of CCV and controls the coolant flow through the LTR.

The CFV is installed on the lower side of CCV and controls the amount of coolant flow through the LTR and LPCAC. The CFV helps protect the LTR circuit from over-pressure at high engine speeds. If the engine coolant temperature is too low, the CFV closes to reduce the coolant flow through the LPCAC.

When the temperature of the charge air and coolant coming out of the LPCAC is low, the CMV directs the coolant through a LTR bypass directly into the LPCAC. This helps the engine reach its normal operating temperature faster. If the temperature of the charge air and coolant coming out of the LPCAC is high, the CMV directs the coolant flow through the LTR. This prevents an overheating of the charge air cooler which can result in failure of the LPCAC.

Coolant Control Valve (CCV) Test

1. Turn ignition switch to ON, engine OFF.
2. Connect EST to vehicle's Diagnostic Connector.
3. Start ServiceMaxx™ software.

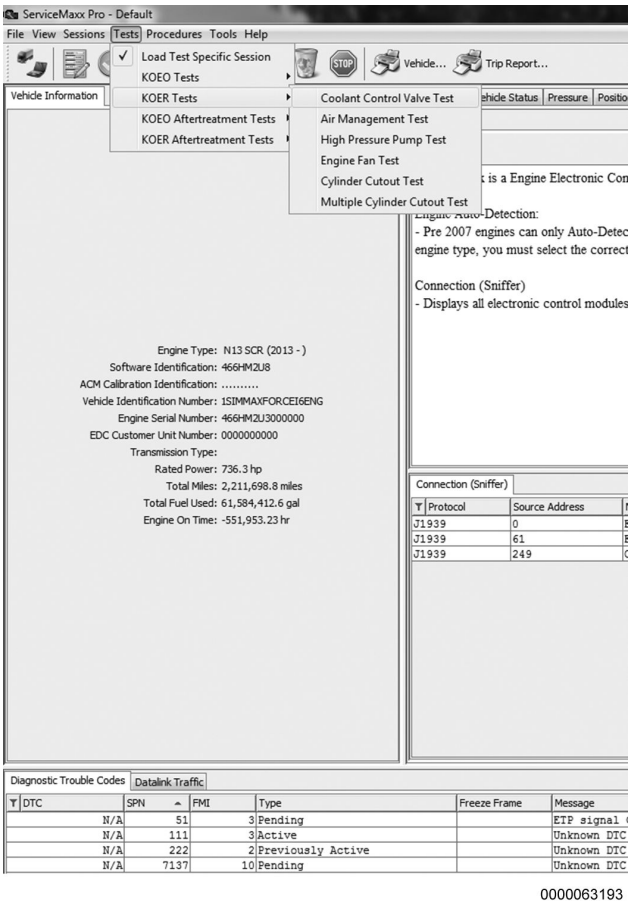

Figure 69 Key-On Engine-Running Tests

4. Select Test > KOER Tests > Coolant Control Valve Tests.
5. Start engine and allow to reach operating temperature.

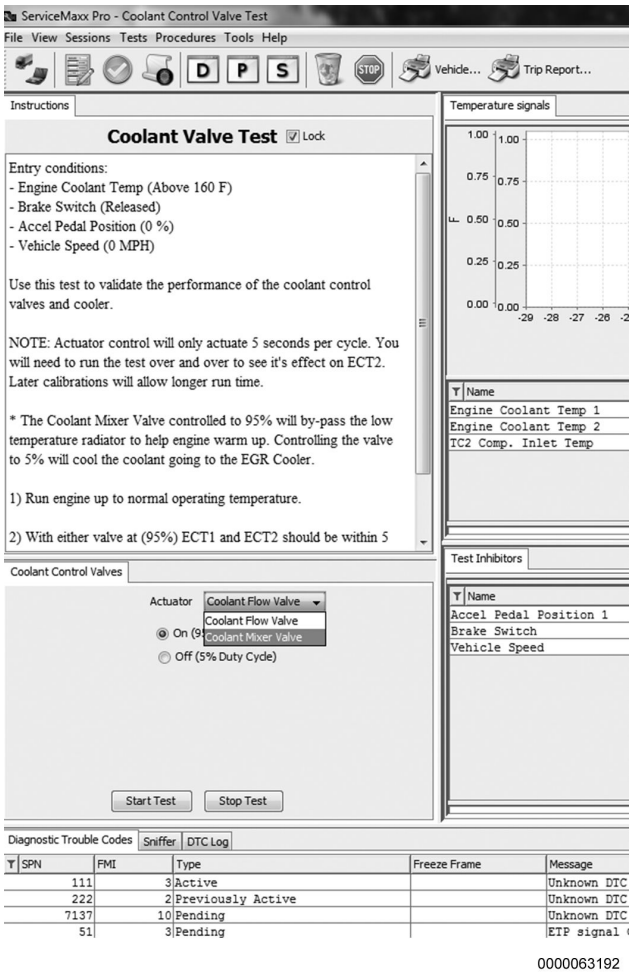

Figure 70 Coolant Control Valve Test

6. Select Coolant Mixer Valve or Coolant Flow Valve from Actuator drop-down menu.

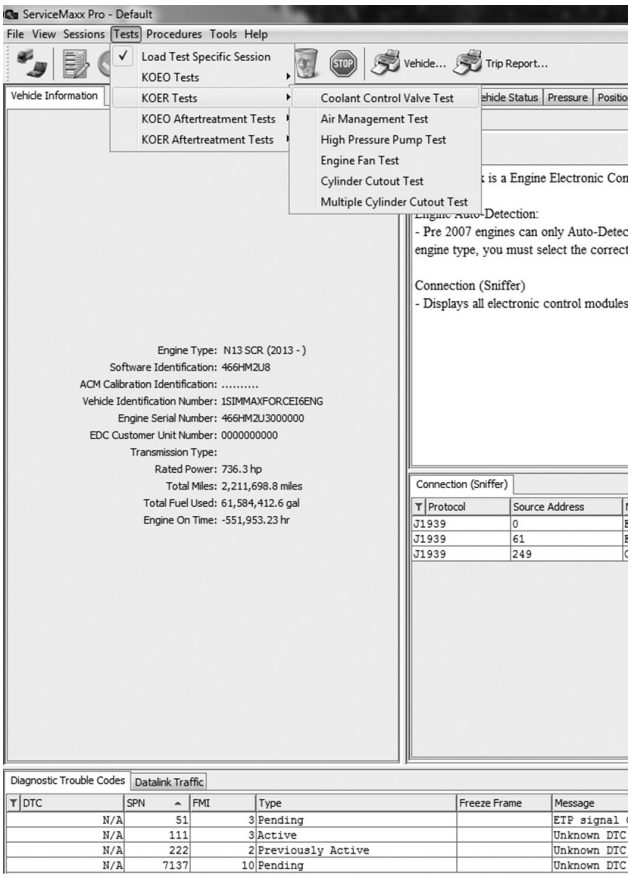

Figure 71 Coolant Mixer Valve actuator session

7. Set actuator to ON (95% Duty Cycle) and click on the Start Test button.
8. Using an infrared thermometer, measure and record coolant inlet and outlet temperatures at the secondary radiator.
9. Using EST with ServiceMaxx™ software, monitor and record temperature readings from ECT, TC2CIS, and ECT2 sensors.
10. Calculate secondary radiator cooling by subtracting coolant inlet temperature from coolant outlet temperature. Record this number as secondary radiator difference.
11. Calculate LPCAC cooling by subtracting TC2CIS sensor temperature from ECT2 sensor temperature. Record this number as cooler temperature difference.
12. Use recorded data to determine if CFV and CMV are operating correctly.
    - If cooler difference is higher than secondary radiator difference, or is within 3 ˚C (5 ˚F) of secondary radiator difference, the Coolant Flow Valve (CFV) is stuck in the fully closed position. Install a new Coolant Control Valve (CCV) assembly following procedures in the *Engine Service Manual*.

- If the ambient temperature is lower than 4 ˚C (40 ˚F), add 2 ˚C (4 ˚F) to ECT and ECT2.

  If ECT sensor reading is higher than ECT2 sensor reading by less than 11 ˚C (20 ˚F), the Coolant Mixer Valve (CMV) is stuck in the fully closed position. Install a new CCV assembly following procedures in the *Engine Service Manual*.

- If cooler difference is lower than secondary radiator difference and ECT sensor reading is higher than ECT2 reading by 11 ˚C (20 ˚F), the CCV is functioning normally. Continue to next step.

13. If over-temperature condition remains, remove secondary radiator and have flow checked at radiator repair facility. Retest engine for over-temperature condition with repaired or replaced secondary radiator.

Lubrication System

GOVERNMENT REGULATION: Engine fluids (oil, fuel, and coolant) may be a hazard to human health and the environment. Handle all fluids and other contaminated materials (e.g., filters rags) in accordance with applicable regulations. Recycle or dispose of engine fluids, filters, and other contaminated materials according to applicable regulations.

Visual Oil Level Inspection

NOTE: If engine has been running, allow a 15 minute oil drain down period before checking oil level.

Park vehicle on level ground and use oil level gauge (dipstick) to check oil level.

Incorrect Maintenance

1. Check service maintenance records and discuss with customer to determine if the lube oil has been overfilled unintentionally.
   - If maintenance is unknown, change engine oil and filter and retest to see if complaint reoccurs.

Dilution from Coolant

Lube oil with coolant dilution can be described different ways, depending on the quantity of coolant that has been introduced into the oil.

- A milky substance left under the valve cover and in the oil fill tube is the result of ethylene glycol based coolant which has not had the moisture evaporated from the coolant/oil mixture.
- When the moisture has evaporated from the coolant contaminated oil, a light gray, thick, sludgy consistency is present. If lube oil exhibits signs of coolant dilution, go to Coolant Leak to Lube Oil (page 148).

Power Steering Fluid Leak to Lube Oil

Symptom

Oil level increases while power steering fluid level decreases.

Possible Causes

- Power steering pump leak

Procedure

1. Adjust oil level to full range.
2. Adjust power steering fluid to full range.
3. Start and run engine for a minimum of 10 minutes.
4. Stop engine and inspect lube oil and power steering fluid levels.
   - If power steering level is decreasing and lube oil level is increasing, install a new power steering pump following procedures in the *Engine Service Manual*.

- If power steering level is not decreasing and lube oil level is not increasing, power steering fluid is not leaking into lube oil.

Lube Oil to Coolant

Symptom

An oily residue in engine coolant, that is apparent in the deaeration tank.

Possible Causes

- Oil cooler
- Oil module
- Cracked oil module housing
- Missing/damaged oil module gasket
- Missing/damaged oil cooler gaskets
- Missing mounting bolts for the oil module to the crankcase

Tools

Oil drain pan

Procedure

1. Verify coolant is contaminated by inspecting deaeration tank for presence of oil residue.
   - If coolant is contaminated, continue to next step.
   - If no contamination is found, no repairs are necessary.
2. Place a drain pan under oil module.
3. Remove oil module from engine following procedures in the *Engine Service Manual*.
4. Remove oil cooler from oil module following procedures in the *Engine Service Manual*.
5. Pressure test oil cooler following procedures in the *Engine Service Manual*.
   - If oil cooler fails pressure test, install a new oil cooler following procedures in the *Engine Service Manual* and reinstall oil module.
   - If oil cooler passes pressure test, replace both oil cooler gaskets following procedures in the *Engine Service Manual*.

Lube Oil to Intake

Symptom

Customer complaint of high lube oil consumption.

Possible Causes

- High pressure turbocharger
- Low pressure turbocharger
- High crankcase pressure

Procedure

1. Verify volume of lube oil entering intake system.
   - If residue of lube oil is present at intake air inlet, continue to next step.
   - If no lube oil residue is present at intake air inlet, the system is operating as designed and no repair is necessary.
2. Remove Low Pressure Charge Air Cooler (LPCAC) assembly following procedures in the *Engine Service Manual*.
3. Inspect for lube oil at LPCAC inlet and CAC.
   - If lube oil residue is present at LPCAC inlet, check and repair low-pressure turbocharger assembly following procedures in the *Engine Service Manual*.
   - If lube oil residue is present at CAC and not the LPCAC, check and repair high-pressure turbocharger assembly following procedures in the *Engine Service Manual*.

Lube Oil to Exhaust

Symptom

High lube oil consumption or restricted Diesel Particulate Filter (DPF) or Diesel Oxidation Catalyst (DOC). If the complaint is “wet exhaust” or leakage of exhaust system joints, verify Aftertreatment Fuel Injector (AFTFI) and/or system is functioning properly.

Possible Causes

- High-pressure turbocharger
- Low-pressure turbocharger
- Internal engine damage

NOTE: If lube oil to exhaust is determined from one of the listed possible causes, the Oxygen Sensor (O_2S) must be replaced. See the *Engine Service Manual* for O_2S replacement procedures. Perform O_2S Calibration Procedure (page 123) anytime O2S is replaced.

Procedure

1. Remove exhaust manifold with butterfly from low-pressure turbocharger following procedures in the *Engine Service Manual*. Identify if lube oil is present at turbine side of low-pressure turbocharger.
   - If no oil is present at exhaust outlet of low-pressure turbocharger, the leak into the exhaust is most likely fuel. Verify the AFTFI and Downstream Injection (DSI) system is functioning properly. Go to Fuel to Exhaust (page 174).
   - If oil is present at exhaust outlet of low-pressure turbocharger, remove low-pressure turbocharger following procedures in the *Engine Service Manual* and continue to next step.
2. Inspect turbine housing on high-pressure turbocharger and identify if lube oil is present at turbine side of high-pressure turbocharger.
   - If no oil is present, the leak into exhaust is from the low-pressure turbocharger. Install a new low-pressure turbocharger following procedures in the *Engine Service Manual*.
   - If oil is present, remove high-pressure turbocharger following procedures in the *Engine Service Manual* and continue to next step.

3. Inspect the inside of the high-pressure turbine inlet and exhaust manifold for presence of lube oil.
   - If no oil is present, the leak into exhaust is from the high-pressure turbocharger. Install a new high-pressure turbocharger following procedures in the *Engine Service Manual*.
   - If oil is present, remove exhaust manifolds from cylinder head following procedures in the *Engine Service Manual*. Pinpoint the power cylinder of concern and continue to next step.
4. Repair power cylinder following procedures in the *Engine Service Manual* for repair of specific component.

Low Oil Pressure

NOTE: Oil pressure depends on oil temperature and on engine speed (and thus, oil pump speed). To check oil pressure differences, unless there is a dramatic change, you have to know the oil temperature and engine speed. A typical engine speed is idle. A typical warm oil temperature is 110 °C (230 °F).

Symptom

Oil pressure indicator lamp will illuminate and an alarm will sound if oil pressure is less than 48 kPa (7 psi) with engine running at or above 325 rpm.

Possible Causes

- Low oil level
- High oil level/oil contamination
- Incorrect oil viscosity
- Inaccurate Engine Oil Pressure (EOP) sensor or circuit
- Restricted oil filter
- Oil sump/oil suction line damage
- Scored or damaged oil pump
- Oil pressure regulator wear/damage
- Broken, missing, or loose piston cooling tube(s)
- Internal engine bearing wear/damage
- Camshaft bearing wear/damage
- Missing oil gallery cup plugs (front or rear)
- Missing oil filter
- Clogged oil filter
- Damaged oil cooler
- No rotor in the centrifuge
- Soot in centrifuge filter

Tools

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)
- ZTSE4409 – Pressure Test Kit
- Oil pressure test coupler
- Clean oil drain pan

Procedure

WARNING: To prevent personal injury or death, set parking brake, shift transmission to neutral or park, and block wheels before starting the engine.

WARNING: To prevent personal injury or death, when routing test leads, do not crimp leads, run leads too close to moving parts, or let leads touch hot engine surfaces.

WARNING: To prevent personal injury or death, do not let engine fluids stay on your skin. Clean skin and nails using hand cleaner and wash with soap and water. Wash or discard clothing and rags contaminated with engine fluids.

NOTE: Engine oil level varies depending on temperature of engine.

NOTE: If engine has been running, allow a 15 minute oil drain down period before checking oil level.

1. Park vehicle on level ground and use oil level gauge (dipstick) to check oil level.
   - If lube oil is contaminated with coolant, go to Coolant Leak to Lube Oil (page 148).
   - If lube oil is contaminated with fuel, go to Fuel in Lube Oil (page 173).
   - If oil level is in specification and oil is not contaminated, but oil pressure remains low, continue to next step.
2. Verify low engine oil pressure complaint by checking oil pressure gauge on vehicle's dashboard.
   - If oil pressure is within specification, no repair is necessary.
   - If oil pressure is below specification, continue to next test.
3. Turn ignition switch to ON, engine OFF.
4. Connect EST to vehicle's Diagnostic Connector.
5. Start ServiceMaxx™ software.
6. Using EST, verify Engine Oil Pressure (EOP), Engine Oil Temperature (EOT) , and engine speed differences.
   - If EOP is within specification, investigate failed or malfunctioning oil pressure gauge on vehicle's dashboard. See appropriate chassis service manual for diagnosing oil pressure gauge.
   - If EOP is below specification, continue to next step.

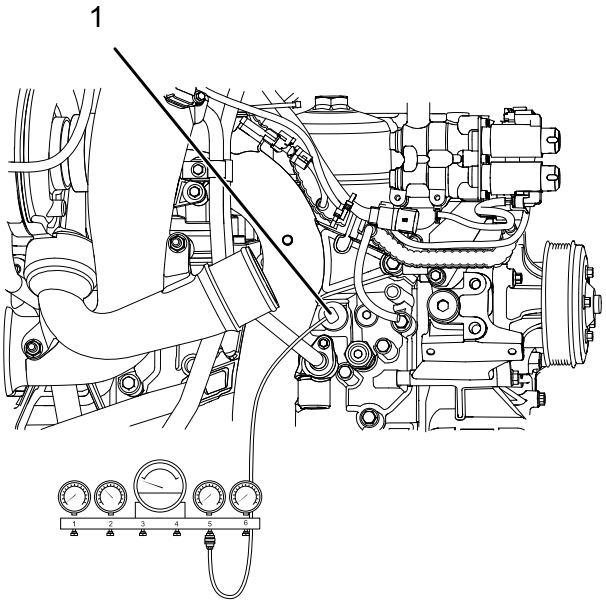

Figure 72 Oil pressure gauge connection

1. Oil pressure test coupler.

7. Remove EOP sensor and install oil pressure test coupler (obtain locally).
8. Connect test line between oil pressure test coupler and 0 to 160 psi gauge on Pressure Test Kit ZTSE4409.

9. Start engine and run to operating temperature. Measure oil pressure at both low and high idle, and under no load conditions.
    - If oil pressure is within specifications listed in ”APPENDIX: A PERFORMANCE SPECIFICATIONS” and the oil pressure gauge indicates low pressure, perform Engine Oil Pressure (EOP) Sensor (page 1031) diagnostics in “ELECTRONIC CONTROL SYSTEMS DIAGNOSTICS."
    - If oil pressure is not within specification, continue to next step.
10. Remove oil filter and inspect for debris.
    - If oil filter has debris, install a new oil filter. Inspect oil bypass valve located in oil module housing. If debris is present in oil bypass valve, clean bypass valve and retest system.
    - If oil filter does not have debris, install new oil filter and retest system.
    - If engine fails test, continue to next step.
11. Drain oil from engine using a clean drain pan. Inspect oil drain plug magnet and drained oil for debris. An oil sample can be taken to determine level of engine wear and contaminants in oil.
12. Remove oil sump following procedures in *Engine Service Manual*.
13. Inspect oil suction line for damage.
    - If oil suction line is damaged, install a new oil suction line following procedures in the *Engine Service Manual*. Retest the engine for correct oil pressure.
    - If oil suction line is not damaged, install a new oil sump following procedures in the *Engine Service Manual*. Continue to next step.
14. Visually inspect for missing, loose, or damaged O-rings, piston cooling tubes, and bearing inserts.
    - If visual inspection identifies any concerns, repair as necessary and retest system.
    - If visual inspection does not identify any concerns, proceed to next step.
15. Connect regulated shop air line to the oil filter module diagnostic coupling assembly.
16. Slowly apply air pressure in 34.5 kPa (5 psi) increments up to 345 kPa (50 psi).

NOTE: There will be loss of air at many lube points; however, the amount of loss should not be excessive.

17. Check for audible loss of air pressure. If air loss is identified in the following areas, inspect and repair the associated components as necessary:
    - Front of engine right side – oil pressure regulator, oil galley plugs
    - If a continuous flow of lube oil is coming out of the oil return port, remove and replace oil pressure relief valve.
    - Rear of engine – oil galley plugs
    - Main and rod bearings
    - Upper engine – camshaft bearings (removal of the valve cover is required)
    - If no leak has been found, remove front cover of engine and inspect oil pump following procedures in the *Engine Service Manual*.

Fuel System

GOVERNMENT REGULATION: Engine fluids (oil, fuel, and coolant) may be a hazard to human health and the environment. Handle all fluids and other contaminated materials (e.g. filters, rags) in accordance with applicable regulations. Recycle or dispose of engine fluids, filters, and other contaminated materials according to applicable regulations.

Excessive Fuel Consumption

Symptom

More fuel is required to perform the same task.

Possible Causes

Operator effects

- Inaccurate record keeping or tank filling
- Winter blend, kerosene, or number one diesel fuel
- Unrealistic expectations
- Excessive transient behavior

Application effects

- Heavy loading Gross Vehicle Weight (GVW)
- Low rear axle ratio
- Large frontal area
- Accessory usage (such as Power Takeoff)
- Additional equipment drawing fuel from vehicle fuel tanks
- Extended idle applications
- Tire size, tire condition, or air pressure

Chassis effects

- Brake drag
- Cooling fan clutch locked ON
- Transmission slippage/shifting
- Fuel tank plumbing or venting
- Intake or exhaust restriction
- Aftertreatment restriction
- Clutch slipping

Engine effects

- Incorrect or inoperative thermostat(s)
- Failed turbocharger control system
- Fuel system performance loss
- Fuel system leaks
- Base engine performance loss
- Exhaust Gas Recirculation (EGR) system failure
- Engine Throttle Valve (ETV) system failure

Procedure

1. Review operator records and fueling procedures. Measurement errors are common. Fuel consumption taken only from one tank of use is susceptible to significant error because of filling procedures and vehicle application differences during operation. Accurate fuel consumption must be measured over time with a record of what the vehicle was doing during the measurement period.

NOTE: Loss of fuel economy is normal if winter blend fuel, kerosene, or number one diesel fuel is being used.

2. Review vehicle specifications to determine if fuel consumption is normal for type of application and use of vehicle. Compare consumption with similar vehicles in the same application and TCAPE report.

3. Do all tests in Engine Symptoms Diagnostics Section.

   These tests verify the operating condition of the following engine and chassis systems:

   - Intake system
   - Exhaust system
   - Fuel delivery and filtration
   - High pressure fuel system
   - Injector operation
   - EGR system operation
   - ETV system operation
   - Boost pressure actuator operation
   - Base engine condition
   - Electronic control system condition

   If all tests are passed, engine is operating normally.

Fuel in Coolant

Symptom

Coolant has a diesel fuel odor.

Possible Causes

- Leaking coolant heated auxiliary fuel filter (if equipped)
- Cracked or porous cylinder head casting in fuel return area
- AFTFI

Tools

- ZTSE4409 – Pressure Test Kit
- Regulated air pressure

Procedure

1. Isolate and test any add-on coolant heated auxiliary fuel filter per manufacturer's instructions.
   - If leak is found, install a new coolant heated auxiliary fuel filter per manufacturer's instructions.
   - If no leak is detected, continue to next step.

WARNING: To prevent personal injury or death, do the following when removing the radiator cap or deaeration cap:

- Allow engine to cool for 15 minutes or more.
- Wrap a thick cloth around radiator cap or deaeration cap.
- Loosen cap slowly a quarter to half turn counterclockwise to vent pressure.
- Pause for a moment to avoid being scalded by steam.
- Continue to turn the cap counterclockwise to remove.

2. Remove deaeration tank cap.
3. Fill deaeration tank with coolant to a level above deaeration tank inlet.

NOTE: Do not reinstall deaeration cap at this time.

4. Disconnect electrical connector to Aftertreatment Fuel Injector (AFTFI).
5. Disconnect fuel supply line from AFTFI.
6. Connect a regulated air pressure source to fuel inlet of AFTFI and pressurize to 207 kPa (30 psi) for up to 20 minutes.
   - If air bubbles are observed at deaeration tank, install a new AFTFI following Hydrocarbon Injector installation procedure in the *Engine Service Manual*.
   - If no air bubbles are present at deaeration tank, continue to next step.

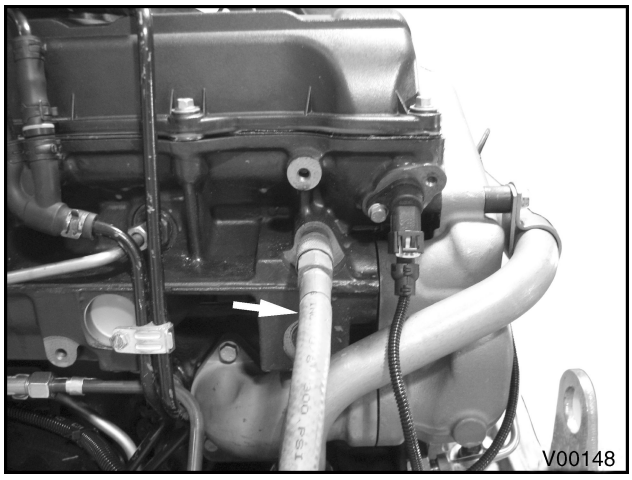

Figure 73 Compressed air source connected to cylinder head

7. Remove Banjo Bolt at the rear of cylinder head and adapt compressed air source to cylinder head.
8. Pressurize cylinder head to 550 to 690 kPa (80 to 100 psi) for up to 20 minutes.
9. Observe deaeration tank for air bubbles or loss of pressure at gauge. If air bubbles are observed at deaeration tank, install a new cylinder head following procedures in the *Engine Service Manual*.

Fuel in Lube Oil

Symptom

Oil has a diesel fuel odor and engine oil level in consistently increases.

Possible Causes

- Fuel injector(s)
- Cylinder misfire (wash down)
- High pressure fuel lines

Tools

- ZTSE4618 – UV Leak Detection Kit
- 15-637-01 – Clean Fuel Source Tool
- UV Leak Detection Fluorescent Dye Cartridge

Procedure

1. If engine has a misfire, see Special Test Procedures (page 216) in ”Engine Symptoms Diagnostics." Use procedures in the *Engine Service Manual* for repair of specific components.
2. Verify oil contamination by performing a white paper test or oil analysis. Place one drop of suspected diluted oil on a clean sheet of printer or copier paper.
   - If oil wicks away rapidly into the paper, there is fuel contamination.
   - If oil maintains a uniform and slow expanding stain, there is no fuel contamination.
3. Inspect fuel system for leaks.

NOTE: The UV Leak Detection Kit ZTSE4618 requires warm-up time. Turn on UV Leak Detection Kit.

NOTE: Before starting dye test, verify there is no dye in oil.

4. Using Clean Fuel Source Tool 15-637-01, supply engine with an alternate supply of clean diesel fuel with dye mixed to manufacturers specification.
5. Start and run engine at high idle for a maximum of 5 minutes. Turn engine OFF.
6. Using the UV Leak Detection Kit ZTSE4618, inspect for leaks in the following areas:
   - High-pressure pump front seal. If a leak is found, replace fuel pump following procedures in the *Engine Service Manual*. To prevent damage to a newly installed fuel pump and to verify high back pressure did not cause fuel pump to fail, perform HP Pump Fuel Return Pressure Test (page 233) any time fuel pump is replaced.
   - Injector body. Remove valve cover following procedures in the *Engine Service Manual*. If a leak is found, replace fuel injector and pressure pipe neck following procedures in the *Engine Service Manual*.
   - If no leaks are found, take an oil sample for analysis and monitor engine oil level.

Fuel to Intake

Symptom

Fuel leaking into the intake results in black smoke and eventual Diesel Particulate Filter (DPF) Diagnostic Trouble Codes (DTCs).

Possible Causes

- Inlet Air Heater Fuel Solenoid (IAHFS) valve
- IAHFS valve control

Procedure

1. If engine has a misfire, see Special Test Procedures (page 216) in “Engine Symptoms Diagnostics."
2. Disconnect electrical connector from IAHFS valve.
3. Disconnect fuel supply line from Inlet Air Heater Fuel Igniter (IAHFI).
4. Pump fuel primer pump while checking IAHFS valve for fuel leakage.
5. Start engine and run at low idle. Check for fuel leakage from IAHFS valve.
   - If leakage is observed, install a new IAHFS valve following procedures in the *Engine Service Manual*.
   - If no leakage is observed, check the IAHFS valve control circuit. See IAHFS (Inlet Air Heater Fuel Solenoid) (page 531) in “ELECTRONIC CONTROL SYSTEMS DIAGNOSTICS”.

Fuel to Exhaust

Symptom

Wet exhaust system and possible damage to the Diesel Particulate Filter (DPF).

Possible Causes

- AFTFI
- Internal engine damage

Tools

Regulated air pressure source with shut off valve

Procedure

1. Perform Aftertreatment Fuel Shutoff Valve (AFTFSV) Leak Test (page 121).
   - If Aftertreatment Fuel Injector (AFTFI) is not dry and free of fuel, replace the AFTFSV.
   - If AFTFI is dry and free of fuel, continue to next step.
2. Perform AFT Fuel Injector Leak Test (page 120).
   - If Aftertreatment Fuel Injector (AFTFI) is not dry and free of fuel, replace the AFTFI.
   - If AFTFI is dry and free of fuel, continue to next step.

3. Perform AFT Fuel Dosing Test (page 118).
    - If Aftertreatment Fuel Injector (AFTFI) does not dispense 225ml to 500ml of fuel with in 2.5 minutes, replace the AFTFI.
    - If AFTFI dispenses 225ml to 500ml of fuel with in 2.5 minutes, continue to next step.
4. If engine has a misfire, see Special Test Procedures (page 216) in “Engine Symptoms Diagnostics”.
5. Remove exhaust manifold from cylinder head following procedures in the *Engine Service Manual* and pinpoint the power cylinder of concern.

Fuel Pressure and Aeration

Symptom

Fuel aeration exhibits one or more of the following characteristics:

- Engine stall during operation
- Rough running engine
- Extended engine crank time (hard start)
- Fuel pressure slow to build while cranking
- Excessive fuel pressure while cranking
- Pulsating fuel pressure during crank or engine running at idle.
- Difficulty priming fuel system

Possible Cause

- Leaks in fuel supply to fuel pump
- Loose fuel injector hold down
- Missing/damaged fuel injector sealing washer

Procedure

If aeration is suspected, go to Fuel System (page 205).

Water in Fuel

Symptoms

Water in fuel exhibits one or more of the following characteristics:

- Water in fuel shown in Integral Digital Display
- Low power
- Engine stall during operation
- Rough running engine
- No start if water has frozen

Possible Causes

- Water in fuel supply system

- Ice in fuel lines

Tools

Clean, flat drain pan with a wide opening

Procedure

WARNING: To prevent personal injury or death, do not let engine fluids stay on your skin. Clean skin and nails using hand cleaner and wash with soap and water. Wash or discard clothing and rags contaminated with engine fluids.

WARNING: To prevent personal injury or death, do not mix gasoline, gasohol, or alcohol with diesel fuel. An open heat source, spark, cell phone, or electronic device can ignite these fuel mixtures. This creates a fire hazard and possible explosion.

1. Place drain pan under filter housing.
2. Drain water separator following procedures in the *Engine Operation and Maintenance Manual*.
3. Check fuel in drain pan for engine coolant or other contamination. Dispose of the contents in the drain pan in accordance with local requirements.
   - Excessive water or contaminants may indicate the tank and fuel system need to be flushed and cleaned.
   - Some sediment and water may be present if fuel filter has not been replaced for a long period of time, or if sediment and water have not been drained recently.
   - Fuel should be clear and not cloudy. Cloudy fuel indicates that fuel is not a suitable grade for cold temperatures.
   - The fuel should not be dyed red or blue, these colors indicate off-highway fuel.
   - Fuel should not be waxing or gelling. Waxing or gelling of some fuels in cold weather could clog fuel filters and fuel pump and cause restrictions or low fuel pressure.
4. If fuel sample indicates water in fuel, obtain a fuel sample from fuel tanks.
   - If fuel sample indicates water in fuel, drain fuel tanks, and refill tanks with clean fuel.

Priming the Fuel System

WARNING: To prevent personal injury or death, do not smoke and keep fuel away from flames and sparks.

WARNING: To prevent personal injury or death, shift transmission to park or neutral, set parking brake, and block wheels before doing diagnostic or service procedures.

CAUTION: To prevent engine damage, do not manually actuate the Fuel Pressure Control Valve (FPCV) to build fuel rail pressure, if the engine will not start. This can damage internal parts in the high-pressure pump.

CAUTION: To prevent damage to engine, plug component connections immediately after each fuel line is removed using clean fuel system caps.

NOTE: If fuel system will not prime during diagnosis and engine exhibits pulsating fuel pressure, see Low Pressure Fuel System (page 217) in “ENGINE SYSTEM TESTS AND INSPECTIONS”.

Procedure

Prime fuel system when the following conditions occur:

- Fuel tank is drained or runs dry
- Primary fuel filter is removed or replaced
- Any fuel connection between fuel tank and secondary fuel filter is broken
- Secondary fuel filter is removed or replaced
- High-pressure fuel system is serviced

1. Ensure all fuel system connections are secure and proper fuel filters are installed.
2. Ensure battery is fully charged or install battery charger.
3. Turn ignition switch to ON, engine OFF.
4. Connect EST to vehicle's Diagnostic Connector.
5. Start ServiceMaxx™ software.
6. Prime suction side of low-pressure fuel system:
   a. Tighten primary fuel filter components that were removed (canister filter element, seals, or bowl) to specified torque values.
   b. Unscrew piston knob on fuel primer pump assembly and start pumping until fuel pressure builds up on delivery side of fuel primer pump. Pressure build up is indicated by higher pumping force on piston knob.
   c. Fully screw piston knob back in when priming is complete.

CAUTION: To prevent damage to the starter, if engine fails to start within 20 seconds, release ignition switch and wait two to three minutes to allow starter motor to cool.

7. Engage starter for 20 seconds and allow starter to cool for two minutes.
8. If engine does not fire during the first two cranking attempts, use EST to monitor Fuel Delivery Pressure (FDP) during third cranking attempt.
   a. If pressure does not build up during third cranking attempt, unscrew primary filter cap and separate filter element from filter cap.

b. Ensure filter element is fully seated on standpipe.

c. Reassemble primary fuel filter assembly.

9. Engage starter for 20 seconds and monitor FDP sensor using EST with ServiceMaxx™ software.

   • If engine does not start and there is no increase in pressure, allow starter to cool for two minutes, then repeat steps 6 and 7.

10. Using EST with ServiceMaxx™ software, prime fuel system. If engine does not fire after five crank events, using EST with ServiceMaxx™ software, select Tests > KOEO Tests > Actuator Test. Then select Fuel Pressure Control Valve from the drop down menu, de-energize the FPCV in the high-pressure pump by setting the duty cycle to 5%.

NOTE: De-energizing the FPCV closes the valve and controls the valve at the lower limit of 5% Pulse Width Modulation (PWM) signal. This allows all fuel delivered by the internal transfer pump to go to the high-pressure pump and allows for minimum high-pressure pump outlet pressure, making refilling easy.

11. Engage starter for 20 seconds to purge any trapped air from high-pressure pump. Allow starter to cool for two minutes.

12. Reenergize FPCV. Engage starter for 20 seconds and allow starter to cool for two minutes.

Engine Brake System

Engine Brake Inspection

Symptom

Vehicle not decelerating properly when engine brake is activated.

WARNING: To prevent personal injury or death, read all safety instructions in the *Engine Service Manual*.

WARNING: To prevent personal injury or death, shift transmission to park or neutral, set parking brake, and block wheels before doing diagnostic or service procedures.

WARNING: To prevent personal injury or death, allow engine to cool before removing components.

WARNING: To prevent personal injury or death, do not let engine fluids stay on the skin. Clean skin and nails using hand cleaner and wash with soap and water. Wash or discard clothing and rags contaminated with engine fluids.

Possible Causes

- ON/OFF switch malfunctioning
- Engine brake lash adjustment (one or more cylinders out of adjustment)
- Low engine oil pressure (insufficient supply of oil pressure to operate engine brake)
- Engine boost pressure is low while braking, below 20 psi @ 2100 rpm with the engine brake on high
- Lubricating oil is too cold or thick
- Improper slave piston adjustment or slave piston binding in bore
- Master piston not moving in bore
- Control valves defective or binding in housing bore
- Engine brake housing plugs leaking
- Outer control valve springs broken or engine oil pressure extremely high
- Housing pipe plug(s) missing
- Aeration in lubricating oil
- Lubricating oil diluted by fuel oil
- Low engine oil level
- Worn engine rocker lever bushings
- Restrictions in the engine oil passages leading to engine brake

Tools

- ZTSE4357 – Digital Multimeter (DMM)
- ZTSE60756–7A – Lash Gauge (0.8 mm)

Preliminary Steps

WARNING: To prevent personal injury or death, wear safely glasses with side shields.

1. Before starting engine brake troubleshooting procedures, check the following:
   a. Check engine oil level on dipstick. Over or under filled crankcase oil will cause aeration in the engine brake hydraulic system.
   b. Check the condition of engine lubricating oil for presence of fuel, water, or both. This indicates engine problems and must be corrected.
   c. Check turbocharger, air cooler, piping, and intake manifold leakage. Loss of boost pressure will cause a reduction in engine brake power output.
2. Before inspecting engine brake housing, remove over-engine equipment such as air intake, turbocharger crossover pipes, and valve mechanism upper covers. Follow procedures in the *Engine Service Manual*.
   a. Inspect pipe plugs on housing ends where applicable, to make sure none are missing.
   b. Remove upper valve cover, following procedures in the *Engine Service Manual*.
   c. Check for cracks in engine brake housing.
   d. Check for loose, damaged, brittle, or cracked wiring or connections at engine brake solenoid.
   e. Check for loose or damaged hold down bolts.
   f. Check exhaust bridges and actuator pins. Actuator pins should move freely with no signs of distress.
   g. Check engine brake slave piston setting of 0.8 mm and engine valve settings.

NOTE: When operating the engine brake with the valve cover removed, be aware that there will be a significant amount of oil spray in this area. This engine brake has separate drilling to lubricate the master piston roller area. This adds to the oil spray in the area, but does not indicate leakage or a problem with the oil supply needed for engine brake operations. These are two separate systems within the engine brake housing.

WARNING: To prevent personal injury or death, wear safely glasses with side shields.

WARNING: Whenever engine is running and valve cover is removed, lubrication oil splashing in the engine brake could cause personal injury.

Engine Brake does not Turn on/Slow to Turn On

3. If supplied voltage to engine brake solenoids is 8.4 V DC or lower, check ECM input sensors.
   a. Harness failure: Check continuity from each engine brake solenoid to engine ground. Must be “open” (no connection). Repair harness as required.
   b. Engine brake solenoid resistance: Between 8.7 and 10 Ω at 25 °C (77 °F). If resistance is out of specifications, replace engine brake solenoid assembly.

Engine Brake Solenoid Specifications

Engine Temperature	Ohms
Cold: 25 °C (77 °F)	8.7 – 10
Hot: 121 °C (250 °F)	12 – 15.5

4. Check resistance from ECM 96-pin to Engine Compression Brake (ECB) harness connector.
5. Check resistance from Engine Compression Brake 1 (ECB1) and Engine Compression Brake 2 (ECB2) to ECB harness connector.
6. Check resistance from each terminal to engine brake solenoid can. This should be an "open circuit." If a resistance is measured, replace engine brake solenoid assembly.
7. Check continuity from each engine brake solenoid to engine ground. Must be “open circuit” (no connection). Repair harness if required.
8. Check upper and lower engine brake solenoid seal rings for leaks or damage. Replace if necessary.
9. Check engine brake solenoid valve, screen, and engine brake solenoid seal rings. Replace if necessary.
    - Shake the engine brake solenoid, a distinct rattle should be heard. This will indicate free component movement. Move poppet stem (the pin exposed on the bottom of the engine brake solenoid) to confirm it moves freely. If poppet stem does not move freely or a distinct rattle can not be heard, replace engine brake solenoid.

Engine Brake does not Turn Off/Slow to Turn Off

10. Check ECM input sensors, repair if necessary.
11. Check undercover wiring and engine brake solenoid connectors for short(s).
    - Check continuity from each engine brake solenoid to engine ground. Must be “open circuit” (no connection). Replace wiring harness or engine brake solenoid if required.
12. Check for low Engine Oil Pressure (EOP).
    - Determine oil pressure at engine brake housing using procedures given in this section. If EOP is below specifications, but engine brake housing oil pressure is 138 kPa (20 psi) and engine is at operating temperature, engine should be repaired before proceeding to next step.

Engine Fails to Start

13. If engine brake solenoid valve is stuck in the ON position, see diagnostics above.

Engine Brake Weak in Effect or Low on Engine Brake Power

14. Check engine boost pressure while braking. If boost pressure is below 138 kPa (20 psi) @ 2100 rpm with the engine brake on high, check engine brake adjustment. If out of specification, see procedure below.

    NOTE: To get boost pressure, the vehicle has to be road tested.
15. Check turbocharger for proper output. Inspect Charge Air Cooler (CAC) and piping for any exhaust leakage or intake restrictions.

Engine Brake Slow to Operate or Weak in Effect

NOTE: Allow engine to warm before operating engine brakes.

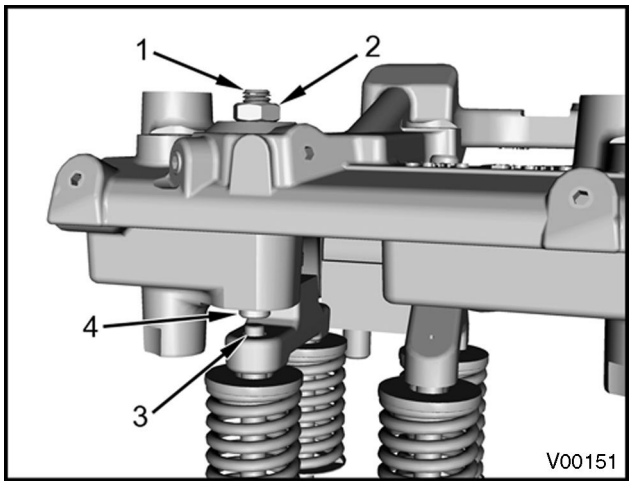

Figure 74 Engine Brake Assembly

1. Adjusting screw
2. Jam nut
3. Actuator pin (in exhaust valve bridge)
4. Slave piston

16. Check for improper slave piston adjustment or slave piston binding in bore.
    - If slave piston adjustment is incorrect or slave piston is binding in bore, readjust slave piston clearance lash setting to 0.8 mm. Ensure slave piston responds smoothly to the adjusting screw by loosening jam nut and moving adjusting screw through its full travel and for a full slave piston motion. Ensure piston travels full range without any binding or sticking.

NOTE: Master Piston Assembly – This is not a serviceable group. No attempt should be made to disassemble this group from the brake housing.

17. Check control valves for binding in housing bore.
    - Remove control valve. If body is scored, replace control valve. Check for contaminants in lube oil. Clean housing and control valve. If binding continues, replace housing.
18. Check control valve for defects.
    - Remove control valve. Ensure check ball is seated in bore and can be moved off seat. Ensure there is spring pressure against ball. Flush in cleaning solvent. Replace if necessary.
19. Check engine brake housing plugs for leakage.
    - If leaks are present, remove plug, clean threads, and install at 11 N•m (100 lb-in).
20. Check outer control valve springs for damage.

Oil Pressure Dropping Below Minimum Required for Engine Brake Operation

Engine Brake Oil Pressure Requirements

Model	Control Valve	Control Valve Spring	Full Flow PSI	Over Pressure PSI
5783	11930	037215 / 019632	20-55	80

NOTE: For proper engine brake operation, oil pressure at engine brake housing must be 138 to 172 kPa (20 to 25 psi) with engine at operating temperature and running between 1000 rpm and governed engine speed.

21. Check for missing housing pipe plug(s).
    - Check all housing pipe plugs, replace as needed, and torque to 11 N•m (100 lb-in).
22. Aeration of lubricating oil.
    - Check for aeration, activate, and then deactivate engine brake. Watch escape oil coming from control valve cover. If there are air bubbles in the oil, or if the oil is white and foamy, air is present in system. Aeration can be caused by the crankcase being too full of oil, too low on oil, or a problem with the engine oil pump or pick up tube.
23. Lubricating oil being diluted by fuel oil.
    - Obtain an oil sample to determine if fuel is present. See *Engine Operation and Maintenance Manual* for procedures on obtaining an oil sample.
24. Check engine oil level. See Visual Oil Level Inspection (page 161).
25. Check for worn engine rocker lever bushings. Replace if necessary.
26. Check for restrictions in engine oil passages leading to engine brake. Inspect all passageways. Repair if necessary.

One or More Cylinders Fail to Stop Braking or Engine Stalls

27. Check control valve inner spring for damage. Replace if necessary.
28. If one or more control valves are stuck in the ON or UP positions, check control valves for binding.
    - Remove, clean, or replace if necessary.
    - Inspect lubricating oil for contaminants.

Engine Misses or Loses Power

29. If slave piston adjustment is tight, readjust slave piston clearance to lash setting of 0.8 mm.
30. If engine brake solenoid is stuck in ON position, see procedure above.
31. If control valve is sticking or dragging in bore, clean control valve and bore. Replace if necessary.
32. Check control valve spring for damage. Replace if necessary.

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Required Test Procedures

GOVERNMENT REGULATION: Engine fluids (oil, fuel, and coolant) may be a hazard to human health and the environment. Handle all fluids and other contaminated materials (e.g. filters, rags) in accordance with applicable regulations. Recycle or dispose of engine fluids, filters, and other contaminated materials according to applicable regulations.

WARNING: To prevent personal injury or death, read all safety instructions in the "Safety Information" section of this manual.

WARNING: To prevent personal injury or death, do not let engine fluids stay on your skin. Clean skin and nails using hand cleaner and wash with soap and water. Wash or discard clothing and rags contaminated with engine fluids.

WARNING: To prevent personal injury or death, shift transmission to park or neutral, set parking brake, and block wheels before doing diagnostic or service procedures.

WARNING: To prevent personal injury or death, do not smoke and keep fuel away from flames and sparks.

WARNING: To prevent personal injury or death, provide proper ventilation when operating an engine in a closed area. Inhalation of exhaust gas can be fatal.

Performance Specification Information See "APPENDIX A: PERFORMANCE SPECIFICATIONS" or "APPENDIX C: TECHNICAL SERVICE INFORMATION (TSI)" to obtain required specification information:

NOTE: Performance specifications may be periodically published in a Technical Service Information (TSI) format to support new model year products. Check service bulletin repository on Navistar® Service Portal for appropriate model year application.

1. Initial Key ON Check

Determine if Engine Control Module (ECM) is powered up and if water is in fuel supply.

Tools

None

1. Turn ignition switch to ON, engine OFF. Observe the following:
   - Wait to Start lamp
   - WATER IN FUEL indicator (Integral Digital Display)
2. Record results on Diagnostics Form.
   - If WATER IN FUEL indicator stays ON, go to Fuel Quality Check (page 193).

2. Visual Inspection

Check all fluid levels and inspect engine systems for problems (leaks, open connections, harness chaffing, etc.).

Tools

None

Engine Oil

1. Park vehicle on level ground and check oil level.

   NOTE: Engine should be at normal operating temperature. Turn engine OFF. Wait 15 minutes for level to stabilize.

   NOTE: API CJ-4 oils are recommended for high speed diesel engines with advanced exhaust aftertreatment systems that meet 2007 and beyond on-highway exhaust emission standards.

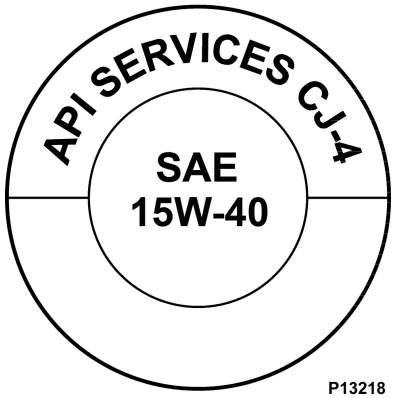


Figure 75 Lube oil requirements label

2. Use oil level gauge (dipstick) to verify engine oil level.

   NOTE: If oil is diluted or contaminated, oil and filter must be replaced.

3. Record results on Diagnostics Form.
   - If level is below specification, inspect for leaks, oil consumption, or improper servicing. If engine oil level is low, fill to specification.
   - If level is above specification, inspect for fuel dilution, coolant contamination, or improper servicing. If engine oil level is above specification, drain to proper level and diagnose contamination.

Engine Coolant Level

1. Park vehicle on level ground.

NOTE: Turn engine OFF and allow to cool. Ensure coolant temperature has stabilized to safe temperature and pressure.

2. Check coolant level as indicated on deaeration tank level window.

NOTE: Coolant in the exhaust could damage the DPF. Inspect DPF for damage. See AFT System (page 286) in “ELECTRONIC CONTROL SYSTEMS DIAGNOSTICS” for inspection of the DPF.

3. Record results on Diagnostics Form.
   - If level is above or below deaeration tank fill level, inspect for leaks, coolant in oil, coolant in combustion exhaust, or improper servicing.
   - If coolant is contaminated, replace coolant.

Electrical System

1. Inspect batteries and electrical system (engine and vehicle) for poor or loose connections, corroded terminals, or broken and damaged wires.
2. Record results on Diagnostics Form.
    - If electrical system problem is found, make necessary repairs.

Intake Air

NOTE: Intake air restriction should be less than 172.3 kPa (25 psi) at full load, rated speed.

1. Inspect air filter gauge, located on air filter housing or dashboard.
2. Record results on Diagnostics Form.
   - If gauge indicates air filter requires replacement, verify there are no other restrictions in the air inlet or filter housing before replacing air filter.

Charge Air Cooler (CAC) System

1. Inspect CAC, interstage cooler, and all piping for leaks.
2. Inspect all CAC connections and clamps.
   - If CAC system problem is found, make necessary repairs. See Coolant Over-Temperature Conditions Inspection (page 150) in “ENGINE SYMPTOMS DIAGNOSTICS”.

Exhaust System

1. Inspect exhaust system (engine and vehicle) for restrictions, leaks, or damage.
2. Record results on Diagnostics Form.
   - If exhaust system problem is found, make necessary repairs.

Vehicle Air Tanks

1. Inspect vehicle air tanks for water.
   - If water is detected in air tanks, drain all water from air tanks.

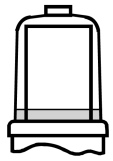
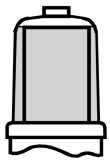
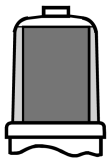
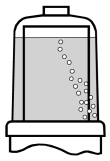
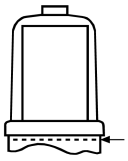
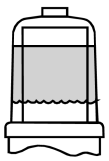
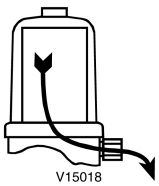
Fuel Level

WARNING: To prevent personal injury or death, do not smoke and keep fuel away from flames and sparks.

1. Park vehicle on level ground.
2. Check instrument panel fuel gauge and look into fuel tank to verify fuel level.
3. Record results on Diagnostics Form.
   - If fuel gauge reads above empty, but tank is empty, diagnose instrument panel fuel gauge. Verify sufficient fuel level before diagnosing a pressure problem.
   - If fuel tank is empty, add fuel and prime fuel system. See Priming the Fuel System (page 177).

Primary Fuel Filter Inspection

Visually inspect primary fuel filter condition following the inspection table on next page.

Fuel Level	Visual Indication	Possible Solution
 V15021	Fuel level below top of fuel filter.	Normal - no repair necessary.
 V15013	Fuel level above top of fuel filter. May cause loss of power complaint.	Change primary fuel filter element.
 V15014	Fuel level is to top of fuel filter and looks to be full of wax.	1. Change primary fuel filter element 2. Run engine for a minimum of 25 minutes at idle. Do not run at high idle.
 V15015	Bubbles are seen flowing within fuel.	1. Check all fittings and lines from between fuel tank and chassis fuel filter assembly. 2. Check upper and lower connector O-rings.
 V15016	Loss of power complaint. Fuel level is below fuel filter housing collar.	1. Check for missing grommet at lower end of filter. 2. Check for missing or broken spring at top of primary fuel filter element.
 V15017	Water is seen (noticeable separation) in fuel filter assembly.	1. Inspect fuel tank(s) for water contamination. 2. Drain a full cup of fuel from chassis fuel filter assembly. **NOTE:** Do not drain with engine running. 3. Restart engine. Shut off engine and drain chassis fuel filter assembly. 4. Repeat step 3 until ALL water is removed.
 V15018	Fuel drains back to fuel tank when changing fuel filter or draining water separator.	1. Remove and inspect check valve assembly. 2. Repair (clean) or replace as necessary, and retest.

Fuel Quality Check

Check for poor fuel quality or contaminants.

Tools

- Clear diesel fuel container
- Clear plastic hose

NOTE: Ultra Low Sulfur Diesel (ULSD) fuel is required for Navistar® N13 Diesel Engines used with advanced aftertreatment systems.

Figure 76 Fuel requirements label

NOTE: WATER IN FUEL indicator illuminates ON, then OFF, on the Integral Digital Display if there is no water in the system. If WATER IN FUEL indicator stays ON, water is detected.

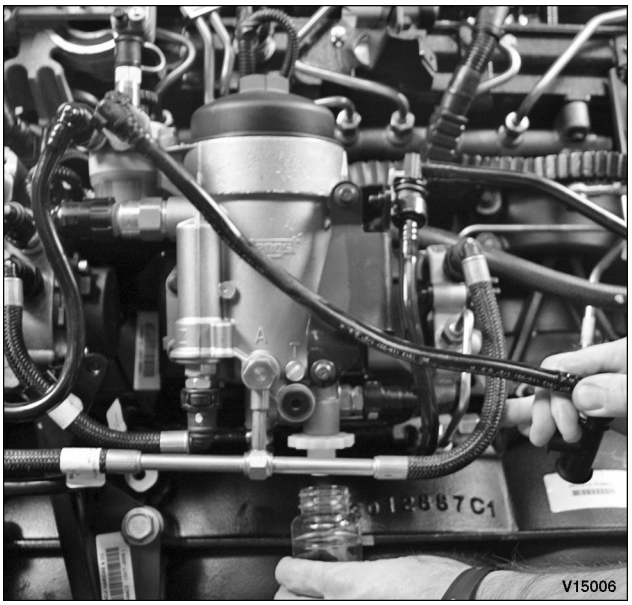


Figure 77 Fuel sample

1. Install clear plastic hose on fuel drain valve.

2. Route clear plastic hose into clear diesel fuel container.
3. Open fuel drain valve to fill container.

NOTE: If fuel does not flow, crank engine.

4. Check for water, waxing, icing, sediment, gasoline, Diesel Exhaust Fluid (DEF) or kerosene by shaking fuel sample container and letting contents settle. Record results on Diagnostics Form.
   - Sediments will fall to bottom of fuel sample container.
   - Gasoline and kerosene will separate from diesel fuel.
   - Waxing or icing will prevent diesel fuel from flowing out of fuel drain valve.
   - If fuel quality is questionable, repair as necessary. Take another sample to verify fuel quality is satisfactory.
   - If fuel quality is satisfactory, continue to Electronic Service Tool (EST) Connection and Data Recording test.

   NOTE: Do not continue diagnostic procedures if fuel is contaminated.
5. Inspect fuel strainer for debris. The fuel strainer is located in the fuel primer pump assembly.

3. Electronic Service Tool (EST) Connection and Data Recording

Purpose

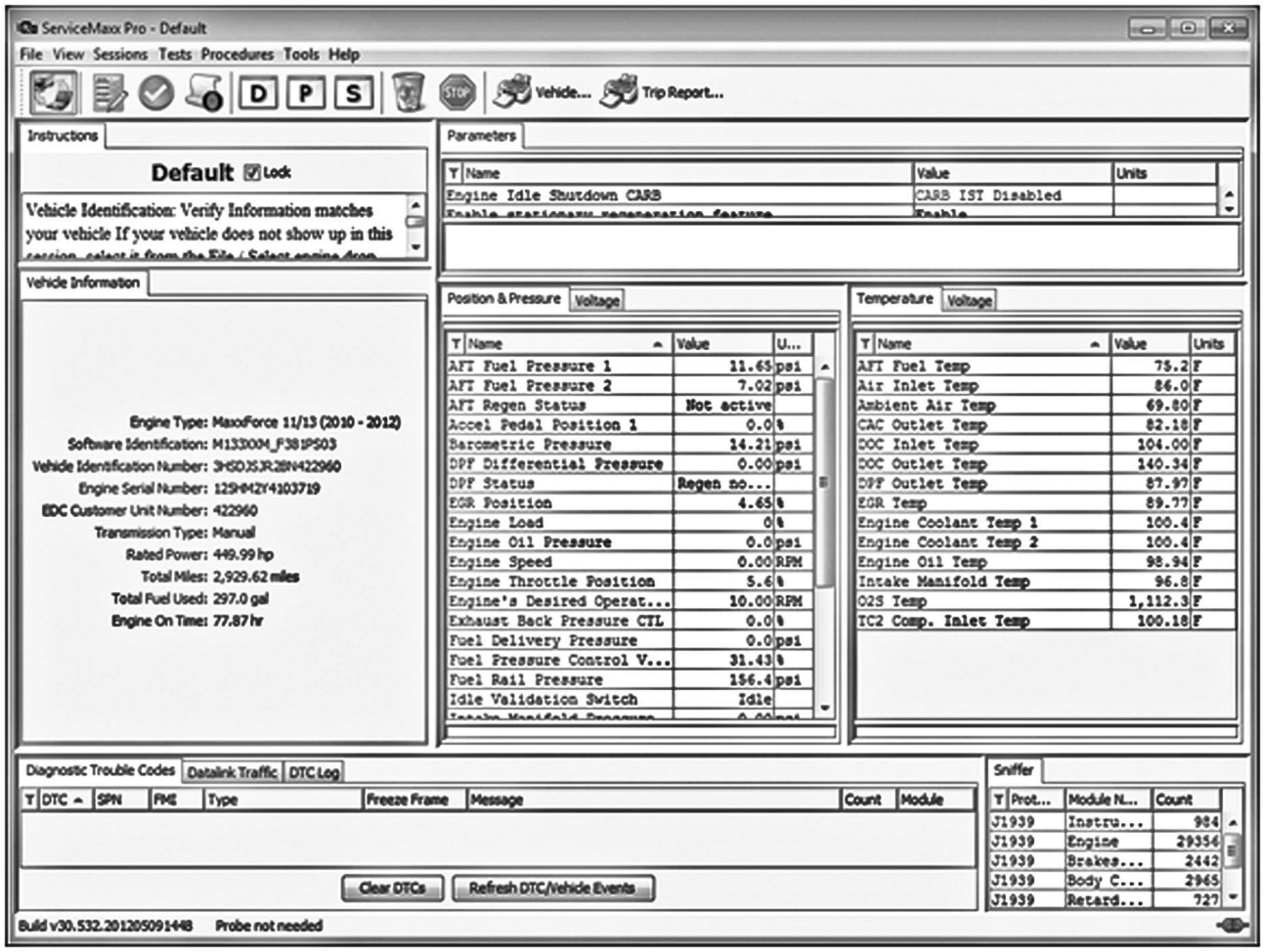
Check Engine Control Module (ECM) software, sensor signals and DTCs, and to record additional vehicle information on Diagnostics Form.

Tools

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

Procedure

1. Turn ignition switch to ON, engine OFF.
2. Connect EST to vehicle's Diagnostic Connector.
3. Start ServiceMaxx™ software.
   - If unable to communicate with the ECM, see the *ServiceMaxx™ Users Guide*.
   - If unable to communicate with the ECM and no problems are found using the *ServiceMaxx™ Users Guide*, go to J1939 Data Link (page 1218) in “ELECTRONIC CONTROL SYSTEMS DIAGNOSTICS.”



V00133a

Figure 78 ServiceMaxx™ startup screen – vehicle connected

4. Verify the following vehicle information matches the displayed information in ServiceMaxx™ software and record on Diagnostics Form.
   - Software Identification
   - Vehicle Identification Number (VIN)
   - Engine Serial Number (ESN)
   - Transmission Type
   - Rated Power
   - Total Miles
   - Engine On Time

   NOTE: The engine serial number is located on the front left side of the crankcase, below the cylinder head. It is also on the engine emission label on the valve cover.

5. Record the following Key ON, Engine OFF (KOEO) temperature sensor values on Diagnostics Form:

   NOTE: If possible, allow the engine to cold soak for at least 8 hours before recording results.

   - Inlet Air Temperature (IAT)
   - Engine Coolant Temperature 1 (ECT1)
   - Engine Coolant Temperature 2 (ECT2)
   - Engine Oil Temperature (EOT)

6. Record the following KOEO pressure sensor values on Diagnostics Form:
   - Fuel Rail Pressure (FRP)
   - Fuel Delivery Pressure (FDP)
   - TC1 Turbine Outlet Pressure (TC1TOP)
   - Intake Manifold Pressure (IMP)
   - Barometric Pressure (BARO)
   - DPF Differential Pressure (DPFDP)

7. Look for sensor values that are out of specification. A sensor out of specification could cause abnormal operating behavior, incorrect fueling, and injection timing problems.
   - If sensor is out of specification, go to the suspect sensor in “ELECTRONIC CONTROL SYSTEMS DIAGNOSTICS.”

8. Use ServiceMaxx™ software to run Actuator Test.

9. Record EGR Valve Position and Engine Throttle Position values at 5% (open) and 95% (closed) on Diagnostics Form.
   - If either signal is not within specification, go to the suspect actuator in “ELECTRONIC CONTROL SYSTEMS DIAGNOSTICS.”

10. Look for sensor values that are not within specification. A sensor out of specification could cause air management problems.

11. Use ServiceMaxx™ software to run Actuator Test.

12. Visually monitor movement of Exhaust Back Pressure Valve (EBPV). Record results on Diagnostics Form.

    NOTE: ServiceMaxx™ software does not have an EBPV feedback position signal.

    - If EBPV does not move, go to Exhaust Back Pressure Valve (page 213).

13. Use ServiceMaxx™ software to monitor DPF status. Record results on Diagnostics Form.
    - If DPF status is “Regen needed - critical level”, run an DPF Filter Regeneration procedure.

4. Check for Diagnostic Trouble Codes (DTCs)

NOTE: 2010 model year vehicles no longer utilize DTC identification by number. DTCs are now identified using the SPN and FMI identifiers only. These two identifiers, known as the Suspect Parameter Number (SPN) and the Failure Mode Indicator (FMI) are displayed in the DTC Window.

- Suspect Parameter Number (SPN) – The SPN identifies the individual component causing the DTC.
- Failure Mode Indicator (FMI) – The FMI identifies the fault or condition affecting the individual component.
- Pending DTCs are possible emission faults that were detected on first drive cycle.
- Active DTC are faults that are present now or emission faults that were detected on two consecutive drive cycles.
- Previously Active or Healing DTCs are historical faults. These faults may have been cause by an intermittent or operating condition which is not currently present.

Purpose

Identify DTCs.

Tools

- EST with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

1. Turn ignition switch to ON, engine OFF.
2. Connect EST to vehicle's Diagnostic Connector.
3. Start ServiceMaxx™ software.

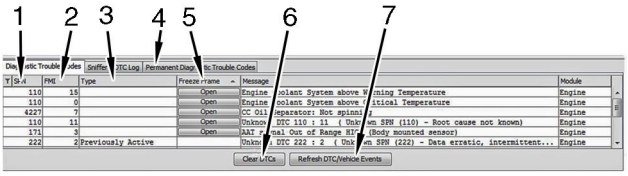


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Figure 79 DTC window

1. Suspect Parameter Number (SPN)
2. Failure Mode Indicator (FMI)
3. Fault Code Type
4. Permanent Diagnostic Trouble Codes tab
5. Freeze Frame
6. Clear DTCs button
7. Refresh DTC/Vehicle Events button

4. Record DTCs and Freeze Frame Data on Diagnostics Form.
   - Correct any circuit (FMI 3, 4, 5, or 19), or component (FMI 2, 7, 11, 13, or 14), Active and Pending DTCs. See “ELECTRONIC CONTROL SYSTEMS DIAGNOSTICS.”
   - Investigate system DTCs (FMI 0, 1, 10, 15, 16, 17, 18, 20, 21, or 31) with high counts..

NOTE: Freeze Frame Data is a snapshot of all influencing signals at the time the DTC was set. This can help diagnose hard to duplicate failures. Freeze Frame Data is cleared as soon as the DTC is cleared.

5. Engine Low Idle to High Idle

Validate engine performance throughout rpm range.

Tools

- EST with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

1. Turn ignition switch to ON, engine OFF.
2. Connect EST to vehicle's Diagnostic Connector.
3. Start ServiceMaxx™ software.
4. Select Performance session.
5. Monitor Accel Pedal Position 1 (APP1) signal and depress accelerator pedal to floor. Record results on Diagnostics Form.
   - If APP1 signal does not go from 0% to 99.6%, see APP Sensor (page 437) in “ELECTRONIC CONTROL SYSTEMS DIAGNOSTICS.”
   - If APP1 signal does go from 0% to 99.6%, continue to next step.

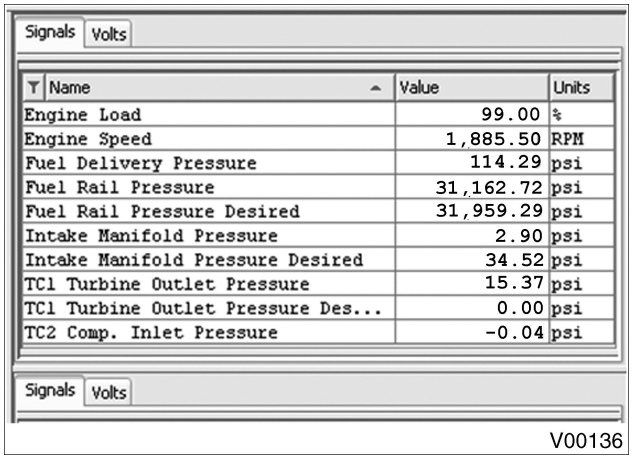

Figure 80 Performance session signals

6. Monitor the following signals:

   NOTE: ServiceMaxx™ software displays Fuel Delivery Pressure (FDP) signal 15 psi below actual gauge pressure. When monitoring FDP with ServiceMaxx™ software, the specification listed below is correct.

   - Fuel Delivery Pressure (FDP)
   - Fuel Rail Pressure (FRP)
   - Fuel Rail Pressure Desired (FRPD)
   - Engine Speed
   - Intake Manifold Pressure (IMP)
   - TC1 Turbine Outlet Pressure (TC1TOP)

7. Press the record button and start engine.
8. Allow engine to idle for 5 seconds. Depress accelerator pedal to floor and hold for 20 seconds, then return to low idle.
9. Review results with accelerator pedal at 99.6% and record on Diagnostics Form.
    - If FDP is below specification, go to Fuel Delivery Pressure Test (page 218) in the Low-pressure Fuel System section.
    - If FDP is above specification, go to High-pressure Pump Inlet Pressure Test (page 228).
    - If engine does not accelerate smoothly, or feels unbalanced, (not running on all cylinders), perform Cylinder Performance Test (page 239)and Fuel Pressure Control Valve (FPCV) Test (page 244).
    - If TC1TOP is above specification, verify Exhaust Back Pressure Valve (EBPV) is not the cause of the performance loss. See Exhaust Back Pressure Valve (EBPV) (page 213). If EBPV is operating correctly, inspect Diesel Oxidation Catalyst (DOC) for face plugging.
    - If IMP is below specifications, visually inspect for:
        - Charge Air Cooler (CAC) and tubing leaks
        - Intake restriction
        - Turbocharger damage
    - Remove and inspect IMP sensor for soot build up. clean sensor, reinstall, and continue.

6. KOER Air Management Test

NOTE: Truck air tank must be full before running this test.

Purpose

To verify air management valves are working correctly.

Tools

- EST with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

1. Turn ignition switch to ON, engine OFF.
2. Connect EST to vehicle's Diagnostic Connector.
3. Start ServiceMaxx™ software.
4. Start engine.
5. Select KOER Air Management Test from the Tests drop-down menu. Begin recording snapshot and follow instructions in ServiceMaxx™ software. Record results on Diagnostics Form.

   NOTE: Record whether Intake Manifold Pressure (IMP) increases or decreases with actuator change.

   NOTE: Turbocharger 1 Wastegate Control (TC1WC) does not affect engine performance and is removed from later-built engines.

   - If IMP does not decrease during EGR Valve and TC2 Wastegate CTL movement, or IMP increases during Exhaust Back Pressure Valve movement, go to the appropriate actuator in Air Control Valve (ACV) Tests (page 212) to diagnose suspect actuator.

7. Road Test (Full load to highway speed)

Purpose

Check for unacceptable engine performance at full load and rated speeds by means of maximum boost, minimum fuel pressure, and minimum Fuel Rail Pressure (FRP).

Tools

- EST with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

⚠ WARNING: To prevent personal injury or death, read all safety instructions in the "Safety Information" section of this manual.

NOTE: If truck has progressive shift or gear down protection enabled, disable these features prior to performing the road test.

NOTE: Perform test while bobtailing (not pulling a trailer).

1. Turn ignition switch to ON, engine OFF.
2. Connect EST to vehicle's Diagnostic Connector.
3. Start ServiceMaxx™ software.
4. Select Performance session.
5. Start engine.

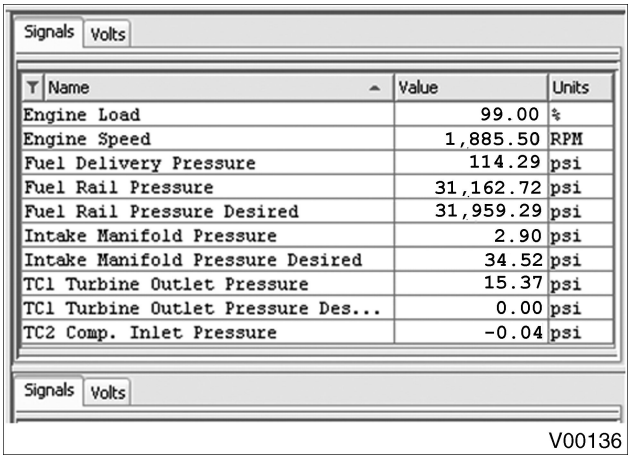

Figure 81 Performance session signals

6. Monitor the following signals:
   - Fuel Rail Pressure (FRP)
   - Fuel Delivery Pressure (FDP)
   - Fuel Rail Pressure Desired (FRPD)
   - Intake Manifold Pressure (IMP)
   - TC1 Turbine Outlet Pressure (TC1TOP)

7. Find an open stretch of road. Begin recording. When driving conditions are safe, select a suitable gear, press accelerator pedal fully to the floor, and accelerate to rated speed at 100% load.
8. When road test is complete, stop recording.
9. Review recorded results when engine was at 100% engine load and engine speed was at the rated speed specified in “APPENDIX A: PERFORMANCE SPECIFICATIONS." Record results on Diagnostics Form.
    - If FDP is below specification, go to Fuel Delivery Pressure Test (page 218) in the Low-pressure Fuel System section.
    - If FDP is above specification, go to High-pressure Pump Inlet Pressure Test (page 228).
    - If engine does not accelerate smoothly, or feels unbalanced, (not running on all cylinders), perform Cylinder Performance Test (page 239)and Fuel Pressure Control Valve (FPCV) Test (page 244).
    - If TC1TOP is above specification, verify Exhaust Back Pressure Valve (EBPV) is not the cause of the performance loss. See Exhaust Back Pressure Valve (EBPV) (page 213). If EBPV is operating correctly, inspect Diesel Oxidation Catalyst (DOC) for face plugging.
    - If IMP is below specifications, check for Charge Air Cooler (CAC) and tubing leaks.

Test Procedures

Fuel System

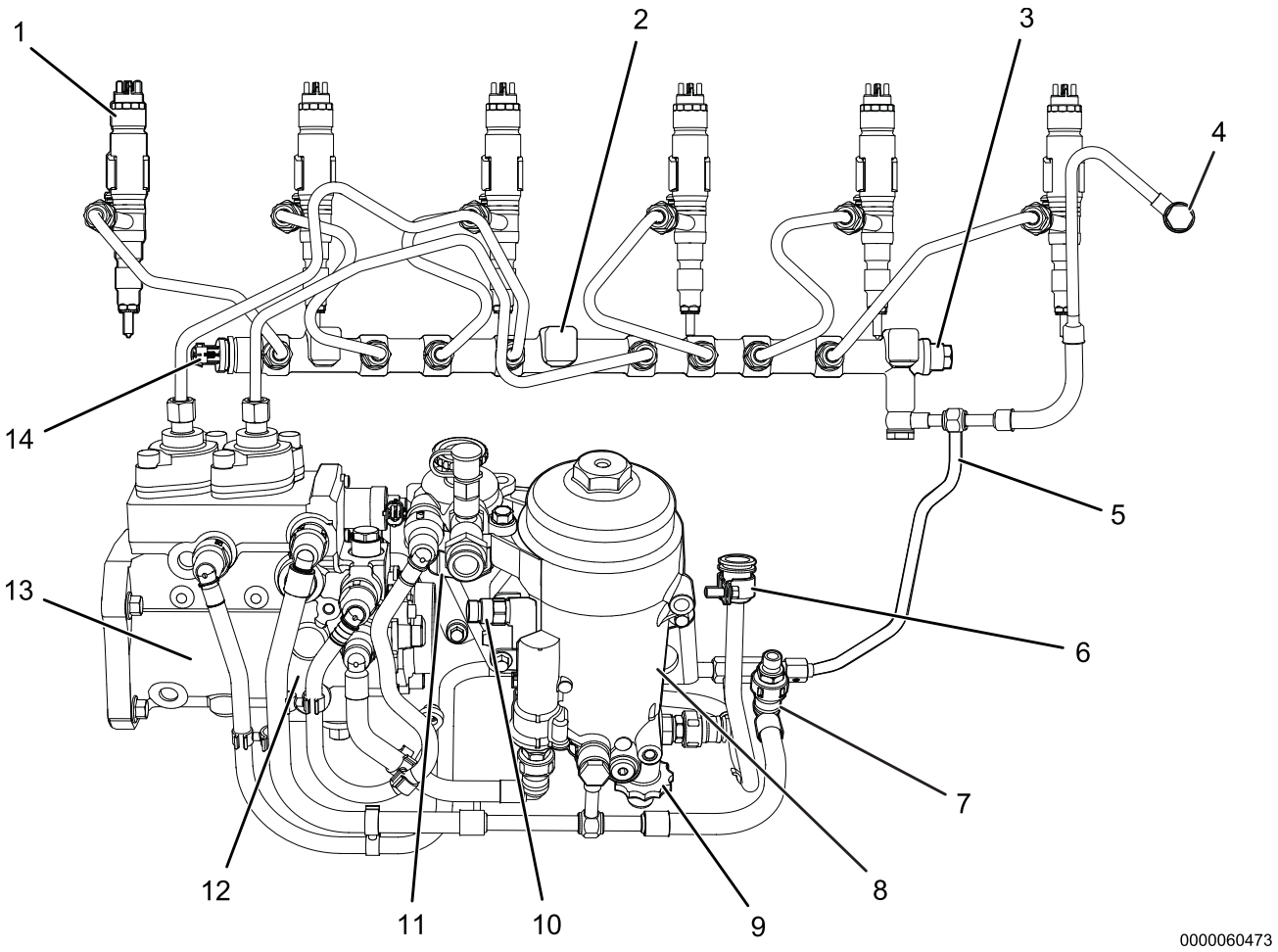

Figure 82 Fuel system

1. Injector (6)
2. Fuel Rail
3. Fuel rail pressure limiting valve
4. Fuel return from cylinder head
5. Fuel return line
6. Engine fuel return connection (to chassis filter)
7. Fuel supply to AFT fuel doser module
8. Fuel filter assembly
9. Drain screw
10. Fuel Delivery Pressure (FDP) sensor
11. Fuel primer pump assembly
12. LP fuel pump
13. HP fuel pump
14. Fuel Rail Pressure (FRP) sensor

Inlet Air Heater System

WARNING: To prevent personal injury or death, do not smoke or park vehicle near open flames or sparks when taking a fuel sample.

WARNING: To prevent personal injury or death, set parking brake, shift transmission to neutral or park, and block wheels starting the engine.

Inlet Air Heater System Test

Purpose

Verify Inlet Air Heater system is working correctly at any temperature.

Tools

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

Procedure

NOTE: Inlet Air Heater is commanded ON when Engine Coolant Temperature 1 (ECT1) is below 10°C (50°F).

Post production, ServiceMaxx™ software will have the ability to run Inlet Air Heater at higher temperatures.

1. Turn ignition switch to ON, engine OFF.
2. Connect EST to vehicle's Diagnostic Connector.
3. Start ServiceMaxx™ software.
4. Select Hard Start - No Start session.
5. Monitor Engine Coolant Temperature 1 (ECT1).
   - If ECT1 is above 10°C (50°F), use ServiceMaxx™ software to run Inlet Air Heater procedure.
   - If ECT1 is below 10°C (50°F), continue to next step.

   NOTE: The ECM may take 15 seconds or longer to reset between ignition switch cycles.
6. Cycle ignition switch and monitor Wait to Start lamp in vehicle's dashboard.
7. When Wait to Start lamp begins flashing, crank engine while monitoring Intake Manifold Temperature (IMT) and Fuel Delivery Pressure (FDP). Record results on Diagnostics Form.
   - If IMT does not rise approximately 5.5°C (10°F) during engine crank, go to Inlet Air Heater Fuel Igniter (IAHFI) Test.
   - If IMT rises 5.5°C (10°F) during engine crank, the Inlet Air Heater system is working correctly.
   - If FDP is below specification, go to Low-pressure Fuel System (page 217).

Inlet Air Heater Fuel Igniter (IAHFI) Test

Purpose

Verify IAHFI is working properly.

Tools

- Digital Multimeter (DMM)
- EXP-1000 HD by Midtronics

Procedure

1. Turn ignition switch to ON, engine OFF.
2. Connect EST to vehicle's Diagnostic Connector.
3. Start ServiceMaxx™ software.
4. Select 2010 BB Actuator session from the Sessions drop-down menu.

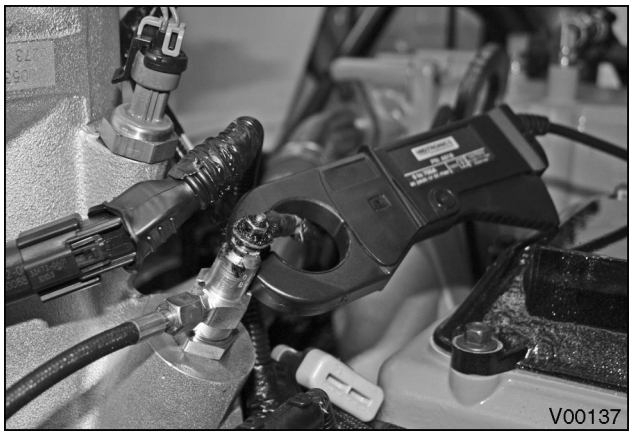

Figure 83 Current clamp on IAHFI

5. Connect EXP-1000 HD by Midtronics current clamp around IAHFI power circuit.
6. Select Inlet Air Heater Igniter from Actuator drop-down menu.
7. Press the Start Test button while monitoring current draw. Record results on Diagnostics Form.
   - If current draw is below specification, go to Inlet Air Heater Fuel Igniter (IAHFI) (page 520) in “ELECTRONIC CONTROL SYSTEMS DIAGNOSTICS.”
   - If current draw is above specification, IAHFI is working correctly. Continue to Fuel Supply at Inlet Air Heater Fuel Solenoid (IAHFS) Test.

Fuel Supply at Inlet Air Heater Fuel Solenoid (IAHFS) Test

Purpose

Verify sufficient fuel pressure is being supplied to the IAHFS.

Tools

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)
- ZTSE4681 – Fuel Pressure Gauge
- ZTSE6059 – Inlet Air Heater Solenoid Test Adapter Kit

Procedure

1. Turn ignition switch to ON, engine OFF.
2. Connect EST to vehicle's Diagnostic Connector.
3. Start ServiceMaxx™ software.
4. Select Hard Start - No Start session.
5. Crank engine while monitoring Fuel Delivery Pressure (FDP).
   - If FDP is below specification, go to Fuel Delivery Pressure Test (page 218).
   - If FDP is within specification, continue to next step.
6. Disconnect fuel supply to IAHFS.

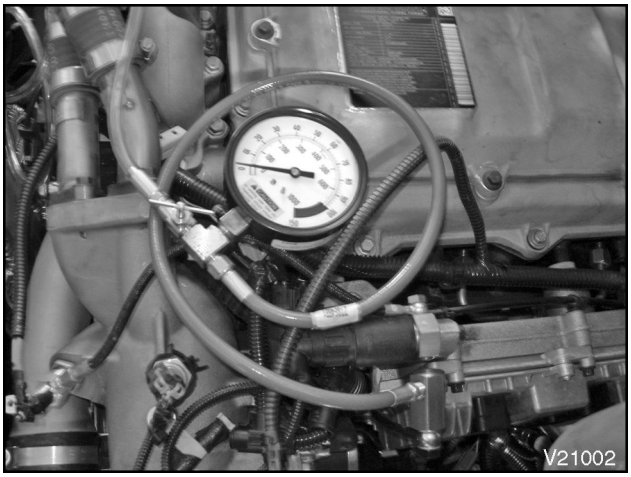

Figure 84 Fuel Pressure Gauge ZTSE4681 connected to IAHFS fuel supply line

7. Use Inlet Air Heater Solenoid Test Adapter Kit ZTSE6059 to connect Fuel Pressure Gauge ZTSE4681 to IAHFS fuel supply line.

8. Crank engine while monitoring Fuel Pressure Gauge ZTSE4681. Record results on Diagnostics Form.
   - If pressure is below specification, inspect IAHFS fuel supply line for restriction. If IAHFS fuel supply line is not restricted, replace fuel regulator in fuel filter housing.
   - If pressure is within specification, go to Fuel Supply at Inlet Air Heater Fuel Igniter (IAHFI) Test.

Fuel Supply at Inlet Air Heater Fuel Igniter (IAHFI) Test

Purpose

Verify sufficient fuel pressure is being supplied to the IAHFI.

Tools

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)
- ZTSE4681 – Fuel Pressure Gauge
- ZTSE6059 – Inlet Air Heater Solenoid Test Adapter Kit

Procedure

NOTE: This test can only be run if ECT1 is below 10 °C (50 °F) or ServiceMaxx™ software can run the Inlet Air Heater procedure.

NOTE: Post production, ServiceMaxx™ software will have the ability to run Inlet Air Heater at higher temperatures.

1. Turn ignition switch to ON, engine OFF.
2. Connect EST to vehicle's Diagnostic Connector.
3. Start ServiceMaxx™ software.
4. Select Hard Start - No Start session.
5. Reinstall fuel supply line to Inlet Air Heater Fuel Solenoid (IAHFS) disconnected in previous test.
6. Disconnect fuel supply to IAHFI.

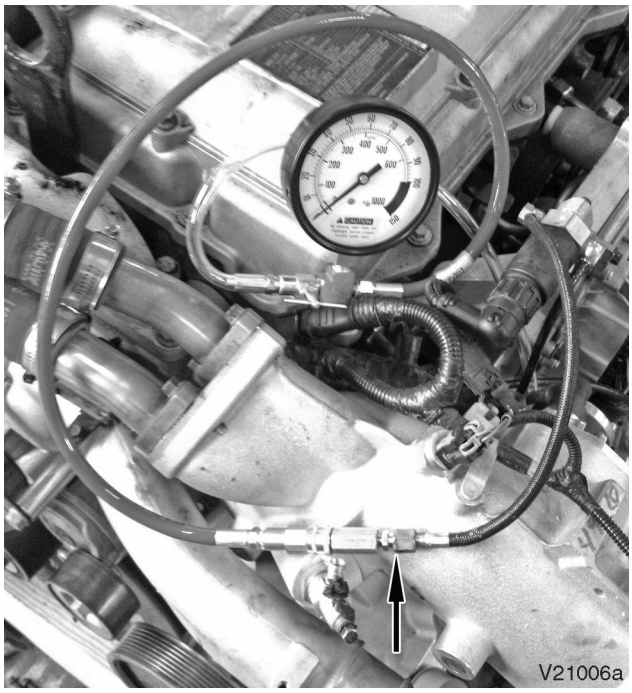

Figure 85 Fuel Pressure Gauge ZTSE4681 connected to IAHFI fuel supply line

7. Use Inlet Air Heater Solenoid Test Adapter Kit ZTSE6059 to connect Fuel Pressure Gauge ZTSE4681 to IAHFI fuel supply line.
8. Monitor Wait to Start lamp in vehicle's dashboard.
9. When Wait to Start lamp begins flashing, crank engine while monitoring Fuel Pressure Gauge ZTSE4681. Record results on Diagnostics Form.
    - If pressure is below specification, inspect IAHFI fuel supply line for restriction. If IAHFI fuel supply line is not restricted, see Inlet Air Heater Fuel Solenoid (page 520) in “ELECTRONIC CONTROL SYSTEMS DIAGNOSTICS.”
    - If pressure is within specification, replace IAHFI.

Air Control Valve (ACV) Tests

NOTE: Truck air tank must be full before running these tests.

Purpose

Verify air management valves are working correctly.

Tools

- EST with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

Exhaust Back Pressure Valve (EBPV)

NOTE: To ease measurement, slide a piece of cardboard behind the EBPV. Mark a line with a pen, run the actuator test, then mark another line when the valve is fully extended. Take the cardboard out and measure the distance.

1. Turn ignition switch to ON, engine OFF.
2. Connect EST to vehicle's Diagnostic Connector.
3. Start ServiceMaxx™ software.
4. Select Tools > KOEO Tests > Actuator Test.
5. Select Exhaust Back Pressure Valve from Actuator drop-down menu and set to 95%.

NOTE: Test will command the actuator ON for 5 seconds, then will return it to the default closed position.

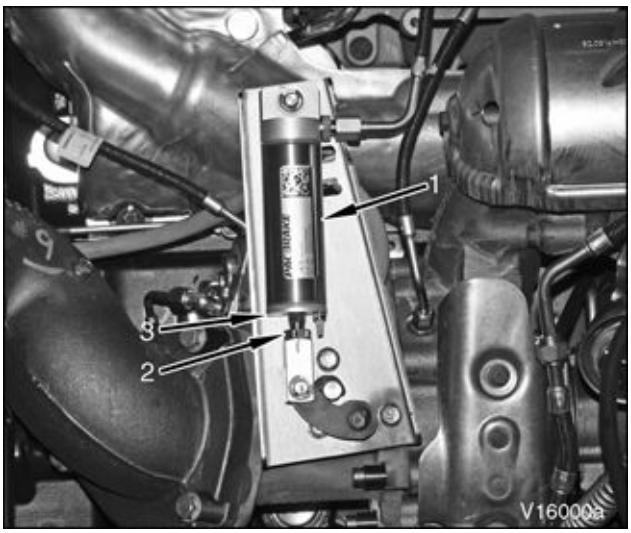

Figure 86 EBPV closed

1. EBPV
2. Jam nut
3. Bottom of housing

6. Press the Start button and measure actuator rod movement. Record results on Diagnostics Form.

   NOTE: Measurement is taken between the bottom of the housing and the jam nut.

   - If actuator rod moves full travel, no action is required.
   - If actuator rod does not move full travel, continue to next step.

7. Remove air supply line from actuator and repeat actuator test.

   - If air cannot be heard leaving the open air supply line when running the test, inspect supply line for blockage or damage. If supply line is not blocked or damaged, see EBPV (page 959), in “ELECTRONIC CONTROL SYSTEMS DIAGNOSTICS.”
   - If air can be heard leaving the open air supply line, continue to next step.

8. Remove actuator rod from valve arm. Check if the valve arm moves freely.
   - If valve arm moves freely, replace air actuator.
   - If valve arm does not move freely, replace valve.

Turbocharger 2 Wastegate Control (TC2WC)

NOTE: To ease measurement, slide a piece of cardboard behind the TC2WC. Mark a line with a pen, run the actuator test, then mark another line when it's fully extended. Take the cardboard out and measure the distance.

1. Turn ignition switch to ON, engine OFF.
2. Connect EST to vehicle's Diagnostic Connector.
3. Start ServiceMaxx™ software.
4. Select 2010 BB Actuator session.

NOTE: On a cold engine, the TC2 Wastegate Control defaults to open (100.00%) to prevent turbocharger damage.

5. Select TC2 Wastegate Control from Actuator drop-down menu and set to ON (95% Duty Cycle).

   NOTE: If TC2 Wastegate CTL displays a value of 100.00% before test is started, duty cycle must be set to Off (5% duty cycle) for actuator rod to move.

NOTE: Test will command actuator ON for 5 seconds, then actuator will return to default position.

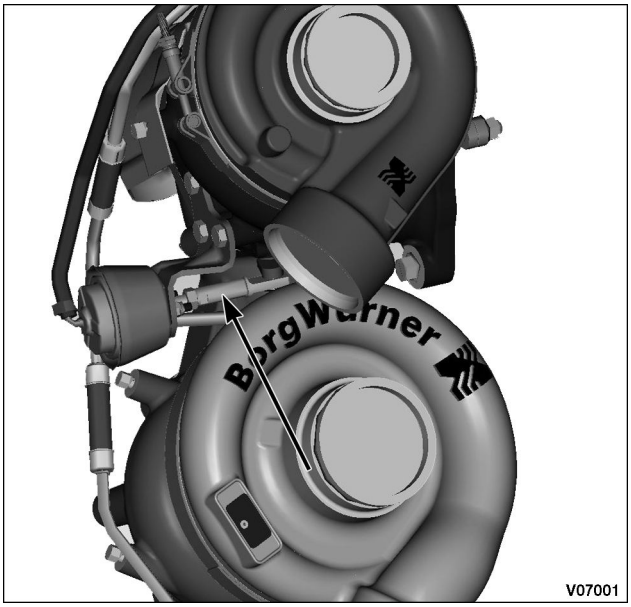

Figure 87 TC2 wastegate valve in closed position

6. Press the Start button and measure actuator rod movement. Record results on Diagnostics Form.
   - If actuator rod moves full travel, no action is required.
   - If actuator rod does not move full travel, continue to next step.
7. Remove air supply line from actuator and repeat actuator test.
   - If air cannot be heard leaving the open air supply line when running the test, see TC2WC (page 1404), in "ELECTRONIC CONTROL SYSTEMS DIAGNOSTICS."
   - If air can be heard leaving the open air supply line, continue to next step.

8. Remove actuator rod from valve arm. Check if the valve arm moves freely.
   - If valve arm moves freely, replace air actuator.
   - If valve arm does not move freely, replace valve.

Fuel System

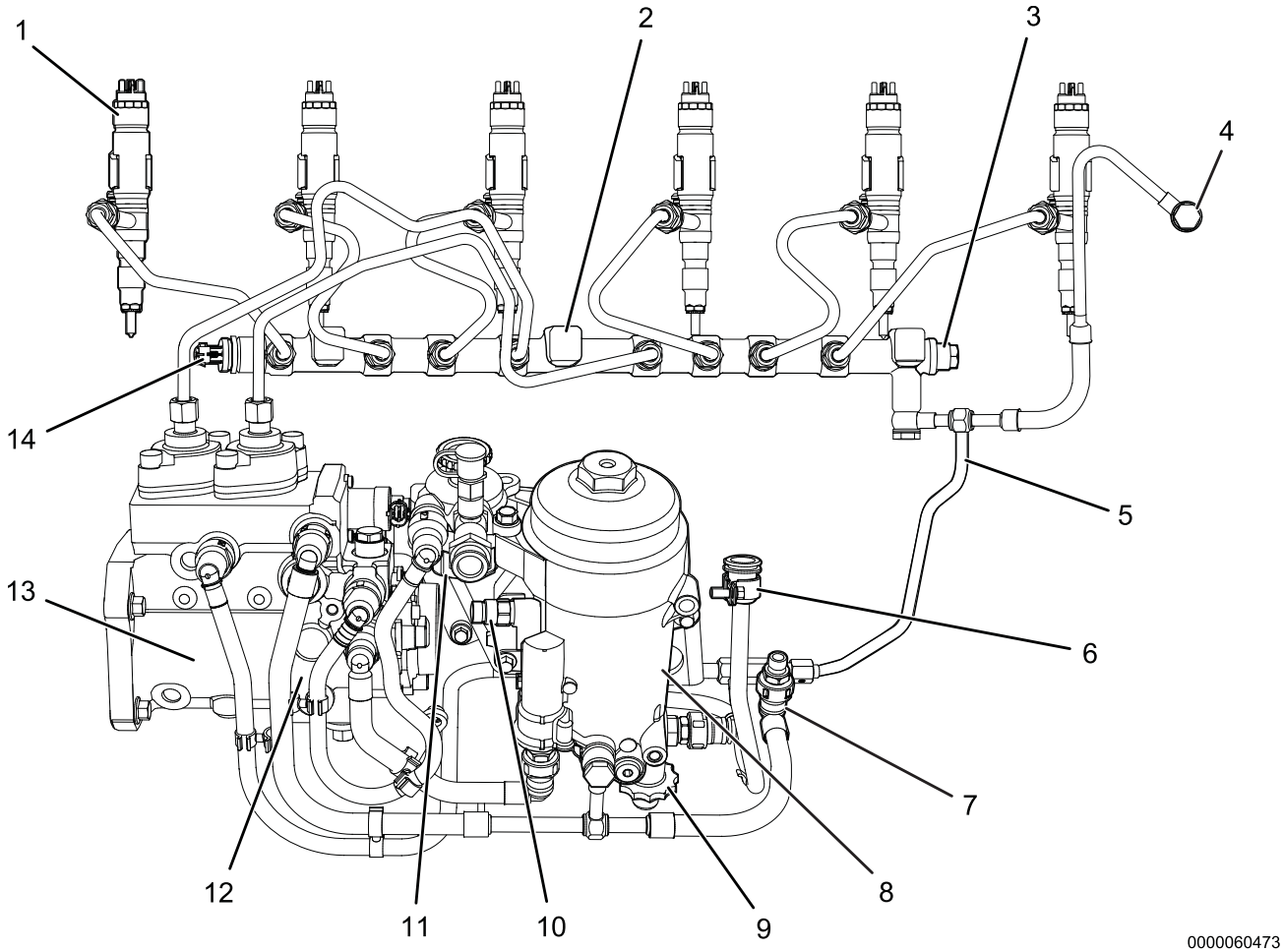

Figure 88 Fuel system

1. (Fuel) Injector (6)
2. Fuel Rail
3. Fuel rail pressure limiting valve
4. Fuel return from cylinder head
5. Fuel return line
6. Engine fuel return connection (to chassis filter)
7. Fuel supply to AFT fuel doser module
8. Secondary fuel filter assembly
9. Drain screw
10. Fuel Delivery Pressure (FDP) sensor
11. Fuel primer pump assembly
12. Low-pressure (LP) fuel pump
13. HP fuel pump
14. Fuel Rail Pressure (FRP) sensor

Low-pressure Fuel System

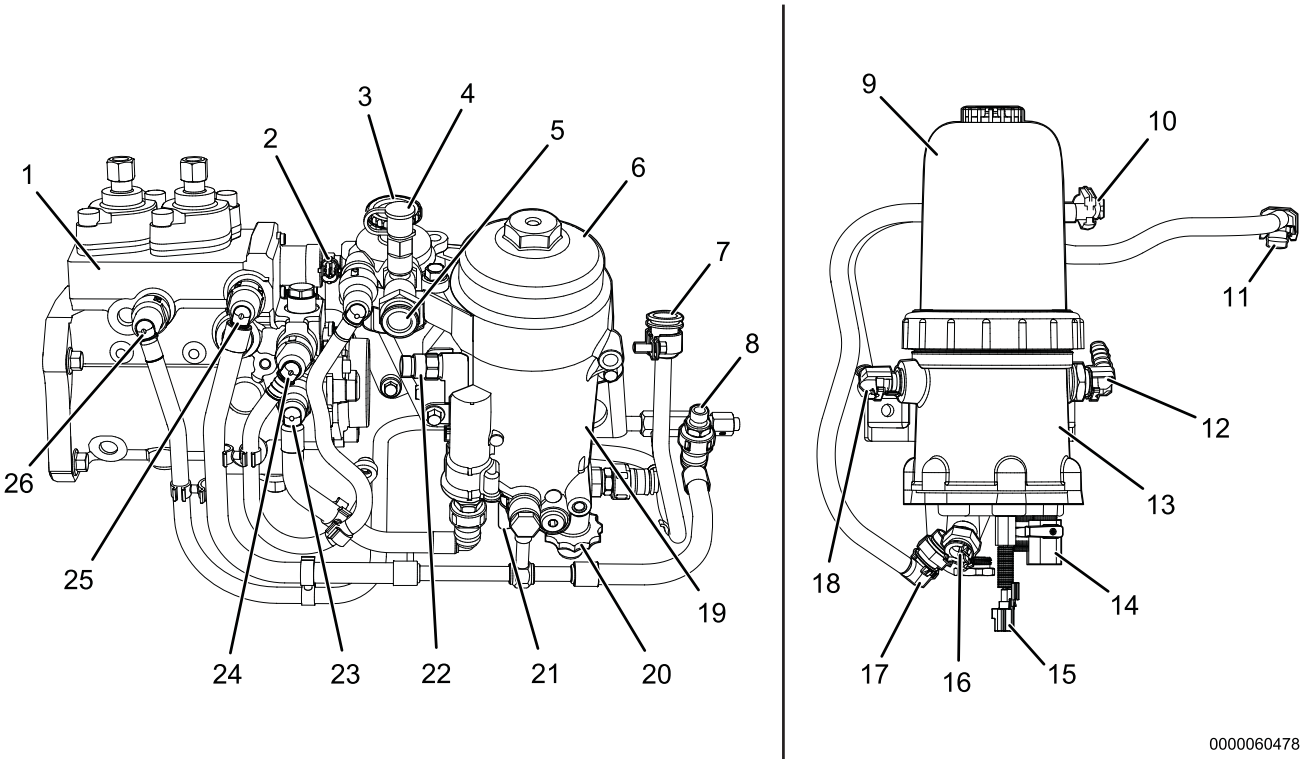

Figure 89 Low-pressure (LP) fuel system

1. HP fuel pump
2. Fuel Pressure Control Valve (FPCV)
3. Fuel primer pump assembly w/ fuel strainer element
4. Fuel pressure test port
5. Engine fuel supply connection
6. Engine mounted secondary fuel filter access
7. Engine fuel return connection
8. Fuel supply to AFT fuel doser module
9. Chassis mounted primary fuel filter access
10. Fuel supply to engine
11. Fuel return from engine
12. Fuel supply from tank
13. Chassis mounted fuel filter/water separator
14. Fuel Heater
15. Water In Fuel (WIF) sensor
16. Fuel return to tank
17. Fuel return from engine
18. Fuel supply to engine
19. Fuel filter housing assembly (engine mounted)
20. Fuel filter drain screw
21. Inlet air heater port
22. Fuel Delivery Pressure (FDP) sensor
23. LP fuel pump outlet
24. LP fuel pump inlet
25. HP fuel pump inlet
26. HP fuel pump return

GOVERNMENT REGULATION: Engine fluids (oil, fuel, and coolant) may be a hazard to human health and the environment. Handle all fluids and other contaminated materials (e.g. filters, rags) in accordance with applicable regulations. Recycle or dispose of engine fluids, filters, and other contaminated materials according to applicable regulations.

WARNING: To prevent personal injury or death, read all safety instructions in the "Safety Information" section of this manual.

WARNING: To prevent personal injury or death, do not let engine fluids stay on your skin. Clean skin and nails using hand cleaner and wash with soap and water. Wash or discard clothing and rags contaminated with engine fluids.

WARNING: To prevent personal injury or death, shift transmission to park or neutral, set parking brake, and block wheels before doing diagnostic or service procedures.

WARNING: To prevent personal injury or death, do not smoke and keep fuel away from flames and sparks.

WARNING: To prevent personal injury or death, provide proper ventilation when operating an engine in a closed area. Inhalation of exhaust gas can be fatal.

Fuel Delivery Pressure (FDP) Test

NOTE: Perform this test if led here from the Low Idle to High Idle Test or Road Test.

Purpose

Verify low-pressure fuel pump has the ability to build sufficient fuel pressure for proper engine performance.

Tools

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)
- 15-637-01 – Clean Fuel Source Tool
- ZTSE4891 – Air Cap, Fuel Cap, and Plug Kit

Procedure

CAUTION: To prevent damage to engine, use clean fuel system caps to plug component connections immediately after each fuel line is removed.

NOTE: Ensure fuel lines are clean from heavy debris before breaking fuel line connections.

1. With the engine OFF, disconnect fuel supply line at low-pressure fuel pump inlet and cap it off using Air Cap, Fuel Cap, and Plug Kit ZTSE4891.

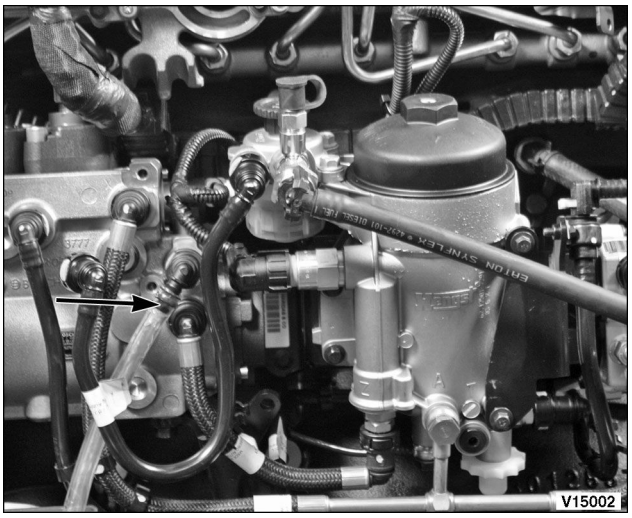

Figure 90 Clean Fuel Source Tool connected to low-pressure fuel pump inlet

2. Connect Clean Fuel Source Tool 15-637-01 to low-pressure fuel pump inlet.
3. Use Clean Fuel Source Tool 15-637-01 to prime fuel system.
    a. Close the ball valve on the Clean Fuel Source Tool 15-637-01 fuel supply line
    b. Fully squeeze the primer bulb on the Clean Fuel Source Tool 15-637-01. Repeat until fuel system is primed (no air visible in clear lines of Clean Fuel Source Tool).
    c. After fuel system is primed, open ball valve on Clean Fuel Source Tool 15-637-01 fuel supply line.
4. Turn ignition switch to ON, engine OFF.
5. Connect EST to vehicle's Diagnostic Connector.
6. Start ServiceMaxx™ software.
7. Select Performance session.

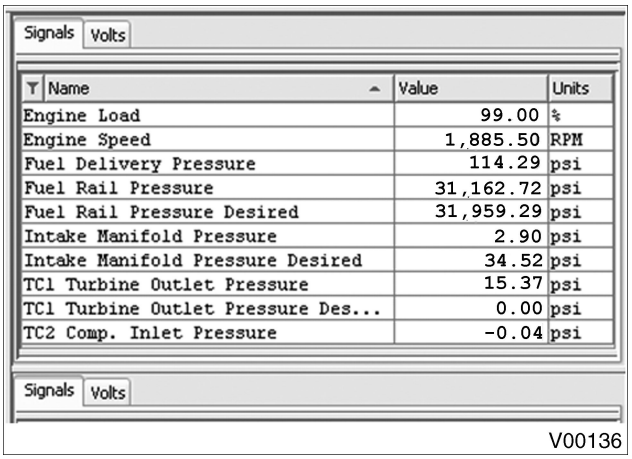

Figure 91 Performance session signals

8. Start engine while monitoring Fuel Delivery Pressure (FDP). Depress accelerator pedal to floor for 20 seconds and return to low idle.

   NOTE: ServiceMaxx™ software displays Fuel Delivery Pressure (FDP) signal 15 psi below actual gauge pressure. When monitoring FDP with ServiceMaxx™ software, the specification listed on the Diagnostics Form is correct.

   - If FDP is within specification, go to Fuel Aeration and Restriction Tests (page 221).
   - If FDP builds above specification, go to High Pressure Pump Inlet Pressure Test (High-pressure Pump Inlet Pressure Test, page 228).

Fuel Aeration and Restriction Tests

Aeration Test

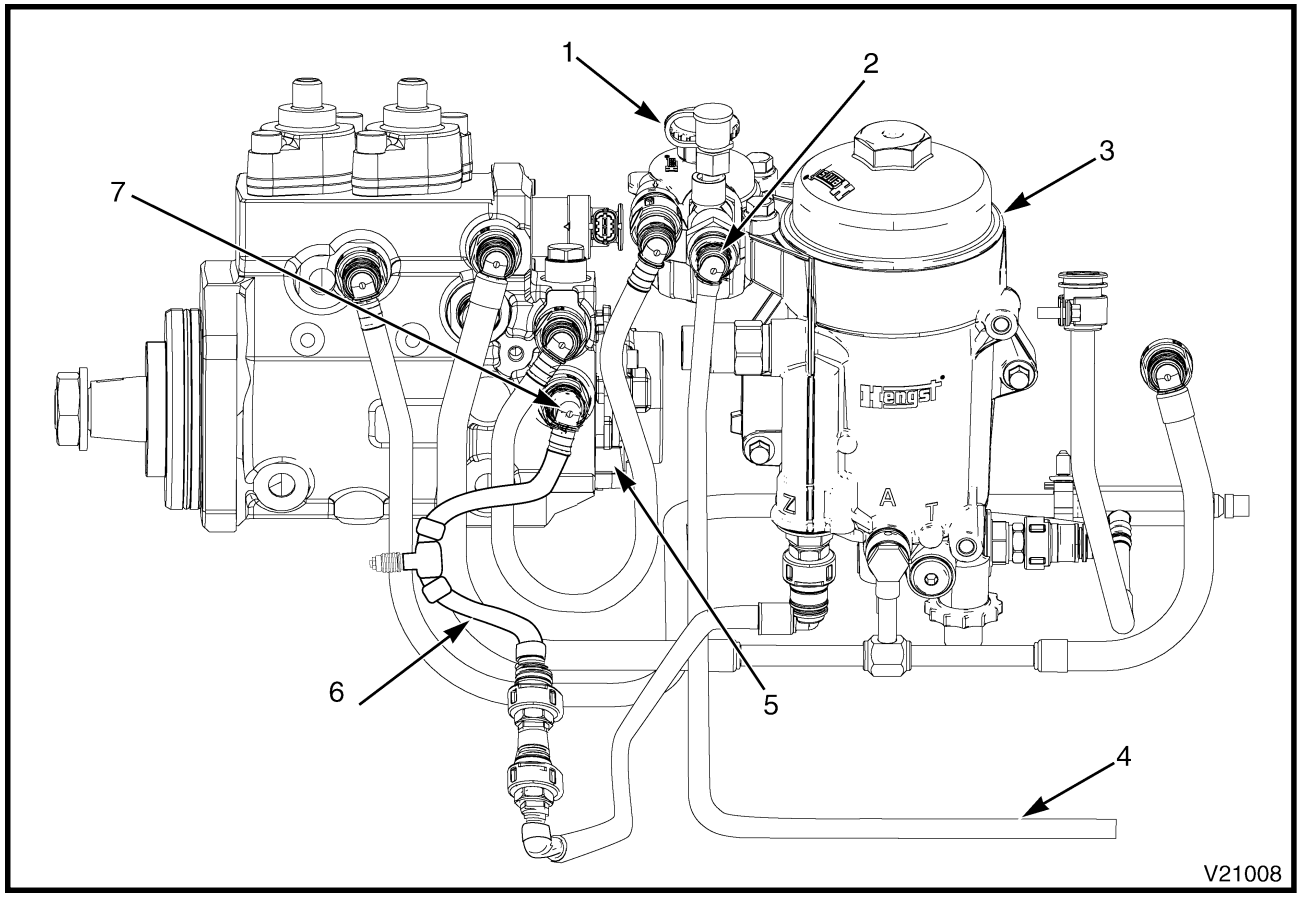

Figure 92 Fuel Aeration Test

1. Strainer / primer pump
2. Test point 2
3. Secondary fuel filter
4. Fuel supply from primary fuel filter
5. Low-pressure fuel pump
6. Fuel Inlet Restriction / Aeration Tool
7. Test point 1

Purpose

Check for fuel aeration.

Tools

- 15-637-01 – Clean Fuel Source Tool
- ZTSE4886 – Fuel Inlet Restriction / Aeration Tool
- ZTSE4905 – Fuel Block Off Tool
- ZTSE4906 – Fuel Line Coupler

Aeration Test Point 1

Procedure

1. Remove Clean Fuel Source Tool 15-637-01 from low-pressure fuel pump inlet and restore vehicle fuel supply line.
2. Use Fuel Line Coupler ZTSE4906 to connect Fuel Inlet Restriction / Aeration Tool ZTSE4886 between fuel supply line to secondary fuel filter and low-pressure fuel pump outlet.
3. Prime fuel system by pumping primer pump.
4. Start engine. Raise engine speed to high idle while visually monitoring for fuel aeration (air bubbles passing through the clean line).
    - If fuel is not aerated, go to Restriction Test.
    - If fuel is aerated, continue to step 5.

Aeration Test Point 2

5. Connect Clean Fuel Source Tool 15-637-01 to primer pump inlet.
6. Prime fuel system by pumping primer pump.
7. Start engine. Raise engine speed to high idle while visually monitoring for fuel aeration (air bubbles passing through the clean line).
    - If fuel is not aerated, repair fuel supply line between fuel primer pump and fuel tank.
    - If fuel is aerated, repair low-pressure fuel pump supply line or fuel primer pump.

Restriction Test

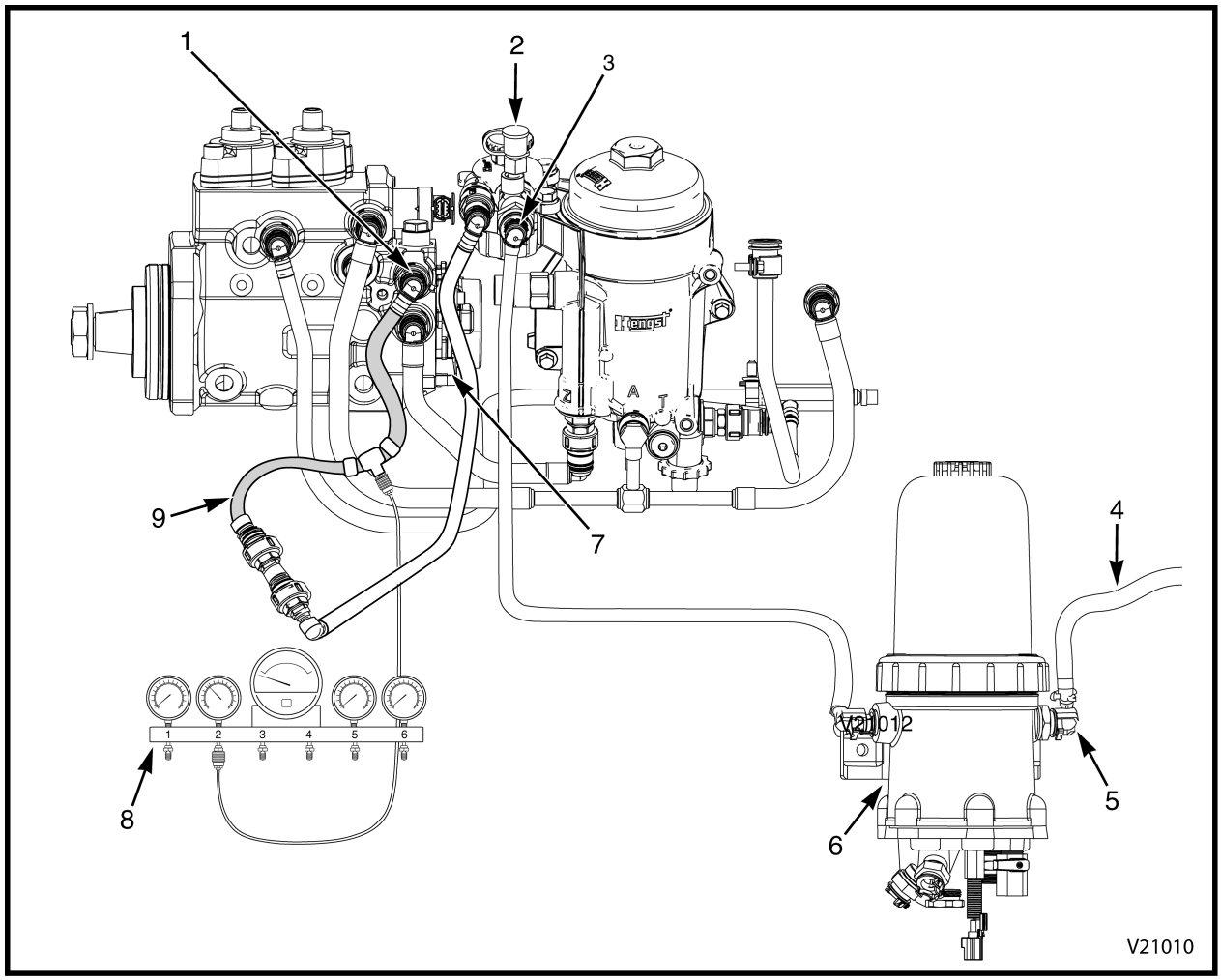

Figure 93 Fuel Restriction Test

1. Test point 1
2. Strainer / primer pump
3. Test point 2
4. Fuel supply from tank
5. Test point 3
6. Primary fuel filter
7. Low-pressure fuel pump
8. Pressure Test Kit (vacuum gauge)
9. Fuel Inlet Restriction / Aeration Tool

Purpose

Check for fuel supply restriction.

Tools

- ZTSE4526 – Compucheck fitting
- 15-637-01 – Clean Fuel Source Tool
- ZTSE4409 – Pressure Test Kit
- ZTSE4886 – Fuel Inlet Restriction / Aeration Tool
- ZTSE4906 – Fuel Line Coupler

Procedure

Test Point 1

1. Use Fuel Line Coupler ZTSE4906 to connect Fuel Inlet Restriction / Aeration Tool ZTSE4886 between low-pressure fuel pump supply line and low-pressure fuel pump inlet.
2. Connect Pressure Test Kit ZTSE4409 vacuum gauge to Fuel Inlet Restriction / Aeration Tool ZTSE4886.
3. Prime fuel system by pumping primer pump.
4. Start engine. Raise engine speed to high idle while monitoring Pressure Test Kit vacuum gauge.
   - If restriction is above specification, go to Restriction Test Point 2.

Test Point 2

1. Connect Clean Fuel Source Tool 15-637-01 to primer pump inlet.
2. Prime fuel system by pumping primer pump.
3. Start engine. Raise engine speed to high idle while monitoring Pressure Test Kit ZTSE4409 vacuum gauge.
   - If restriction is within specification, go to Restriction Test Point 3.
   - If restriction is above specification, repair or replace fuel strainer and primer pump assembly, and check fuel lines.

Test Point 3

1. Connect Clean Fuel Source Tool 15-637-01 to primary filter inlet.
2. Prime fuel system by pumping primer pump.
3. Start engine. Raise engine speed to high idle while monitoring Pressure Test Kit ZTSE4409 vacuum gauge.
   - If restriction is within specification, repair restriction between primary fuel filter and fuel tank.
   - If restriction is above specification, replace primary fuel filter, clean fuel strainer, and check fuel lines.

Fuel Dead Head Test

Purpose

Isolate fuel pump to determine if it is able to build proper pressure.

Tools

- Compucheck fitting
- 15-637-01 – Clean Fuel Source Tool
- ZTSE4681 – Fuel Pressure Gauge
- ZTSE4886 – Fuel Inlet Restriction / Aeration Tool
- ZTSE4905 – Fuel Block Off Tool

Procedure

1. Retain connection between Clean Fuel Source Tool 15–637–01 and low-pressure fuel pump inlet from previous test.
2. Disconnect fuel line from low-pressure fuel pump outlet.

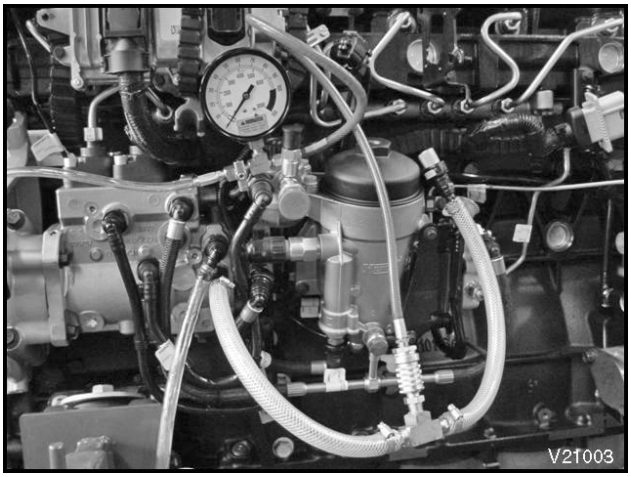

Figure 94 Fuel Inlet Restriction / Aeration Tool ZTSE4886 connected to low-pressure fuel pump outlet.

3. Connect Fuel Inlet Restriction / Aeration Tool ZTSE4886 to low-pressure fuel pump outlet.
4. Use compucheck fitting to connect Fuel Pressure Gauge to Fuel Inlet Restriction / Aeration Tool ZTSE4886.
5. Connect Fuel Block Off Tool to Fuel Restriction / Aeration Tool ZTSE4886.
6. Crank engine to remove air from fuel lines.
7. Crank engine until fuel pressure stabilizes or up to a maximum of 20 seconds.
8. Record gauge pressure on Diagnostics Form.
    - If pressure is within specification, inspect secondary fuel filter, stand pipe, and housing for defects or damage. If no defect or damage is found, go to Fuel Rail Pressure (FRP) Return Flow Test.

- If pressure is below specification, replace fuel pump following procedures in the *Engine Service Manual*. To prevent damage to a newly installed fuel pump and to verify high back pressure did not cause fuel pump to fail, perform HP Pump Fuel Return Pressure Test (page 227) any time fuel pump is replaced.

NOTE: Before installing a new fuel pump, ensure new fuel pump is the correct replacement part.

High-pressure Fuel System

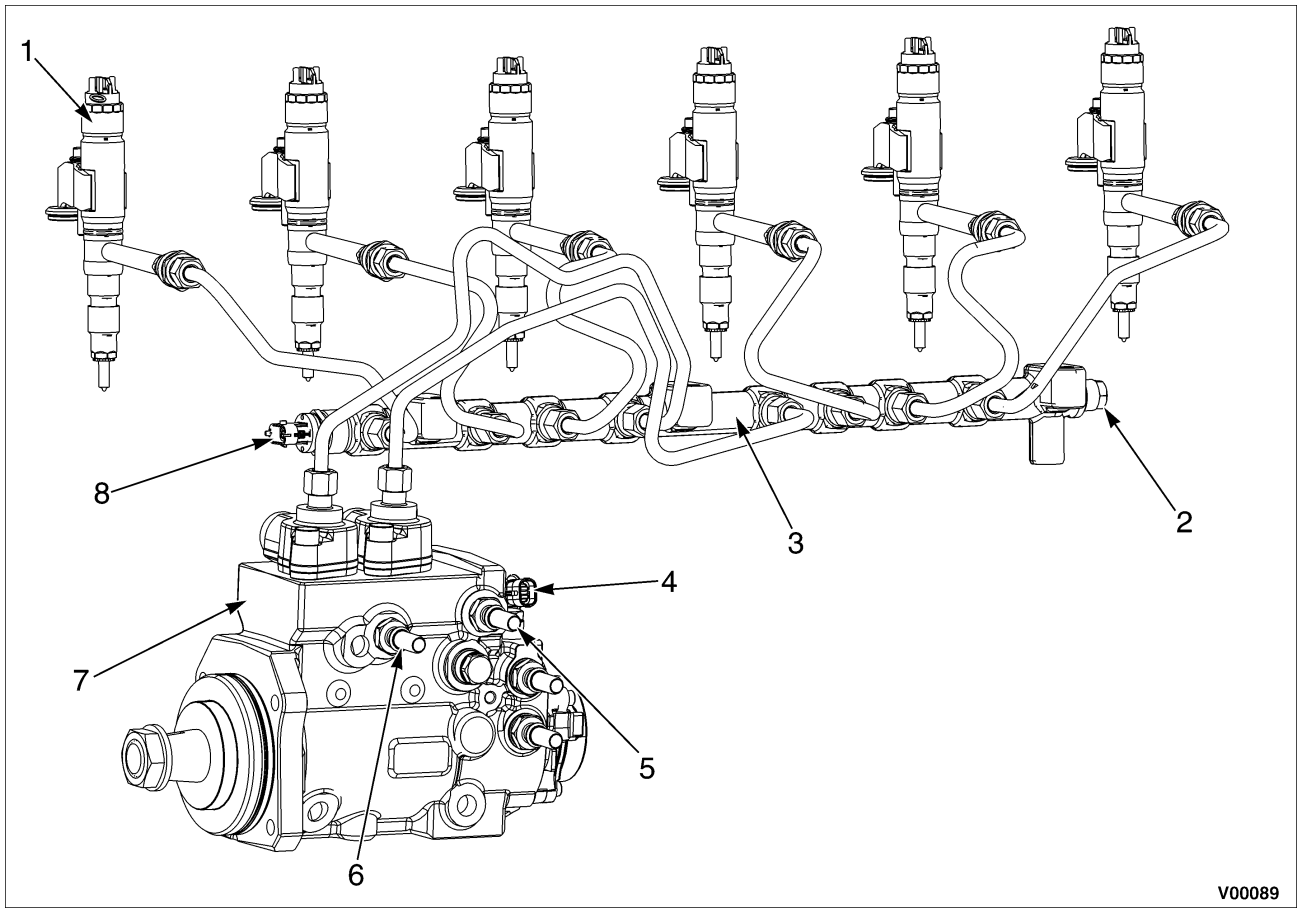

Figure 95 High-pressure (HP) fuel system

1. Injector (6)
2. Fuel rail pressure limiting valve
3. Fuel Rail
4. Fuel Pressure Control Valve (FPCV)
5. HP fuel pump inlet
6. HP fuel pump return
7. HP fuel pump
8. Fuel Rail Pressure (FRP) sensor

High-pressure Pump Inlet Pressure Test

Purpose

Verify high-pressure fuel pump is receiving fuel.

Tools

- ZTSE4681 – Fuel Pressure Gauge
- ZTSE4886 – Fuel Inlet Restriction / Aeration Tool
- ZTSE4905 – Fuel Block Off Tool
- ZTSE4906 – Fuel Line Coupler

Procedure

1. Disconnect fuel supply to AFT fuel doser module.
2. Use Fuel Line Coupler ZTSE4906 to connect Fuel Inlet Restriction / Aeration Tool ZTSE4886 to AFT fuel doser module fuel supply line.

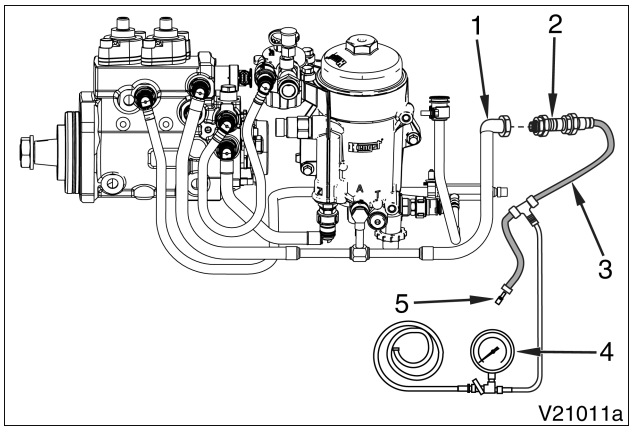

Figure 96 Pressure Test Kit connected to AFT fuel doser module fuel supply line

1. AFT fuel doser module Fuel Supply Line
2. Fuel Line Coupler
3. Fuel Inlet Restriction / Aeration Tool
4. Fuel Pressure Gauge
5. Fuel Block Off Tool

3. Connect Fuel Block Off Tool ZTSE4905 to Fuel Inlet Restriction / Aeration Tool ZTSE4886.
4. Connect ZTSE4681 Fuel Pressure Gauge to Fuel Inlet Restriction / Aeration Tool ZTSE4886.
5. Start engine and run at high idle for 20 seconds, while monitoring Fuel Pressure Gauge ZTSE4681.
   - If gauge pressure is within specification, go to Fuel Rail Pressure (FRP) Return Flow Test (page 229).
   - If gauge pressure is below specification, replace secondary fuel filter.

Fuel Rail Pressure (FRP) Return Flow Test

Purpose

Verify return flow is within specifications.

Tools

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)
- Diesel fuel container with measuring marks
- ZTSE4887 – High Pressure Return Line Tester

Fuel Rail Pressure (FRP) Return Flow Test Part 1

NOTE: Before running this test, ensure low-pressure fuel system is operating correctly.

1. Restore fuel line connection between low-pressure fuel pump outlet and secondary fuel filter housing.
2. Disconnect fuel drain tube assembly at rear of cylinder head.

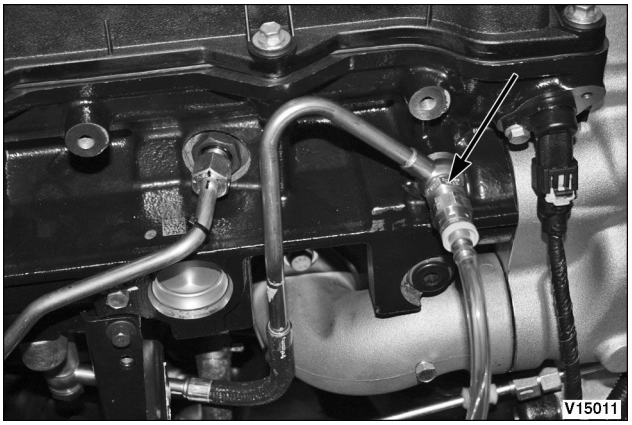

Figure 97 High Pressure Return Line Tester connected to cylinder head

3. Connect High Pressure Return Line Tester ZTSE4887-2 using 2 banjo ring seals to cylinder head fuel drain tube fitting. Thread ZTSE4887-3 to ZTSE4887-2 and route the end into a diesel fuel container.
4. Start engine and run at low idle. When fuel flow is steady and fuel volume reaches a good starting measurement point, start timer and begin measurement. Measure fuel return volume for 1 minute.
   - If fuel volume is above specification, go to Fuel Rail Pressure (FRP) Leak Isolation.
   - If fuel volume is within specification, continue to next step.

Fuel Rail Pressure (FRP) Return Flow Test Part 2

NOTE: Before running this test, ensure low-pressure fuel system is operating correctly.

5. Reinstall fuel drain tube assembly disconnected in step 1.
6. Disconnect fuel rail return line at fuel rail.

7. Connect High Pressure Return Line Tester ZTSE4887-2 using 2 banjo ring seals to fuel rail return port. Thread ZTSE4887-3 to ZTSE4887-2 and route the end into a diesel fuel container.
8. Start engine and run at high idle. Monitor fuel return from High Pressure Return Line Tester ZTSE4887.
   - If fuel flows from High Pressure Return Line Tester ZTSE4887, replace fuel rail pressure relief valve.
   - If fuel does not flow from High Pressure Return Line Tester ZTSE4887, no further action is required.

Fuel Rail Pressure (FRP) Leak Isolation

Normal fuel return flow with number of connected injectors

All 6 INJs	5 INJs	4 INJs	3 INJs	2 INJs
> 20 - 22 ml	16 - 18 ml	12 – 16 ml	8 - 12 ml	8 - 10 ml

NOTE: This table displays typical fuel return volume specifications for a good running engine. Results much higher than specification indicate an excessive leak.

Purpose

Isolate pressure loss in high-pressure fuel system.

Tools

- Diesel fuel container measuring in milliliters
- ZTSE4887 – High Pressure Rail Return Line Tester
- ZTSE6098 – High Pressure Rail Plugs

Procedure

WARNING: The high-pressure fuel system may have extremely high pressure. Verify pressure is below 500 psi before cracking a line. Every time the engine is shut down and the key is in the OFF position, the ECM commands a blank shot injection process that drains the high-pressure fuel rail.

NOTE: Only run this test if engine fails High Pressure Pump test.

1. Retain High Pressure Return Line Tester ZTSE4887 connection to cylinder head from previous test.

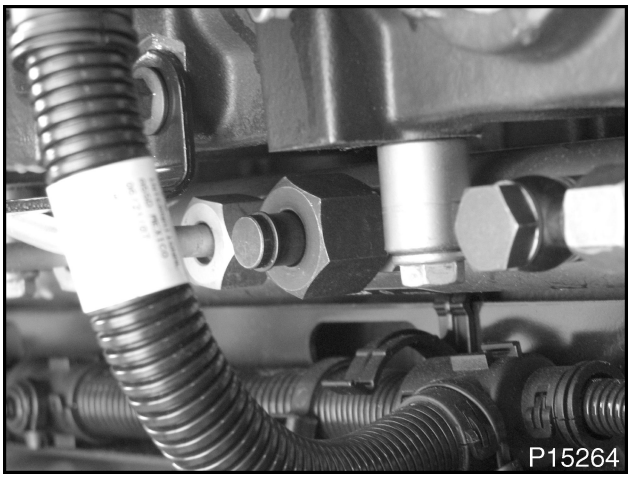

Figure 98 High Pressure Rail Plug installed on injector six

2. Disconnect number six injector fuel line and cap off rail with High Pressure Rail Plug ZTSE6098.

3. Start engine and run at low idle. When fuel flow is steady and fuel volume reaches a good starting measurement point, start timer, and begin measurement. Measure fuel return volume for 1 minute.
   - If fuel volume is above specification, leave High Pressure Rail Plug ZTSE6098 installed and continue to next step.
   - If fuel volume is within specification, replace injector tube and high-pressure connector body following procedures in the *Engine Service Manual*. Retest volume of fuel being returned with all six injectors connected to verify repair.
4. Disconnect number five injector fuel line and cap off rail with High Pressure Rail Plug ZTSE6098.

5. Start engine and run at low idle. When fuel flow is steady and fuel volume reaches a good starting measurement point, start timer and begin measurement. Measure fuel return volume for 1 minute.
   - If fuel volume is above specification, leave High Pressure Rail Plug ZTSE6098 connected and continue capping off one injector supply port at a time until excessive leak is isolated. Once the excessive leak is isolated, replace the removed injector tubes with new parts.

HP Pump Fuel Return Pressure Test

Purpose

Verify return flow is within specifications.

Tools

- ZTSE4526 – Compucheck fitting
- ZTSE4681 – Fuel Pressure Gauge
- ZTSE4886 – Fuel Inlet Restriction / Aeration Tool
- ZTSE4906 – Fuel Line Coupler

Procedure

NOTE: Prior to performing this test, ensure new fuel pump is the correct replacement part.

1. Restore fuel system to normal operating condition.
2. Disconnect high-pressure fuel pump return line.

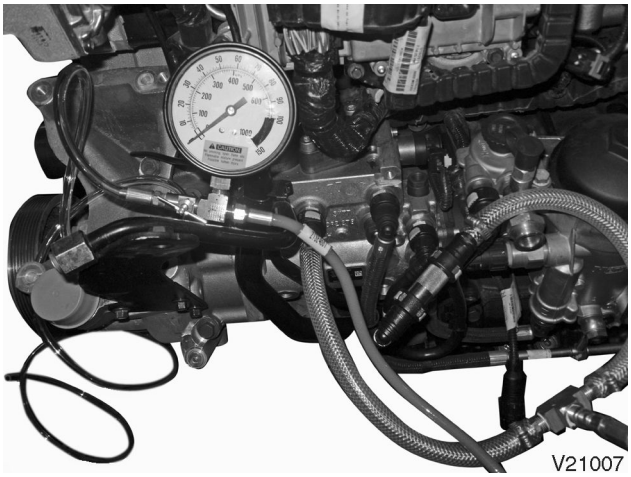

Figure 99 High-pressure fuel pump return line connected to Fuel Pressure Gauge

3. Use Fuel Line Coupler ZTSE4906 to connect high-pressure fuel pump return line to Fuel Inlet Restriction / Aeration Tool ZTSE4886.
4. Use Compucheck fitting ZTSE4526 to connect Fuel Inlet Restriction / Aeration Tool ZTSE4886 to Fuel Pressure Gauge ZTSE4681.

5. Start engine and run high idle while monitoring Fuel Pressure Gauge.
   - If pressure is above specification, inspect fuel return line for restriction between high-pressure fuel pump and fuel tank.
   - If pressure is below specification, no further action is required.

Crankcase Oil Breather Separator Test

Purpose

Check if centrifuge breather is functioning properly.

Tools

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)
- ZTSE4800 – Ultrasonic Ear

Procedure

WARNING: To prevent personal injury or death, read all safety instructions in the "Safety Information" section of this manual.

WARNING: To prevent personal injury or death, set parking brake, shift transmission to neutral or park, and block wheels starting the engine.

WARNING: To prevent personal injury or death, avoid rotating parts (belts and fan) and hot engine surfaces.

NOTE: Before performing this test, ensure engine operating temperature is 82 to 88˚ C (180 to 190˚ F) and oil level and pressure are within specification.

1. Turn ignition switch to ON, engine OFF.
2. Connect EST to vehicle's Diagnostic Connector.
3. Start ServiceMaxx™ software.
4. Select Performance session.
5. Start engine. Ensure engine operating temperature is 82 to 88˚ C (180 - 190˚ F).

   NOTE: The Crankcase Oil Separator Speed (CCOSS) sensor does not have circuit fault codes. A Diagnostic Trouble Code (DTC) will only be set if the Engine Control Module (ECM) does not see an rpm signal with the engine running.
6. Monitor CC Oil Separator (CCOS) signal with engine at low and high idle. Record results on Diagnostics Form.
   - If CCOS is within specification, crankcase breather system is operating correctly.
   - If CCOS is reading 0 rpm with engine running, continue to next step.
7. With engine running, place Ultrasonic Ear ZTSE4800 near CCOSS sensor.
8. Turn engine OFF and quickly monitor for centrifugal noise.

   NOTE: The centrifuge will continue spinning for 15 seconds after engine is shut off.
   - If centrifuge noise is not heard, go to *Engine Service Manual* for removal and replacement procedures.
   - If centrifuge noise can be heard, go to Crankcase Oil Separator Speed (CCOSS) Sensor (page 486) in "ELECTRONIC CONTROL SYSTEMS DIAGNOSTICS."

Crankcase Pressure Test

Purpose

Verify if engine is in need for a possible overhaul or repair due to cylinder or valve wear or damage. Verify operation of air compressor or turbochargers for possible worn or damaged parts.

Tools

- Digital manometer
- ZTSE2217A – Water Manometer
- ZTSE4039 – Crankcase Pressure Test Tool
- ZTSE4891 – Air Cap, Fuel Cap and Plug Kit

Procedure

NOTE: Before performing this test, ensure engine is at normal operating temperature of 70˚ C (158˚ F) and oil level and pressure are within specification.

1. Verify crankcase oil breather separator is functioning properly before running this test. See Crankcase Oil Breather Separator Test.
2. Disconnect breather outlet tube from top of oil separator.
3. Connect Crankcase Pressure Test Tool ZTSE4039 to 90 degree breather elbow.

Figure 100 Digital manometer connected to Crankcase Pressure Tool

1. Crankcase Pressure Test Tool
2. Digital manometer

4. Connect manometer to Crankcase Pressure Test Tool ZTSE4039.

WARNING: To prevent personal injury or death, when routing test line, do not crimp line, run line too close to moving parts, or let line touch hot engine. Secure the gauge and test line to not obstruct vehicle operation.

WARNING: To prevent personal injury or death, shift transmission to park or neutral, set parking brake, and block wheels before doing diagnostic or service procedures.

WARNING: To prevent personal injury or death, wear safety glasses with side shields.

5. Start engine and run at high idle. Allow manometer reading to stabilize before recording pressure reading.
6. Record crankcase pressure on Diagnostics Form.
   - If pressure is within specification, no repair is required.
   - If pressure is above specification, continue to next step.
7. Shut engine OFF. Drain vehicle air tanks until pressure is removed from air system.
8. Remove air line from remote-mounted centrifugal filter and cap using Air Cap, Fuel Cap and Plug Kit ZTSE4891.
9. Start engine and run at high idle. Allow manometer reading to stabilize before recording pressure reading.
10. Record crankcase pressure on Diagnostics Form.
    - If pressure is within specification, repair or replace centrifugal filter assembly.
    - If pressure is above specification, continue to next step.

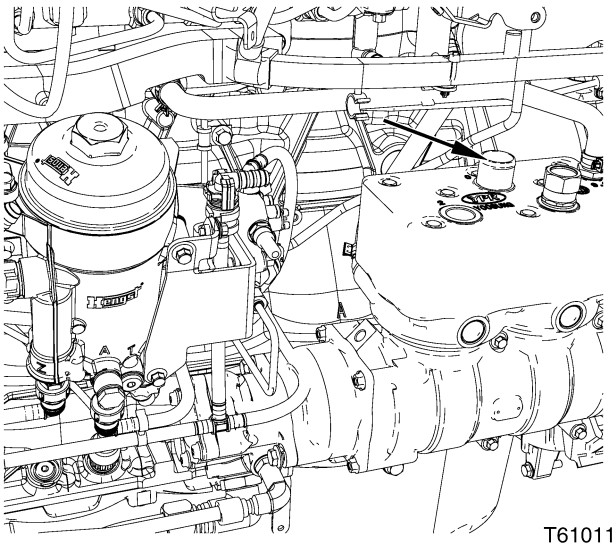

Figure 101 Air compressor discharge port

11. If engine has an air compressor, remove discharge line and test again. Allow manometer reading to stabilize before recording pressure reading.
12. Record crankcase pressure on Diagnostics Form.
    - If pressure is above specification, go to Relative Compression Test to pinpoint suspect cylinder.

- If pressure is at or below specification, compressed air is leaking into crankcase. Repair or replace air compressor.

Cylinder Performance Test – Step 1

Relative Compression Test

Purpose

Verify all cylinders have good compression.

NOTE: The Relative Compression Test will help validate cylinder balance. If an unbalanced cylinder is found, it is caused by a mechanical problem, not an injector fault.

Tools

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

Procedure

WARNING: To prevent personal injury or death, read all safety instructions in the "Safety Information" section of this manual.

NOTE: Use a battery charger when performing this test. It is important that cranking rpm remains consistent throughout test.

NOTE: Run Relative Compression Test a minimum of three times.

1. Turn ignition switch to ON, engine OFF.
2. Connect EST to vehicle's Diagnostic Connector.
3. Start ServiceMaxx™ software.
4. Select Relative Compression test.
5. Follow on-screen instructions.
6. Record results on Diagnostics Form.
    - If the speed difference for one cylinder is significantly lower than the others, that cylinder is suspect for compression loss.

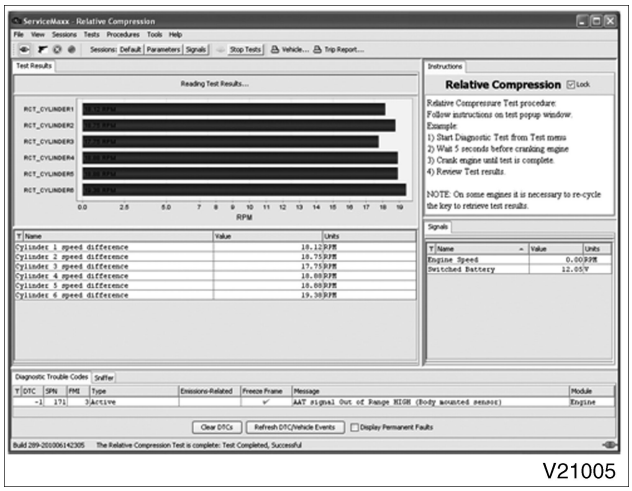

Figure 102 Relative Compression test

Possible Causes

- Valve train damage
- Valves out of adjustment
- Worn or broken piston rings
- Excessive cylinder wall wear
- Damaged piston

Cylinder Performance Test – Step 2

Cylinder Cutout Test

Purpose

Determine cause of rough engine idle.

Tools

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

Possible Causes

- Open or shorted injector wiring
- Scuffed or failed injector
- Power cylinder problem

Procedure

NOTE: Steps taken before running this test:

- Run Relative Compression Test. If Relative Compression Test results display low balanced cylinder(s), there is no need to run Cylinder Cutout Test. Repair mechanical fault.
- Verify fuel system pressure is not below specification and fuel is not aerated.

1. Turn ignition switch to ON, engine OFF.
2. Connect EST to vehicle's Diagnostic Connector.
3. Start ServiceMaxx™ software.
4. Start engine.
5. Select Cylinder Cutout Test.
6. Follow on-screen instructions.

NOTE: This test is only meant to isolate a low contributing cylinder due to an injector or injector circuit failure.

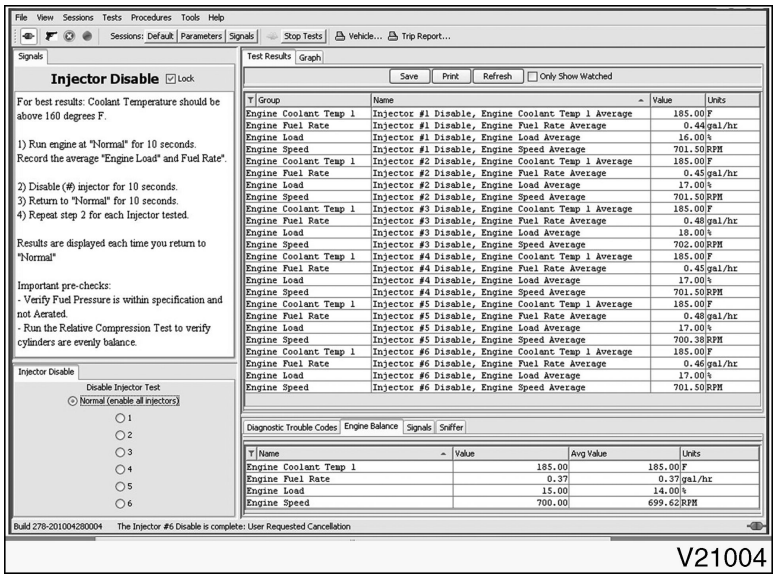

Figure 103 ServiceMaxx™ Cylinder Cutout Test

7. Record results on Diagnostics Form.

- If Cylinder Cutout Test does not identify a suspect cylinder, no action is required.
- If Cylinder Cutout Test identifies a suspect cylinder and Relative Compression Test does not, replace failed Injector. See Injector Replacement.

Injector Replacement

Purpose

Calibrate Engine Control Module (ECM) for newly installed injectors.

NOTE: Each injector is encrypted with an Injection Quantity Adjustment (IQA) code that must be programmed into the ECM anytime an injector has been replaced.

Tools

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

Procedure

IQA injects the correct amount of fuel for each individual injector throughout the operating range of the engine. Injector mechanical tolerances, high flow, and low flow can be evenly balanced with the ECM calibration.

1. Turn ignition switch to ON, engine OFF.
2. Connect EST to vehicle's Diagnostic Connector.
3. Start ServiceMaxx™ software.

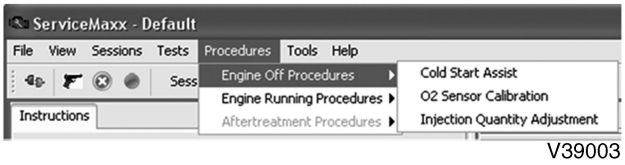

Figure 104 Injector Quantity Adjustment procedure

4. Select Injection Quantity Adjustment from Procedures drop-down menu.

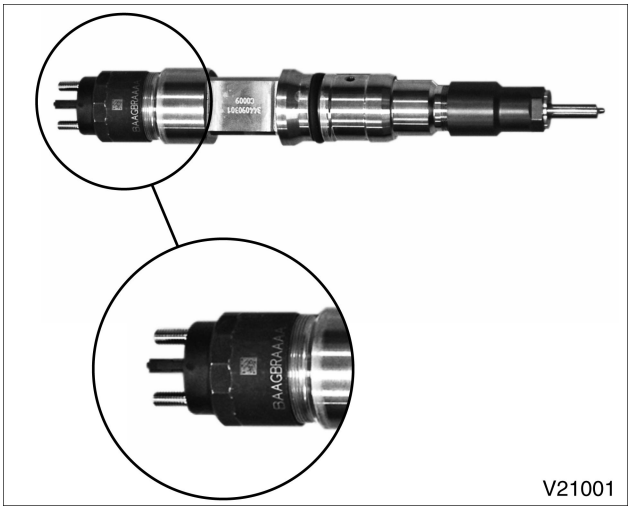

Figure 105 Picture of IQA code location

5. Type in new IQA code (stamped on top portion of injector) into proper cylinder location.

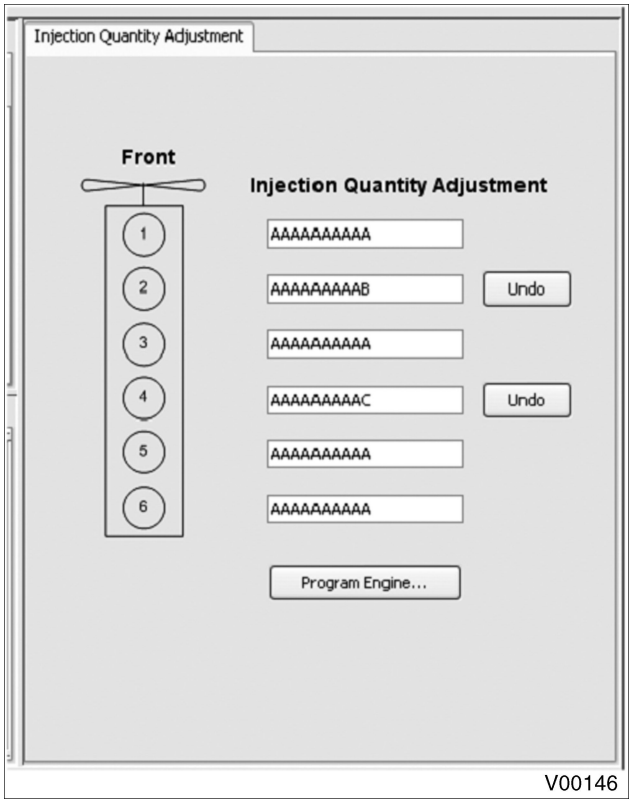

Figure 106 Injector Quantity Adjustment

NOTE: When the Undo button appears, the Program Engine button becomes active.

6. Press the Program Engine button.
7. Replace failed injector following procedures in the *Engine Service Manual*.

Fuel Pressure Control Valve (FPCV) Test

Purpose

Verify FPCV is not sticking.

Tools

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

Procedure

1. Verify fuel system is operating within specifications and is not aerated.
2. Start engine and run until Engine Coolant Temperature is above 65 °C (150 °F)
3. Use ServiceMaxx™ software to run the Fuel Pressure Control Valve Test. Follow on-screen instructions.

4. Record results on Diagnostics Form.

   NOTE: A minor ripple in the FRP signal graph display is acceptable. A shark-tooth fluctuation indicates FPCV is sticking.

   - If FRP signal fluctuates in a shark-tooth pattern, replace FPCV following procedures in the *Engine Service Manual*.
   - If FRP signal does not fluctuate in a shark-tooth pattern, no further action is required.

Charge Air Cooler (CAC) Pressure Test

Procedure

1. Attach Charge Air Cooler Test Kit ZTSE6042 to the CAC.
2. Attach pressure test gauge and gradually pressurize CAC to 30 psi (207 kPa). Turn off air supply when pressure reaches 30 psi (207 kPa).
3. If pressure drops, spray a soapy water solution on the CAC. Look for leaks from hose connections, CAC, and test components. Locate and mark leaks.
4. If a leak is detected on the CAC or the test gauge pressure drops, replace the CAC.

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Diagnostic Trouble Codes (DTCs) and Sub-section Diagnostics Page Locations

SPN	FMI	Sub-section	Condition Description
27	0	EGR (page 1014)	EGRP fault: over temperature
27	3	EGR (page 1014)	EGRP signal Out of Range HIGH
27	4	EGR (page 1014)	EGRP signal Out of Range LOW
27	7	EGR (page 1014)	EGRP does not agree with commanded position
27	10	EGR (page 1014)	EGRP sensor feedback deviation during CSER
51	0	ETV (page 1037)	ETP fault: over temperature
51	3	ETV (page 1037)	ETP signal Out of Range HIGH
51	4	ETV (page 1037)	ETP signal Out of Range LOW
51	7	ETV (page 1037)	ETP does not agree with commanded position
51	10	ETV (page 1037)	ETP sensor feedback deviation during CSER
84	2	VS (page 1428)	Vehicle speed anti-tampering fault
91	2	APP (page 437)	APP1 and APP2 signal conflict
91	3	APP (page 437)	APP1 signal Out of Range HIGH
91	4	APP (page 437)	APP1 signal Out of Range LOW
94	0	FDP (page 1083)	Fuel Delivery Pressure above maximum
94	3	FDP (page 1083)	FDP signal Out of Range HIGH
94	4	FDP (page 1083)	FDP signal Out of Range LOW
96	3	Fuel Level (page 1121)	Fuel Level signal Out of Range HIGH
96	4	Fuel Level (page 1121)	Fuel Level signal Out of Range LOW
96	19	Fuel Level (page 1121)	Fuel Level not detected on J1939
98	3	EOL (page 1027)	EOL signal Out-of-Range HIGH
98	4	EOL (page 1027)	EOL signal Out-of-Range LOW
100	1	EWPS (page 1044)	Engine Oil System below Critical Pressure
100	3	EOP (page 1031)	EOP signal Out of Range HIGH
100	4	EOP (page 1031)	EOP signal Out of Range LOW
100	11	EWPS (page 1044)	Engine oil pressure below dealer programmed engine RPM value
100	17	EWPS (page 1044)	Low Oil Pressure vehicle event fault
100	18	EWPS (page 1044)	Engine Oil System below Warning Pressure
102	2	IMP (page 1130)	IMP signal does not agree with BARO
102	3	IMP (page 1130)	IMP signal Out of Range HIGH
102	4	IMP (page 1130)	IMP signal Out of Range LOW
102	10	IMP (page 1130)	IMP Boost slow response

SPN	FMI	Sub-section	Condition Description
102	16	AMS (page 429)	Intake Manifold Pressure Overboost
102	18	AMS (page 429)	Intake Manifold Pressure Underboost
105	2	IMT (page 1139)	IMT signal erratic, intermittent or incorrect
105	3	IMT (page 1139)	IMT signal Out of Range HIGH
105	4	IMT (page 1139)	IMT signal Out of Range LOW
108	3	ECM Self (page 984)	BARO signal Out of Range HIGH
108	4	ECM Self (page 984)	BARO signal Out of Range LOW
110	0	EWPS (page 1044)	Engine Coolant System above Critical Temperature
110	2	ECT1 (page 994)	ECT1 signal erratic, intermittent, or incorrect
110	3	ECT1 (page 994)	ECT1 signal Out of Range HIGH
110	4	ECT1 (page 994)	ECT1 signal Out of Range LOW
110	11	EWPS (page 1044)	Event logger, coolant temperature hot, extreme
110	15	EWPS (page 1044)	Engine Coolant System above Warning temperature
110	16	EWPS (page 1044)	Engine Coolant System above OBD maximum temperature
110	17	ECS (page 988)	Engine Coolant System below OBD maximum temperature
110	18	ECS (page 988)	Engine Coolant System below closed loop minimum Temperature
111	1	ECL (page 975)	Low Engine Coolant Level
157	0	FRP (page 1104)	FRP relief valve opening fault
157	3	FRP (page 1095)	FRP signal Out of Range HIGH
157	4	FRP (page 1095)	FRP signal Out of Range LOW
157	14	FRP (page 1104)	FRP Relief Valve failure
157	20	FRP (page 1095)	FRP signal Drifted HIGH
157	21	FRP (page 1095)	FRP signal Drifted LOW
158	15	ECM PWR (page 977)	ECM Switched voltage too HIGH
158	17	ECM PWR (page 977)	ECM Switched voltage too LOW
168	16	ACM PWR (page 280)	ACM battery voltage too HIGH
168	18	ACM PWR (page 280)	ACM battery voltage too LOW
171	2	AAT (page 269)	AAT signal erratic, intermittent or incorrect
171	3	AAT (page 269)	AAT signal Out of Range HIGH (Body mounted sensor)
171	4	AAT (page 269)	AAT signal Out of Range LOW (Body mounted sensor)
172	2	IAT (page 1126)	IAT signal erratic, intermittent or incorrect
172	3	IAT (page 1126)	IAT signal Out of Range HIGH

SPN	FMI	Sub-section	Condition Description
172	4	IAT (page 1126)	IAT signal Out of Range LOW
175	0	EWPS (page 1044)	Engine Oil System above Critical Temperature
175	3	EOT (page 1034)	EOT signal Out of Range HIGH
175	4	EOT (page 1034)	EOT signal Out of Range LOW
175	11	EWPS (page 1044)	Oil Temperature Exceeds limit by large amount
175	15	EWPS (page 1044)	Engine Oil System above warning temperature
188	0	EWPS (page 1044)	Engine unable to achieve desired idle speed (too high)
188	1	EWPS (page 1044)	Engine unable to achieve desired idle speed (too low)
188	15	EWPS (page 1044)	Engine Speed during CSER unable to achieve desired idle speed (Too HIGH)
188	16	EWPS (page 1044)	Engine unable to achieve desired speed: secondary fuel detected
188	17	EWPS (page 1044)	Engine Speed during CSER unable to achieve desired idle speed (Too LOW)
190	0	EWPS (page 1044)	Engine overspeed most severe level
190	11	EWPS (page 1044)	Engine overspeed vehicle event fault
190	15	EWPS (page 1044)	Engine overspeed detected
191	1	TOSS (page 1428)	TOSS not detected with vehicle moving
191	2	TOSS (page 1428)	TOSS signal erratic, intermittent or incorrect
191	3	TOSS (page 1428)	TOSS signal Out of Range HIGH
191	4	TOSS (page 1428)	TOSS signal Out of Range LOW
191	16	TOSS (page 1428)	Hard wired vehicle speed reading higher than limit
354	3	HS (page 1126)	Relative Humidity signal Out of Range HIGH
354	4	HS (page 1126)	Relative Humidity signal Out of Range LOW
412	1	EGRT (page 1010)	EGRT signal stuck low, not warming up
412	2	EGRT (page 1010)	EGRT signal erratic, intermittent or incorrect
412	3	EGRT (page 1010)	EGRT signal Out of Range HIGH
412	4	EGRT (page 1010)	EGRT signal Out of Range LOW
560	19	J1939 (page 1218)	Transmission Driveline Engaged not detected on J1939
609	19	J1939 (page 1218)	ACM not detected on J1939
626	3	Inlet Air Heater Fuel Solenoid (page 531)	CSFS short to PWR
626	4	Inlet Air Heater Fuel Solenoid (page 531)	CSFS short to GND
626	5	Inlet Air Heater Fuel Solenoid (page 531)	CSFS open load/circuit

SPN	FMI	Sub-section	Condition Description
626	18	Inlet Air Heater Fuel Solenoid (page 531)	Cold Start Assist fault: Lack of heat in the Intake Manifold
		Inlet Air Heater Fuel Igniter (page 520)	
628	12	ECM Self (page 984)	ECM Memory Error
629	2	ECM Self (page 984)	ECM Error – Level 2 Monitoring
629	8	ECM Self (page 984)	Engine Off timer fault
629	12	ECM Self (page 984)	ECM Internal chip Error
629	14	ECM Self (page 984)	ECM Internal component overtemperature
633	3	FPCV (page 1092)	FPCV short to PWR
633	4	FPCV (page 1092)	FPCV short to GND
633	5	FPCV (page 1092)	FPCV open load/circuit
636	2	CMP (page 503)	CMP and CKP Synchronization Error
636	8	CMP (page 503)	CMP signal noise
636	10	CMP (page 503)	CMP signal missing
637	8	CKP (page 492)	CKP signal noise
637	10	CKP (page 492)	CKP signal inactive
639	14	J1939 (page 1218)	J1939 Data Link Error (ECM unable to transmit)
639	19	J1939 (page 1218)	J1939 Data Link Error (ECM unable to transmit or receive)
647	3	EFC (page 1007)	EFC short to PWR
647	4	EFC (page 1007)	EFC short to GND
647	5	EFC (page 1007)	EFC open load/circuit
651	4	INJ (page 1143)	INJ short circuit
651	5	INJ (page 1143)	INJ open circuit
651	13	CYL Balance (page 534)	Injector 1 programmable parameter error
651	16	CYL Balance (page 534)	Injector 1 Fuel quantity/timing high error
651	18	CYL Balance (page 534)	Injector 1 Fuel quantity/timing low error
652	4	INJ (page 1143)	Injector 2 short circuit
652	5	INJ (page 1143)	Injector 2 open circuit
652	13	CYL Balance (page 534)	Injector 2 programmable parameter error
652	16	CYL Balance (page 534)	Injector 2 Fuel quantity/timing high error
652	18	CYL Balance (page 534)	Injector 2 Fuel quantity/timing low error
653	4	INJ (page 1143)	Injector 3 short circuit
653	5	INJ (page 1143)	Injector 3 open circuit

SPN	FMI	Sub-section	Condition Description
653	13	CYL Balance (page 534)	Injector 3 programmable parameter error
653	16	CYL Balance (page 534)	Injector 3 Fuel quantity/timing high error
653	18	CYL Balance (page 534)	Injector 3 Fuel quantity/timing low error
654	4	INJ (page 1143)	Injector 4 short circuit
654	5	INJ (page 1143)	Injector 4 open circuit
654	13	CYL Balance (page 534)	Injector 4 programmable parameter error
654	16	CYL Balance (page 534)	Injector 4 Fuel quantity/timing high error
654	18	CYL Balance (page 534)	Injector 4 Fuel quantity/timing low error
655	4	INJ (page 1143)	Injector 5 short circuit
655	5	INJ (page 1143)	Injector 5 open circuit
655	13	CYL Balance (page 534)	Injector 5 programmable parameter error
655	16	CYL Balance (page 534)	Injector 5 Fuel quantity/timing high error
655	18	CYL Balance (page 534)	Injector 5 Fuel quantity/timing low error
656	4	INJ (page 1143)	Injector 6 short circuit
656	5	INJ (page 1143)	Injector 6 open circuit
656	13	CYL Balance (page 534)	Injector 6 programmable parameter error
656	16	CYL Balance (page 534)	Injector 6 Fuel quantity/timing high error
656	18	CYL Balance (page 534)	Injector 6 Fuel quantity/timing low error
724	2	O2S (page 1323)	O_2S Slow response detecting fueling to non-fueling
724	3	O2S (page 1323)	O_2S Circuit Fault: Open or short to PWR
724	4	O2S (page 1323)	O_2S Circuit Fault: Short to GND
724	5	O2S (page 1323)	O_2S Circuit Fault: Open circuit
724	20	O2S (page 1323)	O_2S adaptation above maximum limit
724	21	O2S (page 1323)	O_2S adaptation below minimum limit
731	16	EWPS (page 1044)	Knock detected: Cylinder Acceleration Above Normal
731	18	EWPS (page 1044)	Knock Detected: Unexpected Fueling without Demand
837	14	SPEEDO	Speedometer Drive Output Error
			Refer to the *Chassis Electrical Circuit Diagram Manual*
974	3	RAPP (page 1339)	Remote APP signal Out of Range HIGH
974	4	RAPP (page 1339)	Remote APP signal Out of Range LOW
1072	3	ECB1 (page 969)	ECB1 Control short to PWR
1072	4	ECB1 (page 969)	ECB1 Control short to GND
1072	5	ECB1 (page 969)	ECB1 Control open load/circuit
1073	3	ECB2 (page 972)	ECB2 Control short to PWR

SPN	FMI	Sub-section	Condition Description
1073	4	ECB2 (page 972)	ECB2 Control short to GND
1073	5	ECB2 (page 972)	ECB2 Control open load/circuit
1081	3	WTSL (page 1447)	WTSL short to PWR
1081	4	WTSL (page 1447)	WTSL short to GND
1081	5	WTSL (page 1447)	WTSL open load/circuit
1110	31	ECM Self (page 984)	ECM detects fueling without demand
1135	3	EOL (page 1027)	EOT2 signal Out of Range HIGH
1135	4	EOL (page 1027)	EOT2 signal Out of Range LOW
1173	2	TC2CIS (page 1407)	TC2CIT signal does not agree with other sensors
1173	3	TC2CIS (page 1407)	TC2CIT signal Out of Range HIGH
1173	4	TC2CIS (page 1407)	TC2CIT signal Out of Range LOW
1173	16	AMS (page 429)	TC2CIT signal above desired (interstage CAC under cooling)
1177	2	TC2CIS (page 1407)	TC2CIP Underdevelopment
1177	3	TC2CIS (page 1407)	TC2CIP signal Out of Range HIGH
1177	4	TC2CIS (page 1407)	TC2CIP signal Out of Range LOW
1189	3	TC2WC (page 1404)	TC2WC short to PWR
1189	4	TC2WC (page 1404)	TC2WC short to GND
1189	5	TC2WC (page 1404)	TC2WC open load/circuit
1213	3	MIL (page 1256)	MIL circuit short to PWR
1213	4	MIL (page 1256)	MIL circuit short to GND
1213	5	MIL (page 1256)	MIL open load/circuit
1322	31	CYL Balance (page 534)	Misfire - Multiple Cylinders
1323	31	CYL Balance (page 534)	Misfire - Cylinder 1
1324	31	CYL Balance (page 534)	Misfire - Cylinder 2
1325	31	CYL Balance (page 534)	Misfire - Cylinder 3
1326	31	CYL Balance (page 534)	Misfire - Cylinder 4
1327	31	CYL Balance (page 534)	Misfire - Cylinder 5
1328	31	CYL Balance (page 534)	Misfire - Cylinder 6
1378	31	Service (page 1398)	Change Engine Oil Service Interval
1569	31	AFT System (page 286)	SCR Tamperproof Warning & Protection System Inducement Severe
1590	19	Adaptive Cruise Control (page 1218)	Adaptive Cruise Control not detected on J1939
1659	20	ECS (page 988)	ECT1 below expected: Check Thermostat

SPN	FMI	Sub-section	Condition Description
1761	1	DEFTLT (page 764)	DEF Tank Level sensor Inducement (Level 3 - 5)
1761	3	DEFTLT (page 764)	DEFTL signal Out of Range HIGH
1761	4	DEFTLT (page 764)	DEFTL signal Out of Range LOW
1761	10	DEFTLT (page 764)	DEF Level abnormal rate of change
1761	11	DEFTLT (page 764)	DEFTL Signal erratic, intermittent, or incorrect
1761	17	DEFTLT (page 764)	DEFTL Inducement Level 1
1761	18	DEFTLT (page 764)	DEFTL Inducement Level 2
1761	19	DEFTLT (page 764)	DEFTL not detected on J1939
1810	0	Hard Brake Monitor (page 1125)	Hard Brake monitor, event log, extreme
1810	15	Hard Brake Monitor (page 1125)	Hard Brake monitor, event log, non-extreme
2588	0	EWPS (page 1044)	Vehicle overspeed 1, event log, extreme
2588	15	EWPS (page 1044)	Vehicle overspeed 1, event log, non-extreme
2589	0	EWPS (page 1044)	Vehicle overspeed 2, event log, extreme
2589	15	EWPS (page 1044)	Vehicle overspeed 2, event log, non-extreme
2623	3	APP (page 437)	APP2 signal Out of Range HIGH
2623	4	APP (page 437)	APP2 signal Out of Range LOW
2630	2	CACOT (page 478)	CACOT signal erratic, intermittent, or incorrect
2630	3	CACOT (page 478)	CACOT signal Out of Range HIGH
2630	4	CACOT (page 478)	CACOT signal Out of Range LOW
2630	16	CACOT (page 478)	CACOT undercooling
2659	20	AMS (page 429)	EGR High Flow Rate detected
2659	21	AMS (page 429)	EGR Low Flow Rate detected
2791	3	EGR (page 1014)	EGRC short to PWR
2791	5	EGR (page 1014)	EGRC open load/circuit
2791	8	EGR (page 1014)	EGR valve not receiving ECM PWM signal
2797	11	INJ (page 1143)	Injector Control Group 1 short circuit (INJ 1, 3, 5)
2798	11	INJ (page 1143)	Injector Control Group 2 short circuit (INJ 2, 4, 6)
3031	2	DEFTLT (page 764)	DEFTT signal erratic, intermittent or incorrect
3031	3	DEFTLT (page 764)	DEFTT signal Out of Range HIGH
3031	4	DEFTLT (page 764)	DEFTT signal Out of Range LOW
3031	9	DEFTLT (page 764)	DEFTT signal erratic, intermittent or incorrect
3055	0	FRPS (page 1104)	FRP exceeded maximum
3055	1	FRPS (page 1104)	No start due to low rail fuel pressure

SPN	FMI	Sub-section	Condition Description
3055	15	FRPS (page 1104)	FRP below minimum with maximum command
3055	17	FRPS (page 1104)	FRP above maximum with minimum command
3058	10	EGR System Monitor (page 1023)	EGR did not go into Closed loop EGR control when expected
3061	31	CSER Exhaust warm up time fault (page 520)	Cold start system warm-up fault during CSER
3216	2	NOx IN sensor module (page 1258)	NOx IN signal erratic, intermittent or incorrect
3216	4	NOx IN sensor module (page 1258)	NOx IN signal drifted LOW
3216	10	NOx IN sensor module (page 1258)	NOx IN signal abnormal rate of change
3216	13	NOx IN sensor module (page 1258)	NOx IN Out of Calibration
3216	19	NOx IN sensor module (page 1258)	NOx IN not detected on J1939
3216	20	NOx IN sensor module (page 1258)	NOx IN signal drifted HIGH
3216	21	NOx IN sensor module (page 1258)	NOx IN signal drifted LOW
3218	2	NOx IN sensor module (page 1258)	NOx IN power supply signal erratic, intermittent or incorrect
3223	0	O_2S (page 1323)	O2S heater temperature above maximum
3223	1	O_2S (page 1323)	O_2S heater temperature below minimum
3223	3	O_2S (page 1323)	O_2S heater short to PWR
3223	4	O_2S (page 1323)	O_2S heater short to GND
3223	5	O_2S (page 1323)	O_2S heater open load/circuit
3223	17	O_2S (page 1323)	O_2S heater temperature below minimum at low battery PWR
3226	2	NOx OUT Sensor Module (page 1292)	NOx OUT signal erratic, intermittent or incorrect
3226	4	NOx OUT Sensor Module (page 1292)	NOx OUT signal Out of Range LOW
3226	10	NOx OUT Sensor Module (page 1292)	Aftertreatment Outlet NOx Sensor — abnormal rate of change
3226	13	NOx OUT Sensor Module (page 1292)	NOx OUT Out of Calibration
3226	19	NOx OUT Sensor Module (page 1292)	NOx OUT not detected on J1939

SPN	FMI	Sub-section	Condition Description
3226	20	NOx OUT Sensor Module (page 1292)	NOx OUT signal drifted HIGH
3226	21	NOx OUT Sensor Module (page 1292)	NOx OUT signal drifted LOW
3228	2	NOx OUT Sensor Module (page 1292)	NOx OUT power supply signal erratic, intermittent or incorrect
3242	0	DPFIT (page 866)	DPFIT above Critical
3242	2	DPFIT (page 866)	DPFIT signal erratic, intermittent, or incorrect
3242	3	DPFIT (page 866)	DPFIT Signal Out of Range HIGH
3242	4	DPFIT (page 866)	DPFIT signal Out of Range LOW
3242	15	DPFIT (page 866)	DPFIT above Warning Temperature
3242	16	DPFIT (page 866)	DPFIT above Maximum Temperature
3246	0	DPFOT (page 899)	DPFOT above Critical
3246	2	DPFOT (page 899)	DPFOT signal erratic, intermittent, or incorrect
3246	3	DPFOT (page 899)	DPFOT signal Out of Range HIGH
3246	4	DPFOT (page 899)	DPFOT signal Out of Range LOW
3246	15	DPFOT (page 899)	DPFOT above Warning Temperature
3246	16	DPFOT (page 899)	DPFOT Above Maximum Temperature
3251	2	DPFDP / Outlet Pressure Sensor (page 846)	DPFDP signal erratic, intermittent, or incorrect
3251	3	DPFDP / Outlet Pressure Sensor (page 846)	DPFDP signal Out of Range HIGH
3251	4	DPFDP / Outlet Pressure Sensor (page 846)	DPFDP signal Out of Range LOW
3361	2	DEFSP (page 722)	DEFSP signal erratic, intermittent or incorrect
3361	3	DEFSP (page 722)	DEFSP signal Out of Range HIGH
3361	4	DEFSP (page 722)	DEFSP signal Out of Range LOW
3362	31	DEFSP (page 722)	DEF dosing unable to prime
3363	3	DEFTHC (page 748)	DEFTHC short to PWR
3363	4	DEFTHC (page 748)	DEFTHC short to GND
3363	7	DEFTHC (page 748)	DEFTHC Mechanical system not responding
3363	16	DEFTHC (page 748)	DEFTHC stuck on fault
3363	18	DEFTHC (page 748)	DEFTHC unable to thaw frozen DEF
3464	3	ETV (page 1037)	ETC short to PWR
3464	5	ETV (page 1037)	ETC open load/circuit
3464	8	ETV (page 1037)	ETC not receiving command from ECM

SPN	FMI	Sub-section	Condition Description
3480	2	AFTFP1 (page 382)	AFTFP1 signal erratic, intermittent, or incorrect
3480	3	AFTFP1 (page 382)	AFTFP1 signal Out of Range HIGH
3480	4	AFTFP1 (page 382)	AFTFP1 signal Out of Range LOW
3480	17	AFTFP1 (page 382)	AFTFP1 below normal operating range
3482	2	AFTFSV (page 396)	AFT Fuel Shutoff Valve signal erratic, intermittent or incorrect
3482	3	AFTFSV (page 396)	AFT Fuel Shutoff Valve short to PWR
3482	4	AFTFSV (page 396)	AFT Fuel Shutoff Valve short to GND
3482	7	AFTFSV (page 396)	AFT Fuel Shutoff Valve Mechanical system not responding or out of adjustment
3482	16	AFTFSV (page 396)	AFT Fuel Shutoff Valve Plugged
3490	3	AFTPAV (page 417)	AFTPAV short to PWR
3490	4	AFTPAV (page 417)	AFTPAV short to GND
3490	7	AFTPAV (page 417)	AFTPAV Mechanical system not responding
3509	14	VREF (page 1437)	VREF1 voltage deviation ECM pins: C1-36
3510	14	VREF (page 1437)	VREF2 voltage deviation ECM pins: E1-85 and E1-86
3511	14	VREF (page 1437)	VREF3 voltage deviation ECM pins: E1-89
3512	14	VREF (page 1437)	VREF4 voltage deviation ECM pins: C1-37, C1-49, C2-08, and E1-58
3513	14	VREF (page 1437)	VREF5 voltage deviation ECM pins: C1-50, E1-81, and E1-82
3514	14	VREF (page 1437)	VREF6 voltage deviation ECM pin: E1-88
3521	11	AFT System (page 286)	Improper Reductant in DEF Tank
3556	2	AFTFI (page 359)	AFT Fuel Injector signal erratic, intermittent or incorrect
3556	5	AFTFI (page 359)	AFT Fuel Injector open load/circuit
3556	18	AFTFI (page 359)	AFT Fuel Pressure 2 below Warning Pressure
3597	4	ECM PWR Output (page 979)	ECM Power Output 1 below normal ECM Pins: C1-31, C1-33, C1-54, C2-51, E1-01 and E1-51
3598	4	ECM PWR Output (page 979)	ECM Power Output 2 below normal ECM Pins: C1-42, C2-06, E1-05, E1-28, E1-29 and E1-54
3599	4	ECM PWR Output (page 979)	ECM Power Output 3 below normal ECM Pins: C1-30, C2-03, E1-24, E1-26 and E1-27
3610	2	DPFDP / Outlet Pressure Sensor (page 846)	DPFOP signal erratic, intermittent or incorrect
3610	3	DPFDP / Outlet Pressure Sensor (page 846)	DPFOP signal Out of Range HIGH

SPN	FMI	Sub-section	Condition Description
3610	4	DPFDP / Outlet Pressure Sensor (page 846)	DPFOP signal Out of Range LOW
3695	2	AFT System (page 286)	DPF Regen Inhibit Switch erratic, intermittent or incorrect
3695	19	J1939 (page 1218)	DPF Regen Inhibit Switch status not detected on J1939
3696	19	J1939 (page 1218)	DPF Park Regen Switch status not detected on J1939
3703	31	AFT System (page 286)	DPF Active Regeneration Inhibited Due to Inhibit Switch
3713	31	AFT System (page 286)	DPF Active Regeneration Inhibited Due to System Timeout
3719	0	DPF System (page 920)	DPF Soot Load - Highest (level 3/3)
3719	15	DPF System (page 920)	DPF Soot Load - Lowest (level 1/3)
3719	16	DPF System (page 920)	DPF Soot Load - Moderate (level 2/3)
3750	31	AFT System (page 286)	DPF Regen inhibited due to low exhaust temperatures
3936	0	DPF System (page 920)	DPF Soot Load - Severe De-Rate
3936	7	DPF System (page 920)	DPF System - DPF exceeded maximum temperature threshold - replace DPF
3936	14	DPF System (page 920)	DOC/DPF Temperature Module (Incorrect Part)
3936	15	DPF System (page 920)	DPF System above Warning Pressure
4076	0	EWPS (page 1044)	ECT2 above Critical (EWPS programmable limit)
4076	2	ECT2 (page 1001)	ECT2 signal erratic, intermittent, or incorrect
4076	3	ECT2 (page 1001)	ECT2 signal Out of Range HIGH
4076	4	ECT2 (page 1001)	ECT2 signal Out of Range LOW
4076	15	EWPS (page 1044)	ECT2 above Warning (EWPS programmable limit)
4076	17	ECT2 (page 1001)	ECT2 signal stuck low, not warming up
4094	31	AFT System (page 286)	Improper Reductant in Tank
4192	3	WIF (page 1444)	WIF signal Out of Range HIGH
4192	4	WIF (page 1444)	WIF signal Out of Range LOW
4227	7	CCOSS (page 486)	CC Oil Separator Speed: Not spinning
4334	2	DEFLP Sensor (page 652)	DEFLP signal erratic, intermittent or incorrect
4334	3	DEFLP Sensor (page 652)	DEFLP signal Out of Range HIGH
4334	4	DEFLP Sensor (page 652)	DEFLP signal Out of Range LOW
4334	16	DEFLP Sensor (page 652)	DEFLP above Maximum Pressure
4334	18	DEFLP Sensor (page 652)	DEFLP below normal operating range
4337	2	DEFSP Temp (page 722)	DEF Supply Module Temperature erratic, intermittent or incorrect
4337	10	DEFSP Temp (page 722)	DEF Supply Module Temperature abnormal rate of change

SPN	FMI	Sub-section	Condition Description
4340	3	DEFSLH (page 709)	DEFL3HC short to PWR
4340	5	DEFSLH (page 709)	DEFL3HC open load/circuit
4342	3	DEFRLH (page 684)	DEFL2HC short to PWR
4342	5	DEFRLH (page 684)	DEFL2HC open load/circuit
4344	3	DEFPLH (page 671)	DEFL1HC short to PWR
4344	5	DEFPLH (page 671)	DEFL1HC open load/circuit
4360	0	SCRIT Senor (page 1356)	SCRIT above Critical Temperature
4360	2	SCRIT Senor (page 1356)	SCRIT signal erratic, intermittent or incorrect
4360	3	SCRIT Senor (page 1356)	SCRIT signal Out of Range HIGH
4360	4	SCRIT Senor (page 1356)	SCRIT signal Out of Range LOW
4360	15	SCRIT Senor (page 1356)	SCRIT above Warning Temperature
4360	16	SCRIT Senor (page 1356)	SCRIT Above Maximum Temperature
4360	19	SCRIT Senor (page 1356)	SCRIT signal not detected on J1939
4363	0	SCROT (page 1375)	SCROT above Critical Temperature
4363	2	SCROT (page 1375)	SCROT signal erratic, intermittent or incorrect
4363	3	SCROT (page 1375)	SCROT signal Out of Range HIGH
4363	4	SCROT (page 1375)	SCROT signal Out of Range LOW
4363	15	SCROT (page 1375)	SCROT above Warning Temperature
4363	16	SCROT (page 1375)	SCROT above Maximum Temperature
4363	19	SCROT (page 1375)	SCROT signal not detected on J1939
4364	18	AFT System (page 286)	Low NOx Conversion Detected
4376	3	DEFRV (page 697)	DEF Return Valve short to PWR
4376	4	DEFRV (page 697)	DEF Return Valve short to GND
4376	7	DEFRV (page 697)	DEF Return Valve - Mechanical system not responding or out of adjustment
4377	2	Ammonia (NH_3) Sensor Module (page 442)	NH_3 in range stuck fault
4377	4	Ammonia (NH_3) Sensor Module (page 442)	NH_3 operation fault
4377	10	Ammonia (NH_3) Sensor Module (page 442)	NH_3 abnormal rate of change
4377	12	Ammonia (NH_3) Sensor Module (page 442)	NH_3 internal chip error
4377	13	Ammonia (NH_3) Sensor Module (page 442)	NH_3 operation fault
4377	19	Ammonia (NH_3) Sensor Module (page 442)	NH_3 signal not detected on J1939

SPN	FMI	Sub-section	Condition Description
4380	2	Ammonia (NH_3) Sensor Module (page 442)	NH_3 signal erratic, intermittent, or incorrect
4380	16	Ammonia (NH_3) Sensor Module (page 442)	Outlet NH_3 signal Out of Range HIGH
4380	18	Ammonia (NH_3) Sensor Module (page 442)	Outlet NH_3 signal Out of Range LOW
4382	10	Ammonia (NH_3) Sensor Module (page 442)	Outlet NH_3 Gas Sensor Heater abnormal rate of change
4752	4	ECS (page 988)	EGR Cooler Efficiency: EGR outlet Temperature above expected
4765	0	DOCIT (page 826)	DOCIT above Critical Temperature
4765	2	DOCIT (page 826)	DOCIT signal erratic, intermittent, or incorrect
4765	3	DOCIT (page 826)	DOCIT signal Out of Range HIGH
4765	4	DOCIT (page 826)	DOCIT signal Out of Range LOW
4765	15	DOCIT (page 826)	DOCIT above Warning Temperature
4765	16	DOCIT (page 826)	DOCIT Above Maximum Temperature
4766	0	AFT System (page 286)	DPFIT above Critical Temperature
4766	15	AFT System (page 286)	DPFIT above Warning Temperature
4766	16	AFT System (page 286)	DPFIT above Maximum Temperature
4792	7	AFT System (page 286)	SCR Catalyst System - Mechanical system not responding or out of adjustment
4792	14	AFT System (page 286)	SCR Catalyst System - Out of Calibration
4794	31	AFT System (page 286)	SCR Catalyst System Missing
4795	31	AFT System (page 286)	DPFDP excessively LOW (sensor/circuit fault or missing DPF)
4796	31	AFT System (page 286)	Diesel Oxidation Catalyst Missing
5024	10	NOx IN sensor module (page 1258)	NOx IN Sensor Heater abnormal rate of change
5031	10	NOx OUT Sensor Module (page 1292)	NOx OUT Sensor Heater not reading correctly
5246	15	AFT System (page 286)	SCR Tamper Proof Inducement Level 1 status
5298	17	AFT System (page 286)	DOC Conversion Efficiency below minimum
5298	18	AFT System (page 286)	DOC Conversion Efficiency below Warning Pressure
5302	18	Ammonia (NH_3) Sensor Module (page 442)	Post SCR NH_3 Conversion Efficiency - Data Valid But Below Normal Operating Range - Moderately Severe Level
5319	31	DPF System (page 920)	DPF incomplete Regeneration
5394	2	DEFDV (page 629)	DEFDC signal erratic, intermittent or incorrect

SPN	FMI	Sub-section	Condition Description
5394	5	DEFDV (page 629)	DEFDC open load/circuit
5394	7	DEFDV (page 629)	DEF Dosing Valve - Mechanical system not responding
5395	0	EWPS (page 1044)	Engine unable to achieve desired idle torque (too high)
5395	1	EWPS (page 1044)	Engine unable to achieve desired idle torque (too low)
5397	31	DPF System (page 920)	DPF regenerations are occurring too frequently
5491	3	DEFLHR (page 640)	DEFLHR short to PWR
5491	4	DEFLHR (page 640)	DEFLHR short to GND
5541	2	TC1TOP (page 1399)	TC1TOP does not agree with BARO
5541	3	TC1TOP (page 1399)	TC1TOP signal Out of Range HIGH
5541	4	TC1TOP (page 1399)	TC1TOP signal Out of Range LOW
5542	15	EBPV (page 959)	TC1TOP above desired
5542	16	EBPV (page 959)	EBP Above Desired during CSER
5542	17	EBPV (page 959)	TC1TOP below desired - Check Exhaust Back Pressure Valve
5542	18	EBPV (page 959)	EBP Below Desired during CSER
5543	3	EBPV (page 959)	EBPC short to PWR
5543	4	EBPV (page 959)	EBPC short to GND
5543	5	EBPV (page 959)	EBPC open load/circuit
5546	3	CMV (page 518)	CMV short to PWR
5546	4	CMV (page 518)	CMV short to GND
5546	5	CMV (page 518)	CMV open load/circuit
5547	3	CFV (page 490)	CFV short to PWR
5547	4	CFV (page 490)	CFV short to GND
5547	5	CFV (page 490)	CFV open load/circuit
5548	3	Inlet Air Heater Fuel Igniter (page 520)	IAHFI short to PWR
5548	4	Inlet Air Heater Fuel Igniter (page 520)	IAHFI short to GND
5548	5	Inlet Air Heater Fuel Igniter (page 520)	IAHFI open load/circuit
5548	7	Inlet Air Heater Fuel Igniter (page 520)	Inlet Air Heater Relay return (relay, or igniter, or circuit failure)
5742	3	DOC / DPF Temperature Sensor Module (page 811)	DPF Thermocouple Controller Out of Range HIGH
5742	4	DOC / DPF Temperature Sensor Module (page 811)	DPF Thermocouple Controller Out of Range LOW

SPN	FMI	Sub-section	Condition Description
5742	11	DOC / DPF Temperature Sensor Module (page 811)	DPF Thermocouple Controller signal erratic, intermittent, or incorrect
5742	16	DOC / DPF Temperature Sensor Module (page 811)	DPF Thermocouple Controller above Maximum Temperature
5742	19	DOC / DPF Temperature Sensor Module (page 811)	DPF Thermocouple Controller signal not detect on J1939
5743	3	SCR Temperature Sensor Module Assembly (page 1341)	SCR Thermocouple Controller Out of Range HIGH
5743	4	SCR Temperature Sensor Module Assembly (page 1341)	SCR Thermocouple Controller Out of Range LOW
5743	11	SCR Temperature Sensor Module Assembly (page 1341)	SCR Thermocouple Controller signal erratic, intermittent, or incorrect
5743	16	SCR Temperature Sensor Module Assembly (page 1341)	SCR Thermocouple Controller above Maximum Temperature
5743	19	SCR Temperature Sensor Module Assembly (page 1341)	SCR Thermocouple Controller signal not detect on J1939
5745	3	DEFDUH (page 603)	DEF Dosing Unit Heater Out of Range HIGH
5745	4	DEFDUH (page 603)	DEF Dosing Unit Heater Out of Range LOW
5745	18	DEFDUH (page 603)	DEF Dosing Unit Heater below Warning Temperature
5746	3	DEFUHR (page 801)	DEF Dosing Unit Heater Relay short to PWR
5746	4	DEFUHR (page 801)	DEF Dosing Unit Heater Relay short to GND
5798	2	DEFDUH (page 603)	DEF Dosing Unit Heater Temperature erratic, intermittent or incorrect
5798	10	DEFDUH (page 603)	DEF Dosing Unit Heater Temperature abnormal rate of change
520668	31	AFT System (page 286)	Controller Adaptation Outer Limits Reached (Low Reductant Delivery)
520669	31	AFT System (page 286)	Controller Adaptation Outer Limits Reached (Low Reductant Delivery)

Sensor and Actuator Locations

Engine Mounted Components

See Appendix D (page 1572) for engine mounted sensor and actuator locations.

SCR Switchback Assembly

0000068063

Figure 107 SCR Switchback Assembly

See Appendix D (page 1572) for SCR switchback mounted sensor locations.

Vehicle Mounted Components

Accelerator Pedal Position Sensor

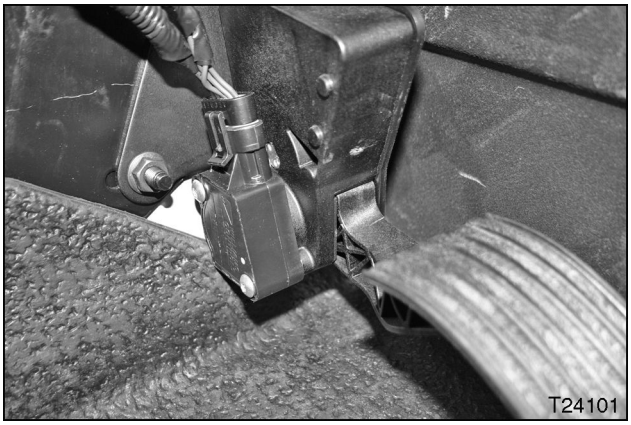


Figure 108 Accelerator Pedal Position (APP) sensor

The APP sensor is mounted on the accelerator pedal.

Ambient Air Temperature Sensor

The AAT is mounted in various cab locations, depending on vehicle configuration.

Engine and Aftertreatment Wiring Schematic Form 000002203 Usage

Engine and Aftertreatment Wiring Schematic Form Example

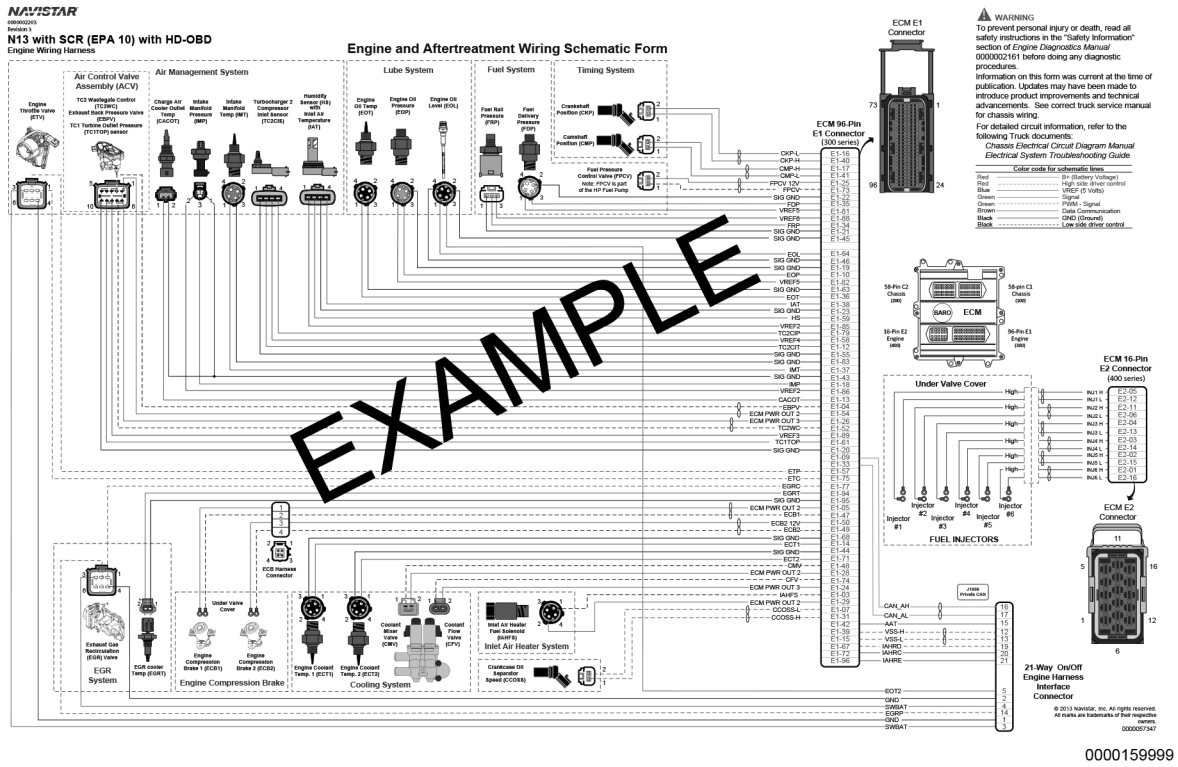


Figure 109 Engine and Aftertreatment Wiring Schematic Form (front side)

Engine and Aftertreatment Wiring Schematic Form 000002203 assists technicians in troubleshooting Navistar® diesel engines. Diagnostic schematics and signal values help technicians find problems to avoid unnecessary repairs.

The Electronic Control System, Engine and Aftertreatment Wiring Schematic Form consists of a circuit diagram for electrical components mounted on the engine and vehicle. For a detailed description of vehicle circuits, circuit numbers, or connector and fuse locations, see truck *Chassis Electrical Circuit Diagram Manual* and *Electrical System Troubleshooting Guide*. The back side of the form consists of signal values.

Engine and Aftertreatment Wiring Schematic Form 000002203 is available in 50 sheet pads. To order technical service literature, contact your International dealer.

Circuit Diagnostics

AAT Sensor (Ambient Air Temperature)

SPN	FMI	Condition	Possible Causes	Actions
171	2	AAT signal does not agree with other sensors	• Failed AAT sensor • High resistance in AAT circuit • High resistance in SIG GND circuit	Step-Based Diagnostics (page 272)
171	3	AAT signal Out of Range HIGH (Body mounted sensor)	• High resistance or open in SIG GND circuit • High resistance or open in AAT circuit • Short to PWR in AAT circuit • Failed AAT sensor	Step-Based Diagnostics (page 275)
171	4	AAT signal Out of Range LOW (Body mounted sensor)	• Short to GND in AAT circuit • SIG GND circuit shorted to AAT circuit • Failed AAT sensor	Step-Based Diagnostics (page 278)

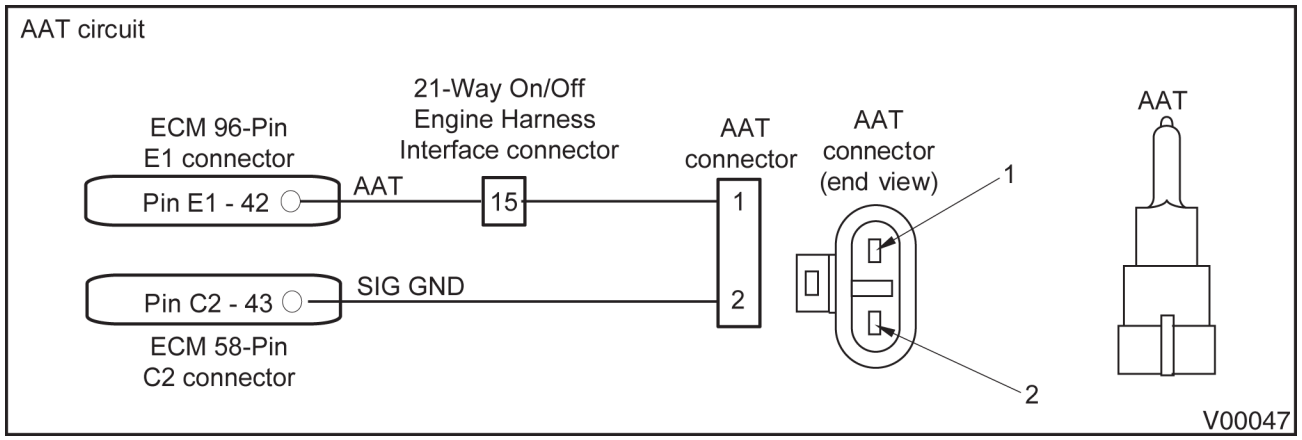


Figure 110 AAT circuit diagram

NOTE: See latest version of Navistar N13 Engine and Aftertreatment Wiring Schematic Form 0000002203 for additional circuit information.

Overview

The Ambient Air Temperature (AAT) measures the outside air temperature where the engine is operating. AAT represents the air temperature for engine cooling performance.

Tools Required

- 180-Pin Breakout Box 00-00956-08
- Breakout Harness 00-01467-00
- Breakout Harness 00-01468-00
- 3-Banana Plug Harness ZTSE4498
- Breakout Harness ZTSE4871 (AAT)
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

SPN 171 FMI 2 - AAT signal erratic, intermittent, or incorrect

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Ambient Air Temperature (AAT) does not agree with other sensors.	AAT sensor temperature differs from Inlet Air Temperature (IAT), Engine Coolant Temperature 1 (ECT1), and Engine Coolant Temperature 2 (ECT2) > 27°F (15°C).	Key ON Engine is cold soaked Engine speed > 1000 RPM Vehicle speed > 24.85 mph Engine speed and vehicle speed conditions met for > 30 seconds	1 event

Fault Overview

Fault code sets when Ambient Air Temperature (AAT) sensor temperature differs from Inlet Air Temperature (IAT), Engine Coolant Temperature 1 (ECT1), and Engine Coolant Temperature 2 (ECT2) by greater than 27°F (15°C) after a cold soak.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 171 FMI 3 and 4 (AAT)

Fault Facts

Diagnostic runs at initial Key ON after a minimum of an 8 hour cold soak.

Drive Cycle to Determine Fault Status

Drive Cycle 10 then 5 in 2013 HD-OBD Diagnostic Reference Manual.

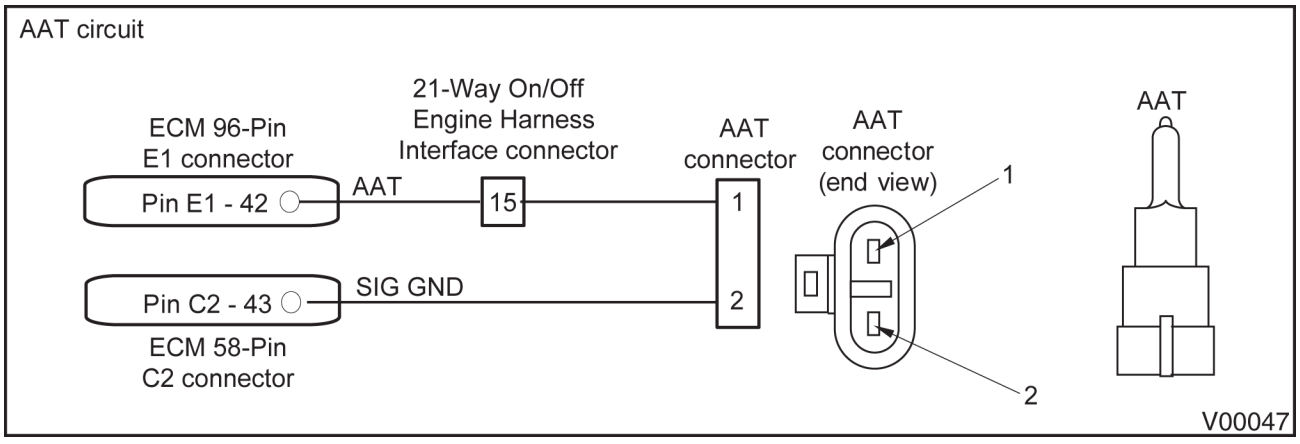


Figure 111 AAT circuit diagram

Possible Causes

- Failed AAT sensor

- High resistance in AAT circuit
- High resistance in SIG GND circuit

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 171 FMI 3 and 4 (AAT). Is EST DTC list free of SPN 171 FMI 3 and 4?	Yes: Go to step 2. No: Repair SPN 171 FMI 3 and 4. After repairs are complete, retest for SPN 171 FMI 2.

Step	Action	Decision
2	Inspect connections at Ambient Air Temperature (AAT) sensor. Key OFF, disconnect AAT sensor connector. Check AAT sensor and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the AAT sensor, connector, harness, and terminals clean and undamaged?	Yes: Go to step 3. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 171 FMI 2.

Step	Action	Decision
3	Inspect connections at Engine Control Module (ECM). Key OFF, disconnect ECM connector. Check ECM and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the ECM connector, harness, and terminals clean and undamaged?	Yes: Go to step 4. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 171 FMI 2.

Step	Action	Decision
4	Check AAT circuit for high resistance. Connect Breakout Harness ZTSE4871 to AAT harness and leave AAT disconnected. Connect 180-pin Breakout Box with ECM Breakout Harness 00-01468-00 to ECM E1 harness, and leave ECM disconnected. Key OFF, use a DMM to measure resistance from Breakout Harness ZTSE4871 pin-1 and 180-pin Breakout Box pin E1-42. Is resistance less than 5 ohms?	Yes: Go to step 5. No: Repair high resistance between AAT connector pin-1 and ECM connector pin E1-42. After repairs are complete, retest for SPN 171 FMI 2.

Step	Action	Decision
5	Check SIG GND circuit for high resistance. Connect Breakout Harness ZTSE4871 to AAT harness and leave AAT disconnected. Connect 180-pin Breakout Box with ECM Breakout Harness 00-01467-00 to Chassis C2 harness, and leave ECM disconnected. Key OFF, use a DMM to measure resistance from Breakout Harness ZTSE4871 pin-2 and 180-pin Breakout Box pin C2-43. Is resistance less than 5 ohms?	Yes: Replace AAT sensor. After repairs are complete, retest for SPN 171 FMI 2. No: Repair high resistance between AAT connector pin-2 and ECM connector pin C2-43. After repairs are complete, retest for SPN 171 FMI 2.

NOTE: After performing all diagnostic steps, if SPN 171 FMI 2 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 171 FMI 3- AAT Signal Out of Range HIGH

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Ambient Air Temperature (AAT) value greater than expected.	AAT sensor voltage > 4.5 volts.	Key ON	2 seconds

Fault Overview

Fault code sets when the Engine Control Module (ECM) detects that the Ambient Air Temperature (AAT) voltage is greater than 4.5 volts for 2 seconds.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

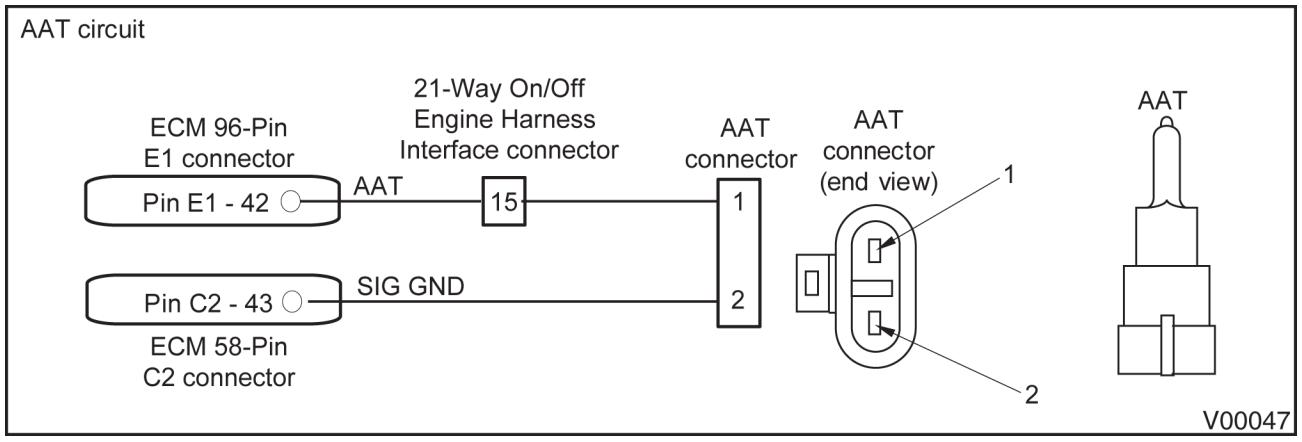


Figure 112 AAT circuit diagram

Possible Causes

- High resistance or open in SIG GND circuit
- High resistance or open in AAT circuit
- Short to PWR in AAT circuit
- Failed AAT sensor

Step	Action	Decision
1	Inspect connections at Ambient Air Temperature (AAT) sensor. Key OFF, disconnect AAT sensor connector. Check AAT sensor and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the AAT sensor, connector, harness, and terminals clean and undamaged?	Yes: Go to step 2. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 171 FMI 3.

Step	Action	Decision
2	Check AAT circuit for short to PWR. Connect Breakout Harness ZTSE4871 to vehicle harness and leave AAT sensor disconnected. Key-On Engine-Off (KOEO) measure voltage between Breakout Harness pin-1 and a known good ground. Is voltage within 0.5 volts of 5 volts?	Yes: Go to step 3. No: Repair short to power in AAT circuit. After repairs are complete, retest for SPN 171 FMI 3.

Step	Action	Decision
3	Inspect connections at Engine Control Module (ECM). Key OFF, disconnect ECM connector. Check ECM and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the ECM connector, harness, and terminals clean and undamaged?	Yes: Go to step 4. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 171 FMI 3.

Step	Action	Decision
4	Check AAT circuit for high resistance or Open. Connect 180-pin Breakout Box with Breakout Harness 00-01468-00 to vehicle harness, and leave ECM disconnected. With Breakout Harness ZTSE4871 connected to vehicle harness and with AAT sensor disconnected. Use a DMM to measure resistance from Breakout Box pin E1-42 and Breakout Harness pin-1. Is resistance less than 5 ohms?	Yes: Go to step 5. No: Repair Open or high resistance in AAT circuit between ECM pin E1-42 and AAT sensor pin-1. After repairs are complete, retest for SPN 171 FMI 3.

Step	Action	Decision
5	Check SIG GND circuit for high resistance or Open. Connect 180-pin Breakout Box with Breakout Harness 00-01467-00 to vehicle harness, and leave ECM disconnected. With Breakout Harness ZTSE4871 connected to vehicle harness and with AAT sensor disconnected. Use a DMM to measure resistance from Breakout Box pin C2-43 and Breakout Harness pin-2. Is resistance less than 5 ohms?	Yes: Replace AAT sensor. After repairs are complete, retest for SPN 171 FMI 3.
		No: Repair Open or high resistance in SIG GND circuit between ECM pin C2-43 and AAT sensor pin-2. After repairs are complete, retest for SPN 171 FMI 3.

NOTE: After performing all diagnostic steps, if SPN 171 FMI 3 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 171 FMI 4- AAT Signal Out of Range LOW

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Ambient Air Temperature (AAT) sensor reading less than expected.	AAT sensor voltage > 0.25 volts.	Key ON	2 seconds

Fault Overview

Fault code sets when the Engine Control Module (ECM) detects that the Ambient Air Temperature (AAT) signal voltage is less than expends.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

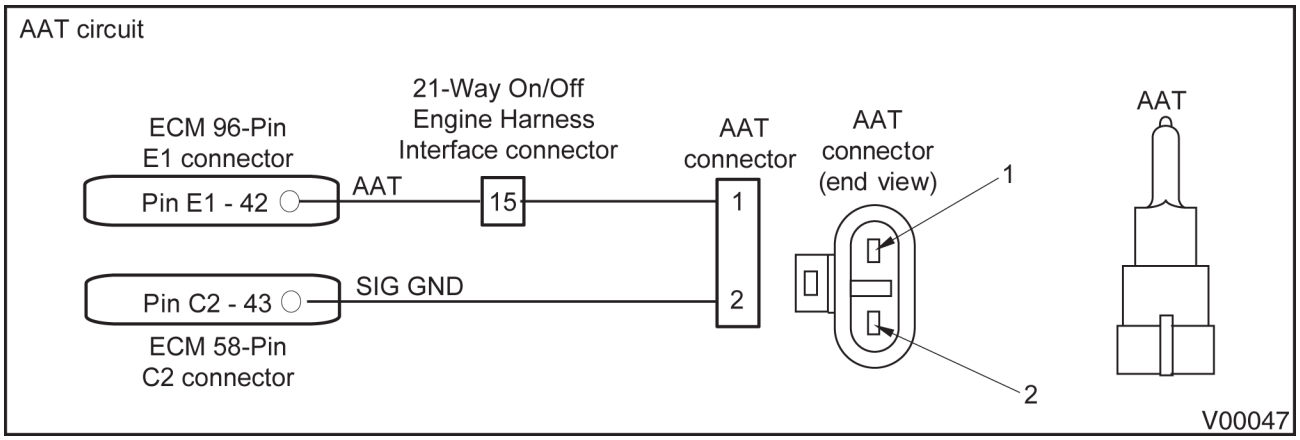


Figure 113 AAT circuit diagram

Possible Causes

- Short to GND in AAT circuit
- SIG GND circuit shorted to AAT circuit
- Failed AAT sensor

Step	Action	Decision
1	Inspect connections at Ambient Air Temperature (AAT) sensor. Key OFF, disconnect AAT sensor connector. Check AAT sensor and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the AAT sensor, connector, harness, and terminals clean and undamaged?	Yes: Go to step 2. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 171 FMI 4.

Step	Action	Decision
2	Check AAT circuit for short to GND. Connect Breakout Harness ZTSE4871 to vehicle harness and leave AAT sensor disconnected. Key-On Engine-Off (KOEO) measure voltage between breakout harness pin-1 and a known good ground. Is voltage within 0.5 volts of 5 volts?	Yes: Go to step 3. No: Repair short to GND in AAT circuit. After repairs are complete, retest for SPN 171 FMI 4.

Step	Action	Decision
3	Inspect connections at Engine Control Module (ECM). Key OFF, disconnect ECM connector. Check ECM and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the ECM connector, harness, and terminals clean and undamaged?	Yes: Go to step 4. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 171 FMI 4.

Step	Action	Decision
4	Check for short between AAT and SIG GND circuits. Connect Breakout Harness ZTSE4871 and leave AAT sensor disconnected. Key OFF, disconnect ECM and measure resistance between Breakout Harness pin-1 and pin-2. Is resistance greater than 1000 ohms?	Yes: Replace AAT sensor. After repairs are complete, retest for SPN 171 FMI 4. No: Repair short between AAT and SIG GND circuits. After repairs are complete, retest for SPN 171 FMI 4.

NOTE: After performing all diagnostic steps, if SPN 171 FMI 4 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

ACM Power (Aftertreatment Control Module)

SPN	FMI	Condition	Possible Causes	Actions
168	16	ACM Battery voltage too HIGH	• Charging voltage excessive • Incorrect battery pack wiring (series instead of parallel)	Step-Based Diagnostics (page 282)
168	18	ACM Battery voltage too LOW	• Low battery or charging system voltage • SWBAT circuit high resistance • GND circuit high resistance	Step-Based Diagnostics (page 284)

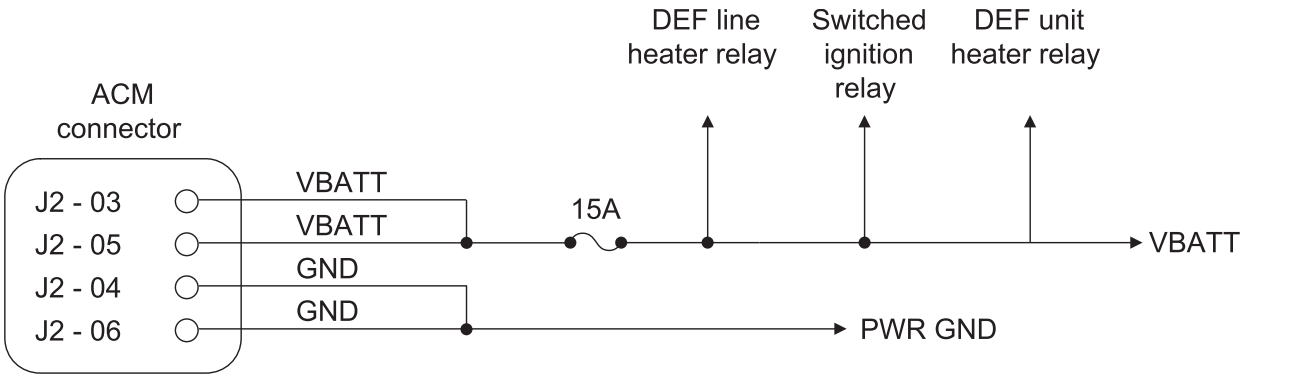


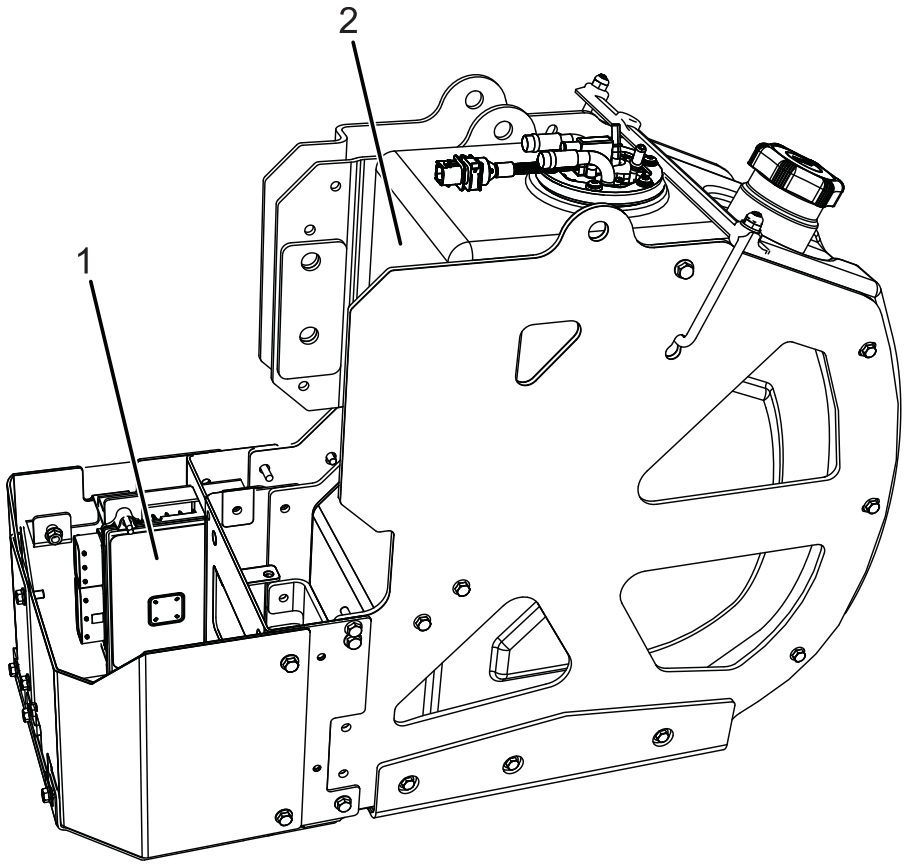
Figure 114 ACM PWR circuit diagram

Overview

The Aftertreatment Control Module (ACM) controls the Selective Catalyst Reduction (SCR) Diesel Exhaust Fluid (DEF) and Aftertreatment (AFT) Fuel dosing systems. The ACM controls DEF dosing, AFT Fuel Injection, DEF fluid temperature, and monitors DEF tank level. The ACM will also initiate the aftertreatment regeneration cycle when necessary.

Tools Required

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)
- Approved Battery Testing Device
- Digital Multimeter (DMM)



0000048976

Figure 115 ACM Location (Typical)

1. Aftertreatment Control Module (ACM)
2. Diesel Exhaust Fluid (DEF) tank

SPN 168 FMI 16 - ACM Battery voltage too HIGH

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Battery voltage data valid but above normal operating range.	Battery voltage > 16 volts	Key-On Engine-Running (KOER)	4 seconds

Fault Overview

Fault code sets when the voltage supplied to the Aftertreatment Control Module (ACM) exceeds 16 volts while the engine is running.

Malfunction Indicator Lamp (MIL) Reaction

When fault is active, MIL will not illuminate.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

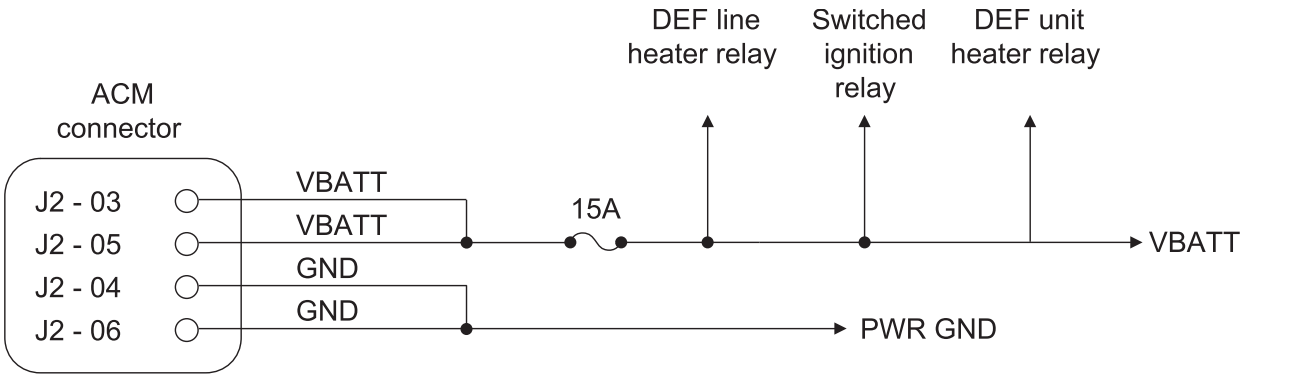


Figure 116 ACM PWR circuit diagram

Possible Causes

- Charging voltage excessive
- Incorrect battery pack wiring (series instead of parallel)

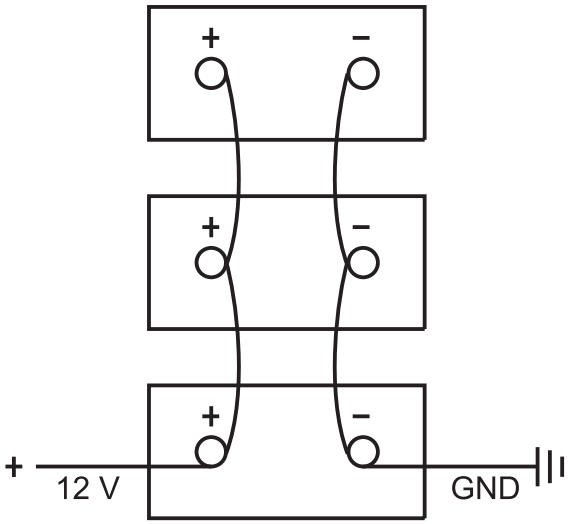


Figure 117 Parallel Battery Connections (12 Volt System)

Step	Action	Decision
1	Check for correct parallel battery pack wiring. Positive battery cable(s) should be connected from positive battery terminal to positive battery terminal. Negative battery cable(s) should be connected from negative battery terminal to negative battery terminal. Is battery pack correctly assembled (wired in parallel and not in series)?	Yes: Replace alternator. After repairs are complete, retest for SPN 168 FMI 16.
		No: Reassemble battery pack. After repairs are complete, retest for SPN 168 FMI 16.

NOTE: After doing all diagnostic steps, if SPN 168 FMI 16 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 168 FMI 18 - ACM Battery voltage too LOW

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Battery voltage data valid but below normal operating range.	Battery voltage < 6.5 volts	Key-On Engine-Running (KOER)	4 seconds

Fault Overview

Fault code sets when the voltage supplied to the Aftertreatment Control Module (ACM) is below 6.5 volts while the engine is running.

Malfunction Indicator Lamp (MIL) Reaction

When fault is active, MIL will not illuminate.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

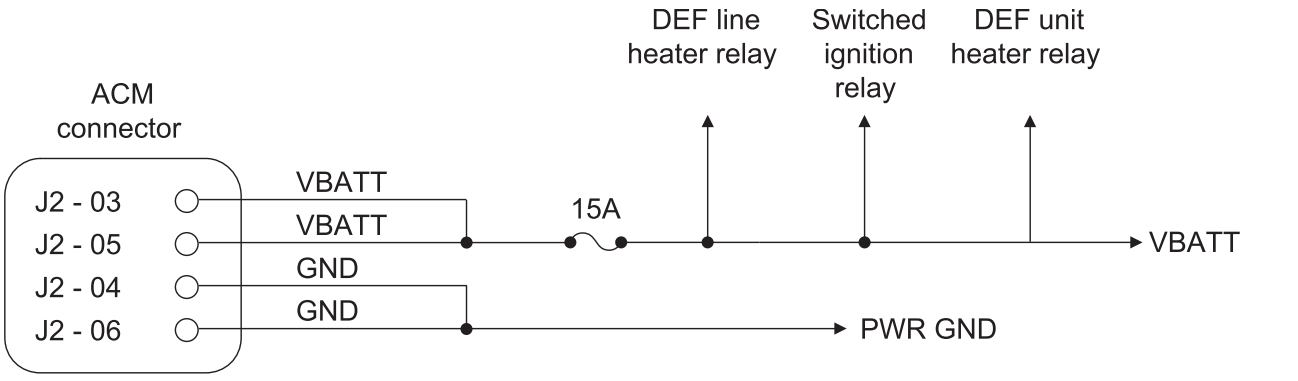


Figure 118 ACM PWR circuit diagram

Possible Causes

- Low battery or charging system voltage
- SWBAT circuit high resistance
- GND circuit high resistance

NOTE: Note: Verify batteries are fully charged and connections are clean.

Step	Action	Decision
1	Inspect connections at Aftertreatment Control Module (ACM). Key OFF, disconnect ACM. Check ACM and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the ACM harness, and terminals clean and undamaged?	Yes: Go to step 2. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 168 FMI 18.

Step	Action	Decision
2	Check VBATT circuit for high resistance. Disconnect ACM and connect 180-Pin Breakout Box and SCR (ACM) Breakout Harness 18-100-01 (58-Pin) to ACM harness and leave ACM disconnected, Key-On Engine-Off (KOEO), use a DMM to measure voltage between pin J2-03 and a known good ground; and between pin J2-05 and a known good ground. Is voltage at pin J2-03 and J2-05 within .5 volts of battery voltage?	Yes: Repair high resistance between ACM pin J2-04 or J2-06 and ground. After repairs are complete, retest for SPN 168 FMI 18. No: Repair high resistance between ACM pin J2-03 or J2-05 and 15-way connector pin-13. After repairs are complete, retest for SPN 168 FMI 18.

NOTE: After doing all diagnostic steps, if SPN 168 FMI 18 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

AFT (Aftertreatment) System

SPN	FMI	Condition	Possible Causes	Actions
1569	31	SCR tamper proof warning & protection system inducement severe	• Aftertreatment sensor or actuator circuit Open or disconnected	Step-Based Diagnostics (page 293)
3521	11	Improper Reductant in Tank	• Contaminated or degraded DEF	Step-Based Diagnostics(page 294)
3695	2	DPF Regen Inhibit Switch erratic, intermittent or incorrect	• DPF regen inhibit switch On • Failed DPF regen inhibit switch	Step-Based Diagnostics (page 295)
3703	31	DPF Active Regeneration Inhibited Due to Inhibit Switch	• Regen Inhibit Switch enabled when active regeneration is needed	Step-Based Diagnostics (page 296)
3713	31	DPF Active Regeneration Inhibited Due to System Timeout	• Fault present which prohibits regeneration	Step-Based Diagnostics (page 298)
3750	31	DPF Regen inhibited due to low exhaust temperatures	• Degraded Diesel Oxidation Catalyst (DOC) • Exhaust leak • Damaged or missing Diesel Particulate Filter (DPF) • Failed DOC / DPF temperature sensor module	Step-Based Diagnostics (page 301)
3826	18	DEF Adaption maxed out with low NOx conversion	• Frozen or restricted lines • Restricted filter • Failed / restricted supply module	Step-Based Diagnostics(page 303)

4094	31	Improper Reductant in Tank	• DEF tank, supply module, or doser valve line or connection loose, leaking, damaged, or restricted • Contaminated or degraded DEF • Failed or Restricted Diesel Exhaust Fluid Dosing Valve (DEFDV)	Step-Based Diagnostics(page 306)
4364	18	Low NOx Conversion Detected	• Exhaust system leak(s) • DEF tank, supply module, or doser valve line or connection loose, leaking, damaged, or restricted • Contaminated or degraded DEF • Failed or Restricted Diesel Exhaust Fluid Dosing Valve (DEFDV) • Restricted DEF supply module filter • DEF crystallization or deposits in exhaust piping • Failed Selective Catalyst Reduction (SCR) Catalyst	Step-Based Diagnostics(page 310)
4792	7	SCR Catalyst System - Mechanical system not responding or out of adjustment	• Failed SCR catalyst	Step-Based Diagnostics(page 315)
4792	14	SCR Catalyst System - Out of Calibration	• Failed SCR temperature sensor module	Step-Based Diagnostics(page 317)

4794	31	SCR Catalyst System Missing (Low NOx Conversion)	• Missing SCR Catalyst • Contaminated, damaged, or cracked SCR Catalyst • Contaminated DEF • Failed DEFDV	Step-Based Diagnostics(page 318)
4795	31	DPFDP excessively LOW (Sensor / Circuit Fault or Missing DPF)	• Missing DPF • DPF damaged or failed • DPFDP sensor hoses reversed or damaged	Step-Based Diagnostics(page 321)
4796	31	Diesel Oxidation Catalyst Missing	• Missing DOC • Damaged or failed DOC	Step-Based Diagnostics(page 323)
5246	15	SCR Tamper Proof Inducement Level 1 status	• Aftertreatment sensor or actuator circuit Open or disconnected	Step-Based Diagnostics(page 325)
5298	17	DOC Conversion Efficiency below minimum	• Damaged or failed DOC • Restricted DOC (soot accumulation) • Exhaust system leak between turbocharger and DOC • Failed Aftertreatment Fuel Injector (AFTFI) • Failed Aftertreatment Fuel Shutoff Valve (AFTFSV)	Step-Based Diagnostics(page 326)

5298	18	DOC Conversion Efficiency below Warning Pressure	• Damaged or failed DOC • Restricted DOC (soot accumulation) • Exhaust system leak between turbocharger and DOC • Failed Aftertreatment Fuel Injector (AFTFI) • Aftertreatment Fuel Injector (AFTFI) missing poppet • Failed Aftertreatment Fuel Shutoff Valve (AFTFSV)	Step-Based Diagnostics(page 329)
520668	31	Controller Adaptation Outer Limits Reached (Low Reductant Delivery)	• Exhaust system leak(s) • DEF tank, supply module, or doser valve line or connection loose, leaking, damaged, or restricted • Contaminated or degraded DEF • Failed or Restricted Diesel Exhaust Fluid Dosing Valve (DEFDV) • Restricted DEF supply module filter • DEF crystallization or deposits in exhaust piping • Failed NOx OUT sensor module (drifted out of range)	Step-Based Diagnostics (page 332)

			• Failed Selective Catalyst Reduction (SCR) Catalyst	
520669	31	Controller Adaptation Inner Limits Reached (Low Reductant Delivery)	• Exhaust system leak(s) • DEF tank, supply module, or doser valve line or connection loose, leaking, damaged, or restricted • Contaminated or degraded DEF • Failed or Restricted Diesel Exhaust Fluid Dosing Valve (DEFDV) • Restricted DEF supply module filter • DEF crystallization or deposits in exhaust piping • Failed NH_3 sensor • Failed Selective Catalyst Reduction (SCR) Catalyst	Step-Based Diagnostics (page 337)

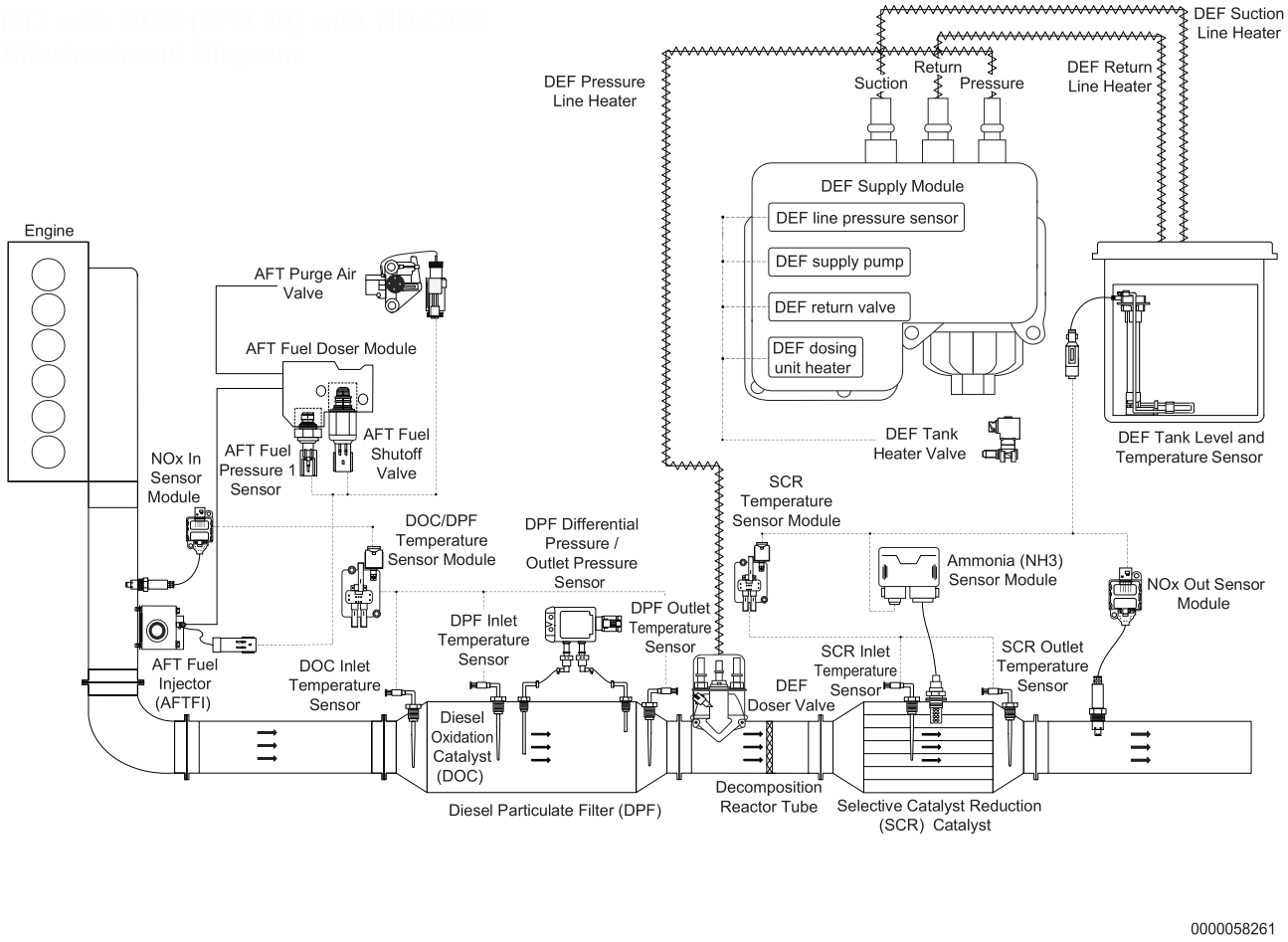


Figure 119 Functional Diagram of AFT system

NOTE: Note: See latest version of N13 Engine and Aftertreatment Wiring Schematic Form 0000002203 for additional circuit information.

Overview

The Aftertreatment (AFT) System catalyzes carbon monoxide (CO), Oxides of Nitrogen (NOx), and Hydrocarbons (HC), and has three main components: the Diesel Oxidation Catalyst (DOC) and Diesel Particulate Filter (DPF), decomposition reactor tube, and Selective Catalyst Reduction (SCR) catalyst.

The DPF captures soot and other particulates exiting the engine. Typically a good running engine will have 99% soot to 1% ash.

Soot is captured by the DPF. Although the DOC should not require regular maintenance, the DPF does require occasional off-board cleaning to remove ash.

Soot is converted to carbon dioxide by a process of regeneration (Regen). The temperature at the face of the DPF is raised to approximately 1000°F (538°C), for a period of time, depending on the amount of soot that accumulated within the DPF. Regen time is calculated by the DPF Differential Pressure (DPFDP) feedback.

The Regen may take place as the vehicle is in operation under a steady state heavy engine loading condition, or by commanding a Parked Regen.

During a Parked Regen, engine speed is increased, while the Engine Control Module (ECM) controls Post-Injection, Exhaust Gas Recirculation (EGR), and Engine Throttle Valve (ETV) to increase heat going into the exhaust system. The Inlet Air Heater (IAH) may also cycle on and off, not just to increase the Inlet Air Temperature (IAT), but to add extra load on the engine.

The health of the system and the Regen processes are monitored by the DOC Inlet Temperature (DOCIT), DPF Inlet Temperature (DPFIT), DPF Outlet Temperature (DPFOT), and the Diesel Particulate Filter Differential Pressure (DPFDP) / outlet pressure sensor. The DPFDP / outlet pressure sensor measures the pressure difference across the DPF. The DOCIT, DPFIT, and DPFOT sensors measure the temperature differences across the DOC and DPF and are part of the DOC / DPF temperature sensor module.

The DPF and / or the DOC may fail or become restricted prematurely for a number of reasons. It is important to pinpoint the root cause and repair the failure before replacing the DOC or DPF. Failure to do so could result in destroying a newly replaced component.

NOTE: Any time the DPF is replaced or removed for cleaning, record DPF serial number and use ServiceMaxx™ software to run the Diesel Particulate Filter Servicing procedure. Follow on-screen instructions.

The aftertreatment system reduces NOx by injecting Diesel Exhaust Fluid (DEF) through the Diesel Exhaust Fluid Doser Valve (DEFDV), and into the decomposition reactor tube. Exhaust heat in the decomposition reactor tube causes the DEF to break down and convert to ammonia and CO2.

The final component of the aftertreatment system is the SCR catalyst. The SCR catalyst completes the break down of DEF into ammonia and CO2, and then converts ammonia and NOx into Nitrogen gas and water.

Tools Required

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)
- Compucheck fitting ZTSE4526
- Fuel Pressure Gauge ZTSE4681
- Fuel Inlet Restriction / Aeration Tool ZTSE4886
- Fuel Line Coupler ZTSE4906
- DEF Refractometer 5025

SPN 1569 FMI 31 - SCR Tamper Proof Warning & Protection System Inducement Severe

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
The Aftertreatment Control Module (ACM) detects a open circuit in the aftertreatment system.	No signal return from an aftertreatment component	Key ON	0 seconds

Fault Overview

Fault sets when any aftertreatment sensor or actuator is Open or disconnected for at least one hour. After one hour (level 2) the engine will be de-rated by 25%. After 5 hours (level 3 and 4) the engine will be de–rated by 40%, and the Engine Control Module (ECM) will illuminate the Red Stop Lamp (RSL) and turn on the warning buzzer.

Malfunction Indicator Lamp (MIL) Reaction

The MIL will illuminate when this fault is detected during two consecutive drive cycles. The Red Stop Lamp (RSL) will illuminate when this fault is active for 5 hours.

Associated Faults

Any Aftertreatment Open circuit faults.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Aftertreatment sensor or actuator circuit Open or disconnected

CAUTION: This fault code is generated by the system and is associated with other fault code(s) for the SCR and Aftertreatment systems. There are no diagnostics required for this code. Only diagnose associated faults, failure to comply will result in misdiagnosis and unnecessary repairs.

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for active SCR and Aftertreatment Open circuit fault code(s). Are any aftertreatment Open circuit fault code(s) active?	Yes: Repair active aftertreatment Open circuit fault code(s). After repairs are complete, retest for SPN 1569 FMI 31.

NOTE: After performing all diagnostic steps, if SPN 1569 FMI 31 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3521 FMI 11- Improper Reductant in DEF Tank

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Contaminated, degraded, or incorrect Diesel Exhaust Fluid (DEF) detected.	Aftertreatment Control Module (ACM) detects the Diesel Exhaust Fluid (DEF) is contaminated, degraded, or incorrect	Key ON	

Fault Overview

Fault code sets when Aftertreatment Control Module (ACM) detects the Diesel Exhaust Fluid (DEF) is contaminated, degraded, or incorrect.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in the 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Contaminated or degraded DEF

Step	Action	Decision
1	Check DEF quality. Obtain a sample of DEF. Visually inspect for contamination, and use DEF Refractometer 5025 to test urea concentration of DEF fluid. Is urea concentration between 30 – 34 percent and Not contaminated?	Yes: Retest for SPN 3521 FMI 11.
		No: Drain the DEF tank, flush with distilled water, and fill with new and / or known good DEF. After repairs are complete, retest for SPN 3521 FMI 11.

NOTE: After performing all diagnostic steps, if SPN 3521 FMI 11 remains, verify each step was completed correctly, and the proper decision was made. Notify supervisor for further action.

SPN 3695 FMI 2- DPF Regen Inhibit Switch erratic, intermittent or incorrect

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Active regeneration of the aftertreatment system inhibited due to DPF regen inhibit switch left ON.	Active regeneration needed and DPF regen inhibit switch active.	DPF regen inhibit switch On Key-On Engine-Running (KOER)	0 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the DPF regen inhibit switch is On, and active regeneration of the aftertreatment system is needed.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 3695 FMI 19 (J1939)

Drive Cycle to Determine Fault Status

Drive cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- DPF regen inhibit switch On
- Failed DPF regen inhibit switch

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3695 FMI 19 (J1939). Is EST DTC list free of SPN 3695 FMI 19?	Yes: Go to step 2. No: Repair SPN 3695 FMI 19. After repairs are complete, retest for SPN 3695 FMI 2.

Step	Action	Decision
2	Verify DPF regen inhibit switch is in the correct position. Is the DPF regen inhibit switch Off allowing for active regenerations of the aftertreatment system?	Yes: Replace the DPF regen inhibit switch. After repairs are complete, retest for SPN 3695 FMI 2. No: Turn DPF regen inhibit switch Off and perform a parked regeneration of the aftertreatment system. After repairs are complete, retest for SPN 3695 FMI 2.

NOTE: After performing all diagnostic steps, if SPN 3695 FMI 2 remains verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3703 FMI 31 - DPF Active Regeneration Inhibited Due to Inhibit Switch

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Active regeneration of the aftertreatment system inhibited due to inhibit switch.	SPN 3719 FMI 0, 15, or 16 active OR active regeneration requested	Key-ON Engine-Running (KOER) Regen inhibit switch enabled	0 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the regen inhibit switch is enabled when any of the following occur:

- SPN 3719 FMI 0, 15, or 16 (DPF soot load) active.
- Active regeneration of the aftertreatment system is needed.

Malfunction Indicator Lamp (MIL) Reaction

When fault is active, MIL will not illuminate.

Associated Faults

SPN 3695 FMI 2 and 19 (Regen Inhibit Switch).

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Fault Facts

This fault can indicate the reason high soot load faults have been logged.

Possible Causes

- Regen Inhibit Switch enabled when active regeneration is needed.

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3695 FMI 2 and 19 (regen inhibit switch). Is EST DTC list free of SPN 3695 FMI 2 and 19?	Yes: Go to step 2. No: Repair SPN 3695 FMI 2 and 19. After repairs are complete, retest for SPN 3703 FMI 31.

Step	Action	Decision
2	Verify regen inhibit switch is in the correct position. Is the regen inhibit switch disabled allowing for active regenerations of the aftertreatment system?	Yes: Run a parked regeneration of the aftertreatment system, and retest for SPN 3703 FMI 31. No: Disable regen inhibit switch and perform a parked regeneration of the aftertreatment system. Retest for SPN 3703 FMI 31.

NOTE: After performing all diagnostic steps, if SPN 3703 FMI 31 remains, verify each step was completed correctly, and the proper decision was made. Notify supervisor for further action.

SPN 3713 FMI 31 - DPF Active Regeneration Inhibited Due to System Timeout

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Active regeneration of the aftertreatment system is needed, but a fault that inhibits regeneration is present.	Regen inhibit fault present	Key ON	Immediate

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects active regeneration is needed, but a fault that inhibits regeneration is present.

Malfunction Indicator Lamp (MIL) Reaction

This fault will not illuminate the MIL.

Associated Faults

SPN 3242 FMI 0, 2, 3, 4, 15, 16 (DPFIT); SPN 3246 FMI 0, 2, 3, 4, 15, 16 (DPFOT); SPN 3251 FMI 2, 3, 4 (DPFDP); SPN 3610 FMI 2, 3, 4 (DPFDP); SPN 3695 FMI 2, 19 (DPF); SPN 3936 FMI 7, 14, 15 (DPF System); SPN 4765 FMI 2, 3, 4, 16 (DOCIT); SPN 5742 FMI 11, 16 (DOC / DPF Temperature Sensor Module);

SPN 3480 FMI 2, 3, 4, 17 (AFTFP1); SPN 3482 FMI 2, 3, 4, 7, 16 (AFTFSV); SPN 3490 FMI 3, 4, 7 (AFTPAV); SPN 3556 FMI 2, 5 (AFTFI);

SPN 3703 FMI 31 (AFT); SPN 3719 FMI 0, 16 (AFT); SPN 3750 FMI 31 (AFT); SPN 4792 FMI 14 (AFT); SPN 4794 FMI 31 (AFT); SPN 4795 FMI 31 (AFT System); SPN 4796 FMI 31 (AFT); SPN 5298 FMI 17, 18 (AFT); SPN 5397 FMI 31 (AFT);

SPN 4360 FMI 2 (SCRIT); SPN 4363 FMI 16 (SCROT); SPN 5743 FMI 11, 16 (SCR Temp sensor module).

Drive Cycle to Determine Fault Status

Drive Cycle 1 in 2013 HD-OBD Diagnostic Reference Manual.

Fault Fact

This fault can indicate the reason high soot load faults have been logged.

Possible Causes

- Regen inhibit faults present when active regeneration is needed.

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3242 FMI 0, 2, 3, 4, 15, 16 (DPFIT); SPN 3246 FMI 0, 2, 3, 4, 15, 16 (DPFOT); SPN 3251 FMI 2, 3, 4 (DPFDP); SPN 3610 FMI 2, 3, 4 (DPFDP); SPN 3695 FMI 2, 19 (DPF); SPN 3936 FMI 7, 14, 15 (DPF System); SPN 4765 FMI 2, 3, 4, 16 (DOCIT); SPN 5742 FMI 11, 16 (DOC / DPF Temperature Sensor Module) Is EST DTC list free of SPN 3242 FMI 0, 2, 3, 4, 15, 16; SPN 3246 FMI 0, 2, 3, 4, 15, 16; SPN 3251 FMI 2, 3, 4; SPN 3610 FMI 2, 3, 4; SPN 3695 FMI 2, 19; SPN 3936 FMI 7, 14, 15; SPN 4765 FMI 2, 3, 4, 16; SPN 5742 FMI 11, 16?	Yes: Go to step 2. No: Repair SPN 3242 FMI 0, 2, 3, 4, 15, 16; SPN 3246 FMI 0, 2, 3, 4, 15, 16; SPN 3251 FMI 2, 3, 4; SPN 3610 FMI 2, 3, 4; SPN 3695 FMI 2, 19; SPN 3936 FMI 7, 14, 15; SPN 4765 FMI 2, 3, 4, 16; SPN 5742 FMI 11, 16. After repairs are complete, retest for SPN 3713 FMI 31.

Step	Action	Decision
2	Using EST with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3480 FMI 2, 3, 4, 17 (AFTFP1); SPN 3482 FMI 2, 3, 4, 7, 16 (AFTFSV); SPN 3490 FMI 3, 4, 7 (AFTPAV); SPN 3556 FMI 2, 5 (AFTFI). Is EST DTC list free of SPN 3480 FMI 2, 3, 4, 17; SPN 3482 FMI 2, 3, 4, 7, 16; SPN 3490 FMI 3, 4, 7; SPN 3556 FMI 2, 5?	Yes: Go to step 3. No: Repair SPN 3480 FMI 2, 3, 4, 17; SPN 3482 FMI 2, 3, 4, 7, 16; SPN 3490 FMI 3, 4, 7; SPN 3556 FMI 2, 5. After repairs are complete, retest for SPN 3713 FMI 31.

Step	Action	Decision
3	Using EST with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3703 FMI 31 (AFT); SPN 3719 FMI 0, 16 (AFT); SPN 3750 FMI 31 (AFT); SPN 4792 FMI 14 (AFT); SPN 4794 FMI 31 (AFT); SPN 4795 FMI 31 (AFT System); SPN 4796 FMI 31 (AFT); SPN 5298 FMI 17, 18 (AFT); SPN 5397 FMI 31 (AFT). Is EST DTC list free of SPN 3703 FMI 31; SPN 3719 FMI 0, 16; SPN 3750 FMI 31; SPN 4792 FMI 14; SPN 4794 FMI 31; SPN 4795 FMI 31; SPN 4796 FMI 31; SPN 5298 FMI 17, 18; SPN 5397 FMI 31?	Yes: Go to step 4. No: Repair SPN 3703 FMI 31; SPN 3719 FMI 0, 16; SPN 3750 FMI 31; SPN 4792 FMI 14; SPN 4794 FMI 31; SPN 4795 FMI 31; SPN 4796 FMI 31; SPN 5298 FMI 17, 18; SPN 5397 FMI 31. After repairs are complete, retest for SPN 3713 FMI 31.

Step	Action	Decision
4	Using EST with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 4360 FMI 2 (SCRIT); SPN 4363 FMI 16 (SCROT); SPN 5743 FMI 11, 16 (SCR Temp sensor module). Is EST DTC list free of SPN 4360 FMI 2; SPN 4363 FMI 16; SPN 5743 FMI 11, 16?	Yes: Run a parked regeneration of the aftertreatment system, and retest for SPN 3713 FMI 31. No: Repair SPN 4360 FMI 2; SPN 4363 FMI 16; SPN 5743 FMI 11, 16. After repairs are complete, retest for SPN 3713 FMI 31.

NOTE: After performing all diagnostic steps, if SPN 3713 FMI 31 remains, verify each step was completed correctly, and the proper decision was made. Notify supervisor for further action.

SPN 3750 FMI 31 - DPF Regen inhibited due to low exhaust temperatures

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Unable to begin closed loop control of active regeneration of Diesel Particulate Filter (DPF) due to low DOC temperature.	Diesel Particulate Filter Inlet Temperature (DPFIT) < 500°F (260°C)	Engine speed > 800 RPM for 200 seconds Barometric Pressure (BARO) ≥ 10.9 psi (75 kPa) Ambient Air Temperature (AAT) ≥ -4°F (-20°C) Active regeneration of DPF has been requested more than 200 seconds. Inactive: SPN 3242 FMI 3 and 4; SPN 4765 FMI 3 and 4; SPN 5742 FMI 3 and 4.	90 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) is unable to achieve closed loop control of active regeneration of the aftertreatment system due to low Diesel Oxidation Catalyst (DOC) temperature.

Malfunction Indicator Lamp (MIL) Reaction

This fault does not illuminate the MIL when active.

Associated Faults

SPN 27 (EGR); SPN 51 (ETV); SPN 2659 (AMS); SPN 2791 (EGR); SPN 3058 FMI 10 (EGR System Monitor); SPN 3251 FMI 2, 3, and 4 (DPFDP);SPN 3242 (DPFIT); SPN 3246 (DPFOT); and SPN 4796 FMI 31 (DOC)

Drive Cycle to Determine Fault Status

Drive Cycle 13 then 3 in 2013 HD-OBD Diagnostic Reference Manual.

Fault Facts

This fault code may indicate exhaust temperature is not high enough to actively regenerate the aftertreatment system. Driving the vehicle with long-term increased load may increase exhaust temperatures and decrease aftertreatment regeneration frequency.

Possible Causes

- Degraded Diesel Oxidation Catalyst (DOC)
- Exhaust leak
- Damaged or missing Diesel Particulate Filter (DPF)
- Failed DOC / DPF temperature sensor module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 27 (EGR); SPN 51 (ETV); SPN 2659 (AMS); SPN 2791 (EGR); SPN 3058 FMI 10 (EGR System Monitor); SPN 3251 FMI 2, 3, and 4 (DPFDP); SPN 3242 (DPFIT); SPN 3246 (DPFOT); and SPN 4796 FMI 31 (DOC). Is EST DTC list free of SPN 27; SPN 51; SPN 2659; SPN 2791; SPN 3058 FMI 10; SPN 3251 FMI 2, 3, and 4; SPN 3242; SPN 3246; and SPN 4796 FMI 31?	Yes: Go to step 2. No: Repair SPN 27; SPN 51; SPN 2659; SPN 2791; SPN 3058 FMI 10; SPN 3251 FMI 2, 3, and 4; SPN 3242; SPN 3246; and SPN 4796 FMI 31. After repairs are complete, retest for SPN 3750 FMI 31.

Step	Action	Decision
2	Inspect exhaust system for leaks and physical damage. Is exhaust system free of leaks and physical damage?	Yes: Go to step 3. No: Repair or replace leaking or damaged exhaust components. After repairs are complete, retest for SPN 3750 FMI 31.

Step	Action	Decision
3	Compare Diesel Oxidation Catalyst Inlet Temperature (DOCIT), Diesel Particulate Filter Inlet (DPFIT) and DPF Outlet Temperature (DPFOT) temperatures. Perform Hot Run Sensor Comparison Test (page 96). Are the DOCIT, DPFIT, and DPFOT temperatures within 77°F (25°C) of each other?	Yes: Go to step 3. No: Replace DOC / DPF temperature sensor module. After repairs are complete, retest for SPN 3750 FMI 31.

Step	Action	Decision
4	Check the exhaust system for an installed and undamaged Diesel Particulate Filter (DPF). Is a DPF installed in the exhaust system and free damage?	Yes: Inspect DOC for damage and replace if damaged. After repairs are complete, retest for SPN 3750 FMI 31. No: Install correct DPF. After repairs are complete, retest for SPN 3750 FMI 31.

NOTE: After performing all diagnostic steps, if SPN 3750 FMI 31 remains, verify each step was completed correctly, and the proper decision was made. Notify supervisor for further action.

SPN 3826 FMI 18- DEF Adaption maxed out with low NOx conversion

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Restriction in the DEF pressure line between the DEF supply module and DEF Doser Valve (DEFDV), or in the DEF supply module. Difference between commanded and actual DEF injection.	Measured pressure drop at first test point < 7.25 psi (50 kPa [gauge]) OR Measured pressure drop at second test point < 5.8 psi (40 kPa [gauge]) OR 7.25 psi (50 kPa [gauge]) <= Measured pressure drop at first test point < 26 psi (180 kPa [gauge]) AND 5.8 psi (40 kPa [gauge]) <= Measured pressure drop at second test point < 13.05 psi (90 kPa [gauge]) AND (Pressure drop measured at the first test point minus the pressure drop measured at the second test point) > 2.9 psi (20 kPa [gauge]) First Test Point: Monitor measures pressure drop at test point one if the monitor made a pass or fail decision in the previous operation cycle. Second Test Point: Monitor measures pressure drop at test point two if the monitor measured a pressure drop at test point one in the previous operation cycle AND the measured pressure drop falls in a given range and the monitor was unable to determine the cause of failure and report a pass / fail decision.	Inactive: SPN 3361 FMI 3, 4 (DEFSP); SPN 3362 FMI 31 (DEFSP), SPN 4334 FMI 2, 3, 4, 16, 18 (DEFLP); SPN 4360 FMI 3, 4 (SCRIT); SPN 4363 FMI 3, 4 (SCROT); SPN 5394 FMI 5 (DEFDV); SPN 5742 FMI 9 (DOC/DPF Temp); SPN 5743 FMI 3, 4, 9, 11, 12 (SCR Temp) Exhaust gas flow rate >30 g/sec Exhaust gas temperature between 356°F and 1112°F (180°C and 600°C) SCR catalyst temperature between 392°F and 932°F (200°C and 500°C) The monitor has not already measured a pressure drop at either the first or second test point, and made a pass or fail decision in this current operation cycle. The monitor has not already measured a pressure drop at the first test point, and set a parameter in run-time memory indicating that the monitor is unable to determine the cause of failure and whether a pass or fail decision should be reported, so is requesting that a second intrusive test is performed in the next operation cycle. Amount of DEF injected since DEF supply module last primed: ≥ 0.028 L DEF supply module has completed priming and is actively maintaining the target DEF line pressure.	9.4 seconds

Fault Overview

Fault code sets when Aftertreatment Control Module (ACM) detects a restriction in the Diesel Exhaust Fluid (DEF) lines, DEF Doser Valve (DEFDV), or in the DEF supply module. Maximum adaption limits reached for DEF injection, and NOx conversion remains low.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 3361 FMI 2, 3, and 4 (DEFSP); SPN 3362 FMI 31 (DEFSP); SPN 3363 FMI 3, 4, and 7 (DEFTHC); SPN 4334 FMI 2, 16 and 18 (DEFLP); SPN 4340 FMI 3 and 5 (DEFPLH); SPN 4342 FMI 3 and 5 (DEFRLH); SPN 4344 FMI 3 and 5 (DEFSLH); SPN 5394 FMI 5 and 7 (DEFDV); SPN 5745 (DEFDUH); SPN 5746 (DEFDUH); SPN 5798 (DEFUHR); SPN 520668 (AFT system); and SPN 520669 (AFT system)

SPN 3216 (NOx IN); SPN 3218 (NOx IN); SPN 3226 (NOx OUT); SPN 3228 (NOx OUT)

SPN 4360 FMI 2, 3, and 4 (SCRIT); SPN 4363 FMI 2, 3, and 4 (SCROT); SPN 5742 (DOC / DPF Temp);SPN 5743 (SCR Temp)

Drive Cycle to Determine Fault Status

Drive Cycle 2 in the 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Frozen or restricted DEF pressure line
- Restricted DEF supply module filter
- Failed / restricted DEF supply module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3216 (NOx IN), SPN 3218 (NOx IN), SPN 3226 (NOx OUT), and SPN 3228 (NOx OUT). Is EST DTC list free of SPN 3216, SPN 3218, SPN 3226, and SPN 3228?	Yes: Go to step 2. No: Repair SPN 3216, SPN 3218, SPN 3226, and SPN 3228. After repairs are complete, retest for SPN 3826 FMI 18.

Step	Action	Decision
2	Using EST with ServiceMaxx™ software, check DTC list for SPN 4377 (NH_3), SPN 4380 (NH_3), and SPN 4382 (NH_3). Is EST DTC list free of SPN 4377, SPN 4380, and SPN 4382?	Yes: Go to step 3. No: Repair SPN 4377, SPN 4380, and SPN 4382. After repairs are complete, retest for SPN 3826 FMI 18.

Step	Action	Decision
3	Using EST with ServiceMaxx™ software, check DTC list for SPN 4360 FMI 2, 3, and 4 (SCRIT); SPN 4363 FMI 2, 3, and 4 (SCROT); SPN 5742 (DOC / DPF Temp); and SPN 5743 (SCR temp sensor module). Is EST DTC list free of SPN 4360 FMI 2, 3, and 4; SPN 4363 FMI 2, 3, and 4; SPN 5742; and SPN 5743?	Yes: Go to step 4. No: Repair SPN 4360 FMI 2, 3, and 4; SPN 4363 2, 3, and 4; SPN 5742; and SPN 5743. After repairs are complete, retest for SPN 3826 FMI 18.

Step	Action	Decision
4	Using EST with ServiceMaxx™ software, check DTC list for SPN 3361 FMI 2, 3, and 4 (DEFSP); SPN 3362 FMI 31 (DEFSP); SPN 3363 FMI 3, 4, and 7 (DEFTHC); SPN 4334 FMI 2, 16, and 18 (DEFLP); SPN 4340 FMI 3 and 5 (DEFPLH); SPN 4342 FMI 3 and 5 (DEFRLH); SPN 4344 FMI 3 and 5 (DEFSLH); SPN 5394 FMI 5 and 7 (DEFDV); SPN 5745 (DEFDUH); SPN 5746 (DEFDUH); SPN 5798 (DEFUHR); SPN 520668 (AFT system); and SPN 520669 (AFT system). Is EST DTC list free of SPN 3361 FMI 2, 3, and 4; SPN 3362 FMI 31; SPN 3363 FMI 3, 4, and 7; SPN 4334 FMI 2, 16, and 18; SPN 4340 FMI 3 and 5; SPN 4342 FMI 3 and 5; SPN 4344 FMI 3 and 5; SPN 5394 FMI 5 and 7; SPN 5745; SPN 5746; SPN 5798; SPN 520668; and SPN 520669?	Yes: Go to step 5. No: Repair SPN 3361 FMI 2, 3, and 4; SPN 3362 FMI 31; SPN 3363 FMI 3, 4, and 7; SPN 4334 FMI 2, 16, and 18; SPN 4340 FMI 3 and 5; SPN 4342 FMI 3 and 5; SPN 4344 FMI 3 and 5; SPN 5394 FMI 5 and 7; SPN 5745; SPN 5746; SPN 5798; SPN 520668; and SPN 520669. After repairs are complete, retest for SPN 3826 FMI 18.

Step	Action	Decision
5	Check Diesel Exhaust Fluid (DEF) tank, DEF supply module, and DEF Doser Valve (DEFDV) lines and connections for: cracks and pitting; loose, leaking, or damaged connections; and restrictions. Are the DEF tank, DEF supply module, and DEFDV lines and connections in good condition and unrestricted?	Yes: Go to step 6. No: Repair or replace failed line or connection. After repairs are complete, retest for SPN 3826 FMI 18.

Step	Action	Decision
6	Check DEF supply module pressure line for restrictions. Disconnect both ends of pressure line and blow compressed air through the line. Does compressed air flow freely through the pressure line?	Yes: Perform DEF supply module flush (page 107). If DEFDV still does not operate correctly, replace DEF supply module. After repairs are complete, retest for SPN 3826 FMI 18. No: Clean or replace DEF supply module pressure line. After repairs are complete, retest for SPN 3826 FMI 18.

NOTE: After performing all diagnostic steps, if SPN 3826 FMI 18 remains, verify each step was completed correctly, and the proper decision was made. Notify supervisor for further action.

SPN 4094 FMI 31- Improper Reductant in (DEF) Tank

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Incorrect Diesel Exhaust Fluid (DEF) detected.	Nitrogen Oxide (NOx) Out greater than expected.	Key ON	

Fault Overview

Fault code sets when Aftertreatment Control Module (ACM) detects that the NOx Out is seeing greater NOx than expected within a calibrated time after Diesel Exhaust Fluid (DEF) tank is filled.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 3361 FMI 2, 3, and 4 (DEFSP); SPN 3362 FMI 31 (DEFSP); SPN 3363 FMI 3, 4, and 7 (DEFTHC); SPN 4334 FMI 2, 16 and 18 (DEFLP); SPN 4340 FMI 3 and 5 (DEFPLH); SPN 4342 FMI 3 and 5 (DEFRLH); SPN 4344 FMI 3 and 5 (DEFSLH); SPN 5394 FMI 5 and 7 (DEFDV); SPN 5745 (DEFDUH); SPN 5746 (DEFDUH); SPN 5798 (DEFUHR); SPN 520668 (AFT system); and SPN 520669 (AFT system)

SPN 3216 (NOx IN); SPN 3218 (NOx IN); SPN 3226 (NOx OUT); SPN 3228 (NOx OUT)

SPN 4360 FMI 2, 3, and 4 (SCRIT); SPN 4363 FMI 2, 3, and 4 (SCROT); SPN 5742 (DOC / DPF Temp); SPN 5743 (SCR Temp)

Drive Cycle to Determine Fault Status

Drive Cycle 26 in the 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- DEF tank, supply module, or doser valve line or connection loose, leaking, damaged, or restricted
- Contaminated or degraded DEF
- Failed or restricted DEFDV

Step	Action	Decision
1	Check for active Nitrogen Oxides (NOx) sensor module fault codes. Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3216 (NOx IN), SPN 3218 (NOx IN), SPN 3226 (NOx OUT), and SPN 3228 (NOx OUT). Is EST DTC list free of SPN 3216, SPN 3218, SPN 3226, and SPN 3228?	Yes: Go to step 2. No: Repair SPN 3216, SPN 3218, SPN 3226, and SPN 3228. After repairs are complete, retest for SPN 4094 FMI 31.

Step	Action	Decision
2	Check for active Ammonia (NH_3) sensor module fault codes. Using EST, check DTC list for SPN 4377 (NH_3), SPN 4380 (NH_3), and SPN 4382 (NH_3). Is EST DTC list free of SPN 4377, SPN 4380, and SPN 4382?	Yes: Go to step 3. No: Repair SPN 4377, SPN 4380, and SPN 4382. After repairs are complete, retest for SPN 4094 FMI 31.

Step	Action	Decision
3	Check for active Selective Catalyst Reduction (SCR) temperature sensor module fault codes. Using EST, check DTC list for SPN 4360 FMI 2, 3, and 4 (SCRIT); SPN 4363 FMI 2, 3, and 4 (SCROT); SPN 5742 (DOC / DPF Temp); and SPN 5743 (SCR temp sensor module). Is EST DTC list free of SPN 4360 FMI 2, 3, and 4; SPN 4363 FMI 2, 3, and 4; SPN 5742; and SPN 5743?	Yes: Go to step 4. No: Repair SPN 4360 FMI 2, 3, and 4; SPN 4363 2, 3, and 4; SPN 5742; and SPN 5743. After repairs are complete, retest for SPN 4094 FMI 31.

Step	Action	Decision
4	Check for active Diesel Exhaust Fluid (DEF) dosing system fault codes. Using EST, check DTC list for SPN 3361 FMI 2, 3, and 4 (DEFSP); SPN 3362 FMI 31 (DEFSP); SPN 3363 FMI 3, 4, and 7 (DEFTHC); SPN 4334 FMI 2, 16, and 18 (DEFLP); SPN 4340 FMI 3 and 5 (DEFPLH); SPN 4342 FMI 3 and 5 (DEFRLH); SPN 4344 FMI 3 and 5 (DEFSLH); SPN 5394 FMI 5 and 7 (DEFDV); SPN 5745 (DEFDUH); SPN 5746 (DEFDUH); SPN 5798 (DEFUHR); SPN 520668 (AFT system); and SPN 520669 (AFT system). Is EST DTC list free of SPN 3361 FMI 2, 3, and 4; SPN 3362 FMI 31; SPN 3363 FMI 3, 4, and 7; SPN 4334 FMI 2, 16, and 18; SPN 4340 FMI 3 and 5; SPN 4342 FMI 3 and 5; SPN 4344 FMI 3 and 5; SPN 5394 FMI 5 and 7; SPN 5745; SPN 5746; SPN 5798; SPN 520668; and SPN 520669?	Yes: Go to step 5. No: Repair SPN 3361 FMI 2, 3, and 4; SPN 3362 FMI 31; SPN 3363 FMI 3, 4, and 7; SPN 4334 FMI 2, 16, and 18; SPN 4340 FMI 3 and 5; SPN 4342 FMI 3 and 5; SPN 4344 FMI 3 and 5; SPN 5394 FMI 5 and 7; SPN 5745; SPN 5746; SPN 5798; SPN 520668; and SPN 520669. After repairs are complete, retest for SPN 4094 FMI 31.

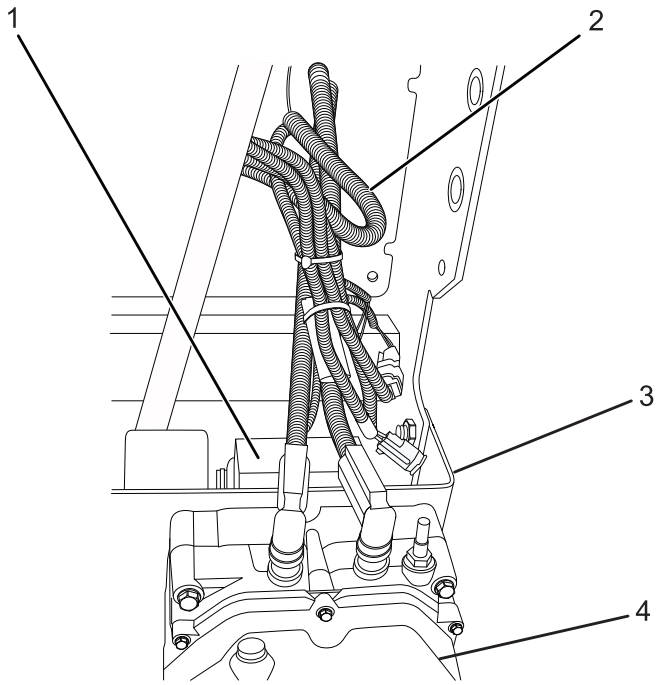


Figure 120 DEF Supply Module Location

1. Power Distribution Module (PDM)
2. DEF Lines
3. DEF Tank Bracket
4. DEF Supply Module

Step	Action	Decision
5	Check Diesel Exhaust Fluid (DEF) tank, DEF supply module, and DEF Doser Valve (DEFDV) lines and connections for: cracks and pitting; loose, leaking, or damaged connections; and restrictions. Are the DEF tank, DEF supply module, and DEFDV lines and connections in good condition and unrestricted?	Yes: Go to step 6. No: Repair or replace failed line or connection. After repairs are complete, retest for SPN 4094 FMI 31.

Step	Action	Decision
6	Check DEF quality. Obtain a sample of DEF. Visually inspect for contamination, and use DEF Refractometer 5025 to test urea concentration of DEF fluid. Is urea concentration between 30 - 34 percent and Not contaminated?	Yes: Go to step 7. No: Drain the DEF tank, flush with distilled water, and fill with new and / or known good DEF. After repairs are complete, retest for SPN 4094 FMI 31.

Step	Action	Decision
7	Verify correct Diesel Exhaust Fluid Doser Valve (DEFDV) operation. Using EST, do the DEF Doser Pump Override Test (page 98). Is the DEFDV operating correctly?	Yes: Replace NOx OUT sensor module. After repairs are complete, retest for SPN 4094 FMI 31.
		No: Replace DEF supply module filter and clean DEF supply Module using 18-200-01. Repeat step 7. If DEFDV still does not operate correctly, replace DEFDV. After repairs are complete, retest for SPN 4094 FMI 31.

NOTE: After performing all diagnostic steps, if SPN 4094 FMI 31 remains, verify each step was completed correctly, and the proper decision was made. Notify supervisor for further action.

SPN 4364 FMI 18- Low NOx Conversion Detected

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Aftertreatment system Nitrogen Oxides (NOx) conversion less than expected.	Control system detects low NOx conversion rate in aftertreatment system.	Inactive: SPN 3242 FMI 2, 3, and 4 (DPFIT); SPN 3480 FMI 2, 3, 4, and 17 (AFTFP1); SPN 3482 FMI 2, 3, 4, and 7 (AFTFSV); SPN 3490 FMI 3 and 4 (AFTPAV); SPN 3556 FMI 2 and 5 (AFTFI); SPN 3610 FMI 2, 3, and 4 (DPFDP / outlet pressure sensor); SPN 4360 FMI 0 (SCRIT); SPN 4363 FMI 0 (SCROT); SPN 4765 FMI 2, 3, and 4 (DOCIT); SPN 4794 FMI 31 (SCR); SPN 5742 FMI 3, 4, 11, and 12 (DOC / DPF temp sensor module) EGR Off Engine Protection is not active. Estimated SCR catalyst bed temperature between 356°F (180°C) to 842°F (450°C) Exhaust Flow rate 100 g/s to 440 g/s NOx IN 100 ppm to 826 ppm NOx OUT 0 ppm to 766 ppm DEF injection rate > 0.07 ml/sec Ambient pressure (absolute) 12 psi (80 kPa) to 23 psi (160 kPa) Ambient air temperature ≥ 19.9°F (-6.7°C) Rate of change of NOx IN < 40 ppm/sec Rate of change of estimated SCR bed temperature ≤ 0.5 °C/sec	7 seconds

		Rate of change of estimated exhaust mass flow < 10 g/sec SCR system NOx conversion efficiency is > -70%, urea deposit timer is < 150 hours, and DPFDP high error is not present for longer than 29 seconds. Ammonia to NOx ratio is ≥ 0.01 for 5 seconds. Timer to exit this enable condition is enabled if Ammonia to NOx Ratio is < 0.01 for 3 seconds consecutively 0.1 < Filtered ammonia to NOx ratio < 3.	

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Nitrogen Oxides (NOx) conversion efficiency of the Selective Catalyst Reduction (SCR) catalyst is less than expected. Engine torque will be reduced if fault is active for an extended period of time.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 3361 FMI 2, 3, and 4 (DEFSP); SPN 3362 FMI 31 (DEFSP); SPN 3363 FMI 3, 4, and 7 (DEFTHC); SPN 4334 FMI 2, 16 and 18 (DEFLP); SPN 4340 FMI 3 and 5 (DEFPLH); SPN 4342 FMI 3 and 5 (DEFRLH); SPN 4344 FMI 3 and 5 (DEFSLH); SPN 5394 FMI 5 and 7 (DEFDV); SPN 520668 (AFT system); and SPN 520669 (AFT system)

SPN 3216 (NOx IN), SPN 3218, SPN 3226 (NOx OUT) ; SPN 3228 (NOx OUT)

SPN 4360 FMI 2, 3, and 4 (SCRIT); SPN 4363 FMI 2, 3, and 4 (SCROT), SPN 5743 (SCR temp sensor module)

Drive Cycle to Determine Fault Status

Drive Cycle 1 then 4 in the 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Exhaust system leak(s)
- DEF tank, supply module, or doser valve line or connection loose, leaking, damaged, or restricted
- Contaminated or degraded DEF
- Failed or Restricted Diesel Exhaust Fluid Dosing Valve (DEFDV)
- Restricted DEF supply module filter
- DEF crystallization or deposits in exhaust piping
- Failed Selective Catalyst Reduction (SCR) Catalyst

Step	Action	Decision
1	Check for active Nitrogen Oxides (NOx) sensor module fault codes. Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3216 (NOx IN), SPN 3218 (NOx IN), SPN 3226 (NOx OUT), and SPN 3228 (NOx OUT). Is EST DTC list free of SPN 3216, SPN 3218, SPN 3226, and SPN 3228?	Yes: Go to step 2. No: Repair SPN 3216, SPN 3218, SPN 3226, and SPN 3228. After repairs are complete, retest for SPN 4364 FMI 18.

Step	Action	Decision
2	Check for active Ammonia (NH_3) sensor module fault codes. Using EST, check DTC list for SPN 4377 (NH_3), SPN 4380 (NH_3), and SPN 4382 (NH_3). Is EST DTC list free of SPN 4377, SPN 4380, and SPN 4382?	Yes: Go to step 3. No: Repair SPN 4377, SPN 4380, and SPN 4382. After repairs are complete, retest for SPN 4364 FMI 18.

Step	Action	Decision
3	Check for active Selective Catalyst Reduction (SCR) temperature sensor module fault codes. Using EST, check DTC list for SPN 4360 FMI 2, 3 and 4 (SCRIT); SPN 4363 2, 3, and 4 (SCROT); and SPN 5743 (SCR temp sensor module). Is EST DTC list free of SPN 4360 FMI 2, 3 and 4; SPN 4363 2, 3, and 4; and SPN 5743?	Yes: Go to step 4. No: Repair SPN 4360 FMI 2, 3 and 4; SPN 4363 2, 3, and 4; and SPN 5743. After repairs are complete, retest for SPN 4364 FMI 18.

Step	Action	Decision
4	Check for active Diesel Exhaust Fluid (DEF) dosing system fault codes. Using EST, check DTC list for SPN 3361 FMI 2, 3, and 4 (DEFSP); SPN 3362 FMI 31 (DEFSP); SPN 3363 FMI 3, 4, and 7 (DEFTHC); SPN 4334 FMI 2, 16 and 18 (DEFLP); SPN 4340 FMI 3 and 5 (DEFPLH); SPN 4342 FMI 3 and 5 (DEFRLH); SPN 4344 FMI 3 and 5 (DEFSLH); SPN 5394 FMI 5 and 7 (DEFDV); SPN 520668 (AFT system); and SPN 520669 (AFT system). Is EST DTC list free of SPN 3361 FMI 2, 3, and 4; SPN 3362 FMI 31; SPN 3363 FMI 3, 4, and 7; SPN 4334 FMI 2, 16 and 18; SPN 4340 FMI 3 and 5; SPN 4342 FMI 3 and 5; SPN 4344 FMI 3 and 5; SPN 5394 FMI 5 and 7; SPN 520668; and SPN 520669?	Yes: Go to step 5. No: Repair SPN 3361 FMI 2, 3, and 4; SPN 3362 FMI 31; SPN 3363 FMI 3, 4, and 7; SPN 4334 FMI 2, 16 and 18; SPN 4340 FMI 3 and 5; SPN 4342 FMI 3 and 5; SPN 4344 FMI 3 and 5; SPN 5394 FMI 5 and 7; SPN 520668; and SPN 520669. After repairs are complete, retest for SPN 4364 FMI 18.

Step	Action	Decision
5	Inspect exhaust system for leaks and physical damage. Is the exhaust system free of leaks and physical damage?	Yes: Go to step 6. No: Repair leaks or physical damage. After repairs are complete, retest for SPN 4364 FMI 18.

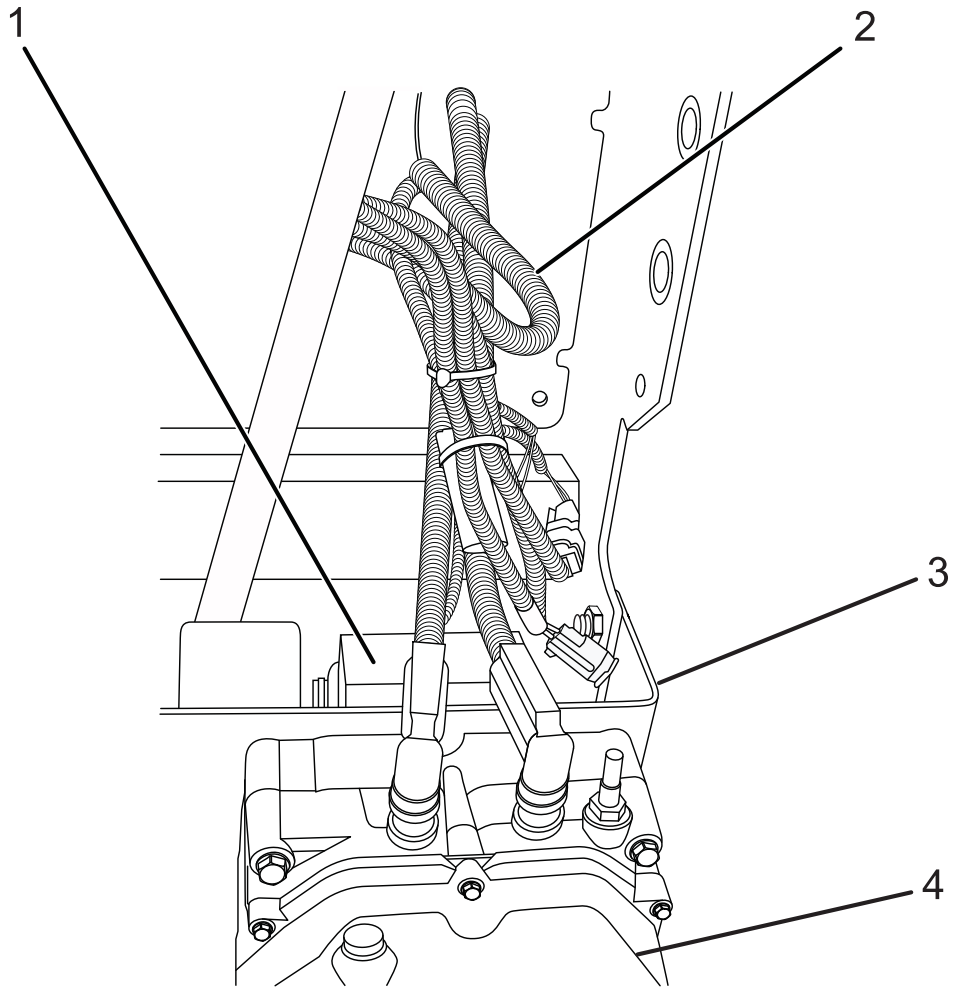


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Figure 121 DEF Supply Module Location

1. Power Distribution Module (PDM)
2. Diesel Exhaust Fluid (DEF) lines
3. DEF tank bracket
4. DEF supply module

Step	Action	Decision
6	Check Diesel Exhaust Fluid (DEF) tank, DEF supply module, and DEF Doser Valve (DEFDV) lines and connections for: cracks and pitting; loose, leaking, or damaged connections; and restrictions. Are the DEF tank, DEF supply module, and DEFDV lines and connections in good condition and unrestricted?	Yes: Go to step 7. No: Repair or replace failed line or connection. After repairs are complete, retest for SPN 4364 FMI 18.

Step	Action	Decision
7	Check DEF quality. Obtain a sample of DEF. Visually inspect for contamination, and use DEF Refractometer 5025 to test urea concentration of DEF fluid. Is urea concentration between 30 - 34 percent and Not contaminated?	Yes: Go to step 8. No: Drain the DEF tank, flush with distilled water, and fill with new and / or known good DEF. After repairs are complete, retest for SPN 4364 FMI 18.

Step	Action	Decision
8	Check decomposition tube for crystallization. Disconnect decomposition tube from exhaust system (see Exhaust System Service Manual) and inspect for DEF crystallization. Is decomposition tube free of DEF crystallization?	Yes: Go to step 9. No: Remove DEF crystallization from decomposition tube. After repairs are complete, retest for SPN 4364 FMI 18.

Step	Action	Decision
9	Verify correct Diesel Exhaust Fluid Doser Valve (DEFDV) operation. Using EST, do the DEF Doser Pump Override Test (page 98). Is the DEFDV operating correctly?	Yes: Replace SCR catalyst. After repairs are complete, retest for SPN 4364 FMI 18. No: Perform DEF supply module flush using 18-200-01. See DEF Supply Module Flush (page 107). If DEFDV still does not operate correctly, replace DEFDV. After repairs are complete, retest for SPN 4364 FMI 18.

NOTE: After performing all diagnostic steps, if SPN 4364 FMI 18 remains, verify each step was completed correctly, and the proper decision was made. Notify supervisor for further action.

SPN 4792 FMI 7- SCR Catalyst System- Mechanical system not responding or out of adjustment

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
A malfunctioning Selective Catalyst Reduction (SCR) catalyst has been detected.	NOx conversion rate does not meet ACM predetermined value.	Key-On Engine-Running (KOER) DPF Filter Regeneration procedure running	1 event

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects that the Nitrogen Oxides (NOx) conversion across the Selective Catalyst Reduction (SCR) catalyst is lower than expected, indicating a malfunctioning SCR catalyst.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 4094 FMI 31 (contaminated or degraded DEF); SPN 4364 FMI 18 (Low NOx conversion); and SPN 4794 FMI 31 (missing SCR catalyst)

Drive Cycle to Determine Fault Status

Drive Cycle 1 in the 2013 HD-OBD Diagnostic Reference Manual.

NOTE: Diagnostics for this fault code only runs during the Electronic Service Tool (EST) DPF Filter Regeneration procedure.

Fault Facts

This fault code is only used to assist in troubleshooting fault codes SPN 4094 FMI 31 (AFT system), SPN 4364 FMI 18 (AFT system), and SPN 4794 FMI 31 (AFT system). One of these associated fault codes being active while SPN 4792 FMI 7 is active indicate the following conditions must be present:

- Diesel Exhaust Fluid (DEF) uncontaminated and in good condition
- Properly functioning DEF dosing system (no leaks, restrictions, or failed components)
- No exhaust system leaks
- Decomposition reactor tube free of DEF crystallization and deposits
- Properly installed SCR catalyst

Possible Causes

- Failed SCR catalyst

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 4094 FMI 31 (contaminated or degraded DEF); SPN 4364 FMI 18 (Low NOx conversion); and SPN 4794 FMI 31 (missing SCR catalyst). Is EST DTC list free of SPN 4094 FMI 31, SPN 4364 FMI 18, and SPN 4794 FMI 31?	Yes: Clear fault and retest for SPN 4792 FMI 7. No: Replace the SCR catalyst. After repairs are complete, retest for SPN 4792 FMI 7.

NOTE: After performing all diagnostic steps, if SPN 4792 FMI 7 remains, verify each step was completed correctly, and the proper decision was made. Notify supervisor for further action.

SPN 4792 FMI 14 - SCR Catalyst System- Out of Calibration

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Internal failure of the Selective Catalyst Reduction (SCR) temperature sensor module	Aftertreatment Control Module (ACM) detects an internal circuit failure of the SCR temperature sensor module.	Key ON	2 event

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects an internal circuit error in the Selective Catalytic Reduction (SCR) temperature sensor module, or wrong SCR temperature sensor module installed. Active and parked regeneration of the aftertreatment system is disabled, and the Exhaust Gas Recirculation (EGR) valve is closed.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

None

Drive Cycle to Determine Fault Status

Drive Cycle 2 in the 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Failed SCR temperature sensor module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 4792 FMI 14 (AFT). Is SPN 4792 FMI 14 active?	Yes: Replace the SCR temperature sensor module. After repairs are complete, retest for SPN 4792 FMI 14.

NOTE: After performing all diagnostic steps, if SPN 4792 FMI 14 remains, verify each step was completed correctly, and the proper decision was made. Notify supervisor for further action.

SPN 4794 FMI 31- SCR Catalyst System Missing (Low NOx Conversion)

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
The Selective Catalyst Reduction (SCR) catalyst has low NOx conversion.	SCR catalyst conversion efficiency < 20% (NOx IN sensor module compared to NOx OUT sensor module)	Inactive: SPN 3242 FMI 2, 3, and 4 (DPFIT); SPN 3480 FMI 2, 3, 4, and 17 (AFTFP1); SPN 3482 FMI 2, 3, 4, and 7 (AFTFSV); SPN 3490 FMI 3 and 4 (AFTPAV); SPN 3556 FMI 2 and 5 (AFT); SPN 3610 FMI 2, 3, and 4 (DPFDP / outlet pressure); SPN 4363 FMI 0 (SCROT); SPN 4377 FMI 20 and 21 (NH_3); SPN 4765 FMI 2, 3, and 4 (DOCIT); SPN 5742 FMI 3, 4, 11, and 12 (DOC / DPF temp sensor module) EGR Off Engine Protection is not active. Estimated SCR catalyst bed temperature from 356 °F (180°C) to 842°F (450°C) Exhaust Flow rate 100 g/s to 440 g/s NOx IN 100 ppm to 826 ppm NOx OUT 0 ppm to 766 ppm DEF injection rate > 0.07 ml/sec Ambient pressure (absolute) 12 psi (80 kPa) to 23 psi (160 kPa) Ambient air temperature ≥ 19.9°F (-6.7°C) Rate of change of NOx IN < 40 ppm/sec Rate of change of estimated SCR bed temperature ≤ 32.9°F (0.5°C) /sec Rate of change of estimated exhaust mass flow < 10 g/sec	7 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Nitrogen Oxides (NOx) conversion efficiency of the Selective Catalyst Reduction (SCR) catalyst is critically low. The ACM compares NOx IN sensor value, to the NOx OUT sensor value. Engine torque will be reduced if fault is active for a limited period of time. Engine torque will be severely reduced and vehicle speed limited if fault is active for an extended period of time.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 3226 (NOx OUT); SPN 3228 (NOx OUT); SPN 4360 FMI 2, 3, and 4 (SCRIT); SPN 4363 FMI 2, 3, and 4 (SCROT)

Drive Cycle to Determine Fault Status

Drive Cycle 1 in the 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Missing SCR Catalyst
- Contaminated, damaged, or cracked SCR Catalyst
- Contaminated DEF
- Failed DEFDV

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3226 (NOx Out); SPN 3228 (NOx OUT); SPN 4360 FMI 2, 3, and 4 (SCRIT); and SPN 4363 FMI 2, 3, and 4 (SCROT). Is EST DTC list free of SPN 3226; SPN 3228; SPN 4360 FMI 2, 3, and 4; and SPN 4363 FMI 2, 3, and 4?	Yes: Go to step 2. No: Repair SPN 3226; SPN 3228; SPN 4360 FMI 2, 3, and 4; and SPN 4363 FMI 2, 3, and 4. After repairs are complete, retest for SPN 4794 FMI 31.

Step	Action	Decision
2	Check exhaust system for an installed Selective Catalyst Reduction (SCR) catalyst. Is an SCR catalyst installed in the exhaust system?	Yes: Go to step 3. No: Install proper SCR. After repairs are complete, retest for SPN 4794 FMI 31.

Step	Action	Decision
3	Check DEF quality. Obtain a sample of DEF. Visually inspect for contamination, and use DEF Refractometer 5025 to test urea concentration of DEF fluid. Is urea concentration between 30 - 34 percent and Not contaminated?	Yes: Do DEF Doser Pump Override Test (page 98) . After repairs are complete, retest for SPN 4794 FMI 31.
		No: Drain the DEF tank, flush with distilled water, and fill with new and / or known good DEF. After repairs are complete, retest for SPN 4794 FMI 31.

NOTE: After performing all diagnostic steps, if SPN 4794 FMI 31 remains, verify each step was completed correctly, and the proper decision was made. Notify supervisor for further action.

SPN 4795 FMI 31- DPFDP excessively LOW (Sensor / Circuit Fault or Missing DPF)

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Particulate Filter (DPF) is not present in the exhaust system.	Diesel Particulate Filter Differential Pressure (DPFDP) does not meet Aftertreatment Control Module (ACM) predetermined value.	Key-On Engine-Running (KOER)	0 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Diesel Particulate Filter Differential Pressure (DPFDP) is below a minimum value, and exhaust flow rate is above a minimum flow rate. Active and parked regeneration of the DPF will be disabled. The Exhaust Gas Recirculation (EGR) valve will be closed, and engine torque will be reduced if fault is active for an extended period of time.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 3251 FMI 3 and 4 (DPFDP)

Drive Cycle to Determine Fault Status

Drive Cycle 31 in the 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Missing DPF
- DPF damaged or failed
- DPFDP sensor hoses reversed or damaged

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3251 FMI 3 and 4 (DPFDP). Is EST DTC list free of SPN 3251 FMI 3 and 4?	Yes: Go to step 2. No: Repair SPN 3251 FMI 3 and 4. After repairs are complete, retest for SPN 4795 FMI 31.

Step	Action	Decision
2	Check the exhaust system for an installed Diesel Particulate Filter (DPF). Is a DPF installed in the exhaust system?	Yes: Go to step 3. No: Install proper DPF. After repairs are complete, retest for SPN 4795 FMI 31.

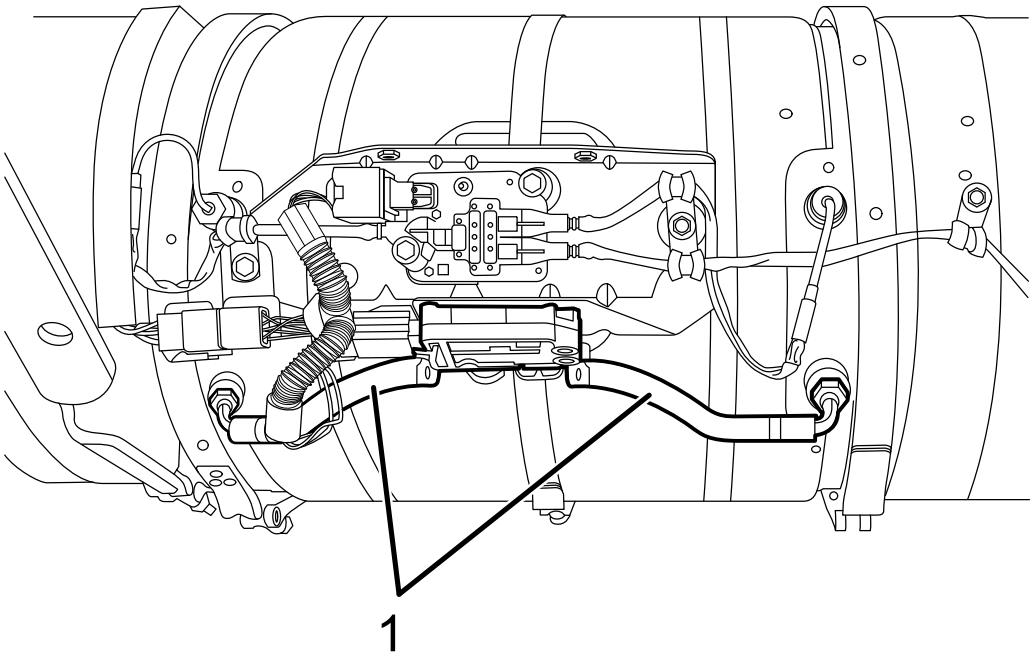

Figure 123 DPFDP / Outlet Pressure Sensor Hoses Location

1. Diesel Particulate Filter Differential Pressure (DPFDP) / outlet pressure sensor hoses (2)

Step	Action	Decision
3	Check Diesel Particulate Filter Differential Pressure (DPFDP) / outlet pressure sensor hoses for correct routing and restrictions. Inspect the DPFDP / outlet pressure sensor hoses for kinks, improper hose routing, reversed hoses, or damage.	Yes: Inspect DPF for damage and replace as necessary. After repairs are complete, retest for SPN 4795 FMI 31.
	Are the DPFDP / outlet pressure sensor hoses routed correctly and free of damage?	No: Reroute or replace DPFDP / outlet pressure sensor hoses. After repairs are complete, retest for SPN 4795 FMI 31.

NOTE: After performing all diagnostic steps, if SPN 4795 FMI 31 remains, verify each step was completed correctly, and the proper decision was made. Notify supervisor for further action.

SPN 4796 FMI 31- Diesel Oxidation Catalyst Missing

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Oxidation Catalyst (DOC) is not present in the exhaust system.	Difference between Diesel Particulate Filter Inlet Temperature (DPFIT) and Diesel Oxidation Catalyst Inlet Temperature (DOCIT) < 95 °F (35 °C)	Inactive: SPN 3242 FMI 2, 3, and 4 (DPFIT); SPN 3480 FMI 2, 3, 4, and 17 (AFTFP1); SPN 3482 FMI 2, 3, 4, and 7 (AFTFSV); SPN 3490 FMI 3 and 4 (AFTPAV); SPN 3556 FMI 2 and 5 (AFT); SPN 4765 FMI 2, 3, and 4 (DOCIT); SPN 5742 FMI 3, 4, 11, and 12 (DOC / DPF temp sensor module) Exhaust flow rate of change < 200 g/sec Exhaust flow rate from 57.5 g/sec - 600 g/sec DPFIT ≥ 403 °F (206 °C) DOCIT ≥ 460 °F (238 °C) Rate of fuel injection into exhaust > 0.43 g/sec Rate of change of fuel injection into exhaust < 4.5 g/sec Elapsed time all enable conditions met ≥ 29.5 seconds	80 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Diesel Oxidation Catalyst Inlet Temperature (DOCIT) sensor and Diesel Particulate Filter Inlet Temperature (DPFIT) sensor are reading the same temperature during an active regeneration. Active and parked regeneration of the DPF will be disabled. The Exhaust Gas Recirculation (EGR) valve will be closed, and engine torque will be reduced if fault is active for an extended period of time.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 3242 FMI 2, 3, and 4 (DPFIT); and SPN 4765 FMI 2, 3, and 4 (DOCIT).

Drive Cycle to Determine Fault Status

Drive Cycle 1 in the 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Missing DOC

- Damaged or failed DOC

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3242 FMI 2, 3, and 4 (DPFIT); and SPN 4765 FMI 2, 3, and 4 (DOCIT). Is EST DTC list free of SPN 3242 FMI 2, 3, and 4; and SPN 4765 FMI 2, 3, and 4?	Yes: Inspect DOC for damage and replace as necessary. After repairs are complete, retest for SPN 4796 FMI 31.
		No: Repair SPN 3242 FMI 2, 3, and 4; and SPN 4765 FMI 2, 3, and 4. After repairs are complete, retest for SPN 4796 FMI 31.

NOTE: After performing all diagnostic steps, if SPN 4796 FMI 31 remains, verify each step was completed correctly, and the proper decision was made. Notify supervisor for further action.

SPN 5246 FMI 15- SCR Tamperproof Inducement Level 1 status

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Detects an Open circuit in the aftertreatment system.	No signal return from an aftertreatment component	Key ON	0 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects that any Aftertreatment (AFT) sensor or actuator is Open or disconnected.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

Any Aftertreatment Open circuit faults.

Drive Cycle to Determine Fault Status

Drive Cycle 1 in the 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Aftertreatment sensor or actuator circuit Open or disconnected

CAUTION: This fault code is generated by the system and is associated with other fault code(s) for the SCR and Aftertreatment systems. There are no diagnostics required for this code. Only diagnose associated faults, failure to comply will result in misdiagnosis and unnecessary repairs.

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for active aftertreatment Open circuit fault code(s). Are any aftertreatment Open circuit fault code(s) active?	Yes: Repair active aftertreatment Open circuit fault code(s). After repairs are complete, retest for SPN 5246 FMI 15.

NOTE: After performing all diagnostic steps, if SPN 5246 FMI 15 remains, verify each step was completed correctly, and the proper decision was made. Notify supervisor for further action.

SPN 5298 FMI 17- DOC Conversion Efficiency below minimum

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Active regeneration of the Diesel Particulate Filter (DPF) aborted due to the system detecting a malfunction with the closed loop temperature controller, using up all of the adjustment allowed.	Three occurrences of the following conditions during an active regeneration of the DPF, with each lasting for a minimum of 60 seconds: • Desired Diesel Particulate Filter Inlet Temperature (DPFIT) compared to actual DPFIT > 59 °F (15 °C) • Allowed Aftertreatment Fuel Injector (AFTFI) injection compared to desired AFTFI injection greater then expected.	Key-On Engine-Running (KOER) Rate of active / intrusive injection of HC's into exhaust > 0.1 g/sec Ambient air temperature > 19 °F (-7 °C) Active regeneration running Inactive: SPN 3242 FMI 2, 3, and 4; SPN 3480 FMI 2, 3, 4, and 17; SPN 3482 FMI 2, 3, 4, and 7; SPN 3490 FMI 3 and 4; SPN 3556 FMI 2 and 5; SPN 4765 FMI 2, 3, and 4; SPN 5742 FMI 3, 4, 11, and 12	0 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the temperature differential across the Diesel Oxidation Catalyst (DOC) during active regeneration of the aftertreatment system is Not matching expected temperature increase. Active and parked regeneration of the DPF will be disabled. The Exhaust Gas Recirculation (EGR) valve will be closed, and engine torque will be reduced if fault is active for an extended period of time.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 3242 FMI 2, 3, and 4 (DPFIT); SPN 3246 FMI 2, 3, and 4 (DPFOT); SPN 4765 FMI 2, 3, and 4 (DOCIT)

Drive Cycle to Determine Fault Status

Drive Cycle 1 in the 2013 HD-OBD Diagnostic Reference Manual.

Fault Facts

If aftertreatment system has had excess fuel, oil, coolant, metal, or other contamination; inspect the entire aftertreatment system for causal damage before re-installing. Inspect for overheated aftertreatment components, cracked exhaust system welds, leaking exhaust system seams, or other damage.

Possible Causes

- Damaged or failed DOC

- Restricted DOC (soot accumulation)
- Exhaust system leak between turbocharger and DOC
- Failed Aftertreatment Fuel Injector (AFTFI)
- Failed Aftertreatment Fuel Shutoff Valve (AFTFSV)

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3242 FMI 2, 3, and 4 (DPFIT); SPN 3246 FMI 2, 3, and 4 (DPFOT); and SPN 4765 FMI 2, 3, and 4 (DOCIT). Is EST DTC list free of SPN 3242 FMI 2, 3, and 4; SPN 3246 FMI 2, 3, and 4; and SPN 4765 FMI 2, 3, and 4?	Yes: Go to step 2. No: Repair SPN 3242 FMI 2, 3, and 4; SPN 3246 FMI 2, 3, and 4; and SPN 4765 FMI 2, 3, and 4. After repairs are complete, retest for SPN 5298 FMI 17.

Step	Action	Decision
2	Inspect exhaust system for leaks between the turbocharger outlet and Diesel Oxidation Catalyst (DOC) inlet. Key-On Engine-Running (KOER), check for cracked exhaust system welds, leaking exhaust system seams, or other damage. Is the exhaust system between the turbocharger outlet and DOC inlet sealed and undamaged?	Yes: Go to step 3. No: Repair or replace damaged exhaust system components. After repairs are complete, retest for SPN 5298 FMI 17.

Step	Action	Decision
3	Inspect for a restricted or damaged DOC. Remove the DOC (see appropriate Exhaust System Service Manual). Check DOC for restrictions from soot or oil contamination, cracks or damage to cells in the DOC, and soot restrictions at the front face of the DOC. Is the DOC unrestricted and free of damage?	Yes: Go to step 4. No: Clean or replace DOC. Refer to fault facts. After repairs are complete, retest for SPN 5298 FMI 17.

Step	Action	Decision
4	Check for failed Aftertreatment Fuel Shutoff Valve (AFTFSV). Perform AFT Fuel Shutoff Valve Leak Test (page 121). Is the Aftertreatment Fuel Injector (AFTFI) dry and free of fuel?	Yes: Go to step 5. No: Replace AFTFSV. After repairs are complete, retest for SPN 5298 FMI 17.

Step	Action	Decision
5	Check for failed AFTFI. Perform AFT Fuel Injector Leak Test (page 120). Is the AFTFI dry and free of fuel?	Yes: Go to step 6. No: Replace AFTFI. After repairs are complete, retest for SPN 5298 FMI 17.

Step	Action	Decision
6	Check for failed AFT fuel flow (AFTFI). Perform AFT Dosing System Test (page 118). Was between 225 ml - 500 ml of fuel dispensed within 2.5 minutes?	Yes: Replace DOC. After repairs are complete, retest for SPN 5298 FMI 17. No: Replace AFTFI. After repairs are complete, retest for SPN 5298 FMI 17.

NOTE: After performing all diagnostic steps, if SPN 5298 FMI 17 remains, verify each step was completed correctly, and the proper decision was made. Notify supervisor for further action.

SPN 5298 FMI 18- DOC Conversion Efficiency below Warning Temperature

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Decrease in conversion capability of the Diesel Oxidation Catalyst (DOC) that would cause tailpipe out emissions to exceed the applicable OBD threshold.	Filtered value of Hydrocarbon (HC) dosing efficiency < 57 %, where HC dosing efficiency is defined as DOC Heat / DOC Dosing Heat	Key-On Engine-Running (KOER) Active regeneration running	225 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the temperature differential across the Diesel Oxidation Catalyst (DOC) during active regeneration does not indicate a temperature increase.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 3242 FMI 2, 3, and 4 (DPFIT); SPN 3246 FMI 2, 3, and 4 (DPFOT); SPN 3556 FMI 18 (AFT); and SPN 4765 FMI 2, 3, and 4 (DOCIT)

Drive Cycle to Determine Fault Status

Drive Cycle 32 in the 2013 HD-OBD Diagnostic Reference Manual.

Fault Facts

If aftertreatment system has had excess fuel, oil, coolant, metal, or other contamination; inspect the entire aftertreatment system for causal damage before re-installing. Inspect for overheated aftertreatment components, cracked exhaust system welds, leaking exhaust system seams, or other damage.

Possible Causes

- Damaged or failed DOC
- Restricted DOC (soot accumulation)
- Exhaust system leak between turbocharger and DOC
- Failed Aftertreatment Fuel Injector (AFTFI)
- Aftertreatment Fuel Injector (AFTFI) missing poppet
- Failed Aftertreatment Fuel Shutoff Valve (AFTFSV)

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3242 FMI 2, 3, and 4 (DPFIT); SPN 3246 FMI 2, 3, and 4 (DPFOT); SPN 3556 FMI 18 (AFT); and SPN 4765 FMI 2, 3, and 4 (DOCIT). Is EST DTC list free of SPN 3242 FMI 2, 3, and 4; SPN 3246 FMI 2, 3, and 4; SPN 3556 FMI 18; and SPN 4765 FMI 2, 3, and 4?	Yes: Go to step 2. No: Repair SPN 3242 FMI 2, 3, and 4; SPN 3246 FMI 2, 3, and 4; SPN 3556 FMI 18; and SPN 4765 FMI 2, 3, and 4. After repairs are complete, retest for SPN 5298 FMI 18.

Step	Action	Decision
2	Inspect exhaust system for leaks between the turbocharger outlet and Diesel Oxidation Catalyst (DOC) inlet. Key-On Engine-Running (KOER), check for cracked exhaust system welds, leaking exhaust system seams, or other damage. Is the exhaust system between the turbocharger outlet and DOC inlet sealed and undamaged?	Yes: Go to step 3. No: Repair or replace damaged exhaust system components. After repairs are complete, retest for SPN 5298 FMI 18.

Step	Action	Decision
3	Inspect for a restricted or damaged DOC. Remove the DOC (see appropriate Exhaust System Service Manual). Check DOC for restrictions from soot or oil contamination, cracks or damage to cells in the DOC, and soot restrictions at the front face of the DOC. Is the DOC unrestricted and free of damage?	Yes: Go to step 4. No: Clean or replace DOC. Refer to fault facts. After repairs are complete, retest for SPN 5298 FMI 18.

Step	Action	Decision
4	Remove the Aftertreatment Fuel Injector (AFTFI) see *Engine Service Manual*. Inspect the AFTFI lower poppet. Is the AFTFI missing the lower poppet?	Yes: Replace AFTFI. After repairs are complete, retest for SPN 5298 FMI 18. No: Go to step 5.

Step	Action	Decision
4	Check for failed Aftertreatment Fuel Shutoff Valve (AFTFSV). Perform AFT Fuel Shutoff Valve Leak Test (page 121). Is the Aftertreatment Fuel Injector (AFTFI) dry and free of fuel?	Yes: Go to step 5. No: Replace AFTFSV. After repairs are complete, retest for SPN 5298 FMI 18.

Step	Action	Decision
5	Check for failed AFTFI. Perform AFT Fuel Injector Leak Test (page 120). Is the AFTFI dry and free of fuel?	Yes: Go to step 6. No: Replace AFTFI. After repairs are complete, retest for SPN 5298 FMI 18.

Step	Action	Decision
6	Check for failed AFT fuel flow. Perform AFT Dosing System Test (page 118). Was between 225 ml - 500 ml of fuel dispensed within 2.5 minutes?	Yes: Replace DOC. After repairs are complete, retest for SPN 5298 FMI 18. No: Replace AFTFI. After repairs are complete, retest for SPN 5298 FMI 18.

NOTE: After performing all diagnostic steps, if SPN 5298 FMI 18 remains, verify each step was completed correctly, and the proper decision was made. Notify supervisor for further action.

SPN 520668 FMI 31- Controller Adaptation Outer Limits Reached (Low Reductant Delivery)

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Nitrogen Oxide (NOx) OUT sensor is requesting more DEF than expected.	{ [Percent of time (Estimated NOx reduction levels) / (Measured NOx reduction levels) < 60 ppm] / [Percent of time all enable conditions are active] } > 100%	Inactive: SPN 3226 FMI 4, 9, 10, 13, 20 (NOx OUT); SPN 3228 FMI 2 (NOx OUT); SPN 3242 FMI 2, 3, 4 (DPFIT); SPN 3246 FMI 2, 3, 4 (DPFOT); SPN 3361 FMI 2 (DEF Supply Pump); SPN 4360 FMI 2, 3, 4 (SCRIT); SPN 4363 FMI 2, 3, 4 (SCRIT); SPN 4364 FMI 18 (AFT); SPN 4377 FMI 2, 4, 12, 13, 20, 21 (NH_3); SPN 4380 FMI 2, 16, 18 (NH_3); SPN 4765 FMI 2, 3, 4 (DOCIT); SPN 4794 FMI 31 (AFT); SPN 5031 FMI 10 (AFT); SPN 5742 FMI 3, 4, 11, 9, 12 (DOC / DPF Temperature Sensor Module); SPN 5743 FMI 3, 4, 11, 9, 12 (SCR Temperature Sensor Module) Engine protection Not active Barometric (BARO) density ≥ 0 kg / m^3 Ambient Air Temperature (AAT) ≥ 19.4°F (-7°C) Barometric Pressure ≥ 10.9 psi (75 kpa) gauge Exhaust Gas mass flow rate ≥ 20 g / sec Diesel Particulate Filter Outlet Temperature ≤ 1292°F (700°C) DEF pump pressure control is completed AND DEF supply pressure is within the range of 116-145 psi (800-1,000 kPa) gauge for > 3 seconds NH_3 sensor status and signal valid Ammonia Storage Timer ≥ 1400 seconds Exhaust flow rate ≥ 130 g / sec for 20 seconds	300 seconds

SPN 520668 FMI 31- Controller Adaptation Outer Limits Reached (Low Reductant Delivery) (cont.)

		Injection command ≥ 0.2 g / sec for 20 seconds	

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Nitrogen Oxide (NOx) OUT sensor is requesting more DEF than expected.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 3361 FMI 2, 3, and 4 (DEFSP); SPN 3362 FMI 31 (DEFSP); SPN 3363 FMI 3, 4, and 7 (DEFTHC); SPN 4334 FMI 2, 16 and 18 (DEFLP); SPN 4340 FMI 3 and 5 (DEFPLH); SPN 4342 FMI 3 and 5 (DEFRLH); SPN 4344 FMI 3 and 5 (DEFSLH); SPN 5394 FMI 5 and 7 (DEFDV); and SPN 520669 (AFT system)

SPN 3216 (NOx IN); SPN 3218 (NOx IN); SPN 3226 (NOx OUT); SPN 3228 (NOx OUT)

SPN 4360 FMI 2, 3, and 4 (SCRIT); SPN 4363 FMI 2, 3, and 4 (SCROT); SPN 5743 (SCR temp sensor module)

Drive Cycle to Determine Fault Status

Drive Cycle 2 in the 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Exhaust system leak(s)
- DEF tank, supply module, or doser valve line or connection loose, leaking, damaged, or restricted
- Contaminated or degraded DEF
- Failed or restricted Diesel Exhaust Fluid Dosing Valve (DEFDV)
- Restricted DEF supply module filter
- DEF crystallization or deposits in decomposition tube
- Failed Selective Catalyst Reduction (SCR) catalyst

Step	Action	Decision
1	Check for active Nitrogen Oxides (NOx) sensor module fault codes. Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3216 (NOx IN), SPN 3218 (NOx IN), SPN 3226 (NOx OUT), and SPN 3228 (NOx OUT). Is EST DTC list free of SPN 3216, SPN 3218, SPN 3226, and SPN 3228?	Yes: Go to step 2. No: Repair SPN 3216, SPN 3218, SPN 3226, and SPN 3228. After repairs are complete, retest for SPN 520668 FMI 31.

Step	Action	Decision
2	Check for active Ammonia (NH_3) sensor module fault codes. Using EST, check DTC list for SPN 4377 (NH_3), SPN 4380 (NH_3), and SPN 4382 (NH_3). Is EST DTC list free of SPN 4377, SPN 4380, and SPN 4382?	Yes: Go to step 3. No: Repair SPN 4377, SPN 4380, and SPN 4382. After repairs are complete, retest for SPN 520668 FMI 31.

Step	Action	Decision
3	Check for active Selective Catalyst Reduction (SCR) temperature sensor module fault codes. Using EST, check DTC list for SPN 4360 FMI 2, 3, and 4 (SCRIT); SPN 4363 FMI 2, 3, and 4 (SCROT); and SPN 5743 (SCR temp sensor module). Is EST DTC list free of SPN 4360 FMI 2, 3, and 4; SPN 4363 FMI 2, 3, and 4; and SPN 5743?	Yes: Go to step 4. No: Repair SPN 4360 FMI 2, 3, and 4; SPN 4363 FMI 2, 3, and 4; and SPN 5743. After repairs are complete, retest for SPN 520668 FMI 31.

Step	Action	Decision
4	Check for active Diesel Exhaust Fluid (DEF) dosing system fault codes. Using EST, check DTC list for SPN 3361 FMI 2, 3, and 4 (DEFSP); SPN 3362 FMI 31 (DEFSP); SPN 3363 FMI 3, 4, and 7 (DEFTHC); SPN 4334 FMI 2, 16, and 18 (DEFLP); SPN 4340 FMI 3 and 5 (DEFPLH); SPN 4342 FMI 3 and 5 (DEFRLH); SPN 4344 FMI 3 and 5 (DEFSLH); SPN 5394 FMI 5 and 7 (DEFDV); and SPN 520669 (AFT system). Is EST DTC list free of SPN 3361 FMI 2, 3, and 4; SPN 3362 FMI 31; SPN 3363 FMI 3, 4, and 7; SPN 4334 FMI 2, 16, and 18; SPN 4340 FMI 3 and 5; SPN 4342 FMI 3 and 5; SPN 4344 FMI 3 and 5; SPN 5394 FMI 5 and 7; and SPN 520669?	Yes: Go to step 5. No: Repair SPN 3361 FMI 2, 3, and 4; SPN 3362 FMI 31; SPN 3363 FMI 3, 4, and 7; SPN 4334 FMI 2, 16, and 18; SPN 4340 FMI 3 and 5; SPN 4342 FMI 3 and 5; SPN 4344 FMI 3 and 5; SPN 5394 FMI 5 and 7; and SPN 520669. After repairs are complete, retest for SPN 520668 FMI 31.

Step	Action	Decision
5	Inspect exhaust system for leaks and physical damage. Is the exhaust system free of leaks and physical damage?	Yes: Go to step 6. No: Repair leaks or physical damage. After repairs are

		complete, retest for SPN 520668 FMI 31.

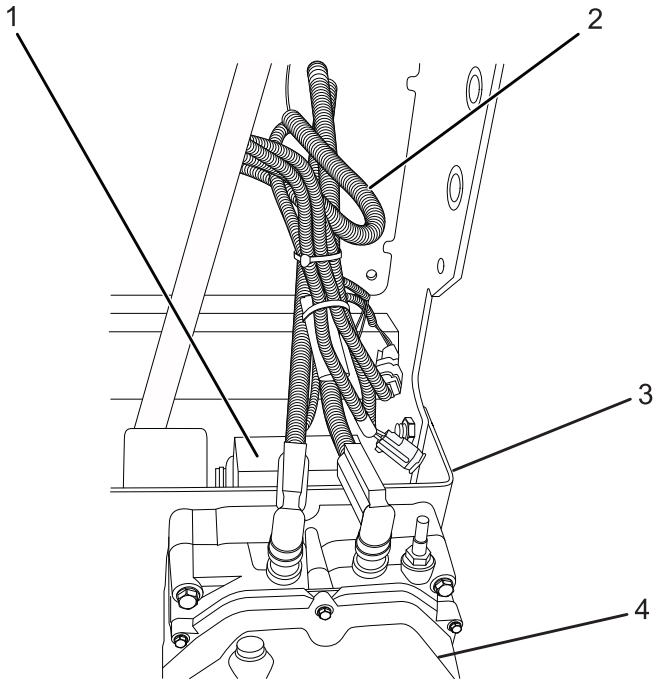

Figure 124 DEF Supply Module Location

1. Power Distribution Module (PDM)
2. DEF Lines
3. DEF Tank Bracket
4. DEF Supply Module

Step	Action	Decision
6	Check Diesel Exhaust Fluid (DEF) tank, DEF supply module, and DEF Doser Valve (DEFDV) lines and connections for: cracks and pitting; loose, leaking, or damaged connections; and restrictions. Are the DEF tank, DEF supply module, and DEFDV lines and connections in good condition and unrestricted?	Yes: Go to step 7. No: Repair or replace failed line or connection. After repairs are complete, retest for SPN 520668 FMI 31.

Step	Action	Decision
7	Check DEF quality. Obtain a sample of DEF. Visually inspect for contamination, and use DEF Refractometer 5025 to test urea concentration of DEF fluid. Is urea concentration between 30 - 34 percent and Not contaminated?	Yes: Go to step 8. No: Drain the DEF tank, flush with distilled water, and fill with new and / or known good DEF. After repairs are complete, retest for SPN 520668 FMI 31.

Step	Action	Decision
8	Verify correct Diesel Exhaust Fluid Doser Valve (DEFDV) operation. Using EST, do the DEF Doser Pump Override Test (page 98). Is the DEFDV operating correctly?	Yes: Go to step 9.
		No: Replace DEF supply module filter and clean DEF supply module using 18-200-01. Repeat step 8. If DEFDV still does not operate correctly, replace DEFDV. After repairs are complete, retest for SPN 520668 FMI 31.

Step	Action	Decision
9	Check decomposition tube for crystallization. Disconnect decomposition tube from exhaust system (see Exhaust System Service Manual) and inspect for DEF crystallization. Is decomposition tube free of DEF crystallization?	Yes: Remove and inspect SCR catalyst. Replace SCR catalyst if damage or plugging is found. After repairs are complete, retest for SPN 520668 FMI 31.
		No: Remove DEF crystallization from decomposition tube. After repairs are complete, retest for SPN 520668 FMI 31.

NOTE: After performing all diagnostic steps, if SPN 520668 FMI 31 remains, verify each step was completed correctly, and the proper decision was made. Notify supervisor for further action.

SPN 520669 FMI 31- Controller Adaptation Inner Limits Reached (Low Reductant Delivery)

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Ammonia (NH_3) sensor is requesting more DEF than expected.	(Percent of time Inner Loop is used up) / (Percent of time all Enable Conditions are active) > 98% Inner Loop used up = ([NH_3 sensor is requesting high dosing for the Selective Catalyst Reduction (SCR) AND (NH_3 sensor ≤ 1.5 ppm) OR (SCR Inlet Temperature (SCRIT) ≤ 518°F [270°C]) OR (Estimate SCR brick temperature ≤ 482°C [250°C])] AND(Ammonia adjusted reference - Mid bed Ammonia concentration) > 34.7°F/ sec (1.5°C / sec)	Inactive: SPN 3226 FMI 4, 9, 10, 13, 20 (NOx OUT); SPN 3228 FMI 2 (NOx OUT); SPN 3242 FMI 2, 3, 4 (DPFIT); SPN 3246 FMI 2, 3, 4 (DPFOT); SPN 3361 FMI 2 (DEF Supply Pump); SPN 4360 FMI 2, 3, 4 (SCRIT); SPN 4363 FMI 2, 3, 4 (SCRIT); SPN 4364 FMI 18 (AFT); SPN 4377 FMI 2, 4, 12, 13, 20, 21 (NH_3); SPN 4380 FMI 2, 16, 18 (NH_3); SPN 4765 FMI 2, 3, 4 (DOCIT); SPN 4794 FMI 31 (AFT); SPN 5031 FMI 10 (AFT); SPN 5742 FMI 3, 4, 11, 9, 12 (DOC / DPF Temperature Sensor Module); SPN 5743 FMI 3, 4, 11, 9, 12 (SCR Temperature Sensor Module) Engine protection Not active Barometric (BARO) density ≥ 0 kg / m^3 Ambient Air Temperature (AAT) ≥ 19.4 ° F (-7°C) Barometric Pressure ≥ 10.9 psi (75 kpa) gauge Exhaust Gas mass flow rate ≥ 20 g / sec Diesel Particulate Filter Outlet Temperature ≤ 1292°F (700°C) DEF pump pressure control is completed AND DEF supply pressure is within the range of 116-145 psi (800-1,000 kPa) gauge for > 3 seconds NH_3 sensor status and signal valid Ammonia Storage Timer ≥ 1400 seconds Exhaust flow rate ≥ 130 g / sec for 20 seconds	300

SPN 520669 FMI 31- Controller Adaptation Inner Limits Reached (Low Reductant Delivery) (cont.)

		Injection command ≥ 0.2 g / sec for 20 seconds	

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects that the Ammonia (NH_3) sensor is requesting more DEF than expected.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 3361 FMI 2, 3, and 4 (DEFSP); SPN 3362 FMI 31 (DEFSP); SPN 3363 FMI 3, 4, and 7 (DEFTHC); SPN 4334 FMI 2, 16 and 18 (DEFLP); SPN 4340 FMI 3 and 5 (DEFPLH); SPN 4342 FMI 3 and 5 (DEFRLH); SPN 4344 FMI 3 and 5 (DEFSLH); SPN 5394 FMI 5 and 7 (DEFDV); and SPN 520668 (AFT system)

SPN 3216 (NOx IN); SPN 3218 (NOx IN); SPN 3226 (NOx OUT); SPN 3228 (NOx OUT)

SPN 4360 FMI 2, 3, and 4 (SCRIT); SPN 4363 FMI 2, 3, and 4 (SCROT); SPN 5743 (SCR temp sensor module)

Drive Cycle to Determine Fault Status

Drive Cycle 2 in the 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Exhaust system leak(s)
- DEF tank, supply module, or doser valve line or connection loose, leaking, damaged, or restricted
- Contaminated or degraded DEF
- Failed or Restricted Diesel Exhaust Fluid Dosing Valve (DEFDV)
- Restricted DEF supply module filter
- DEF crystallization or deposits in exhaust piping
- Failed Selective Catalyst Reduction (SCR) Catalyst

Step	Action	Decision
1	Check for active Nitrogen Oxides (NOx) sensor module fault codes. Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3216 (NOx IN), SPN 3218 (NOx IN), SPN 3226 (NOx OUT), and SPN 3228 (NOx OUT). Is EST DTC list free of SPN 3216, SPN 3218, SPN 3226, and SPN 3228?	Yes: Go to step 2. No: Repair SPN 3216, SPN 3218, SPN 3226, and SPN 3228. After repairs are complete, retest for SPN 520669 FMI 31.

Step	Action	Decision
2	Check for active Ammonia (NH_3) sensor module fault codes. Using EST, check DTC list for SPN 4377 (NH_3), SPN 4380 (NH_3), and SPN 4382 (NH_3). Is EST DTC list free of SPN 4377, SPN 4380, and SPN 4382?	Yes: Go to step 3. No: Repair SPN 4377, SPN 4380, and SPN 4382. After repairs are complete, retest for SPN 520669 FMI 31.

Step	Action	Decision
3	Check for active Selective Catalyst Reduction (SCR) temperature sensor module fault codes. Using EST, check DTC list for SPN 4360 FMI 2, 3, and 4 (SCRIT); SPN 4363 FMI 2, 3, and 4 (SCROT); and SPN 5743 (SCR temp sensor module). Is EST DTC list free of SPN 4360 FMI 2, 3, and 4; SPN 4363 FMI 2, 3, and 4; and SPN 5743?	Yes: Go to step 4. No: Repair SPN 4360 FMI 2, 3, and 4; SPN 4363 FMI 2, 3, and 4; and SPN 5743. After repairs are complete, retest for SPN 520669 FMI 31.

Step	Action	Decision
4	Check for active Diesel Exhaust Fluid (DEF) dosing system fault codes. Using EST, check DTC list for SPN 3361 FMI 2, 3, and 4 (DEFSP); SPN 3362 FMI 31 (DEFSP); SPN 3363 FMI 3, 4, and 7 (DEFTHC); SPN 4334 FMI 2, 16, and 18 (DEFLP); SPN 4340 FMI 3 and 5 (DEFPLH); SPN 4342 FMI 3 and 5 (DEFRLH); SPN 4344 FMI 3 and 5 (DEFSLH); SPN 5394 FMI 5 and 7 (DEFDV); and SPN 520668 (AFT system). Is EST DTC list free of SPN 3361 FMI 2, 3, and 4; SPN 3362 FMI 31; SPN 3363 FMI 3, 4, and 7; SPN 4334 FMI 2, 16, and 18; SPN 4340 FMI 3 and 5; SPN 4342 FMI 3 and 5; SPN 4344 FMI 3 and 5; SPN 5394 FMI 5 and 7; and SPN 520668?	Yes: Go to step 5. No: Repair SPN 3361 FMI 2, 3, and 4; SPN 3362 FMI 31; SPN 3363 FMI 3, 4, and 7; SPN 4334 FMI 2, 16 and 18; SPN 4340 FMI 3 and 5; SPN 4342 FMI 3 and 5; SPN 4344 FMI 3 and 5; SPN 5394 FMI 5 and 7; and SPN 520668. After repairs are complete, retest for SPN 520669 FMI 31.

Step	Action	Decision
5	Inspect exhaust system for leaks and physical damage. Is the exhaust system free of leaks and physical damage?	Yes: Go to step 6. No: Repair leaks or physical damage. After repairs are

		complete, retest for SPN 520669 FMI 31.

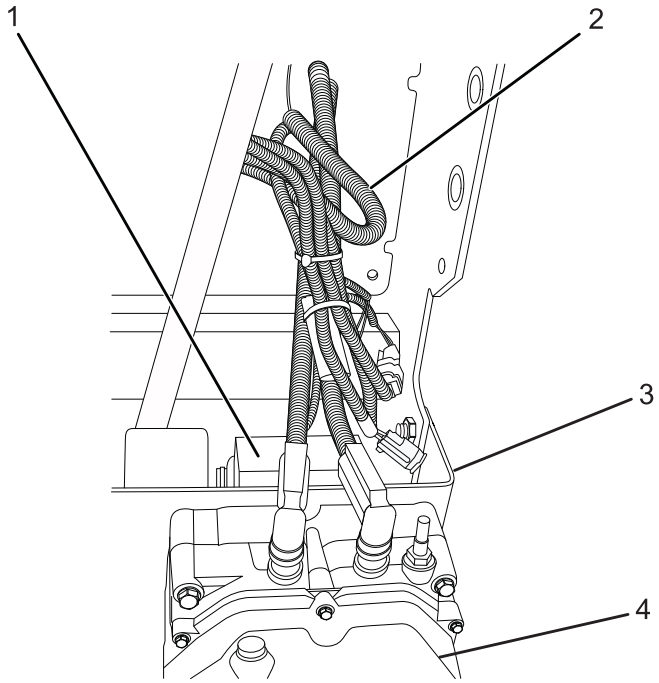

Figure 125 DEF Supply Module Location

1. Power Distribution Module (PDM)
2. DEF Lines
3. DEF Tank Bracket
4. DEF Supply Module

Step	Action	Decision
6	Check Diesel Exhaust Fluid (DEF) tank, DEF supply module, and DEF Doser Valve (DEFDV) lines and connections for: cracks and pitting; loose, leaking, or damaged connections; and restrictions. Are the DEF tank, DEF supply module, and DEFDV lines and connections in good condition and unrestricted?	Yes: Go to step 7. No: Repair or replace failed line or connection. After repairs are complete, retest for SPN 520669 FMI 31.

Step	Action	Decision
7	Check DEF quality. Obtain a sample of DEF. Visually inspect for contamination, and use DEF Refractometer 5025 to test urea concentration of DEF fluid. Is urea concentration between 30 - 34 percent and Not contaminated?	Yes: Go to step 8. No: Drain the DEF tank, flush with distilled water, and fill with new and / or known good DEF. After repairs are complete, retest for SPN 520669 FMI 31.

Step	Action	Decision
8	Verify correct Diesel Exhaust Fluid Doser Valve (DEFDV) operation. Using EST, do the DEF Doser Pump Override Test (page 98). Is the DEFDV operating correctly?	Yes: Go to step 9.
		No: Replace DEF supply module filter and clean DEF supply module using 18-200-01. repeat step 8. If DEFDV still does not operate correctly, replace DEFDV. After repairs are complete, retest for SPN 520669 FMI 31.

Step	Action	Decision
9	Check decomposition tube for crystallization. Disconnect decomposition tube from exhaust system (see Exhaust System Service Manual) and inspect for DEF crystallization. Is decomposition tube free of DEF crystallization?	No: Remove and inspect SCR catalyst. Replace SCR catalyst if damage or plugging is found. After repairs are complete, retest for SPN 520669 FMI 31.
		No: Remove DEF crystallization from decomposition tube. After repairs are complete, retest for SPN 520669 FMI 31.

NOTE: After performing all diagnostic steps, if SPN 520669 FMI 31 remains, verify each step was completed correctly, and the proper decision was made. Notify supervisor for further action.

AFT System Overview

AFT System Indicators

Fault codes that require a Regen are better understood as Alert codes. This is a normal condition used to alert the operator or technician that soot level in the DPF has reached a set point and the system is running or needs to run a DPF Regen.

Types of Regens

Passive – Not initiated by operator or by control system. Occurs when exhaust gas temperatures are hot enough to ignite soot particles in the aftertreatment system.

Active – Initiated by control system. Occurs when exhaust gas temperatures are too low to ignite soot particles. The ACM will command the Aftertreatment Fuel Injector ON causing extra fuel to be injected into the aftertreatment system increasing exhaust gas temperatures.

Parked – Initiated by operator. Occurs when soot levels are too high for Passive or Active regen methods. During a Parked regen, engine RPM is raised, fuel is injected into the exhaust, and the Engine Throttle Valve (ETV) is positioned to restrict air flow. If equipped with an Exhaust Back Pressure Valve (EBPV), the valve is positioned to restrict exhaust gas flow.

Hot Exhaust Temperature (HET) Lamp

Figure 126 HET Lamp

Hot Exhaust System Temperature lamp indicates exhaust temperature is above 400 °C (752 °F) and vehicle speed is below 5 mph.

Operator Action: Beware of surroundings, the exhaust is very hot.

Technician Action: None

Diesel Particulate Filter (DPF) Lamp

Figure 127 DPF Lamp

DPF lamp on solid. This notifies the operator the Aftertreatment System is cleaning the DPF.

Operator Action: Drive at highway speed, until lamp goes out, or perform a Parked Regen.

Technician Action: None

If system is unable to finish the cleaning process due to driving conditions (Low load, short trip) or if there's a problem with the system, the soot level will continue to build in the DPF and trigger the next soot level DTC.

SPN 3719 FMI 15 – DPF Soot Load - Lowest (level 1/3)

Figure 128 DPF Lamp Flashing

DPF soot level 1, DPF lamp flashing. This notifies the operator the Aftertreatment System is cleaning the DPF.

Operator Action: Perform a Parked Regen.

Technician Action: Verify the system is working without fault. See below procedure.

DPF soot level 1, DPF lamp flashing. This notifies the operator the soot level is reaching a much higher level and the system is not completing a Regen through the operators current drive cycle. If this is ignored, the soot level will continue to build to setting the next level DTC.

SPN 3719 FMI 16 – DPF Soot Load - Moderate (level 2/3)

Figure 129 DPF Lamp Flashing, Amber Warning Lamp On Solid

Operator Action: Perform a Parked Regen.

Technician Action: Verify the system is working without fault. See below procedure.

DPF soot level 2, DPF lamp flashing and the buzzer sounding. This notifies the operator the soot level has reached a critical level and the engine now de-rated engine is de-rated by 15% of normal engine power.

SPN 3719 FMI 0 DPF Soot Load - Highest (level 3/3)

Figure 130 DPF Lamp Flashing and Buzzer Sounding

Operator Action: Tow vehicle in for service.

Technician Action: The DPF must be replaced at soot level 3, when the DPF lamp is flashing and the buzzer sounding. This notifies the operator the soot level has reached a critical level and the engine is engine is de-rated by 85% of normal power.

Regen Inhibitors

A DPF Regen can be inhibited by disabling switches, or the entry conditions have not yet been met to start the regeneration process.

Fault Code Regen Inhibitors

Fault codes that can inhibit a Regen will not allow a Regen process to take place. The ECM continuously monitors for system faults. If a fault is detected the Malfunction Indicator Lamp (MIL) lamp will illuminate and a DTC will set.

Entry Conditions for an Active Regen

When the ECM determines the soot level threshold is reached, the system triggers DPF Regen.

NOTE: Short trips or stop and go driving could prevent a successful Regen.

The following conditions are required for an Active Regen:

- DPF Status signal displaying: Regen Needed
- Red stop engine lamp not on
- Engine Coolant Temperature is above or at least 75 ºC (170 ºF)
- Inhibiting DTCs must not be active (See Fault Code Regen Inhibitors (page 344)
- Regen Inhibit switch not active (switch must be off)
- PTO not active (switch must be off)
- Exhaust Temperature sensors below safe thresholds
    - DOCIT below 500 °C (932 °F)
    - DPFIT below 650 °C (120 °F)
    - DPFOT below 750 °C (1382 °F)

If DPF Status displays "Regen needed" and vehicle is unable to perform an Active Regen, perform the Diagnostic Test Procedure .

Entry Conditions for a Parked Regen

A Parked Regen can only be performed when the DPF soot level threshold is reached. The DPF lamp will flash or stay on solid, signaling the need for Regen.

The following conditions are required for a Parked Regen:

- Engine Running
- DPF lamp is on
- Parked Regen switch on
- DPF Status signal displaying: Regen Needed
- Red stop engine lamp not on
- Engine Coolant Temperature is above or at least 75 ºC (170 ºF)
- Vehicle speed not rolling
- Inhibiting DTCs must not be active (See Fault Code Regen Inhibitors (page 344)
- Regen Inhibit switch not active (switch must be off)
- PTO not active (switch must be off)
- Exhaust Temperature sensors below safe thresholds
  - DOCIT below 500 °C (932 °F)
  - DPFIT below 650 °C (1202 °F)
  - DPFOT below 750 °C (1382 °F)

Onboard Filter Cleanliness Test. DPF Status displays “Regen needed” and vehicle is unable to perform an Active Regen, perform Diagnostic Test Procedure .

DPF Regeneration

This test checks the status of the DPF if the Soot level is within a Regen Needed limit. The test will automatically start a Parked Regen.

This test will perform a complete Parked Regen.

Engine speed is ramped up to increase exhaust flow through the DPF while the DPFDP sensor monitors the pressure difference across the DPF. The test runs for about 15 minutes. If a Regen is needed, the engine ramps up for another 15 minutes, but this time to run DPF Regen cycle.

The following conditions are required for a Onboard Filter Cleanliness Test.

- Engine Running
- Engine Coolant Temperature is above or at least 75 ºC (170 ºF)
- Vehicle stationary
- Inhibit DTCs must not be active: Refer to Fault Code Regen Inhibitors (page 344)
- PTO not active (switch must be off)
- Regen inhibit switch not active (switch must be off)
- Parking brake must be applied
- Brake pedal not depressed
- Accelerator pedal not depressed
- Driveline disengaged

- If the Soot level is within normal range, the test completes and displays “Test Completed Successful.” No further action is required.
- If the test is aborted, perform the following Diagnostic Test Procedure.

Exhaust Restriction Test

Connect EST, open the Performance session, and select the All signals tab.

NOTE: Run engine at High Idle while monitoring DPF Differential Pressure and TC1 Turbine Outlet Pressure.

Checks	Specification	Comment – < Less than, > Greater than
DPFDP	< 1.5 psi	If > 1.5 psi, the DPF is restricted, go to Parked Regen.
TC1TOP	< 45 psi	If TC1TOP is > 45 psi and DPFDP is < 1.5 psi, remove DOC and inspect for face plugging.

If TC1TOP and DPFDP are within expected range, but the DPF Status reads “Regen Needed”, go to Parked Regen Checks (page 350).

Regen Inhibitors

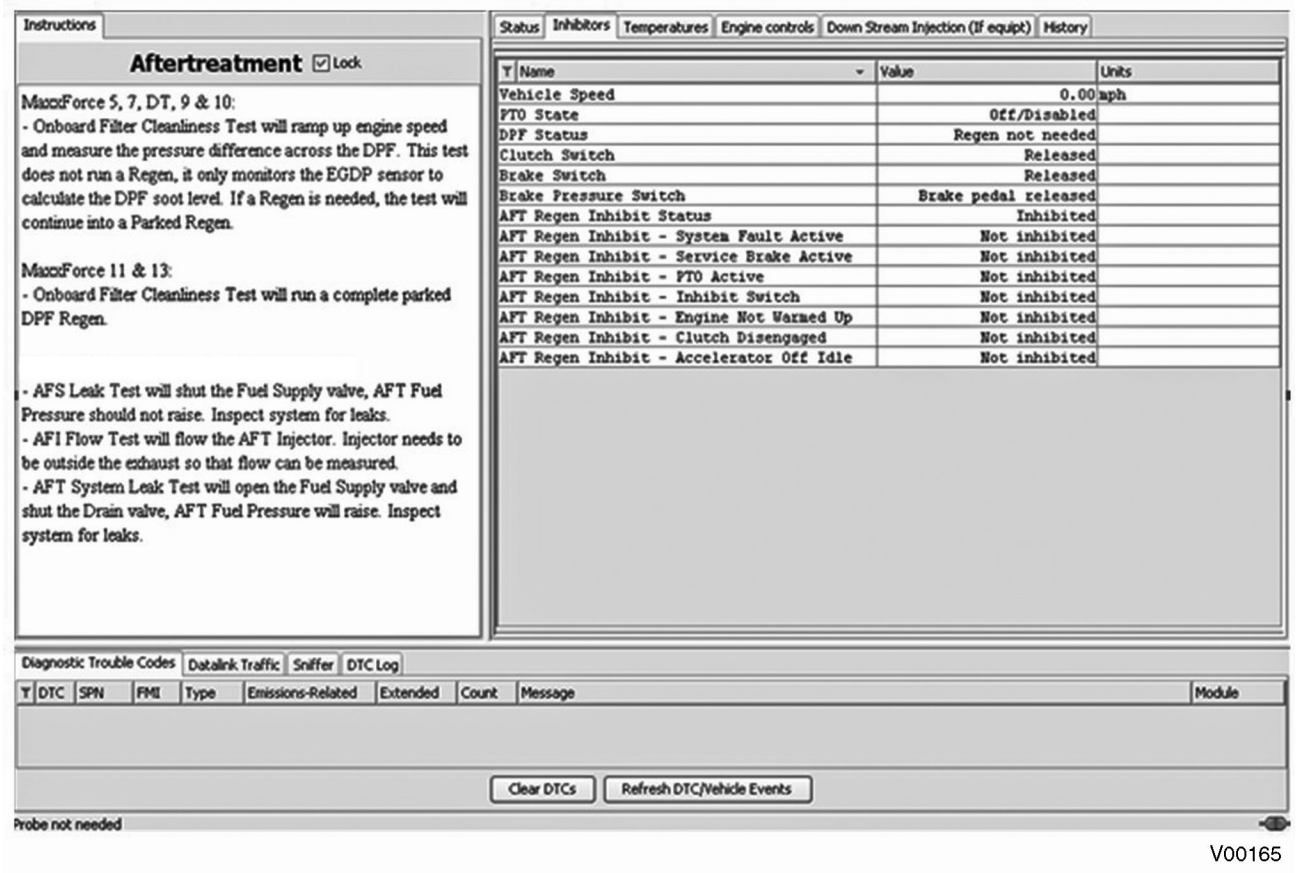

Figure 131 Aftertreatment session screen shot

Check Active Regen Inhibitors

1. Turn ignition switch ON, engine OFF.
2. Using ServiceMaxx™ software, load the Aftertreatment session.
3. Start engine and run vehicle speed above 5 mph.
4. Verify all listed inhibitors are displaying "Not Inhibited."

Check	Expected Results	Comment
AFT Regen Inhibit Status	Not Inhibited	If inhibited, correct the cause. Check switches and any DTC that may be causing the Regen inhibit.
Red Stop Alert Lamp	Off	If On, Regen can't be run. DPF must be replaced before continuing.
Regen Inhibit Switch	Off	If On, turn switch Off. If switch does not turn Off, then diagnose circuit fault.
PTO Enable Switch	Off	If On, turn switch Off. If switch does not turn Off, then diagnose circuit fault.
PTO Switch	Off	If On, turn switch Off. If switch does not turn Off, then diagnose circuit fault.
If no inhibitors are active and Regen is needed, go to Parked Regen Checks (page 350).		

Check Parked Regen Inhibitors

1. Turn ignition switch ON, engine OFF.
2. Using ServiceMaxx™ software, load the Aftertreatment session.
3. Verify all listed Inhibitors are displaying "Not Inhibited."

Checks	Expected Results	Comment
AFT Regen Inhibit status	Not Inhibited	If inhibited, correct the cause. Check switches and any DTC that may be causing the Regen inhibit.
Red Stop Alert lamp	Off	If On, Regen can't be run. DPF must be replaced before continuing.
Regen inhibit switch	Off	If On, turn switch Off. If switch does not turn Off, then diagnose circuit fault.
PTO enable switch	Off	If On, turn switch Off. If switch does not turn Off, then diagnose circuit fault.
PTO switch	Off	If On, turn switch Off. If switch does not turn Off, then diagnose circuit fault.
Parking brake switch	On	If Off, set parking brake, if switch does not turn On, then diagnose circuit fault.
Brake Pedal switch	Off	If On and foot is off pedal, then diagnose circuit fault.
Accelerator Pedal Position	0%	If above 0%, and foot is off pedal, then diagnose circuit fault.
Clutch Pedal Switch	Off	If On and foot is off pedal, then diagnose circuit fault.
Transmission Position	Park or Neutral	If engaged, disengage, or diagnose circuit fault.
If no inhibitors and a Regen is needed, go to the following Parked Regen Checks.		

Parked Regen Checks

During a Parked Regen the engine speed will ramp up to 1200-1800 rpm.

Typical readings:

- **ETV:** 80% (closed).
- **EGR Position:** 0% (closed)
- **DOCIT:** 482 - 572°F (250 - 300°C)
- **DPFIT:** 1022 - 1112°F (550 - 600°C) (after 5-10 minutes)
- **DPFOT:** 1112 - 1202°F (600 - 650°C) (after 10-15 minutes)
- **DPFDP:** Decreasing steadily once DPFIT and DPFOT are steady and above 1022°F (550 °C).

Connect the EST, open the Aftertreatment session. Start a Parked Regen and monitor signals.

Parked Regen Checks

Connect EST, open the Aftertreatment session. Open the inhibitors tab and check for Inhibitors.

Checks	Expected Results	Comment
Engine condition	Smooth, not stumbling	If engine does not run smoothly, diagnose engine performance problem. See “Engine Symptoms Diagnostics."
DPF Status	Regen Needed	If signal reads “Not needed”, than a Regen cannot be commanded to run.
Engine Coolant Temp	Above 66 ºC (150 ºF)	If below 66 ºC (150 ºF), warm engine above set point.
AFT Regen Status	Active	If signal reads “Not Active”, check for fault codes and Parked Regen Inhibitors.
EGR Position	Closed	If not closed, see EGR Valve (page 1014).
ETV Position	80% ±5%	If not within specifications, see ETV (page 1037).
DOCIT	250 ºC (482 ºF) to 300ºC (572 ºF)	If below 250 ºC (482 ºF), using Electronic Service Tool (EST) with ServiceMaxx™ software, run the KOER Air Management Test. If above 300 ºC (572 ºF), check for proper ETV operation, and if engine is over fueling.
DPFIT	After 5-10 minutes above 530 ºC (986 ºF)	If below 530 ºC (986 ºF), replace DOC, and inspect DPF for soot leaking through the filter.
DPFOT	Below 700 ºC (1292 ºF)	If above 700 ºC (1292 ºF), replace DPF
DPFDP	Below 0.5 psi	If above 0.5 psi, after the system completes a full Parked Regen, replace the DPF.
If the DPF is face plugged, measure the distance between the filter and outlet. If not within specification, the filter cannot be cleaned and must be replaced.		

DPF Filter Inspection

Normal DPF Inlet

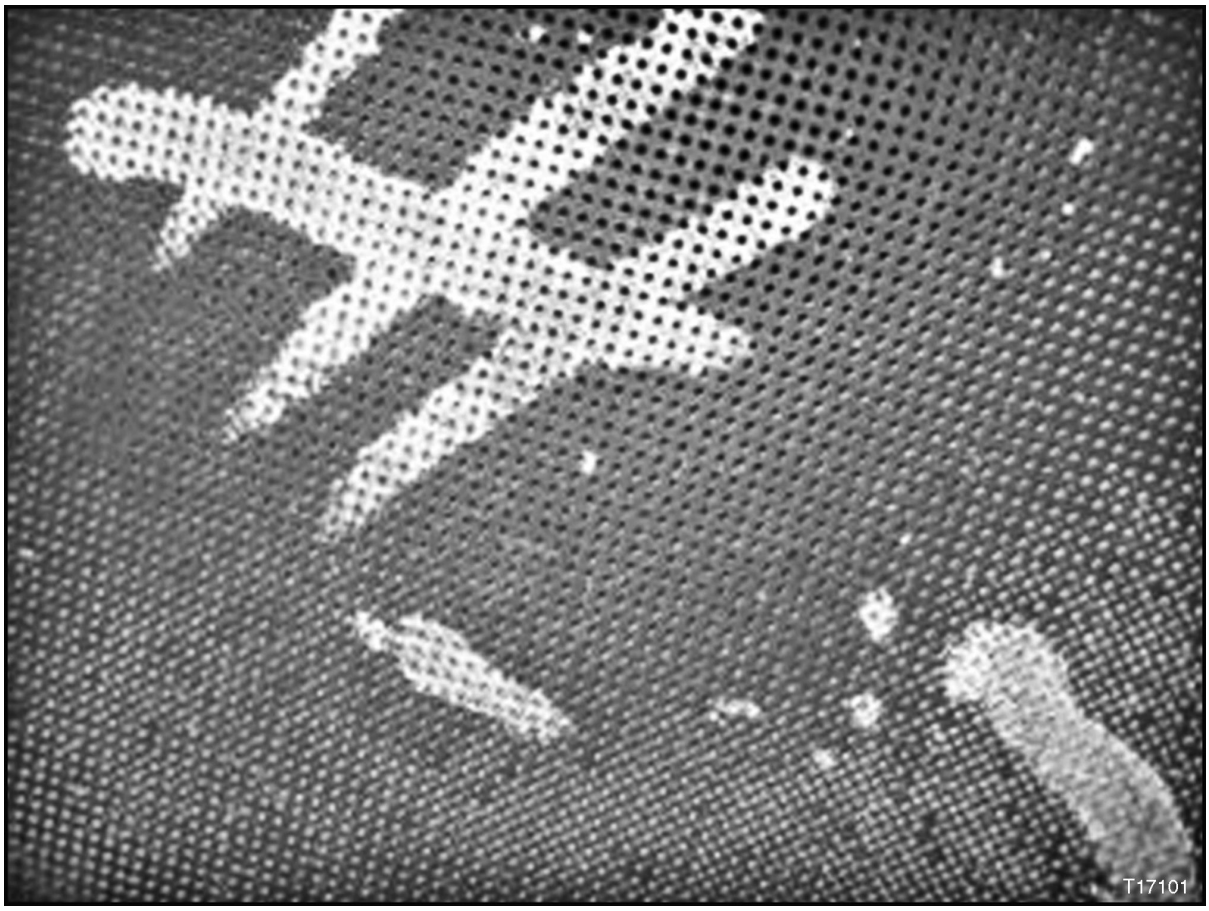

Figure 132 DPF Inlet (Normal)

Normal DPF Outlet

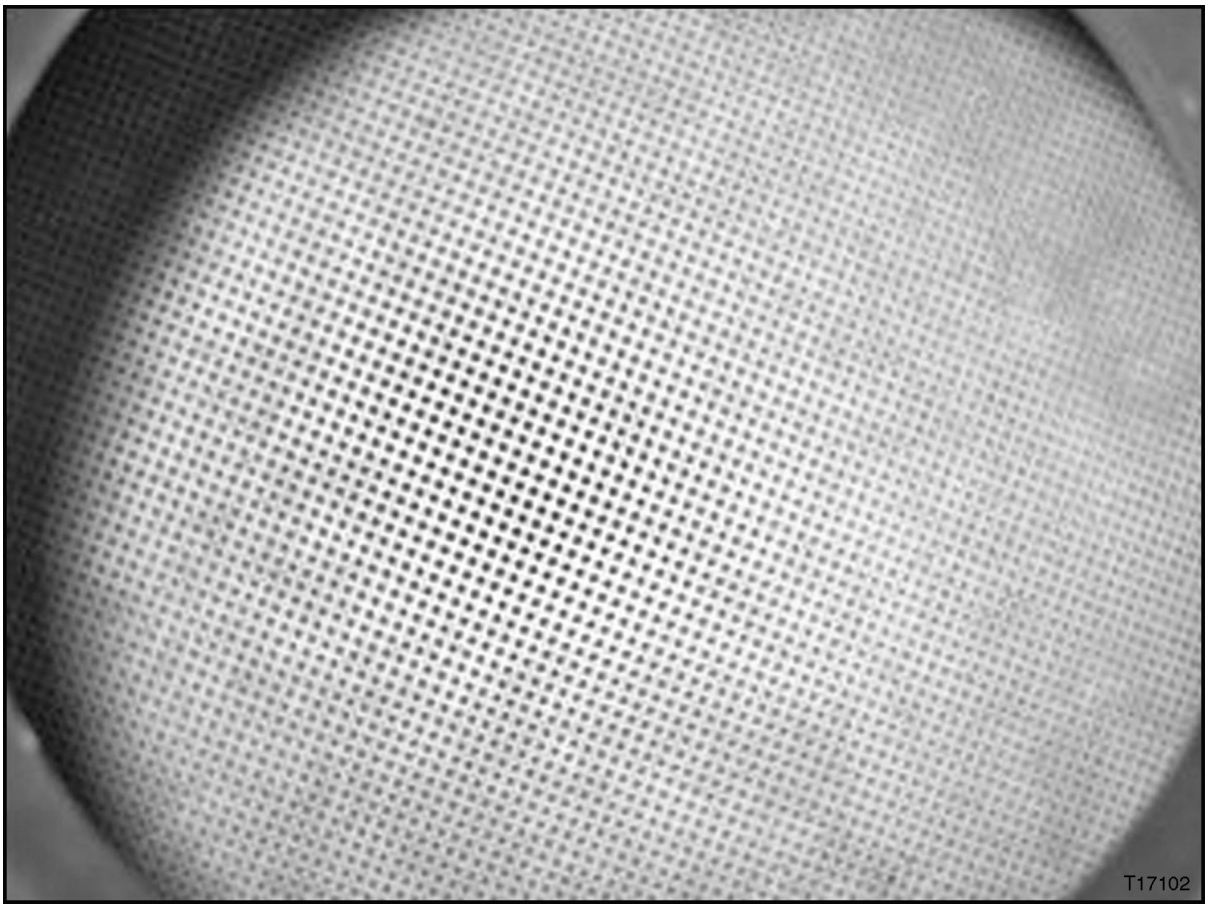

Figure 133 DPF Outlet (Normal)

Inspect the inlet and outlet of the DPF.

Insure all inlet channels are visible and the light soot coating over the whole inlet face easily wiped away with a finger. Soot amount on face may vary depending on the time since last DPF regeneration, but should be less than 1/8."

Possible Causes	Action
System is working correctly	None.

Restricted DPF Inlet

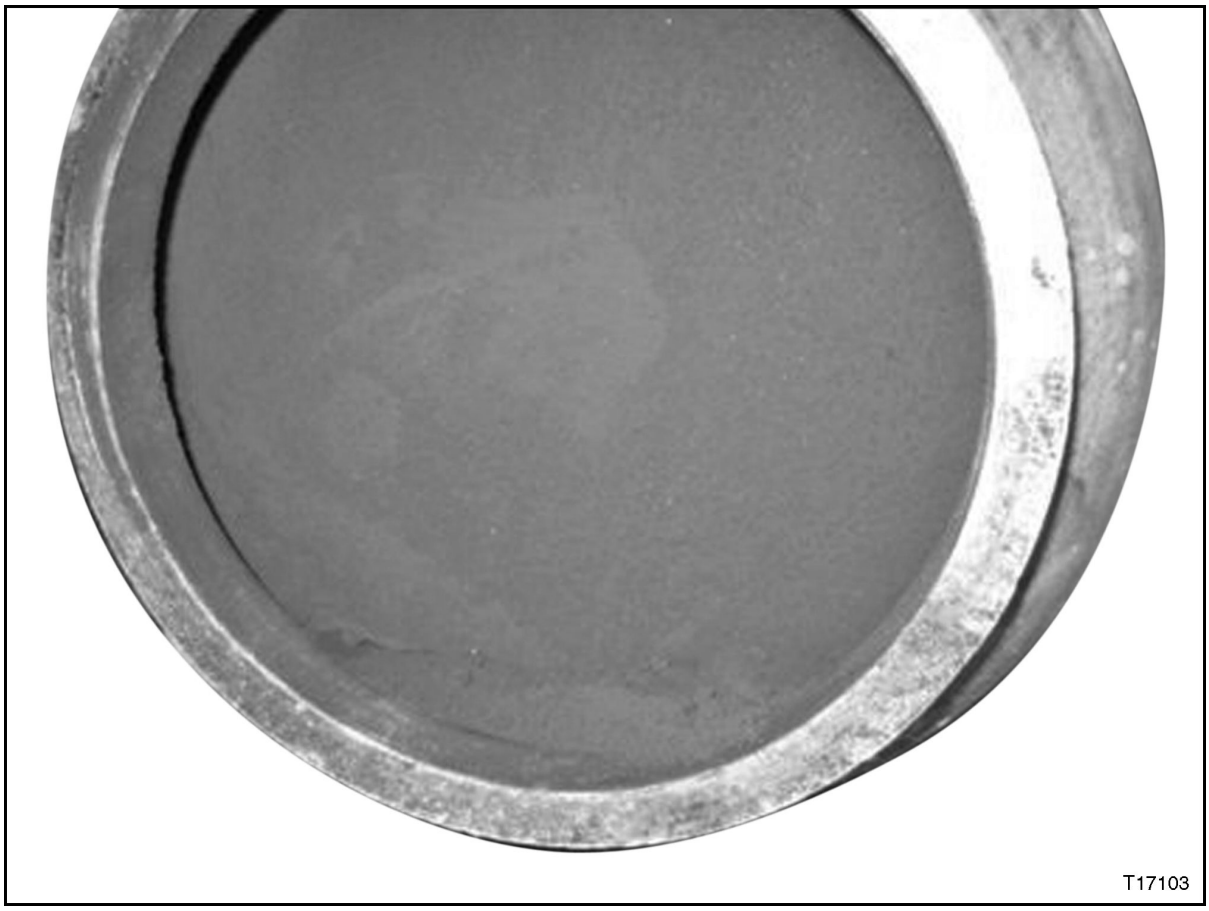

Figure 134 DPF Face Plugged

Inspect Inlet of the DPF.

If no channels are visible and the face of the DPF has a deep cake of soot greater than 1/8”, remove DPF for external cleaning.

Possible Causes	Action
• Drive cycle (Unable to complete Regen) • Engine over fueling • Boost problem • Intake throttle problem	1. Interview the operator about his drive cycle. 2. Verify there are no inhibitors (DTCs or switches). 3. Replace the DPF.

DPF Contaminated with Coolant

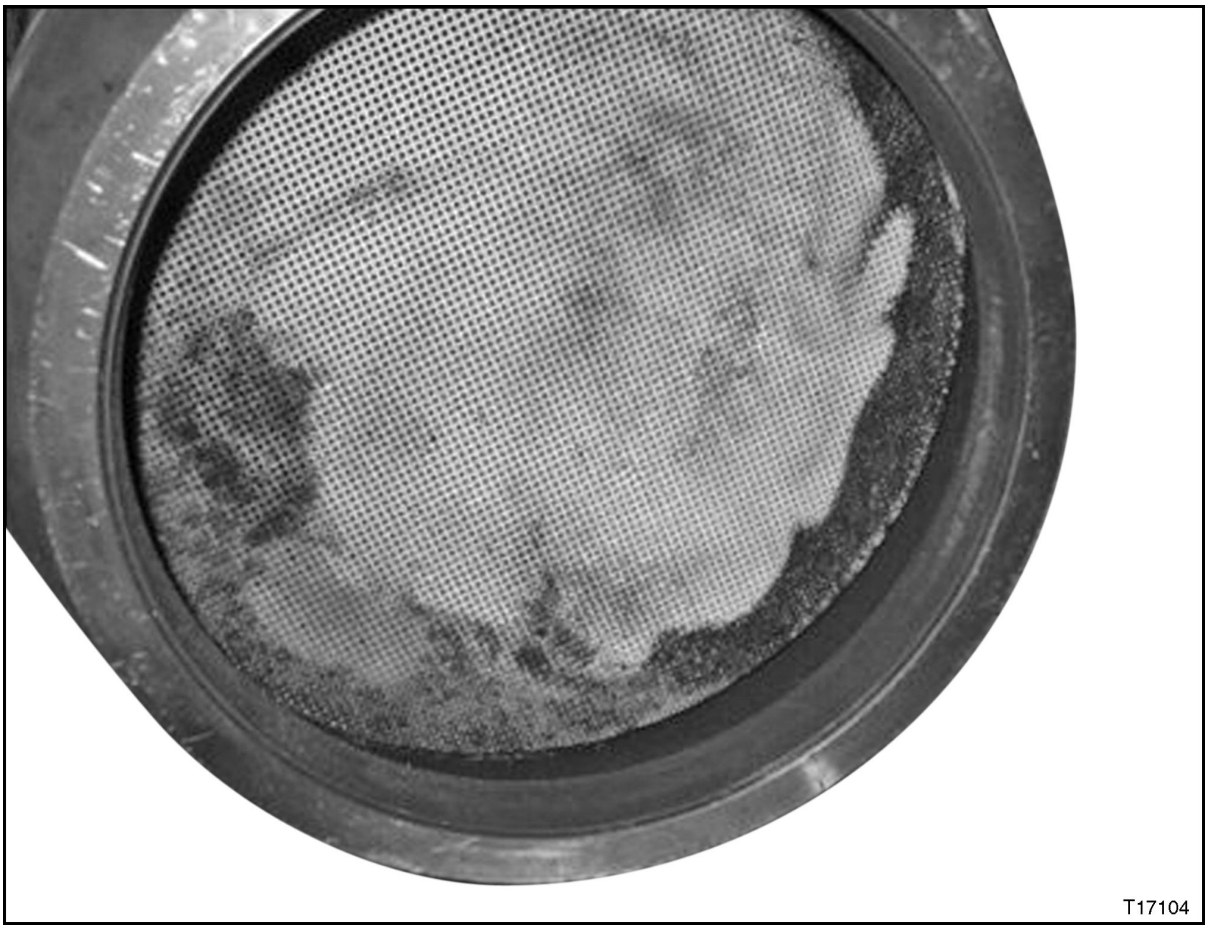

Figure 135 Coolant Contamination

Inspect the inlet and outlet of the DPF.

DPF will show signs of coolant flowing through exhaust system and contaminating the DPF.

Possible Causes	Action
• Coolant is flowing through exhaust • Failed Interstage cooler • Failed EGR cooler • Failed injector sleeve • Leaking cylinder head cup plugs • Cylinder head porosity	1. Repair coolant problem. 2. The DPF cannot be cleaned, it must be replaced.

DPF Contaminated with Oil

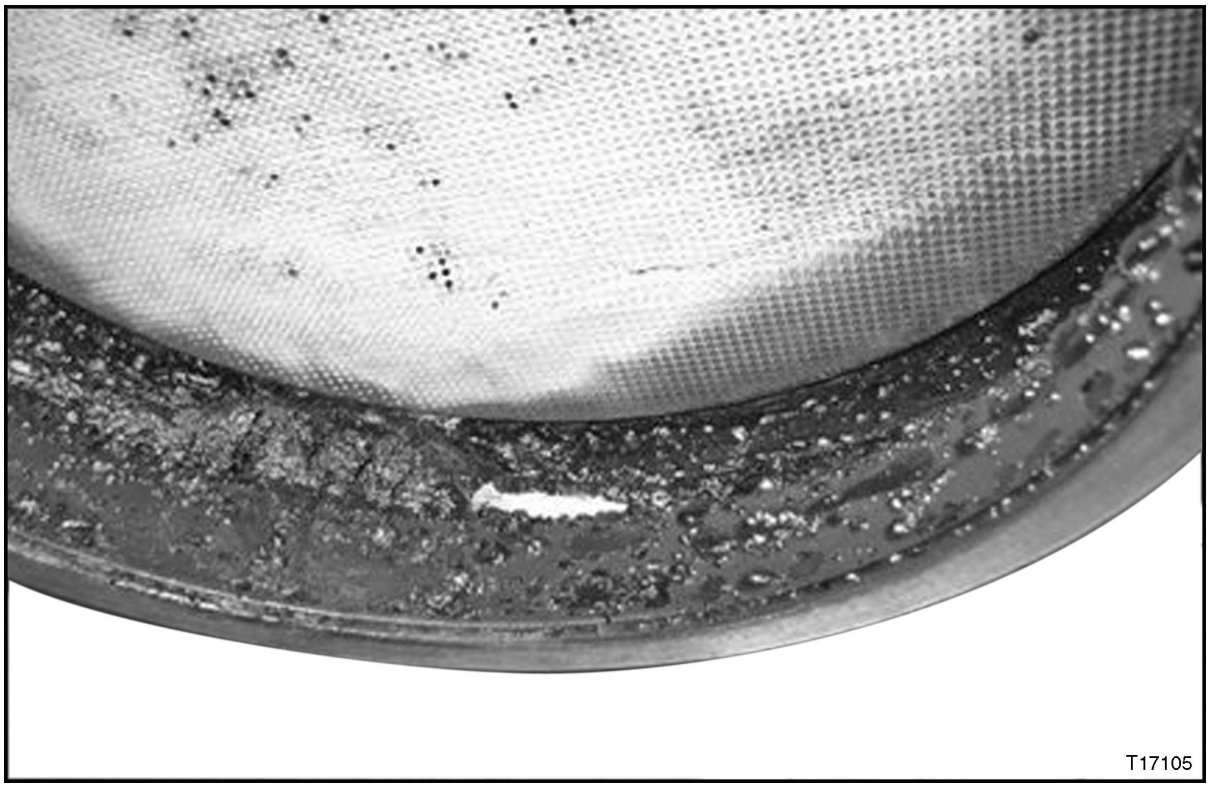

Figure 136 Engine Oil Contamination, Soot Leakage

Inspect the inlet and outlet of the DPF.

DPF will show signs of soot leakage and oil.

Possible Causes	Action
• Failed turbocharger • Failed piston rings • Failed cylinder sleeves • Failed valve guides	1. Repair engine oil to exhaust problem. 2. The DPF cannot be cleaned, it must be replaced. 3. Inspect the DOC for damage and replace if necessary.

DPF Outlet Leaking Soot

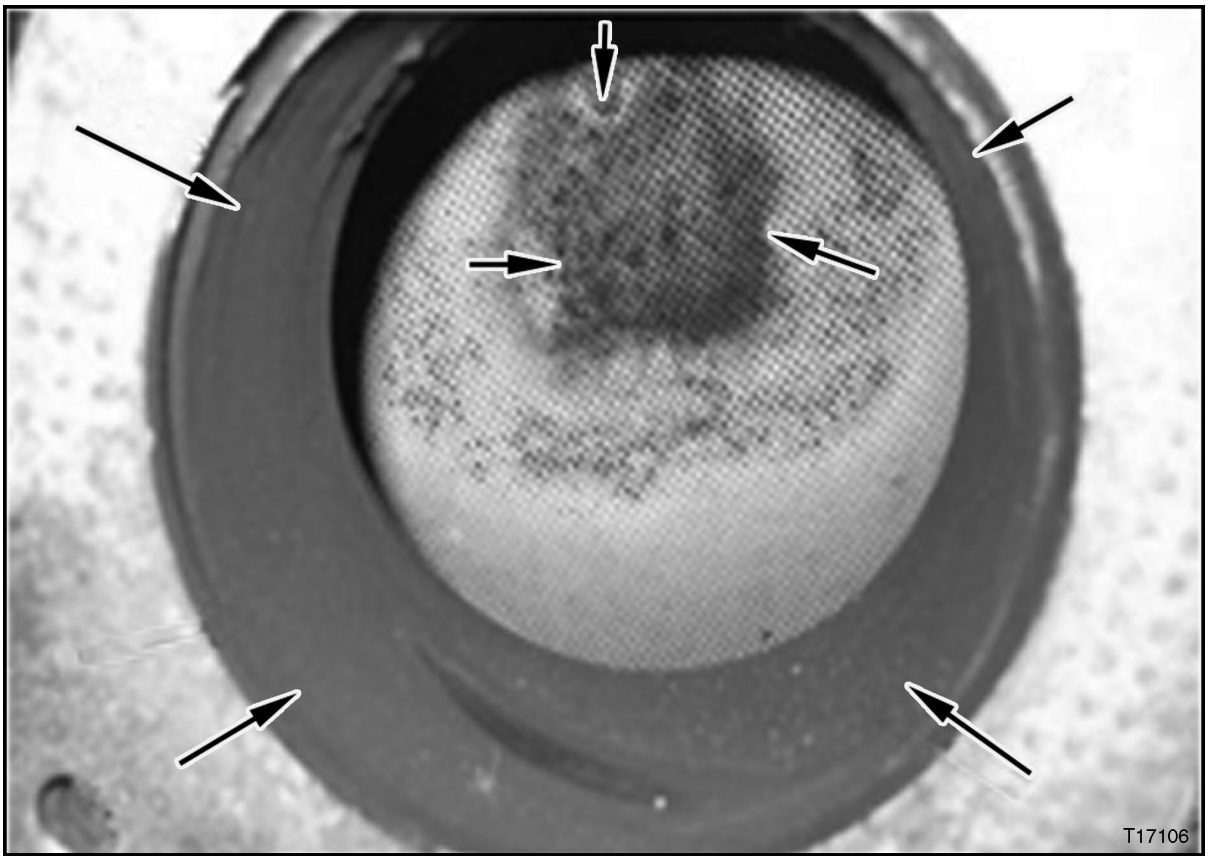

Figure 137 DPF Filter Damage, Soot Leakage

Inspect the outlet of the DPF.

DPF will show signs of soot leakage as indicated by the arrows in figure.

Possible Causes	Action
• DPF is damaged	1. The DPF cannot be cleaned, it must be replaced. 2. Inspect the DOC for damage and replace if necessary.

External Damage to DPF

Figure 138 DPF Filter, Can Damage

Inspect the exterior of the DPF.

DPF will show signs of damage such as dents or cracks.

Possible Causes	Action
• Road debris • Vehicle accident	1. The DPF cannot be cleaned, it must be replaced.

DPF Ceramic Filter Brick Measurement

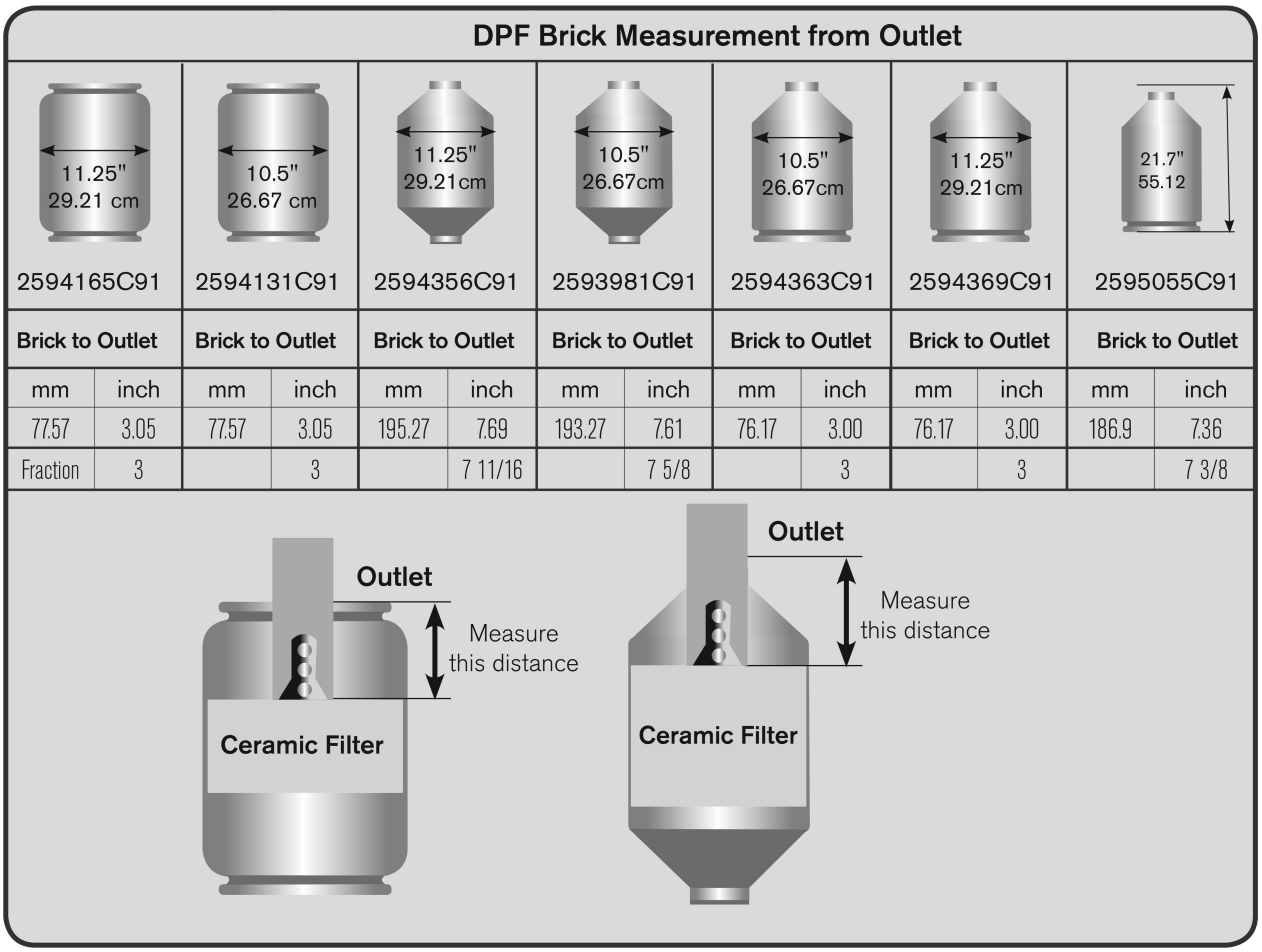

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Figure 139 DPF Ceramic Filter Brick Measurement

Measure the distance between the ceramic filter brick and the outlet. If the distance is greater then the specification, the ceramic filter brick has moved out of its correct location. Replace the DPF Filter.

Possible Causes	Action
Face plugged	If the distance is greater then the specification, the DPF cannot be cleaned. It must be replaced.

AFTFI (Aftertreatment Fuel Injector)

SPN	FMI	Condition	Possible Causes	Actions
3556	2	AFT Fuel Injector signal erratic, intermittent or incorrect	• Leaking fuel line to AFTFI • Leaking AFT Fuel Doser Module • Failed Aftertreatment Fuel Injector (AFTFI)	Step-Based Diagnostics (page 361)
3556	5	AFT Fuel Injector open load/circuit	• AFTFI-1 circuit Open or high resistance • AFTFI-1 short to GND • AFTFI-1 short to power • AFTFI-2 circuit Open or high resistance • AFTFI-2 short to GND • AFTFI-2 short to power • AFTFI-1 short to AFTFI-2 • Failed Aftertreatment Fuel Injector (AFTFI)	Step-Based Diagnostics (page 364)
3556	18	AFT Fuel Pressure below Warning Pressure (AFTFI at high adaptation limit)	• Damaged or restricted supply line to AFTFI • AFTFI missing poppet • Restricted AFTFI • Exhaust leak or restriction	Step-Based Diagnostics (page 379)

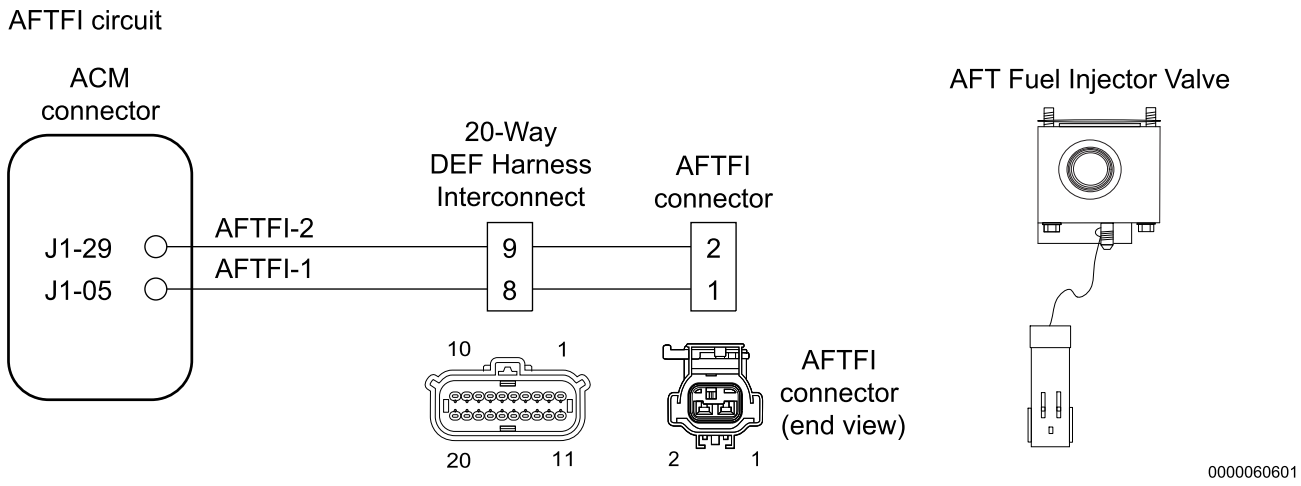

Figure 140 AFTFI Circuit Diagram

NOTE: See latest version of N13 Engine and Aftertreatment Wiring Schematic Form 0000002203 for additional circuit information.

Overview

The Aftertreatment Fuel Injector (AFTFI) is controlled by the Aftertreatment Control Module (ACM) to dispense fuel into the aftertreatment system during active and parked regenerations of the aftertreatment system.

Tools Required

- 180-Pin Breakout Box 00-00956-08
- Breakout Harness 18-100-01
- Breakout Harness 18-050-01
- Breakout Harness ZTSE4845
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

SPN 3556 FMI 2 - AFT Fuel Injector signal erratic, intermittent, or incorrect

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Leak detected in the aftertreatment fuel injection system.	(Pressure measured by AFTFP1 with AFTFSV Open) - (Pressure measured by AFTFP1 after AFTFSV closed for a predetermined time) > 87 psi (600 kPa)(gauge)	Key ON Active Regeneration requested. Inactive: SPN 168 FMI 18 (ACM); SPN 3242 FMI 2, 3, 4 (DPFIT); SPN 3246 FMI 2 3, 4 (DPFOT); SPN 3251 FMI 0 (DPFDP); SPN 3480 FMI 2, 3, 4, 17 (AFTFP1); SPN 3482 FMI 2, 3, 4, 7 (AFTFSV); SPN 3490 FMI 3, 4 (AFTPAV); SPN 3556 FMI 5 (AFTFI); SPN 3936 FMI 7, 15 (DPF System); SPN 4363 FMI 0 (SCROT); SPN 4765 FMI 2, 3, 4 (DOCIT); SPN 4795 FMI 31 (DPFDP); SPN 4796 FMI 31 (DOC); SPN 5742 FMI 3 (DPF Temp Module); SPN 5742 FMI 4, 11, 12 (DPF Temp Module)	67 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects a leaking Aftertreatment Fuel Injector (AFTFI) or an external leak. Fuel pressure is building in the system as expected, but not holding.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 3480 (AFTFP1), SPN 3556 FMI 5 (AFTFI), SPN 3482 (AFTFSV), SPN 3490 (AFTPAV)

Fault Facts

These diagnostics are only performed prior to starting an active regeneration of the DPF, or at Key ON if the active regeneration is continuing across key cycles.

Drive Cycle to Determine Fault Status

Drive cycle 1 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Leaking fuel line to AFTFI
- Leaking AFT Fuel Doser Module
- Failed AFTFI

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3480 (AFTFP1), SPN 3556 FMI 5 (AFTFI), SPN 3482 (AFTFSV), SPN 3490 (AFTPAV). Is EST DTC list free of SPN 3480, SPN 3556 FMI 5, SPN 3482, or SPN 3490?	Yes: Go to step 2. No: Repair SPN 3480, SPN 3556 FMI 5, SPN 3482, or SPN 3490. After repairs are complete, retest for SPN 3556 FMI 2.

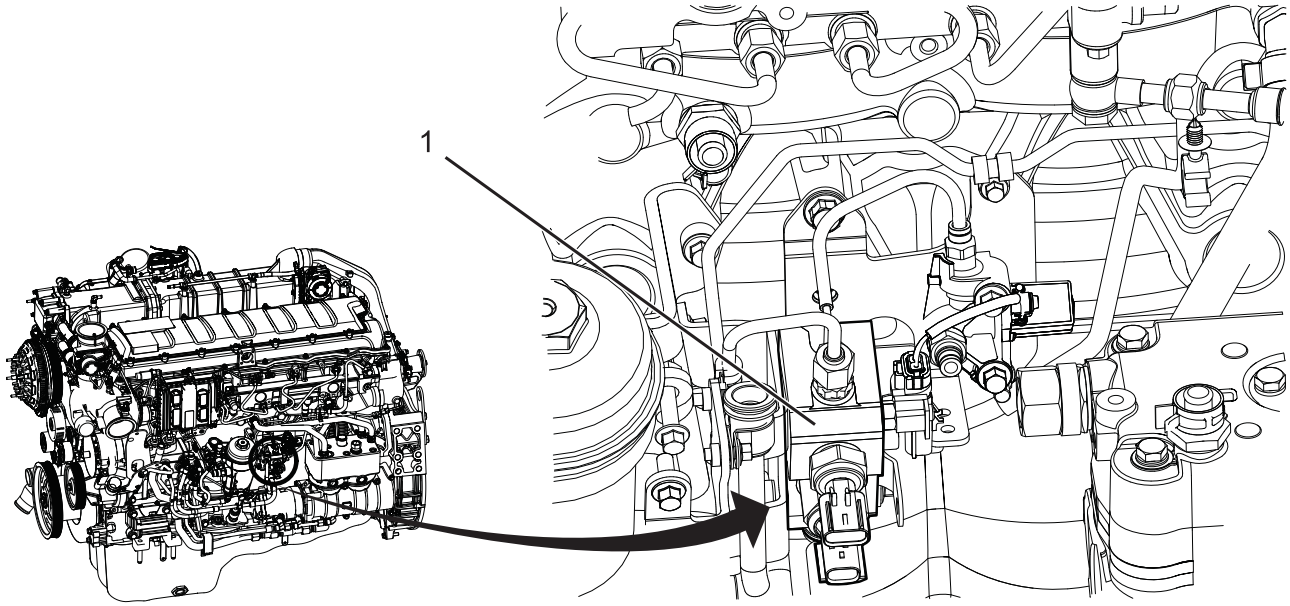

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Figure 141 AFT Fuel Doser Module Location

1. AFT fuel doser module

Step	Action	Decision
2	Inspect the AFT fuel doser module for leaks or damage. Is the AFT fuel doser module Not leaking or damaged?	Yes: Go to step 3. No: Replace AFT fuel doser module. After repairs are complete, retest for SPN 3556 FMI 2.

Step	Action	Decision
3	Check for leaking or damaged fuel supply line to Aftertreatment Fuel Injector (AFTFI). Key-On Engine-Running (KOER), inspect fuel supply line to AFTFI for leaks and damage. Is the fuel supply line to the AFTFI Not leaking or damaged?	Yes: Clean or replace AFTFI. After repairs are complete, retest for SPN 3556 FMI 2. No: Repair or replace fuel supply line to AFTFI. After repairs are complete, retest for SPN 3556 FMI 2.

NOTE: After performing all diagnostic steps, if SPN 3556 FMI 2 remains verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3556 FMI 5- AFT Fuel Injector open load / circuit

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Aftertreatment Fuel Injector (AFTFI) circuit electrical fault - shorted to battery, shorted to ground or open.	Resistance between the AFTFI high side and ground < 0.2 Ohms. Resistance between the AFTFI high side and ground, with AFTFI Off, > 1,000,000 Ohms. Resistance between the AFTFI low side and ground, with AFTFI Off, < 0.2 Ohms. Resistance between the AFTFI low side and ground, with AFTFI On, > 1,000,000 Ohms. Resistance between the AFTFI low side and ground, with AFTFI Off, > 1,000,000 Ohms.	Key ON	3 seconds

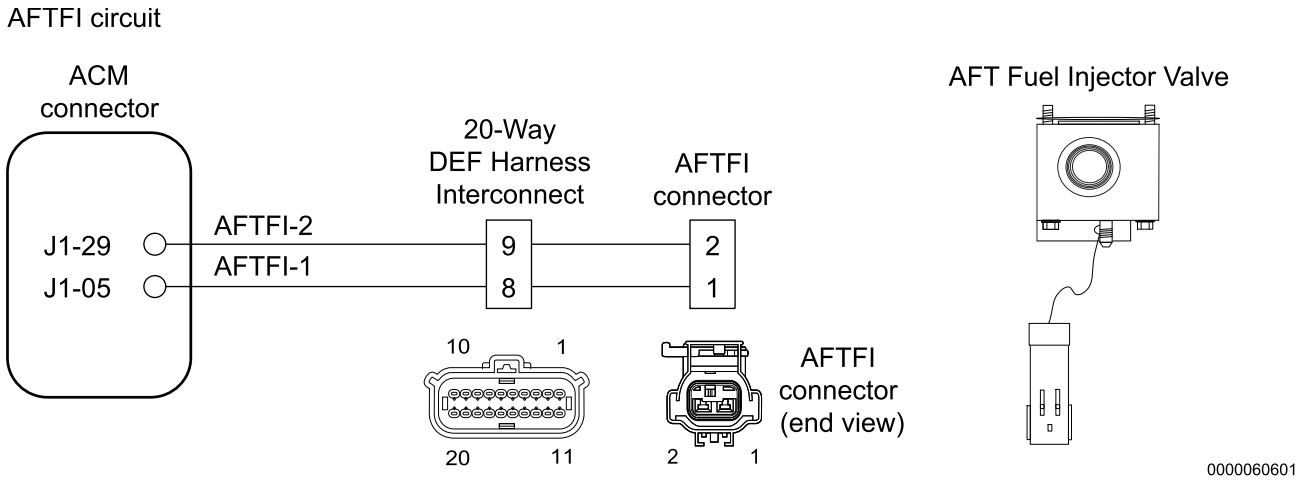

Figure 142 AFTFI Circuit Diagram

Fault Overview

Fault codes sets when the Aftertreatment Control Module (ACM) detects a fault in the Aftertreatment Fuel Injector (AFTFI) circuit. Active regeneration of the aftertreatment diesel particulate filter will be disabled until the next key cycle. Engine torque will be reduced if the engine is operated for an extended period of time with this fault active.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive cycle 1 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- AFTFI-1 circuit Open or high resistance
- AFTFI-1 short to GND
- AFTFI-1 short to power
- AFTFI-2 circuit Open or high resistance
- AFTFI-2 short to GND
- AFTFI-2 short to power
- AFTFI-1 short to AFTFI-2
- Failed Aftertreatment Fuel Injector (AFTFI)

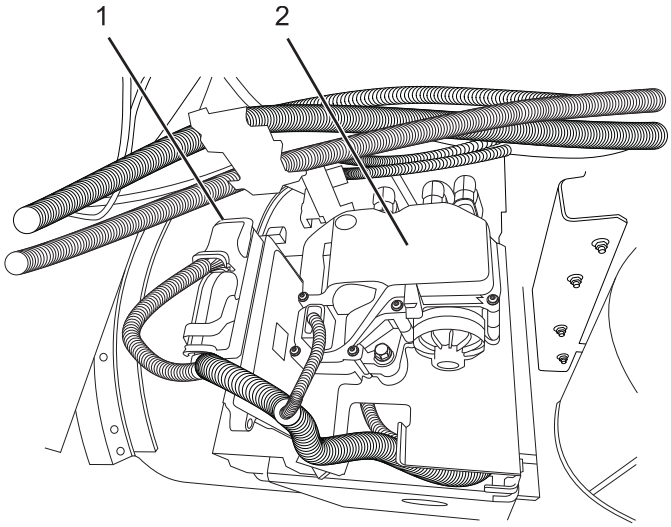

Figure 143 ACM Location (typical)

1. Aftertreatment Control Module (ACM)
2. DEF supply module

Step	Action	Decision
1	Inspect connections at ACM connector J1. Key OFF, disconnect ACM connector J1. Check ACM connector J1 and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the ACM connector J1, harness, and terminals clean and undamaged?	Yes: Go to step 2. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3556 FMI 5.

Step	Action	Decision
2	Check AFTFI circuits for short to ground. Disconnect ACM and connect 180-Pin Breakout Box and SCR (ACM) Breakout Harness 18-100-01 (96-Pin) to ACM harness and leave ACM disconnected. Key OFF, use a DMM to measure resistance between Breakout Box pin J1-05 and a known good ground. Is resistance greater than 1000 ohms?	Yes: Go to step 3. No: Go to step 5.

Step	Action	Decision
3	Check AFTFI circuits for short to power. With ACM disconnected, Key-On Engine-Off (KOEO), use a DMM to measure voltage between Breakout Box pin J1-05 and a known good ground. Is voltage less than 0.5 volts?	Yes: Go to step 4. No: Go to step 11.

Step	Action	Decision
4	Check AFTFI circuits for Open. With ACM disconnected, Key OFF, use a DMM to measure resistance from Breakout Box pin J1-05 and J1-29. Is resistance less than 10 ohms?	Yes: Go to step 23. No: Go to step 17.

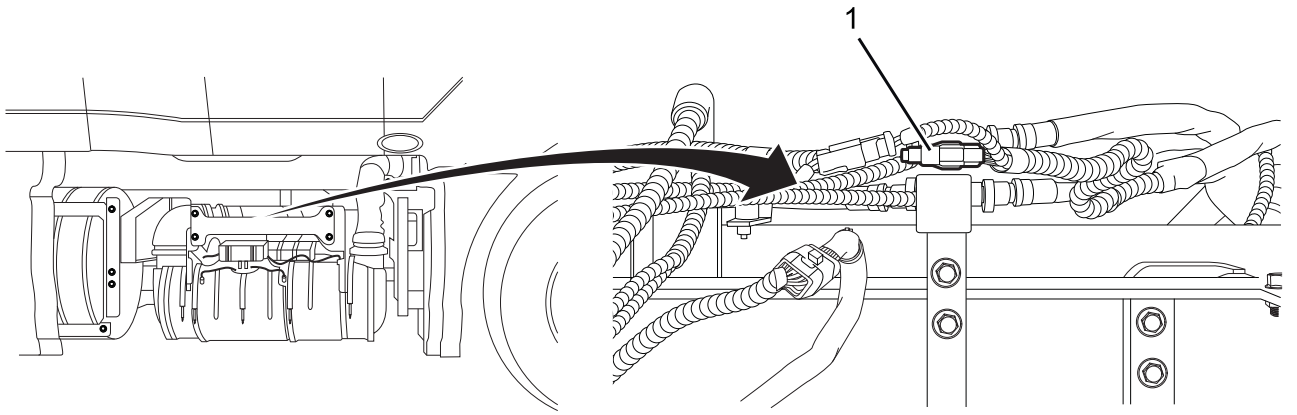

Figure 144 20-Way Connector Location

1. 20-way connector

Step	Action	Decision
5	Inspect connections at 20-Way DEF harness interconnect. Key OFF, disconnect 20-Way. Check 20-Way and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the 20-Way DEF harness interconnect connector, harness, and terminals clean and undamaged?	Yes: Go to step 6. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3556 FMI 5.

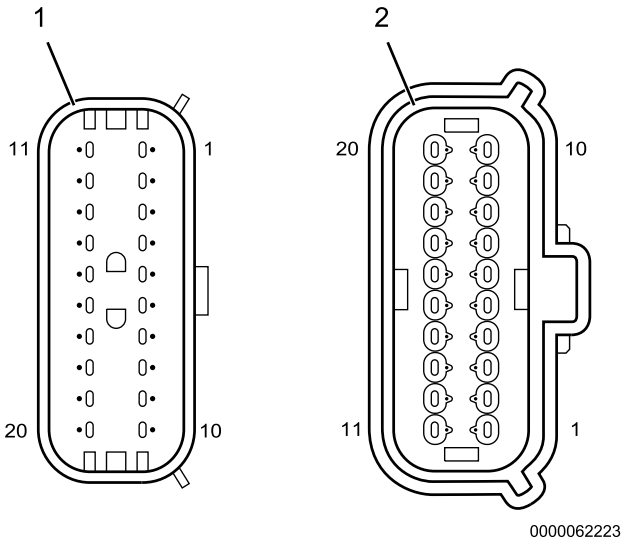

Figure 145 20-Way DEF Harness Connector End View

1. 20-Way DEF harness male side connector
2. 20-Way DEF harness female side connector

Step	Action	Decision
6	Check AFTFI-1 circuit for short to ground between ACM and 20-way DEF harness interconnect. With ACM disconnected, connect Breakout Harness 18-050-01 to the male side of the 20-way and leave female side disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness 18-050-01 pin-8 and a known good ground. Is resistance greater than 1000 ohms?	Yes: Go to step 7. No: Repair short to ground between 20-way connector pin-8 and Aftertreatment Control Module (ACM) connector pin J1-05. After repairs are complete, retest for SPN 3556 FMI 5.

Step	Action	Decision
7	Check AFTFI-2 circuit for short to ground between ACM and 20-way DEF harness interconnect. Use a DMM to measure resistance between Breakout Harness 18-050-01 pin-9 and a known good ground. Is resistance greater than 1000 ohms?	Yes: Go to step 8. No: Repair short to ground between 20-way connector pin-9 and Aftertreatment Control Module (ACM) connector pin J1-29. After repairs are complete, retest for SPN 3556 FMI 5.

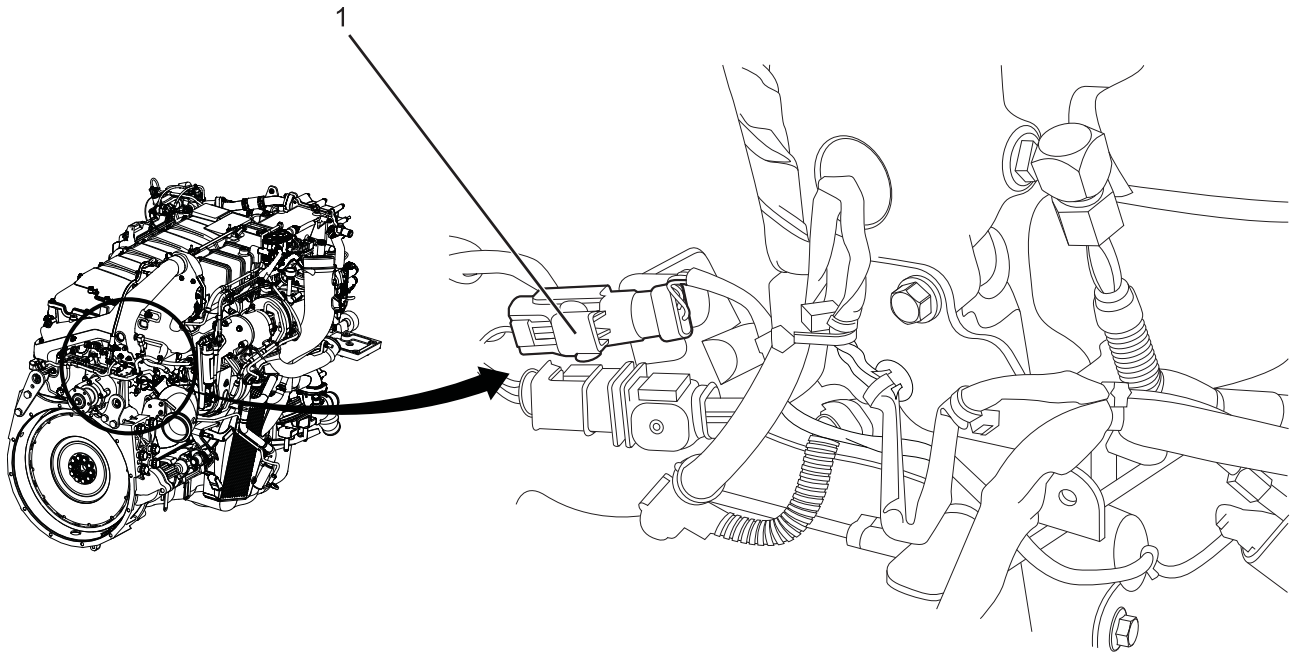

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Figure 146 AFTFI Connector Location

1. Aftertreatment Fuel Injector (AFTFI) connector

Step	Action	Decision
8	Inspect connections at Aftertreatment Fuel Injector (AFTFI). Key OFF, disconnect AFTFI. Check AFTFI connector and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the AFTFI connector, harness, and terminals clean and undamaged?	Yes: Go to step 9. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3556 FMI 5.

Step	Action	Decision
9	Check AFTFI-1 circuit for short to ground between AFTFI and 20-way DEF harness interconnect. With 20-way disconnected, connect Breakout Harness ZTSE4760A to the vehicle harness and leave AFTFI disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness ZTSE4760A pin-1 and a known good ground. Is resistance greater than 1000 ohms?	Yes: Go to step 10. No: Repair short to ground between 20-way connector pin-8 and AFTFI pin-1. After repairs are complete, retest for SPN 3556 FMI 5.

Step	Action	Decision
10	Check AFTFI-2 circuit for short to ground between AFTFI and 20-way DEF harness interconnect. Use a DMM to measure resistance between Breakout Harness ZTSE4760A pin-2 and a known good ground. Is resistance greater than 1000 ohms?	Yes: Replace AFTFI. After repairs are complete, retest for SPN 3556 FMI 5. No: Repair short to ground between 20-way connector pin-9 and AFTFI pin-2. After repairs are complete, retest for SPN 3556 FMI 5.

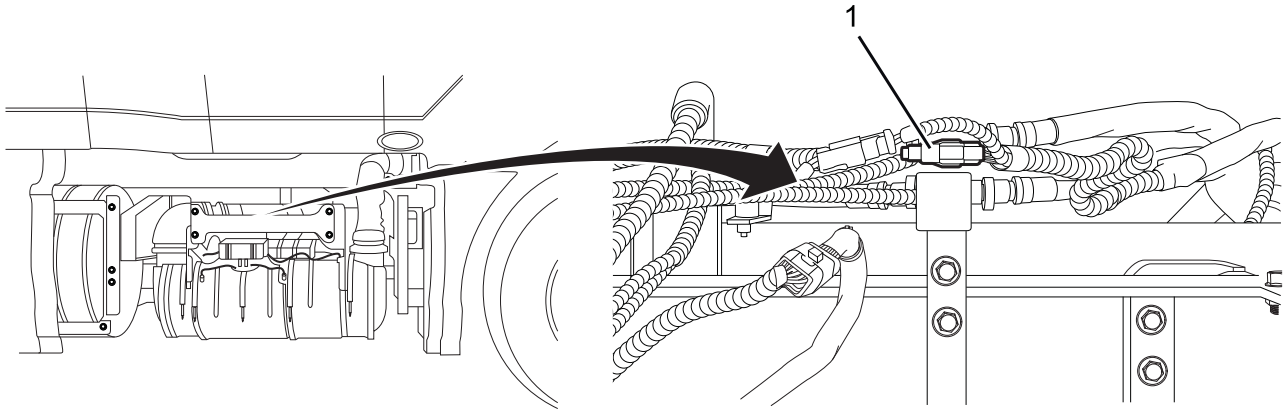

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Figure 147 20-Way Connector Location

1. 20-way connector

Step	Action	Decision
11	Inspect connections at 20-Way DEF harness interconnect. Key OFF, disconnect 20-Way DEF harness interconnect. Check 20-Way DEF harness interconnect and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the 20-Way DEF harness interconnect connector, harness, and terminals clean and undamaged?	Yes: Go to step 12. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3556 FMI 5.

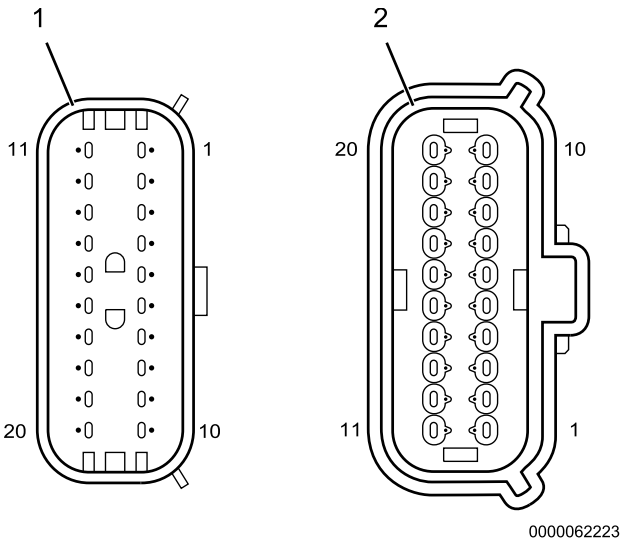

Figure 148 20-Way DEF Harness Connector End View

1. 20-Way DEF harness male side connector
2. 20-Way DEF harness female side connector

Step	Action	Decision
12	Check AFTFI-1 circuit for short to power between ACM and 20-way DEF harness interconnect. With ACM disconnected, connect Breakout Harness 18-050-01 to the male side of the 20-way and leave female side disconnected. KOEO, use a DMM to measure voltage between Breakout Harness 18-050-01 pin-8 and a known good ground. Is voltage less than 0.5 volts?	Yes: Go to step 13. No: Repair short to power between 20-way connector pin-8 and Aftertreatment Control Module (ACM) connector pin J1-05. After repairs are complete, retest for SPN 3556 FMI 5.

Step	Action	Decision
13	Check AFTFI-2 circuit for short to power between ACM and 20-way DEF harness interconnect. KOEO, use a DMM to measure voltage between Breakout Harness 18-050-01 pin-9 and a known good ground. Is voltage less than 0.5 volts?	Yes: Go to step 14. No: Repair short to power between 20-way connector pin-9 and Aftertreatment Control Module (ACM) connector pin J1-29. After repairs are complete, retest for SPN 3556 FMI 5.

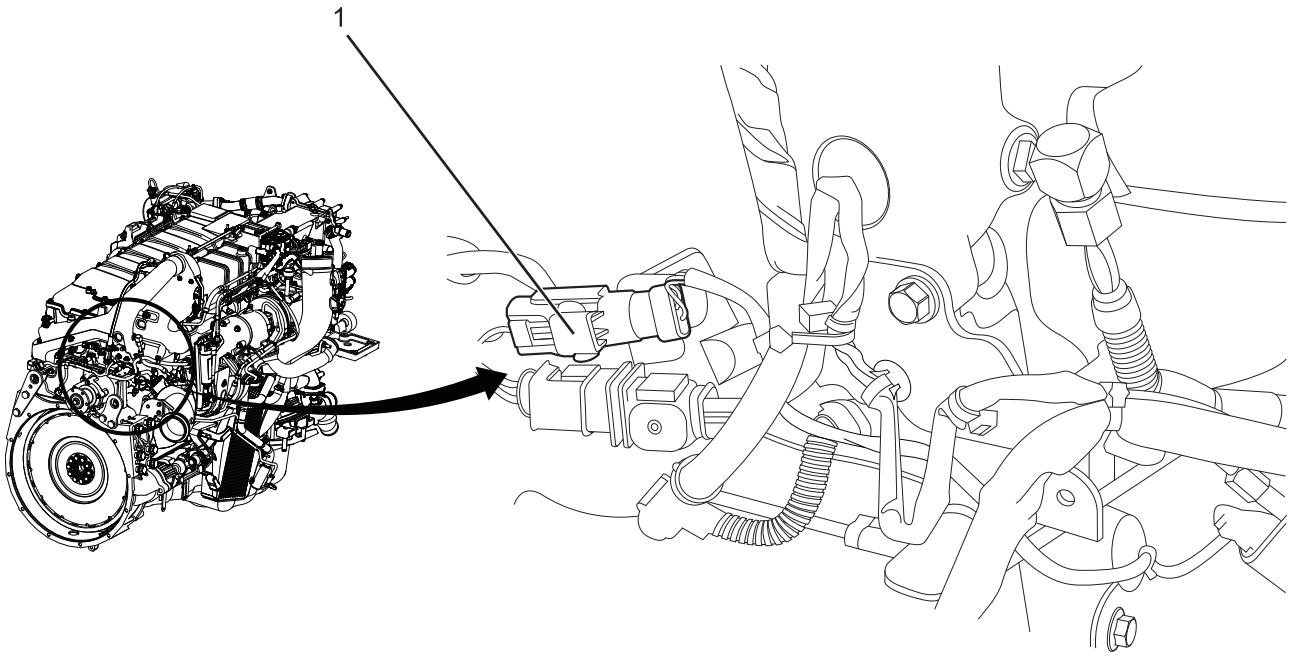

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Figure 149 AFTFI Connector Location

1. Aftertreatment Fuel Injector (AFTFI) connector

Step	Action	Decision
14	Inspect connections at AFTFI. Key OFF, disconnect AFTFI. Check AFTFI connector and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the AFTFI connector, harness, and terminals clean and undamaged?	Yes: Go to step 15. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3556 FMI 5.

Step	Action	Decision
15	Check AFTFI-1 circuit for short to power between 20-way DEF harness interconnect and AFTFI. With 20-way disconnected, connect Breakout Harness ZTSE4760A to the AFTFI vehicle harness, and leave AFTFI disconnected. KOEO, use a DMM to measure voltage between Breakout Harness pin-1 and a known good ground. Is voltage less than 0.5 volts?	Yes: Go to step 16. No: Repair short to power between 20-way connector pin-8 and AFTFI pin-1. After repairs are complete, retest for SPN 3556 FMI 5.

Step	Action	Decision
16	Check AFTFI-2 circuit for short to power between 20-way DEF harness interconnect and AFTFI. KOEO, use a DMM to measure voltage between Breakout Harness ZTSE4760A pin-2 and a known good ground. Is voltage less than 0.5 volts?	Yes: Replace AFTFI. After repairs are complete, retest for SPN 3556 FMI 5. No: Repair short to power between 20-way connector pin-9 and AFTFI pin-2. After repairs are complete, retest for SPN 3556 FMI 5.

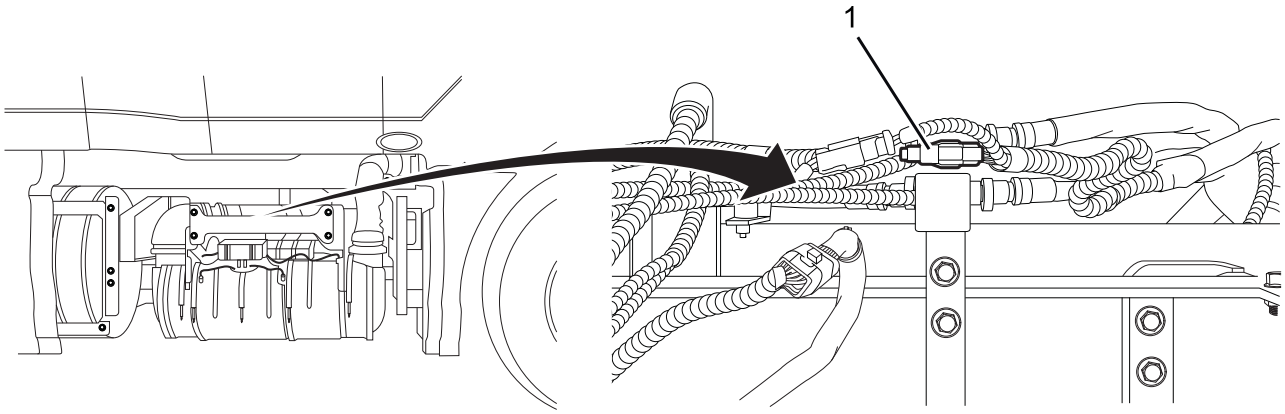

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Figure 150 20-Way Connector Location

1. 20-way connector

Step	Action	Decision
17	Inspect connections at 20-Way DEF harness interconnect. Key OFF, disconnect 20-Way DEF harness interconnect. Check 20-Way DEF harness interconnect and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the 20-Way DEF harness interconnect connector, harness, and terminals clean and undamaged?	Yes: Go to step 18. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3556 FMI 5.

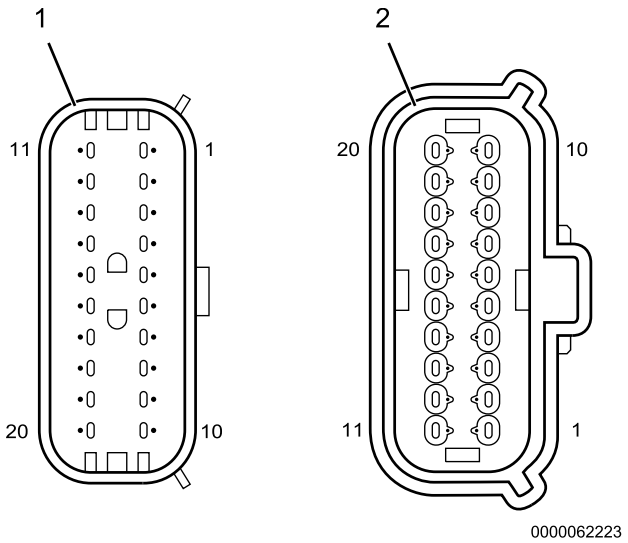

Figure 151 20-Way DEF Harness Connector End View

1. 20-Way DEF harness male side connector
2. 20-Way DEF harness female side connector

Step	Action	Decision
18	Check AFTFI-1 circuit for Open between ACM and 20-way DEF harness interconnect. With ACM disconnected, connect Breakout Harness 18-050-01 to the male side of the 20-way and leave female side disconnected. Key OFF, use a DMM to measure resistance from Breakout Harness pin-8 and 180-pin Breakout Box pin J1-05. Is resistance less than 5 ohms?	Yes: Go to step 19. No: Repair Open between 20-way connector pin-8 and Aftertreatment Control Module (ACM) connector pin J1-05. After repairs are complete, retest for SPN 3556 FMI 5.

Step	Action	Decision
19	Check AFTFI-2 circuit for Open between ACM and 20-way DEF harness interconnect. Key OFF, use a DMM to measure resistance from Breakout Harness 18-050-01 pin-9 and 180-pin Breakout Box pin J1-29. Is resistance less than 5 ohms?	Yes: Go to step 20. No: Repair Open between 20-way connector pin-9 and Aftertreatment Control Module (ACM) connector pin J1-29. After repairs are complete, retest for SPN 3556 FMI 5.

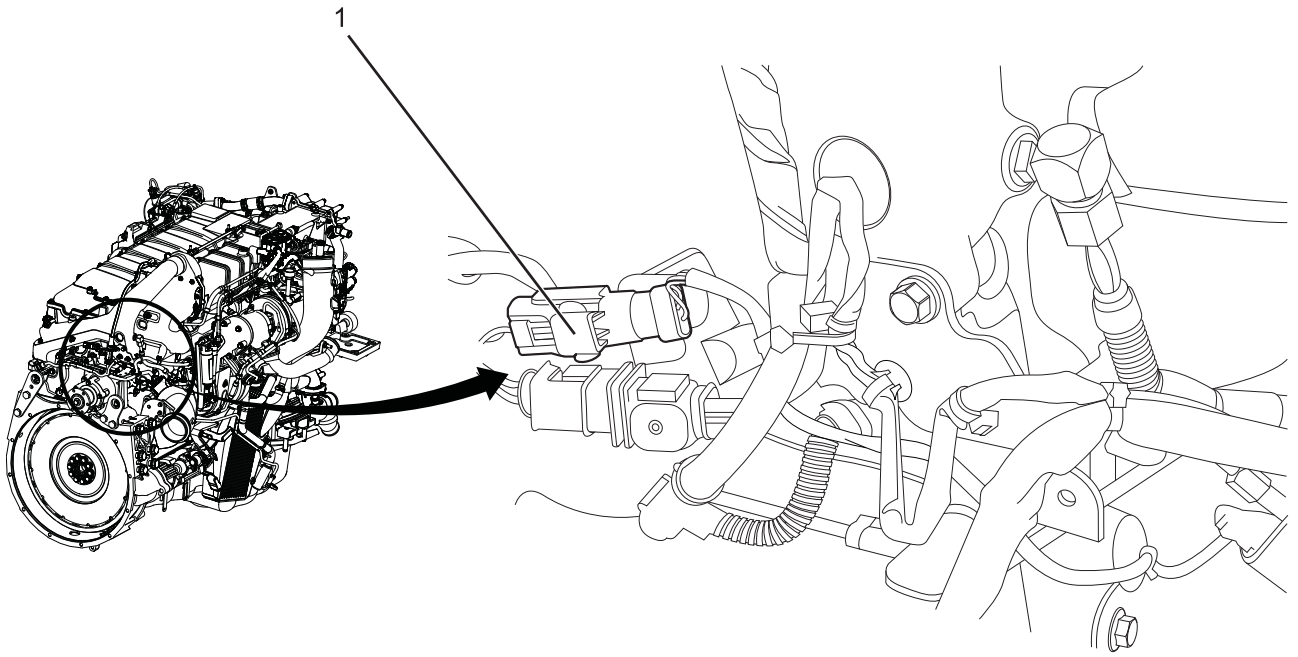

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Figure 152 AFTFI Connector Location

1. Aftertreatment Fuel Injector (AFTFI) connector

Step	Action	Decision
20	Inspect connections at AFTFI. Key OFF, disconnect AFTFI. Check AFTFI connector and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the AFTFI connector, harness, and terminals clean and undamaged?	Yes: Go to step 21. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3556 FMI 5.

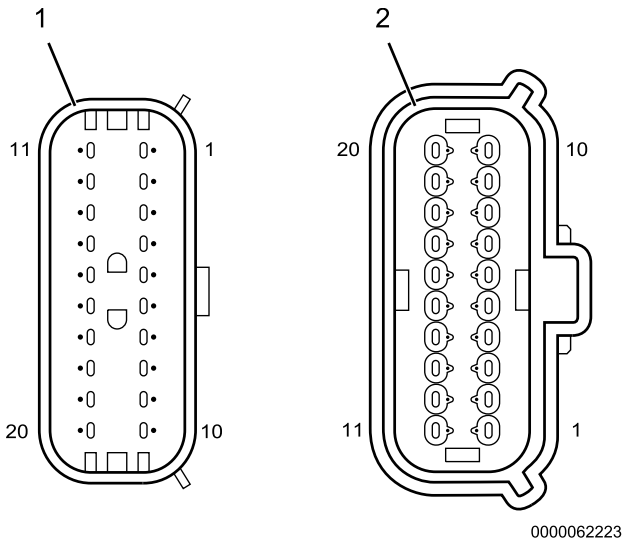

Figure 153 20-Way DEF Harness Connector End View

1. 20-Way DEF harness male side connector
2. 20-Way DEF harness female side connector

Step	Action	Decision
21	Check AFTFI-1 circuit for Open between 20-way DEF harness interconnect and AFTFI. Connect Breakout Harness 18-050-01 to the female side of the 20-way and leave male side disconnected. Connect Breakout Harness ZTSE4760A to the AFTFI vehicle harness and leave AFTFI disconnected. Key OFF, use a DMM to measure resistance from Breakout Harness 18-050-01 pin-8 and Breakout Harness ZTSE4760A pin-1. Is resistance less than 5 ohms?	Yes: Go to step 22. No: Repair Open between 20-way connector pin-8 and AFTFI pin-1. After repairs are complete, retest for SPN 3556 FMI 5.

Step	Action	Decision
22	Check AFTFI-2 circuit for Open between 20-way DEF harness interconnect and AFTFI. Key OFF, use a DMM to measure resistance from Breakout Harness 18-050-01 pin-9 and Breakout Harness ZTSE4760A pin-2. Is resistance less than 5 ohms?	Yes: Replace AFTFI. After repairs are complete, retest for SPN 3556 FMI 5. No: Repair Open between 20-way connector pin-9 and AFTFI pin-2. After repairs are complete, retest for SPN 3556 FMI 5.

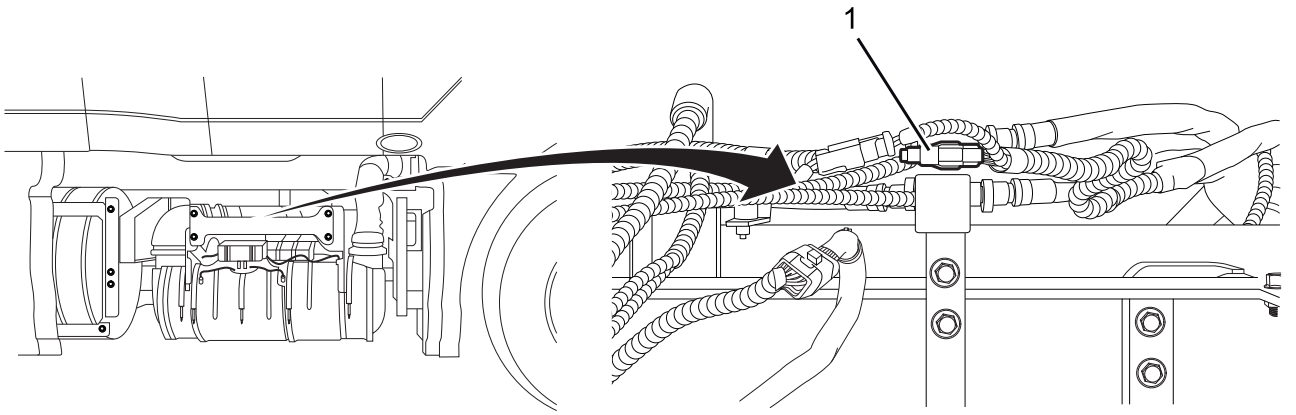

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Figure 154 20-Way Connector Location

1. 20-way connector

Step	Action	Decision
23	Inspect connections at 20-Way DEF harness interconnect. Key OFF, disconnect 20-Way DEF harness interconnect. Check 20-Way DEF harness interconnect and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the 20-Way DEF harness interconnect connector, harness, and terminals clean and undamaged?	Yes: Go to step 24. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3556 FMI 5.

Step	Action	Decision
24	Check for AFTFI-1 shorted to AFTFI-2 between the 20-way DEF harness interconnect and ACM. With ACM disconnected, connect Breakout Harness 18-050-01 to the male side of the 20-way and leave female side disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness pin-8 and pin-9. Is resistance greater than 1000 ohms?	Yes: Go to step 25. No: Repair AFTFI-1 shorted to AFTFI-2 between ACM and 20-way connector. After repairs are complete, retest for SPN 3556 FMI 5.

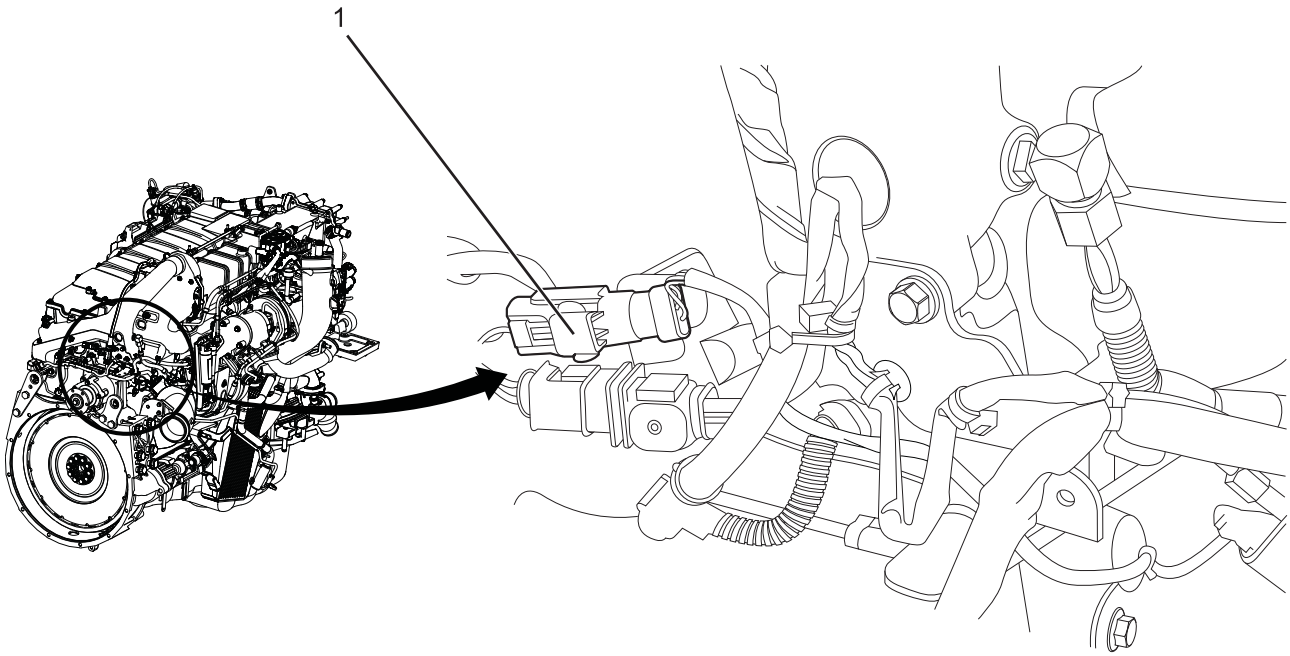

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Figure 155 AFTFI Connector Location

1. Aftertreatment Fuel Injector (AFTFI) connector

Step	Action	Decision
25	Inspect connections at AFTFI. Key OFF, disconnect AFTFI. Check AFTFI connector and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the AFTFI connector, harness, and terminals clean and undamaged?	Yes: Go to step 19. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3556 FMI 5.

Step	Action	Decision
26	Check for AFTFI-1 shorted to AFTFI-2 between the 20-way DEF harness interconnect and AFTFI. With AFTFI disconnected, connect Breakout Harness 18-050-01 to the female side of the 20-way DEF Harness Interconnect and leave male side disconnected. Key OFF, use a DMM to measure resistance from 18-050-01 pin-8 and pin-9. Is resistance greater than 1000 ohms?	Yes: Replace AFTFI. After repairs are complete, retest for SPN 3556 FMI 5. No: Repair AFTFI-1 shorted to AFTFI-2 between AFTFI and 20-way connector. After repairs are complete, retest for SPN 3556 FMI 5.

NOTE: After performing all diagnostic steps, if SPN 3556 FMI 5 remains verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3556 FMI 18 - AFT Fuel Pressure below Warning Pressure (AFTFI at high adaptation limit)

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Unable to inject sufficient fuel through the Aftertreatment Fuel Injector (AFTFI) to achieve DPF regeneration.	DPF Inlet Temperature (DPFIT) below regeneration target temperature.	System test has run (Occurs before dosing). Key ON Inactive: SPN 168 FMI 18 (ACM); SPN 3242 FMI 2, 3, 4 (DPFIT); SPN 3246 FMI 2 3, 4 (DPFOT); SPN 3251 FMI 0 (DPFDP); SPN 3480 FMI 2, 3, 4, 17 (AFTFP1); SPN 3482 FMI 2, 3, 4, 7 (AFTFSV); SPN 3490 FMI 3, 4 (AFTPAV); SPN 3556 FMI 2, 5 (AFTFI); SPN 3936 FMI 7, 15 (DPF System); SPN 4363 FMI 0 (SCROT); SPN 4765 FMI 2, 3, 4 (DOCIT); SPN 4795 FMI 31 (DPFDP); SPN 4796 FMI 31 (DOC); SPN 5742 FMI 3 (DPF Temp Module); SPN 5742 FMI 4, 11, 12 (DPF Temp Module)	Minimum 30 seconds. Maximum 5000 seconds.

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Aftertreatment Fuel Injector (AFTFI) can not inject enough fuel for active regeneration of the aftertreatment Diesel Particulate Filter (DPF).

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 94 (FDP); SPN 3242 (DPFIT); SPN 3246 (DPFOT); SPN 3480 (AFTFP1); SPN 3556 FMI 2, 5 (AFTFI); SPN 3482 (AFTFSV); SPN 3490 (AFTPAV); SPN 4765 (DOCIT); SPN 4796 (AFT); and SPN 5742 (DOC/DPF temp sensor module)

Drive Cycle to Determine Fault Status

Drive cycle 1 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Damaged or restricted supply line to AFTFI
- Missing Poppet in Aftertreatment Fuel Injector (AFTFI)
- Restricted AFTFI
- Exhaust leak or restriction

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 94 (FDP); SPN 3242 (DPFIT); SPN 3246 (DPFOT); SPN 3480 (AFTFP1); SPN 3556 FMI 2, 5 (AFTFI); SPN 3482 (AFTFSV); SPN 3490 (AFTPAV); SPN 4765 (DOCIT); SPN 4796 (AFT); and SPN 5742 (DOC/DPF temp sensor module). Is EST DTC list free of SPN 3242; SPN 3246; SPN 3480; SPN 3556 FMI 2, 5; SPN 3482; SPN 3490; SPN 4765; and SPN 5742?	Yes: Go to step 2. No: Repair SPN 3242; SPN 3246; SPN 3480; SPN 3556 FMI 2, 5; SPN 3482; SPN 3490; SPN 4765; SPN 4796 (AFT); and SPN 5742. After repairs are complete, retest for SPN 3556 FMI 18.

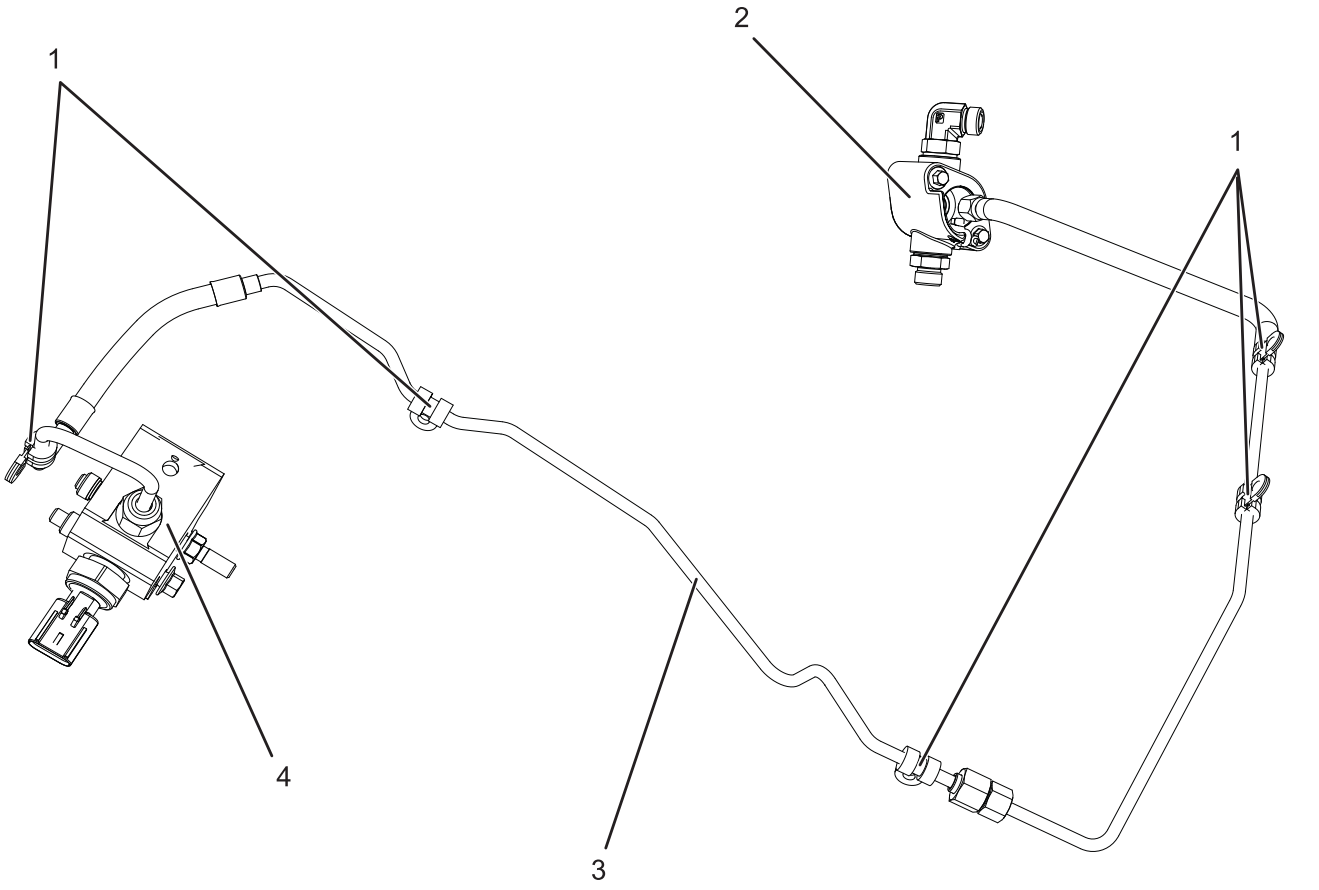

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Figure 156 Aftertreatment Fuel Injection Components (Top View)

1. Fuel line retainers (rear and left side of engine block)
2. Aftertreatment Fuel Injector (AFTFI)
3. AFTFI fuel pressure line
4. AFT fuel doser module

Step	Action	Decision
2	Check for restricted or damaged fuel supply line to Aftertreatment Fuel Injector (AFTFI). Key-On Engine-Running (KOER), inspect fuel supply line between AFT fuel doser module and AFTFI for restrictions and leaks. Is the fuel supply line between the AFT fuel doser module and the AFTFI in good condition and not restricted?	Yes: Go to step 3. No: Repair or replace the fuel line to AFTFI. After repairs are complete, retest for SPN 3556 FMI 18.

Step	Action	Decision
3	Inspect exhaust system for leaks and physical damage. Is exhaust system free of leaks and physical damage?	Yes: Go to step 4. No: Repair or replace leaking or damaged exhaust components. After repairs are complete, retest for SPN 3556 FMI 18.

Step	Action	Decision
4	Remove the Aftertreatment Fuel Injector (AFTFI) see *Engine Service Manual*. Inspect the AFTFI lower poppet. Is the AFTFI missing the lower poppet?	Yes: Replace AFTFI. After repairs are complete, retest for SPN 3556 FMI 18. No: Go to step 5.

Step	Action	Decision
5	Check for failed AFTFI fuel flow. Perform AFT Dosing System Test (page 118). Was 225 to 500 ml of fuel dispensed within 2 minutes 30 seconds?	Yes: Retest for SPN 3556 FMI 18. No: Clean or replace AFTFI. After repairs are complete, retest for SPN 3556 FMI 18.

NOTE: After performing all diagnostic steps, if SPN 3556 FMI 18 remains verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

AFTFP1 (Aftertreatment Fuel Pressure 1 Sensor)

SPN	FMI	Condition	Possible Causes	Actions
3480	2	AFTFP1 pressure sensor plausibility error	• Failed AFTFP1 • Aftertreatment fuel doser module or AFT Fuel Injector (AFTFI) fuel lines or connections loose, leaking, restricted, or damaged.	Step-Based Diagnostics (page 385)
3480	3	AFTFP1 signal Out of Range HIGH	• Failed AFTFP1 • AFTFP1 circuit short to power • SIG GND circuit Open or high resistance	Step-Based Diagnostics (page 388)
3480	4	AFTFP1 signal Out of Range LOW	• Failed AFTFP1 • AFTFP1 signal circuit short to GND • AFTFP1 signal circuit Open or high resistance • VREF-4 circuit Open or high resistance	Step-Based Diagnostics (page 390)
3480	17	AFTFP1 below normal operating range	• Restricted, damaged, or leaking fuel line to the aftertreatment fuel doser module • Restricted, damaged, or leaking aftertreatment fuel doser module • Low Fuel Delivery Pressure (FDP)	Step-Based Diagnostics (page 393)

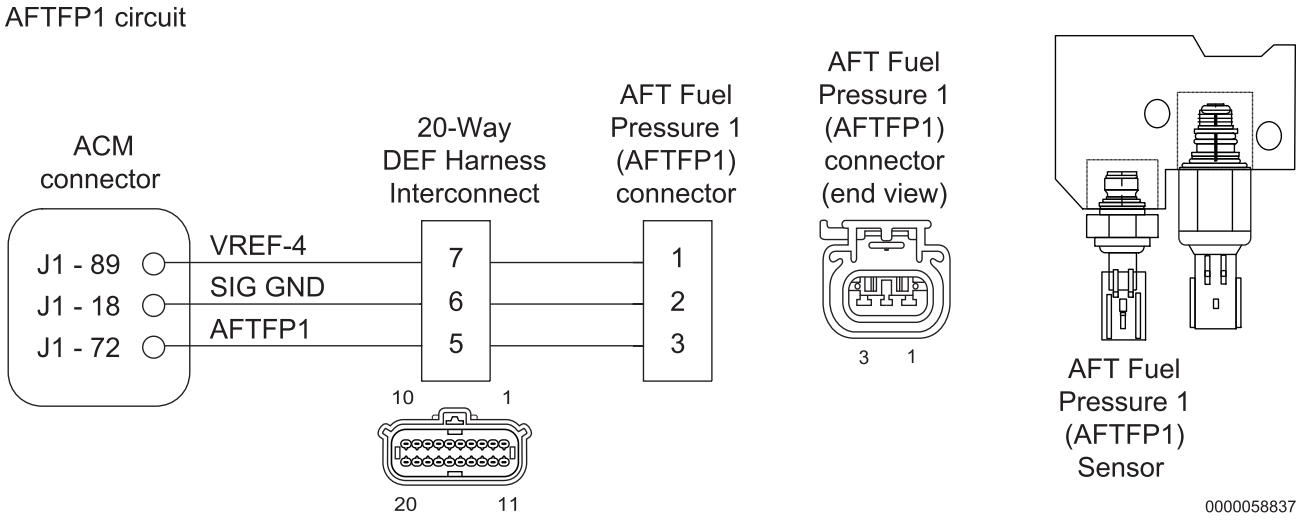


Figure 157 AFTFP1 Circuit Diagram.

NOTE: See latest version of N13 Engine and Aftertreatment Wiring Schematic Form 0000002203 for additional circuit information.

Overview

The Aftertreatment Control Module (ACM) monitors the Aftertreatment Fuel Pressure 1 (AFTFP1) signal voltage to calculate fuel pressure in the aftertreatment system feeding the Aftertreatment Fuel Injector (AFTFI). This is used during active and parked regeneration only.

Tools Required

- 180-Pin Breakout Box 00-00956-08
- SCR (ACM) Breakout Harness 18-100-01 (96-pin)
- Breakout Harness ZTSE4845
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

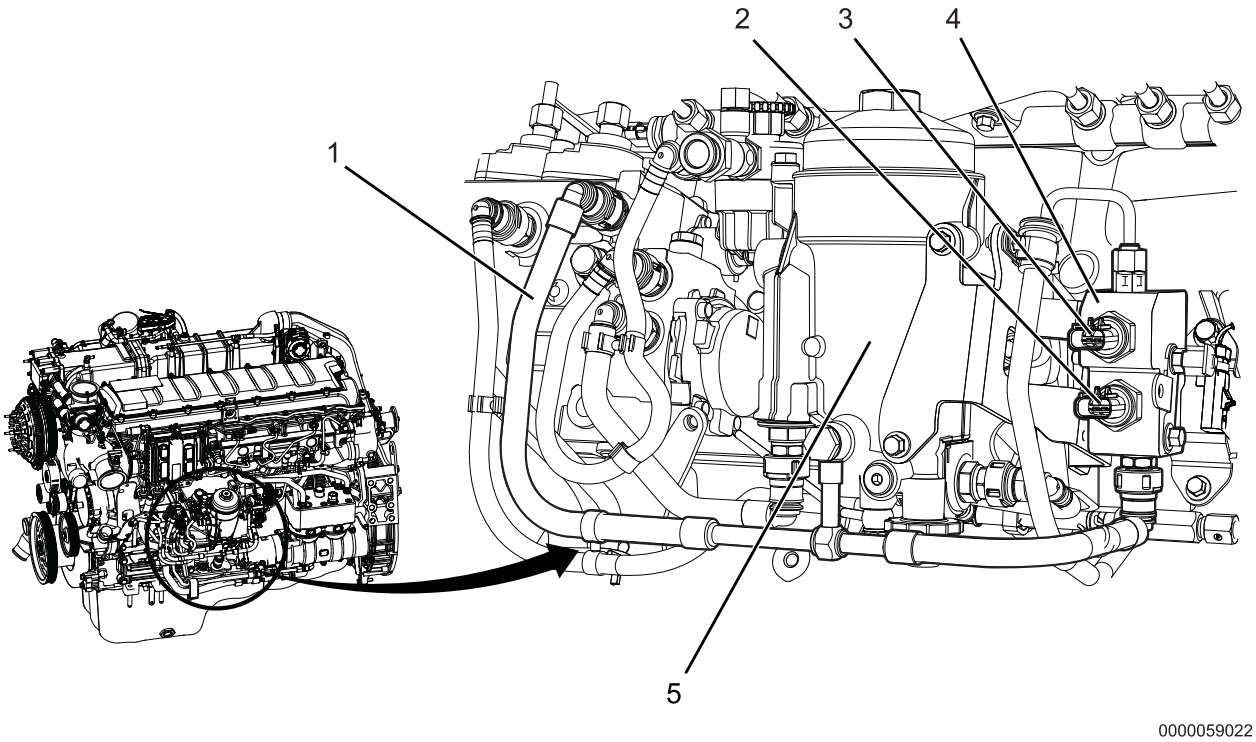


Figure 158 AFTFP1 Location.

1. AFT Fuel Doser Module fuel supply line
2. AFT Fuel Shutoff Valve (AFTFSV)
3. AFT Fuel Pressure 1 (AFTFP1)
4. AFT Fuel Doser Module

SPN 3480 FMI 2 - AFTFP1 signal erratic, intermittent or incorrect

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Aftertreatment Fuel Pressure 1 (AFTFP1) sensor is in range, but not rational.	[(Aftertreatment Fuel Pressure 1 (AFTFP1) pressure at Ambient pressure state < -7.3 psi (-50 kPa) or > 61.6 psi (425 kPa)) OR (AFTFP1 pressure at Air Supply state < 49.9 psi (344 kPa) or > 159 psi (1,100 kPa)) OR (AFTFP1 pressure at Fuel pressure state < 79.8 psi (550 kPa) or > 246 psi (1,700 kPa)) AND SPN 3490 FMI 7 (AFTPAV)] OR [(AFTFP1 pressure with the Aftertreatment Fuel Shutoff Valve (AFTFSV) commanded open) - (AFTFP1 pressure when the AFT Fuel Injector (AFTFI) is open and the AFT Purge Air Valve (AFTPAV) and AFTFSV are closed) < 50.7 psi (350 kPa)] AND [(AFTFP1 pressure with the AFTPAV commanded open) - (AFTFP1 pressure when the AFTFI is open and the AFTPAV and AFTFSV are closed) < 50.7 psi (350 kPa)]	Inactive: SPN 168 FMI 18 (ACM Power); SPN 3242 FMI 2, 3, 4 (DPFIT); SPN 3246 FMI 2, 3, 4 (DPFOT); SPN 3251 FMI 0 (DPFDP); SPN 3480 FMI 3, 4, 17 (AFTFP1); SPN 3482 FMI 2, 3, 4, 7 (AFTFSV); SPN 3490 FMI 3, 4 (AFTPAV); SPN 3556 FMI 2, 5 (AFTFI); SPN 3936 FMI 7, 15 (DPF System); SPN 4363 FMI 0 (SCROT); SPN 4765 FMI 2, 3, 4 (DOCIT); SPN 4795 FMI 31 (AFT System); SPN 4796 FMI 31 (AFT System); SPN 5742 FMI 3, 4, 11, 12 (DOC/DPF Temp Sensor Module)	67 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects Aftertreatment Fuel Pressure 1 (AFTFP1) sensor stuck in-range fault. Diagnostics are only performed prior to starting an active regeneration of the DPF, or at Key ON if the active regeneration is continuing across key cycles. If the diagnostics fail, then the regeneration request is aborted. Active regeneration of the aftertreatment diesel particulate filter will be disabled until the next key cycle. Engine torque will be reduced if the engine is operated for an extended period of time with this fault active.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 94 (FDP); SPN 108 (BARO); SPN 157 (FRP); SPN 168 FMI 18 (ACM Power); SPN 3242 FMI 2, 3, 4 (DPFIT); SPN 3246 FMI 2, 3, 4 (DPFOT); SPN 3251 FMI 0 (DPFDP); SPN 3480 FMI 3, 4, 17 (AFTFP1); SPN 3482 FMI 2, 3, 4, 7 (AFTFSV); SPN 3490 FMI 3, 4 (AFTPAV); SPN 3512 FMI 14 (VREF-4); SPN 3556 FMI 2, 5 (AFTFI); SPN 3936 FMI 7, 15 (DPF System); SPN 4363 FMI 0 (SCROT); SPN 4765 FMI 2, 3, 4 (DOCIT); SPN 4795 FMI 31 (AFT System); SPN 4796 FMI 31 (AFT System); SPN 5742 FMI 3, 4, 11, 12 (DOC/DPF Temp Sensor Module)

Fault Facts

This fault is detected by comparing measured pressure at three pressure reference states to see if the measured pressures are unique in all cases. The reference pressure states are 1): Ambient, 2) Air Supply Pressure, and 3) Fuel Pressure.

- 1: An ambient pressure (BARO) reading is taken when the AFTFI is open AND the AFTPAV and AFTFSV are closed.
- 2: An air supply pressure reading is taken when the AFTPAV is open AND the AFTFSV and AFTFI are closed.
- 3: A fuel pressure reading is taken when the AFTFSV is open AND the AFTFI and AFTPAV are closed.

Also, the individual measured pressures at each state are checked against their expected pressure range. A fault is set if any measured value is outside the expected range.

Drive Cycle to Determine Fault Status

Drive Cycle 1 in 2013 HD-OBD Diagnostic Reference Manual.

AFTFP1 circuit

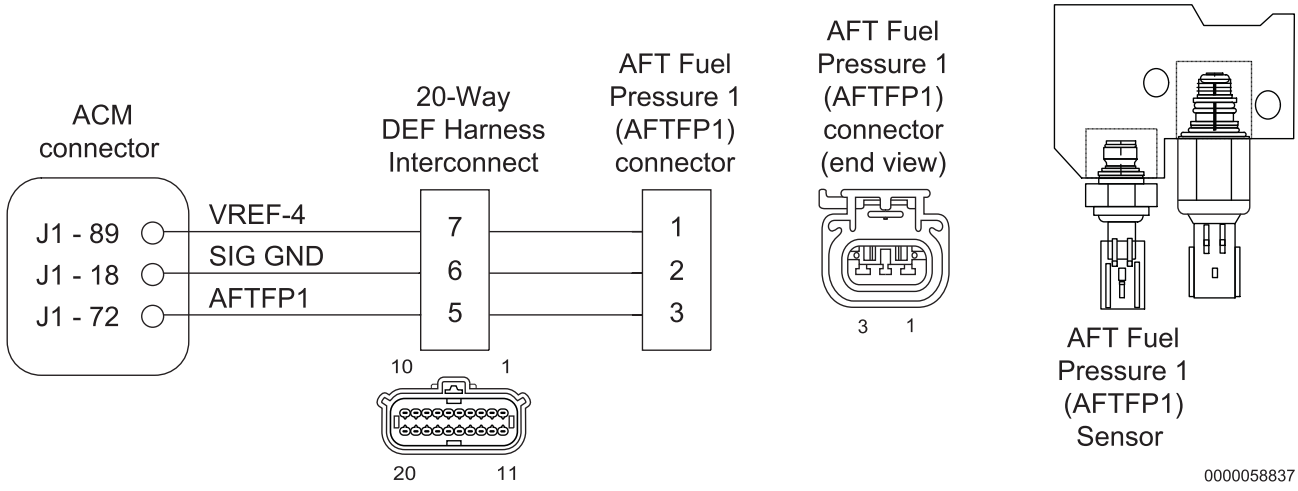


Figure 159 AFTFP1 Circuit Diagram.

Possible Causes

- Failed AFTFP1

- Aftertreatment fuel doser module or AFT Fuel Injector (AFTFI) fuel lines or connections loose, leaking, restricted, or damaged.

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 94 (FDP); SPN 108 (BARO); SPN 157 (FRP); SPN 168 FMI 18 (ACM Power); SPN 3242 FMI 2, 3, 4 (DPFIT); SPN 3246 FMI 2, 3, 4 (DPFOT); SPN 3251 FMI 0 (DPFDP); SPN 3480 FMI 3, 4, 17 (AFTFP1); SPN 3482 FMI 2, 3, 4, 7 (AFTFSV); SPN 3490 FMI 3, 4 (AFTPAV); SPN 3512 FMI 14 (VREF-4); SPN 3556 FMI 2, 5 (AFTFI); SPN 3936 FMI 7, 15 (DPF System); SPN 4363 FMI 0 (SCROT); SPN 4765 FMI 2, 3, 4 (DOCIT); SPN 4795 FMI 31 (AFT System); SPN 4796 FMI 31 (AFT System); SPN 5742 FMI 3, 4, 11, 12 (DOC/DPF Temp Sensor Module). Is EST DTC list free of SPN 94; SPN 108; SPN 157; SPN 168 FMI 18; SPN 3242 FMI 2, 3, 4; SPN 3246 FMI 2, 3, 4; SPN 3251 FMI 0; SPN 3480 FMI 3, 4, 17; SPN 3482 FMI 2, 3, 4, 7; SPN 3490 FMI 3, 4; SPN 3512 FMI 14; SPN 3556 FMI 2, 5; SPN 3936 FMI 7, 15; SPN 4363 FMI 0; SPN 4765 FMI 2, 3, 4; SPN 4795 FMI 31; SPN 4796 FMI 31; SPN 5742 FMI 3, 4, 11, 12?	Yes: Go to step 2. No: Repair SPN 94; SPN 108; SPN 157; SPN 168 FMI 18; SPN 3242 FMI 2, 3, 4; SPN 3246 FMI 2, 3, 4; SPN 3251 FMI 0; SPN 3480 FMI 3, 4, 17; SPN 3482 FMI 2, 3, 4, 7; SPN 3490 FMI 3, 4; SPN 3512 FMI 14; SPN 3556 FMI 2, 5; SPN 3936 FMI 7, 15; SPN 4363 FMI 0; SPN 4765 FMI 2, 3, 4; SPN 4795 FMI 31; SPN 4796 FMI 31; SPN 5742 FMI 3, 4, 11, 12. After repairs are complete, retest for SPN 3480 FMI 2.

Step	Action	Decision
2	Check AFT fuel doser module and AFT Fuel Injector (AFTFI) fuel lines and connections for: loose connections, leaks, restrictions, or damage. Are the AFT fuel doser module and AFTFI fuel lines and connections leaking, restricted, or damaged?	Yes: Repair or replace leaking, restricted, or damaged fuel line or connection. After repairs are complete, retest for SPN 3480 FMI 2. No: Install new AFTFP1 sensor. After repairs are complete, retest for SPN 3480 FMI 2.

NOTE: After performing all diagnostic steps, if SPN 3480 FMI 2 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

3480 FMI 3 - AFTFP1 Signal Out of Range HIGH

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
AFTFP1 sensor circuit voltage above normal or shorted to high source.	AFTFP1 sensor value > 4.8 V for more than 1 second	Key ON	1 second

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects Aftertreatment Fuel Pressure 1 (AFTFP1) signal voltage is more than 4.8 volts for more than 1 second. Engine torque may be reduced if the engine is operated for an extended period of time with this fault active. Active regeneration of the aftertreatment system may be disabled until the next key cycle.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 3512 FMI 14 (VREF-4)

Fault Facts

The (ACM) monitors the (AFTFP1) signal voltage to calculate fuel pressure in the aftertreatment system.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

AFTFP1 circuit

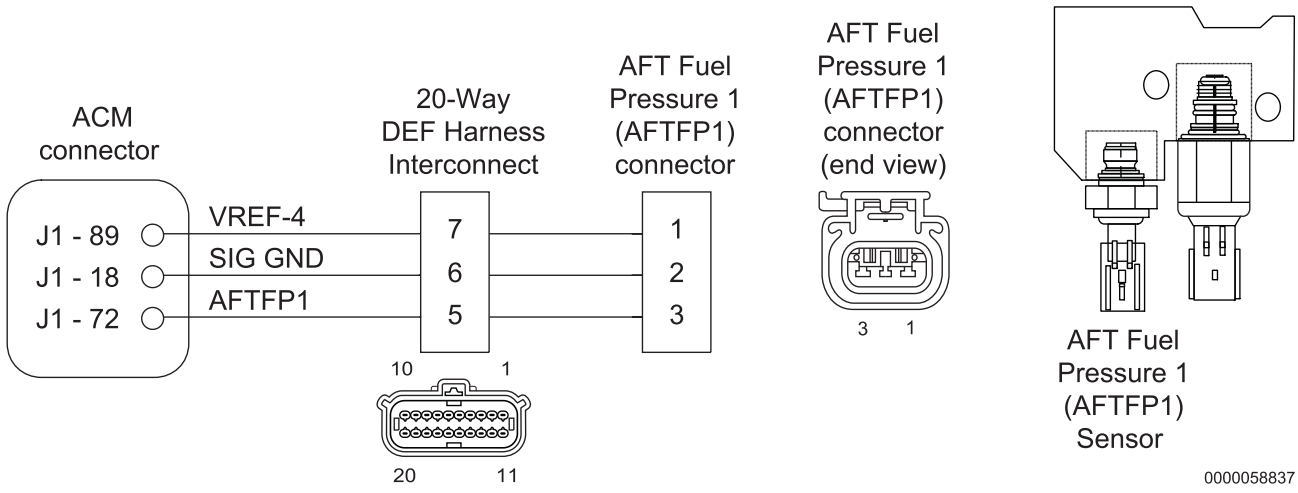


Figure 160 AFTFP1 Circuit Diagram

Possible Causes

- Failed AFTFP1

- AFTFP1 circuit short to power
- SIG GND circuit Open or high resistance

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3512 FMI 14 (VREF-4). Is EST DTC list free of SPN 3512 FMI 14?	Yes: Go to step 2. No: Repair SPN 3512 FMI 14. After repairs are complete, retest for SPN 3480 FMI 3.

Step	Action	Decision
2	Inspect connections at AFT Fuel Pressure 1 (AFTFP1) sensor. Key OFF, disconnect AFTFP1 connector. Check AFTFP1 sensor and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the AFTFP1 sensor connector, harness, and terminals clean and undamaged?	Yes: Go to step 3. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3480 FMI 3.

Step	Action	Decision
3	Check AFTFP1 circuit for short to power. Key-On Engine-Off (KOEO), with Breakout Harness ZTSE4845 connected to AFTFP1, use a DMM to measure voltage between AFTFP1 pin-3 and a known good ground. Is voltage less than 4.7 volts?	Yes: Go to step 4. No: Repair short to power between AFTFP1 connector pin-3 and ACM connector pin J1-72. After repairs are complete, retest for SPN 3480 FMI 3.

Step	Action	Decision
4	Check SIG GND circuit for Open or high resistance. Key OFF, Connect Breakout Harness ZTSE4845 to AFTFP1 and leave disconnected. Connect 180-pin Breakout Box with SCR (ACM) Breakout Harness 18-100-01 (96-pin) to ACM and leave ACM disconnected. Use a DMM to measure resistance from Breakout Harness ZTSE4845 pin-2 to 180-pin Breakout Box pin J1-18. Is resistance less than 5 ohms?	Yes: Replace AFTFP1 sensor. After repairs are complete, retest for SPN 3480 FMI 3. No: Repair Open or high resistance between AFTFP1 pin-2 and ACM connector J1-18. After repairs are complete, retest for SPN 3480 FMI 3.

NOTE: After performing all diagnostic steps, if SPN 3480 FMI 3 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

3480 FMI 4 - AFTFP1 Signal Out of Range LOW

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Aftertreatment Fuel Pressure 1 (AFTFP1) sensor circuit - Voltage below normal or shorted to low source.	AFTFP1 < 0.25 volts	Key ON	2 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the signal from the Aftertreatment Fuel Pressure Fuel Pressure 1 (AFTFP1) sensor is less than 0.25 volts for 2 seconds. Active aftertreatment regeneration disabled until the next key cycle. Engine torque will be reduced if fault is active for an extended period of time.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 3512 FMI 14 (VREF-4)

Fault Facts

The (ACM) monitors the (AFTFP1) signal voltage to calculate fuel pressure in the aftertreatment system.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

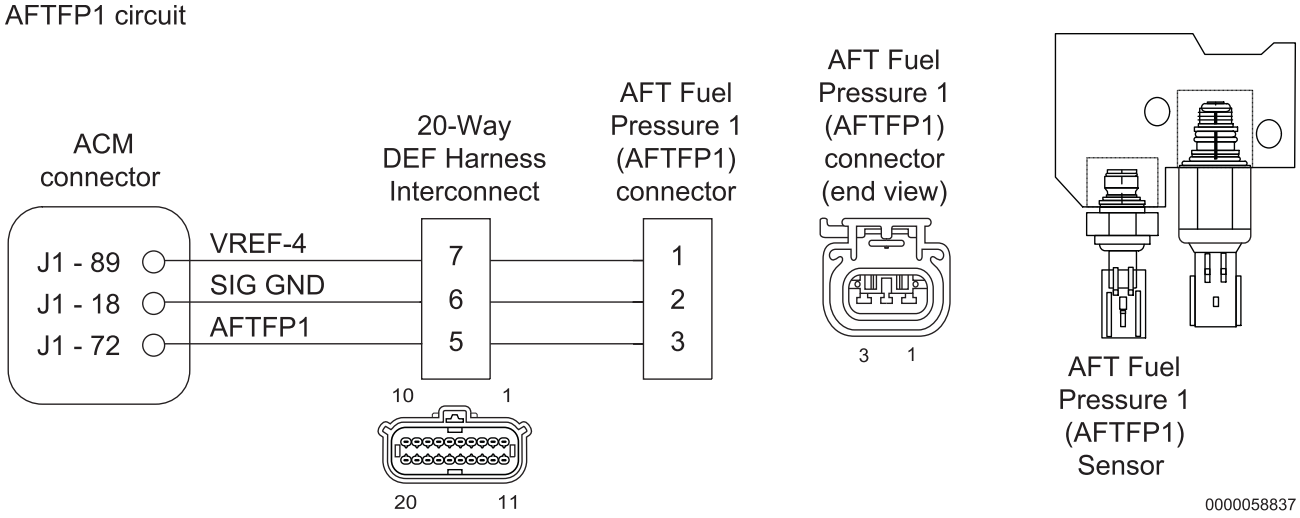


Figure 161 AFTFP1 Circuit Diagram.

Possible Causes

- Failed AFTFP1
- AFTFP1 signal circuit short to GND
- AFTFP1 signal circuit Open or high resistance
- VREF-4 circuit Open or high resistance

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3512 FMI 14 (VREF-4). Is EST DTC list free of SPN 3512 FMI 14?	Yes: Go to step 2. No: Repair SPN 3512 FMI 14. After repairs are complete, retest for SPN 3480 FMI 4.

Step	Action	Decision
2	Inspect connections at AFT Fuel Pressure 1 (AFTFP1) sensor. Key OFF, disconnect AFTFP1 connector. Check AFTFP1 sensor and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the AFTFP1 sensor connector, harness, and terminals clean and undamaged?	Yes: Go to step 3. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3480 FMI 4.

Step	Action	Decision
3	Check AFTFP1 signal circuit for short to ground. Connect Breakout Harness ZTSE4845 to AFTFP1 connector and leave sensor disconnected. Use DMM to measure resistance between Breakout Harness pin-3 and a known good ground. Is resistance greater than 1000 ohms?	Yes: Go to step 4. No: Repair short to ground between AFTFP1 connector pin-3 and ACM connector J1-72. After repairs are complete, retest for SPN 3480 FMI 4.

Step	Action	Decision
4	Check VREF-4 circuit for Open or high resistance. Connect Breakout Harness ZTSE4845 to AFTFP1 connector and leave sensor disconnected. Connect 180-pin Breakout Box with SCR (ACM) Breakout Harness 18-100-01 (96-pin) to ACM connector and leave ACM disconnected. Use a DMM to measure resistance between Breakout Harness ZTSE4845 pin-1 and 180-pin Breakout Box pin J1-89. Is resistance less than 5 ohms?	Yes: Go to step 5. No: Repair Open or high resistance between AFTFP1 pin-1 and ACM connector J1-89. After repairs are complete, retest for SPN 3480 FMI 4.

Step	Action	Decision
5	Check AFTFP1 signal circuit for Open or high resistance. Connect Breakout Harness ZTSE4845 to AFTFP1 connector and leave sensor disconnected. Connect 180-pin Breakout Box with SCR (ACM) Breakout Harness 18-100-01 (96-pin) to ACM and leave ACM disconnected. Use a DMM to measure resistance between Breakout Harness ZTSE4845 pin-3 and 180-pin Breakout Box pin J1-72. Is resistance less than 5 ohms?	Yes: Replace AFTFP1 sensor. After repairs are complete, retest for SPN 3480 FMI 4. No: Repair Open or high resistance between AFTFP1 pin-3 and ACM connector J1-72. After repairs are complete, retest for SPN 3480 FMI 4.

NOTE: After performing all diagnostic steps, if SPN 3480 FMI 4 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

3480 FMI 17- AFTFP1 below normal operating range

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Aftertreatment Fuel Pressure 1 (AFTFP1) sensor signal is valid but below normal operating range.	Aftertreatment Fuel Pressure 1 (AFTFP1) sensor signal is below 300 kPa (gauge) (43.5 psi) for greater than 15 seconds.	Rate of active / intrusive injection of fuel in exhaust > 0.1 g/sec Inactive: SPN 168 FMI 18 (ACM Power); SPN 3242 FMI 2, 3, 4 (DPFIT); SPN 3246 FMI 2, 3, 4 (DPFOT); SPN 3251 FMI 0 (DPFDP); SPN 3480 FMI 2, 3, 4 (AFTFP1); SPN 3482 FMI 2, 3, 4, 7 (AFTFSV); SPN 3490 FMI 3, 4 (AFTPAV); SPN 3556 FMI 2, 5 (AFTFI); SPN 3936 FMI 7, 15 (DPF System); SPN 4363 FMI 0 (SCROT); SPN 4765 FMI 2, 3, 4 (DOCIT); SPN 4795 FMI 31 (AFT System); SPN 4796 FMI 31 (AFT System); SPN 5742 FMI 3, 4, 11, 12 (DOC/DPF Temp Sensor Module)	0 seconds

Fault Overview

The Aftertreatment Control Module (ACM) detects the Aftertreatment Fuel Pressure 1 (AFTFP1) sensor signal is valid but below normal operating range. This diagnostic runs during active regeneration of the aftertreatment diesel particulate filter. When this fault is active, active regeneration of the aftertreatment diesel particulate filter will be disabled until the next key cycle. Engine torque will be reduced if the engine is operated for an extended period of time with this fault active.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Fault Facts

Fuel restriction diagnostic runs when AFT Fuel Injector (AFTFI) is open, AFT Fuel Shutoff Valve (AFTFSV) is open, and AFT Purge Air Valve (AFTPAV) is closed. When enable conditions are met, a counter will count when fuel pressure is below the minimum to dose threshold. A fault will set when the failure monitor is triggered.

Drive Cycle to Determine Fault Status

Drive Cycle 1 in 2013 HD-OBD Diagnostic Reference Manual.

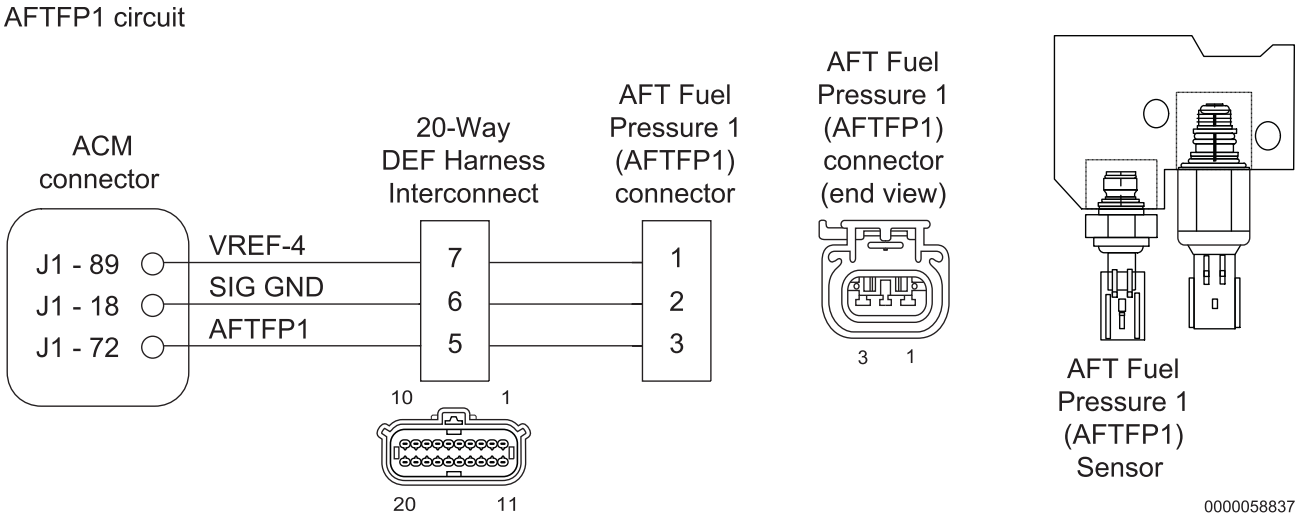


Figure 162 AFTFP1 Circuit Diagram.

Possible Causes

- Restricted, damaged, or leaking fuel line to the aftertreatment fuel doser module
- Restricted, damaged, or leaking aftertreatment fuel doser module
- Low Fuel Delivery Pressure (FDP)

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx software, check Fuel Delivery Pressure (FDP). Select Sessions > Performance. Start engine and monitor FDP. Is Fuel Delivery Pressure 85 psi or greater?	Yes: Go to step 2. No: Perform Fuel Delivery Pressure (FDP) Test (see page 165). After repairs are complete, retest for SPN 3480 FMI 17.

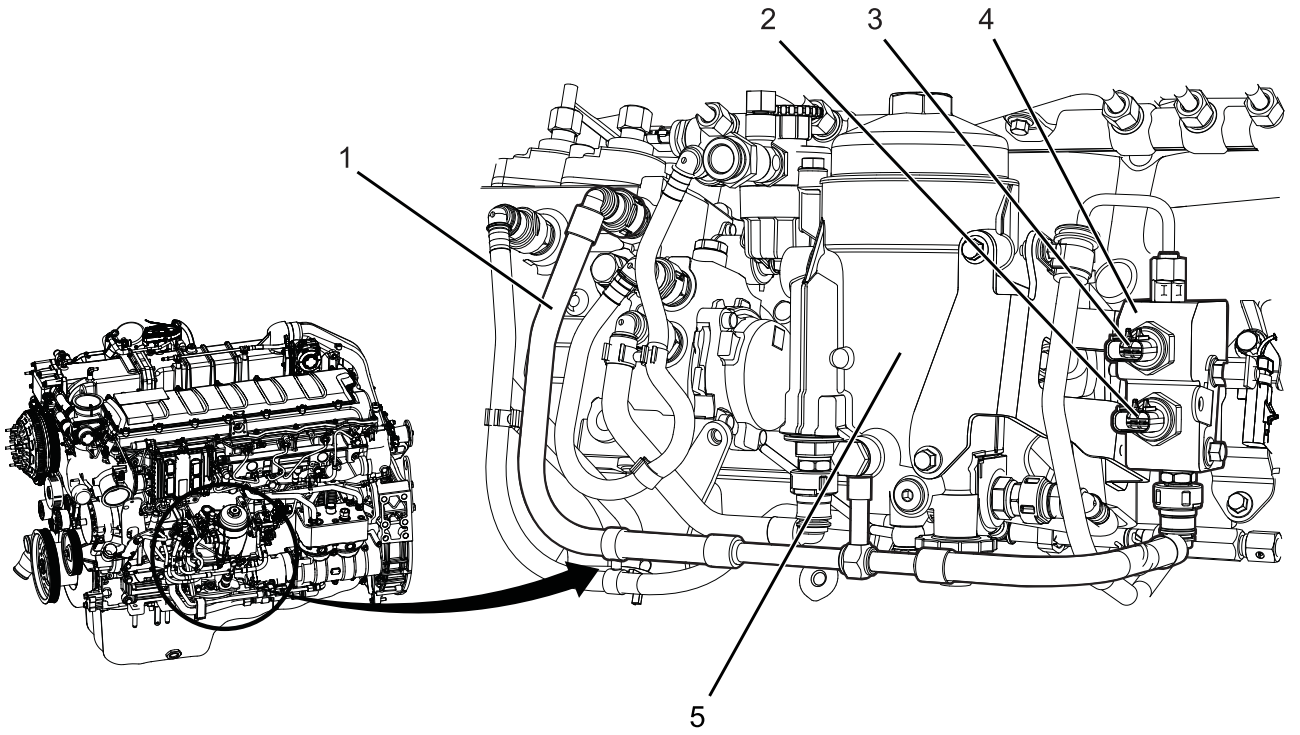


Figure 163 AFTFP1 Location.

1. AFT Fuel Doser Module fuel supply line
2. AFT Fuel Shutoff Valve (AFTFSV)
3. AFT Fuel Pressure 1 (AFTFP1)
4. AFT Fuel Doser Module
5. Secondary Fuel Filter

Step	Action	Decision
2	Check AFT fuel Doser module fuel supply line from the secondary fuel filter assembly to the AFT fuel doser module for damage, restrictions, or leaks. Is fuel supply line in good condition, not restricted, or damaged?	Yes: Replace aftertreatment fuel doser module. After repairs are complete, retest for SPN 3480 FMI 17.
		No: Replace AFT Fuel Doser Module fuel supply line. After repairs are complete, retest for SPN 3480 FMI 17.

NOTE: After performing all diagnostic steps, if SPN 3480 FMI 17 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

AFTFSV (Aftertreatment Fuel Shutoff Valve)

SPN	FMI	Condition	Possible Causes	Actions
3482	2	AFT Fuel Shutoff Valve signal erratic, intermittent, or incorrect	• Failed Aftertreatment Fuel Pressure 1 (AFTFP1) sensor • Failed Aftertreatment Fuel Shutoff Valve (AFTFSV) • Failed Aftertreatment Purge Air Valve (AFTPAV) • Aftertreatment Fuel Injector (AFTFI) missing poppet • Aftertreatment Fuel Injector (AFTFI) restricted • Restricted fuel line to AFTFI	Step-Based Diagnostics (page 399)
3482	3	AFT Fuel Shutoff Valve short to PWR (Open or high resistance)	• AFTFSV-H circuit short to PWR • AFTFSV-H circuit Open or high resistance • AFTFSV-L circuit Open or high resistance • Failed Aftertreatment Fuel Shutoff Valve (AFTFSV)	Step-Based Diagnostics (page 402)
3482	4	AFT Fuel Shutoff Valve short to GND	• AFTFSV-H short to GND • AFTFSV-H shorted to AFTFSV-L • Failed Aftertreatment Fuel Shutoff Valve (AFTFSV)	Step-Based Diagnostics (page 407)

3482	7	AFT Fuel Shutoff Valve Mechanical system not responding or out of adjustment	• Leaking fuel supply line to the AFT fuel doser module • Restricted fuel filter • Failed low-pressure fuel pump • Restricted Aftertreatment Fuel Shutoff Valve (AFTFSV) • Failed AFT Fuel Pressure 1 (AFTFP1)	Step-Based Diagnostics (page 411)
3482	16	AFT Fuel Shutoff Valve Plugged	• Missing, damaged, or leaking fuel supply hose to the AFT Fuel Doser Module • Restricted or stuck closed Aftertreatment Fuel Shutoff Valve (AFTFSV) • Failed AFT Fuel Pressure 1 (AFTFP1)	Step-Based Diagnostics (page 414)

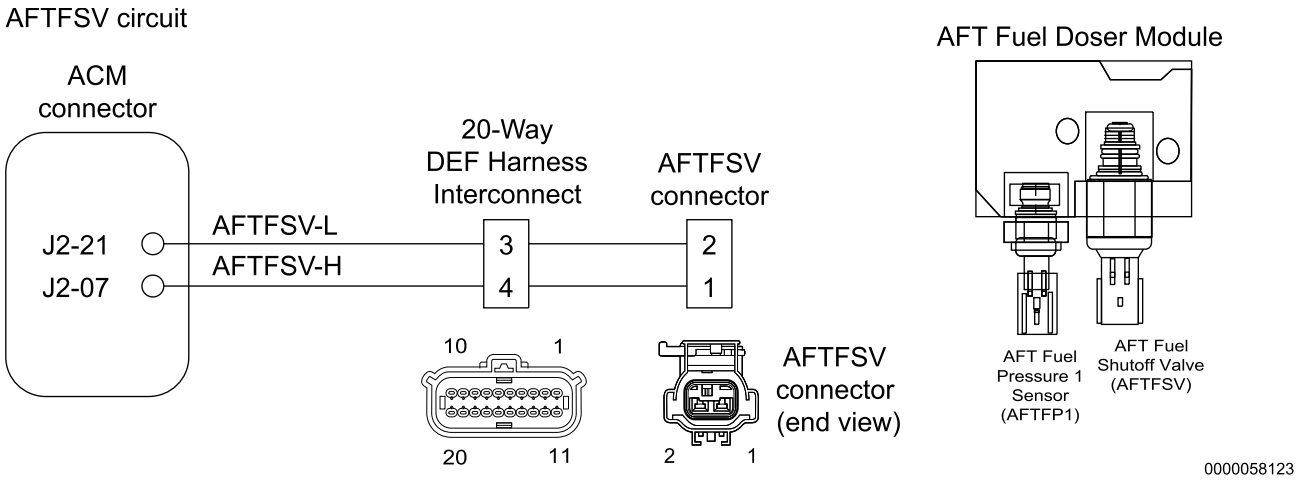


Figure 164 Aftertreatment Fuel Shutoff Valve Circuit Diagram

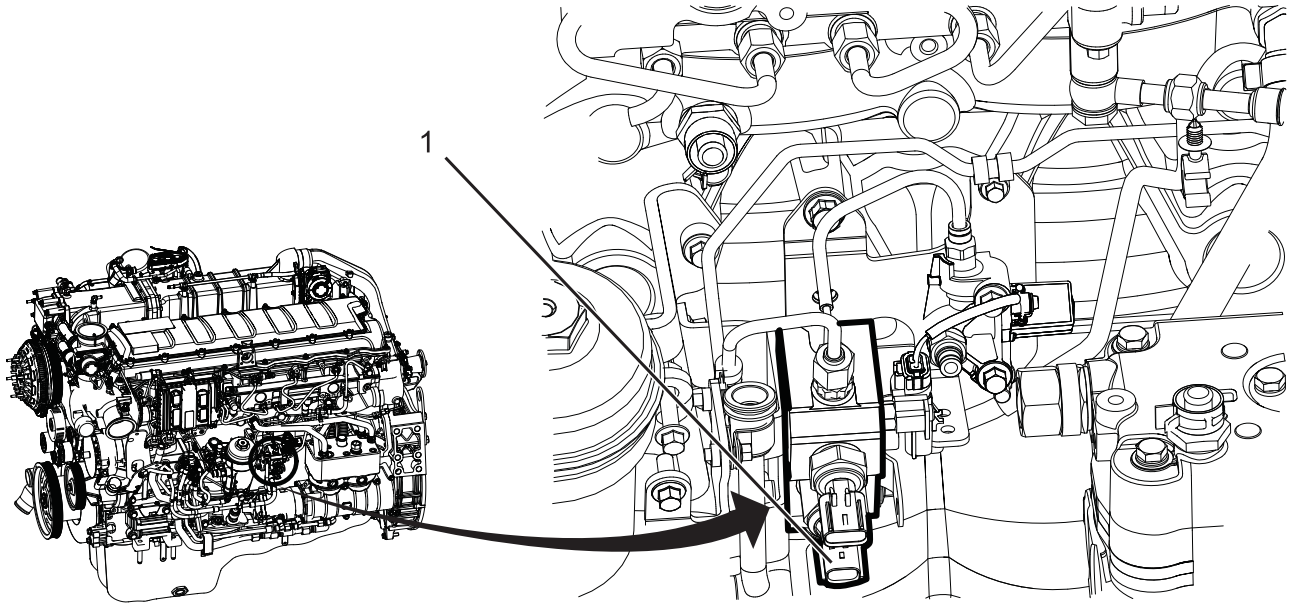
NOTE: See latest version of N13 Engine and Aftertreatment Wiring Schematic Form 0000002203 for additional circuit information.

Overview

The Aftertreatment Fuel Shutoff Valve (AFTFSV) is used during active and parked regeneration of the aftertreatment system and is commanded open by the Aftertreatment Control Module (ACM). Diesel fuel is supplied to the AFTFSV from the low-pressure fuel pump which supplies the AFT fuel doser module.

Tools Required

- 180-Pin Breakout Box 00-00956-08
- ACM Breakout Harness 18-100-01
- Breakout Harness ZTSE4760A
- Breakout Harness 18-050-01
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)



0000058136

Figure 165 Aftertreatment Shutoff Valve Location

1. Aftertreatment Fuel Shutoff Valve (AFTFSV)

3482 FMI 2 - AFT Fuel Shutoff Valve signal erratic, intermittent or incorrect

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Aftertreatment Fuel Pressure 1 (AFTFP1) has detected a leaking Aftertreatment Fuel Shutoff Valve (AFTFSV), leaking Aftertreatment Purge Air Valve (AFTPAV), or a stuck closed Aftertreatment Fuel Injector (AFTFI).	AFTFP1 pressure greater than 62 psi (425 kpa) when AFTFI is open AND the AFTPAV and AFTFSV are closed. OR (Pressure measured by the AFTFP1 with the AFTFI, AFTFSV and AFTPAV closed) - (pressure measured by AFTFP1 when the AFTFI is open AND the AFTPAV and AFTFSV are closed) > 58 psi (400 kPa).	Engine Running Engine run time > 180 sec Active regeneration Inactive: SPN 168 FMI 18 (ACM PWR); SPN 3242 FMI 2, 3, 4 (DPFIT); SPN 3246 FMI 2, 3, 4 (DPFOT); SPN 3480 FMI 2, 3, 4, 17 (AFTFP1); SPN 3482 FMI 2, 3, 4, 7 (AFTFSV); SPN 3490 FMI 3, 4 (AFTPAV); SPN 3556 FMI 2, 5 (AFTFI); SPN 3936 FMI 7, 15 (DPF System); SPN 4363 FMI 0 (SCROT); SPN 4765 FMI 2, 3, 4 (DOCIT); SPN 4795 FMI 31 (DPFDP); SPN 4796 FMI 31 (DOC); SPN 5742 FMI 3, 4, 11, 12 (DOC/DPF Temp Sensor Module).	67 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects an internally leaking Aftertreatment Fuel Shutoff Valve (AFTFSV), Aftertreatment Purge Air Valve (AFTPAV), or a stuck closed Aftertreatment Fuel Injector (AFTFI). The AFTFI is commanded On at the start of the test. This will purge pressure in the fuel supply line. A pressure sample is then taken by the AFTFP1. An AFTFI restricted, stuck closed or missing the lower poppet, a leaking AFTFSV, or a leaking AFTPAV is detected if this pressure sample is above expected ambient pressure.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 3480 FMI 2, 3, and 4 (AFTFP1); SPN 3482 FMI 3 and 4 (AFTFSV); SPN 3556 FMI 2 and 5 (AFTFI).

Drive Cycle to Determine Fault Status

Drive Cycle 1 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Failed AFTFP1
- Failed AFTFSV
- Failed AFTPAV
- AFTFI missing lower poppet
- AFTFI failed or restricted

- Restricted fuel line to AFTFI

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3480 FMI 2, 3, and 4 (AFTFP1); SPN 3482 FMI 3 and 4 (AFTFSV); and SPN 3556 FMI 2 and 5 (AFTFI). Is EST DTC list free of SPN 3480 FMI 2, 3, and 4; SPN 3482 FMI 3 and 4; and SPN 3556 FMI 2 and 5?	Yes: Go to step 2. No: Repair SPN 3480 FMI 2, 3, and 4; and SPN 3482 FMI 3 and 4; SPN 3556 FMI 2 and 5. After repairs are complete, retest for SPN 3482 FMI 2.

Step	Action	Decision
2	Check for restricted or damaged fuel line between AFT fuel doser module and Aftertreatment Fuel Injector (AFTFI). Is the fuel line unrestricted and in good condition?	Yes: Go to step 3. No: Repair or replace fuel line. After repairs are complete, retest for SPN 3482 FMI 2.

Step	Action	Decision
3	Check for leaking or stuck open Aftertreatment Fuel Shutoff Valve (AFTFSV). Perform AFT Fuel Shutoff Valve Leak Test (page 121). Was 5 ml or less of fuel dispensed?	Yes: Go to step 4. No: Replace AFTFSV. After repairs are complete, retest for SPN 3482 FMI 2.

Step	Action	Decision
4	Remove the Aftertreatment Fuel Injector (AFTFI) see *Engine Service Manual*. Inspect the AFTFI lower poppet. Is the AFTFI missing the lower poppet?	Yes: Replace AFTFI. After repairs are complete, retest for SPN 3842 FMI 2. No: Go to step 5.

Step	Action	Decision
5	Check for leaking or stuck open AFTFI. Perform AFT Fuel Injector Leak Test (page 120). Was 5 ml or less of fuel dispensed?	Yes: Go to step 6. No: Replace AFTFI. After repairs are complete, retest for SPN 3482 FMI 2.

Step	Action	Decision
6	Check for failed AFT fuel flow. Perform AFT Dosing System Test (page 118). Was 225 to 500 ml of fuel dispensed within 2.5 minutes?	Yes: Go to step 7
		No: Replace AFTFI. Refer to Fault Facts. After repairs are complete, retest for SPN 3482 FMI 2.

Step	Action	Decision
7	Check for a leaking or stuck open Aftertreatment Purge Air Valve (AFTPAV). Using EST, command AFTFI ON and check for air flow from AFTFI tip. Is the AFTFI Free of air flow?	Yes: Replace AFTFP1 sensor. After repairs are complete, retest for SPN 3482 FMI 2.
		No: Replace AFTPAV. After repairs are complete, retest for SPN 3482 FMI 2.

NOTE: After performing all diagnostic steps, if SPN 3482 FMI 2 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

3482 FMI 3 - AFT Fuel Shutoff Valve short to PWR (Open or High Resistance)

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Aftertreatment Fuel Shutoff Valve (AFTFSV) circuit voltage above normal, shorted to high source, or open or high resistance. High signal voltage detected at the AFTFSV.	The resistance between AFTFSV-H circuit and AFTFSV-L circuit > 500,000 ohms	Key ON	1 second

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the voltage signal from the Aftertreatment Fuel Shutoff Valve (AFTFSV) is high. Active regeneration of the aftertreatment system is disabled. Engine torque will be reduced if fault is active for an extended period of time.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 1 in 2013 HD-OBD Diagnostic Reference Manual.

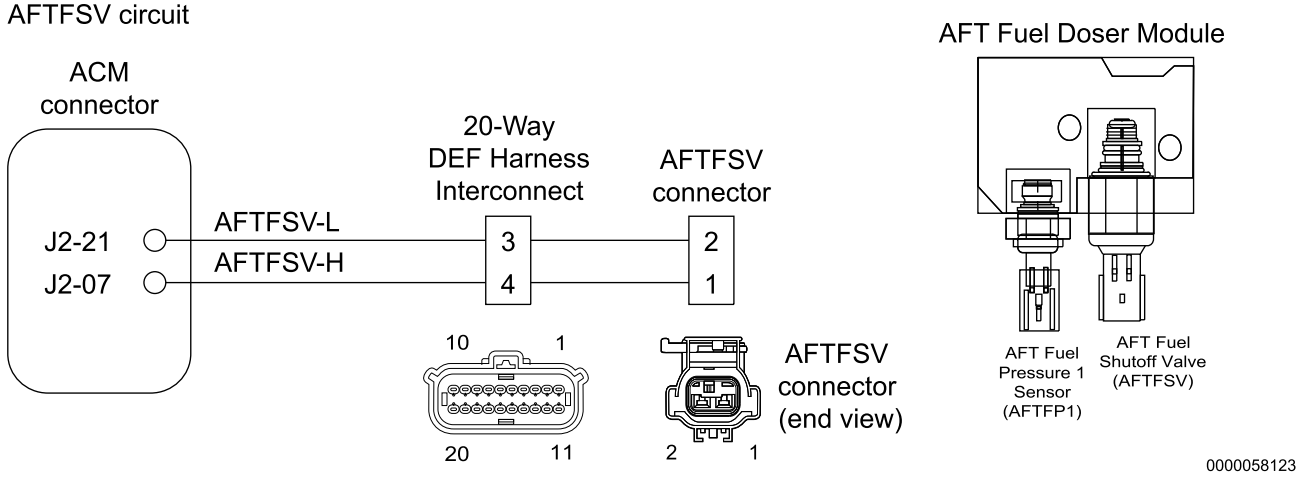


Figure 166 Aftertreatment Fuel Shutoff Valve Circuit Diagram

Possible Causes

- AFTFSV-H circuit short to PWR
- AFTFSV-H circuit Open or high resistance
- AFTFSV-L circuit Open or high resistance
- Failed Aftertreatment Fuel Shutoff Valve (AFTFSV)

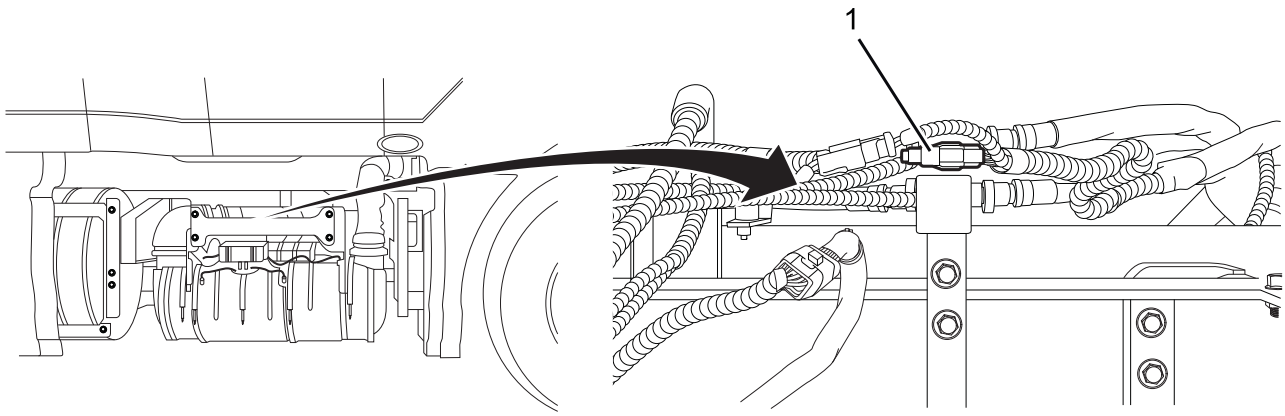


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Figure 167 20-Way DEF Harness Interconnect Location (Typical)

1. 20-Way DEF Harness Interconnect

Step	Action	Decision
1	Inspect connections at 20-Way DEF harness interconnect. Key OFF, disconnect 20-Way DEF harness interconnect. Check 20-Way DEF harness interconnect and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the 20-Way DEF harness interconnect connector, harness, and terminals clean and undamaged?	Yes: Go to step 2. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3482 FMI 3.

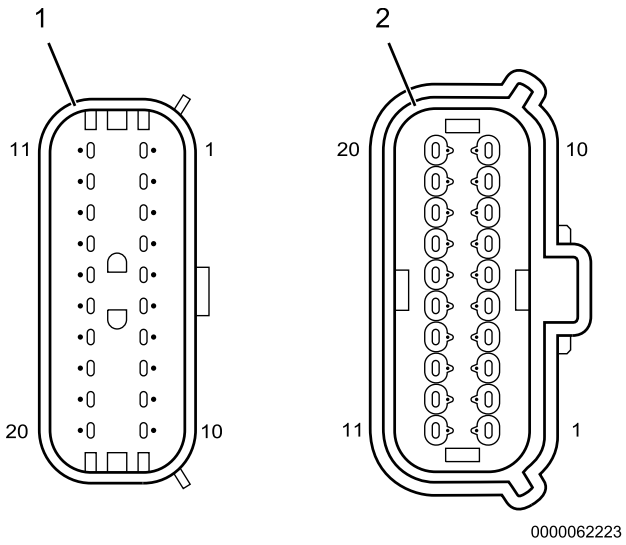

Figure 168 20-Way DEF Harness Connector End View

1. 20-Way DEF harness male side connector
2. 20-Way DEF harness female side connector

Step	Action	Decision
2	Check Aftertreatment Fuel Shutoff Valve (AFTFSV-H) circuit for short to PWR. Connect Breakout Harness 18-050-01 to the female side of the 20-Way DEF harness interconnect and leave 20-Way disconnected. Key OFF, use a DMM to measure voltage between Breakout Harness pin-4 and a known good ground. Is voltage less than 0.5 Volts?	Yes: Go to step 3. No: Repair short to PWR between 20-way DEF harness interconnect and AFTFSV. After repairs are complete, retest for SPN 3482 FMI 3.

Step	Action	Decision
3	Check Aftertreatment Fuel Shutoff Valve (AFTFSV) circuit for Open or high resistance. Connect Breakout Harness 18-050-01 to the female side of the 20-Way DEF harness interconnect and leave 20-Way disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness pin-3 and pin-4. Is resistance less than 20 ohms?	Yes: Go to step 7. No: Go to step 4.

Step	Action	Decision
4	Inspect connections at AFTFSV. Key OFF, disconnect AFTFSV. Check AFTFSV and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the AFTFSV connector, harness, and terminals clean and undamaged?	Yes: Go to step 5. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3482 FMI 3.

Step	Action	Decision
5	Check AFTFSV-H circuit for Open or high resistance between the 20-way DEF harness interconnect and the AFTFSV. Connect Breakout Harness ZTSE4760A to AFTFSV connector and leave AFTFSV disconnected. Connect Breakout Harness 18-050-01 to 20-way DEF harness interconnect and leave disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness ZTSE4760A pin-1 and Breakout Harness 18-050-01 pin-4. Is resistance less than 5 ohms?	Yes: Go to step 6. No: Repair Open or high resistance between 20-Way DEF harness interconnect pin-4 and AFTFSV pin-1. After repairs are complete, retest for SPN 3482 FMI 3.

Step	Action	Decision
6	Check AFTFSV-L circuit for Open or high resistance between the 20-way DEF harness interconnect and the AFTFSV. Connect Breakout Harness ZTSE4760A to AFTFSV connector and leave AFTFSV disconnected. Connect Breakout Harness 18-050-01 to 20-way DEF harness interconnect and leave disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness ZTSE4760A pin-2 and Breakout Harness 18-050-01 pin-3. Is resistance less than 5 ohms?	Yes: Replace AFTFSV. After repairs are complete, retest for SPN 3482 FMI 3 No: Repair Open or high resistance between 20-Way DEF harness interconnect pin-3 and AFTFSV pin-2. After repairs are complete, retest for SPN 3482 FMI 3.

Step	Action	Decision
7	Check Aftertreatment Fuel Shutoff Valve (AFTFSV-H) circuit for short to PWR. Connect Breakout Harness 18-050-01 to the male side of the 20-Way DEF harness interconnect and leave 20-Way DEF harness interconnect disconnected. Key ON with ACM disconnected, use a DMM to measure voltage between Breakout Harness 18-050-01 pin-4 and a known good ground. Is voltage less than 0.5 Volts?	Yes: Go to step 8. No: Repair short to PWR between 20-way connector pin-4 and ACM DEF harness interconnect J2-07. After repairs are complete, retest for SPN 3482 FMI 3.

Step	Action	Decision
8	Check AFTFSV-H circuit for Open or high resistance between the 20-Way DEF harness interconnect and the ACM. Key OFF, use a DMM to measure resistance between Breakout Harness 18-050-01 pin-4 and 180-pin Breakout Box pin J2-07. Is resistance less than 5 ohms?	Yes: Repair Open or high resistance between 20-Way DEF harness interconnect pin-3 and ACM DEF harness interconnect J2-21. After repairs are complete, retest for SPN 3482 FMI 3.
		No: Repair Open or high resistance between 20-Way DEF harness interconnect pin-4 and ACM DEF harness interconnect J2-07. After repairs are complete, retest for SPN 3482 FMI 3.

NOTE: After performing all diagnostic steps, if SPN 3482 FMI 3 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

3482 FMI 4- AFT Fuel Shutoff Valve short to GND

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Aftertreatment Fuel Shutoff Valve (AFTFSV) driver control line is shorted to ground.	The resistance between the AFTFSV driver line and ground < 0.2 Ohms	Key ON The AFTFSV is commanded ON	1 second

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects a short to ground in the Aftertreatment Fuel Shutoff Valve (AFTFSV) circuit. Active regeneration of the Diesel Particulate Filter (DPF) is disabled until the next key cycle, and engine torque will be reduced if fault is active for an extended period of time.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

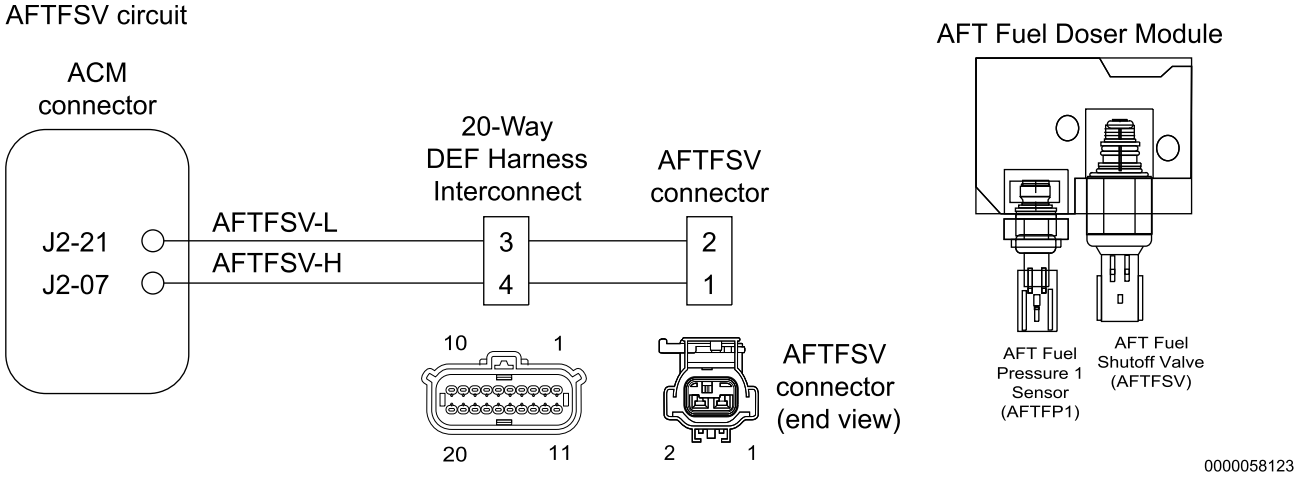

Figure 169 Aftertreatment Fuel Shutoff Valve Circuit Diagram

Possible Causes

- AFTFSV-H short to GND
- AFTFSV-H shorted to AFTFSV-L
- Failed Aftertreatment Fuel Shutoff Valve (AFTFSV)

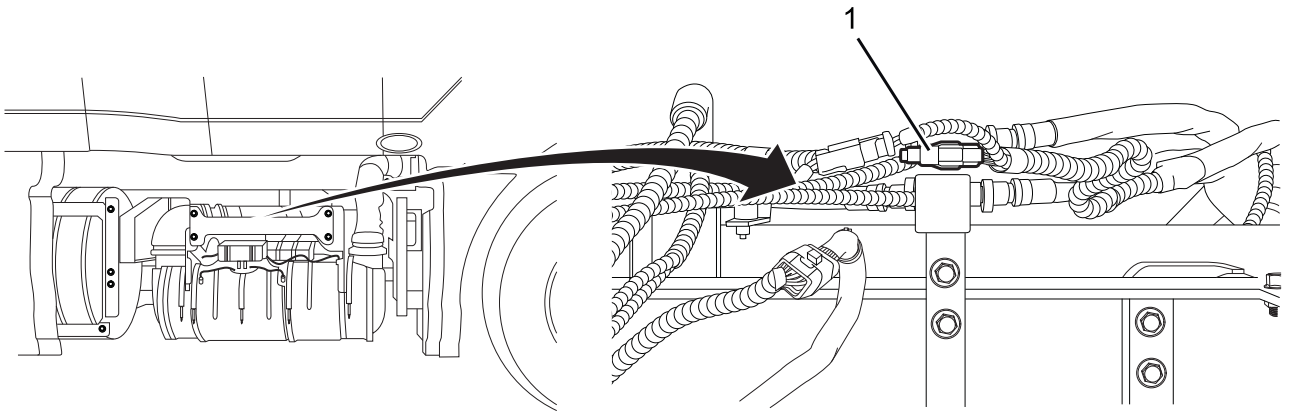

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Figure 170 20-Way DEF Harness Interconnect Location (Typical)

1. 20-Way DEF Harness Interconnect

Step	Action	Decision
1	Inspect connections at 20-Way DEF harness interconnect. Key OFF, disconnect 20-Way DEF harness interconnect. Check 20-Way DEF harness interconnect and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the 20-Way DEF harness interconnect connector, harness, and terminals clean and undamaged?	Yes: Go to step 2. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3482 FMI 4.

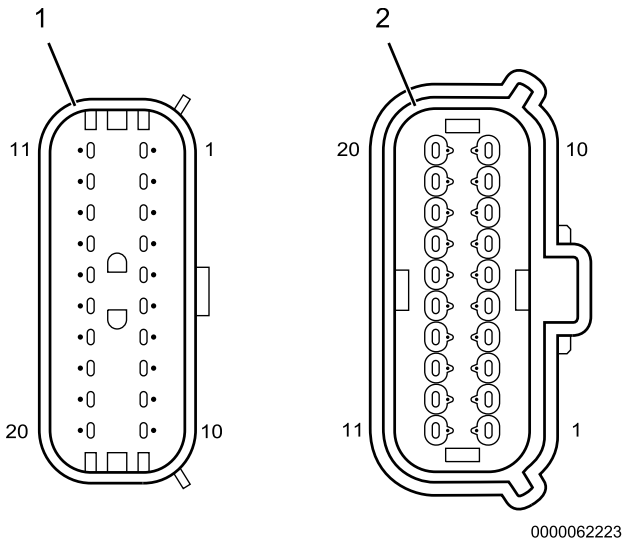

Figure 171 20-Way DEF Harness Connector End View

1. 20-Way DEF harness male side connector
2. 20-Way DEF harness female side connector

Step	Action	Decision
2	Check AFTFSV-H circuit for short to ground on male side of 20-Way DEF harness interconnect. Connect Breakout Harness 18-050-01 to the male side of the 20-Way DEF harness interconnect and leave 20-Way DEF harness interconnect disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness 18-050-01 pin-4 and a known good ground. Is resistance greater than 1000 ohms?	Yes: Go to step 3. No: Repair short to ground between 20-Way DEF harness interconnect pin-4 and ACM connector J2-07. After repairs are complete, retest for SPN 3482 FMI 4.

Step	Action	Decision
3	Determine if AFTFSV-H circuit is shorted to AFTFSV-L circuit between 20-Way DEF harness interconnect and Aftertreatment Control Module (ACM). Connect 180-Pin Breakout Box and ACM Breakout Harness 18-100-01 to ACM harness and leave ACM disconnected. Key OFF, with 20-Way DEF harness interconnect disconnected, measure resistance between Breakout Box pin J2-07 and pin J2-21. Is resistance greater than 1000 ohms?	Yes: Go to step 4. No: Repair short between AFTFSV-H circuit and AFTFSV-L circuit. After repairs are complete, retest for SPN 3482 FMI 4.

Step	Action	Decision
4	Inspect connections at Aftertreatment Fuel Shutoff Valve (AFTFSV). Key OFF, disconnect AFTFSV. Check AFTFSV and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the AFTFSV connector, harness, and terminals clean and undamaged?	Yes: Go to step 5. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3482 FMI 4.

Step	Action	Decision
5	Check AFTFSV-H circuit for short to ground between 20-Way DEF harness interconnect and AFTFSV. Connect Breakout Harness ZTSE4760A to AFTFSV and leave AFTFSV disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness ZTSE4760A pin-1 and a known good ground. Is resistance greater than 1000 ohms?	Yes: Go to step 6. No: Repair short to ground between AFTFSV connector pin-1 and 20-Way DEF harness interconnect pin-4. After repairs are complete, retest for SPN 3482 FMI 4.

Step	Action	Decision
6	Determine if AFTFSV-H circuit is shorted to AFTFSV-L circuit between 20-Way DEF harness interconnect and AFTFSV. Connect Breakout Harness ZTSE4760A to AFTFSV connector and leave AFTFSV disconnected. Key OFF, with 20-Way DEF harness interconnect disconnected, use a DMM to measure resistance between Breakout Harness ZTSE4760A pin-1 and pin-2. Is resistance greater than 1000 ohms?	Yes: Replace AFTFSV. After repairs are complete, retest for SPN 3482 FMI 4. No: Repair short between AFTFSV-H circuit and AFTFSV-L circuit, between 20-Way DEF harness interconnect and AFTFSV. After repairs are complete, retest for SPN 3482 FMI 4.

NOTE: After performing all diagnostic steps, if SPN 3482 FMI 4 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

3482 FMI 7- AFT Fuel Shutoff Valve Mechanical system not responding or out of adjustment

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Aftertreatment Fuel Pressure 1 (AFTFP1) pressure is too low when the Aftertreatment Fuel Shutoff Valve (AFTFSV) is commanded open.	(Pressure measured by AFTFP1 with the AFTFSV commanded open) - (ambient pressure reading taken when the Aftertreatment Fuel Injector (AFTFI) open AND the AFTPAV and AFTFSV are closed) < 65 psi (450 kPa) Pressure measured by the AFTFP1 sensor with the AFTFSV command open < 80 psi (550 kPa)	Engine Running Engine run time > 180 sec Diagnostic runs prior to regeneration of the Diesel Particulate Filter (DPF) Inactive: SPN 168 FMI 18 (ACM PWR); SPN 3242 FMI 2, 3, 4 (DPFIT); SPN 3246 FMI 2, 3, 4 (DPFOT); SPN 3251 FMI 0 (DPFDP); SPN 3480 FMI 2, 3, 4, 17 (AFTFP1); SPN 3482 FMI 2, 3, 4, 7 (AFTFSV); SPN 3490 FMI 3, 4 (AFTPAV); SPN 3556 FMI 2, 5 (AFTFI); SPN 3936 FMI 7, 15 (DPF System); SPN 4363 FMI 0 (SCROT); SPN 4765 FMI 2, 3, 4 (DOCIT); SPN 4795 FMI 31 (DPFDP); SPN 4796 FMI 31 (DOC); SPN 5742 FMI 3, 4, 11, 12 (DOC/DPF Temp Sensor Module).	67 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Aftertreatment Fuel Pressure 1 sensor (AFTFP1) is reading lower than expected when the Aftertreatment Fuel Shutoff Valve (AFTFSV) is commanded open. This test closes the Aftertreatment Purge Air Valve (AFTPAV) and the AFTFI and then opens the AFTFSV. A pressure sample will be taken by AFTFP1, which is expected to be the fuel supply pressure. A stuck closed AFTFSV is detected if this pressure is not above a minimum threshold OR is too close to the ambient pressure reading.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 3480 FMI 2, 3, and 4(AFTFP1); SPN 3482 FMI 3 and 4 (AFTFSV); SPN 3556 FMI 2 and 5 (AFTFI).

Drive Cycle to Determine Fault Status

Drive Cycle 1 in 2013 HD-OBD Diagnostic Reference Manual.

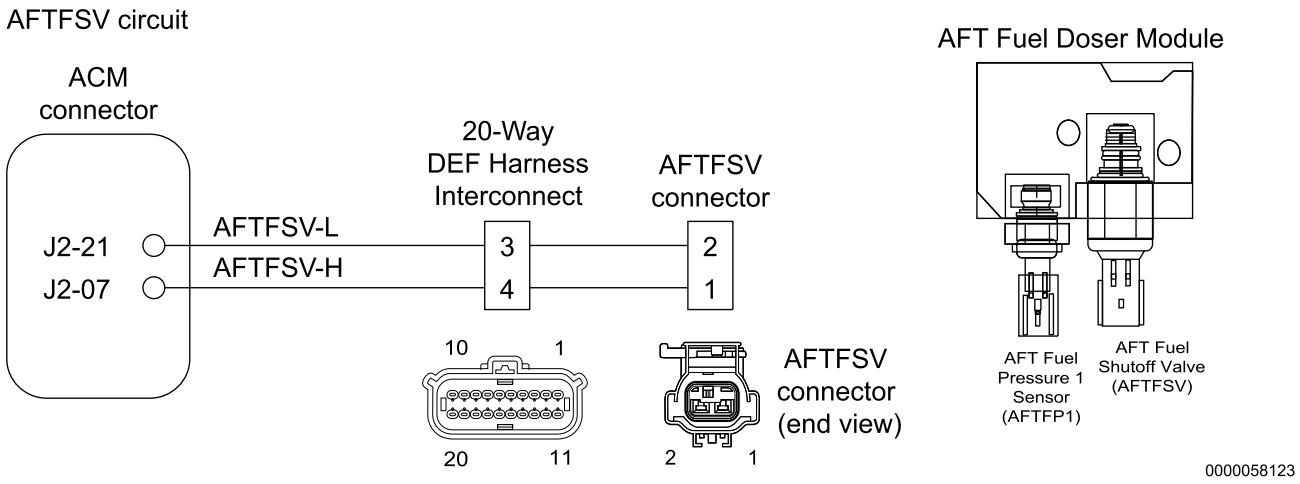

Figure 172 Aftertreatment Fuel Shutoff Valve Circuit Diagram

Possible Causes

- Leaking fuel supply line to the AFT fuel doser module
- Restricted fuel filter
- Failed low-pressure fuel pump
- Restricted Aftertreatment Fuel Shutoff Valve (AFTFSV)
- Failed AFT Fuel Pressure 1 (AFTFP1)

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3480 FMI 2, 3, and 4 (AFTFP1); SPN 3482 FMI 3 and 4 (AFTFSV); and SPN 3556 FMI 2 and 5 (AFTFI). Is EST DTC list free of SPN 3480 FMI 2, 3, and 4; SPN 3482 FMI 3 and 4; and SPN 3556 FMI 2 and 5?	Yes: Go to step 2. No: Repair SPN 3480 FMI 2, 3, and 4; SPN 3482 FMI 3 and 4; and SPN 3556 FMI 2 and 5. After repairs are complete, retest for SPN 3482 FMI 7.

NOTE: If engine performance symptoms are present, see Engine Symptoms Diagnostics .

Step	Action	Decision
2	Check for missing, leaking, or damaged fuel supply line to AFTFSV. Key-On Engine-Running (KOER), inspect fuel supply line to AFTFSV for restrictions and leaks. Is the fuel supply line to the AFTFSV present and in good condition?	Yes: Go to step 3. No: Repair or replace fuel supply to AFTFSV. After repairs are complete, retest for SPN 3482 FMI 7.

Step	Action	Decision
3	Check Fuel Delivery Pressure (FDP). Using EST with ServiceMaxx™ software, Key-On Engine-Running (KOER), monitor FDP. Is FDP 85-120 psi	Yes: Go to step 4.
		No: Repair low-pressure fuel system. After repairs are complete, retest for SPN 3482 FMI 7.

Step	Action	Decision
4	Check for failed AFT fuel flow. Perform AFT Dosing System Test (page 118). Was 225 to 500 ml of fuel dispensed within 2.5 minutes?	Yes: Replace AFTFP1 sensor. After repairs are complete, retest for SPN 3482 FMI 7.
		No: Replace AFTFSV. After repairs are complete, retest for SPN 3482 FMI 7.

NOTE: After performing all diagnostic steps, if SPN 3482 FMI 7 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

3482 FMI 16- AFT Fuel Shutoff Valve Plugged

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Aftertreatment Fuel Shutoff Valve (AFTFSV) mechanically stuck closed.	(Pressure measured by AFTFP1 with the AFTFSV commanded open) - (ambient pressure reading taken when AFTFI is open AND the AFTPAV and AFTFSV are closed) < 65 psi (450 kPa)(gauge) Pressure measured by the AFTFP1 with the AFTFSV command open < 80 psi (550 kPa)(gauge)	Engine Running Engine run time > 180 sec Diagnostic runs during active regeneration of the diesel particulate filter.	67 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects that the aftertreatment fuel pressure sensor (AFTFP1) is not reading a pressure increase when the aftertreatment fuel shutoff valve (AFTFSV) is commanded open.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 94 (FDP); SPN 3480 FMI 2, 3, and 4 (AFTFP1); and SPN 3482 FMI 3 and 4 (AFTFSV).

Drive Cycle to Determine Fault Status

Drive Cycle 1 in 2013 HD-OBD Diagnostic Reference Manual.

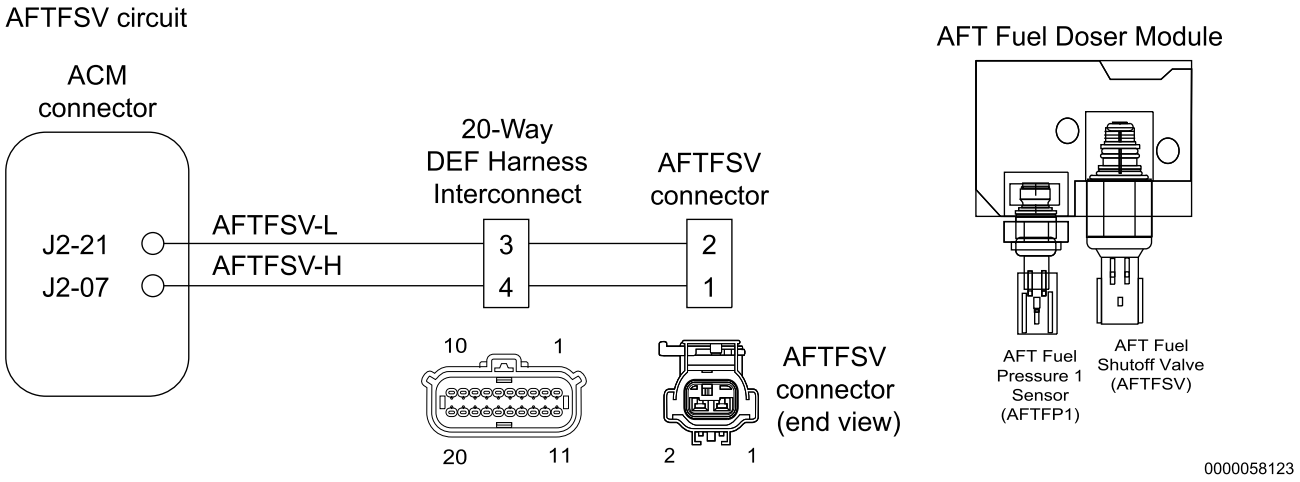

Figure 173 Aftertreatment Fuel Shutoff Valve Circuit Diagram

Possible Causes

- Missing, damaged, or leaking fuel supply hose to the AFT Fuel Doser Module
- Restricted or stuck closed Aftertreatment Fuel Shutoff Valve (AFTFSV)
- Failed AFT Fuel Pressure 1 (AFTFP1)

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 94 (FDP); SPN 3480 FMI 2, 3, and 4 (AFTFP1); and SPN 3482 FMI 3 and 4 (AFTFSV). Is EST DTC list free of SPN 94; SPN 3480 FMI 2, 3, and 4; and SPN 3482 FMI 3 and 4?	Yes: Go to step 2. No: Repair SPN 94; SPN 3480 FMI 2, 3, and 4; and SPN 3482 FMI 3 and 4. After repairs are complete, retest for SPN 3482 FMI 16.

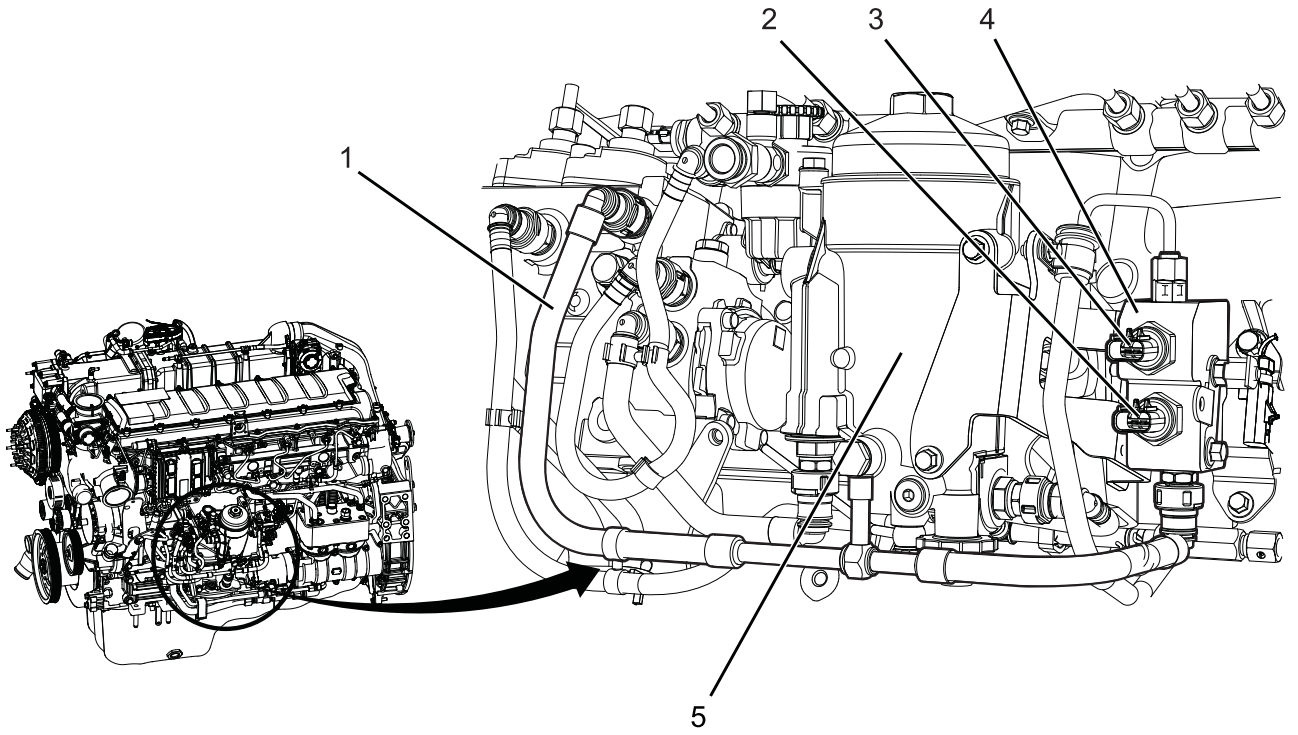

Figure 174 AFTFP1 Location.

1. AFT Fuel Doser Module fuel supply line
2. AFT Fuel Shutoff Valve (AFTFSV)
3. AFT Fuel Pressure 1 (AFTFP1)
4. AFT Fuel Doser Module

Step	Action	Decision
2	Check after-filter fuel supply hose from the secondary fuel filter assembly to the AFT fuel doser module for damage, restrictions, or leaks. Is fuel supply hose in good condition, not restricted, or damaged?	Yes: Replace AFTFSV. After repairs are complete, retest for SPN 3482 FMI 16. No: Repair fuel supply to AFTFSV. After repairs are complete, retest for SPN 3482 FMI 16.

NOTE: After performing all diagnostic steps, if SPN 3482 FMI 16 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

AFTPAV (Aftertreatment Purge Air Valve)

SPN	FMI	Condition	Possible Causes	Actions
3490	3	AFTPAV short to PWR (Open or high resistance)	• AFTPAV-1 circuit short to PWR • AFTPAV-1 circuit Open or high resistance • AFTPAV-2 circuit Open or high resistance • Failed Aftertreatment Purge Air Valve (AFTPAV)	Step-Based Diagnostics (page 419)
3490	4	AFTPAV short to GND	• AFTPAV-1 shorted to AFTPAV-2 • AFTPAV-1 short to GND • Failed Aftertreatment Purge Air Valve (AFTPAV)	Step-Based Diagnostics (page 423)
3490	7	AFTPAV Mechanical system not responding	• Missing or leaking air supply line to AFTPAV • Missing or leaking air supply line to AFT Fuel Doser module • Failed AFTPAV (stuck closed)	Step-Based Diagnostics (page 427)

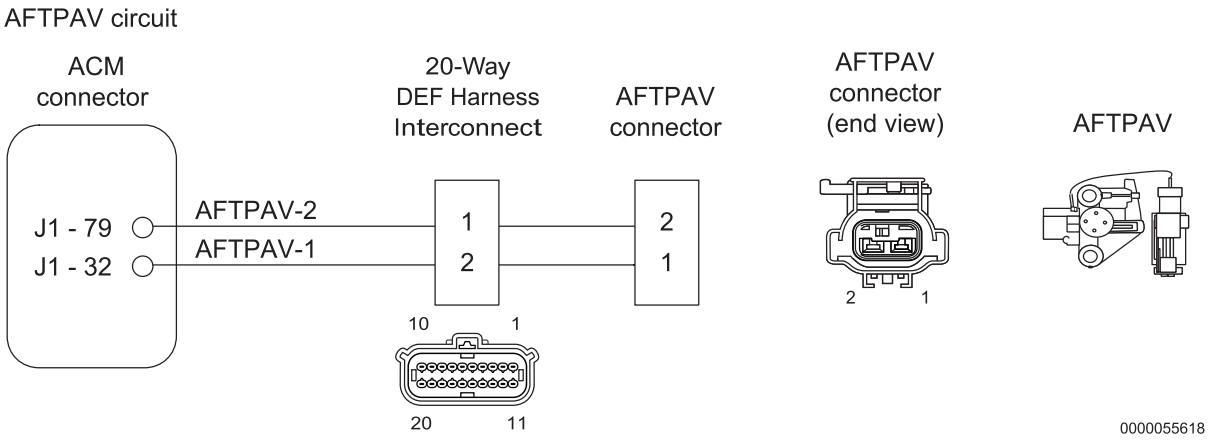

Figure 175 AFTPAV Circuit Diagram

Overview

The Aftertreatment Purge Air Valve (AFTPAV) is used to purge the Aftertreatment Fuel Injector (AFTFI) of fuel after active regeneration of the Aftertreatment system, and at Key Off. When purging is needed, the Aftertreatment Control Module (ACM) commands the AFTPAV ON, and AFTFI open. The ACM does this by sending battery voltage through the AFTPAV-1 circuit to open the AFTPAV. This allows pressurized air to flow from the vehicle air tanks, to the AFTPAV, through the AFT Fuel Doser module, and out the AFTFI.

Tools Required

- 00-00956-08 – 180-Pin Breakout Box
- SCR (ACM) Breakout Harness 18-100-01 (96-Pin)
- Breakout Harness ZTSE4760A
- Breakout Harness 18-050-01
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

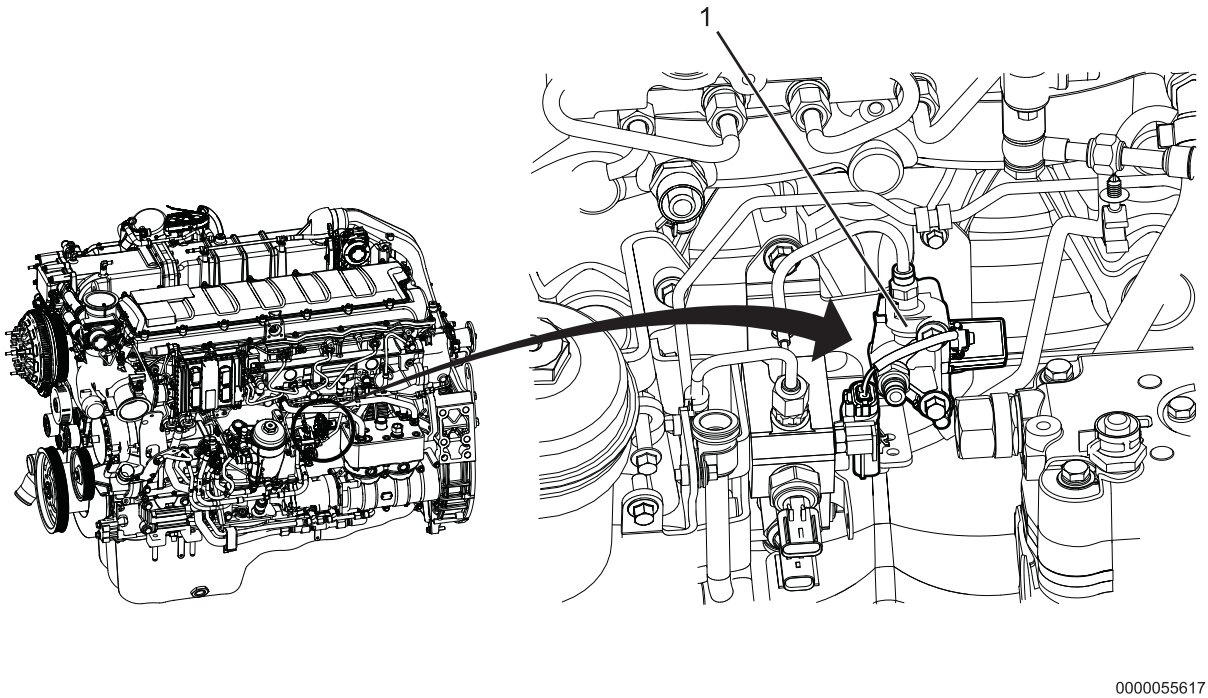

Figure 176 AFTPAV Location

1. Aftertreatment Purge Air Valve (AFTPAV)

SPN 3490 FMI 3 - AFTPAV short to PWR (Open or High Resistance)

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Aftertreatment Purge Air Valve (AFTPAV) circuit voltage above normal, shorted to high source, Open or High resistance. High signal voltage detected at the AFTPAV	The resistance between AFTPAV-1 circuit and ground > 500,000 ohms	Key ON	1 second

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the voltage signal from the Aftertreatment Purge Air Valve (AFTPAV) is high. Active regeneration of the Aftertreatment system is disabled. Engine torque will be reduced if fault is active for an extended period of time.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 1 in 2013 HD-OBD Diagnostic Reference Manual.

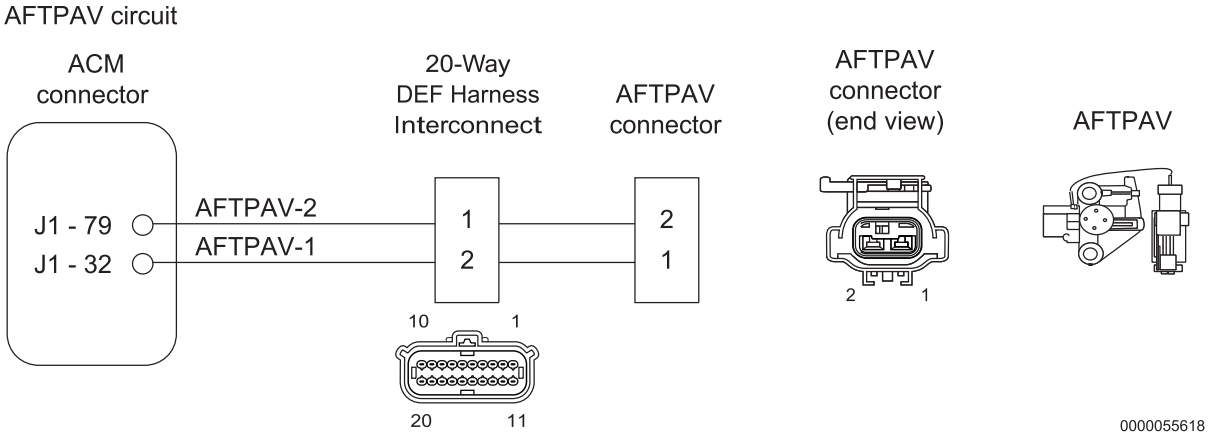

Figure 177 AFTPAV Circuit Diagram

Possible Causes

- AFTPAV-1 circuit short to PWR
- AFTPAV-1 circuit Open or high resistance
- AFTPAV-2 circuit Open or high resistance
- Failed Aftertreatment Purge Air Valve (AFTPAV)

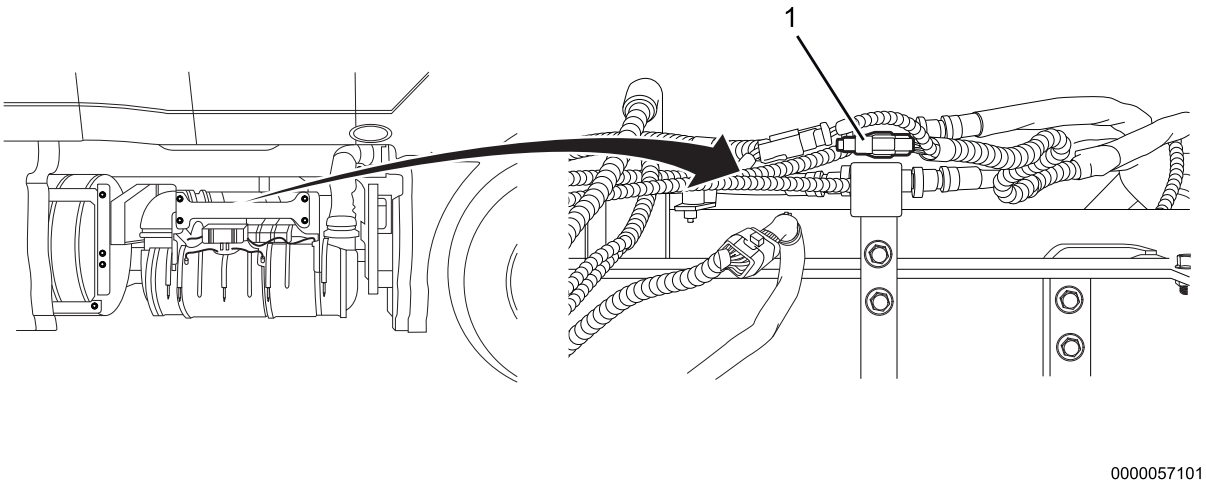

Figure 178 20-Way DEF Harness Interconnect Location (Typical)

1. 20-Way DEF harness interconnect

Step	Action	Decision
1	Inspect connections at 20-Way DEF harness interconnect. Key OFF, disconnect 20-Way DEF harness interconnect. Check 20-Way DEF harness interconnect and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the 20-Way DEF harness interconnect connector, harness, and terminals clean and undamaged?	Yes: Go to step 2. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3490 FMI 3.

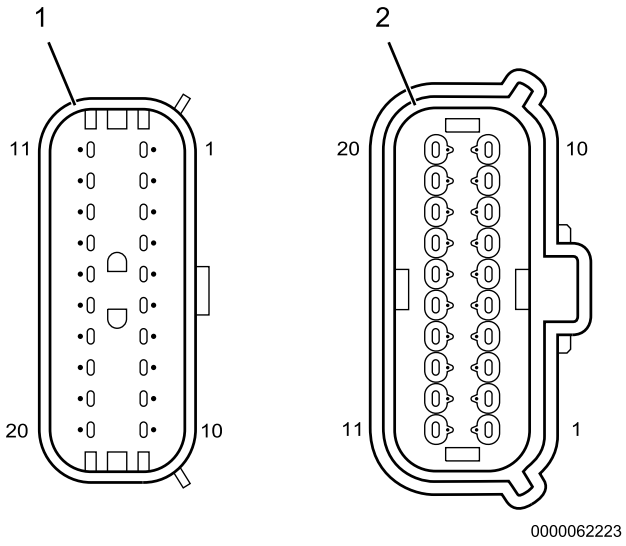

Figure 179 20-Way DEF Harness Connector End View

1. 20-Way DEF harness male side connector
2. 20-Way DEF harness female side connector

Step	Action	Decision
2	Check AFTPAV circuit for Open or high resistance between the 20-Way DEF harness interconnect and AFTPAV. Connect Breakout Harness 18-050-01 to the female side of the 20-Way DEF harness interconnect and leave male side disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness pin-1 and pin-2. Is resistance less than 20 ohms (normal operation)?	Yes: Go to step 6. No: Go to step 3.

Step	Action	Decision
3	Inspect connections at Aftertreatment Purge Air Valve (AFTPAV). Key OFF, disconnect AFTPAV. Check AFTPAV and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the AFTPAV connector, harness, and terminals clean and undamaged?	Yes: Go to step 4. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3490 FMI 3.

Step	Action	Decision
4	Check AFTPAV-1 circuit for Open or high resistance between the 20-way DEF harness interconnect and the AFTPAV. Connect Breakout Harness ZTSE4760A to AFTPAV vehicle harness connector and leave AFTPAV disconnected. Connect Breakout Harness 18-050-01 to the female side of the 20-way DEF harness interconnect and leave male side disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness ZTSE4760A pin-1 and Breakout Harness 18-050-01 pin-2. Is resistance less than 5 ohms?	Yes: Go to step 5. No: Repair Open or high resistance between 20-Way DEF harness interconnect pin-2 and AFTPAV pin-1. After repairs are complete, retest for SPN 3490 FMI 3.

Step	Action	Decision
5	Check AFTPAV-2 circuit for Open or high resistance between the 20-way DEF harness interconnect and the AFTPAV. Connect Breakout Harness ZTSE4760A to AFTPAV vehicle harness connector and leave AFTPAV disconnected. Connect Breakout Harness 18-050-01 to the female side of the 20-way DEF harness interconnect and leave male side disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness ZTSE4760A pin-2 and Breakout Harness 18-050-01 pin-1. Is resistance less than 5 ohms?	Yes: Replace AFTPAV. After repairs are complete, retest for SPN 3490 FMI 3. No: Repair Open or high resistance between 20-Way DEF harness interconnect pin-1 and AFTPAV pin-2. After repairs are complete, retest for SPN 3490 FMI 3.

Step	Action	Decision
6	Check AFTPAV-1 circuit for Open or high resistance between the 20-Way DEF harness interconnect and the ACM. Connect Breakout Harness 18-050-01 to the male side of the 20-Way DEF harness interconnect and leave female side disconnected. Connect 180-Pin Breakout Box with SCR (ACM) Breakout Harness 18-100-01 (96-Pin) to Aftertreatment Control Module (ACM) vehicle harness and leave ACM disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness 18-050-01 pin-2 and Breakout Box pin J1-32. Is resistance less than 5 ohms?	Yes: Go to step 7. No: Repair Open or high resistance between 20-Way DEF harness interconnect pin-2 and ACM connector J1-32. After repairs are complete, retest for SPN 3490 FMI 3.

Step	Action	Decision
7	Check AFTPAV-2 circuit for Open or high resistance between the 20-Way DEF harness interconnect and the ACM. Connect Breakout Harness 18-050-01 to the male side of the 20-Way DEF harness interconnect and leave female side disconnected. Connect 180-Pin Breakout Box with SCR (ACM) Breakout Harness 18-100-01 (96-Pin) to ACM vehicle harness and leave ACM disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness 18-050-01 pin-1 and Breakout Box pin J1-79. Is resistance less than 5 ohms?	Yes: Repair short to power between AFTPAV pin-1 and Aftertreatment Control Module (ACM) connector J1-32. After repairs are complete, retest for SPN 3490 FMI 3. No: Repair Open or high resistance between 20-Way DEF harness interconnect pin-1 and ACM connector J1-79. After repairs are complete, retest for SPN 3490 FMI 3.

NOTE: After doing all diagnostic steps, if SPN 3490 FMI 3 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3490 FMI 4 - AFTPAV short to GND

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Aftertreatment Purge Air Valve (AFTPAV) driver control line is shorted to ground.	The resistance between the AFTPAV driver line and ground < 0.2 Ohms	Key ON AFTPAV commanded OFF	1 second

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects a short to ground in the Aftertreatment Purge Air Valve (AFTPAV) circuit. Active regeneration of the Diesel Particulate Filter (DPF) is disabled until the next key cycle, and engine torque will be reduced if fault is active for an extended period of time.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 1 in 2013 HD-OBD Diagnostic Reference Manual.

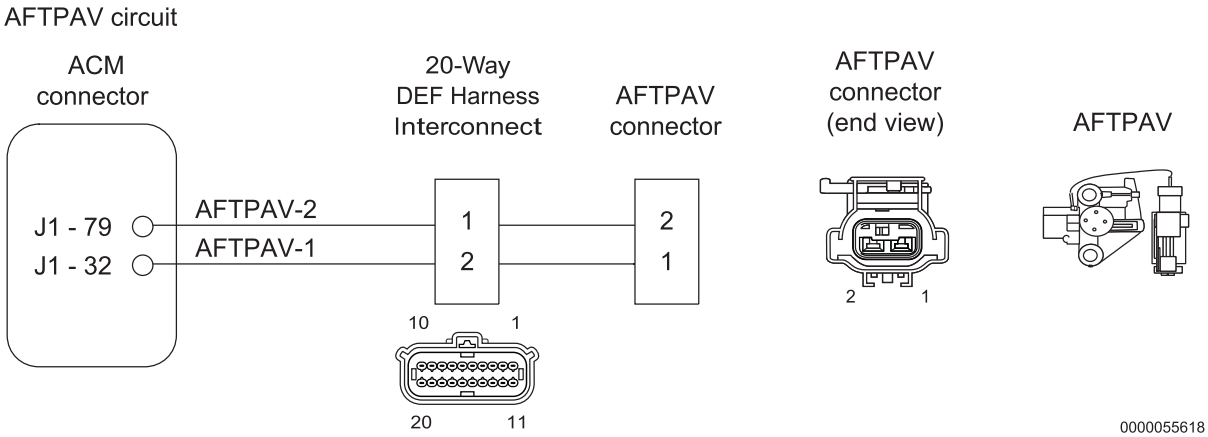

Figure 180 AFTPAV Circuit Diagram

Possible Causes

- AFTPAV-1 shorted to AFTPAV-2
- AFTPAV-1 short to GND
- Failed Aftertreatment Purge Air Valve (AFTPAV)

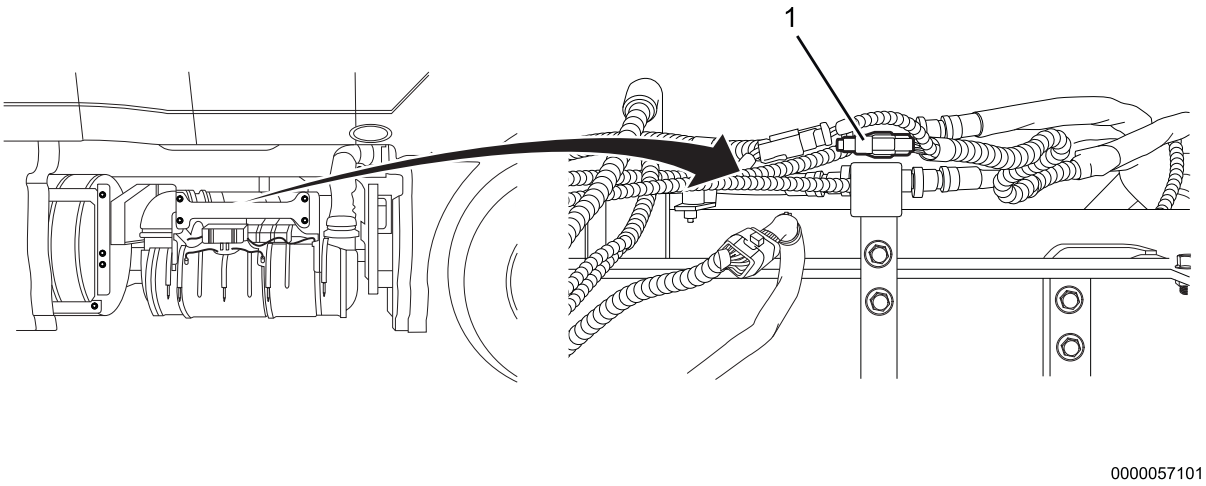

Figure 181 20–Way DEF Harness Interconnect Location (Typical)

1. 20–Way DEF harness interconnect

Step	Action	Decision
1	Inspect connections at 20-Way DEF harness interconnect. Key OFF, disconnect 20-Way DEF harness interconnect. Check 20-Way DEF harness interconnect and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the 20-Way DEF harness interconnect connector, harness, and terminals clean and undamaged?	Yes: Go to step 2. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3490 FMI 4.

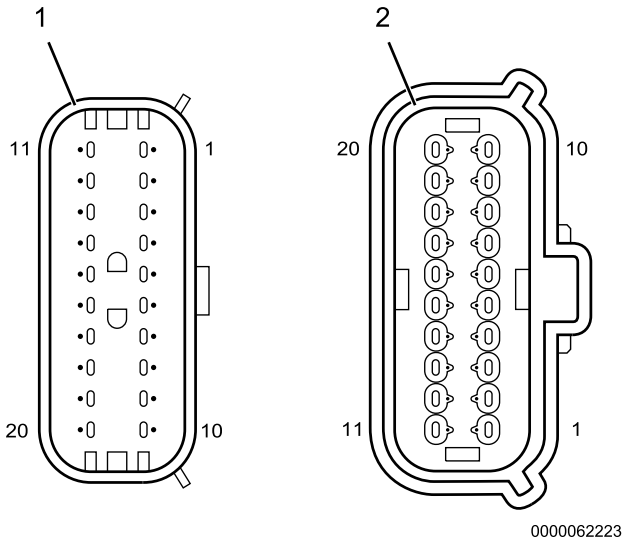

Figure 182 20-Way DEF Harness Connector End View

1. 20-Way DEF harness male side connector
2. 20-Way DEF harness female side connector

Step	Action	Decision
2	Check AFTPAV-1 circuit for short to ground between 20-Way DEF harness interconnect and Aftertreatment Control Module (ACM). Connect Breakout Harness 18-050-01 to the male side of the 20-Way DEF harness interconnect and leave female side disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness 18-050-01 pin-2 and a known good ground. Is resistance greater than 1000 ohms?	Yes: Go to step 3. No: Repair short to ground between 20-Way DEF harness interconnect pin-2 and ACM connector J1-32. After repairs are complete, retest for SPN 3490 FMI 4.

Step	Action	Decision
3	Determine if AFTPAV-1 circuit is shorted to AFTPAV-2 circuit between 20-Way DEF harness interconnect and ACM. Connect 180-Pin Breakout Box with ACM Breakout Harness 18-100-01 to ACM harness and leave ACM disconnected. Key OFF, with 20-Way DEF harness interconnect disconnected, measure resistance between Breakout Box pin J1-32 and pin J1-79. Is resistance greater than 1000 ohms?	Yes: Go to step 4. No: Repair AFTPAV-1 circuit shorted to AFTPAV-2 between 20-Way DEF harness interconnect and ACM. After repairs are complete, retest for SPN 3490 FMI 4.

Step	Action	Decision
4	Inspect connections at Aftertreatment Purge Air Valve (AFTPAV). Key OFF, disconnect AFTPAV. Check AFTPAV and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the AFTPAV connector, harness, and terminals clean and undamaged?	Yes: Go to step 5. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3490 FMI 4.

Step	Action	Decision
5	Check AFTPAV-1 circuit for short to ground between 20-Way DEF harness interconnect and AFTPAV. Connect Breakout Harness ZTSE4760A to AFTPAV vehicle harness connector and leave AFTPAV disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness ZTSE4760A pin-1 and a known good ground. Is resistance greater than 1000 ohms?	Yes: Go to step 6. No: Repair short to ground between AFTPAV connector pin-1 and 20-Way DEF harness interconnect pin-2. After repairs are complete, retest for SPN 3490 FMI 4.

Step	Action	Decision
6	Determine if AFTPAV-1 circuit is shorted to AFTPAV-2 circuit between 20-Way DEF harness interconnect and AFTPAV. Connect Breakout Harness ZTSE4760A to AFTPAV vehicle harness connector and leave AFTPAV disconnected. Key OFF, with 20-Way DEF harness interconnect disconnected, use a DMM to measure resistance between Breakout Harness ZTSE4760A pin-1 and pin-2. Is resistance greater than 1000 ohms?	Yes: Replace AFTPAV. After repairs are complete, retest for SPN 3490 FMI 4. No: Repair AFTPAV-1 circuit shorted to AFTPAV-2 between 20-Way DEF harness interconnect and AFTPAV. After repairs are complete, retest for SPN 3490 FMI 4.

NOTE: After doing all diagnostic steps, if SPN 3490 FMI 4 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3490 FMI 7- AFTPAV Mechanical system not responding

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Aftertreatment Purge Air Valve (AFTPAV) not responding: OR air line leaking or restricted.	AFTFP1 with AFTPAV commanded ON < 50 psi (344 kPa)	Key-On Engine-Running (KOER) Diagnostic runs during active regeneration of the diesel particulate filter	67 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the signal from the Aftertreatment Fuel Pressure 1 (AFTFP1) sensor is lower than expected when the Aftertreatment Purge Air Valve (AFTPAV) is commanded ON.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 1 in 2013 HD-OBD Diagnostic Reference Manual.

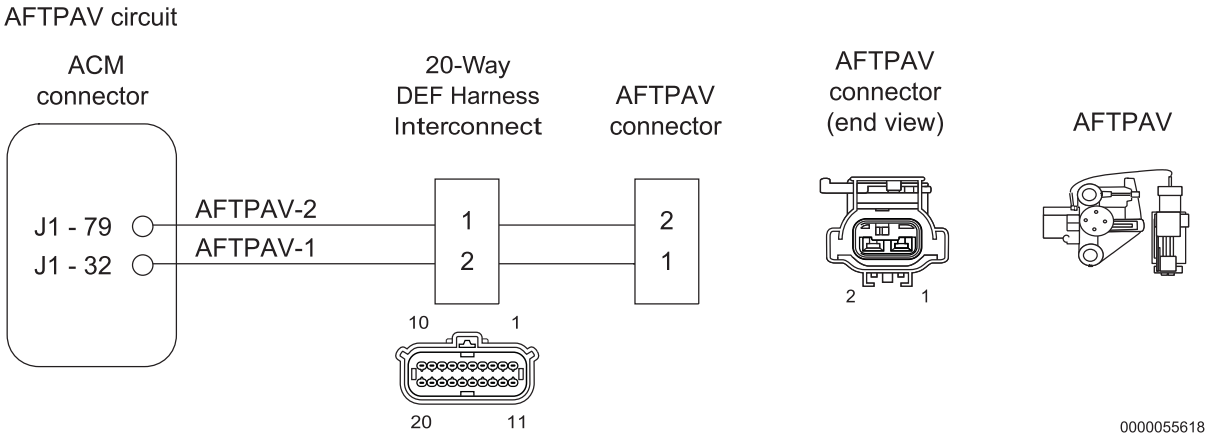

Figure 183 AFTPAV Circuit Diagram

Possible Causes

- Missing or leaking air supply line to AFTPAV
- Missing or leaking air supply line to AFT Fuel Doser module
- Failed AFTPAV (stuck closed)

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3480 FMI 2, 3, and 4 (AFTFP1); and SPN 3490 FMI 3 and 4 (AFTPAV). Is EST DTC list free of SPN 3480 FMI 2, 3, and 4; and SPN 3490 FMI 3 and 4?	Yes: Go to step 2. No: Repair SPN 3480 FMI 2, 3, and 4; and SPN 3490 FMI 3 and 4. After repairs are complete, retest for SPN 3490 FMI 7.

Step	Action	Decision
2	Check for missing, leaking, or damaged air supply line to AFTPAV. Verify vehicle air supply line to AFTPAV is properly installed and not damaged. Key-On Engine-Running (KOER), inspect air supply line to AFTPAV for restrictions and leaks. Is the air supply line to the AFTPAV present and in good condition?	Yes: Go to step 3. No: Repair or replace air supply to AFTPAV. After repairs are complete, retest for SPN 3490 FMI 7.

Step	Action	Decision
3	Check for missing, leaking, or damaged air supply line from AFTPAV to AFT Fuel Doser module. Verify air supply line is properly installed and not damaged. Key-On Engine-Off (KOEO), inspect air supply line to AFT Fuel Doser Module for restrictions and leaks. Is the air supply line to the AFT Fuel Doser Module present and in good condition?	Yes: Replace AFTPAV. After repairs are complete, retest for SPN 3490 FMI 7. No: Repair or replace air supply line to AFT Fuel Doser module. After repairs are complete, retest for SPN 3490 FMI 7.

NOTE: To verify proper operation of the AFTPAV run AFT Purge Air Valve Test. Using EST with ServiceMaxx software go to KOEO Aftertreatment Tests > Actuator - AFT Purge Air Valve, run AFT Purge Air Valve TEST. If AFTPAV is operating correctly an audible sound will be heard when AFTPAV is activated.

NOTE: After doing all diagnostic steps, if SPN 3490 FMI 7 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

AMS (Air Management System)

SPN	FMI	Condition	Possible Causes	Actions
102	16	Intake Manifold Pressure Overboost	• Turbocharger 2 (TC2) wastegate stuck closed	Pin-Point Diagnostics (page 430)
102	18	Intake Manifold Pressure Underboost	• TC2 wastegate stuck open • Restricted intake air system • Charge Air Cooler (CAC) hose leaking • CAC leak • Failed turbocharger	Pin-Point Diagnostics (page 431)
1173	16	TC2CIT signal above desired (Interstage CAC under cooling)	• Failed Coolant Flow Valve (CFV) or circuit • Failed Coolant Mixer Valve (CMV) or circuit • Restricted interstage CAC • Inoperative engine fan • Restricted low-temperature radiator • Engine fan or shroud problem	Pin-Point Diagnostics (page 431)
2659	20	EGR High Flow Rate detected	• Biased O_2S or circuit • Biased Turbocharger 1 Turbo Outlet Pressure (TC1TOP) sensor or circuit • Exhaust Gas Recirculation (EGR) Valve stuck open • Low boost pressure	Step Based Diagnostics (page 433)
2659	21	EGR Low Flow Rate detected	• Biased O_2S or circuit • Biased TC1TOP sensor or circuit • EGR Valve stuck closed • Restricted EGR cooler	Pin-Point Diagnostics (page 432)

- Restricted Diesel Oxidation Catalyst (DOC) or Diesel Particulate Filter (DPF)

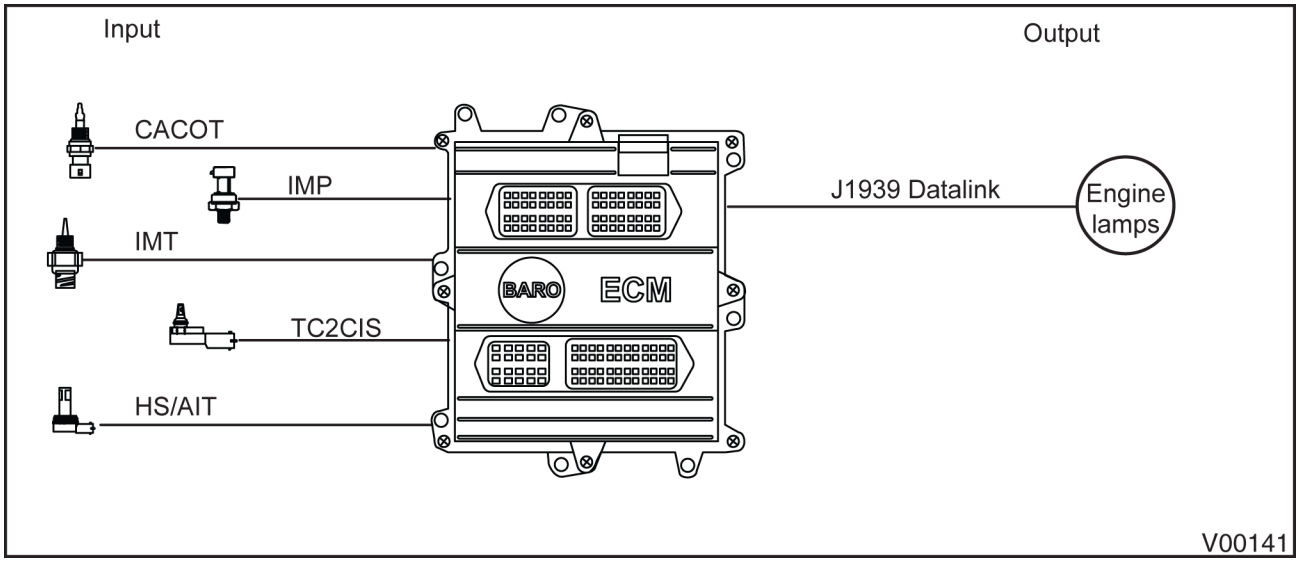

Figure 184 Functional diagram for the AMS

Tools Required

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

SPN 102 FMI 16 – Intake Manifold Pressure Overboost

Pin-point AMS System Fault

1. Check for other active or inactive DTCs. Repair any electrical fault before continuing with this procedure.
2. Check for biased IMP sensor. Verify BAP and IMP are within KOEO specification. See applicable engine horsepower in “APPENDIX A: PERFORMANCE SPECIFICATIONS."
3. Run Air Management test while monitoring IMP sensor signal.
   - If IMP does not change state when TC2WC is cycled, proceed to TC2WC (page 1404) .

SPN 102 FMI 18 – Intake Manifold Pressure Underboost

Pin-point AMS System Fault

1. Check for other active or inactive DTCs. Repair any electrical fault before continuing with this procedure.
2. Check for biased IMP sensor. Verify BAP and IMP are within KOEO specification. See applicable engine horsepower in “APPENDIX A: PERFORMANCE SPECIFICATIONS."
3. Run Air Management test while monitoring IMP sensor signal.
   - If IMP does not change state when TC2WC is cycled, proceed to TC2WC (page 1404).
4. Inspect for leaks in the intake air system.
5. Inspect turbochargers in the *Engine Service Manual*.

SPN 1173 FMI 16 – TC2CIT signal above desired (Interstage CAC under cooling)

Pin-point AMS System Fault

1. Check for other active or inactive DTCs. Repair any electrical fault before continuing with this procedure.
2. Check for biased TC2CIT sensor. Repair as necessary.
3. Using ServiceMaxx™ software, run Engine Fan Procedure to verify correct operation.
4. Perform Coolant Control Valve (CCV) Test (page 156).

SPN 2659 FMI 21 – EGR Low Flow Rate detected

Pin-point AMS System Fault

1. Check for other active or inactive DTCs. Repair any electrical fault before continuing with this procedure. If SPN 5298 is active, correct and then retest for SPN 2659 FMI 21.
2. Check for biased TC1TOP or DPFDP sensor.
3. Run Air Management test while monitoring IMP, during EGR portion of test.
   - If IMP does not change state during EGR portion of Air Management test, proceed to EGR Valve (page 1014) diagnostics.
4. See EGR Cooler Leak Inspection in “ENGINE SYMPTOM DIAGNOSTICS."

SPN 2659 FMI 20 - EGR High Flow Rate Detected

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
High flow by O_2 control error, valve closing.	O_2% in exhaust > 1.4%	Actual EGR Valve Position < 35% Desired EGR Valve Position < 27% Actual EGR Valve Position deviation limit (from set point) < 100% Key ON Limp Home Mode = Inactive DPF Regeneration = Inactive Power Takeoff (PTO) Mode = Inactive Engine Coolant Temperature 1 (ECT1) > -44°F (-7°C) and < 239°F (115°C) Ambient Air Temperature (AAT) > -44°F (-7°C) <131°F (55°C) Barometric pressure (BARO) > 11 psi (75 kPa) O_2 sensor at operating temp. > 1400°F (760°C) and < 1472°F (800°C) Engine operating in monitoring region Function of engine speed and load	2.4 seconds

Fault Overview

The Exhaust Gas Recirculation (EGR) valve is a variable position actuator used to control exhaust flow through the EGR cooler. The EGR valve contains an internal position sensor that monitors valve position. Valve position changes in response to Engine Control Module (ECM) signals.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN's 27, 91, 724, 2623, 2791, 3223, 5298, and 5541. If SPN 5298 is active, correct and then retest for SPN 2659 FMI 20.

Drive Cycle to Determine Fault Status

Drive Cycle 16 in 2013 HD-OBD Diagnostic Reference Manual.

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for other fault codes. Is SPN 2659 FMI 20 the only fault code active?	Yes: Go to step 2. No: Repair other fault code(s). After repairs are complete, retest for SPN 2659 FMI 20.

Step	Action	Decision
2	Check for biased O^2 sensor. Do O^2 Biased Sensor or Circuit Check (page 1332). Does O^2 sensor pass biased sensor or circuit check?	Yes: Go to step 3. No: Repair O^2 sensor or circuits. After repairs are complete, retest for SPN 2659 FMI 20.

Step	Action	Decision
3	Check for biased Turbocharger 1 Turbine Outlet Pressure (TC1TOP) sensor or circuit. Using EST with ServiceMaxx™ software, run the Continuous Monitor test. Use the Key-On Engine-Off (KOEO) values found in “Appendix A: Performance Specifications”. Is TC1TOP within specifications?	Yes: Go to step 4. No: Do TC1TOP sensor circuit and voltage checks (page 1401). After repairs are complete, retest for SPN 2659 FMI 20.

Step	Action	Decision
4	Determine if Intake Manifold Pressure (IMP) sensor or circuit is out of specifications. Using EST with ServiceMaxx™ software, do IMP Biased Sensor Circuit Check (page 1133). Is IMP sensor within specifications?	Yes: Go to step 5. No: Repair IMP sensor or circuit. After repairs are complete, retest for SPN 2659 FMI 20.

Step	Action	Decision
5	Verify IMP changes when Turbocharger 2 Wastegate Control (TC2WC), Exhaust Gas Recirculation (EGR) valve, and Exhaust Back Pressure Valve (EBPV) are commanded On. Key-On Engine-Running (KOER), run Air Management Test while monitoring IMP sensor signal. While monitoring IMP signal: • Does IMP pressure decrease when EGR valve is commanded On? • Does IMP pressure decrease when TC2WC is commanded On? • Does IMP pressure decrease when EBPV is commanded On?	No IMP pressure decrease when EGR is commanded On: Do EGR Pinpoint Diagnostic (page 1020) with ServiceMaxx. After repairs are complete, retest for SPN 2659 FMI 20. No IMP pressure decrease when TC2WC is commanded On: Do Air Control Valve (ACV) TC2WC test (page 215). After repairs are complete, retest for SPN 2659 FMI 20. No IMP pressure decrease when EBPV is commanded On: Do Air Control Valve (ACV) EBPV test (page 213). After repairs are

		complete, retest for SPN 2659 FMI 20.
		IMP signal does not change when any of the valves are commanded On: Go to step 6.

Step	Action	Decision
6	Verify IMP sensor and bore are not restricted due to carbon buildup. Remove and inspect IMP sensor and bore for carbon buildup. Is IMP sensor and bore free of carbon buildup?	Yes: After doing all diagnostic steps, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.
		No: Clean IMP sensor bore of carbon deposits. After repairs are complete, retest for SPN 2659 FMI 20.

NOTE: After doing all diagnostic steps, if SPN 2659 FMI 20 remains verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

APP Sensor (Accelerator Pedal Position)

SPN	FMI	Condition	Possible Causes	Actions
91	2	APP1 and APP2 signal conflict	• APP1 and APP2 mismatched • Biased APP sensor or circuit	Pin-Point Diagnostics (page 439)
91	3	APP1 signal Out of Range HIGH	• APP1 signal circuit short to PWR • SIG GND circuit OPEN • Failed APP sensor	Pin-Point Diagnostics (page 439)
91	4	APP1 signal Out of Range LOW	• APP1 signal circuit OPEN or short to GND • VREF5 circuit OPEN • Failed APP sensor	Pin-Point Diagnostics (page 439)
2623	3	APP2 signal Out of Range HIGH	• APP2 signal circuit short to PWR • SIG GND circuit OPEN • Failed APP sensor	Pin-Point Diagnostics (page 439)
2623	4	APP2 signal Out of Range LOW	• APP2 signal circuit OPEN or short to GND • VREF1 circuit OPEN • Failed APP sensor	Pin-Point Diagnostics (page 439)

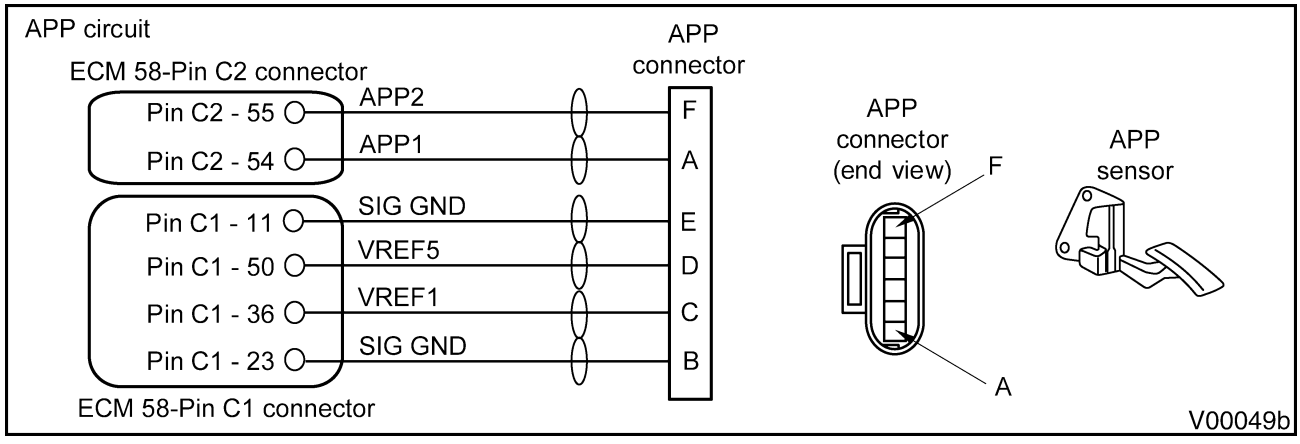

Figure 185 APP circuit diagram

Overview

The Accelerator Pedal Position (APP) sensor is a variable-resistance sensor that increases or decreases resistance as the accelerator pedal position changes. No mechanical attachment is present from the accelerator pedal to the engine. The ECM compares signals from two potentiometers to determine accelerator pedal position, APP1 and APP2. APP1 is supplied 5 volts while APP2 is supplied 2.5 volts. As the pedal is pressed, resistance decreases and change in voltage is interpreted by the ECM.

Tools Required

- 180-Pin Breakout Box 00-00956-08
- 2010 MaxxForce 11 & 13 Harness Kit 00-01462-00
- 3-Banana Plug Harness ZTSE4498
- 500 Ohm Resistor Harness ZTSE4497
- Big Bore Terminal Test Probe Kit ZTSE4899
- Breakout Harness ZTSE4485A (APP)
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

Pinpoint Diagnostics With ServiceMaxx™ software

WARNING: To prevent personal injury or death, stay clear of rotating parts (belts and fan) and hot engine surfaces.

The ECM determines accelerator pedal position by processing input signals from APP1 and APP2.

1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, run the Continuous Monitor test.
2. Monitor sensor voltage and verify an active DTC for this sensor.
   - If DTC is previously active, monitor signal while wiggling harness of suspect sensor. If circuit is interrupted, signal will spike and DTC will go active or pending.
   - If DTC is active, continue to Sensor Circuit Check.

NOTE: Inspect connectors for damaged pins, corrosion, or loose pins. Repair if necessary.

Sensor Circuit Check

Connect Breakout Harness ZTSE4485A to APP vehicle harness, and leave APP sensor disconnected. Turn ignition ON.

Test Point	Specification	Comment – < Less than, > Greater than
EST - Monitor APP1v	0 V	If > 0.5 V, check APP1 circuit for short to PWR.
EST - Monitor APP2v	0 V	If > 0.5 V, check APP2 circuit for short to PWR.
DMM – Measure volts C to GND	5 V ± 0.5 V	If > 5.5 V, check VREF5 for short to PWR. If < 4.5 V, check VREF5 for OPEN or short to GND, go to Harness Resistance Check.
DMM – Measure volts D to GND	5 V ± 0.5 V	If > 5.5 V, check VREF1 for short to PWR. If < 4.5 V, check VREF1 for OPEN or short to GND, go to Harness Resistance Check.
EST - Monitor APP1v Short Pin A to C	5 V	If < 4.5 V, check APP1 circuit for OPEN, go to Harness Resistance check.
EST - Monitor APP2v Short Pin D to F	5 V	If is < 4.5 V, check APP2 circuit for OPEN, go to Harness Resistance Check.
DMM – Measure Volts B to Battery positive	B+	If < B+, check SIG GND for OPEN, go to Harness Resistance Check.
DMM – Measure Volts E to Battery positive	B+	If < B+, check SIG GND for OPEN, go to Harness Resistance Check.
If checks are within specification, connect sensor, clear DTCs, and cycle the accelerator pedal a few times. If active DTC returns, replace sensor.		

Pinpoint Diagnostics Without ServiceMaxx™ Software

Connect Breakout Harness ZTSE4485A to APP vehicle harness, and leave APP sensor disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
A to B+	B+	If < B+, check APP1 for short to PWR.
B to Battery positive	B+	If < B+, check SIG GND for OPEN circuit.
C to GND	5 V	If > 5.5 V, check VREF5 for short to PWR.
		If < 4.5 V, check VREF5 for OPEN or short to GND.
D to GND	5 V	If > 5.5 V, check VREF5 for short to PWR.
		If < 4.5 V, check VREF5 for OPEN or short to GND.
E to Battery positive	B+	If < B+, check SIG GND for OPEN circuit.
F to B+	B+	If < B+, check APP2 for short to PWR.

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM C1 and C2 harness to ECM C1 and C2 connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE4485A to APP vehicle harness, and leave APP sensor disconnected. Use DMM to measure resistance.

Test Point	Specifications	Comment – < Less than, > Greater than
A to GND	> 1k Ω	If < 1k Ω, check for short circuit.
A to C2-54	< 5 Ω	If > 5 Ω, check for OPEN circuit.
B to GND	< 5 Ω	If > 5 Ω, check for OPEN circuit.
B to C1-23	< 5 Ω	If > 5 Ω, check for OPEN circuit.
C to GND	> 1k Ω	If < 1k Ω, check for short circuit.
C to C1-50	< 5 Ω	If > 5 Ω, check for OPEN circuit.
D to GND	> 1k Ω	If < 1k Ω, check for short circuit.
D to C1-36	< 5 Ω	If > 5 Ω, check for OPEN circuit.
E to GND	< 5 Ω	If > 5 Ω, check for OPEN circuit.
E to C1-11	< 5 Ω	If > 5 Ω, check for OPEN circuit.
F to GND	> 1k Ω	If < 1k Ω, check for short circuit.
F to C2-55	< 5 Ω	If > 5 Ω, check for OPEN circuit.

Operational Voltage Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM C1 and C2 harness between ECM C1 and C2 connectors and ECM. Connect Breakout Harness ZTSE4485A between APP vehicle harness and APP sensor. Turn ignition switch to ON. Use DMM to measure voltage or EST to read signal.

Test Point	Condition	DMM	EST Value
APP1	Foot off pedal	1.14 V ± 0.25V	0%
A to GND or C2-54 to GND	Pedal to floor	4.32 V ± 0.25V	99.6%
APP2	Foot off pedal	0.56 V ± 0.25 V	0%
F to GND or C2-55 to GND	Pedal to floor	2.16 V ± 0.25 V	99.6%

NH_3 (Ammonia) Sensor Module

SPN	FMI	Condition	Possible Causes	Actions
4377	2	NH_3 in range stuck fault	• Exhaust system leaks • Failed NH_3 sensor	Step-Based Diagnostics (page 446)
4377	4	NH_3 operation fault	• Failed NH_3 sensor	Step-Based Diagnostics (page 450)
4377	10	NH_3 abnormal rate of change	• Failed NH_3 Sensor	Step-Based Diagnostics (page 454)
4377	12	NH_3 internal chip error	• Failed NH_3 Sensor Module	Step-Based Diagnostics (page 456)
4377	13	NH_3 operation fault	• Incorrect or failed NH_3 sensor	Step-Based Diagnostics (page 458)
4380	2	NH_3 signal erratic, intermittent, or incorrect	• GND circuit intermittent Open or high resistance • Low battery voltage • Power Distribution Module (PDM) loose fuse or relay • SWBAT circuit intermittent short to GND or Open • Failed NH_3 sensor module	Step-Based Diagnostics (page 460)
4380	16	Outlet NH_3 signal Out of Range HIGH	• Charging voltage excessive • Incorrect battery pack wiring (series instead of parallel)	Step-Based Diagnostics (page 465)
4380	18	Outlet NH_3 signal Out of Range LOW	• Low battery or charging system voltage • SWBAT circuit high resistance • GND circuit high resistance	Step-Based Diagnostics (page 468)

4382	10	Outlet NH_3 Gas Sensor Heater abnormal rate of change	• NH_3 sensor failed	Step-Based diagnostics (page 472)
5302	18	Post SCR NH_3 Conversion Efficiency - Data Valid But Below	• Exhaust system leak(s) • Diesel Exhaust Fluid (DEF) tank, supply module, or doser valve lines or connections loose, leaking, damaged, or restricted • Contaminated or degraded DEF • Failed or restricted DEF Doser Valve (DEFDV) • Restricted DEF supply module filter • DEF crystallization or deposits in decomposition tube • Failed Selective Catalyst Reduction (SCR) catalyst	Step-Based Diagnostics(page 474)

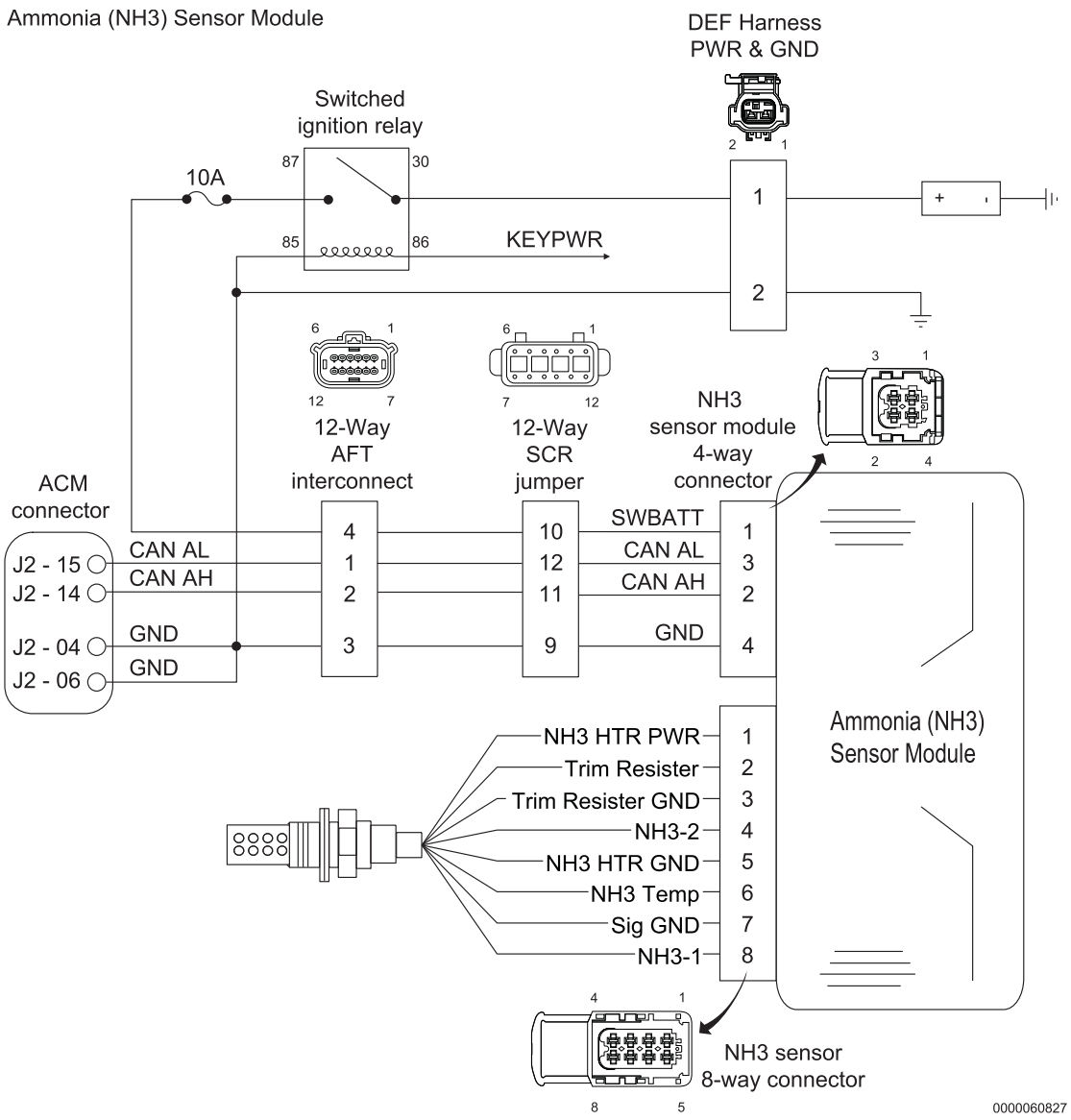

Figure 186 Ammonia (NH_3) Circuit Diagram

NOTE: See latest version of N13 Engine and Aftertreatment Wiring Schematic Form 0000002203 for additional circuit information.

Overview

The Ammonia (NH_3) sensor module is a smart device used to measure NH_3 levels in the Selective Catalyst Reduction (SCR) Catalyst. The NH_3 sensor module performs internal diagnostics and reports malfunctions back to the Aftertreatment Control Module (ACM) using the J1939 CAN datalink. The NH_3 sensor is attached to the NH_3 sensor module.

Tools Required

- 180-Pin Breakout Box 00-00956-08
- SCR (ACM) Breakout Harness 18-100-01 (58-Pin)
- Breakout Harness 18-650-01
- Breakout Harness 18-801-01
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

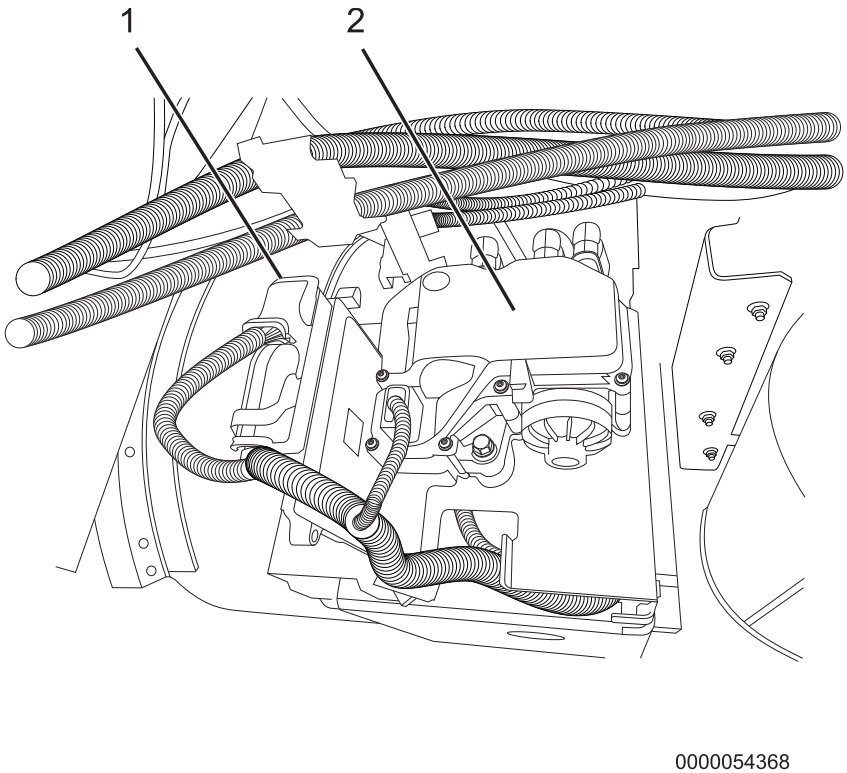

Figure 187 Aftertreatment Control Module (ACM) Location

1. Aftertreatment Control Module (ACM)
2. DEF Supply Module

SPN 4377 FMI 2- NH_3 in range stuck fault

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Ammonia (NH_3) reading higher or lower than expected for operating conditions.	Measured minimum NH_3 quantity drop rate > -1.3 ppm/sec	Engine Running SCR temperature between 482°F (250 °C) and 572°F (300°C) and rate of change >= 0.5°F/sec (0.3°C/sec) Inactive: SPN 3246 FMI 2, 3, 4 (DPFOT); SPN 3361 FMI 2 (DEF supply pump); SPN 4360 FMI 2, 3, 4 (SCRIT); SPN 4363 FMI 2, 3, 4 (SCROT); SPN 4377 FMI 4, 10, 12, 13 (NH_3); SPN 4380 FMI 2, 16,18 (NH_3 Signal); SPN 4382 FMI 10 (NH_3 Sensor); SPN 5742 FMI 12, 3, 4, 9, 11, 12 (DPF temp sensor module); SPN 5743 FMI 2, 3, 4, 9, 11, 12 (SCR temp sensor module) Ammonia storage timer >= 150 seconds SCR temperature > 644°F (340°C) Time since peak SCR temperature >20 seconds, and time since enabled >10 seconds, and temperature difference between SCR peak temperature and SCR initial temperature > 27°F (15°C) NH_3 sensor above 338°F (170°C)	Immediate

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Ammonia (NH_3) sensor reading is higher or lower than expected for operating conditions.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 4377 FMI 4 and 10 (NH_3); SPN 4380 FMI 2, 16, 18 (NH_3).

Drive Cycle to Determine Fault Status

Drive Cycle 1 then 2 in 2013 HD-OBD Diagnostic Reference Manual.

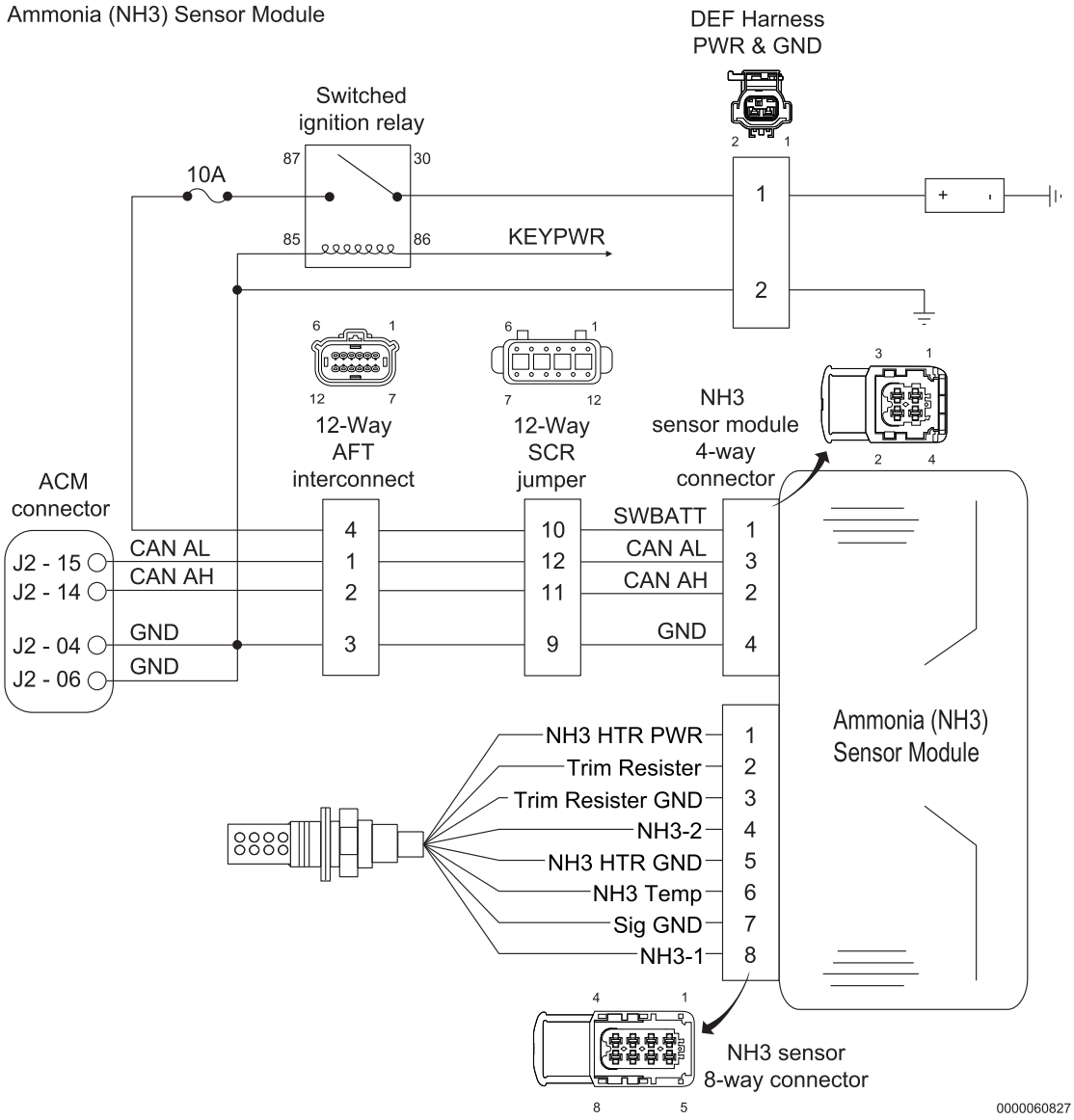

Figure 188 NH_3 Sensor Module Circuit Diagram.

Possible Causes

- Exhaust system leaks
- Failed NH_3 sensor

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 4377 FMI 4 and 10 (NH_3); SPN 4380 FMI 2, 16, and 18 (NH_3). Is EST DTC list free of SPN 4377 FMI 4, 10; SPN 4380 FMI 2, 16, 18?	Yes: Go to step 2. No: Repair SPN 4377 FMI 4, 10; SPN 4380 FMI 2, 16, and 18. After repairs are complete, retest for SPN 4377 FMI 2.

Step	Action	Decision
2	Inspect exhaust system for leaks and physical damage. Is exhaust system free of leaks and physical damage?	Yes: Go to step 3. No: Repair or replace leaking or damaged exhaust components. After repairs are complete, retest for SPN 4377 FMI 2.

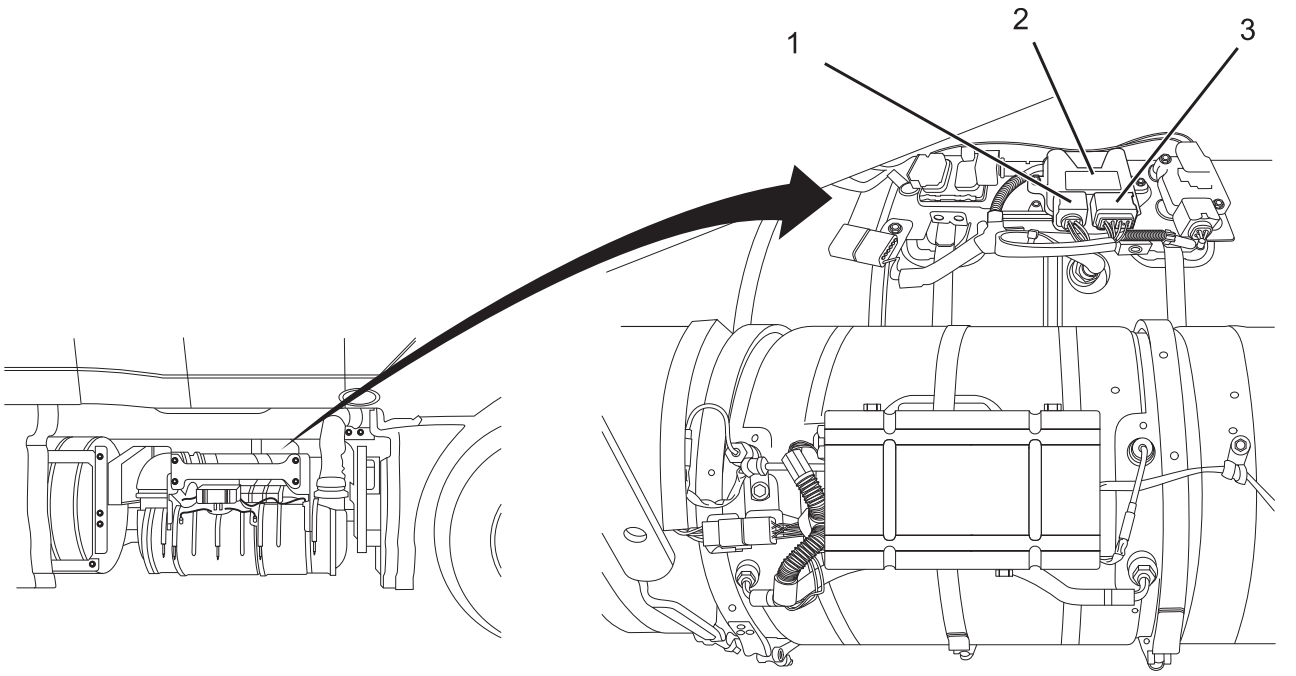

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Figure 189 NH_3 Sensor Module Location.

1. Ammonia (NH_3) sensor module 4-way connector
2. NH_3 sensor module
3. NH_3 sensor 8-way connector

Step	Action	Decision
3	Inspect connections at NH_3 sensor 8-way connector. Key OFF, disconnect NH_3 sensor. Check NH_3 sensor module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the NH_3 sensor module connector, harness, and terminals clean and undamaged?	Yes: Replace NH_3 sensor. After repairs are complete, retest for SPN 4377 FMI 2.
		No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 4377 FMI 2.

NOTE: After performing all diagnostic steps, if SPN 4377 FMI 2 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 4377 FMI 4- NH_3 operation fault

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Circuit fault in any of the Ammonia (NH_3) sensor signal, ground, or heater wires.	Absolute value of NH_3 signal during pulse On time minus NH_3 signal during pulse Off time < 20 mV and absolute value of NH_3 signal at pulse Off >= 250.8 mV Voltage between heater positive pin of NH_3 sensor and ground > 4.41 V Impedance of temperature cell in NH_3 sensor < 200 ohms Voltage across temperature cell of NH_3 sensor > 4.99 V, or NH_3 sensor has met operating temperature once since power up, impedance of temperature cell in NH_3 sensor > 3,000 ohms NH_3 sensor internal temperature cell impedance difference between pulse On and Off < 50 ohms Voltage between the NH_3 sensor signal ground pin and ground > 250 mV Voltage at common terminal of changeover switch > 1.8 V < 3.8 V Voltage between heater positive pin of NH_3 sensor and ground < 0.71 V Absolute value of NH_3 signal during pulse On time minus NH_3 signal during pulse Off time < 20 mV and NH_3 signal < 20 mV. OR absolute value of NH_3 signal during pulse On time minus NH_3 signal	NH_3 sensor heater is ON NH_3 at operating temperature NH_3 sensor above 338°F (170°C)	20 seconds

SPN 4377 FMI 4- NH_3 operation fault (cont.)

	during pulse Off time < 20 mV and absolute value of NH_3 signal at pulse off < 250.8 mV and >= 20 mV		

Fault Overview

Fault code sets when an internal circuit error has been detected in the aftertreatment Ammonia (NH_3) sensor. Engine torque will be reduced if the engine is operated for a limited period of time with the fault code active. Engine torque will be severely reduced and vehicle speed will be limited after extended operation with the fault code active.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 4380 FMI 2, 16, 18 (NH_3)

Drive Cycle to Determine Fault Status

Drive Cycle 1 then 2 in 2013 HD-OBD Diagnostic Reference Manual.

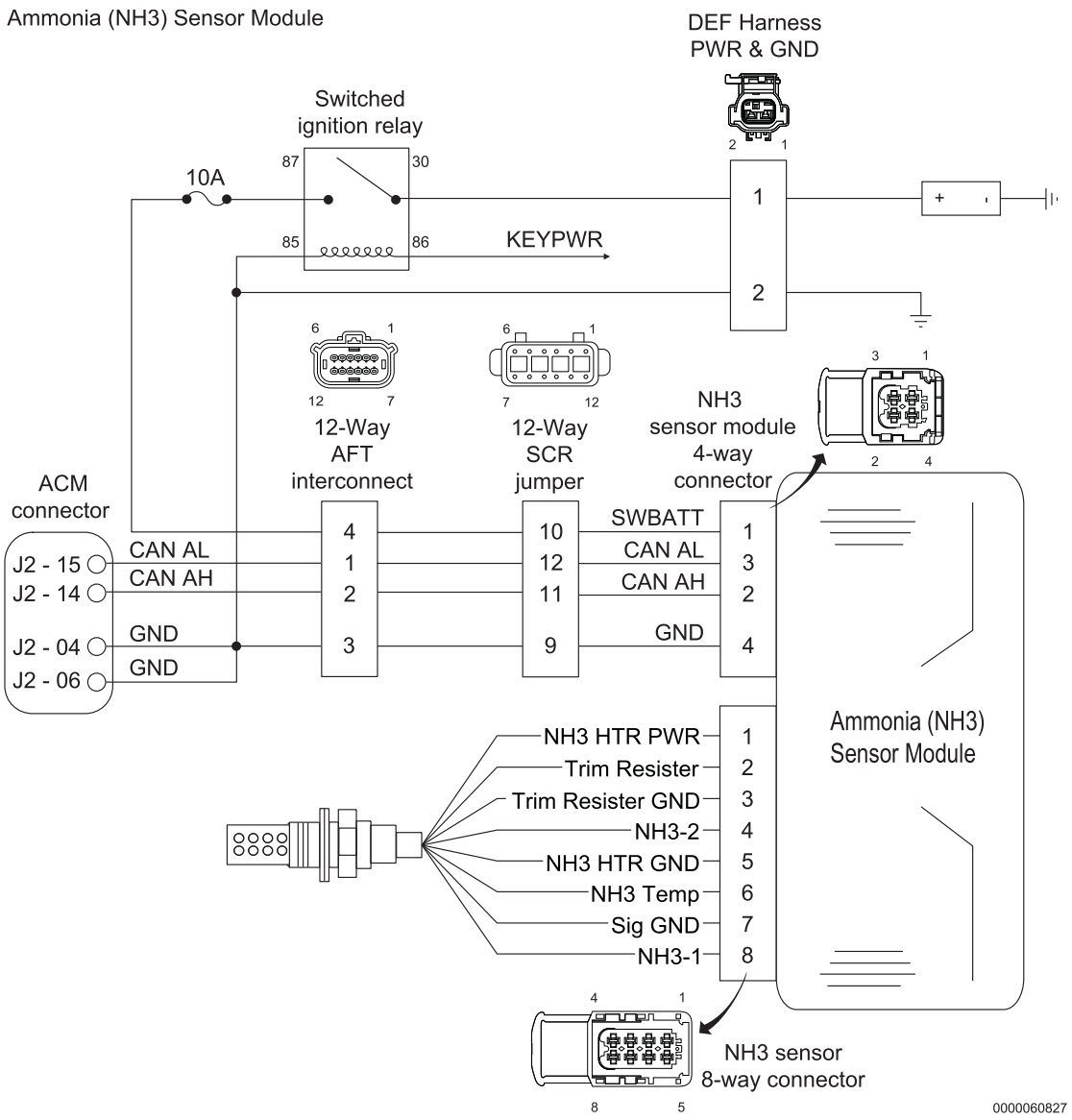

Figure 190 NH_3 Sensor Module Circuit Diagram.

Possible Causes

- Failed NH_3 sensor

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 4380 FMI 2, 16, 18 (NH_3). Is EST DTC list free of SPN 4380 FMI 2, 16, 18?	Yes: Go to step 2. No: Repair SPN 4380 FMI 2, 16, 18. After repairs are complete, retest for SPN 4377 FMI 4.

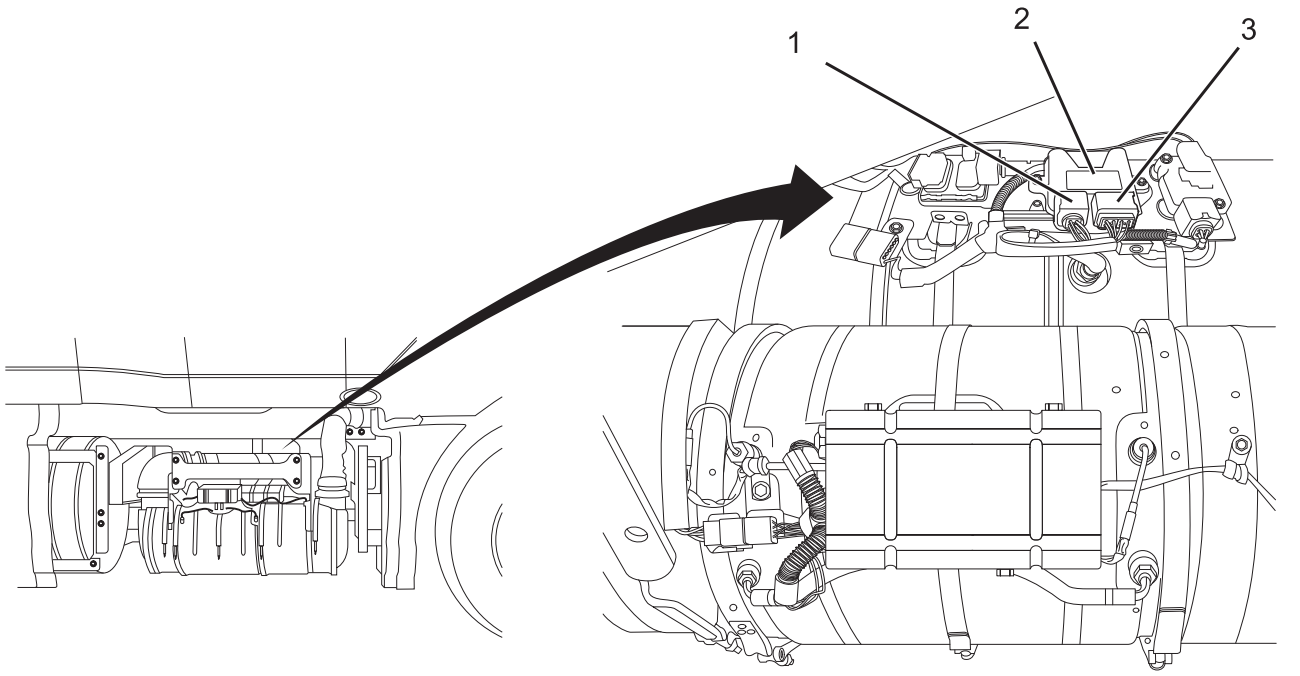

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Figure 191 NH_3 Sensor Module Location.

1. Ammonia (NH_3) Sensor Module 4-way connector
2. NH_3 sensor module
3. NH_3 sensor 8-way connector

Step	Action	Decision
2	Inspect connections at NH_3 sensor module. Key OFF, disconnect NH_3 sensor module. Check NH_3 sensor module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the NH_3 sensor module connector, harness, and terminals clean and undamaged?	Yes: Replace NH_3 sensor. After repairs are complete, retest for SPN 4377 FMI 4.
		No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 4377 FMI 4.

NOTE: After performing all diagnostic steps, if SPN 4377 FMI 4 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 4377 FMI 10- NH_3 abnormal rate of change

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
The Ammonia (NH_3) sensor status is Not valid.	Percent of time that the NH_3 sensor is in Not valid condition NH_3 Not at operating temperature condition OR Voltage between the NH3-2 signal pin and the signal ground pin > 20 mV OR Voltage between the NH3-2 signal pin and the signal ground pin < -70 mV) within a moving time window of 60 seconds, > 20%	Inactive: SPN 4360 FMI 2, 3, 4 (NH_3); SPN 4377 FMI 4, 12, 13 (NH_3); SPN 4380 FMI 2, 16, 18 (NH_3); SPN 4382 FMI 10 (NH_3 Sensor); SPN 5743 FMI 3, 4, 11, 12, 16 (SCR temp sensor module) Exhaust flow rate < 500 g/sec Exhaust temperature at NH_3 sensor location < 570°C The exhaust gas temperature as measured by the thermistor closest to the NH_3 sensor > 160°C for 5 seconds. AFTFI dosing rate ≤ 30 g/sec Engine operation mode is Normal Mode or SCR Thermal Management Mode. NH_3 sensor is above 338°F (170°C) Engine running All the enable conditions are satisfied for 20 seconds.	60 seconds

Fault Overview

Fault code sets when the Ammonia (NH_3) sensor reading is not valid.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 4377 FMI 2, 4 (NH_3); SPN 4380 FMI 2 (NH_3)

Drive Cycle to Determine Fault Status

Drive Cycle 1 then 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Failed NH_3 Sensor

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code list for SPN 4377 FMI 2, 4 (NH_3) and SPN 4380 FMI 2 (NH_3).	Yes: Replace NH_3 sensor. After repairs are complete, retest for SPN 4377 FMI 10.
	Is EST DTC list free of SPN 4377 FMI 2, 4 and SPN 4380 FMI 2?	No: Repair SPN 4377 FMI 2, 4 and SPN 4380 FMI 2. After repairs are complete retest for SPN 4377 FMI 10.

NOTE: After performing all diagnostic steps, if SPN 4377 FMI 10 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 4377 FMI 12- NH_3 internal chip error

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
NH_3 sensor module has detected an internal error.	The NH_3 sensor module has an internal RAM failure, code checksum mismatch, or an internal Application Specific Integrated Circuit (ASIC) and SPI bus communication failure.	Key ON	2 seconds

Fault Overview

Fault Code is set when the NH_3 sensor module has detected an internal error.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Failed NH_3 sensor module

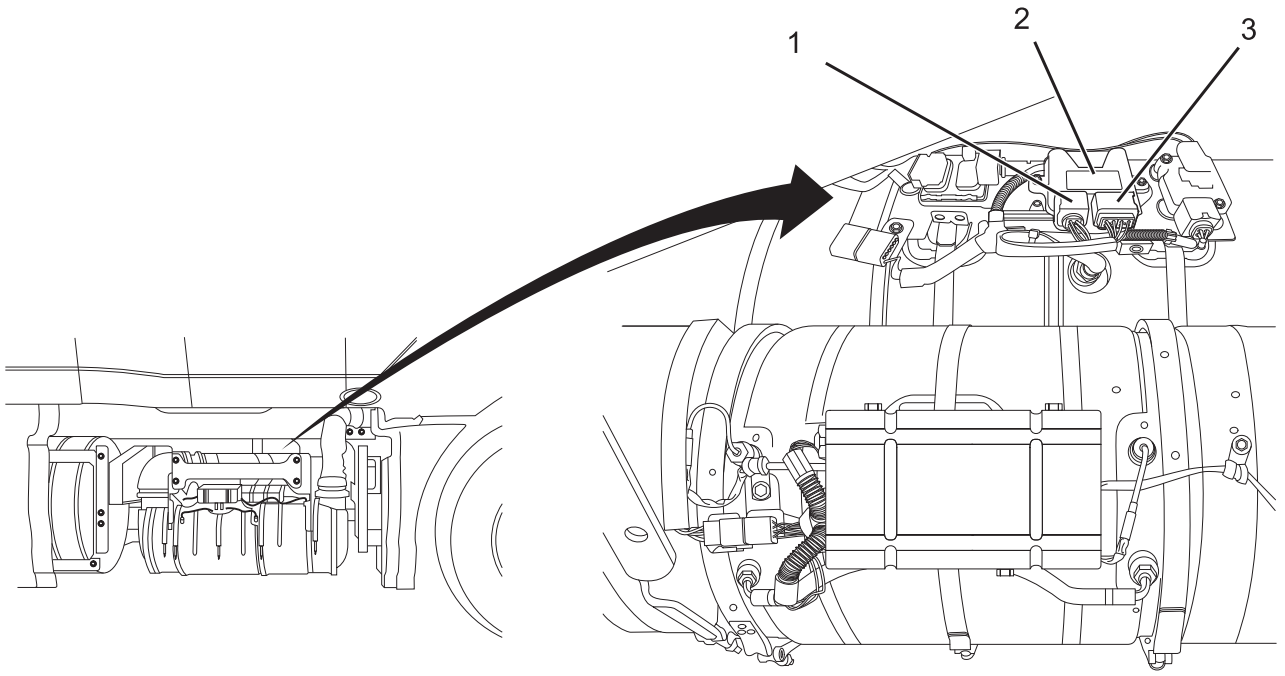

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Figure 192 NH_3 Sensor Module Location.

1. Ammonia (NH_3) sensor module 4-way connector
2. NH_3 sensor module
3. NH_3 sensor 8-way connector

Step	Action
1	Replace NH_3 sensor module. Repair or replace NH_3 sensor module heat shield if missing or damaged.

NOTE: After performing all diagnostic steps, if SPN 4377 FMI 12 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 4377 FMI 13- NH_3 sensor out of calibration

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Ammonia (NH_3) sensor module has detected the trim resistor is out of range (wrong sensor installed).	The functional resistance of the sensor internal trim resistor is greater than 2,000 ohms or less than 500 ohms.	Key ON	4 seconds

Fault Overview

Fault Code sets when the Ammonia (NH_3) sensor module has detected the trim resistor is out of range, indicating the wrong NH_3 sensor may be installed.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Incorrect or failed NH_3 sensor

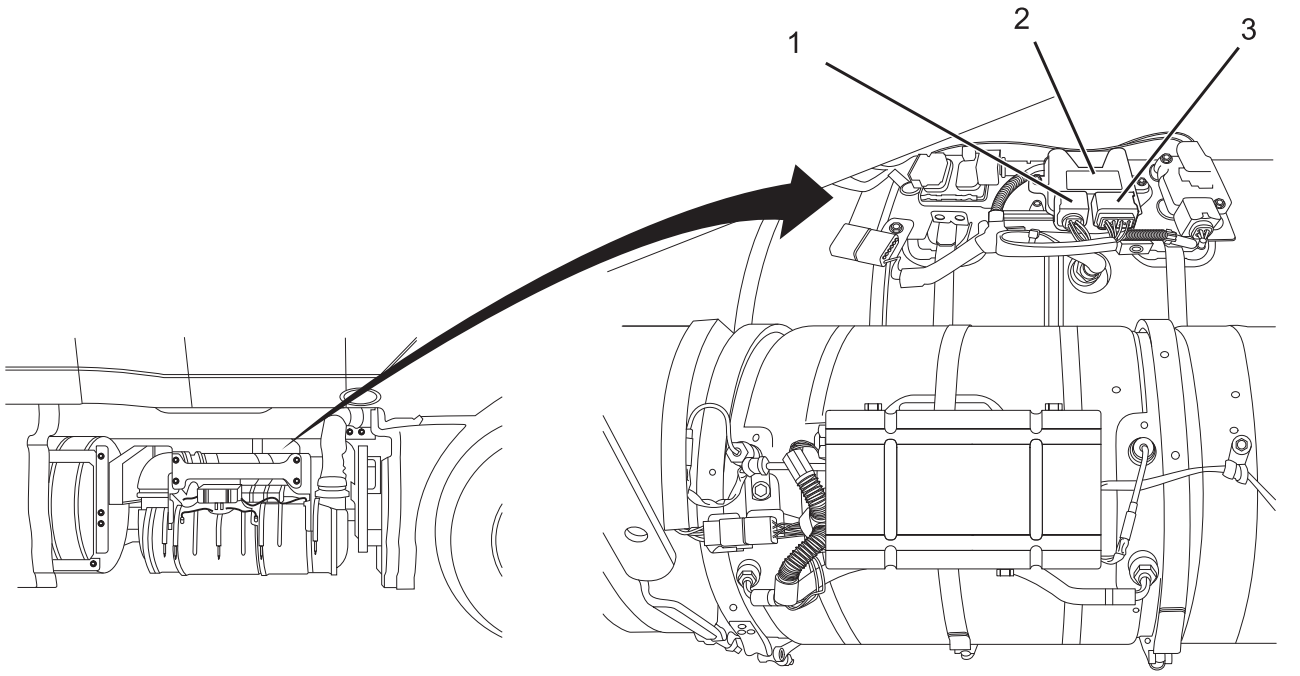

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Figure 193 NH_3 Sensor Module Location.

1. Ammonia (NH_3) sensor module 4-way connector
2. NH_3 sensor module
3. NH_3 sensor 8-way connector

Step	Action	Decision
1	Inspect connections at NH_3 sensor module. Key OFF, disconnect NH_3 sensor module. Check NH_3 sensor module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the NH_3 sensor module connector, harness, and terminals clean and undamaged?	Yes: Install correct NH_3 sensor. After repairs are complete, retest for SPN 4377 FMI 13.
		No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 4377 FMI 13

NOTE: After performing all diagnostic steps, if SPN 4377 FMI 13 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 4380 FMI 2- NH_3 Signal Erratic, Intermittent, or Incorrect

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Ammonia (NH_3) sensor power supply - erratic, intermittent, or incorrect resulting in an internal reset of the NH_3 sensor module.	Number of NH_3 sensor reset events ≥ 10 count within a 300 second window	{Key-On Engine-Running (KOER) AND (Inactive: SPN 4360 FMI 2, 3, 4 (SCRIT); and SPN 5743 FMI 3, 4, 11, 12, 16 (SCR) AND Exhaust gas temperature measured by thermistor closest to NH_3 sensor > 320°F (160°C) for 5 seconds.} >= 10 seconds	Immediate

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) has detected ten or more internal resets of the NH_3 sensor module. Engine torque will be reduced if the engine is operated for a limited period of time with this fault code active.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 168 FMI 16, 18 (ACM)

Fault Facts

The NH_3 sensor module shares common power and ground with the NOx Out, SCR temp sensor module, and other aftertreatment components. If more than one aftertreatment power or ground fault is set, suspect a common power or ground circuit problem.

Drive Cycle to Determine Fault Status

Drive Cycle 1 then 2 in 2013 HD-OBD Diagnostic Reference Manual.

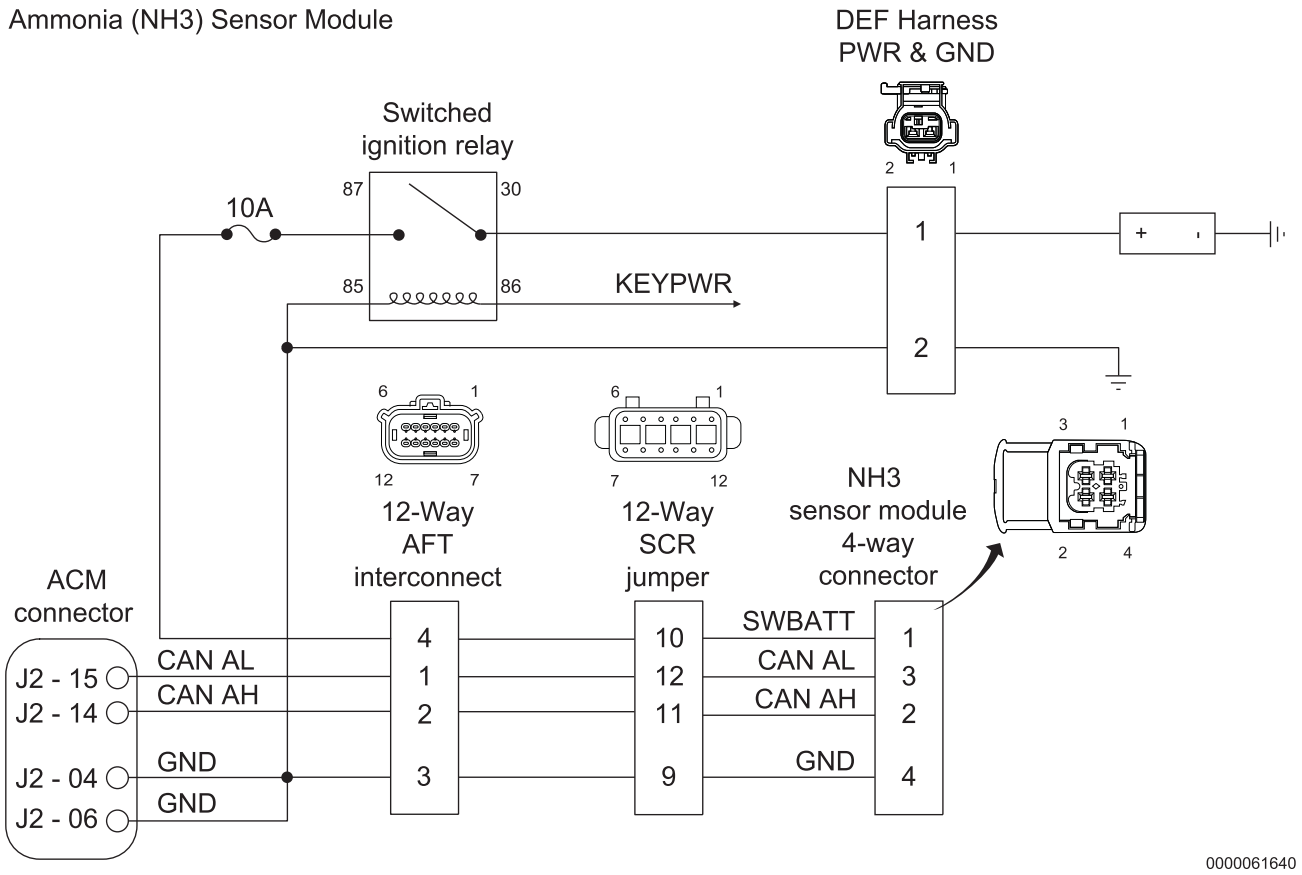

Figure 194 Ammonia (NH_3) Sensor Module Circuit Diagram

Possible Causes

- GND circuit intermittent Open or high resistance
- Low battery voltage
- Power Distribution Module (PDM) loose fuse or relay
- SWBAT circuit intermittent short to GND or Open
- Failed NH_3 sensor module

NOTE: Verify batteries are fully charged and connections are clean.

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 168 FMI 16 and 18 (ACM). Is EST DTC list free of SPN 168 FMI 16 and 18?	Yes: Go to step 2. No: Repair SPN 168 FMI 16 and 18. After repairs are complete, retest for SPN 4380 FMI 2.

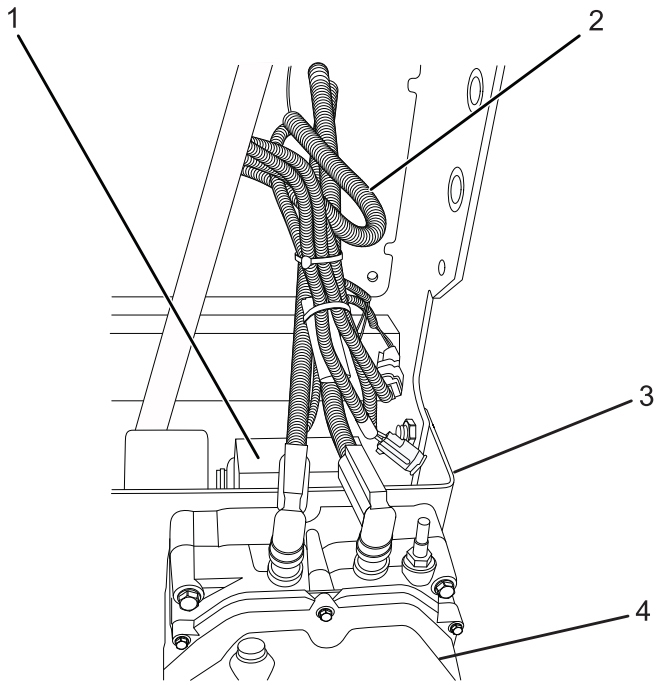

Figure 195 Power Distribution Module (PDM) Location (Typical)

1. Power Distribution Module (PDM)
2. DEF lines
3. DEF tank bracket
4. DEF supply module

Step	Action	Decision
2	Check Power Distribution Module (PDM) fuse(s) and relay(s) for blown fuses; loose, missing, or intermittent connections. Are all fuses and relays securely attached and in good condition?	Yes: Go to step 3.
		No: Secure or replace failed fuse(s) or relay(s) to PDM connector. After repairs are complete, retest for SPN 4380 FMI 2.

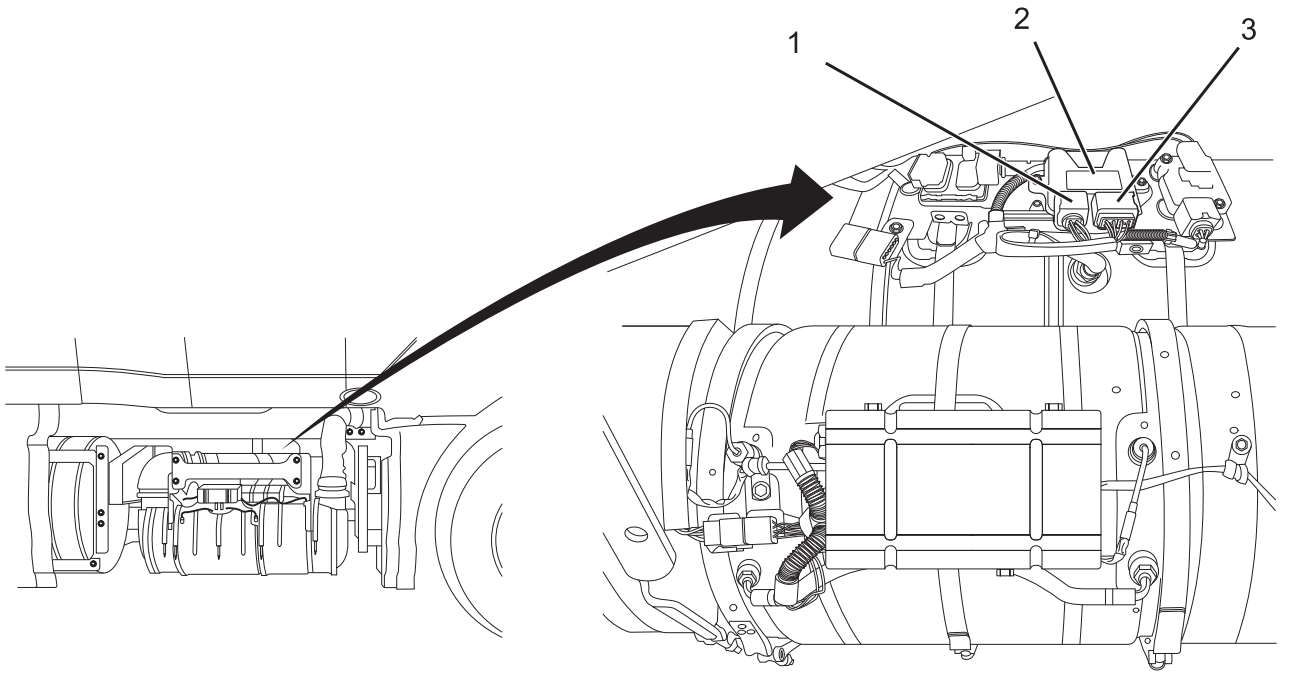

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Figure 196 NH_3 Sensor Module Location.

1. (Ammonia) NH_3 sensor module 4-way connector
2. NH_3 sensor module
3. NH_3 sensor 8-way connector

Step	Action	Decision
3	Inspect connections at the NH_3 sensor module 4-way. Key OFF, disconnect NH_3 sensor module 4-way. Check NH_3 sensor module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the NH_3 sensor module 4-way connector, harness, and terminals clean and undamaged?	Yes: Go to step 4. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 4380 FMI 2.

Step	Action	Decision
4	Check voltage to the NH_3 sensor module. Key-On Engine-Off (KOEO), with Breakout Harness 18-801-01 connected to NH_3 sensor module 4-way, use a DMM to measure voltage between NH_3 sensor module pin-1 and pin-4 (wiggle test may be necessary if code is inactive or pending). Is voltage consistent and within 0.5 volts of battery voltage?	Yes: Replace NH_3 sensor module. After repairs are complete, retest for SPN 4380 FMI 2 No: Go to step 5.

Step	Action	Decision
5	Check SWBAT circuit for intermittent Open or short to ground. KOEO, with Breakout Harness 18-801-01 connected to NH_3 sensor module 4-way, use a DMM to measure voltage between NH_3 sensor module pin-1 and a known good ground (wiggle test may be necessary if code is inactive or pending).	Yes: Repair Open or high resistance between NH_3 sensor module pin-4 and ground. After repairs are complete, retest for SPN 4380 FMI 2.
	Is voltage at pin-1 consistent and within 0.5 volts of battery voltage?	No: Repair Open or short to ground between NH_3 sensor module connector pin-1 and switched ignition relay pin-87. After repairs are complete, retest for SPN 4380 FMI 2.

NOTE: After performing all diagnostic steps, if SPN 4380 FMI 2 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 4380 FMI 16- NH_3 signal out of range high

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Higher voltage than expected detected at the Ammonia (NH_3) sensor module.	The voltage supplied to the NH_3 sensor module > 16 V.	Key ON	12 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) has detected higher than expected voltage supplied to the Ammonia (NH_3) sensor module. Engine torque will be reduced if the engine is operated for a limited period of time with the fault code active. Engine torque will be severely reduced and vehicle speed will be limited after extended operation with the fault code active.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 1 then 2 in 2013 HD-OBD Diagnostic Reference Manual.

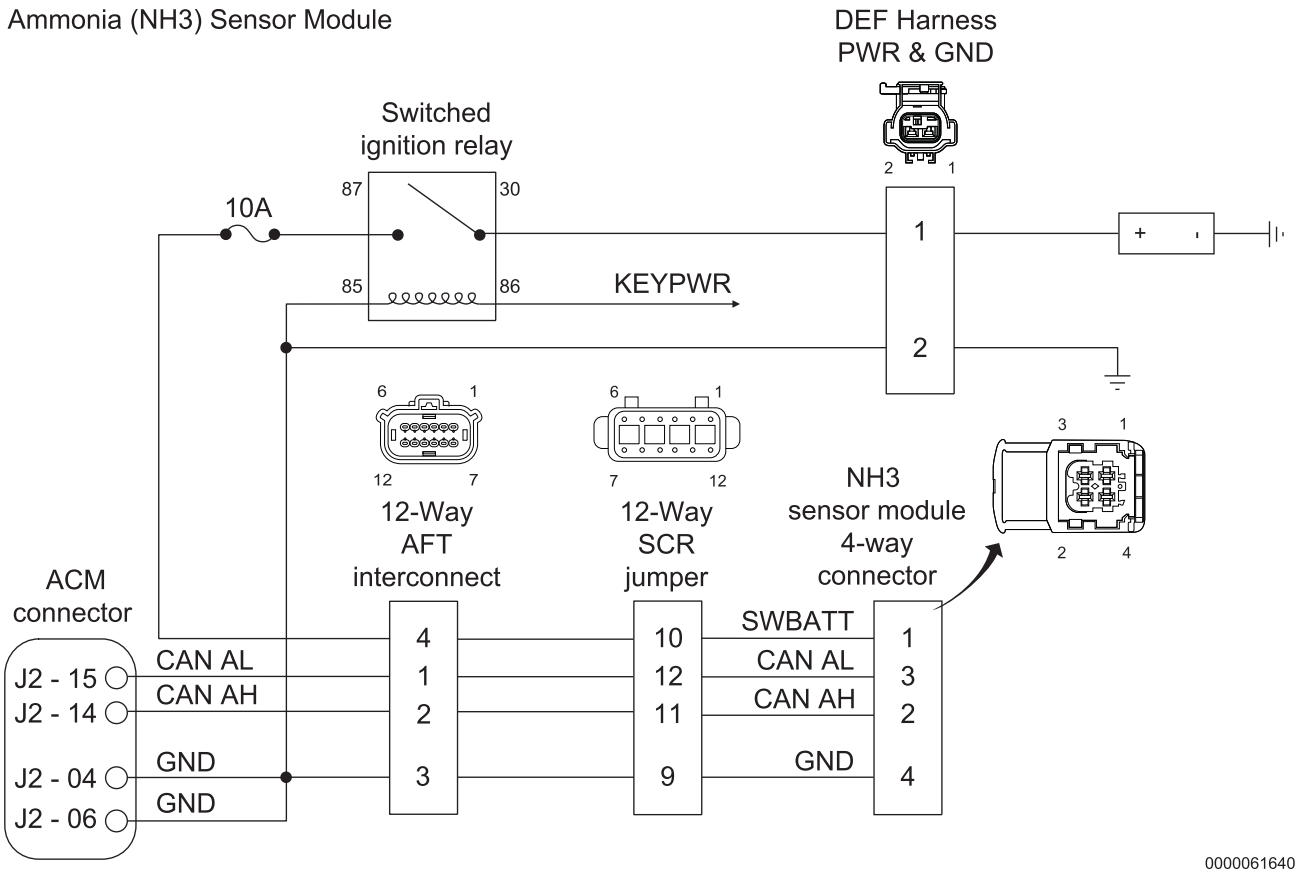

Figure 197 Ammonia (NH_3) Sensor Module Circuit Diagram

Possible Causes

- Charging voltage excessive
- Incorrect battery pack wiring (series instead of parallel)

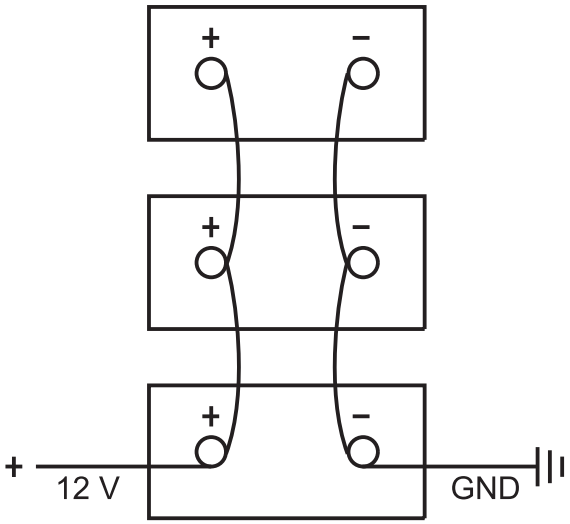

Figure 198 Parallel Battery Connections (12 Volt System)

Step	Action	Decision
1	Check for correct parallel battery pack wiring. Positive battery cable(s) should be connected from positive battery terminal to positive battery terminal. Negative battery cable(s) should be connected from negative battery terminal to negative battery terminal. Is battery pack correctly assembled (wired in parallel and not in series)?	Yes: Replace alternator. After repairs are complete, retest for SPN 4380 FMI 16. No: Reassemble battery pack. After repairs are complete, retest for SPN 4380 FMI 16.

Step	Action	Decision
2	Check charging voltage. Key-On Engine-Running (KOER), with Breakout Harness 18-801-01 connected to NH_3 sensor module 4-way, use a DMM to measure voltage between NH_3 sensor module pin-1 and pin-4. Is voltage between pin-1 and pin-4 within .5 volts of 14 volts.	Yes: Clear Fault Code. After repairs are complete, retest for SPN 4380 FMI 16. No: Replace alternator. After repairs are complete, retest for SPN 4380 FMI 16.

NOTE: After performing all diagnostic steps, if SPN 4380 FMI 16 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 4380 FMI 18 - NH_3 signal out of range low

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Voltage supplied to the Ammonia (NH_3) sensor module lower than expected.	Voltage supplied to the NH_3 sensor module < 10 V.	Key-On Engine-Running (KOER) Inactive: SPN 4360 FMI 2, 3, 4 (SCRIT); SPN 5743 FMI 3, 4, 11, 12, 16 (SCR) Exhaust gas temperature as measured by thermistor closest to NH_3 sensor > 320°F (160°C) for 5 seconds.	12 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) has detected that voltage supplied to the Ammonia (NH_3) sensor module is lower than expected. Engine torque will be reduced if the engine is operated for a limited period of time with the fault code active. Engine torque will be severely reduced and vehicle speed will be limited after extended operation with the fault code active.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 1 then 2 in 2013 HD-OBD Diagnostic Reference Manual.

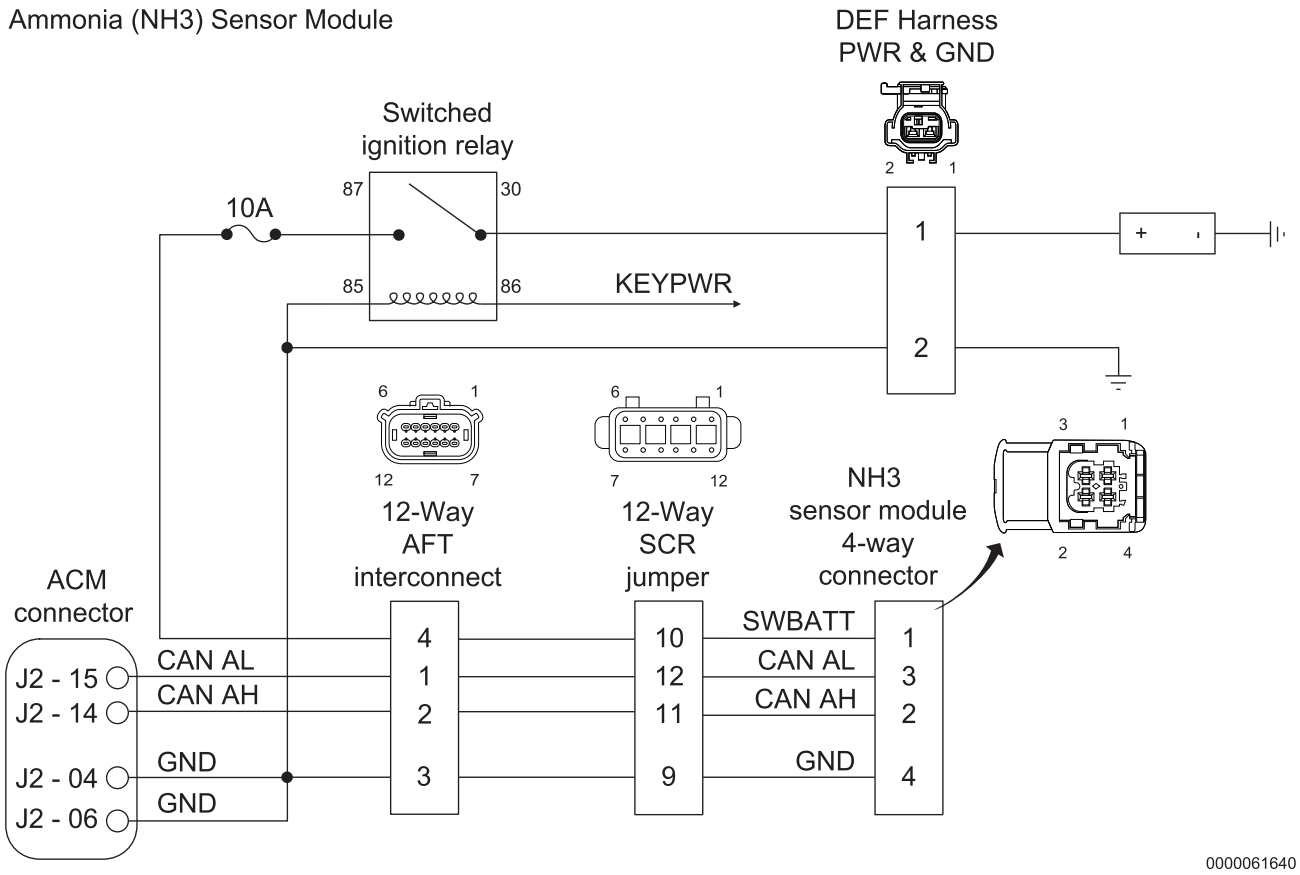

Figure 199 Ammonia (NH_3) Sensor Module Circuit Diagram

Possible Causes

- Low battery or charging system voltage
- SWBAT circuit high resistance
- GND circuit high resistance

NOTE: Verify batteries are fully charged and connections are clean.

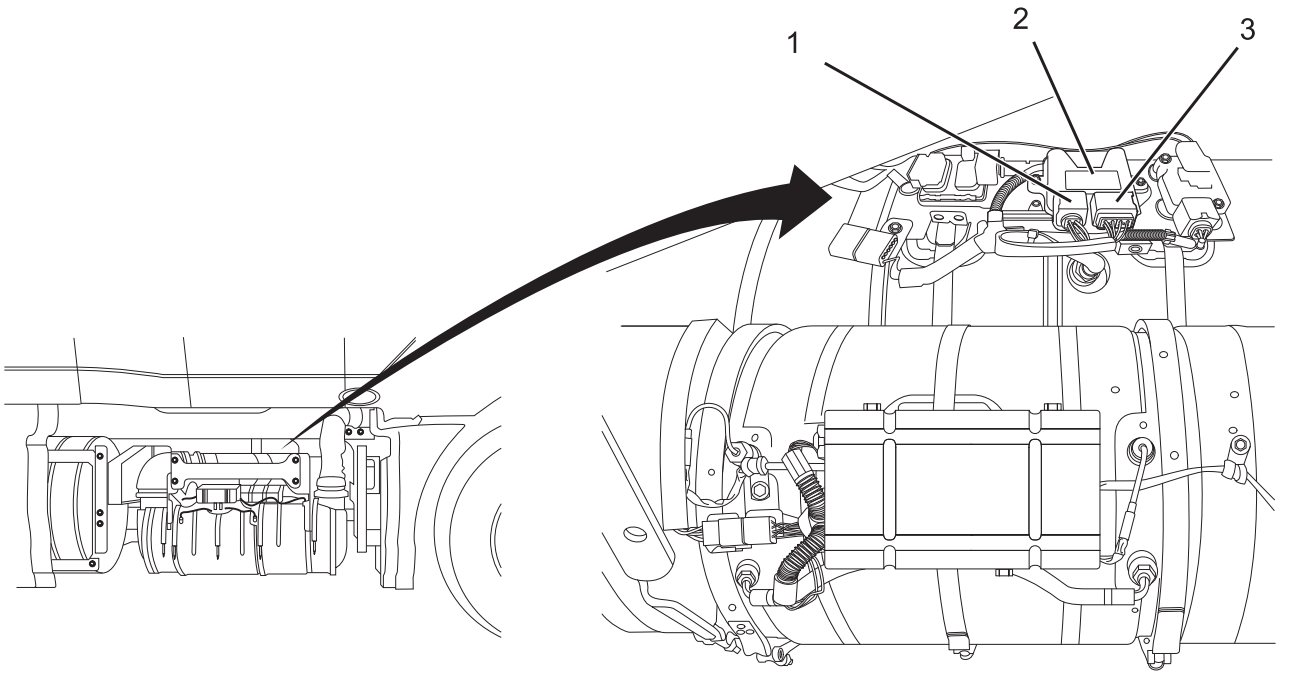

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Figure 200 NH_3 Sensor Module Location.

1. Ammonia (NH_3) sensor module 4-way connector
2. NH_3 sensor module
3. NH_3 sensor 8-way connector

Step	Action	Decision
1	Inspect connections at NH_3 sensor module 4-way connector. Key OFF, disconnect NH_3 sensor module 4-way. Check NH_3 sensor module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the NH_3 sensor module connector 4-way, harness, and terminals clean and undamaged?	Yes: Go to step 2. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 4380 FMI 18.

Step	Action	Decision
2	Check SWBAT circuit for high resistance. Key-On Engine-Off, with Breakout Harness 18-801-01 connected to NH_3 sensor module 4-way, use a DMM to measure voltage between NH_3 sensor module pin-1 and a known good ground. Is voltage at pin-1 within .5 volts of battery voltage.	Yes: Repair high resistance between NH_3 sensor module pin-4 and ground. After repairs are complete, retest for SPN 4380 FMI 18.
		No: Repair high resistance between NH_3 sensor module connector pin-1 and switched ignition relay pin-87. After repairs are complete, retest for SPN 4380 FMI 18.

NOTE: After performing all diagnostic steps, if SPN 4380 FMI 18 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 4382 FMI 10- NH_3 signal out of range high

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Ammonia (NH_3) sensor heater is unable to maintain operating temperature.	Time for NH_3 sensor heater to meet NH_3 operating temperature after enable conditions are satisfied ≥ 120 sec. Percentage of time when NH_3 sensor heater in NH_3 Not at operating temperature within a window of 180 second after first time NH_3 sensor met NH_3 At Operating Temperature Condition ≥ 50% Number of transitions from NH_3 At Operating Temperature, to NH_3 Not At Operating Temperature within a window of 180 seconds. After first time NH_3 sensor met NH_3 At Operating Temperature ≥ 20 counts	Key-On Engine-Running (KOER) Exhaust flow rate < 500 g / sec Exhaust temperature at NH_3 sensor location < 1058°F (570°C) Exhaust gas temperature measured by the temperature sensor closest to the NH_3 sensor > 320°F (160°C) for 5 seconds Ambient air temperature ≥ 21.2°F (-6°C) No reset on the NH_3 sensor since power up. NH_3 sensor at operating temperature Inactive: SPN 4360 FMI 2, 3, 4 (SCRIT); and SPN 5743 FMI 3, 4, 11, 12, 16 (SCR temp sensor module)	180 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the NH_3 sensor heater is unable to maintain its normal operating temperature.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 4377 FMI 4 (NH_3); SPN 4380 FMI 2 (NH_3)

Drive Cycle to Determine Fault Status

Drive Cycle 1 then 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Failed NH_3 sensor

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 4377 FMI 4 (NH_3) and SPN 4380 FMI 2 (NH_3). Is EST DTC list free of SPN 4377 FMI 4 and SPN 4380 FMI 2?	Yes: Replace NH_3 sensor. After repairs are complete, retest for SPN 4382 FMI 10. No: Repair SPN 4377 FMI 4 (NH_3) and SPN 4380 FMI 2 (NH_3). After repairs are complete, retest for SPN 4382 FMI 10.

NOTE: After performing all diagnostic steps, if SPN 4382 FMI 10 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 5302 FMI 18 - NH_3 Conversion Efficiency - Data Valid But Below Normal Operating Range - Moderately Severe Level

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Ammonia (NH_3) conversion is less than expected.	NH_3 conversion sensed at the NH_3 sensor module is low.	Key-On Engine-Running (KOER) SCR outlet temperature is ≥ catalyst activation temperature SCR outlet temperature is ≤ NH_3 oxidation temperature Data from NH_3 sensor is valid Data from NOx out sensor is valid Inactive: SPN 3226 (NOx OUT); SPN 3228 (NOx OUT); SPN 3242 (DPFIT); SPN 4360 (SCRIT); SPN 4363 (SCROT); SPN 4377 (NH_3); SPN 4380 (NH_3); SPN 4382 (NH_3); SPN 4765 (DOCIT); SPN 5742 (DOC / DPF); and SPN 5743 (SCR);	0 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects that the NH_3 conversion across the SCR catalyst is lower than expected. Engine torque will be reduced if the engine is operated for an extended period of time with this fault code active.

Malfunction Indicator Lamp (MIL) Reaction

When fault is active, MIL will not illuminate.

Associated Faults

SPN 3216 (NOx IN); SPN 3218 (NOx IN); SPN 3226 (NOx OUT); SPN 3228 (NOx OUT); SPN 3361 FMI 2, 3, and 4 (DEFSP); SPN 3362 FMI 31 (DEFSP); SPN 3363 FMI 3, 4, and 7 (DEFTHC); SPN 4334 FMI 2, 16 and 18 (DEFLP); SPN 4340 FMI 3 and 5 (DEFPLH); SPN 4342 FMI 3 and 5 (DEFRLH); SPN 4344 FMI 3 and 5 (DEFSLH); SPN 4360 FMI 2, 3 and 4 (SCRIT); SPN 4363 FMI 2, 3, and 4 (SCROT); SPN 4377 (NH_3); SPN 4380 (NH_3); SPN 4382 (NH_3); SPN 5394 FMI 5 and 7 (DEFDV); SPN 5743 (SCR temp sensor module); SPN 520668 (AFT system); and SPN 520669 (AFT system).

Fault Facts

NH_3 sensor data is gathered over varying engine speeds and loads. When enough data has been gathered, the ACM will make a pass / fail decision.

Drive Cycle to Determine Fault Status

Drive Cycle 33 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Exhaust system leak(s)
- Diesel Exhaust Fluid (DEF) tank, supply module, or doser valve lines or connections loose, leaking, damaged, or restricted
- Contaminated or degraded DEF
- Failed or restricted DEF Doser Valve (DEFDV)
- Restricted DEF supply module filter
- DEF crystallization or deposits in decomposition tube
- Failed Selective Catalyst Reduction (SCR) catalyst

Step	Action	Decision
1	Check for active Nitrogen Oxides (NOx) sensor module fault codes. Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3216 (NOx IN), SPN 3218 (NOx IN), SPN 3226 (NOx OUT), and SPN 3228 (NOx OUT). Is EST DTC list free of SPN 3216, SPN 3218, SPN 3226, and SPN 3228?	Yes: Go to step 2. No: Repair SPN 3216, SPN 3218, SPN 3226, and SPN 3228. After repairs are complete, retest for SPN 5302 FMI 18.

Step	Action	Decision
2	Check for active Ammonia (NH_3) sensor module fault codes. Using EST, check DTC list for SPN 4377 (NH_3), SPN 4380 (NH_3), and SPN 4382 (NH_3). Is EST DTC list free of SPN 4377, SPN 4380, and SPN 4382?	Yes: Go to step 3. No: Repair SPN 4377, SPN 4380, and SPN 4382. After repairs are complete, retest for SPN 5302 FMI 18.

Step	Action	Decision
3	Check for active Selective Catalyst Reduction (SCR) temperature sensor module fault codes. Using EST, check DTC list for SPN 4360 FMI 2, 3, and 4 (SCRIT); SPN 4363 FMI 2, 3, and 4 (SCROT); and SPN 5743 (SCR temp sensor module). Is EST DTC list free of SPN 4360 FMI 2, 3, and 4; SPN 4363 FMI 2, 3, and 4; and SPN 5743?	Yes: Go to step 4. No: Repair SPN 4360 FMI 2, 3, and 4; SPN 4363 FMI 2, 3, and 4; and SPN 5743. After repairs are complete, retest for SPN 5302 FMI 18.

Step	Action	Decision
4	Check for active Diesel Exhaust Fluid (DEF) dosing system fault codes. Using EST, check DTC list for SPN 3361 FMI 2, 3, and 4 (DEFSP); SPN 3362 FMI 31 (DEFSP); SPN 3363 FMI 3, 4, and 7 (DEFTHC); SPN 4334 FMI 2, 16, and 18 (DEFLP); SPN 4340 FMI 3 and 5 (DEFPLH); SPN 4342 FMI 3 and 5 (DEFRLH); SPN 4344 FMI 3 and 5 (DEFSLH); SPN 5394 FMI 5 and 7 (DEFDV); SPN 520668 (AFT system); and SPN 520669 (AFT system). Is EST DTC list free of SPN 3361 FMI 2, 3, and 4; SPN 3362 FMI 31; SPN 3363 FMI 3, 4, and 7; SPN 4334 FMI 2, 16, and 18; SPN 4340 FMI 3 and 5; SPN 4342 FMI 3 and 5; SPN 4344 FMI 3 and 5; SPN 5394 FMI 5 and 7; SPN 520668; and SPN 520669?	Yes: Go to step 5. No: Repair SPN 3361 FMI 2, 3, and 4; SPN 3362 FMI 31; SPN 3363 FMI 3, 4, and 7; SPN 4334 FMI 2, 16 and 18; SPN 4340 FMI 3 and 5; SPN 4342 FMI 3 and 5; SPN 4344 FMI 3 and 5; SPN 5394 FMI 5 and 7; SPN 520668; and SPN 20669. After repairs are complete, retest for SPN 5302 FMI 18.

Step	Action	Decision
5	Inspect exhaust system for leaks and physical damage. Is the exhaust system free of leaks and physical damage?	Yes: Go to step 6. No: Repair leaks or physical damage. After repairs are complete, retest for SPN 5302 FMI 18.

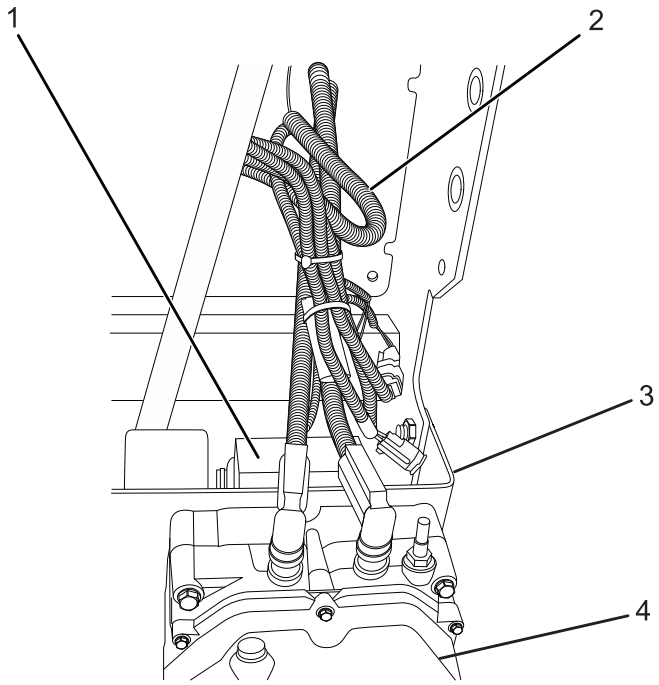

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Figure 201 DEF Supply Module Location (typical)

1. Power Distribution Module (PDM)
2. DEF Lines
3. DEF Tank Bracket
4. DEF Supply Module

Step	Action	Decision
6	Check Diesel Exhaust Fluid (DEF) tank, DEF supply module, and DEF Doser Valve (DEFDV) lines and connections for: cracks and pitting; loose, leaking, or damaged connections; and restrictions. Are the DEF tank, DEF supply module, and DEFDV lines and connections in good condition and unrestricted?	Yes: Go to step 7. No: Repair or replace failed line or connection. After repairs are complete, retest for SPN 5302 FMI 18.

Step	Action	Decision
7	Check DEF quality. Obtain a sample of DEF. Visually inspect for contamination and use DEF Refractometer 5025 to test urea concentration of DEF fluid. Is urea concentration between 30 - 34 percent and Not contaminated?	Yes: Go to step 8. No: Drain the DEF tank, flush with distilled water, and fill with new and / or known good DEF. After repairs are complete, retest for SPN 5302 FMI 18.

Step	Action	Decision
8	Verify correct Diesel Exhaust Fluid Doser Valve (DEFDV) operation. Using EST, do the DEF Doser Pump Override Test (page 98). Is the DEFDV operating correctly?	Yes: Go to step 9. No: Clean DEF supply module using 18-200-01. See DEF Supply Module Flush (page 107). If DEFDV still does not operate correctly, replace DEFDV. After repairs are complete, retest for SPN 5302 FMI 18.

Step	Action	Decision
9	Check decomposition tube for crystallization. Disconnect decomposition tube from exhaust system (see Exhaust System Service Manual) and inspect for DEF crystallization. Is decomposition tube free of DEF crystallization?	Yes: Replace SCR catalyst. After repairs are complete, retest for SPN 5302 FMI 18. No: Remove DEF crystallization from decomposition tube. After repairs are complete, retest for SPN 5302 FMI 18.

NOTE: After performing all diagnostic steps, if SPN 5302 FMI 18 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

CACOT Sensor (Charge Air Cooler Outlet Temperature)

SPN	FMI	Condition	Possible Causes	Actions
2630	2	CACOT signal does not agree with other sensors	• Biased CACOT sensor or circuit	Pin-Point Diagnostics (page 481)
2630	3	CACOT signal Out of Range HIGH	• CACOT signal circuit OPEN or short to PWR • SIG GND circuit OPEN • Failed CACOT sensor	Pin-Point Diagnostics (page 481)
2630	4	CACOT signal Out of Range LOW	• CACOT signal circuit short to GND • Failed CACOT sensor	Pin-Point Diagnostics (page 481)
2630	7	CACOT signal not responding as expected	• Biased CACOT sensor or circuit	Pin-Point Diagnostics (page 481)
2630	16	CACOT Undercooling	• Restricted CAC • Engine fan and/or engine fan shroud failure • Inoperative engine fan • Winter front installed outside recommended temperatures • Failed Coolant Control Valve (CCV)	Step-Based Diagnostics (page 483)

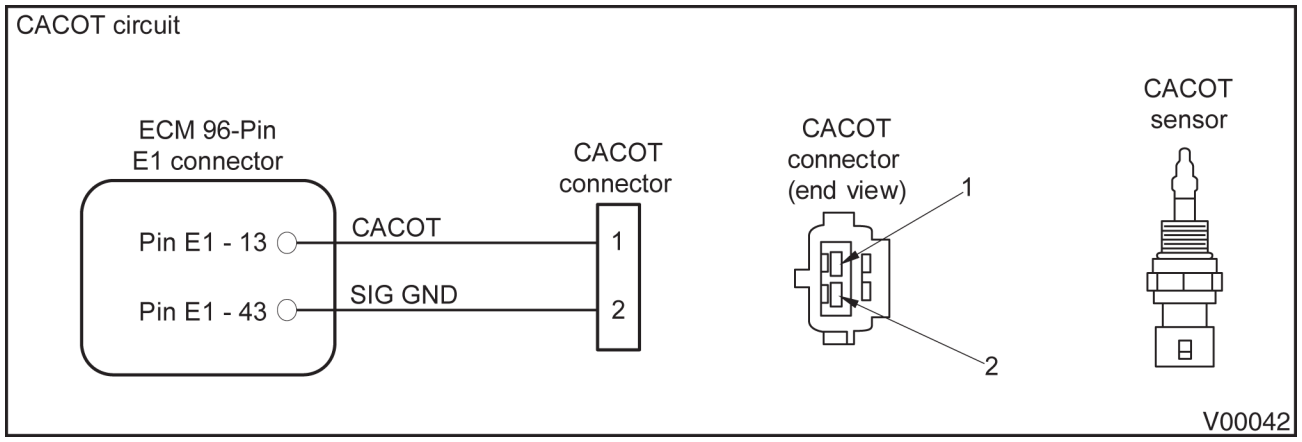

Figure 202 CACOT sensor circuit diagram

Overview

The Charge Air Cooler Outlet Temperature (CACOT) is a thermistor sensor that measures charged-air temperature entering the Engine Throttle Valve (ETV). As temperature increases, resistance drops, causing the voltage signal interpreted by the Engine Control Module (ECM) to vary. The ECM monitors this signal for Exhaust Gas Recirculation (EGR) system control and CAC performance.

Tools Required

- 180-Pin Breakout Box 00-00956-08
- 3-Banana Plug Harness ZTSE4498
- 500 Ohm Resistor Harness ZTSE4497
- Big Bore Terminal Test Probe Kit ZTSE4899
- Breakout Harness ZTSE4993 (CACOT)
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

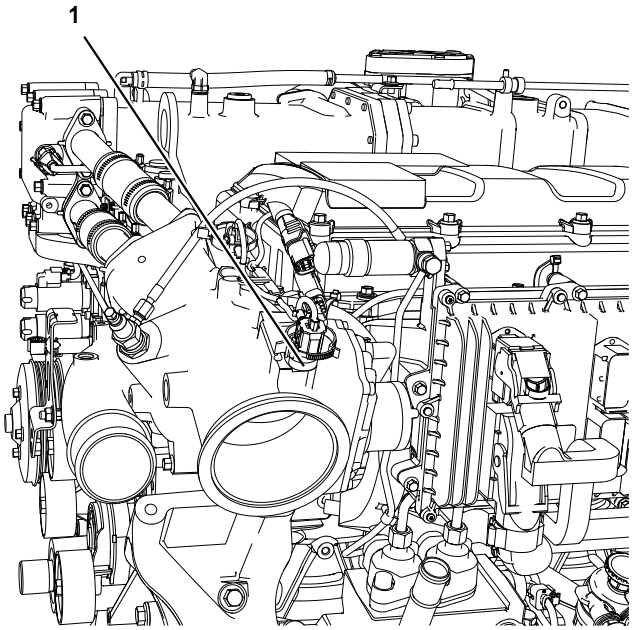

Figure 203 CACOT Sensor Location

1. Charge Air Cooler Outlet Temperature (CACOT) sensor

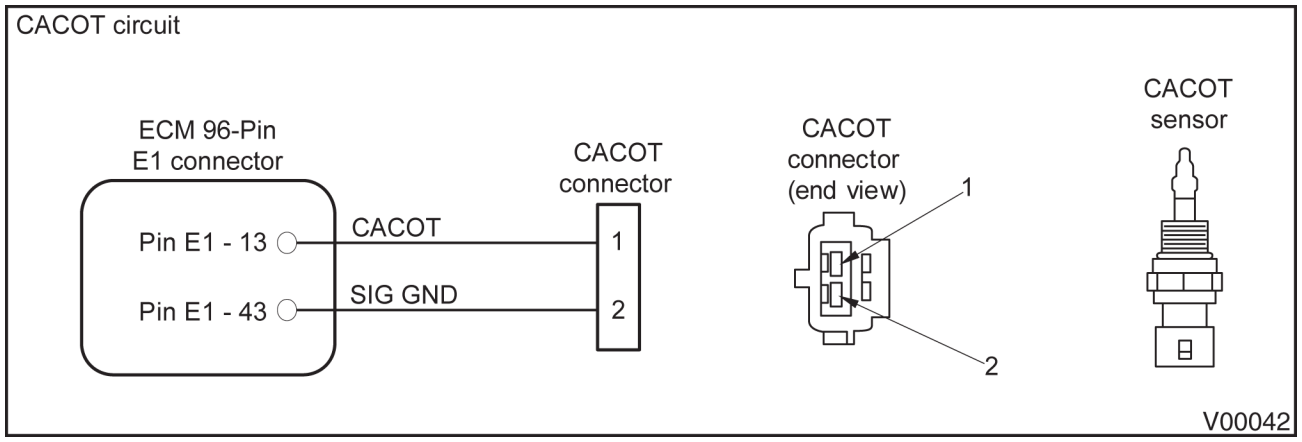

Figure 204 CACOT sensor circuit diagram

Pinpoint Diagnostics With ServiceMaxx™ Software

WARNING: To prevent personal injury or death, stay clear of rotating parts (belts and fan) and hot engine surfaces.

1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, run the Continuous Monitor test.
2. Monitor sensor voltage and verify an active DTC for this sensor.
   - If DTC is previously active, monitor signal while wiggling harness of suspect sensor. If circuit is interrupted, signal will spike and DTC will go active or pending.
   - If DTC is pending or active, continue to Cold Soak Sensor Compare Check.

NOTE: Inspect connectors for damaged pins, corrosion, or loose pins. Repair if necessary.

SPN 2630 FMI 2 – CACOT signal erratic, intermittent or incorrect

Cold Soak Sensor Compare Check With ServiceMaxx™ Software

NOTE: Temperature values need to be measured after 8 hours of cold soak.

1. Turn ignition switch ON, engine OFF.
2. Using ServiceMaxx™ software, open the Default session.
3. Compare CACOT to Ambient Air Temperature (AAT), Inlet Air Temperature (IAT), and Intake Manifold Temperature (IMT). Sensor temperatures should be within 5 °C (10 °F) of each other.
   - If CACOT is 5 °C (10 °F) above or below AAT, IAT, or IMT, check for poor circuitry going to the CACOT sensor.
   - If circuits are within specification, replace CACOT sensor.

Sensor Circuit Check With ServiceMaxx™ Software

Connect Breakout Harness ZTSE4993 to CACOT engine harness, and leave CACOT sensor disconnected. Turn ignition ON.

Test Point	Specifications	Comment– < Less than, > Greater than
EST – Monitor CACOTv	5 V	If <4.5 V, check CACOT signal circuit for short to GND.
EST – Monitor CACOTv Short pin 1 to 2	0 V	If > 0.25 V, check SIG GND circuit for OPEN. Do Harness Resistance Check (page 482).
EST – Monitor CACOTv Short 500 Ω resistor across pins 1 and 2	< 1.0 V	If > 1.0 V, check CACOT signal circuit for short to PWR.
If checks are within specification, connect sensor and clear DTCs. If active code remains, replace CACOT sensor.		

Connector Voltage Check Without ServiceMaxx™ Software

Connect Breakout Harness ZTSE4993 to CACOT engine harness, and leave CACOT sensor disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specifications	Comment – < Less than, > Greater than
1 to GND	4.5 V to 5 V	If < 4.5 V, check for OPEN or short to GND. Do Harness Resistance Check (page 482).
2 to B+	B+	If < B+, check for short to PWR.

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM E1 and E2 harness to ECM E1 and E2 connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE4993 to CACOT engine harness, and leave CACOT sensor disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
1 to E1-13	< 5 Ω	If > 5 Ω, check for OPEN circuit.
2 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
2 to E1-43	< 5 Ω	If > 5 Ω, check for OPEN circuit.

SPN 2630 FMI 16 - CACOT Undercooling

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Comparison of Charge Air Cooler Outlet Temperature (CACOT) sensor reading to modeled value. Actual cooler effectiveness is less than the threshold effectiveness.	Function of engine speed and load, corrected for vehicle speed and ambient air temp	Function of engine speed and load > 0 Key ON Vehicle speed > 6.2 mph Limp Home Mode = Inactive DPF Regeneration = Inactive Power Takeoff (PTO) Mode = Inactive Ambient Air Temperature (AAT) >50°F (10°C) and <131°F (55°C) Barometric pressure (BARO) > 11 psi (75 kPa)	3 events

Fault Overview

Fault sets when the Engine Control Module (ECM) determines the Charge Air Cooler Outlet Temperature (CACOT) sensor reading is greater than a predetermined value. The ECM uses vehicle speed and Ambient Air Temperature (AAT) to determine CAC effectiveness.

Malfunction Indicator Lamp (MIL) Reaction

When fault is active, MIL will not illuminate.

Associated Faults

SPN 647

Drive Cycle to Determine Fault Status

Drive cycle 4 in 2013 HD-OBD Diagnostic Reference Manual.

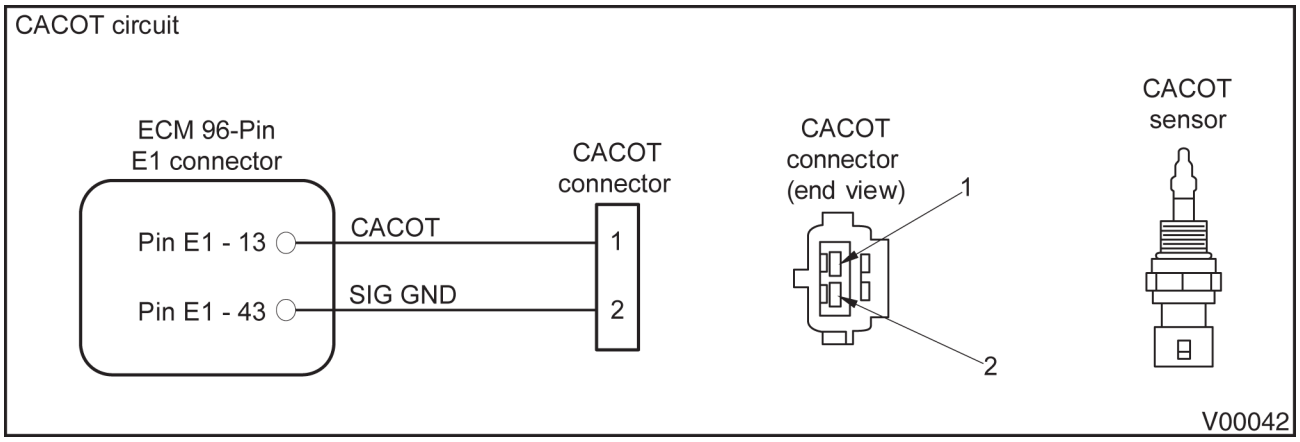

Figure 205 CACOT sensor circuit diagram

Possible Causes

- Restricted CAC
- Engine fan and/or engine fan shroud failure
- Inoperative engine fan
- Winter front installed outside recommended temperatures
- Failed Coolant Control Valve (CCV)

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for other fault codes. Is SPN 2630 FMI 16 the only fault code active?	Yes: Go to step 2. No: Repair other fault code(s). After repairs are complete, retest for SPN 2630 FMI 16.

Step	Action	Decision
2	Determine if a winter front (grill cover) is installed during warm temperatures. Is winter front (grill cover) removed during warm temperatures outside the recommended range?	Yes: Go to step 3. No: Remove winter front. After repairs are complete, retest for SPN 2630 FMI 16.

Step	Action	Decision
3	Inspect Charge Air Cooler (CAC) for damage, blockage, or anything that could prevent proper air flow through the CAC. Is the CAC undamaged, not blocked, and is air able to flow through it properly?	Yes: Go to step 4. No: Repair CAC damage or blockage. After repairs are complete, retest for SPN 2630 FMI 16.

Step	Action	Decision
4	Inspect for damage to the engine cooling fan and shroud. Are the engine cooling fan and shroud in good condition and not damaged?	Yes: Go to step 5. No: Repair engine cooling fan or shroud damage. After repairs are made, retest for SPN 2630 FMI 16.

Step	Action	Decision
5	Determine if engine cooling fan is working when engine is hot. Using EST with ServiceMaxx go to: Tests > KOER Tests > Engine Fan Test. Does engine cooling fan come ON when the engine gets hot (approximately 205°F (96°C) to 225°F (107°C) and above)?	Yes: Go to step 6. No: Diagnosis and repair engine cooling fan or circuit. See EFC (Engine Fan Control) Voltage and Harness resistance checks (page 1009). After repairs are complete, retest for SPN 2630 FMI 16.

Step	Action	Decision
6	Determine if Coolant Flow Valve (CFV) and Coolant Mixture Valve (CMV) are working correctly. Perform Coolant Control Valve (CCV) Test (page 156). Are the CFV and CMV operating correctly?	Yes: Verify each step was completed correctly and the proper decision was made. Notify supervisor for further action. No: Repair CCV. After repairs are complete, retest for SPN 2630 FMI 16.

NOTE: After performing all diagnostic steps, if SPN 2630 FMI 16 remains verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

CCOSS Sensor (Crankcase Oil Separator Speed)

SPN	FMI	Condition	Possible Causes	Actions
4227	7	CC Oil Separator Speed: Not spinning	• Crankcase Oil Separator failure • Crankcase Oil Separator circuit or sensor fault	Pin-Point Diagnostics (page 487)

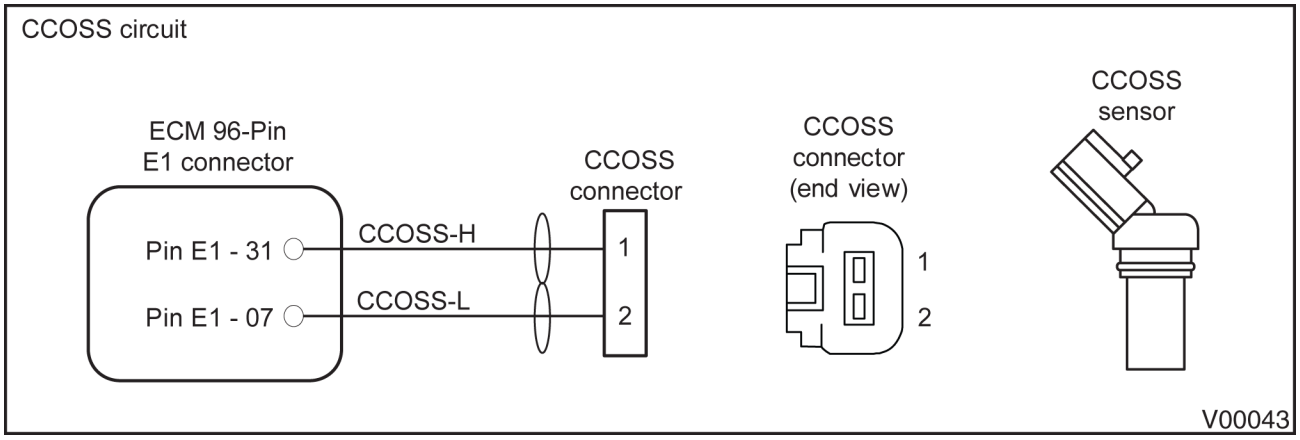

Figure 206 CCOSS circuit diagram

Tools Required

- 180-Pin Breakout Box 00-00956-08
- 2010 MaxxForce 11 & 13 Harness Kit 00-01462-00
- 3-Banana Plug Harness ZTSE4498
- 500 Ohm Resistor Harness ZTSE4497
- Big Bore Terminal Test Probe Kit ZTSE4899
- Breakout Harness ZTSE4951 (CCOSS)
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

WARNING: To prevent personal injury or death, stay clear of rotating parts (belts and fan) and hot engine surfaces.

Pinpoint Crankcase Oil Separator: Not spinning fault

1. Using ServiceMaxx™ software, monitor Crankcase Oil Separator signal while running the engine.
   - If CC Oil Separator signal stays at 0 rpm, verify sensor and voltage to sensor are within specification, go to Connector Voltage Check and Sensor Resistance Check.
   - If sensor resistance and sensor connector voltage are within specification, go to Crankcase Oil Breather Separator Test in “Engine Symptoms Diagnostics."

Sensor Resistance Check

Turn ignition switch to OFF. Connect Breakout Harness ZTSE4951 to CCOSS sensor and leave engine harness disconnected. Use DMM to measure resistance.

Test Point	Specifications	Comment – < Less than, > Greater than
1 to 2	300 Ω to 400 Ω	If not within specification, replace CCOSS sensor.

Connector Voltage Check Without ServiceMaxx™ software

Connect Breakout Harness ZTSE4951 to CCOSS engine harness, and leave CCOSS sensor disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specifications	Comment – < Less than, > Greater than
1 to GND	2.0 V – 2.5 V	If < 2.0 V, check for OPEN of short to GND. Do Harness Resistance Check.
2 to GND	2.0 V – 2.5 V	If < 2.0 V, check for OPEN of short to GND. Do Harness Resistance Check.

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM E1 and E2 harness to ECM E1 and E2 connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE4951 to CCOSS engine harness, and leave CCOSS sensor disconnected. Use DMM to measure resistance.

Test Point	Specifications	Comment – < Less than, > Greater than
E1-07 to 2	< 5 Ω	If > 5 Ω, check for OPEN circuit.
E1-07 to GND	> 1k Ω	If < 1k Ω, check for short to GND.
E1-31 to 1	< 5 Ω	If > 5 Ω, check for OPEN circuit.
E1-31 to GND	> 1k Ω	If < 1k Ω, check for short to GND.

CCS (Cruise Control System)

Function

The CCS is a function of the Electronic Control Module (ECM). Using the cruise control switches, the operator is able to set, resume, accelerate or coast to any desired vehicle speed within range of the system.

The ECM continuously monitors the clutch, brake and accelerator pedals before cruise can be activated, and is used to deactivate after cruise speed has been set.

CCS Operation

The cruise control switches are wired to the Body Controller (BC). The switch state is communicated to the ECM through the J1939 CAN Data Link network.

CCS Pinpoint Diagnostics – With ServiceMaxx™ Software

Programmable Parameters

Turn ignition switch ON. Connect EST to vehicle Diagnostic Connector. Using ServiceMaxx™ software, open the Programming session and verify all Parameters are set correctly.

Test Point	Specification	Comment
Cruse Control Mode	Enabled	If Disabled, change to Enabled

Switch Checks

Using ServiceMaxx™ software, open the Driver Switch Controls session to monitor signals.

NOTE:

- If signals are not within specification, diagnose switch interface with Body Controller (BC) or Multiplex System Module (MSM) module. See *Chassis Electrical Circuit Diagnostic Manual* and *Electrical System Troubleshooting Guides*.
- If signals are within specification, go to next test point.

Test Point	Specification	Comment
Brake Switch	Normal state = Released Depressed = Applied	See Note
Park brake	Normal state = OFF Depressed = ON	See Note
Cruise On/Off	Unlatched = OFF Latched = ON	See Note
Cruise Set	Normal state = OFF Depressed = ON	See Note
Cruise Resume / Accel	Normal state = OFF Depressed = ON	See Note
If all switches are within specifications, drive the vehicle and verify the Vehicle Speed Sensor (VSS) is working.		

CFV (Coolant Flow Valve)

SPN	FMI	Condition	Possible Causes	Actions
5547	3	CFV short to PWR	• CFV circuit short to PWR • Failed CFV	Circuit Checks (page 490)
5547	4	CFV short to GND	• CFV circuit short to GND • Failed CFV	Circuit Checks (page 490)
5547	5	CFV open load/circuit	• CFV circuit OPEN • Failed CFV	Circuit Checks (page 490)

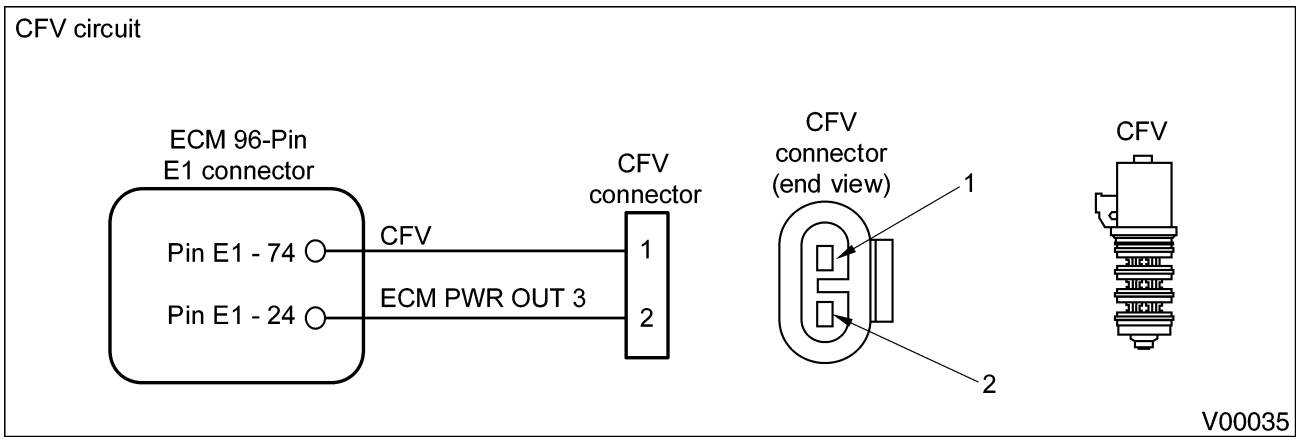

Figure 207 CFV circuit diagram

Connector Voltage Check

Connect Breakout Harness ZTSE4871 to CFV engine harness, and leave CFV disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specifications	Comment – < Less than, > Greater than
Pin 1 to GND	4 V ± 1 V	If < 3 V, check for OPEN or short to GND in CFV circuit. If > 5 V, check for short to PWR in CFV circuit.
Pin 2 to GND	B+	If < B+, check for OPEN in ECM PWR OUT 3 circuit.
If measurements are within specifications, go to Operational Voltage Check.		

Operational Voltage Check

NOTE: Ensure battery voltage is at or above 12 V, before running this procedure.

1. Connect Breakout Harness ZTSE4871 between CFV and engine harness.
2. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests > KOEO Tests > Actuator Test. Select Coolant Flow Valve from the drop-down menu.
3. Command Coolant Flow Valve to 5%, then 95%.
4. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	5% = 12.0 V ± 2.0 V	If < 10.0 V, check for OPEN circuit.
1 to GND	95% = 1.5 V ± 0.5 V	If > 2.0 V, check for OPEN circuit or failed CFV.

Actuator Resistance Check

Turn ignition switch OFF. Connect Breakout Harness ZTSE4871 to CFV and leave engine harness disconnected. Use DMM to measure resistance.

Test Point	Specifications	Comment
1 to 2	4 Ω to 8 Ω	If not within specification, replace the CFV.
If measurements are within specifications, go to Harness Resistance Check.		

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM E1 and E2 harness to ECM E1 and E2 connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE4871 to CFV engine harness, and leave CFV disconnected. Use DMM to measure resistance.

Test Point	Specifications	Comment – < Less than, > Greater than
1 to E1-74	< 5 Ω	If > 5 Ω, check for OPEN circuit.
1 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
2 to E1-24	< 5 Ω	If > 5 Ω, check for OPEN circuit.
2 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
If voltage and resistance checks are within specifications, the CFV is working correctly. See Coolant System (page 135) in “ENGINE SYMPTOMS DIAGNOSTICS” to diagnose a mechanical fault.		

CKP Sensor (Crankshaft Position)

SPN	FMI	Condition	Possible Causes	Actions
637	8	CKP signal noise	• Debris accumulation on the Crankshaft Position (CKP) sensor • CKP-L circuit intermittent high resistance • CKP-H circuit intermittent high resistance • CKP-L circuit intermittent short to GND • CKP-H circuit intermittent short to GND • CKP-L circuit intermittent short to CKP-H circuit • Failed CKP sensor	Step-Based Diagnostics (page 495)
637	10	CKP signal inactive	• Debris accumulation on the Crankshaft Position (CKP) sensor • CKP-L circuit Open or high resistance • CKP-H circuit Open or high resistance • CKP-L circuit short to GND • CKP-H circuit short to GND • CKP-L circuit shorted to CKP-H circuit • Failed CKP sensor	Step-Based Diagnostics (page 499)

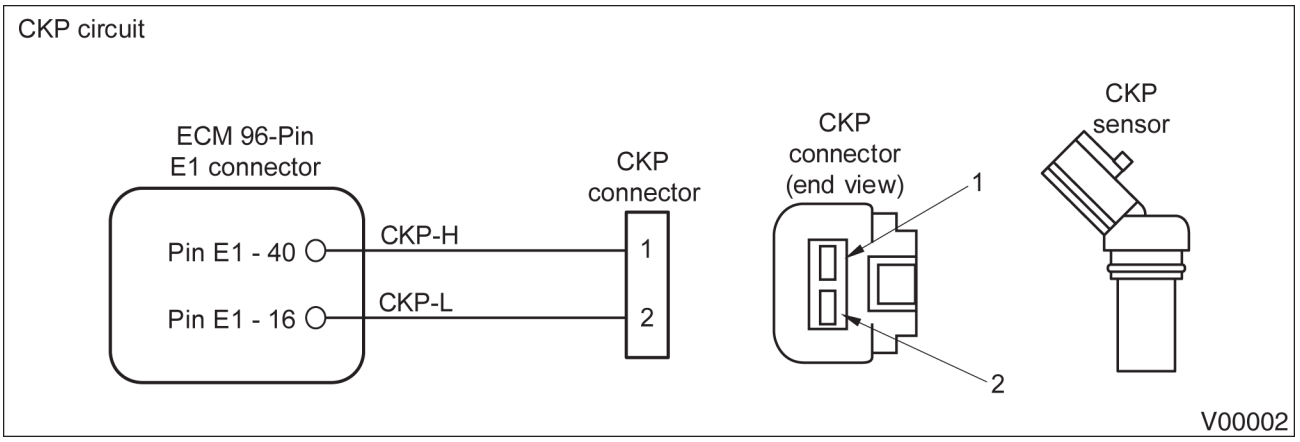

Figure 208 CKP sensor circuit diagram

Overview

The Crankshaft Position (CKP) sensor is a magnetic pickup sensor that indicates crankshaft speed and position. The CKP sensor is compared with the Camshaft Position (CMP) sensor by the Electronic Control Module (ECM) to calculate the RPM and timing of the engine. The engine will still start with a failed CKP or CMP sensor, but will have a longer crank time.

Tools Required

- 180-Pin Breakout Box 00-00956-08
- ECM Breakout Harness 00-01468-00
- Breakout Harness ZTSE6021 (CKP)
- International Electrical Engine. Terminal Test Kit ZTSE4435
- 500 Ohm Resistor Jumper Harness ZTSE4497
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

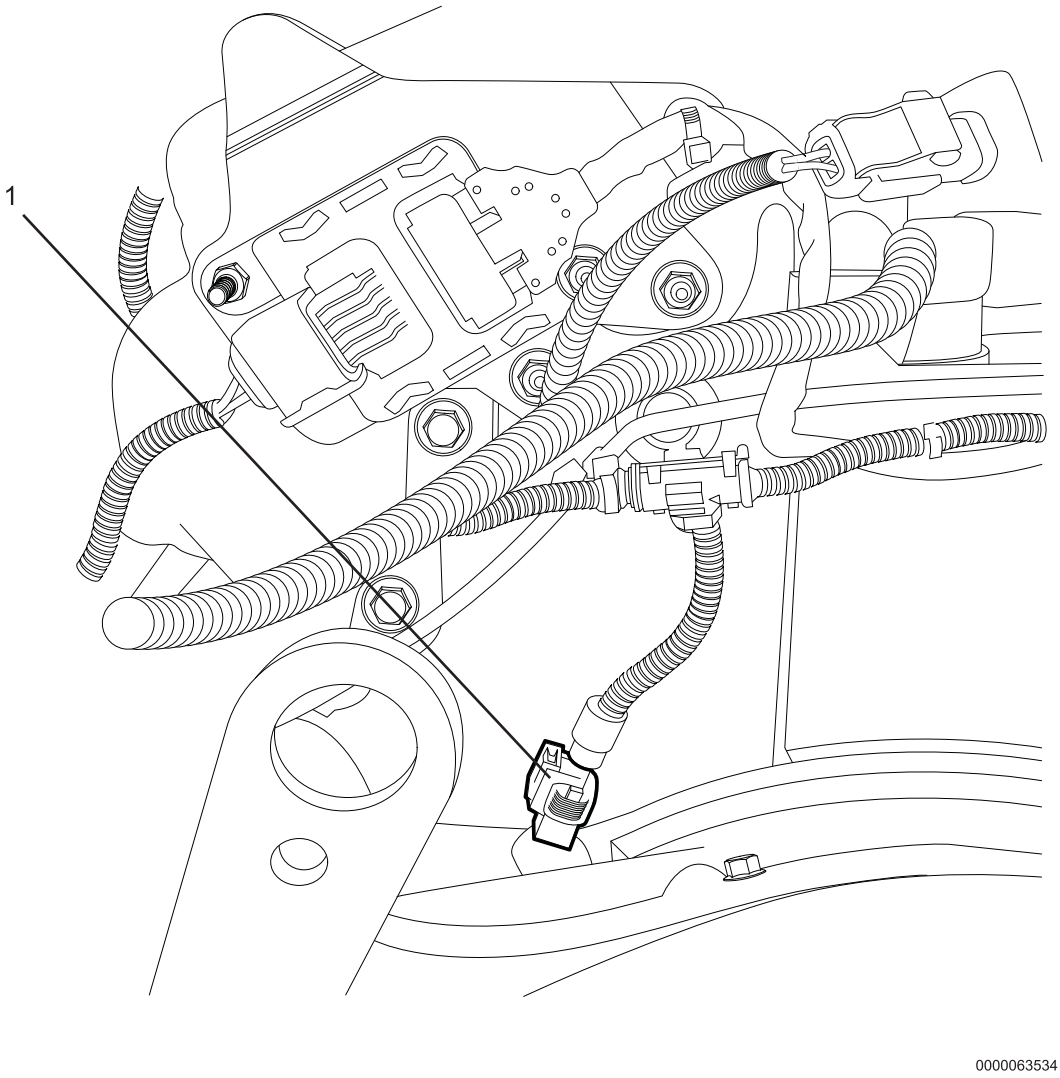

Figure 209 CKP Sensor Location (Back of Engine)

1. Crankshaft Position (CKP) sensor

SPN 637 FMI 8 - CKP signal noise

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Crankshaft Position (CKP) sensor signal greater than expected.	CKP signal > 8000 rpm	Engine cranking OR Key-On Engine-Running (KOER)	8 engine revolutions (per cam signal)

Fault Overview

Fault Code sets when the Electronic Control Module (ECM) detects the signal from the Crankshaft Position (CKP) sensor indicates engine speed is greater than 8000 rpm.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

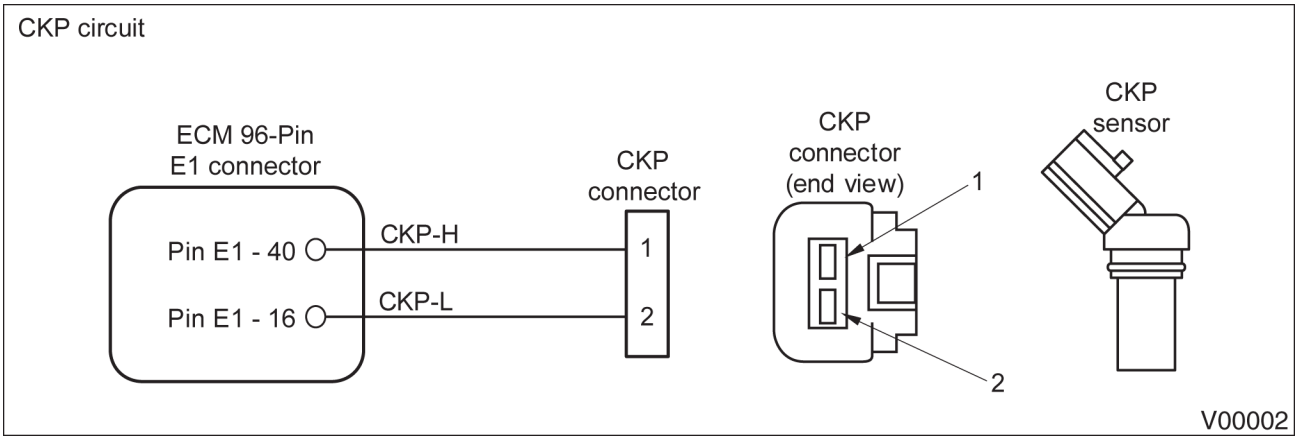

Figure 210 CKP sensor circuit diagram

Possible Causes

- Debris accumulation on the Crankshaft Position (CKP) sensor
- CKP-L circuit intermittent high resistance
- CKP-H circuit intermittent high resistance
- CKP-L circuit intermittent short to GND
- CKP-H circuit intermittent short to GND
- CKP-L circuit intermittent short to CKP-H circuit
- Failed CKP sensor

Step	Action	Decision
1	Inspect connections at Crankshaft Position (CKP) sensor. Key OFF, disconnect CKP sensor. Check sensor and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the CKP sensor connector, harness, and terminals clean and undamaged?	Yes: Go to step 2. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 637 FMI 8.

CAUTION: To prevent damage, do not use chemical cleaners to clean crankshaft position sensor.

Step	Action	Decision
2	Remove CKP sensor. Inspect sensor for debris build up on the sensor. Is the sensor free of damage or debris on the sensor surface?	Yes: Go to step 3. No: Clean CKP sensor with a rag or towel. After repairs are complete, retest for SPN 637 FMI 8.

Step	Action	Decision
3	Check for a failed CKP sensor. Connect Breakout Harness ZTSE6021 to CKP sensor, and leave vehicle harness disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness pin-1 and pin-2. Is resistance 774 - 946 Ohms?	Yes: Go to step 4. No: Replace CKP sensor. After repairs are complete, retest for SPN 637 FMI 8.

Step	Action	Decision
4	Check for intermittent short to GND in CKP-H circuit. Connect Breakout Harness ZTSE6021 to vehicle harness and leave CKP sensor disconnected. Key OFF Use a DMM to measure resistance between Breakout Harness pin-1 and a known good ground. Is resistance greater than 1000 ohms?	Yes: Go to step 5. No: Repair short to GND between CKP connector pin-1 and ECM pin E1-10. After repairs are complete, retest for SPN 637 FMI 8.

Step	Action	Decision
5	Check for intermittent short to GND in CKP-L circuit. Connect Breakout Harness ZTSE6021 to vehicle harness and leave CKP sensor disconnected. Key OFF, Use a DMM to measure resistance between Breakout Harness pin-2 and a known good ground. Is resistance greater than 1000 ohms?	Yes: Go to step 6. No: Repair short to GND between CKP connector pin-2 and ECM pin E1-16. After repairs are complete, retest for SPN 637 FMI 8.

Step	Action	Decision
6	Check CKP-H circuit for intermittent high resistance (voltage drop). 1. Key OFF, disconnect CKP sensor and Engine Control Module (ECM). 2. Connect Breakout Harness ZTSE6021 to vehicle harness, and leave CKP sensor disconnected. 3. Using a jumper wire, connect Breakout Harness pin-1 to a known good ground. 4. Insert proper terminal into the ECM vehicle harness pin E1-40. 5. Connect one end of the 500 Ohm Resistor Jumper Harness ZTSE4497 to pin previously installed, and the other end to PWR (use a jumper wire if needed). 6. Using a DMM, measure voltage between Breakout Harness pin-1 and ECM pin E1-40. Is voltage less than 0.3 volts?	Yes: Go to step 7. No: Repair intermittent high resistance between CKP connector pin-1 and ECM pin E1-40. After repairs are complete, retest for SPN 637 FMI 8.

Step	Action	Decision
7	Check CKP-L circuit for intermittent high resistance (voltage drop). 1. Key OFF, disconnect CKP sensor and Engine Control Module (ECM). 2. Connect Breakout Harness ZTSE6021 to vehicle harness, and leave CKP sensor disconnected. 3. Using a jumper wire, connect Breakout Harness pin-2 to a known good ground. 4. Insert proper terminal into the ECM vehicle harness pin E1-16. 5. Connect one end of the 500 Ohm Resistor Jumper Harness ZTSE4497 to pin previously installed, and the other end to PWR (use a jumper wire if needed). 6. Using a DMM, measure voltage between Breakout Harness pin-2 and ECM pin E1-16. Is voltage less than 0.3 volts?	Yes: Go to step 8. No: Repair intermittent high resistance between CKP connector pin-2 and ECM pin E1-16. After repairs are complete, retest for SPN 637 FMI 8.

Step	Action	Decision
8	Check for intermittent short CKP-L to CKP-H. With ECM Disconnected, connect Breakout Harness ZTSE6021 to vehicle harness, and leave CKP sensor disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness pin-1 to pin-2. Is resistance greater than 1000 ohms?	Yes: Go to step 9. No: Repair short between CKP-L and CKP-H circuits. After repairs are complete, retest for SPN 637 FMI 8.

Step	Action	Decision
9	Check for incorrect output from the CKP sensor. With ECM connected, connect Breakout Harness ZTSE6021 between CMP sensor and vehicle harness. Using DMM set to AC Volts - RPM2. Measure RPM between pin-1 and pin-2 during cranking, low idle, and high idle. Is RPM measured 99 RPM to 250 RPM at cranking, 549 RPM to 700 RPM at low idle, and 1250 RPM to 1500 RPM at high idle?	Yes: Clear code and retest for SPN 637 FMI 8. No: Replace CKP sensor. After repairs are complete, retest for SPN 637 FMI 8.

NOTE: After performing all diagnostic steps, if SPN 637 FMI 8 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 637 FMI 10 - CKP signal inactive

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
No Crankshaft Position (CKP) signal	CKP circuit voltage < 0.40 volts	Engine cranking OR Key-On Engine-Running (KOER)	10 camshaft revolutions

Fault Overview

Fault code sets when the Electronic Control Module (ECM) receives no signal from the Crankshaft Position (CKP) sensor.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

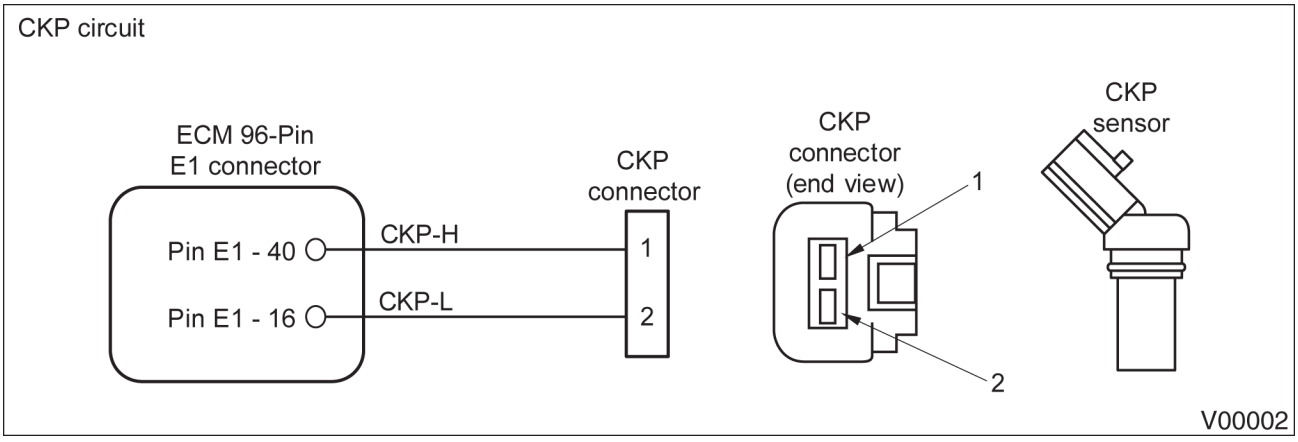

Figure 211 CKP sensor circuit diagram

Possible Causes

- Debris accumulation on the Crankshaft Position (CKP) sensor
- CKP-L circuit Open or high resistance
- CKP-H circuit Open or high resistance
- CKP-L circuit short to GND
- CKP-H circuit short to GND
- CKP-L circuit shorted to CKP-H circuit
- Failed CKP sensor

Step	Action	Decision
1	Inspect connections at Crankshaft Position (CKP) sensor. Key OFF, disconnect CKP sensor. Check sensor and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the CKP sensor connector, harness, and terminals clean and undamaged?	Yes: Go to step 2. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 637 FMI 10.

CAUTION: To prevent damage, do not use chemical cleaners to clean crankshaft position sensor.

Step	Action	Decision
2	Remove CKP sensor. Inspect sensor for debris build up on the sensor. Is the sensor free of damage or debris on the sensor surface?	Yes: Go to step 3. No: Clean CKP sensor with a rag or towel. After repairs are complete, retest for SPN 637 FMI 10.

Step	Action	Decision
3	Check for a failed CKP sensor. Connect Breakout Harness ZTSE6021 to CKP sensor and leave Breakout Harness disconnected from vehicle. Key OFF, use a DMM to measure resistance between Breakout Harness pin-1 and pin-2. Is resistance 774 – 946 Ohms?	Yes: Go to step 4. No: Replace CKP sensor. After repairs are complete, retest for SPN 637 FMI 10.

Step	Action	Decision
4	Check for short to GND in CKP-H circuit. Connect Breakout Harness ZTSE6021 to vehicle harness and leave CKP sensor disconnected. Key OFF Use a DMM to measure resistance between Breakout Harness pin-1 and a known good ground. Is resistance greater than 1000 ohms?	Yes: Go to step 5. No: Repair short to GND between CKP connector pin-1 and ECM pin E1-10. After repairs are complete, retest for SPN 637 FMI 10.

Step	Action	Decision
5	Check for short to GND in CKP-L circuit. Connect Breakout Harness ZTSE6021 to vehicle harness and leave CKP sensor disconnected. Key OFF, Use a DMM to measure resistance between Breakout Harness pin-2 and a known good ground. Is resistance greater than 1000 ohms?	Yes: Go to step 6. No: Repair short to GND between CKP connector pin-2 and ECM pin E1-16. After repairs are complete, retest for SPN 637 FMI 10.

Step	Action	Decision
6	Check CKP-H circuit for Open or high resistance (voltage drop). 1. Key OFF, disconnect CKP sensor and Engine Control Module (ECM). 2. Connect Breakout Harness ZTSE6021 to vehicle harness, and leave CKP sensor disconnected. 3. Using a jumper wire, connect Breakout Harness pin-1 to a known good ground. 4. Insert proper terminal into the ECM vehicle harness pin E1-40. 5. Connect one end of the 500 Ohm Resistor Jumper Harness ZTSE4497 to pin previously installed, and the other end to PWR (use a jumper wire if needed). 6. Using a DMM, measure voltage between Breakout Harness pin-1 and ECM pin E1-40. Is voltage less than 0.3 volts?	Yes: Go to step 7. No: Repair Open or high resistance between CKP connector pin-1 and ECM pin E1-40. After repairs are complete, retest for SPN 637 FMI 10.

Step	Action	Decision
7	Check CKP-L circuit for Open or high resistance (voltage drop). 1. Key OFF, disconnect CKP sensor and Engine Control Module (ECM). 2. Connect Breakout Harness ZTSE6021 to vehicle harness, and leave CKP sensor disconnected. 3. Using a jumper wire, connect Breakout Harness pin-2 to a known good ground. 4. Insert proper terminal into the ECM vehicle harness pin E1-16. 5. Connect one end of the 500 Ohm Resistor Jumper Harness ZTSE4497 to pin previously installed, and the other end to PWR (use a jumper wire if needed). 6. Using a DMM, measure voltage between Breakout Harness pin-2 and ECM pin E1-16. Is voltage less than 0.3 volts?	Yes: Go to step 8. No: Repair Open or high resistance between CKP connector pin-2 and ECM pin E1-16. After repairs are complete, retest for SPN 637 FMI 10.

Step	Action	Decision
8	Check for CKP-H shorted to CKP-L. With ECM Disconnected, connect Breakout Harness ZTSE6021 to vehicle harness and leave CMP sensor disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness pin-1 and pin-2. Is resistance greater than 1000 ohms?	Yes: Go to step 9. No: Repair short between CKP-H and CKP-L circuits. After repairs are complete, retest for SPN 637 FMI 10.

Step	Action	Decision
9	Check for a failed CKP sensor. Reconnect ECM. Connect Breakout Harness ZTSE6021 between CKP sensor and vehicle harness. Using a DMM set to measure AC frequency (Hz), measure the voltage of the sensor when cranking, low idle, and high idle (100-250 RPM). Is RPM measured 99 RPM to 250 RPM at cranking, 549 RPM to 700 RPM at low idle, and 1250 RPM to 1500 RPM at high idle?	Yes: Clear code and retest for SPN 637 FMI 10. No: Replace CKP sensor. After repairs are complete, retest for SPN 637 FMI 10.

NOTE: After performing all diagnostic steps, if SPN 637 FMI 10 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

CMP (Camshaft Position) Sensor

SPN	FMI	Condition	Possible Causes	Actions
636	2	CMP and CKP Synchronization Error	• Debris accumulation on the Camshaft Position (CMP) sensor • CMP-L high resistance • CMP-H high resistance • CMP-L short to GND • CMP-H short to GND • CMP-L shorted to CMP-H • Camshaft and Crankshaft not synchronized • Failed CMP	Step-Based Diagnostics (page 506)
636	8	CMP signal noise	• Debris accumulation on the Camshaft Position (CMP) sensor • CMP-L intermittent high resistance • CMP-H intermittent high resistance • CMP-L intermittent short to GND • CMP-H intermittent short to GND • CMP-L intermittent short to CMP-H • Failed CMP	Step-Based Diagnostics (page 510)
636	10	CMP signal inactive	• Debris accumulation on the Camshaft Position (CMP) sensor • CMP-L Open or high resistance	Step-Based Diagnostics (page 514)

- CMP-H Open or high resistance
- CMP-L short to GND
- CMP-H short to GND
- CMP-L shorted to CMP-H
- Failed CMP

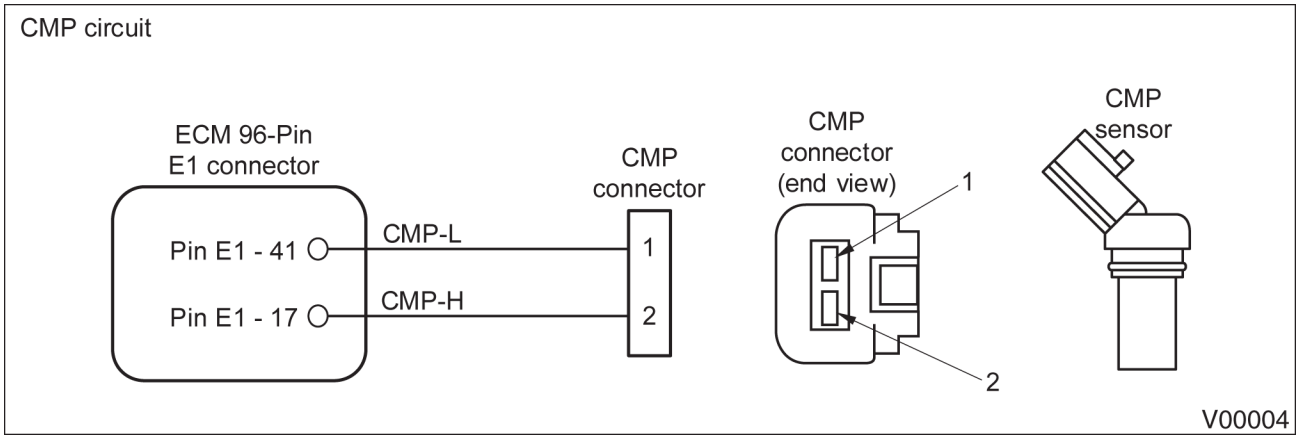

Figure 212 CMP sensor circuit diagram

NOTE: See latest version of N13 with SCR Engine and Aftertreatment Wiring Schematic Form 0000002203 for additional circuit information.

Overview

The Camshaft Position (CMP) sensor is a magnetic pickup sensor that indicates camshaft speed and position. The CMP sensor is compared with the Crankshaft Position (CKP) sensor by the Electronic Control Module (ECM) to calculate the RPM and timing of the engine. The engine will still start with a failed CMP or CKP sensor, but will have a longer crank time.

Tools Required

- 180-Pin Breakout Box 00-00956-08
- ECM Breakout Harness 00-01468-00
- Breakout Harness ZTSE6021
- International Electrical Engine. Terminal Test Kit ZTSE4435
- 500 Ohm Resistor Jumper Harness ZTSE4497
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

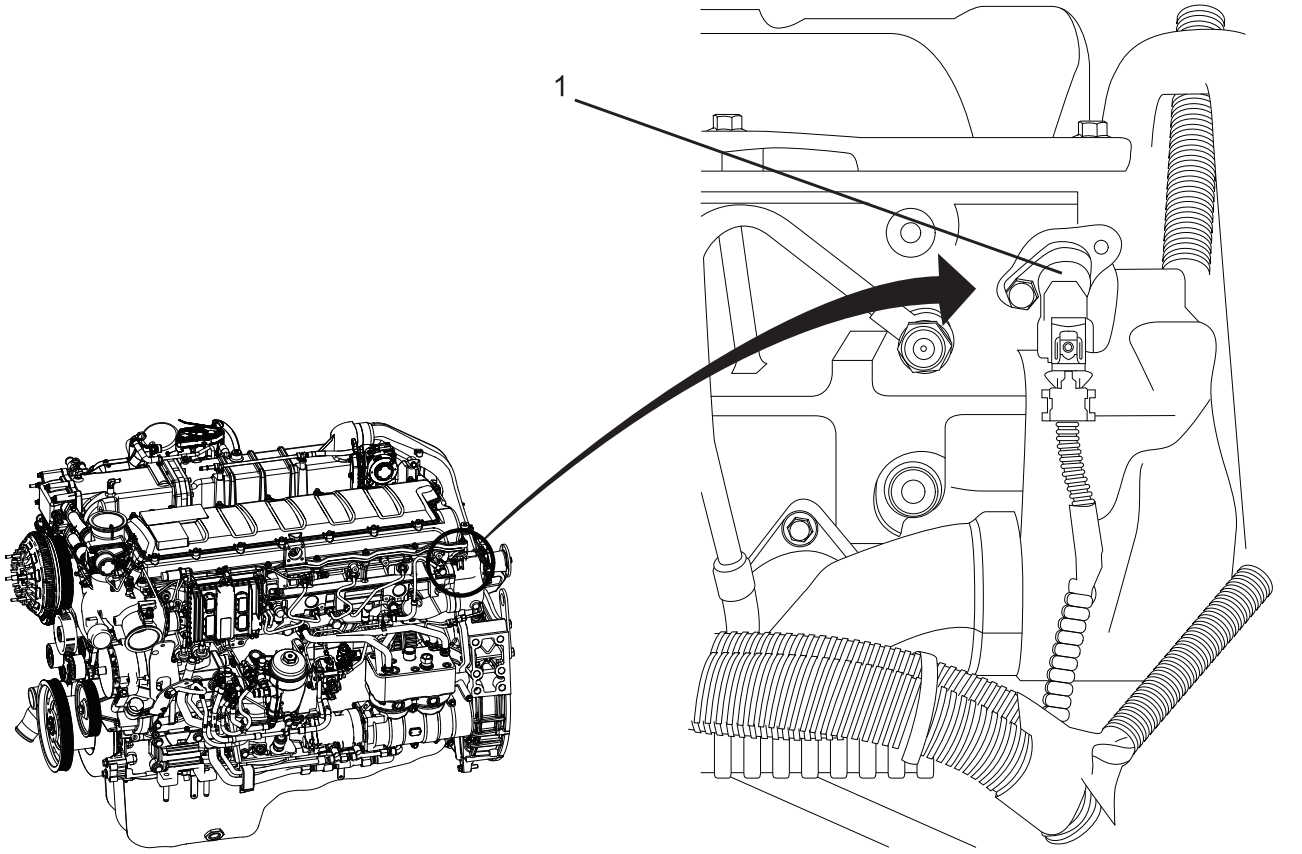

Figure 213 CMP Sensor Location

1. Camshaft Position (CMP) sensor

SPN 636 FMI 2 - CMP and CKP Synchronization Error

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Camshaft position signal error	Camshaft position signal error > 20 crank degrees OR < -20 crank degrees	Engine cranking OR Key-On Engine-Running (KOER)	2 consecutive camshaft revolutions

Fault Overview

Fault code sets when the Electronic Control Module (ECM) detects the difference between the camshaft and crankshaft position signals is > 20 degrees.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

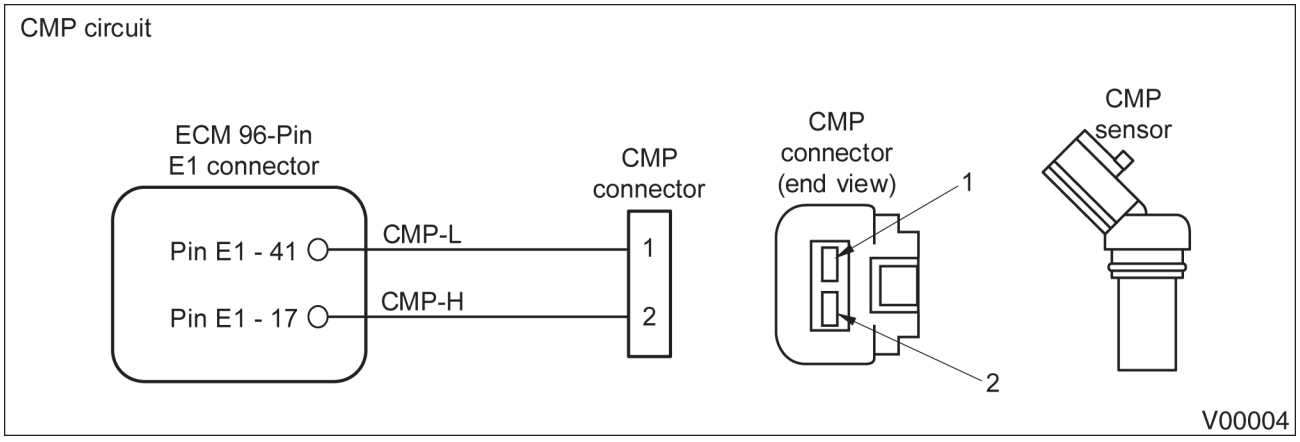

Figure 214 CMP sensor circuit diagram

Possible Causes

- Debris accumulation on the Camshaft Position (CMP) sensor
- CMP-L high resistance
- CMP-H high resistance
- CMP-L short to GND
- CMP-H short to GND
- CMP-L shorted to CMP-H
- Camshaft and Crankshaft not synchronized
- Failed CMP

Step	Action	Decision
1	Inspect connections at Camshaft Position (CMP) sensor. Key OFF, disconnect CMP sensor. Check CMP sensor and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the CMP sensor connector, harness, and terminals clean and undamaged?	Yes: Go to step 2. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 636 FMI 2.

CAUTION: To prevent damage, do not use chemical cleaners to clean camshaft position sensor.

Step	Action	Decision
2	Inspect CMP sensor and bore for damage or debris build up. Remove CMP sensor and inspect sensor and bore. Is the sensor and bore free of damage or debris?	Yes: Go to step 3. No: Clean or replace CMP sensor with a rag or towel and clean sensor bore. After repairs are complete, retest for SPN 636 FMI 2.

Step	Action	Decision
3	Check for a failed CMP sensor. Connect Breakout Harness ZTSE6021 to CMP sensor and leave Breakout Harness disconnected from vehicle harness. Key OFF, use a DMM to measure resistance between pin-1 and pin-2. Is CMP sensor resistance 774 to 946 ohms?	Yes: Go to step 4. No: Replace the CMP sensor. After repairs are complete, retest for SPN 636 FMI 2.

Step	Action	Decision
4	Check for short to GND in CMP-H circuit. Connect Breakout Harness ZTSE6021 to vehicle harness and leave sensor disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness pin-2 and a known good ground. Is resistance greater than 1000 ohms?	Yes: Go to step 5. No: Repair short to GND between CMP connector pin-2 and ECM pin E1-17. After repairs are complete, retest for SPN 636 FMI 2.

Step	Action	Decision
5	Check for short to GND in CMP-L circuit. Connect Breakout Harness ZTSE6021 to vehicle harness and leave sensor disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness pin-1 and a known good ground. Is resistance greater than 1000 ohms?	Yes: Go to step 6. No: Repair short to GND between CMP connector pin-1 and ECM pin E1-41. After repairs are complete, retest for SPN 636 FMI 2.

Step	Action	Decision
6	Check CMP-L circuit for high resistance (voltage drop). 1. Key OFF, disconnect CMP sensor and Engine Control Module (ECM). 2. Connect Breakout Harness ZTSE6021 to vehicle harness, and leave CMP sensor disconnected. 3. Using a jumper wire, connect Breakout Harness pin-1 to a known good ground. 4. Insert proper terminal into the ECM vehicle harness pin E1-41. 5. Connect one end of the 500 Ohm Resistor Jumper Harness ZTSE4497 to terminal previously installed, and the other end to PWR (use a jumper wire if needed). 6. Using a DMM, measure voltage between Breakout Harness pin-1 and ECM pin E1-41. Is voltage less than 0.3 volts?	Yes: Go to step 7. No: Repair high resistance between CMP connector pin-1 and ECM pin E1-41. After repairs are complete, retest for SPN 636 FMI 2.

Step	Action	Decision
7	Check CMP-H circuit for high resistance (voltage drop). 1. Key OFF, disconnect CMP sensor and Engine Control Module (ECM). 2. Connect Breakout Harness ZTSE6021 to vehicle harness, and leave CMP sensor disconnected. 3. Using a jumper wire, connect Breakout Harness pin-2 to a known good ground. 4. Insert proper terminal into the ECM vehicle harness pin E1-17. 5. Connect one end of the 500 Ohm Resistor Jumper Harness ZTSE4497 to terminal previously installed, and the other end to PWR (use a jumper wire if needed). 6. Using a DMM, measure voltage between Breakout Harness pin-2 and ECM pin E1-17. Is voltage less than 0.3 volts?	Yes: Go to step 8. No: Repair high resistance between CMP connector pin-2 and ECM pin E1-17. After repairs are complete, retest for SPN 636 FMI 2.

Step	Action	Decision
8	Check for CMP-L shorted to CMP-H. With ECM Disconnected, connect Breakout Harness ZTSE6021 to vehicle harness and leave CMP sensor disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness pin-1 and pin-2. Is resistance greater than 1000 ohms?	Yes: Go to step 9. No: Repair short between CMP-L and CMP-H. After repairs are complete, retest for SPN 636 FMI 2.

Step	Action	Decision
9	Check for incorrect output from the CMP sensor. With ECM connected, connect Breakout Harness ZTSE6021 between CMP sensor and vehicle harness. Using DMM set to AC Volts - RPM2. Measure RPM between pin-1 and pin-2 during cranking, low idle, and high idle. Is RPM measured 99 RPM to 250 RPM at cranking, 549 RPM to 700 RPM at low idle, and 1250 RPM to 1500 RPM at high idle?	Yes: Go to step 10. No: Replace the CMP sensor. After repairs are complete, retest for SPN 636 FMI 2.

Step	Action	Decision
10	Check for correct camshaft / crankshaft synchronization (see Engine Service Manual, "Cylinder Head, Camshaft and Valve Train" section). Are the camshaft and crankshaft timed properly?	Yes: Clear code and retest for SPN 636 FMI 2. No: Check for damage and re-time the camshaft and crankshaft. (see Engine Service Manual). After repairs are complete, retest for SPN 636 FMI 2.

NOTE: After performing all diagnostic steps, if SPN 636 FMI 2 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 636 FMI 8 - CMP signal noise

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Camshaft Position (CMP) sensor signal difference greater than expected.	CMP signal difference	Engine cranking OR Key-On Engine-Running (KOER)	4 engine revolutions

Fault Overview

Fault code sets when the Electronic Control Module (ECM) detects Camshaft Position (CMP) sensor signal difference is greater than expected.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

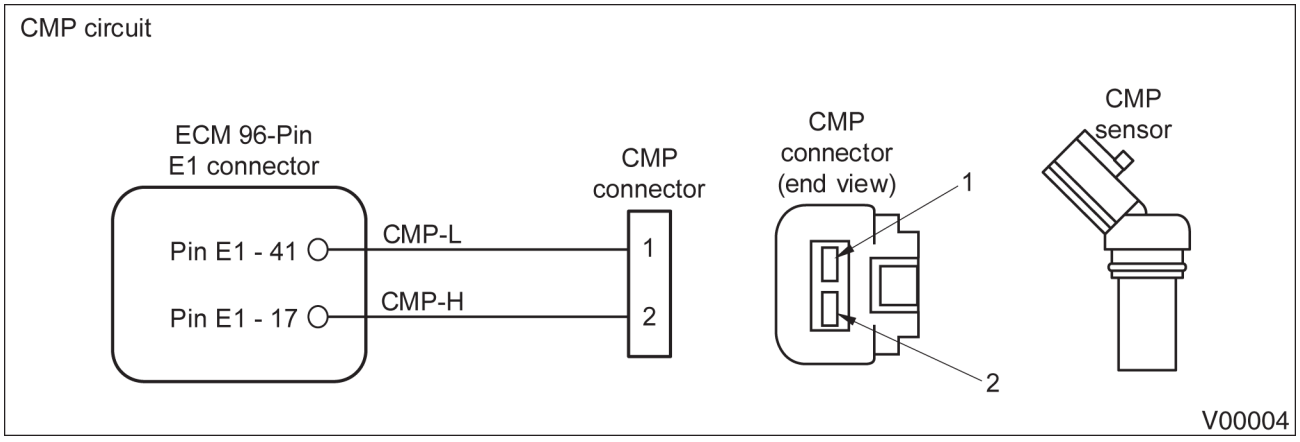

Figure 215 CMP sensor circuit diagram

Possible Causes

- Debris accumulation on the Camshaft Position (CMP) sensor
- CMP-L intermittent high resistance
- CMP-H intermittent high resistance
- CMP-L intermittent short to GND
- CMP-H intermittent short to GND
- CMP-L intermittent short to CMP-H
- Failed CMP

Step	Action	Decision
1	Inspect connections at Camshaft Position (CMP) sensor. Key OFF, disconnect CMP sensor. Check CMP sensor and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the CMP sensor connector, harness, and terminals clean and undamaged?	Yes: Go to step 2. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 636 FMI 8.

CAUTION: To prevent damage, do not use chemical cleaners to clean camshaft position sensor.

Step	Action	Decision
2	Remove CMP sensor. Inspect sensor for damage or debris build up on the sensor. Is the sensor free of damage or debris on the sensor surface?	Yes: Go to step 3. No: Clean CMP sensor with a rag or towel. After repairs are complete, retest for SPN 636 FMI 8.

Step	Action	Decision
3	Check for a failed CMP sensor. Connect Breakout Harness ZTSE6021 to CMP sensor and leave Breakout Harness disconnected from vehicle. Key OFF, use a DMM to measure resistance between Breakout Harness pin-1 and pin-2. Is resistance 774 to 946 ohms?	Yes: Go to step 4. No: Replace the CMP sensor. After repairs are complete, retest for SPN 636 FMI 8.

Step	Action	Decision
4	Check for intermittent short to GND in CMP-H circuit. Connect Breakout Harness ZTSE6021 to vehicle harness and leave sensor disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness pin-2 and a known good ground. Is resistance greater than 1000 ohms?	Yes: Go to step 5. No: Repair intermittent short to GND between CMP connector pin-2 and ECM pin E1-17. After repairs are complete, retest for SPN 636 FMI 8.

Step	Action	Decision
5	Check for short to GND in CMP-L circuit. Connect Breakout Harness ZTSE6021 to vehicle harness and leave sensor disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness pin-1 and a known good ground. Is resistance greater than 1000 ohms?	Yes: Go to step 6. No: Repair intermittent short to GND between CMP connector pin-1 and ECM pin E1-41. After repairs are complete, retest for SPN 636 FMI 8.

Step	Action	Decision
6	Check CMP-L circuit for intermittent high resistance (voltage drop). 1. Key OFF, disconnect CMP sensor and Engine Control Module (ECM). 2. Connect Breakout Harness ZTSE6021 to vehicle harness, and leave CMP sensor disconnected. 3. Using a jumper wire, connect Breakout Harness pin-1 to a known good ground. 4. Insert proper terminal into the ECM vehicle harness pin E1-41. 5. Connect one end of the 500 Ohm Resistor Jumper Harness ZTSE4497 to terminal previously installed, and the other end to PWR (use a jumper wire if needed). 6. Using a DMM, measure voltage between Breakout Harness pin-1 and ECM pin E1-41. Is voltage less than 0.3 volts?	Yes: Go to step 7. No: Repair intermittent high resistance between CMP connector pin-1 and ECM pin E1-41. After repairs are complete, retest for SPN 636 FMI 8.

Step	Action	Decision
7	Check CMP-H circuit for intermittent high resistance (voltage drop). 1. Key OFF, disconnect CMP sensor and Engine Control Module (ECM). 2. Connect Breakout Harness ZTSE6021 to vehicle harness, and leave CMP sensor disconnected. 3. Using a jumper wire, connect Breakout Harness pin-2 to a known good ground. 4. Insert proper terminal into the ECM vehicle harness pin E1-17. 5. Connect one end of the 500 Ohm Resistor Jumper Harness ZTSE4497 to terminal previously installed, and the other end to PWR (use a jumper wire if needed). 6. Using a DMM, measure voltage between Breakout Harness pin-2 and ECM pin E1-17. Is voltage less than 0.3 volts?	Yes: Go to step 8. No: Repair intermittent high resistance between CMP connector pin-2 and ECM pin E1-17. After repairs are complete, retest for SPN 636 FMI 8.

Step	Action	Decision
8	Check for intermittent short CMP-L to CMP-H. With ECM disconnected, connect Breakout Harness ZTSE6021 to vehicle harness and leave CMP sensor disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness pin-1 and pin-2. Is resistance greater than 1000 ohms?	Yes: Go to step 9. No: Repair short between CMP-L and CMP-H circuits. After repairs are complete, retest for SPN 636 FMI 8.

Step	Action	Decision
9	Check for incorrect output from the CMP sensor. Connect Breakout Harness ZTSE6021 between CMP sensor and vehicle harness. Using DMM set to AC Volts - RPM2. Measure RPM between pin-1 and pin-2 during cranking, low idle, and high idle. Is RPM measured 99 RPM to 250 RPM at cranking, 549 RPM to 700 RPM at low idle, and 1250 RPM to 1500 RPM at high idle?	Yes: Clear code and retest for SPN 636 FMI 8. No: Replace the CMP Sensor. After repairs are complete, retest for SPN 636 FMI 8.

NOTE: After performing all diagnostic steps, if SPN 636 FMI 8 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 636 FMI 10 - CMP signal inactive

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
No Camshaft Position (CMP) signal.	CMP circuit voltage < 0.405 volts	Engine cranking OR Key-On Engine-Running (KOER)	4 engine revolutions

Fault Overview

Fault code sets when the Electronic Control Module (ECM) receives no signal from the Camshaft Position (CMP) sensor.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

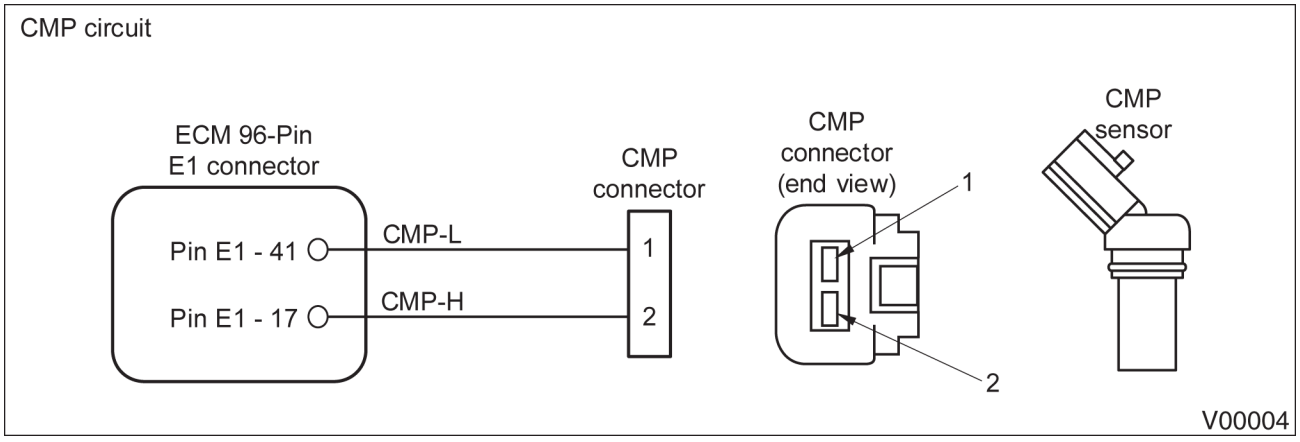

Figure 216 CMP sensor circuit diagram

Possible Causes

- Debris accumulation on the Camshaft Position (CMP) sensor
- CMP-L Open or high resistance
- CMP-H Open or high resistance
- CMP-L short to GND
- CMP-H short to GND
- CMP-L shorted to CMP-H
- Failed CMP

Step	Action	Decision
1	Inspect connections at Camshaft Position (CMP) sensor. Key OFF, disconnect CMP sensor. Check CMP sensor and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the CMP sensor connector, harness, and terminals clean and undamaged?	Yes: Go to step 2. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 636 FMI 10.

CAUTION: To prevent damage, do not use chemical cleaners to clean camshaft position sensor.

Step	Action	Decision
2	Remove CMP sensor. Inspect sensor for damage or debris build up on the sensor. Is the sensor free of damage or debris on the sensor surface?	Yes: Go to step 3. No: Clean CMP sensor with a rag or towel. After repairs are complete, retest for SPN 636 FMI 10.

Step	Action	Decision
3	Check for a failed CMP sensor. Connect Breakout Harness ZTSE6021 to CMP sensor and leave Breakout Harness disconnected from vehicle. Using DMM, measure resistance between pin-1 and pin-2. Is resistance 774 – 946 ohms?	Yes: Go to step 4. No: Replace the CMP sensor. After repairs are complete, retest for SPN 636 FMI 10.

Step	Action	Decision
4	Check for short to GND in CMP-H circuit. Connect Breakout Harness ZTSE6021 to vehicle harness and leave sensor disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness pin-2 and a known good ground. Is resistance greater than 1000 ohms?	Yes: Go to step 5. No: Repair short to GND between CMP connector pin-2 and ECM pin E1-17. After repairs are complete, retest for SPN 636 FMI 10.

Step	Action	Decision
5	Check for short to GND in CMP-L circuit. Connect Breakout Harness ZTSE6021 to vehicle harness and leave sensor disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness pin-1 and a known good ground. Is resistance greater than 1000 ohms?	Yes: Go to step 6. No: Repair short to GND between CMP connector pin-1 and ECM pin E1-41. After repairs are complete, retest for SPN 636 FMI 10.

Step	Action	Decision
6	Check CMP-L circuit for Open or high resistance (voltage drop). 1. Key OFF, disconnect CMP sensor and Engine Control Module (ECM). 2. Connect Breakout Harness ZTSE6021 to vehicle harness, and leave CMP sensor disconnected. 3. Using a jumper wire, connect Breakout Harness pin-1 to a known good ground. 4. Insert proper terminal into the ECM vehicle harness pin E1-41. 5. Connect one end of the 500 Ohm Resistor Jumper Harness ZTSE4497 to terminal previously installed, and the other end to PWR (use a jumper wire if needed). 6. Using a DMM, measure voltage between Breakout Harness pin-1 and ECM pin E1-41. Is voltage less than 0.3 volts?	Yes: Go to step 7. No: Repair Open or high resistance between CMP connector pin-1 and ECM pin E1-41. After repairs are complete, retest for SPN 636 FMI 10.

Step	Action	Decision
7	Check CMP-H circuit for Open or high resistance (voltage drop). 1. Key OFF, disconnect CMP sensor and Engine Control Module (ECM). 2. Connect Breakout Harness ZTSE6021 to vehicle harness, and leave CMP sensor disconnected. 3. Using a jumper wire, connect Breakout Harness pin-2 to a known good ground. 4. Insert proper terminal into the ECM vehicle harness pin E1-17. 5. Connect one end of the 500 Ohm Resistor Jumper Harness ZTSE4497 to terminal previously installed, and the other end to PWR (use a jumper wire if needed). 6. Using a DMM, measure voltage between Breakout Harness pin-2 and ECM pin E1-17. Is voltage less than 0.3 volts?	Yes: Go to step 8. No: Repair Open or high resistance between CMP connector pin-2 and ECM pin E1-17. After repairs are complete, retest for SPN 636 FMI 10.

Step	Action	Decision
8	Check for CMP-L shorted to CMP-H. With ECM Disconnected, connect Breakout Harness ZTSE6021 to vehicle harness and leave CMP sensor disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness pin-1 and pin-2. Is resistance greater than 1000 ohms?	Yes: Go to step 9. No: Repair short between CMP-L and CMP-H. After repairs are complete, retest for SPN 636 FMI 10.

Step	Action	Decision
9	Check for incorrect output from the CMP sensor. Connect Breakout Harness ZTSE6021 between CMP sensor and vehicle harness. Using DMM set to AC Volts - RPM2. Measure RPM between pin-1 and pin-2 during cranking, low idle, and high idle. Is RPM measured 99 RPM to 250 RPM at cranking, 549 RPM to 700 RPM at low idle, and 1250 RPM to 1500 RPM at high idle?	Yes: Clear code and retest for SPN 636 FMI 10. No: Replace the CMP sensor. After repairs are complete, retest for SPN 636 FMI 10.

NOTE: After performing all diagnostic steps, if SPN 636 FMI 10 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

CMV (Coolant Mixer Valve)

SPN	FMI	Condition	Possible Causes	Actions
5546	3	CMV short to PWR	• CMV circuit short to PWR • Failed CMV	Circuit Checks (page 519)
5546	4	CMV short to GND	• CMV circuit short to GND • Failed CMV	Circuit Checks (page 519)
5546	5	CMV open load/circuit	• CMV circuit OPEN • Failed CMV	Circuit Checks (page 519)

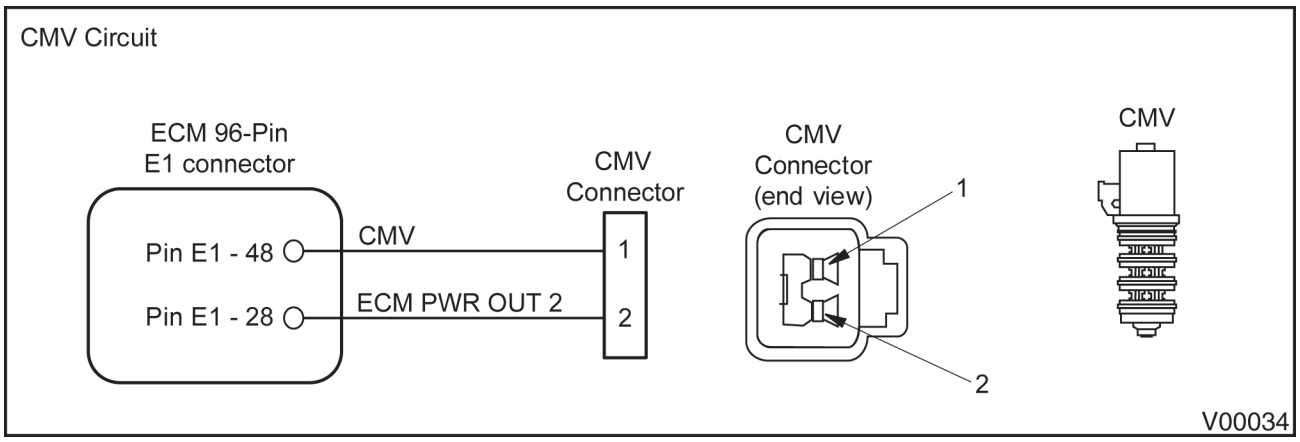

Figure 217 CMV sensor circuit diagram

Tools Required

- 180-Pin Breakout Box 00-00956-08
- 2010 MaxxForce 11 & 13 Harness Kit 00-01462-00
- 3-Banana Plug Harness ZTSE4498
- 500 Ohm Resistor Harness ZTSE4497
- Big Bore Terminal Test Probe Kit ZTSE4899
- Breakout Harness ZTSE4870 (CMV)
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

Connector Voltage Check

Connect Breakout Harness ZTSE4870 to CMV engine harness, and leave CMV disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specifications	Comment – < Less than, > Greater than
Pin 1 to GND	4 V ± 1 V	If < 3 V, check for OPEN or short to GND in CMV circuit.
		If > 5 V, check for short to PWR in CMV circuit.
Pin 2 to GND	B+	If < B+, check for OPEN in ECM PWR OUT 2 circuit.
If measurements are within specifications, go to Operational Voltage Check.		

Operational Voltage Check

NOTE: Ensure battery voltage is at or above 12 V, before running this procedure.

1. Connect Breakout Harness ZTSE4870 between CMV and engine harness.
2. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests > KOEO Tests > Actuator Test. Select Coolant Mixer Valve from the drop-down menu.
3. Command Coolant Mixer Valve to 5%, then 95%.
4. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	5% = 12.0 V ± 2.0 V	If < 10.0 V, check for OPEN circuit.
1 to GND	95% = 1.5 V ± 0.5 V	If > 2.0 V, check for OPEN circuit or failed CMV.

Actuator Resistance Check

Turn ignition switch OFF. Connect Breakout Harness ZTSE4870 to CMV and leave engine harness disconnected. Use DMM to measure resistance.

Test Point	Specifications	Comment
1 to 2	4 Ω to 8 Ω	If not within specification, replace CMV.
If measurements are within specifications, go to Harness Resistance Check.		

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM E1 and E2 harness to ECM E1 and E2 connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE4870 to CMV engine harness, and leave CMV disconnected. Use DMM to measure resistance.

Test Point	Specifications	Comment – < Less than, > Greater than
1 to E1-48	< 5 Ω	If > 5 Ω, check for OPEN circuit.
1 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
2 to E1-28	< 5 Ω	If > 5 Ω, check for OPEN circuit.
2 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
If voltage and resistance checks are within specifications, the CMV is working correctly. See Coolant System in the “ENGINE SYMPTOMS DIAGNOSTICS” section in this manual, to diagnose a mechanical fault.		

IAHFI (Inlet Air Heater Fuel Igniter)

SPN	FMI	Condition	Possible Causes	Actions
626	18	Inlet Air Heater fault: Lack of heat in the Intake Manifold	• Biased IMT sensor or circuit • Inlet Air Heater system failure • Failed Inlet Air Heater Fuel Solenoid (IAHFS) • Failed IAHFI • Failed Inlet Air Heater Relay (IAHR) • Inlet Air Heater circuit faults • Aftermarket engine block heater • Low Fuel Delivery Pressure (FDP)	Pin-Point Diagnostics (page 527)
3061	31	CSER Exhaust warm up fault	• Aftermarket engine block heater installed • Low Fuel Delivery Pressure (FDP) • Leaking or damaged fuel line to the Inlet Air Heater Fuel Ignitor (IAHFI) • Failed Inlet Air Heater Fuel Solenoid (IAHFS) • Failed IAHFI	Step-Based Diagnostics (page 522)
5548	3	IAHFI short to PWR	• IAHFI circuit short to PWR • Failed IAHFI	Circuit Checks (page 527)
5548	4	IAHFI short to GND	• OUT1 short to GND • OUT2 short to GND • IAHRE short to GND • IAHRD / IAHRE shorted together • Failed IAHFI	Step-Based Diagnostics (page 524)

5548	5	IAHFI open load/circuit	• IAHFI circuit OPEN • Failed IAHFI	Circuit Checks (page 527)
5548	7	Inlet Air Heater Relay return (relay, or igniter, or circuit failure)	• IAHR circuit fault • Failed IAHR	Circuit Checks (page 527)

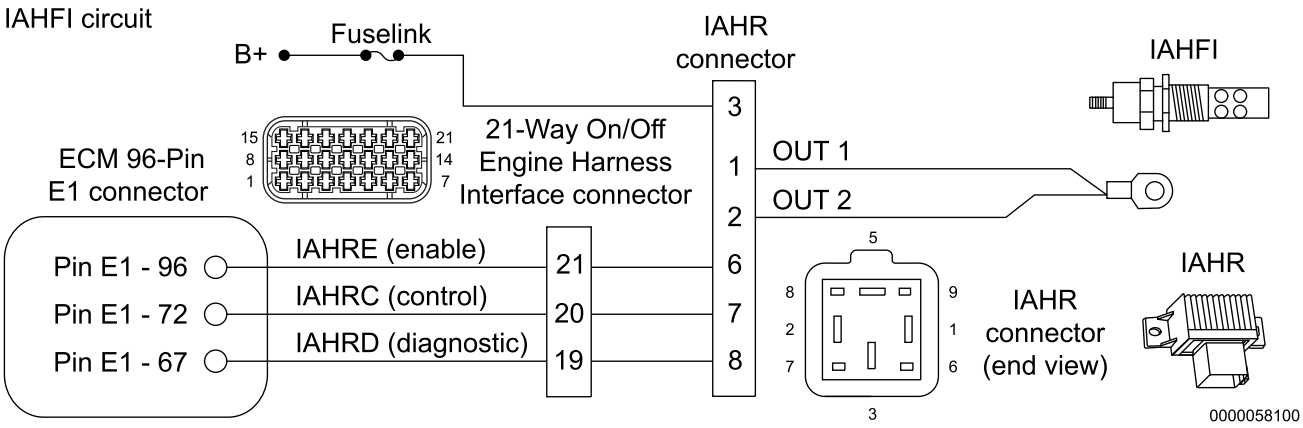

Figure 218 IAHFI circuit diagram

NOTE: See latest version of N13 Engine and Aftertreatment Wiring Schematic Form 0000002203 for additional circuit information.

Overview

The Inlet Air Heater (IAH) system warms the incoming air to aid emissions reduction. When inlet air heating is needed, the Engine Control Module (ECM) sends a signal to the IAH relay (IAHR). The IAHR then supplies B+ to the IAH fuel ignitor (IAHFI). The IAHFI is grounded through the intake manifold.

Tools Required

- 180-Pin Breakout Box 00-00956-08
- 2010 MaxxForce 11 & 13 Harness Kit 00-01462-00
- Breakout Harness ZTSE4885
- Digital Multimeter (DMM)
- Amp clamp ZTSE4575
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

SPN 3061 FMI 31 - CSER Exhaust warm up fault

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Intake Manifold failed to warm-up during Cold Start Emissions Reduction (CSER) period.	Time CSER system in Warm-up mode > 800 seconds Intake Manifold Temperature (IMT) does not rise as expected after CSER.	Key-On Engine-Running (KOER) CSER Warm-up: Active Limp home mode: Active	0 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the intake manifold failed to warm-up during Cold Start Emissions Reduction (CSER) monitoring period. CSER helps reduce emissions during engine warm-up by injecting and igniting fuel in the engine intake.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 94 FMI 0, 3, 4 (FDP); SPN 105 FMI 2, 3, 4, 18 (IMT); SPN 171 FMI 2, 3, 4 (AAT); SPN 626 FMI 3, 4, 5 (IAHFS); SPN 626 FMI 18 (IAH); SPN 5548 FMI 3, 4, 5, 7 (IAHFI)

Drive Cycle to Determine Fault Status

Drive Cycle 19 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Aftermarket engine block heater installed
- Low Fuel Delivery Pressure (FDP)
- Leaking or damaged fuel line to the Inlet Air Heater Fuel Ignitor (IAHFI)
- Failed Inlet Air Heater Fuel Solenoid (IAHFS)
- Failed IAHFI

NOTE: Ambient Air Temperature (AAT) reading is used as reference in determining pass / fail for this fault. Moving vehicle from cold to warm ambient temperature may set this fault.

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 94 FMI 0, 3, 4 (FDP); SPN 105 FMI 2, 3, 4, 18 (IMT); SPN 171 FMI 2, 3, 4 (AAT); SPN 626 FMI 3, 4, 5 (IAHFS); SPN 626 FMI 18 (IAH); SPN 5548 FMI 3, 4, 5, 7 (IAHFI). Is EST DTC list free of SPN 94 FMI 0, 3, 4; SPN 105 FMI 2, 3, 4, 18; SPN 171 FMI 2, 3, 4; SPN 626 FMI 3, 4, 5; SPN 626 FMI 18; SPN 5548 FMI 3, 4, 5, 7?	Yes: Go to step 2. No: Repair SPN 94 FMI 0, 3, 4; SPN 105 FMI 2, 3, 4, 18 (IMT); SPN 171 FMI 2, 3, 4; SPN 626 FMI 3 4 5; SPN 626 FMI 18; SPN 5548 FMI 3 4 5 7. After repairs are complete, retest for SPN 3061 FMI 31.

Step	Action	Decision
2	Inspect the engine for an aftermarket block or coolant heater. Is an aftermarket block or coolant heater installed?	Yes: Disconnect block or coolant heater, run drive cycle 10. Retest for SPN 3061 FMI 31.
		No: Go to step 3.

Step	Action	Decision
3	Check current (amperage) going to Inlet Air Heater Fuel Igniter (IAHFI). With a Digital Multi Meter (DMM) and amperage clamp ZTSE4575 check the current at the IAHFI. Using EST with ServiceMaxx™ software, go to Key-On Engine-Off (KOEO) Test > Actuator Test > Actuate IAHFI. Is the amperage greater than 30 amps within 2 seconds.	Yes: Go to step 4
		No: Replace IAHFI. After repairs are complete, retest for SPN 3061 FMI 31.

Step	Action	Decision
4	Check Fuel Delivery Pressure (FDP). Using EST with ServiceMaxx™ software, Key-On Engine-Running (KOER), monitor FDP. Is FDP 85 - 120 psi?	Yes: Go to step 4.
		No: Repair Low-Pressure Fuel System (page 217). After repairs are complete, retest for SPN 3061 FMI 31.

Step	Action	Decision
5	Check fuel lines and connections going to IAHFI and IAH Fuel Solenoid (IAHFS) for: leaks, damage, and restrictions. Shop air can be used to check for restricted fuel lines. Are fuel lines and connections going to IAHFI and IAHFS in good condition and Not leaking, damaged, or restricted?	Yes: Go to step 6.
		No: Replace leaking, damaged, or restricted line or connection. After repairs are complete, retest for SPN 3061 FMI 31.

Step	Action	Decision
6	Check for fuel flow to the IAHFI. Using EST with ServiceMaxx™ software, go to Key-On Engine-Off (KOEO) Test > Cold Start Assist Test. Does Intake Manifold Temperature (IMT) raise at least 10°F after engine has started.	Yes: Retest for SPN 3061 FMI 31.
		No: Replace IAHFS. After repairs are complete, retest for SPN 3061 FMI 31.

NOTE: After performing all diagnostic steps, if SPN 3061 FMI 31 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

5548 FMI 4- Inlet Air Heater Fuel Ignitor short to GND

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
IAH circuit short to GND	The resistance between the IAHRE or OUT1 / OUT2 circuits and ground < 0.2 Ohms	Key ON Inlet Air Heater commanded ON	1 second

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects a short to GND in the Inlet Air Heater (IAH) circuits.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

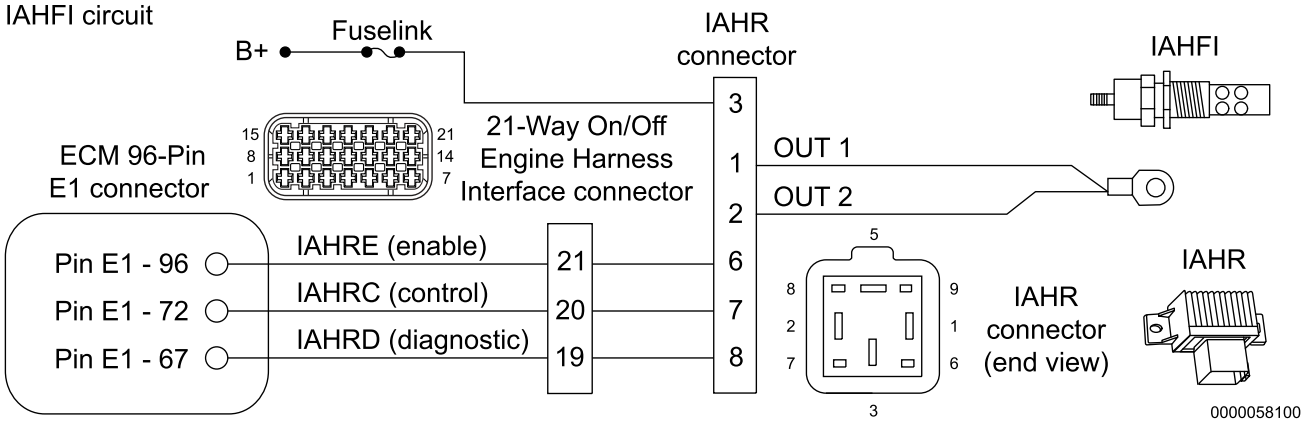

Figure 219 IAHFI circuit diagram

Possible Causes

- OUT1 short to GND
- OUT2 short to GND
- IAHRE short to GND
- IAHRD / IAHRE shorted together
- Failed IAHFI

Step	Action	Decision
1	Inspect connections at Inlet Air Heater Fuel Igniter (IAHFI). Check IAHFI connector and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the IAHFI harness and terminals clean and undamaged?	Yes: Go to step 2. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 5548 FMI 4.

Step	Action	Decision
2	Inspect connections at Inlet Air Heater Relay (IAHR). Key-Off, disconnect IAHR connector. Check IAHR connector and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the IAHR connector, harness, and terminals clean and undamaged?	Yes: Go to step 3. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 5548 FMI 4.

Step	Action	Decision
3	Check IAHRE circuit for short to GND. Connect Breakout Harness ZTSE4885 to vehicle harness and leave IAHR disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness ZTSE4885 pin-6 and a known good ground. Is resistance greater than 1000 ohms?	Yes: Go to step 4. No: Repair short to GND in IAHRE circuit between IAHR pin-6 and ECM pin E1-96. After repairs are complete, retest for SPN 5548 FMI 4.

Step	Action	Decision
4	Check IAHRE circuit for short to IAHRD. Key OFF with Breakout Harness ZTSE4885 connected to vehicle harness and IAHR disconnected. Use a DMM to measure resistance between Breakout Harness pin-6 and pin-8. Is resistance greater than 1000 ohms?	Yes: Go to step 5. No: Repair short between IAHR pin-6 and IAHR pin-8. After repairs are complete, retest for SPN 5548 FMI 4.

Step	Action	Decision
5	Check OUT1 circuit for short to GND. With Breakout Harness ZTSE4885 connected to vehicle harness and IAHR disconnected. Disconnect IAHFI and leave terminals disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness pin-1 and a known good ground. Is resistance greater than 1000 ohms?	Yes: Go to step 6. No: Repair short to GND in OUT1 circuit between IAH relay pin-1 and IAHFI terminal. After repairs are complete, retest for SPN 5548 FMI 4.

Step	Action	Decision
6	Check OUT2 circuit for short to GND. With Breakout Harness ZTSE4885 connected to vehicle harness and IAHR disconnected. Key OFF with IAHFI disconnected, use a DMM to measure resistance between Breakout Harness pin-2 and a known good ground. Is resistance greater than 1000 ohms?	Yes: Replace IAHFI. After repairs are complete, retest for SPN 5548 FMI 4.
		No: Repair short to GND in OUT2 circuit between IAH relay pin-2 and IAHFI terminal. After repairs are complete, retest for SPN 5548 FMI 4.

NOTE: After performing all diagnostic steps, if SPN 5548 FMI 4 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

Cold Soak Sensor Compare Check With ServiceMaxx™ Software

SPN 626 FMI 18 – Inlet Air Heater fault: Lack of heat in the Intake Manifold

During cold start DTC sets when Intake Manifold Temperature (IMT) signal does not raise 50°F (10°C).

NOTE: Temperature values need to be measured after 8 hours of cold soak.

1. Inspect for aftermarket engine block heater. Is engine free of an aftermarket engine block heater?
   - Yes: Go to step 2.
   - No: Disconnect aftermarket engine block heater and retest for SPN 626 FMI 18.
2. Using Electronic Service Tool (EST) with ServiceMaxx™ software, Key-On Engine Off, load the Default session. Compare IMT, Ambient Air Temperature (AAT), and Inlet Air Temperature (IAT).

   Are IMT, Ambient Air Temperature (AAT), and Inlet Air Temperature (IAT) sensor temperatures within 10°F (5°C) of each other.
   - Yes: IMT circuit is in specification, see Inlet Air Heater System Test in “HARD START AND NO START DIAGNOSTICS."
   - No: Go to IMT sensor Circuit Checks (page 1141).

Voltage Check on IAHFI - Actuator Test

NOTE: Ensure battery voltage is at or above 12 V, before running this procedure.

1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests > KOEO Tests > Actuator Test. Select Inlet Air Heater Fuel Igniter from the drop-down menu.
2. Command Inlet Air Heater Fuel Igniter to 95%.
3. Use DMM to measure voltage.

Test Point	Specifications	Comment – < Less than, > Greater than
IAHFI to GND	B+	If > 0 V to B+, do Amperage Draw Check - Actuator Test.
		If 0 V, do Voltage Checks on Relay Connector (page 528).

Amperage Draw Check - Actuator Test

NOTE: Ensure battery voltage is at or above 12 V, before running this procedure.

1. Connect Amp Clamp ZTSE4575 to DMM. Set the DMM to DCmV and Zero the Amp clamp.
2. Connect Amp Clamp ZTSE4575 around the IAHFI wires.
3. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests > KOEO Tests > Actuator Test. Select Inlet Air Heater Fuel Igniter from the drop-down menu.
4. Command Inlet Air Heater Fuel Igniter to 95%.
5. Use DMM to measure voltage from the Amp Clamp, representing amperage through the IAHFI.

Test Point	Specifications	Comment
DMM - Measure amperage to IAHFI		

Amperage Draw Check - Actuator Test (cont.)

IAHFI	30 Amps (within 2 seconds)	If within specification, IAHR and IAHFI are working correctly. If not within specification, do Voltage Checks on Relay - Actuator Test (page 529).
If Amps are within specification, do Harness Resistance Check (page 530) for IAHRD circuit.		

Voltage Checks on Relay Connector

Connect Breakout Harness ZTSE4885 to IAHR engine harness, and leave IAHR disconnected. Turn ignition ON. Use DMM to measure voltage after 60 seconds.

Test Point	Specifications	Comment – < Less than, > Greater than
1 to GND	0 V	If > 0 V, check for short to PWR.
2 to GND	0 V	If > 0 V, check for short to PWR.
3 to GND	B+	If < B+, check for OPEN or short to GND.
6 to GND	1.5 V ± 0.5 V	If < 8 V, check for OPEN or short to GND.
7 to GND	0.5 V ± 0.5 V	If < 3 V, check for OPEN or short to GND. If > 5.5 V, check for short to PWR.
8 to GND	6 V ± 1 V	If < 4 V, check for OPEN or short to GND. If > 6 V, check for short to PWR.
If voltages are within specification, do Voltage Checks on Relay - Actuator Test (page 529).		

Voltage Checks on Relay - Actuator Test

NOTE: Ensure battery voltage is at or above 12 V, before running this procedure.

1. Connect Breakout Harness ZTSE4885 between IAHR and engine harness.
2. Use DMM to measure voltage.
3. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests > KOEO Tests > Actuator Test. Select Inlet Air Heater Fuel Igniter from the drop-down menu.
4. Command Inlet Air Heater Fuel Igniter to 5%.
5. Use DMM to measure voltage.
6. Command Inlet Air Heater Fuel Igniter to 95%.
7. Use DMM to measure voltage.

Connect Breakout Harness ZTSE4885 between IAHR and engine harness. Turn the ignition switch to ON. Use DMM to measure voltage. Batteries must be fully charged before performing this test.

Test Point	Specifications	Comment – < Less than, > Greater than
6 to GND, Run Actuator Test		
Normal state	> 1 V	If < 1 V, check IAHRE circuit for OPEN or short to GND. Do Harness Resistance Check (page 530).
Actuator state LOW (5%)	> 10 V	If < 10 V, check IAHRE circuit for OPEN or short to GND. Do Harness Resistance Check (page 530).
Actuator state HIGH (95%)	> 10 V	If < 10 V, check IAHRE circuit for OPEN or short to GND. Do Harness Resistance Check (page 530).
7 to GND, Run Actuator Test.		
Normal state	< 1 V	If > 1 V, check IAHRC circuit for short to PWR. Do Harness Resistance Check (page 530).
Actuator state LOW (5%)	> 8 V	If < 8 V, check IAHRC circuit for OPEN or short to GND. Do Harness Resistance Check (page 530).
Actuator state HIGH (95%)	<1 V	If > 1 V, check IAHRD circuit for short to PWR. Do Harness Resistance Check (page 530).
8 to GND, Run Actuator Test.		
Normal state	6 V ± 1.5 V	If < 4.5 V, check IAHRD circuit for OPEN or short to GND. Do Harness Resistance Check (page 530).
Actuator state LOW (5%)	6 V ± 1.5 V	If < 4.5 V, check IAHRD circuit for OPEN or short to GND. Do Harness Resistance Check (page 530).
Actuator state HIGH (95%)	1 V ± 0.5 V	If < 0.5 V, check IAHRD circuit for OPEN or short to GND. Do Harness Resistance Check (page 530).
1 to GND, Run Actuator Test.		

Voltage Checks on Relay - Actuator Test (cont.)

Normal state	0 V	If > 0 V, replace IAHR.
Actuator state LOW	0 V	If > 0 V, replace IAHR.
Actuator state HIGH	B+	If < B+, replace IAHR.
2 to GND, Run Actuator Test.		
Normal state	0 V	If > 0 V, replace IAHR.
Actuator state LOW	0 V	If > 0 V, replace IAHR.
Actuator state HIGH	B+	If < B+, replace IAHR.
If measurements are not within specifications, do Harness Resistance Check (page 530).		

IAHFI Resistance Check

Turn ignition switch to OFF. Use DMM to measure resistance between IAHFI and engine GND.

Test Point	Specifications	Comment – < Less than, > Greater than
IAHFI to GND	< 5 Ω	If > 5 Ω, replace failed IAHFI.

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM E1 and E2 harness to ECM E1 and E2 connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE4885 to IAHR engine harness, and leave IAHR disconnected. Use DMM to measure resistance.

Test Point	Specifications	Comment – < Less than, > Greater than
1 to IAHFI	< 5 Ω	If > 5 Ω, check for OPEN circuit.
1 to GND	< 5 Ω	If > 5 Ω, check for OPEN IAHFI.
2 to IAHFI	< 5 Ω	If > 5 Ω, check for OPEN circuit.
2 to GND	< 5 Ω	If > 5 Ω, check for OPEN IAHFI.
3 to B+	< 5 Ω	If > 5 Ω, check for OPEN circuit.
6 to E1-96	< 5 Ω	If > 5 Ω, check for OPEN circuit.
6 to GND	> 1k Ω	If < 1k Ω check for short to GND.
7 to E1-72	< 5 Ω	If > 5 Ω, check for OPEN circuit.
7 to GND	> 1k Ω	If < 1k Ω check for short to GND.
8 to E1-67	< 5 Ω	If > 5 Ω, check for OPEN circuit.
8 to GND	> 1k Ω	If < 1k Ω check for short to GND.
If all checks are within specification, but DTCs are still active, replace the IAHR.		

IAHFS (Inlet Air Heater Fuel Solenoid)

SPN	FMI	Condition	Possible Causes	Actions
626	3	IAHFS short to PWR	• IAHFS circuit short to PWR	Circuit Checks (page 532)
626	4	IAHFS short to GND	• IAHFS circuit short to GND	Circuit Checks (page 532)
626	5	IAHFS open load/circuit	• IAHFS circuit OPEN • IAHFS failure	Circuit Checks (page 532)
626	18	Inlet Air Heater fault: Lack of heat in the Intake Manifold	• Biased IMT sensor or circuit • Inlet Air Heater System failure • Failed Inlet Air Heater Fuel Solenoid • Failed Inlet Air Heater Fuel Igniter • Failed Inlet Air Heater Relay • Inlet Air Heater circuit faults • Aftermarket engine block heater • Restricted Fuel Igniter supply line	Circuit Checks (page 532)

IAHFS circuit

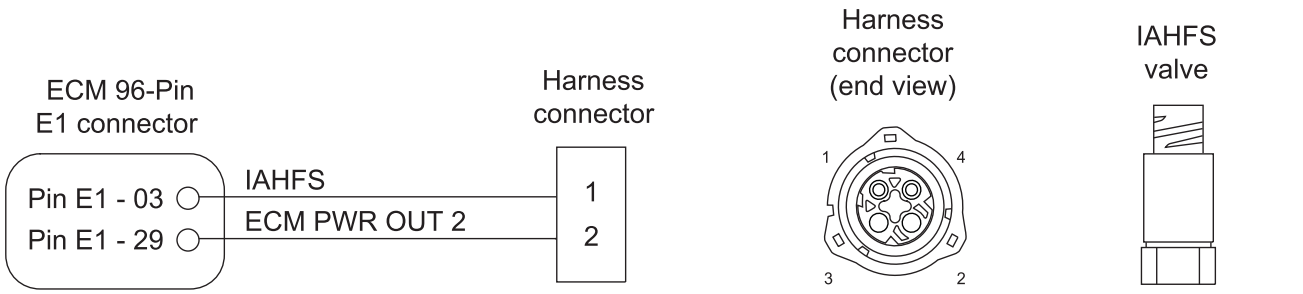

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Figure 220 IAHFS circuit diagram

Tools Required

- 180-Pin Breakout Box 00-00956-08
- 2010 MaxxForce 11 & 13 Harness Kit 00-01462-00
- 3-Banana Plug Harness ZTSE4498
- 500 Ohm Resistor Harness ZTSE4497
- Big Bore Terminal Test Probe Kit ZTSE4899
- Breakout Harness ZTSE4827 (IAHFS)
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

WARNING: To prevent personal injury or death, stay clear of rotating parts (belts and fan) and hot engine surfaces.

Connector Voltage Check – IAHFS Disconnected

Connect Breakout Harness ZTSE4827 to engine harness. Leave IAHFS disconnected. Use DMM to measure voltage.

Test Point	Specifications	Comment – < Less than, > Greater than
2 to GND	B+	If < B+, check for OPEN circuit. Do Harness Resistance Check (page 533).
1 to GND	3.5 V ± 1.0 V	If < 2.5 V, check for OPEN circuit. Do Harness Resistance Check (page 533).
If measurements are within specifications, do Operational Voltage Check.		

Operational Voltage Check

NOTE: Ensure battery voltage is at or above 12 V, before running this procedure.

1. Connect Breakout Harness ZTSE4827 between IAHFS and engine harness.
2. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests > KOEO Tests > Actuator Test. Select Inlet Air Heater Fuel Solenoid from the drop-down menu.
3. Command Inlet Air Heater Fuel Solenoid to 5%.
4. Use DMM to measure voltage.
5. Command Inlet Air Heater Fuel Solenoid to 95%.
6. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	5% = 0.5 V ± 0.5 V	If > 1 V, check for OPEN circuit or failed IAHFS.
1 to GND	95% = 12 V ± 2.0 V	If < 10 V, check for OPEN circuit.

Actuator Resistance Check

Turn ignition switch OFF. Connect Breakout Harness ZTSE4827 to IAHFS and leave engine harness disconnected. Use DMM to measure resistance.

Test Point	Specifications	Comment – < Less than, > Greater than
1 to 2	8 Ω	If not within specification, replace IAHFS.

If measurements are within specifications, do Harness Resistance Check.

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM E1 and E2 harness to ECM E1 and E2 connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE4827 to IAHFS engine harness, and leave IAHFS disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
1 to E1-03	< 5 Ω	If > 5 Ω, check for OPEN circuit.
2 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
2 to E1-29	< 5 Ω	If > 5 Ω, check for OPEN circuit.

If voltage and resistance checks are within specifications, replace IAHFS.

Cylinder Balance

SPN	FMI	Condition	Possible Causes	Actions
651	13	Injector 1 programmable parameter error	• Incorrect Programmed IQA	Step-Based Diagnostics (page 539)
651	16	Injector 1 Fuel quantity/timing high error	• Contaminated fuel • Failed injector (Mechanical) • Base engine compression imbalance	Step-Based Diagnostics (page 541)
651	18	Injector 1 Fuel quantity/timing low error	• Contaminated fuel • Failed injector (Mechanical) • Base engine compression imbalance	Step-Based Diagnostics (page 544)
652	13	Injector 1 programmable parameter error	• Incorrect Programmed IQA	Step-Based Diagnostics (page 546)
652	16	Injector 2 Fuel quantity/timing high error	• Contaminated fuel • Failed injector (Mechanical) • Base engine compression imbalance	Step-Based Diagnostics (page 548)
652	18	Injector 2 Fuel quantity/timing low error	• Contaminated fuel • Failed injector (Mechanical) • Base engine compression imbalance	Step-Based Diagnostics (page 551)
653	13	Injector 1 programmable parameter error	• Incorrect Programmed IQA	Step-Based Diagnostics (page 553)
653	16	Injector 3 Fuel quantity/timing high error	• Contaminated fuel • Failed injector (Mechanical) • Base engine compression imbalance	Step-Based Diagnostics (page 555)

653	18	Injector 3 Fuel quantity/timing low error	•	Contaminated fuel • Failed injector (Mechanical) • Base engine compression imbalance	Step-Based Diagnostics (page 558)
654	13	Injector 1 programmable parameter error	•	Incorrect Programmed IQA	Step-Based Diagnostics (page 560)
654	16	Injector 4 Fuel quantity/timing high error	•	Contaminated fuel • Failed injector (Mechanical) • Base engine compression imbalance	Step-Based Diagnostics (page 562)
654	18	Injector 4 Fuel quantity/timing low error	•	Contaminated fuel • Failed injector (Mechanical) • Base engine compression imbalance	Step-Based Diagnostics (page 565)
655	13	Injector 1 programmable parameter error	•	Incorrect Programmed IQA	Step-Based Diagnostics (page 567)
655	16	Injector 5 Fuel quantity/timing high error	•	Contaminated fuel • Failed injector (Mechanical) • Base engine compression imbalance	Step-Based Diagnostics (page 569)
655	18	Injector 5 Fuel quantity/timing low error	•	Contaminated fuel • Failed injector (Mechanical) • Base engine compression imbalance	Step-Based Diagnostics (page 572)
656	13	Injector 1 programmable parameter error	•	Incorrect Programmed IQA	Step-Based Diagnostics (page 574)

656	16	Injector 6 Fuel quantity/timing high error	•	Contaminated fuel • Failed injector (Mechanical) • Base engine compression imbalance	Step-Based Diagnostics (page 576)
656	18	Injector 6 Fuel quantity/timing low error	•	Contaminated fuel • Failed injector (Mechanical) • Base engine compression imbalance	Step-Based Diagnostics (page 579)
1322	31	Misfire – Multiple cylinders	•	Low Fuel Delivery Pressure (FDP) • Low Fuel Rail Pressure (FRP) • Crankshaft Position (CKP) sensor out of calibration • Contaminated fuel • Failed injector (Mechanical) • Base engine compression imbalance	Step-Based Diagnostics (page 581)
1323	31	Misfire – Cylinder 1	•	Low Fuel Delivery Pressure (FDP) • Low Fuel Rail Pressure (FRP) • Contaminated fuel • Failed injector (Mechanical) • Base engine compression imbalance	Step-Based Diagnostics (page 585)

1324	31	Misfire – Cylinder 2	• Low Fuel Delivery Pressure (FDP) • Low Fuel Rail Pressure (FRP) • Contaminated fuel • Failed injector (Mechanical) • Base engine compression imbalance	Step-Based Diagnostics (page 588)
1325	31	Misfire – Cylinder 3	• Low Fuel Delivery Pressure (FDP) • Low Fuel Rail Pressure (FRP) • Contaminated fuel • Failed injector (Mechanical) • Base engine compression imbalance	Step-Based Diagnostics (page 591)
1326	31	Misfire – Cylinder 4	• Low Fuel Delivery Pressure (FDP) • Low Fuel Rail Pressure (FRP) • Contaminated fuel • Failed injector (Mechanical) • Base engine compression imbalance	Step-Based Diagnostics (page 594)
1327	31	Misfire – Cylinder 5	• Low Fuel Delivery Pressure (FDP) • Low Fuel Rail Pressure (FRP) • Contaminated fuel • Failed injector (Mechanical)	Step-Based Diagnostics (page 597)

			• Base engine compression imbalance	
1328	31	Misfire – Cylinder 6	• Low Fuel Delivery Pressure (FDP) • Low Fuel Rail Pressure (FRP) • Contaminated fuel • Failed injector (Mechanical) • Base engine compression imbalance	Step-Based Diagnostics (page 600)

Overview

Many factors influence the combustion process in a power cylinder. This can affect the production of torque or horsepower from that cylinder. Some of the factors include piston and cylinder geometry, injector performance, and fuel rail pressure. Variations in these factors can cause unevenness in torque and horsepower from one cylinder to the next. Power cylinder unevenness also causes increased engine noise and vibration, especially at low idle. This is also referred to as rough idle.

The Engine Control Module (ECM) uses a Cylinder Balance control strategy to even the power contribution of the cylinders, particularly at low idle. This strategy incorporates information from the Crankshaft Position (CKP) sensor. The ECM uses the instantaneous engine speed near Top Dead Center (TDC) for each cylinder as an indication of that cylinder's power contribution. The ECM computes a nominal instantaneous engine speed value based on all cylinders. The nominal value would be the expected value from all cylinders if the engine is balanced.

By knowing the error quantities, the ECM can add or subtract fuel from a particular cylinder. The control strategy attempts to correct the cylinder unbalance by using fuel quantity compensation through adjustments of the pulse width values for each fuel injector. This method of compensation is repeated until all error quantities are close to zero causing all cylinders to contribute the same amount.

Tools Required

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

SPN 651 FMI 13- Injector 1 programmable parameter error

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Incorrect Injector Quantity Adjustment (IQA) programed to Electronic Control Module (ECM).	IQA checksum or range error	Key ON (runs once per key cycle)	Immediate

Fault Overview

Fault code sets when Electronic Control Module (ECM) detects an incorrect Injector Quantity Adjustment (IQA) has been programmed into the ECM.

Malfunction Indicator Lamp (MIL) Reaction

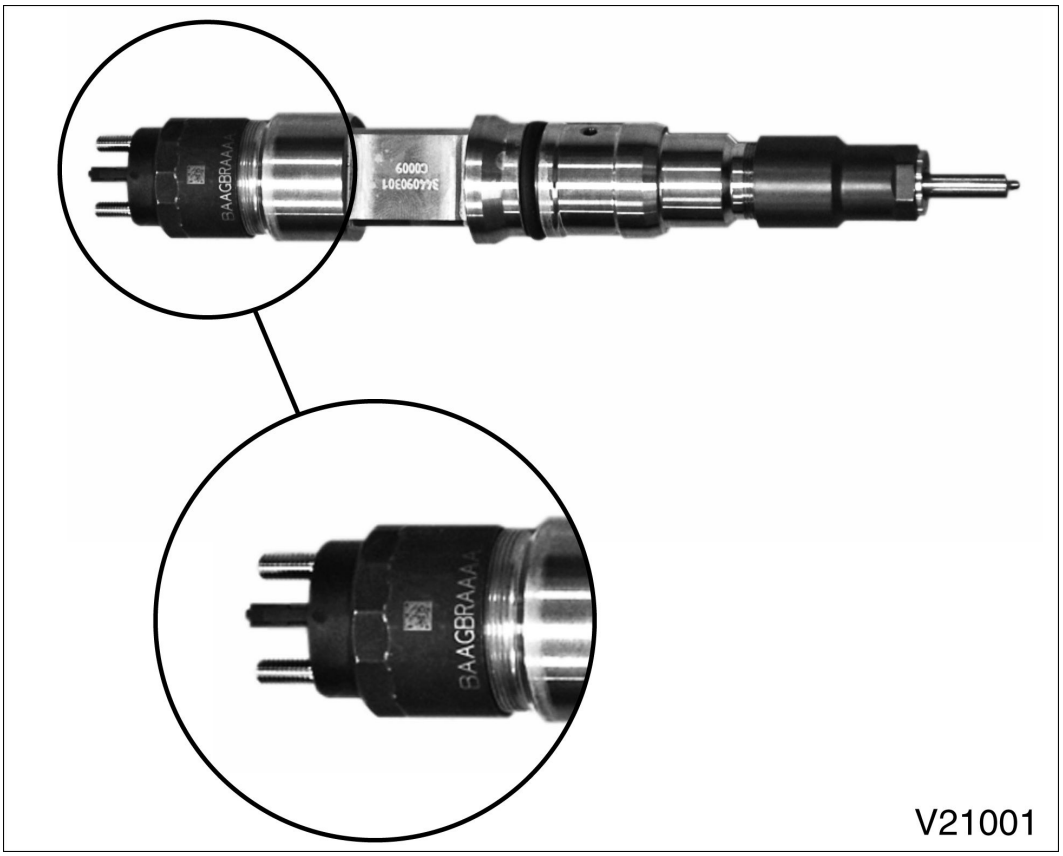
MIL will illuminate when this fault is detected during one drive cycle.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Incorrect Programmed IQA



Step	Action	Decision
1	Check that the proper Injector Quantity Adjustment (IQA) is programed into the Electronic Control Module (ECM). 1. Remove valve cover (see Engine Service Manual) and engine brake housing. Document the IQA code for all six injectors. 2. Using Electronic Service Tool (EST) with ServiceMaxx, select Procedures > KOEO Procedures > Injection Quantity Adjustment. Do the IQA codes displayed in ServiceMaxx match the injectors in the engine?	Yes: Clear fault code. Recheck IQA codes. After repairs are complete, retest for SPN 651 FMI 13. No: Reprogram ECM with correct IQA codes (follow on screen instructions). After repairs are complete, retest for SPN 651 FMI 13.

NOTE: After performing all diagnostic steps, if SPN 651 FMI 13 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 651 FMI 16- Injector 1 Fuel quantity/timing high error

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Fuel injector is energized for longer than expected.	The sum of actual and learned energizing time > 580 microseconds	Charge Air Cooler Outlet Temperature (CACOT) > 14°F (-10°C) Selective Catalyst Reduction (SCR) warm-up mode inactive Engine Coolant Temperature 1 (ECT1) > 158°F (70°C) and < 239°F (115°C) Engine Speed Steady: Engine speed variation < 100 rpm, per time > 3 seconds Ambient air pressure (BARO) > 11.6 psi (80 kpa) and < 16 psi (110 kpa) Idle speed error < 50 rpm Engine speed < 800 rpm Fuel command > 6 mg/stroke and < 66 mg / stroke Vehicle stationary Time in entry conditions > 2 seconds Fuel rail pressure deviation < 725 psi (5000 kpa)	1 second

Fault Overview

Fault code sets when the Engine Control Module (ECM) detects fuel injector is energized longer than expected.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 94 (FDP); SPN 157 (FRP); SPN 651 FMI 4, 5, and 13 (CYL/INJ); and SPN 3055 FMI 0, 1, 15, and 17

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Low Fuel Delivery Pressure (FDP)
- Aerated fuel delivery

- Failed injector (Mechanical)

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 94 (FDP); SPN 157 (FRP); SPN 651 FMI 4, 5, and 13 (CYL/INJ); and SPN 3055 FMI 0, 1, 15, and 17. Is EST DTC list free of SPN 94; SPN 157; SPN 651 FMI 4, 5, and 13; and SPN 3055 FMI 0, 1, 15, and 17?	Yes: Go to step 2. No: Repair SPN 94; SPN 157; SPN 651 FMI 4, 5, and 13; and SPN 3055 FMI 0, 1, 15 and 17. After repairs are complete, retest for SPN 651 FMI 16.

Step	Action	Decision
2	Check for low Fuel Delivery Pressure (FDP). Using EST, monitor FDP at idle. Is FDP above 85 psi??	Yes: Go to step 3. No: Perform Low-pressure Fuel System tests (page 217). After repairs are complete, retest for SPN 651 FMI 16.

Step	Action	Decision
3	Check for aeration in low-pressure fuel system. Perform Fuel Aeration Test (page 221). Is low-pressure fuel system free from aeration?	Yes: Go to step 4. No: Repair aeration in low-pressure fuel system. After repairs are complete, retest for SPN 651 FMI 16.

Step	Action	Decision
4	Run the fault monitors to determine source of fault. • Using EST, load the HD-OBD monitors session. Click the refresh button at the bottom to load the values. Save a screen shot documenting the Injector quantity/timing error values. • Clear all faults, Start the engine and run for 5 minutes at high idle. Verify that the SCR inlet temp is above 446°F (230°C) after 5 minutes, and that the engine coolant temperature is above 160°F (71°C). • Return the engine to normal idle for 5 minutes • Using the HD-OBD monitors session monitor the injector timing quantity error values. Refresh the page using the refresh button at the bottom and save a screenshot of the new values. • Compare last screenshot to the previous. Verify all values changed from the previous screenshot indicating the monitors have run properly. Is EST DTC list free from SPN 651 FMI 16?	Yes: Clear fault. No: Replace Injector 1. After repairs are complete, retest for SPN 651 FMI 16.

NOTE: After performing all diagnostic steps, if SPN 651 FMI 16 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 651 FMI 18- Injector 1 Fuel quantity/timing low error

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Fuel injector is energized shorter than expected.	The sum of actual and learned fuel rail pressure energizing times < 320 microseconds	Charge Air Cooler Outlet Temperature (CACOT) > 14°F (-10°C) Selective Catalyst Reduction (SCR) warm-up mode inactive Engine Coolant Temperature 1 (ECT1) > 158°F (70°C) and < 239°F (115°C) Engine speed steady: Engine speed variation < 100 rpm, per time > 3 seconds] Ambient air pressure (BARO) > 11.6 psi (80 kpa) and < 16 psi (110 kpa) Idle speed error < 50 rpm Engine speed < 800 rpm Fuel command > 6 mg/stroke and < 66 mg / stroke Vehicle stationary Time in entry conditions > 2 seconds Fuel rail pressure deviation < 725 psi (5000 kpa)	1 second

Fault Overview

Fault code sets when the Electronic Control Module (ECM) detects fuel injector is energized shorter than expected.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 94 (FDP); SPN 157 (FRP); and SPN 651 FMI 4, 5, and 13 (CYL/INJ)

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Contaminated fuel
- Failed injector (Mechanical)

- Base engine compression imbalance

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 94 (FDP); SPN 157 (FRP); and SPN 651 FMI 4, 5, and 13 (CYL/INJ). Is EST DTC list free of SPN 94; SPN 157; and SPN 651 FMI 4, 5, and 13?	Yes: Go to step 2. No: Repair SPN 94; SPN 157; and SPN 651 FMI 4, 5, and 13. After repairs are complete, retest for SPN 651 FMI 18.

Step	Action	Decision
2	Check fuel for contamination. Perform Fuel Quality Check (page 193). Is the fuel contaminated?	Yes: Drain fuel tank and fill fuel tank with appropriate diesel fuel. After repairs are complete, retest for SPN 651 FMI 18. No: Go to step 3.

Step	Action	Decision
3	Determine if the engine has a mechanical cylinder balance problem (compression loss). Perform Crankcase Pressure Test (page 236). Does engine have excessive crankcase pressure?	Yes: Repair base engine compression imbalance. After repairs are complete, retest for SPN 651 FMI 18. No: Go to step 4.

Step	Action	Decision
4	Determine if engine has a fuel injector problem. Perform Multiple Cylinder Cutout Test (page 241). Did one or more cylinders have significant speed difference(s) than the others?	Yes: Go to step 5. No: Retest for SPN 651 FMI 18.

Step	Action	Decision
5	Inspect for failed valve train components. Remove upper valve cover (see Engine Service Manual). Inspect for bent valves, fallen bridges, and valves out of adjustment. Is valve train free of failed valve train components?	Yes: Replace injector suspected by Multiple Cylinder Cutout Test. After repairs are complete, retest for SPN 651 FMI 18. No: Repair failed valve train components. After repairs are complete retest for SPN 651 FMI 18.

NOTE: After performing all diagnostic steps, if SPN 651 FMI 18 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 652 FMI 13- Injector 2 programmable parameter error

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Incorrect Injector Quantity Adjustment (IQA) programed to Electronic Control Module (ECM).	IQA checksum or range error	Key ON (runs once per key cycle)	Immediate

Fault Overview

Fault code sets when Electronic Control Module (ECM) detects an incorrect Injector Quantity Adjustment (IQA) has been programmed into the ECM.

Malfunction Indicator Lamp (MIL) Reaction

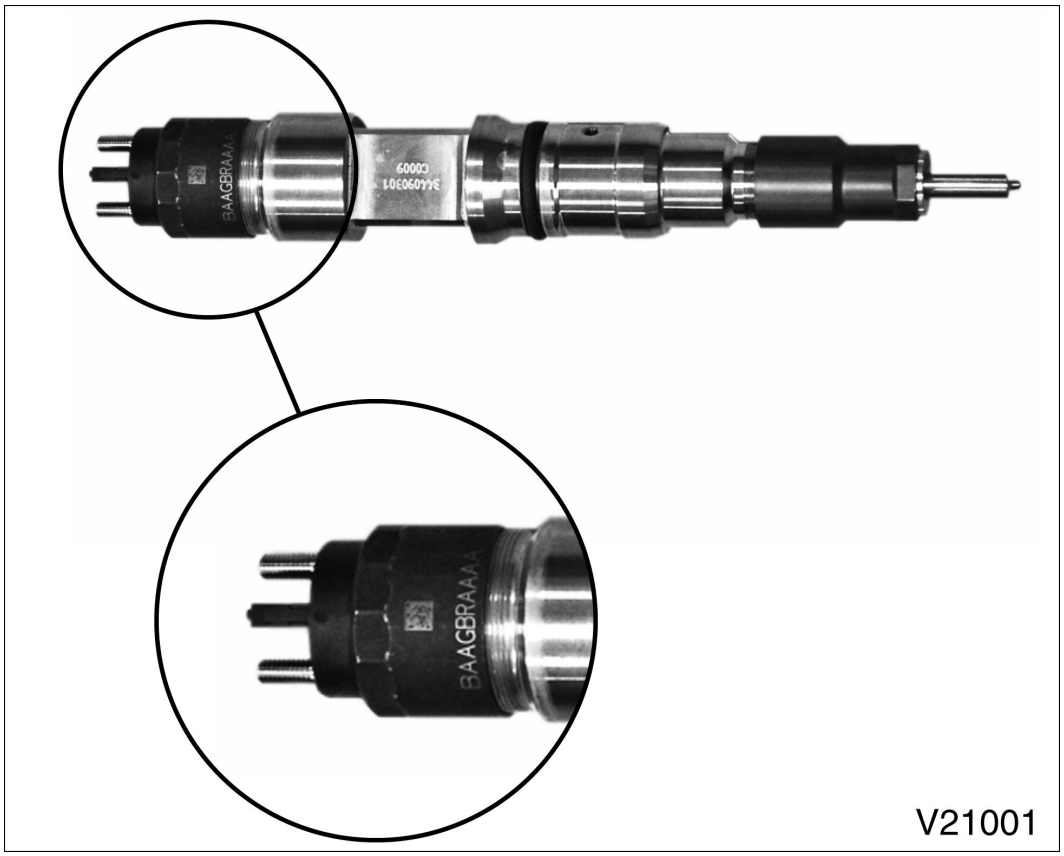
MIL will illuminate when this fault is detected during one drive cycle.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Incorrect Programmed IQA



Step	Action	Decision
1	Check that the proper Injector Quantity Adjustment (IQA) is programed into the Electronic Control Module (ECM). 1. Remove valve cover (see Engine Service Manual) and engine brake housing. Document the IQA code for all six injectors. 2. Using Electronic Service Tool (EST) with ServiceMaxx, select Procedures > KOEO Procedures > Injection Quantity Adjustment. Do the IQA codes displayed in ServiceMaxx match the injectors in the engine?	Yes: Clear fault code. Recheck IQA codes. After repairs are complete, retest for SPN 652 FMI 13. No: Reprogram ECM with correct IQA codes (follow on screen instructions). After repairs are complete, retest for SPN 652 FMI 13.

NOTE: After performing all diagnostic steps, if SPN 652 FMI 13 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 652 FMI 16- Injector 2 Fuel quantity/timing high error

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Fuel injector is energized for longer than expected.	The sum of actual and learned energizing time > 580 microseconds	Charge Air Cooler Outlet Temperature (CACOT) > 14°F (-10°C) Selective Catalyst Reduction (SCR) warm-up mode inactive Engine Coolant Temperature 1 (ECT1) > 158°F (70°C) and < 239°F (115°C) Engine Speed Steady: Engine speed variation < 100 rpm, per time > 3 seconds Ambient air pressure (BARO) > 11.6 psi (80 kpa) and < 16 psi (110 kpa) Idle speed error < 50 rpm Engine speed < 800 rpm Fuel command > 6 mg/stroke and < 66 mg / stroke Vehicle stationary Time in entry conditions > 2 seconds Fuel rail pressure deviation < 725 psi (5000 kpa)	1 second

Fault Overview

Fault code sets when the Engine Control Module (ECM) detects fuel injector is energized longer than expected.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 94 (FDP); SPN 157 (FRP); SPN 652 FMI 4, 5, and 13 (CYL/INJ); and SPN 3055 FMI 0, 1, 15, and 17

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Low Fuel Delivery Pressure (FDP)
- Aerated fuel delivery

- Failed injector (Mechanical)

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 94 (FDP); SPN 157 (FRP); SPN 652 FMI 4, 5, and 13 (CYL/INJ); and SPN 3055 FMI 0, 1, 15, and 17. Is EST DTC list free of SPN 94; SPN 157; SPN 652 FMI 4, 5, and 13; and SPN 3055 FMI 0, 1, 15, and 17?	Yes: Go to step 2. No: Repair SPN 94; SPN 157; SPN 652 FMI 4, 5, and 13; and SPN 3055 FMI 0, 1, 15 and 17. After repairs are complete, retest for SPN 652 FMI 16.

Step	Action	Decision
2	Check for low Fuel Delivery Pressure (FDP). Using EST, monitor FDP at idle. Is FDP above 85 psi??	Yes: Go to step 3. No: Perform Low-pressure Fuel System tests (page 217). After repairs are complete, retest for SPN 652 FMI 16.

Step	Action	Decision
3	Check for aeration in low-pressure fuel system. Perform Fuel Aeration Test (page 221). Is low-pressure fuel system free from aeration?	Yes: Go to step 4. No: Repair aeration in low-pressure fuel system. After repairs are complete, retest for SPN 652 FMI 16.

Step	Action	Decision
4	Run the fault monitors to determine source of fault. • Using EST, load the HD-OBD monitors session. Click the refresh button at the bottom to load the values. Save a screen shot documenting the Injector quantity/timing error values. • Clear all faults, Start the engine and run for 5 minutes at high idle. Verify that the SCR inlet temp is above 446°F (230°C) after 5 minutes, and that the engine coolant temperature is above 160°F (71°C). • Return the engine to normal idle for 5 minutes • Using the HD-OBD monitors session monitor the injector timing quantity error values. Refresh the page using the refresh button at the bottom and save a screenshot of the new values. • Compare last screenshot to the previous. Verify all values changed from the previous screenshot indicating the monitors have run properly. Is EST DTC list free from SPN 652 FMI 16?	Yes: Clear fault. No: Replace Injector 2. After repairs are complete, retest for SPN 652 FMI 16.

NOTE: After performing all diagnostic steps, if SPN 652 FMI 16 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 652 FMI 18- Injector 2 Fuel quantity/timing low error

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Fuel injector is energized shorter than expected.	The sum of actual and learned fuel rail pressure energizing times < 320 microseconds	Charge Air Cooler Outlet Temperature (CACOT) > 14°F (-10°C) Selective Catalyst Reduction (SCR) warm-up mode inactive Engine Coolant Temperature 1 (ECT1) > 158°F (70°C) and < 239°F (115°C) Engine speed steady: Engine speed variation < 100 rpm, per time > 3 seconds] Ambient air pressure (BARO) > 11.6 psi (80 kpa) and < 16 psi (110 kpa) Idle speed error < 50 rpm Engine speed < 800 rpm Fuel command > 6 mg/stroke and < 66 mg / stroke Vehicle stationary Time in entry conditions > 2 seconds Fuel rail pressure deviation < 725 psi (5000 kpa)	1 second

Fault Overview

Fault code sets when the Electronic Control Module (ECM) detects fuel injector is energized shorter than expected.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 94 (FDP); SPN 157 (FRP); and SPN 652 FMI 4, 5, and 13 (CYL/INJ)

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Contaminated fuel
- Failed injector (Mechanical)

- Base engine compression imbalance

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 94 (FDP); SPN 157 (FRP); and SPN 652 FMI 4, 5, and 13 (CYL/INJ). Is EST DTC list free of SPN 94; SPN 157; and SPN 652 FMI 4, 5, and 13?	Yes: Go to step 2. No: Repair SPN 94; SPN 157; and SPN 652 FMI 4, 5, and 13. After repairs are complete, retest for SPN 652 FMI 18.

Step	Action	Decision
2	Check fuel for contamination. Perform Fuel Quality Check (page 193). Is the fuel contaminated?	Yes: Drain fuel tank and fill fuel tank with appropriate diesel fuel. After repairs are complete, retest for SPN 652 FMI 18. No: Go to step 3.

Step	Action	Decision
3	Determine if the engine has a mechanical cylinder balance problem (compression loss). Perform Crankcase Pressure Test (page 236). Does engine have excessive crankcase pressure?	Yes: Repair base engine compression imbalance. After repairs are complete, retest for SPN 652 FMI 18. No: Go to step 4.

Step	Action	Decision
4	Determine if engine has a fuel injector problem. Perform Multiple Cylinder Cutout Test (page 241). Did one or more cylinders have significant speed difference(s) than the others?	Yes: Go to step 5. No: Retest for SPN 652 FMI 18.

Step	Action	Decision
5	Inspect for failed valve train components. Remove upper valve cover (see Engine Service Manual). Inspect for bent valves, fallen bridges, and valves out of adjustment. Is valve train free of failed valve train components?	Yes: Replace injector suspected by Multiple Cylinder Cutout Test. After repairs are complete, retest for SPN 652 FMI 18. No: Repair failed valve train components. After repairs are complete retest for SPN 652 FMI 18.

NOTE: After performing all diagnostic steps, if SPN 652 FMI 18 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 653 FMI 13- Injector 3 programmable parameter error

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Incorrect Injector Quantity Adjustment (IQA) programed to Electronic Control Module (ECM).	IQA checksum or range error	Key ON (runs once per key cycle)	Immediate

Fault Overview

Fault code sets when Electronic Control Module (ECM) detects an incorrect Injector Quantity Adjustment (IQA) has been programmed into the ECM.

Malfunction Indicator Lamp (MIL) Reaction

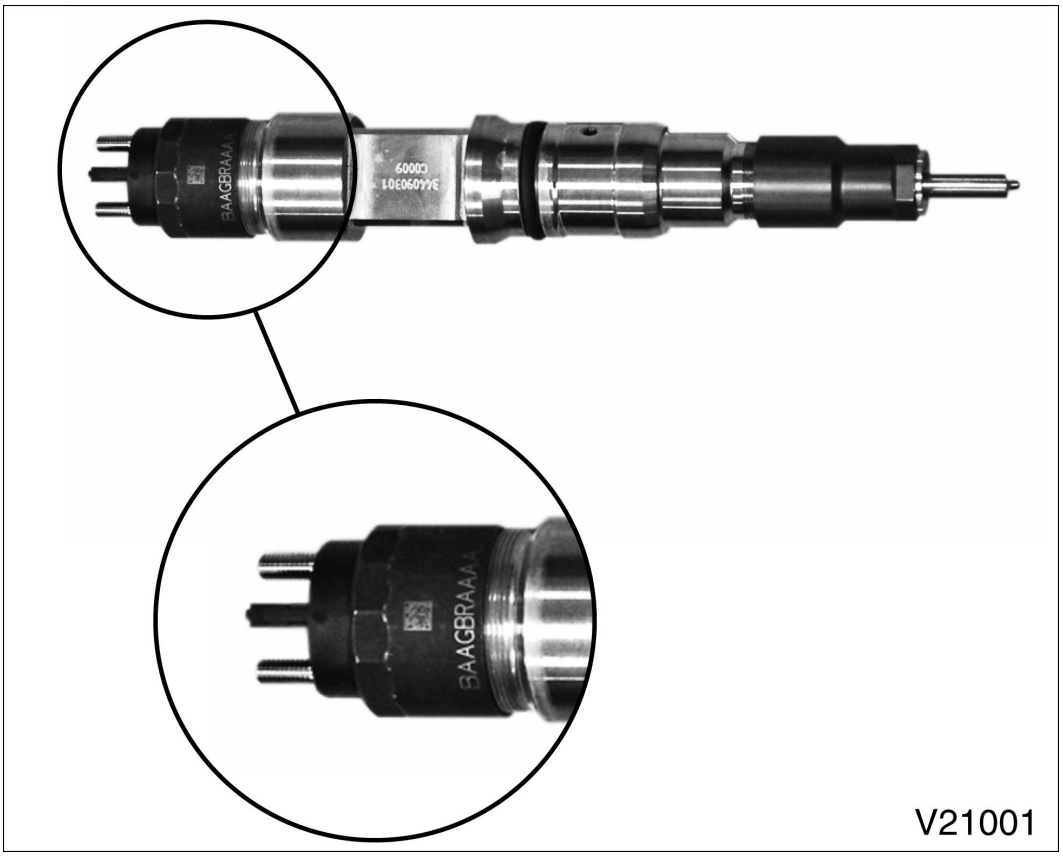
MIL will illuminate when this fault is detected during one drive cycle.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Incorrect Programmed IQA



Step	Action	Decision
1	Check that the proper Injector Quantity Adjustment (IQA) is programed into the Electronic Control Module (ECM). 1. Remove valve cover (see Engine Service Manual) and engine brake housing. Document the IQA code for all six injectors. 2. Using Electronic Service Tool (EST) with ServiceMaxx, select Procedures > KOEO Procedures > Injection Quantity Adjustment. Do the IQA codes displayed in ServiceMaxx match the injectors in the engine?	Yes: Clear fault code. Recheck IQA codes. After repairs are complete, retest for SPN 653 FMI 13. No: Reprogram ECM with correct IQA codes (follow on screen instructions). After repairs are complete, retest for SPN 653 FMI 13.

NOTE: After performing all diagnostic steps, if SPN 653 FMI 13 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 653 FMI 16- Injector 3 Fuel quantity/timing high error

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Fuel injector is energized for longer than expected.	The sum of actual and learned energizing time > 580 microseconds	Charge Air Cooler Outlet Temperature (CACOT) > 14°F (-10°C) Selective Catalyst Reduction (SCR) warm-up mode inactive Engine Coolant Temperature 1 (ECT1) > 158°F (70°C) and < 239°F (115°C) Engine Speed Steady: Engine speed variation < 100 rpm, per time > 3 seconds Ambient air pressure (BARO) > 11.6 psi (80 kpa) and < 16 psi (110 kpa) Idle speed error < 50 rpm Engine speed < 800 rpm Fuel command > 6 mg/stroke and < 66 mg / stroke Vehicle stationary Time in entry conditions > 2 seconds Fuel rail pressure deviation < 725 psi (5000 kpa)	1 second

Fault Overview

Fault code sets when the Engine Control Module (ECM) detects fuel injector is energized longer than expected.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 94 (FDP); SPN 157 (FRP); SPN 653 FMI 4, 5, and 13 (CYL/INJ); and SPN 3055 FMI 0, 1, 15, and 17

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Low Fuel Delivery Pressure (FDP)
- Aerated fuel delivery

- Failed injector (Mechanical)

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 94 (FDP); SPN 157 (FRP); SPN 653 FMI 4, 5, and 13 (CYL/INJ); and SPN 3055 FMI 0, 1, 15, and 17. Is EST DTC list free of SPN 94; SPN 157; SPN 653 FMI 4, 5, and 13; and SPN 3055 FMI 0, 1, 15, and 17?	Yes: Go to step 2. No: Repair SPN 94; SPN 157; SPN 653 FMI 4, 5, and 13; and SPN 3055 FMI 0, 1, 15 and 17. After repairs are complete, retest for SPN 653 FMI 16.

Step	Action	Decision
2	Check for low Fuel Delivery Pressure (FDP). Using EST, monitor FDP at idle. Is FDP above 85 psi??	Yes: Go to step 3. No: Perform Low-pressure Fuel System tests (page 217). After repairs are complete, retest for SPN 653 FMI 16.

Step	Action	Decision
3	Check for aeration in low-pressure fuel system. Perform Fuel Aeration Test (page 221). Is low-pressure fuel system free from aeration?	Yes: Go to step 4. No: Repair aeration in low-pressure fuel system. After repairs are complete, retest for SPN 653 FMI 16.

Step	Action	Decision
4	Run the fault monitors to determine source of fault. • Using EST, load the HD-OBD monitors session. Click the refresh button at the bottom to load the values. Save a screen shot documenting the Injector quantity/timing error values. • Clear all faults, Start the engine and run for 5 minutes at high idle. Verify that the SCR inlet temp is above 446°F (230°C) after 5 minutes, and that the engine coolant temperature is above 160°F (71°C). • Return the engine to normal idle for 5 minutes • Using the HD-OBD monitors session monitor the injector timing quantity error values. Refresh the page using the refresh button at the bottom and save a screenshot of the new values. • Compare last screenshot to the previous. Verify all values changed from the previous screenshot indicating the monitors have run properly. Is EST DTC list free from SPN 653 FMI 16?	Yes: Clear fault. No: Replace Injector 3. After repairs are complete, retest for SPN 653 FMI 16.

NOTE: After performing all diagnostic steps, if SPN 653 FMI 16 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 653 FMI 18- Injector 3 Fuel quantity/timing low error

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Fuel injector is energized shorter than expected.	The sum of actual and learned fuel rail pressure energizing times < 320 microseconds	Charge Air Cooler Outlet Temperature (CACOT) > 14°F (-10°C) Selective Catalyst Reduction (SCR) warm-up mode inactive Engine Coolant Temperature 1 (ECT1) > 158°F (70°C) and < 239°F (115°C) Engine speed steady: Engine speed variation < 100 rpm, per time > 3 seconds] Ambient air pressure (BARO) > 11.6 psi (80 kpa) and < 16 psi (110 kpa) Idle speed error < 50 rpm Engine speed < 800 rpm Fuel command > 6 mg/stroke and < 66 mg / stroke Vehicle stationary Time in entry conditions > 2 seconds Fuel rail pressure deviation < 725 psi (5000 kpa)	1 second

Fault Overview

Fault code sets when the Electronic Control Module (ECM) detects fuel injector is energized shorter than expected.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 94 (FDP); SPN 157 (FRP); and SPN 653 FMI 4, 5, and 13 (CYL/INJ)

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Contaminated fuel
- Failed injector (Mechanical)

- Base engine compression imbalance

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 94 (FDP); SPN 157 (FRP); and SPN 653 FMI 4, 5, and 13 (CYL/INJ). Is EST DTC list free of SPN 94; SPN 157; and SPN 653 FMI 4, 5, and 13?	Yes: Go to step 2. No: Repair SPN 94; SPN 157; and SPN 653 FMI 4, 5, and 13. After repairs are complete, retest for SPN 653 FMI 18.

Step	Action	Decision
2	Check fuel for contamination. Perform Fuel Quality Check (page 193). Is the fuel contaminated?	Yes: Drain fuel tank and fill fuel tank with appropriate diesel fuel. After repairs are complete, retest for SPN 653 FMI 18. No: Go to step 3.

Step	Action	Decision
3	Determine if the engine has a mechanical cylinder balance problem (compression loss). Perform Crankcase Pressure Test (page 236). Does engine have excessive crankcase pressure?	Yes: Repair base engine compression imbalance. After repairs are complete, retest for SPN 653 FMI 18. No: Go to step 4.

Step	Action	Decision
4	Determine if engine has a fuel injector problem. Perform Multiple Cylinder Cutout Test (page 241). Did one or more cylinders have significant speed difference(s) than the others?	Yes: Go to step 5. No: Retest for SPN 653 FMI 18.

Step	Action	Decision
5	Inspect for failed valve train components. Remove upper valve cover (see Engine Service Manual). Inspect for bent valves, fallen bridges, and valves out of adjustment. Is valve train free of failed valve train components?	Yes: Replace injector suspected by Multiple Cylinder Cutout Test. After repairs are complete, retest for SPN 653 FMI 18. No: Repair failed valve train components. After repairs are complete retest for SPN 653 FMI 18.

NOTE: After performing all diagnostic steps, if SPN 653 FMI 18 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 654 FMI 13- Injector 4 programmable parameter error

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Incorrect Injector Quantity Adjustment (IQA) programed to Electronic Control Module (ECM).	IQA checksum or range error	Key ON (runs once per key cycle)	Immediate

Fault Overview

Fault code sets when Electronic Control Module (ECM) detects an incorrect Injector Quantity Adjustment (IQA) has been programmed into the ECM.

Malfunction Indicator Lamp (MIL) Reaction

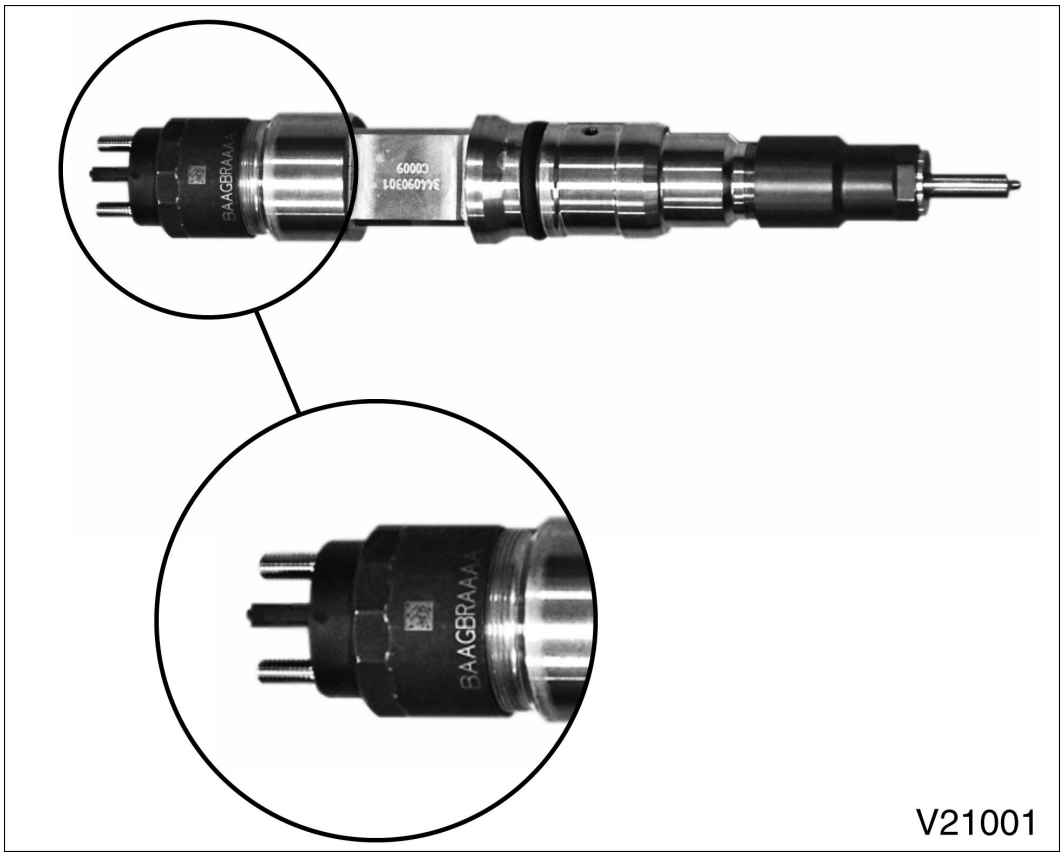
MIL will illuminate when this fault is detected during one drive cycle.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Incorrect Programmed IQA



Step	Action	Decision
1	Check that the proper Injector Quantity Adjustment (IQA) is programed into the Electronic Control Module (ECM). 1. Remove upper valve cover (see Engine Service Manual) and engine brake housing. Document the IQA code for all six injectors. 2. Using Electronic Service Tool (EST) with ServiceMaxx, select Procedures > KOEO Procedures > Injection Quantity Adjustment. Do the IQA codes displayed in ServiceMaxx match the injectors in the engine?	Yes: Clear fault code. Recheck IQA codes. After repairs are complete, retest for SPN 654 FMI 13. No: Reprogram ECM with correct IQA codes (follow on screen instructions). After repairs are complete, retest for SPN 654 FMI 13.

NOTE: After performing all diagnostic steps, if SPN 654 FMI 13 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 654 FMI 16- Injector 1 Fuel quantity/timing high error

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Fuel injector is energized for longer than expected.	The sum of actual and learned energizing time > 580 microseconds	Charge Air Cooler Outlet Temperature (CACOT) > 14°F (-10°C) Selective Catalyst Reduction (SCR) warm-up mode inactive Engine Coolant Temperature 1 (ECT1) > 158°F (70°C) and < 239°F (115°C) Engine Speed Steady: Engine speed variation < 100 rpm, per time > 3 seconds Ambient air pressure (BARO) > 11.6 psi (80 kpa) and < 16 psi (110 kpa) Idle speed error < 50 rpm Engine speed < 800 rpm Fuel command > 6 mg/stroke and < 66 mg / stroke Vehicle stationary Time in entry conditions > 2 seconds Fuel rail pressure deviation < 725 psi (5000 kpa)	1 second

Fault Overview

Fault code sets when the Engine Control Module (ECM) detects fuel injector is energized longer than expected.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 94 (FDP); SPN 157 (FRP); SPN 654 FMI 4, 5, and 13 (CYL/INJ); and SPN 3055 FMI 0, 1, 15, and 17

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Low Fuel Delivery Pressure (FDP)
- Aerated fuel delivery

- Failed injector (Mechanical)

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 94 (FDP); SPN 157 (FRP); SPN 652 FMI 4, 5, 13, 20 and 21(CYL/INJ); and SPN 3055 FMI 0, 1, 15, and 17. Is EST DTC list free of SPN 94; SPN 157; SPN 654 FMI 4, 5, and 13; and SPN 3055 FMI 0, 1, 15, and 17?	Yes: Go to step 2. No: Repair SPN 94; SPN 157; SPN 654 FMI 4, 5, and 13; and SPN 3055 FMI 0, 1, 15 and 17. After repairs are complete, retest for SPN 654 FMI 16.

Step	Action	Decision
2	Check for low Fuel Delivery Pressure (FDP). Using EST, monitor FDP at idle. Is FDP above 85 psi??	Yes: Go to step 3. No: Perform Low-pressure Fuel System tests (page 217). After repairs are complete, retest for SPN 654 FMI 16.

Step	Action	Decision
3	Check for aeration in low-pressure fuel system. Perform Fuel Aeration Test (page 221). Is low-pressure fuel system free from aeration?	Yes: Go to step 4. No: Repair aeration in low-pressure fuel system. After repairs are complete, retest for SPN 654 FMI 16.

Step	Action	Decision
4	Run the fault monitors to determine source of fault. • Using EST, load the HD-OBD monitors session. Click the refresh button at the bottom to load the values. Save a screen shot documenting the Injector quantity/timing error values. • Clear all faults, Start the engine and run for 5 minutes at high idle. Verify that the SCR inlet temp is above 446°F (230°C) after 5 minutes, and that the engine coolant temperature is above 160°F (71°C). • Return the engine to normal idle for 5 minutes • Using the HD-OBD monitors session monitor the injector timing quantity error values. Refresh the page using the refresh button at the bottom and save a screenshot of the new values. • Compare last screenshot to the previous. Verify all values changed from the previous screenshot indicating the monitors have run properly. Is EST DTC list free from SPN 654 FMI 16?	Yes: Clear fault. No: Replace Injector 4. After repairs are complete, retest for SPN 654 FMI 16.

NOTE: After performing all diagnostic steps, if SPN 654 FMI 16 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 654 FMI 18- Injector 4 Fuel quantity/timing low error

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Fuel injector is energized shorter than expected.	The sum of actual and learned fuel rail pressure energizing times < 320 microseconds	Charge Air Cooler Outlet Temperature (CACOT) > 14°F (-10°C) Selective Catalyst Reduction (SCR) warm-up mode inactive Engine Coolant Temperature 1 (ECT1) > 158°F (70°C) and < 239°F (115°C) Engine speed steady: Engine speed variation < 100 rpm, per time > 3 seconds] Ambient air pressure (BARO) > 11.6 psi (80 kpa) and < 16 psi (110 kpa) Idle speed error < 50 rpm Engine speed < 800 rpm Fuel command > 6 mg/stroke and < 66 mg / stroke Vehicle stationary Time in entry conditions > 2 seconds Fuel rail pressure deviation < 725 psi (5000 kpa)	1 second

Fault Overview

Fault code sets when the Electronic Control Module (ECM) detects fuel injector is energized shorter than expected.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 94 (FDP); SPN 157 (FRP); and SPN 654 FMI 4, 5, and 13 (CYL/INJ)

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Contaminated fuel
- Failed injector (Mechanical)

- Base engine compression imbalance

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 94 (FDP); SPN 157 (FRP); and SPN 654 FMI 4, 5, and 13 (CYL/INJ). Is EST DTC list free of SPN 94; SPN 157; and SPN 654 FMI 4, 5, and 13?	Yes: Go to step 2. No: Repair SPN 94; SPN 157; and SPN 654 FMI 4, 5, and 13. After repairs are complete, retest for SPN 654 FMI 18.

Step	Action	Decision
2	Check fuel for contamination. Perform Fuel Quality Check (page 193). Is the fuel contaminated?	Yes: Drain fuel tank and fill fuel tank with appropriate diesel fuel. After repairs are complete, retest for SPN 654 FMI 18. No: Go to step 3.

Step	Action	Decision
3	Determine if the engine has a mechanical cylinder balance problem (compression loss). Perform Crankcase Pressure Test (page 236). Does engine have excessive crankcase pressure?	Yes: Repair base engine compression imbalance. After repairs are complete, retest for SPN 654 FMI 18. No: Go to step 4.

Step	Action	Decision
4	Determine if engine has a fuel injector problem. Perform Multiple Cylinder Cutout Test (page 241). Did one or more cylinders have significant speed difference(s) than the others?	Yes: Go to step 5. No: Retest for SPN 654 FMI 18.

Step	Action	Decision
5	Inspect for failed valve train components. Remove upper valve cover (see Engine Service Manual). Inspect for bent valves, fallen bridges, and valves out of adjustment. Is valve train free of failed valve train components?	Yes: Replace injector suspected by Multiple Cylinder Cutout Test. After repairs are complete, retest for SPN 654 FMI 18. No: Repair failed valve train components. After repairs are complete retest for SPN 654 FMI 18.

NOTE: After performing all diagnostic steps, if SPN 654 FMI 18 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 655 FMI 13- Injector 5 programmable parameter error

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Incorrect Injector Quantity Adjustment (IQA) programed to Electronic Control Module (ECM).	IQA checksum or range error	Key ON (runs once per key cycle)	Immediate

Fault Overview

Fault code sets when Electronic Control Module (ECM) detects an incorrect Injector Quantity Adjustment (IQA) has been programmed into the ECM.

Malfunction Indicator Lamp (MIL) Reaction

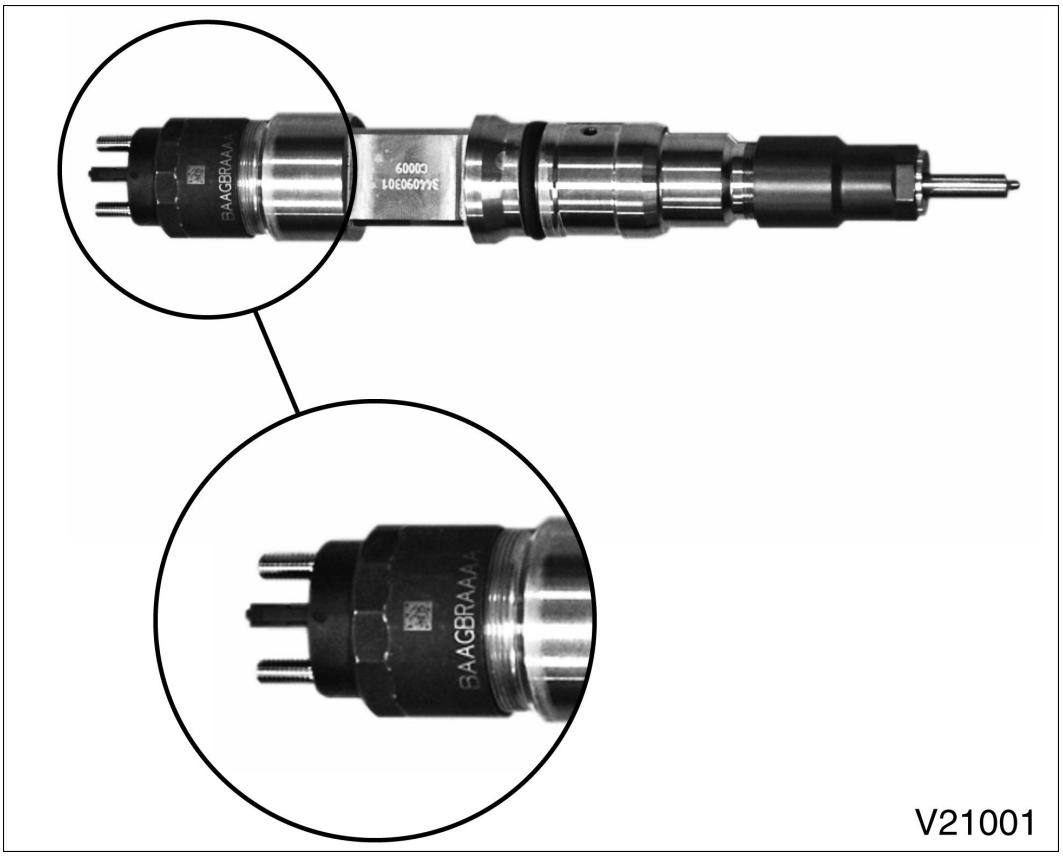
MIL will illuminate when this fault is detected during one drive cycle.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Incorrect Programmed IQA



Step	Action	Decision
1	Check that the proper Injector Quantity Adjustment (IQA) is programed into the Electronic Control Module (ECM). 1. Remove upper valve cover (see Engine Service Manual) and engine brake housing. Document the IQA code for all six injectors. 2. Using Electronic Service Tool (EST) with ServiceMaxx, select Procedures > KOEO Procedures > Injection Quantity Adjustment. Do the IQA codes displayed in ServiceMaxx match the injectors in the engine?	Yes: Clear fault code. Recheck IQA codes. After repairs are complete, retest for SPN 655 FMI 13. No: Reprogram ECM with correct IQA codes (follow on screen instructions). After repairs are complete, retest for SPN 655 FMI 13.

NOTE: After performing all diagnostic steps, if SPN 655 FMI 13 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 655 FMI 16- Injector 5 Fuel quantity/timing high error

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Fuel injector is energized for longer than expected.	The sum of actual and learned energizing time > 580 microseconds	Charge Air Cooler Outlet Temperature (CACOT) > 14°F (-10°C) Selective Catalyst Reduction (SCR) warm-up mode inactive Engine Coolant Temperature 1 (ECT1) > 158°F (70°C) and < 239°F (115°C) Engine Speed Steady: Engine speed variation < 100 rpm, per time > 3 seconds Ambient air pressure (BARO) > 11.6 psi (80 kpa) and < 16 psi (110 kpa) Idle speed error < 50 rpm Engine speed < 800 rpm Fuel command > 6 mg/stroke and < 66 mg / stroke Vehicle stationary Time in entry conditions > 2 seconds Fuel rail pressure deviation < 725 psi (5000 kpa)	1 second

Fault Overview

Fault code sets when the Engine Control Module (ECM) detects fuel injector is energized longer than expected.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 94 (FDP); SPN 157 (FRP); SPN 655 FMI 4, 5, and 13 (CYL/INJ); and SPN 3055 FMI 0, 1, 15, and 17

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Low Fuel Delivery Pressure (FDP)
- Aerated fuel delivery

- Failed injector (Mechanical)

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 94 (FDP); SPN 157 (FRP); SPN 655 FMI 4, 5, and 13 (CYL/INJ); and SPN 3055 FMI 0, 1, 15, and 17. Is EST DTC list free of SPN 94; SPN 157; SPN 655 FMI 4, 5, and 13; and SPN 3055 FMI 0, 1, 15, and 17?	Yes: Go to step 2. No: Repair SPN 94; SPN 157; SPN 655 FMI 4, 5, and 13; and SPN 3055 FMI 0, 1, 15 and 17. After repairs are complete, retest for SPN 655 FMI 16.

Step	Action	Decision
2	Check for low Fuel Delivery Pressure (FDP). Using EST, monitor FDP at idle. Is FDP above 85 psi??	Yes: Go to step 3. No: Perform Low-pressure Fuel System tests (page 217). After repairs are complete, retest for SPN 655 FMI 16.

Step	Action	Decision
3	Check for aeration in low-pressure fuel system. Perform Fuel Aeration Test (page 221). Is low-pressure fuel system free from aeration?	Yes: Go to step 4. No: Repair aeration in low-pressure fuel system. After repairs are complete, retest for SPN 655 FMI 16.

Step	Action	Decision
4	Run the fault monitors to determine source of fault. • Using EST, load the HD-OBD monitors session. Click the refresh button at the bottom to load the values. Save a screen shot documenting the Injector quantity/timing error values. • Clear all faults, Start the engine and run for 5 minutes at high idle. Verify that the SCR inlet temp is above 446°F (230°C) after 5 minutes, and that the engine coolant temperature is above 160°F (71°C). • Return the engine to normal idle for 5 minutes • Using the HD-OBD monitors session monitor the injector timing quantity error values. Refresh the page using the refresh button at the bottom and save a screenshot of the new values. • Compare last screenshot to the previous. Verify all values changed from the previous screenshot indicating the monitors have run properly. Is EST DTC list free from SPN 655 FMI 16?	Yes: Clear fault. No: Replace Injector 5. After repairs are complete, retest for SPN 655 FMI 16.

NOTE: After performing all diagnostic steps, if SPN 655 FMI 16 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 655 FMI 18- Injector 5 Fuel quantity/timing low error

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Fuel injector is energized shorter than expected.	The sum of actual and learned fuel rail pressure energizing times < 320 microseconds	Charge Air Cooler Outlet Temperature (CACOT) > 14°F (-10°C) Selective Catalyst Reduction (SCR) warm-up mode inactive Engine Coolant Temperature 1 (ECT1) > 158°F (70°C) and < 239°F (115°C) Engine speed steady: Engine speed variation < 100 rpm, per time > 3 seconds] Ambient air pressure (BARO) > 11.6 psi (80 kpa) and < 16 psi (110 kpa) Idle speed error < 50 rpm Engine speed < 800 rpm Fuel command > 6 mg/stroke and < 66 mg / stroke Vehicle stationary Time in entry conditions > 2 seconds Fuel rail pressure deviation < 725 psi (5000 kpa)	1 second

Fault Overview

Fault code sets when the Electronic Control Module (ECM) detects fuel injector is energized shorter than expected.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 94 (FDP); SPN 157 (FRP); and SPN 655 FMI 4, 5, and 13 (CYL/INJ)

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Contaminated fuel
- Failed injector (Mechanical)

- Base engine compression imbalance

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 94 (FDP); SPN 157 (FRP); and SPN 655 FMI 4, 5, and 13 (CYL/INJ). Is EST DTC list free of SPN 94; SPN 157; and SPN 655 FMI 4, 5, and 13?	Yes: Go to step 2. No: Repair SPN 94; SPN 157; and SPN 655 FMI 4, 5, and 13. After repairs are complete, retest for SPN 655 FMI 18.

Step	Action	Decision
2	Check fuel for contamination. Perform Fuel Quality Check (page 193). Is the fuel contaminated?	Yes: Drain fuel tank and fill fuel tank with appropriate diesel fuel. After repairs are complete, retest for SPN 655 FMI 18. No: Go to step 3.

Step	Action	Decision
3	Determine if the engine has a mechanical cylinder balance problem (compression loss). Perform Crankcase Pressure Test (page 236). Does engine have excessive crankcase pressure?	Yes: Repair base engine compression imbalance. After repairs are complete, retest for SPN 655 FMI 18. No: Go to step 4.

Step	Action	Decision
4	Determine if engine has a fuel injector problem. Perform Multiple Cylinder Cutout Test (page 241). Did one or more cylinders have significant speed difference(s) than the others?	Yes: Go to step 5. No: Retest for SPN 655 FMI 18.

Step	Action	Decision
5	Inspect for failed valve train components. Remove upper valve cover (see Engine Service Manual). Inspect for bent valves, fallen bridges, and valves out of adjustment. Is valve train free of failed valve train components?	Yes: Replace injector suspected by Multiple Cylinder Cutout Test. After repairs are complete, retest for SPN 655 FMI 18. No: Repair failed valve train components. After repairs are complete retest for SPN 655 FMI 18.

NOTE: After performing all diagnostic steps, if SPN 655 FMI 18 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 656 FMI 13- Injector 6 programmable parameter error

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Incorrect Injector Quantity Adjustment (IQA) programed to Electronic Control Module (ECM).	IQA checksum or range error	Key ON (runs once per key cycle)	Immediate

Fault Overview

Fault code sets when Electronic Control Module (ECM) detects an incorrect Injector Quantity Adjustment (IQA) has been programmed into the ECM.

Malfunction Indicator Lamp (MIL) Reaction

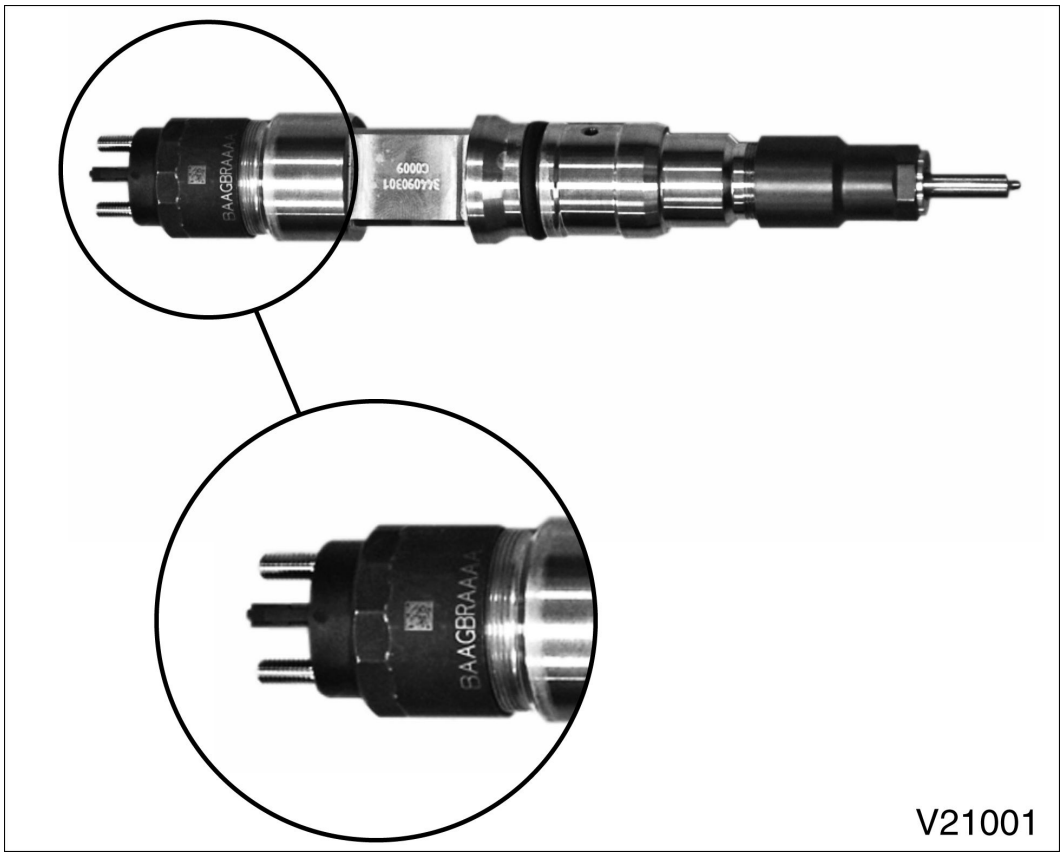
MIL will illuminate when this fault is detected during one drive cycle.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Incorrect Programmed IQA



Step	Action	Decision
1	Check that the proper Injector Quantity Adjustment (IQA) is programed into the Electronic Control Module (ECM). 1. Remove upper valve cover (see Engine Service Manual) and engine brake housing. Document the IQA code for all six injectors. 2. Using Electronic Service Tool (EST) with ServiceMaxx, select Procedures > KOEO Procedures > Injection Quantity Adjustment. Do the IQA codes displayed in ServiceMaxx match the injectors in the engine?	Yes: Clear fault code. Recheck IQA codes. After repairs are complete, retest for SPN 656 FMI 13. No: Reprogram ECM with correct IQA codes (follow on screen instructions). After repairs are complete, retest for SPN 656 FMI 13.

NOTE: After performing all diagnostic steps, if SPN 656 FMI 13 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 656 FMI 16- Injector 6 Fuel quantity/timing high error

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Fuel injector is energized for longer than expected.	The sum of actual and learned energizing time > 580 microseconds	Charge Air Cooler Outlet Temperature (CACOT) > 14°F (-10°C) Selective Catalyst Reduction (SCR) warm-up mode inactive Engine Coolant Temperature 1 (ECT1) > 158°F (70°C) and < 239°F (115°C) Engine Speed Steady: Engine speed variation < 100 rpm, per time > 3 seconds Ambient air pressure (BARO) > 11.6 psi (80 kpa) and < 16 psi (110 kpa) Idle speed error < 50 rpm Engine speed < 800 rpm Fuel command > 6 mg/stroke and < 66 mg / stroke Vehicle stationary Time in entry conditions > 2 seconds Fuel rail pressure deviation < 725 psi (5000 kpa)	1 second

Fault Overview

Fault code sets when the Engine Control Module (ECM) detects fuel injector is energized longer than expected.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 94 (FDP); SPN 157 (FRP); SPN 656 FMI 4, 5, and 13 (CYL/INJ); and SPN 3055 FMI 0, 1, 15, and 17

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Low Fuel Delivery Pressure (FDP)
- Aerated fuel delivery

- Failed injector (Mechanical)

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 94 (FDP); SPN 157 (FRP); SPN 656 FMI 4, 5, and 13 (CYL/INJ); and SPN 3055 FMI 0, 1, 15, and 17. Is EST DTC list free of SPN 94; SPN 157; SPN 656 FMI 4, 5, and 13; and SPN 3055 FMI 0, 1, 15, and 17?	Yes: Go to step 2. No: Repair SPN 94; SPN 157; SPN 656 FMI 4, 5, and 13; and SPN 3055 FMI 0, 1, 15 and 17. After repairs are complete, retest for SPN 656 FMI 16.

Step	Action	Decision
2	Check for low Fuel Delivery Pressure (FDP). Using EST, monitor FDP at idle. Is FDP above 85 psi??	Yes: Go to step 3. No: Perform Low-pressure Fuel System tests (page 217). After repairs are complete, retest for SPN 656 FMI 16.

Step	Action	Decision
3	Check for aeration in low-pressure fuel system. Perform Fuel Aeration Test (page 221). Is low-pressure fuel system free from aeration?	Yes: Go to step 4. No: Repair aeration in low-pressure fuel system. After repairs are complete, retest for SPN 656 FMI 16.

Step	Action	Decision
4	Run the fault monitors to determine source of fault. • Using EST, load the HD-OBD monitors session. Click the refresh button at the bottom to load the values. Save a screen shot documenting the Injector quantity/timing error values. • Clear all faults, Start the engine and run for 5 minutes at high idle. Verify that the SCR inlet temp is above 446°F (230°C) after 5 minutes, and that the engine coolant temperature is above 160°F (71°C). • Return the engine to normal idle for 5 minutes • Using the HD-OBD monitors session monitor the injector timing quantity error values. Refresh the page using the refresh button at the bottom and save a screenshot of the new values. • Compare last screenshot to the previous. Verify all values changed from the previous screenshot indicating the monitors have run properly. Is EST DTC list free from SPN 656 FMI 16?	Yes: Clear fault. No: Replace Injector 6. After repairs are complete, retest for SPN 656 FMI 16.

NOTE: After performing all diagnostic steps, if SPN 656 FMI 16 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 656 FMI 18- Injector 6 Fuel quantity/timing low error

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Fuel injector is energized shorter than expected.	The sum of actual and learned fuel rail pressure energizing times < 320 microseconds	Charge Air Cooler Outlet Temperature (CACOT) > 14°F (-10°C) Selective Catalyst Reduction (SCR) warm-up mode inactive Engine Coolant Temperature 1 (ECT1) > 158°F (70°C) and < 239°F (115°C) Engine speed steady: Engine speed variation < 100 rpm, per time > 3 seconds] Ambient air pressure (BARO) > 11.6 psi (80 kpa) and < 16 psi (110 kpa) Idle speed error < 50 rpm Engine speed < 800 rpm Fuel command > 6 mg/stroke and < 66 mg / stroke Vehicle stationary Time in entry conditions > 2 seconds Fuel rail pressure deviation < 725 psi (5000 kpa)	1 second

Fault Overview

Fault code sets when the Electronic Control Module (ECM) detects fuel injector is energized shorter than expected.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 94 (FDP); SPN 157 (FRP); and SPN 656 FMI 4, 5, and 13 (CYL/INJ)

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Contaminated fuel
- Failed injector (Mechanical)

- Base engine compression imbalance

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 94 (FDP); SPN 157 (FRP); and SPN 656 FMI 4, 5, and 13 (CYL/INJ). Is EST DTC list free of SPN 94; SPN 157; and SPN 655 FMI 4, 5, and 13?	Yes: Go to step 2. No: Repair SPN 94; SPN 157; and SPN 656 FMI 4, 5, and 13. After repairs are complete, retest for SPN 656 FMI 18.

Step	Action	Decision
2	Check fuel for contamination. Perform Fuel Quality Check (page 193). Is the fuel contaminated?	Yes: Drain fuel tank and fill fuel tank with appropriate diesel fuel. After repairs are complete, retest for SPN 656 FMI 18. No: Go to step 3.

Step	Action	Decision
3	Determine if the engine has a mechanical cylinder balance problem (compression loss). Perform Crankcase Pressure Test (page 236). Does engine have excessive crankcase pressure?	Yes: Repair base engine compression imbalance. After repairs are complete, retest for SPN 656 FMI 18. No: Go to step 4.

Step	Action	Decision
4	Determine if engine has a fuel injector problem. Perform Multiple Cylinder Cutout Test (page 241). Did one or more cylinders have significant speed difference(s) than the others?	Yes: Go to step 5. No: Retest for SPN 656 FMI 18.

Step	Action	Decision
5	Inspect for failed valve train components. Remove upper valve cover (see Engine Service Manual). Inspect for bent valves, fallen bridges, and valves out of adjustment. Is valve train free of failed valve train components?	Yes: Replace injector suspected by Multiple Cylinder Cutout Test. After repairs are complete, retest for SPN 656 FMI 18. No: Repair failed valve train components. After repairs are complete retest for SPN 656 FMI 18.

NOTE: After performing all diagnostic steps, if SPN 656 FMI 18 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 1322 FMI 31- Misfire- Multiple Cylinders

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Crankshaft acceleration indicates misfire on multiple cylinders.	Misfire Count > 180	Engine Running Engine speed > 500 rpm and < 950 rpm Idle speed error < 200 rpm Fuel command > 2 mg / stroke and < 60mg / stroke Engine Coolant Temperature 1 (ECT1) > 86°F (30°C) Vehicle speed < 2 mph (3 km/h) Diesel Particulate Filter (DPF) Not regenerating	440 engine revolutions

Fault Overview

Fault code sets when the Electronic Control Module (ECM) detects multiple cylinder misfires from the Crankshaft Position (CKP) sensor signal.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 94 (FDP); SPN 157 (FRP); SPN 633 (FPCV); and SPN 3055 (FRP)

SPN 111 (EWPS); SPN 636 FMI 2, 8, and 10 (CMP); SPN 637 FMI 8 and 10 (CKP); SPN 731 (CYL); SPN 1323 (CYL); SPN 1324 (CYL); SPN 1325 (CYL); SPN 1326 (CYL); SPN 1327 (CYL); and SPN 1328 (CYL)

SPN 651 (CYL/INJ); SPN 652 (CYL/ INJ); SPN 653 (CYL / INJ); SPN 654 (CYL / INJ); SPN 655 (CYL / INJ); SPN 656 (CYL / INJ); SPN 2797 (INJ); and SPN 2798 (INJ)

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Low Fuel Delivery Pressure (FDP)
- Low Fuel Rail Pressure (FRP)
- Crankshaft Position (CKP) sensor out of calibration
- Contaminated fuel
- Failed injector (Mechanical)
- Base engine compression imbalance

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 94 (FDP); SPN 157 (FRP); SPN 633 (FPCV); and SPN 3055 (FRP). Is EST DTC list free of SPN 94; SPN 157; SPN 633; and SPN 3055?	Yes: Go to step 2. No: Repair SPN 94; SPN 157; SPN 633; and SPN 3055. After repairs are complete, retest for SPN 1322 FMI 31.

Step	Action	Decision
2	Using EST with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 111 (EWPS); SPN 636 FMI 2, 8, and 10 (CMP); SPN 637 FMI 8 and 10 (CKP); SPN 731 (CYL); SPN 1323 (CYL); SPN 1324 (CYL); SPN 1325 (CYL); SPN 1326 (CYL); SPN 1327 (CYL); and SPN 1328 (CYL). Is EST DTC list free of SPN 111; SPN 636 FMI 2, 8, and 10; SPN 637 FMI 8 and 10; SPN 731; SPN 1323; SPN 1324; SPN 1325; SPN 1326; SPN 1327; and SPN 1328?	Yes: Go to step 3. No: Repair SPN 111; SPN 636 FMI 2, 8, and 10; SPN 637 FMI 8 and 10; SPN 731; SPN 1323; SPN 1324; SPN 1325; SPN 1326; SPN 1327; and SPN 1328. After repairs are complete, retest for SPN 1322 FMI 31.

Step	Action	Decision
3	Using EST with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 651 (CYL/INJ); SPN 652 (CYL/INJ); SPN 653 (CYL / INJ); SPN 654 (CYL / INJ); SPN 655 (CYL / INJ); SPN 656 (CYL / INJ); SPN 2797 (INJ); and SPN 2798 (INJ). Is EST DTC list free of SPN 651; SPN 652; SPN 653; SPN 654; SPN 655; SPN 656; SPN 2797; and SPN 2798?	Yes: Go to step 4. No: Repair SPN 651; SPN 652; SPN 653; SPN 654; SPN 655; SPN 656; SPN 2797; and SPN 2798. After repairs are complete, retest for SPN 1322 FMI 31.

Step	Action	Decision
4	Check for poor fuel quality or contaminants. Perform Fuel Quality Check (page 193). Is fuel sample clean and free of sediments, traces of gasoline or kerosene, and waxing or icing?	Yes: Go to step 5. No: Drain fuel and fill with new or known good diesel fuel. After repairs are complete, retest for SPN 1322 FMI 31.

Step	Action	Decision
5	Using EST with ServiceMaxx software, check Fuel Rail Pressure (FRP). Select Sessions > Performance. Start engine and monitor FRP. Is Fuel Rail Pressure 10,500 psi (72,395 kPa) or greater?	Yes: Go to step 7. No: Go to step 6.

Step	Action	Decision
6	Using EST with ServiceMaxx software, check Fuel Delivery Pressure (FDP). Select Sessions > Performance. Start engine and monitor FDP. Is Fuel Delivery Pressure 60 psi (414 kpa) or greater?	Yes: Perform High-pressure Fuel System tests (page 227). After repairs are complete, retest for SPN 1322 FMI 31.
		No: Perform Low-pressure Fuel System tests (page 217). After repairs are complete, retest for SPN 1322 FMI 31.

Step	Action	Decision
7	Using EST with ServiceMaxx software, perform crank sensor relearn procedure. 1. Select Sessions > Programming > Service Interval (tab) > Crankshaft Position Learning Reset Request (ID 95232). 2. In Value field select Yes from the drop-down menu. 3. Select Program Engine button (when finished programming Value field will switch back to No). 4. Clear Fault Code and perform drive cycle 2. Did SPN 1322 FMI 31 become active?	Yes: Go to step 8.

Step	Action	Decision
8	Determine if the engine has a mechanical cylinder balance problem (compression loss). Perform Crankcase Pressure Test (page 236). Does engine have excessive crankcase pressure?	Yes: Repair base engine compression imbalance. After repairs are complete, retest for SPN 1322 FMI 31.
		No: Go to step 9.

Step	Action	Decision
9	Determine if engine has a fuel injector problem. Perform Multiple Cylinder Cutout Test (page 241). Did one or more cylinders have significant speed difference(s) than the others?	Yes: Go to step 10.
		No: Retest for SPN 1322 FMI 31.

Step	Action	Decision
10	Inspect for failed valve train components. Remove upper valve cover (see Engine Service Manual). Inspect for bent valves, fallen bridges, and valves out of adjustment. Is valve train free of failed valve train components?	Yes: Replace injector suspected by Multiple Cylinder Cutout Test. After repairs are complete, retest for SPN 1322 FMI 31.
		No: Repair failed valve train components. After repairs are complete retest for SPN 1322 FMI 31.

NOTE: After performing all diagnostic steps, if SPN 1322 FMI 31 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 1323 FMI 31- Misfire- Cylinder 1

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Crankshaft acceleration indicates misfire on cylinder 1.	Misfire Count > 180	Engine Running Engine speed > 500 rpm and < 950 rpm Idle speed error < 200 rpm Fuel command > 2 mg / stroke and < 60mg / stroke Engine Coolant Temperature 1 (ECT1) > 86°F (30°C) Vehicle speed < 2 mph (3 km/h) Diesel Particulate Filter (DPF) Not regenerating	440 engine revolutions

Fault Overview

Fault code sets when the Electronic Control Module (ECM) detects a cylinder 1 misfire from the Crankshaft Position (CKP) sensor.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 94 (FDP); SPN 157 (FRP); SPN 633 (FPCV); and SPN 3055 (FRP)

SPN 111 (EWPS); SPN 636 FMI 2, 8, and 10 (CMP); SPN 637 FMI 8 and 10 (CKP); SPN 731 (CYL); SPN 1322 (CYL); SPN 1324 (CYL); SPN 1325 (CYL); SPN 1326 (CYL); SPN 1327 (CYL); and SPN 1328 (CYL)

SPN 651 (CYL/INJ); SPN 652 (CYL/ INJ); SPN 653 (CYL / INJ); SPN 654 (CYL / INJ); SPN 655 (CYL / INJ); SPN 656 (CYL / INJ); SPN 2797 (INJ); and SPN 2798 (INJ)

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Low Fuel Delivery Pressure (FDP)
- Low Fuel Rail Pressure (FRP)
- Contaminated fuel
- Failed injector (Mechanical)
- Base engine compression imbalance

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 94 (FDP); SPN 157 (FRP); SPN 633 (FPCV); and SPN 3055 (FRP). Is EST DTC list free of SPN 94; SPN 157; SPN 633; and SPN 3055?	Yes: Go to step 2. No: Repair SPN 94; SPN 157; SPN 633; and SPN 3055. After repairs are complete, retest for SPN 1323 FMI 31.

Step	Action	Decision
2	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 111 (EWPS); SPN 636 FMI 2, 8, and 10 (CMP); SPN 637 FMI 8 and 10 (CKP); SPN 731 (CYL); SPN 1322 (CYL); SPN 1324 (CYL); SPN 1325 (CYL); SPN 1326 (CYL); SPN 1327 (CYL); and SPN 1328 (CYL). Is EST DTC list free of SPN 111; SPN 636 FMI 2, 8, and 10; SPN 637 FMI 8 and 10; SPN 731; SPN 1322; SPN 1324; SPN 1325; SPN 1326; SPN 1327; and SPN 1328?	Yes: Go to step 3. No: Repair SPN 111; SPN 636 FMI 2, 8, and 10; SPN 637 FMI 8 and 10; SPN 731; SPN 1322; SPN 1324; SPN 1325; SPN 1326; SPN 1327; and SPN 1328. After repairs are complete, retest for SPN 1323 FMI 31.

Step	Action	Decision
3	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 651 (CYL/INJ); SPN 652 (CYL/ INJ); SPN 653 (CYL / INJ); SPN 654 (CYL / INJ); SPN 655 (CYL / INJ); SPN 656 (CYL / INJ); SPN 2797 (INJ); and SPN 2798 (INJ). Is EST DTC list free of SPN 651; SPN 652; SPN 653; SPN 654; SPN 655; SPN 656; SPN 2797; and SPN 2798?	Yes: Go to step 4. No: Repair SPN 651; SPN 652; SPN 653; SPN 654; SPN 655; SPN 656; SPN 2797; and SPN 2798. After repairs are complete, retest for SPN 1323 FMI 31.

Step	Action	Decision
4	Check for poor fuel quality or contaminants. Perform Fuel Quality Check (page 193). Is fuel sample clean and free of sediments, traces of gasoline or kerosene, and waxing or icing?	Yes: Go to step 5. No: Drain fuel and fill with new or known good diesel fuel. After repairs are complete, retest for SPN 1323 FMI 31.

Step	Action	Decision
5	Using EST with ServiceMaxx software, check Fuel Rail Pressure (FRP). Select Sessions > Performance. Start engine and monitor FRP. Is Fuel Rail Pressure 10,500 psi (72,395 kPa) or greater?	Yes: Go to step 7. No: Go to step 6.

Step	Action	Decision
6	Using EST with ServiceMaxx software, check Fuel Delivery Pressure (FDP). Select Sessions > Performance. Start engine and monitor FDP. Is Fuel Delivery Pressure 60 psi (414 kpa) or greater?	Yes: Perform High-pressure Fuel System tests (page 227). After repairs are complete, retest for SPN 1323 FMI 31.
		No: Perform Low-pressure Fuel System tests (page 217). After repairs are complete, retest for SPN 1323 FMI 31.

Step	Action	Decision
7	Determine if the engine has a mechanical cylinder balance problem (compression loss). Perform Crankcase Pressure Test (page 236). Does engine have excessive crankcase pressure?	Yes: Repair base engine compression imbalance. After repairs are complete, retest for SPN 1323 FMI 31.
		No: Go to step 8.

Step	Action	Decision
8	Determine if engine has a fuel injector problem. Perform Multiple Cylinder Cutout Test (page 241). Did one or more cylinders have significant speed difference(s) than the others?	Yes: Go to step 9.
		No: Retest for SPN 1323 FMI 31.

Step	Action	Decision
9	Inspect for failed valve train components. Remove upper valve cover (see Engine Service Manual). Inspect for bent valves, fallen bridges, and valves out of adjustment. Is valve train free of failed valve train components?	Yes: Replace injector suspected by Multiple Cylinder Cutout Test. After repairs are complete, retest for SPN 1323 FMI 31.
		No: Repair failed valve train components. After repairs are complete retest for SPN 1323 FMI 31.

NOTE: After performing all diagnostic steps, if SPN 1323 FMI 31 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 1324 FMI 31- Misfire- Cylinder 2

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Crankshaft acceleration indicates misfire on cylinder 2.	Misfire Count > 180	Engine Running Engine speed > 500 rpm and < 950 rpm Idle speed error < 200 rpm Fuel command > 2 mg / stroke and < 60mg / stroke Engine Coolant Temperature 1 (ECT1) > 86°F (30°C) Vehicle speed < 2 mph (3 km/h) Diesel Particulate Filter (DPF) Not regenerating	440 engine revolutions

Fault Overview

Fault code sets when the Electronic Control Module (ECM) detects a cylinder 2 misfire from the Crankshaft Position (CKP) sensor.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 94 (FDP); SPN 157 (FRP); SPN 633 (FPCV); and SPN 3055 (FRP)

SPN 111 (EWPS); SPN 636 FMI 2, 8, and 10 (CMP); SPN 637 FMI 8 and 10 (CKP); SPN 731 (CYL); SPN 1322 (CYL); SPN 1324 (CYL); SPN 1325 (CYL); SPN 1326 (CYL); SPN 1327 (CYL); and SPN 1328 (CYL)

SPN 651 (CYL/INJ); SPN 652 (CYL/ INJ); SPN 653 (CYL / INJ); SPN 654 (CYL / INJ); SPN 655 (CYL / INJ); SPN 656 (CYL / INJ); SPN 2797 (INJ); and SPN 2798 (INJ)

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Low Fuel Delivery Pressure (FDP)
- Low Fuel Rail Pressure (FRP)
- Contaminated fuel
- Failed injector (Mechanical)
- Base engine compression imbalance

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 94 (FDP); SPN 157 (FRP); SPN 633 (FPCV); and SPN 3055 (FRP). Is EST DTC list free of SPN 94; SPN 157; SPN 633; and SPN 3055?	Yes: Go to step 2. No: Repair SPN 94; SPN 157; SPN 633; and SPN 3055. After repairs are complete, retest for SPN 1324 FMI 31.

Step	Action	Decision
2	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 111 (EWPS); SPN 636 FMI 2, 8, and 10 (CMP); SPN 637 FMI 8 and 10 (CKP); SPN 731 (CYL); SPN 1322 (CYL); SPN 1324 (CYL); SPN 1325 (CYL); SPN 1326 (CYL); SPN 1327 (CYL); and SPN 1328 (CYL). Is EST DTC list free of SPN 111; SPN 636 FMI 2, 8, and 10; SPN 637 FMI 8 and 10; SPN 731; SPN 1322; SPN 1324; SPN 1325; SPN 1326; SPN 1327; and SPN 1328?	Yes: Go to step 3. No: Repair SPN 111; SPN 636 FMI 2, 8, and 10; SPN 637 FMI 8 and 10; SPN 731; SPN 1322; SPN 1323; SPN 1325; SPN 1326; SPN 1327; and SPN 1328. After repairs are complete, retest for SPN 1324 FMI 31.

Step	Action	Decision
3	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 651 (CYL/INJ); SPN 652 (CYL/ INJ); SPN 653 (CYL / INJ); SPN 654 (CYL / INJ); SPN 655 (CYL / INJ); SPN 656 (CYL / INJ); SPN 2797 (INJ); and SPN 2798 (INJ). Is EST DTC list free of SPN 651; SPN 652; SPN 653; SPN 654; SPN 655; SPN 656; SPN 2797; and SPN 2798?	Yes: Go to step 4. No: Repair SPN 651; SPN 652; SPN 653; SPN 654; SPN 655; SPN 656; SPN 2797; and SPN 2798. After repairs are complete, retest for SPN 1324 FMI 31.

Step	Action	Decision
4	Check for poor fuel quality or contaminants. Perform Fuel Quality Check (page 193). Is fuel sample clean and free of sediments, traces of gasoline or kerosene, and waxing or icing?	Yes: Go to step 5. No: Drain fuel and fill with new or known good diesel fuel. After repairs are complete, retest for SPN 1324 FMI 31.

Step	Action	Decision
5	Using EST with ServiceMaxx software, check Fuel Rail Pressure (FRP). Select Sessions > Performance. Start engine and monitor FRP. Is Fuel Rail Pressure 10,500 psi (72,395 kPa) or greater?	Yes: Go to step 7. No: Go to step 6.

Step	Action	Decision
6	Using EST with ServiceMaxx software, check Fuel Delivery Pressure (FDP). Select Sessions > Performance. Start engine and monitor FDP. Is Fuel Delivery Pressure 60 psi (414 kpa) or greater?	Yes: Perform High-pressure Fuel System tests (page 227). After repairs are complete, retest for SPN 1324 FMI 31.
		No: Perform Low-pressure Fuel System tests (page 217). After repairs are complete, retest for SPN 1324 FMI 31.

Step	Action	Decision
7	Determine if the engine has a mechanical cylinder balance problem (compression loss). Perform Crankcase Pressure Test (page 236). Does engine have excessive crankcase pressure?	Yes: Repair base engine compression imbalance. After repairs are complete, retest for SPN 1324 FMI 31.
		No: Go to step 8.

Step	Action	Decision
8	Determine if engine has a fuel injector problem. Perform Multiple Cylinder Cutout Test (page 241). Did one or more cylinders have significant speed difference(s) than the others?	Yes: Go to step 9.
		No: Retest for SPN 1324 FMI 31.

Step	Action	Decision
9	Inspect for failed valve train components. Remove upper valve cover (see Engine Service Manual). Inspect for bent valves, fallen bridges, and valves out of adjustment. Is valve train free of failed valve train components?	Yes: Replace injector suspected by Multiple Cylinder Cutout Test. After repairs are complete, retest for SPN 1324 FMI 31.
		No: Repair failed valve train components. After repairs are complete retest for SPN 1324 FMI 31.

NOTE: After performing all diagnostic steps, if SPN 1324 FMI 31 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 1325 FMI 31- Misfire- Cylinder 3

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Crankshaft acceleration indicates misfire on cylinder 3.	Misfire Count > 180	Engine Running Engine speed > 500 rpm and < 950 rpm Idle speed error < 200 rpm Fuel command > 2 mg / stroke and < 60mg / stroke Engine Coolant Temperature 1 (ECT1) > 86°F (30°C) Vehicle speed < 2 mph (3 km/h) Diesel Particulate Filter (DPF) Not regenerating	440 engine revolutions

Fault Overview

Fault code sets when the Electronic Control Module (ECM) detects a cylinder 3 misfire from the Crankshaft Position (CKP) sensor.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 94 (FDP); SPN 157 (FRP); SPN 633 (FPCV); and SPN 3055 (FRP)

SPN 111 (EWPS); SPN 636 FMI 2, 8, and 10 (CMP); SPN 637 FMI 8 and 10 (CKP); SPN 731 (CYL); SPN 1322 (CYL); SPN 1323 (CYL); SPN 1324 (CYL); SPN 1326 (CYL); SPN 1327 (CYL); and SPN 1328 (CYL)

SPN 651 (CYL/INJ); SPN 652 (CYL/ INJ); SPN 653 (CYL / INJ); SPN 654 (CYL / INJ); SPN 655 (CYL / INJ); SPN 656 (CYL / INJ); SPN 2797 (INJ); and SPN 2798 (INJ)

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Low Fuel Delivery Pressure (FDP)
- Low Fuel Rail Pressure (FRP)
- Contaminated fuel
- Failed injector (Mechanical)
- Base engine compression imbalance

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 94 (FDP); SPN 157 (FRP); SPN 633 (FPCV); and SPN 3055 (FRP). Is EST DTC list free of SPN 94; SPN 157; SPN 633; and SPN 3055?	Yes: Go to step 2. No: Repair SPN 94; SPN 157; SPN 633; and SPN 3055. After repairs are complete, retest for SPN 1325 FMI 31.

Step	Action	Decision
2	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 111 (EWPS); SPN 636 FMI 2, 8, and 10 (CMP); SPN 637 FMI 8 and 10 (CKP); SPN 731 (CYL); SPN 1322 (CYL); SPN 1323 (CYL); SPN 1324 (CYL); SPN 1325 (CYL); SPN 1326 (CYL); SPN 1327 (CYL); and SPN 1328 (CYL). Is EST DTC list free of SPN 111; SPN 636 FMI 2, 8, and 10; SPN 637 FMI 8 and 10; SPN 731; SPN 1322; SPN 1323; SPN 1324; SPN 1325 ; SPN 1326; SPN 1327; and SPN 1328?	Yes: Go to step 3. No: Repair SPN 111; SPN 636 FMI 2, 8, and 10; SPN 637 FMI 8 and 10; SPN 731; SPN 1322; SPN 1323; SPN 1324; SPN 1326; SPN 1327; and SPN 1328. After repairs are complete, retest for SPN 1325 FMI 31.

Step	Action	Decision
3	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 651 (CYL/INJ); SPN 652 (CYL/ INJ); SPN 653 (CYL / INJ); SPN 654 (CYL / INJ); SPN 655 (CYL / INJ); SPN 656 (CYL / INJ); SPN 2797 (INJ); and SPN 2798 (INJ). Is EST DTC list free of SPN 651; SPN 652; SPN 653; SPN 654; SPN 655; SPN 656; SPN 2797; and SPN 2798?	Yes: Go to step 4. No: Repair SPN 651; SPN 652; SPN 653; SPN 654; SPN 655; SPN 656; SPN 2797; and SPN 2798. After repairs are complete, retest for SPN 1325 FMI 31.

Step	Action	Decision
4	Check for poor fuel quality or contaminants. Perform Fuel Quality Check (page 193). Is fuel sample clean and free of sediments, traces of gasoline or kerosene, and waxing or icing?	Yes: Go to step 5. No: Drain fuel and fill with new or known good diesel fuel. After repairs are complete, retest for SPN 1325 FMI 31.

Step	Action	Decision
5	Using EST with ServiceMaxx software, check Fuel Rail Pressure (FRP). Select Sessions > Performance. Start engine and monitor FRP. Is Fuel Rail Pressure 10,500 psi (72,395 kPa) or greater?	Yes: Go to step 7. No: Go to step 6.

Step	Action	Decision
6	Using EST with ServiceMaxx software, check Fuel Delivery Pressure (FDP). Select Sessions > Performance. Start engine and monitor FDP. Is Fuel Delivery Pressure 60 psi (414 kpa) or greater?	Yes: Perform High-pressure Fuel System tests (page 227). After repairs are complete, retest for SPN 1325 FMI 31.
		No: Perform Low-pressure Fuel System tests (page 217). After repairs are complete, retest for SPN 1325 FMI 31.

Step	Action	Decision
7	Determine if the engine has a mechanical cylinder balance problem (compression loss). Perform Crankcase Pressure Test (page 236). Does engine have excessive crankcase pressure?	Yes: Repair base engine compression imbalance. After repairs are complete, retest for SPN 1325 FMI 31.
		No: Go to step 8.

Step	Action	Decision
8	Determine if engine has a fuel injector problem. Perform Multiple Cylinder Cutout Test (page 241). Did one or more cylinders have significant speed difference(s) than the others?	Yes: Go to step 9.
		No: Retest for SPN 1325 FMI 31.

Step	Action	Decision
9	Inspect for failed valve train components. Remove upper valve cover (see Engine Service Manual). Inspect for bent valves, fallen bridges, and valves out of adjustment. Is valve train free of failed valve train components?	Yes: Replace injector suspected by Multiple Cylinder Cutout Test. After repairs are complete, retest for SPN 1325 FMI 31.
		No: Repair failed valve train components. After repairs are complete retest for SPN 1325 FMI 31.

NOTE: After performing all diagnostic steps, if SPN 1325 FMI 31 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 1326 FMI 31- Misfire- Cylinder 4

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Crankshaft acceleration indicates misfire on cylinder 4.	Misfire Count > 180	Engine Running Engine speed > 500 rpm and < 950 rpm Idle speed error < 200 rpm Fuel command > 2 mg / stroke and < 60mg / stroke Engine Coolant Temperature 1 (ECT1) > 86°F (30°C) Vehicle speed < 2 mph (3 km/h) Diesel Particulate Filter (DPF) Not regenerating	440 engine revolutions

Fault Overview

Fault code sets when the Electronic Control Module (ECM) detects a cylinder 4 misfire from the Crankshaft Position (CKP) sensor.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 94 (FDP); SPN 157 (FRP); SPN 633 (FPCV); and SPN 3055 (FRP)

SPN 111 (EWPS); SPN 636 FMI 2, 8, and 10 (CMP); SPN 637 FMI 8 and 10 (CKP); SPN 731 (CYL); SPN 1322 (CYL); SPN 1323 (CYL); SPN 1324 (CYL); SPN 1325 (CYL); SPN 1327 (CYL); and SPN 1328 (CYL)

SPN 651 (CYL/INJ); SPN 652 (CYL/ INJ); SPN 653 (CYL / INJ); SPN 654 (CYL / INJ); SPN 655 (CYL / INJ); SPN 656 (CYL / INJ); SPN 2797 (INJ); and SPN 2798 (INJ)

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Low Fuel Delivery Pressure (FDP)
- Low Fuel Rail Pressure (FRP)
- Contaminated fuel
- Failed injector (Mechanical)
- Base engine compression imbalance

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 94 (FDP); SPN 157 (FRP); SPN 633 (FPCV); and SPN 3055 (FRP). Is EST DTC list free of SPN 94; SPN 157; SPN 633; and SPN 3055?	Yes: Go to step 2. No: Repair SPN 94; SPN 157; SPN 633; and SPN 3055. After repairs are complete, retest for SPN 1326 FMI 31.

Step	Action	Decision
2	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 111 (EWPS); SPN 636 FMI 2, 8, and 10 (CMP); SPN 637 FMI 8 and 10 (CKP); SPN 731 (CYL); SPN 1322 (CYL); SPN 1323 (CYL); SPN 1324 (CYL); SPN 1325 (CYL); SPN 1327 (CYL); and SPN 1328 (CYL). Is EST DTC list free of SPN 111; SPN 636 FMI 2, 8, and 10; SPN 637 FMI 8 and 10; SPN 731; SPN 1322; SPN 1323; SPN 1324; SPN 1325; SPN 1327; and SPN 1328?	Yes: Go to step 3. No: Repair SPN 111; SPN 636 FMI 2, 8, and 10; SPN 637 FMI 8 and 10; SPN 731; SPN 1322; SPN 1323; SPN 1324; SPN 1325; SPN 1327; and SPN 1328. After repairs are complete, retest for SPN 1326 FMI 31.

Step	Action	Decision
3	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 651 (CYL/INJ); SPN 652 (CYL/ INJ); SPN 653 (CYL / INJ); SPN 654 (CYL / INJ); SPN 655 (CYL / INJ); SPN 656 (CYL / INJ); SPN 2797 (INJ); and SPN 2798 (INJ). Is EST DTC list free of SPN 651; SPN 652; SPN 653; SPN 654; SPN 655; SPN 656; SPN 2797; and SPN 2798?	Yes: Go to step 4. No: Repair SPN 651; SPN 652; SPN 653; SPN 654; SPN 655; SPN 656; SPN 2797; and SPN 2798. After repairs are complete, retest for SPN 1326 FMI 31.

Step	Action	Decision
4	Check for poor fuel quality or contaminants. Perform Fuel Quality Check (page 193). Is fuel sample clean and free of sediments, traces of gasoline or kerosene, and waxing or icing?	Yes: Go to step 5. No: Drain fuel and fill with new or known good diesel fuel. After repairs are complete, retest for SPN 1326 FMI 31.

Step	Action	Decision
5	Using EST with ServiceMaxx software, check Fuel Rail Pressure (FRP). Select Sessions > Performance. Start engine and monitor FRP. Is Fuel Rail Pressure 10,500 psi (72,395 kPa) or greater?	Yes: Go to step 7. No: Go to step 6.

Step	Action	Decision
6	Using EST with ServiceMaxx software, check Fuel Delivery Pressure (FDP). Select Sessions > Performance. Start engine and monitor FDP. Is Fuel Delivery Pressure 60 psi (414 kpa) or greater?	Yes: Perform High-pressure Fuel System tests (page 227). After repairs are complete, retest for SPN 1326 FMI 31.
		No: Perform Low-pressure Fuel System tests (page 217). After repairs are complete, retest for SPN 1326 FMI 31.

Step	Action	Decision
7	Determine if the engine has a mechanical cylinder balance problem (compression loss). Perform Crankcase Pressure Test (page 236). Does engine have excessive crankcase pressure?	Yes: Repair base engine compression imbalance. After repairs are complete, retest for SPN 1326 FMI 31.
		No: Go to step 8.

Step	Action	Decision
8	Determine if engine has a fuel injector problem. Perform Multiple Cylinder Cutout Test (page 241). Did one or more cylinders have significant speed difference(s) than the others?	Yes: Go to step 9.
		No: Retest for SPN 1326 FMI 31.

Step	Action	Decision
9	Inspect for failed valve train components. Remove upper valve cover (see Engine Service Manual). Inspect for bent valves, fallen bridges, and valves out of adjustment. Is valve train free of failed valve train components?	Yes: Replace injector suspected by Multiple Cylinder Cutout Test. After repairs are complete, retest for SPN 1326 FMI 31.
		No: Repair failed valve train components. After repairs are complete retest for SPN 1326 FMI 31.

NOTE: After performing all diagnostic steps, if SPN 1326 FMI 31 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 1327 FMI 31- Misfire- Cylinder 5

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Crankshaft acceleration indicates misfire on cylinder 5.	Misfire Count > 180	Engine Running Engine speed > 500 rpm and < 950 rpm Idle speed error < 200 rpm Fuel command > 2 mg / stroke and < 60mg / stroke Engine Coolant Temperature 1 (ECT1) > 86°F (30°C) Vehicle speed < 2 mph (3 km/h) Diesel Particulate Filter (DPF) Not regenerating	440 engine revolutions

Fault Overview

Fault code sets when the Electronic Control Module (ECM) detects a cylinder 5 misfire from the Crankshaft Position (CKP) sensor.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 94 (FDP); SPN 157 (FRP); SPN 633 (FPCV); and SPN 3055 (FRP)

SPN 111 (EWPS); SPN 636 FMI 2, 8, and 10 (CMP); SPN 637 FMI 8 and 10 (CKP); SPN 731 (CYL); SPN 1322 (CYL); SPN 1323 (CYL); SPN 1324 (CYL); SPN 1325 (CYL); SPN 1326 (CYL); and SPN 1328 (CYL)

SPN 651 (CYL/INJ); SPN 652 (CYL/ INJ); SPN 653 (CYL / INJ); SPN 654 (CYL / INJ); SPN 655 (CYL / INJ); SPN 656 (CYL / INJ); SPN 2797 (INJ); and SPN 2798 (INJ)

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Low Fuel Delivery Pressure (FDP)
- Low Fuel Rail Pressure (FRP)
- Contaminated fuel
- Failed injector (Mechanical)
- Base engine compression imbalance

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 94 (FDP); SPN 157 (FRP); SPN 633 (FPCV); and SPN 3055 (FRP). Is EST DTC list free of SPN 94; SPN 157; SPN 633; and SPN 3055?	Yes: Go to step 2. No: Repair SPN 94; SPN 157; SPN 633; and SPN 3055. After repairs are complete, retest for SPN 1327 FMI 31.

Step	Action	Decision
2	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 111 (EWPS); SPN 636 FMI 2, 8, and 10 (CMP); SPN 637 FMI 8 and 10 (CKP); SPN 731 (CYL); SPN 1322 (CYL); SPN 1323 (CYL); SPN 1324 (CYL); SPN 1325 (CYL); SPN 1326 (CYL); and SPN 1328 (CYL). Is EST DTC list free of SPN 111; SPN 636 FMI 2, 8, and 10; SPN 637 FMI 8 and 10; SPN 731; SPN 1322; SPN 1323; SPN 1324; SPN 1325; SPN 1326; and SPN 1328?	Yes: Go to step 3. No: Repair SPN 111; SPN 636 FMI 2, 8, and 10; SPN 637 FMI 8 and 10; SPN 731; SPN 1322; SPN 1323; SPN 1324; SPN 1325 ; SPN 1326; SPN 1327; and SPN 1328. After repairs are complete, retest for SPN 1327 FMI 31.

Step	Action	Decision
3	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 651 (CYL/INJ); SPN 652 (CYL/ INJ); SPN 653 (CYL / INJ); SPN 654 (CYL / INJ); SPN 655 (CYL / INJ); SPN 656 (CYL / INJ); SPN 2797 (INJ); and SPN 2798 (INJ). Is EST DTC list free of SPN 651; SPN 652; SPN 653; SPN 654; SPN 655; SPN 656; SPN 2797; and SPN 2798?	Yes: Go to step 4. No: Repair SPN 651; SPN 652; SPN 653; SPN 654; SPN 655; SPN 656; SPN 2797; and SPN 2798. After repairs are complete, retest for SPN 1327 FMI 31.

Step	Action	Decision
4	Check for poor fuel quality or contaminants. Perform Fuel Quality Check (page 193). Is fuel sample clean and free of sediments, traces of gasoline or kerosene, and waxing or icing?	Yes: Go to step 5. No: Drain fuel and fill with new or known good diesel fuel. After repairs are complete, retest for SPN 1327 FMI 31.

Step	Action	Decision
5	Using EST with ServiceMaxx software, check Fuel Rail Pressure (FRP). Select Sessions > Performance. Start engine and monitor FRP. Is Fuel Rail Pressure 10,500 psi (72,395 kPa) or greater?	Yes: Go to step 7. No: Go to step 6.

Step	Action	Decision
6	Using EST with ServiceMaxx software, check Fuel Delivery Pressure (FDP). Select Sessions > Performance. Start engine and monitor FDP. Is Fuel Delivery Pressure 60 psi (414 kpa) or greater?	Yes: Perform High-pressure Fuel System tests (page 227). After repairs are complete, retest for SPN 1327 FMI 31.
		No: Perform Low-pressure Fuel System tests (page 217). After repairs are complete, retest for SPN 1327 FMI 31.

Step	Action	Decision
7	Determine if the engine has a mechanical cylinder balance problem (compression loss). Perform Crankcase Pressure Test (page 236). Does engine have excessive crankcase pressure?	Yes: Repair base engine compression imbalance. After repairs are complete, retest for SPN 1327 FMI 31.
		No: Go to step 8.

Step	Action	Decision
8	Determine if engine has a fuel injector problem. Perform Multiple Cylinder Cutout Test (page 241). Did one or more cylinders have significant speed difference(s) than the others?	Yes: Go to step 9.
		No: Retest for SPN 1327 FMI 31.

Step	Action	Decision
9	Inspect for failed valve train components. Remove upper valve cover (see Engine Service Manual). Inspect for bent valves, fallen bridges, and valves out of adjustment. Is valve train free of failed valve train components?	Yes: Replace injector suspected by Multiple Cylinder Cutout Test. After repairs are complete, retest for SPN 1327 FMI 31.
		No: Repair failed valve train components. After repairs are complete retest for SPN 1327 FMI 31.

NOTE: After performing all diagnostic steps, if SPN 1327 FMI 31 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 1328 FMI 31- Misfire- Cylinder 6

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Crankshaft acceleration indicates misfire on cylinder 6.	Misfire Count > 180	Engine Running Engine speed > 500 rpm and < 950 rpm Idle speed error < 200 rpm Fuel command > 2 mg / stroke and < 60mg / stroke Engine Coolant Temperature 1 (ECT1) > 86°F (30°C) Vehicle speed < 2 mph (3 km/h) Diesel Particulate Filter (DPF) Not regenerating	440 engine revolutions

Fault Overview

Fault code sets when the Electronic Control Module (ECM) detects a cylinder 6 misfire from the Crankshaft Position (CKP) sensor.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 94 (FDP); SPN 157 (FRP); SPN 633 (FPCV); and SPN 3055 (FRP)

SPN 111 (EWPS); SPN 636 FMI 2, 8, and 10 (CMP); SPN 637 FMI 8 and 10 (CKP); SPN 731 (CYL); SPN 1322 (CYL); SPN 1324 (CYL); SPN 1325 (CYL); SPN 1326 (CYL); SPN 1327 (CYL); and SPN 1328 (CYL)

SPN 651 (CYL/INJ); SPN 652 (CYL/ INJ); SPN 653 (CYL / INJ); SPN 654 (CYL / INJ); SPN 655 (CYL / INJ); SPN 656 (CYL / INJ); SPN 2797 (INJ); and SPN 2798 (INJ)

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Low Fuel Delivery Pressure (FDP)
- Low Fuel Rail Pressure (FRP)
- Contaminated fuel
- Failed injector (Mechanical)
- Base engine compression imbalance

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 94 (FDP); SPN 157 (FRP); SPN 633 (FPCV); and SPN 3055 (FRP). Is EST DTC list free of SPN 94; SPN 157; SPN 633; and SPN 3055?	Yes: Go to step 2. No: Repair SPN 94; SPN 157; SPN 633; and SPN 3055. After repairs are complete, retest for SPN 1328 FMI 31.

Step	Action	Decision
2	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 111 (EWPS); SPN 636 FMI 2, 8, and 10 (CMP); SPN 637 FMI 8 and 10 (CKP); SPN 731 (CYL); SPN 1322 (CYL); SPN 1323 (CYL); SPN 1324 (CYL); SPN 1325 (CYL); SPN 1326 (CYL); and SPN 1327 (CYL). Is EST DTC list free of SPN 111; SPN 636 FMI 2, 8, and 10; SPN 637 FMI 8 and 10; SPN 731; SPN 1322; SPN 1323; SPN 1324; SPN 1325 ; SPN 1326; and SPN 1327?	Yes: Go to step 3. No: Repair SPN 111; SPN 636 FMI 2, 8, and 10; SPN 637 FMI 8 and 10; SPN 731; SPN 1322; SPN 1323; SPN 1324; SPN 1325 ; SPN 1326; and SPN 1327. After repairs are complete, retest for SPN 1328 FMI 31.

Step	Action	Decision
3	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 651 (CYL/INJ); SPN 652 (CYL/ INJ); SPN 653 (CYL / INJ); SPN 654 (CYL / INJ); SPN 655 (CYL / INJ); SPN 656 (CYL / INJ); SPN 2797 (INJ); and SPN 2798 (INJ). Is EST DTC list free of SPN 651; SPN 652; SPN 653; SPN 654; SPN 655; SPN 656; SPN 2797; and SPN 2798?	Yes: Go to step 4. No: Repair SPN 651; SPN 652; SPN 653; SPN 654; SPN 655; SPN 656; SPN 2797; and SPN 2798. After repairs are complete, retest for SPN 1328 FMI 31.

Step	Action	Decision
4	Check for poor fuel quality or contaminants. Perform Fuel Quality Check (page 193). Is fuel sample clean and free of sediments, traces of gasoline or kerosene, and waxing or icing?	Yes: Go to step 5. No: Drain fuel and fill with new or known good diesel fuel. After repairs are complete, retest for SPN 1328 FMI 31.

Step	Action	Decision
5	Using EST with ServiceMaxx software, check Fuel Rail Pressure (FRP). Select Sessions > Performance. Start engine and monitor FRP. Is Fuel Rail Pressure 10,500 psi (72,395 kPa) or greater?	Yes: Go to step 7. No: Go to step 6.

Step	Action	Decision
6	Using EST with ServiceMaxx software, check Fuel Delivery Pressure (FDP). Select Sessions > Performance. Start engine and monitor FDP. Is Fuel Delivery Pressure 60 psi (414 kpa) or greater?	Yes: Perform High-pressure Fuel System tests (page 227). After repairs are complete, retest for SPN 1328 FMI 31.
		No: Perform Low-pressure Fuel System tests (page 217). After repairs are complete, retest for SPN 1328 FMI 31.

Step	Action	Decision
7	Determine if the engine has a mechanical cylinder balance problem (compression loss). Perform Crankcase Pressure Test (page 236). Does engine have excessive crankcase pressure?	Yes: Repair base engine compression imbalance. After repairs are complete, retest for SPN 1328 FMI 31.
		No: Go to step 8.

Step	Action	Decision
8	Determine if engine has a fuel injector problem. Perform Multiple Cylinder Cutout Test (page 241). Did one or more cylinders have significant speed difference(s) than the others?	Yes: Go to step 9.
		No: Retest for SPN 1328 FMI 31.

Step	Action	Decision
9	Inspect for failed valve train components. Remove upper valve cover (see Engine Service Manual). Inspect for bent valves, fallen bridges, and valves out of adjustment. Is valve train free of failed valve train components?	Yes: Replace injector suspected by Multiple Cylinder Cutout Test. After repairs are complete, retest for SPN 1328 FMI 31.
		No: Repair failed valve train components. After repairs are complete retest for SPN 1328 FMI 31.

NOTE: After performing all diagnostic steps, if SPN 1328 FMI 31 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

DEFDUH (Diesel Exhaust Fluid Dosing Unit Heater)

SPN	FMI	Condition	Possible Causes	Actions
5745	3	DEF Dosing Unit Heater Out of Range HIGH	• DEFDUH power circuit short to PWR • Failed DEF unit heater relay • Failed DEF supply module	Step-Based Diagnostics (page 607)
5745	4	DEF Dosing Unit Heater Out of Range LOW	• Diesel Exhaust Fluid Dosing Unit Heater (DEFDUH) power circuit Open or high resistance • DEFDUH power circuit short to GND • DEFDUH GND circuit Open or high resistance • Failed DEF unit heater relay (stuck open) • Failed DEF supply module • Blown fuse or Open power circuit to DEFUHR	Step-Based Diagnostics (page 611)
5745	18	DEF Dosing Unit Heater Below Warning Temperature	• DEFDUH GND circuit high resistance • DEFDUH power circuit high resistance • Failed DEF supply module	Step-Based Diagnostics (page 617)
5798	2	DEF Dosing Unit Heater Temperature erratic, intermittent, or incorrect	• DEFSP Temp / CTL circuit intermittent short to GND • DEFSP Temp / CTL circuit intermittent short to PWR • DEFSP Temp / CTL circuit intermittent Open or high resistance	Step-Based Diagnostics (page 621)

			• Failed DEF supply module	
5798	10	DEF Dosing Unit Heater Temperature abnormal rate of change	• DEFSP Temp / CTL circuit intermittent short to GND • DEFSP Temp / CTL circuit intermittent short to PWR • DEFSP Temp / CTL circuit intermittent Open or high resistance • Failed DEF supply module	Step-Based Diagnostics (page 625)

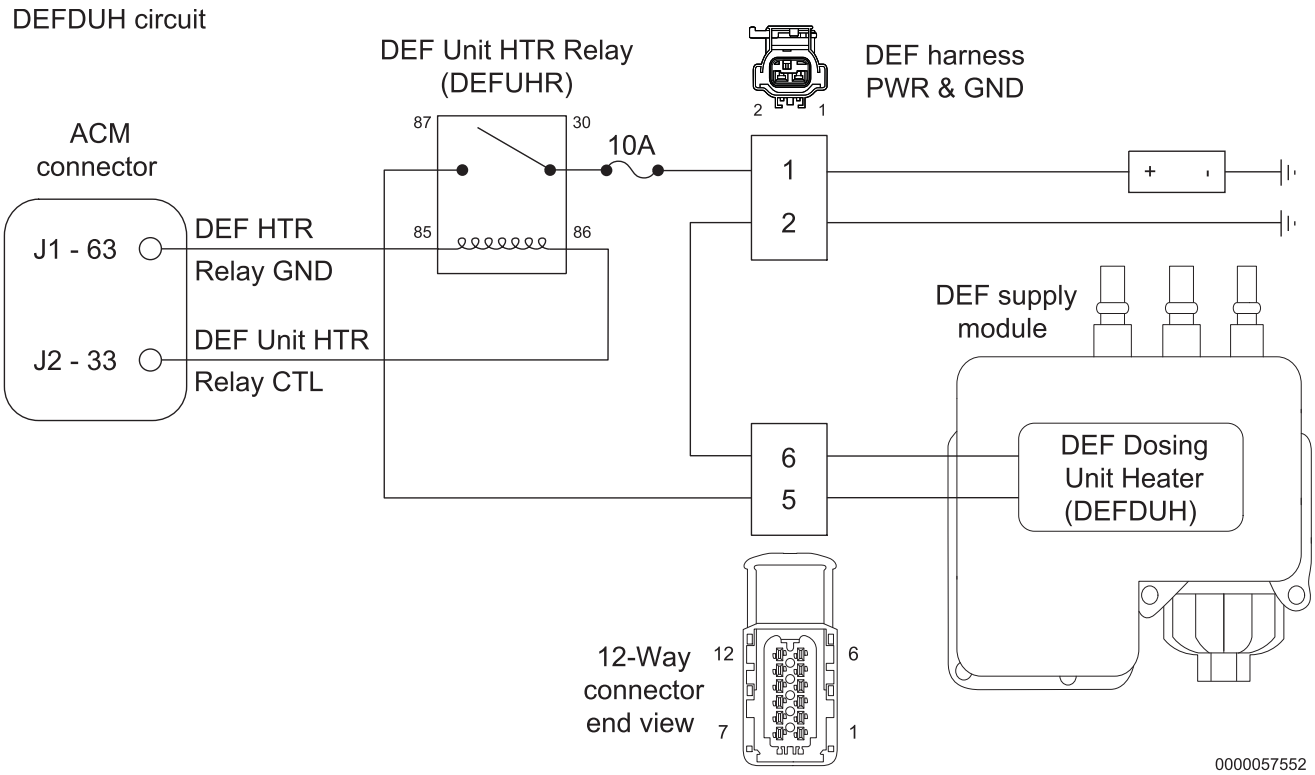


Figure 227 DEFDUH Circuit Diagram

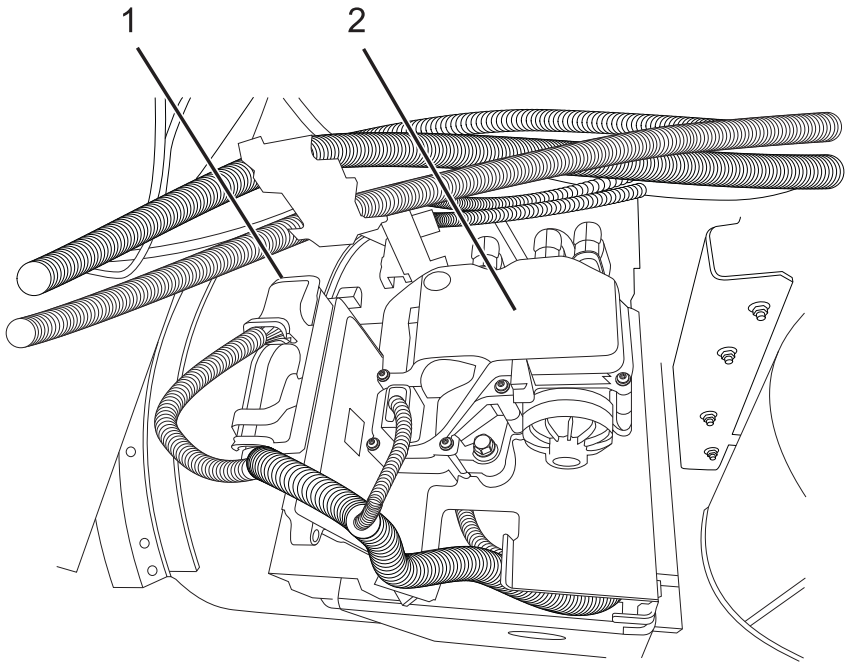
NOTE: See latest version of N13 Engine and Aftertreatment Wiring Schematic Form 0000002203 for additional circuit information.

Overview

The Diesel Exhaust Fluid Dosing Unit Heater (DEFDUH) is controlled by the Aftertreatment Control Module (ACM). When the ACM commands DEFDUH On, it heats the DEF supply module to prevent freezing. Diagnostics are run when the DEF Unit HTR Relay (DEFUHR) is Off. DEFDUH is not serviceable individually, and is part of the DEF supply module.

Tools Required

- 180-Pin Breakout Box 00-00956-08
- ACM Breakout Harness 18-100-01
- Breakout Harness ZTSE4908
- Breakout Harness 18-909-01
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)
- Jumper wire (obtain locally)



0000054368

Figure 228 DEF Supply Module Location

1. Aftertreatment Control Module (ACM)
2. DEF supply module

SPN 5745 FMI 3- DEFDUH Out of Range HIGH

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
DEF supply module temperature too high when heater is Off.	DEF supply module temperature rises > 22˚F (12˚C) within a predetermined time.	Inactive: SPN 3361 FMI 2 (DEFSP); SPN 5746 FMI 3, 4 (DEFUHR); SPN 5798 FMI 2 (DEFDUH Temp). The DEF supply module heater command is Off. Initial DEF supply module heater temperature at Key ON <= 104°F (40°C).	4 hours

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the DEF supply module heater is active when not commanded On. DEF injection into the aftertreatment system will be disabled, and engine torque will be reduced if the engine is operated for an extended period of time with this fault code active.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 3361 (DEFSP) and SPN 5746 FMI 3, 4 (DEFUHR)

Drive Cycle to Determine Fault Status

Drive Cycle 28 in 2013 HD-OBD Diagnostic Reference Manual.

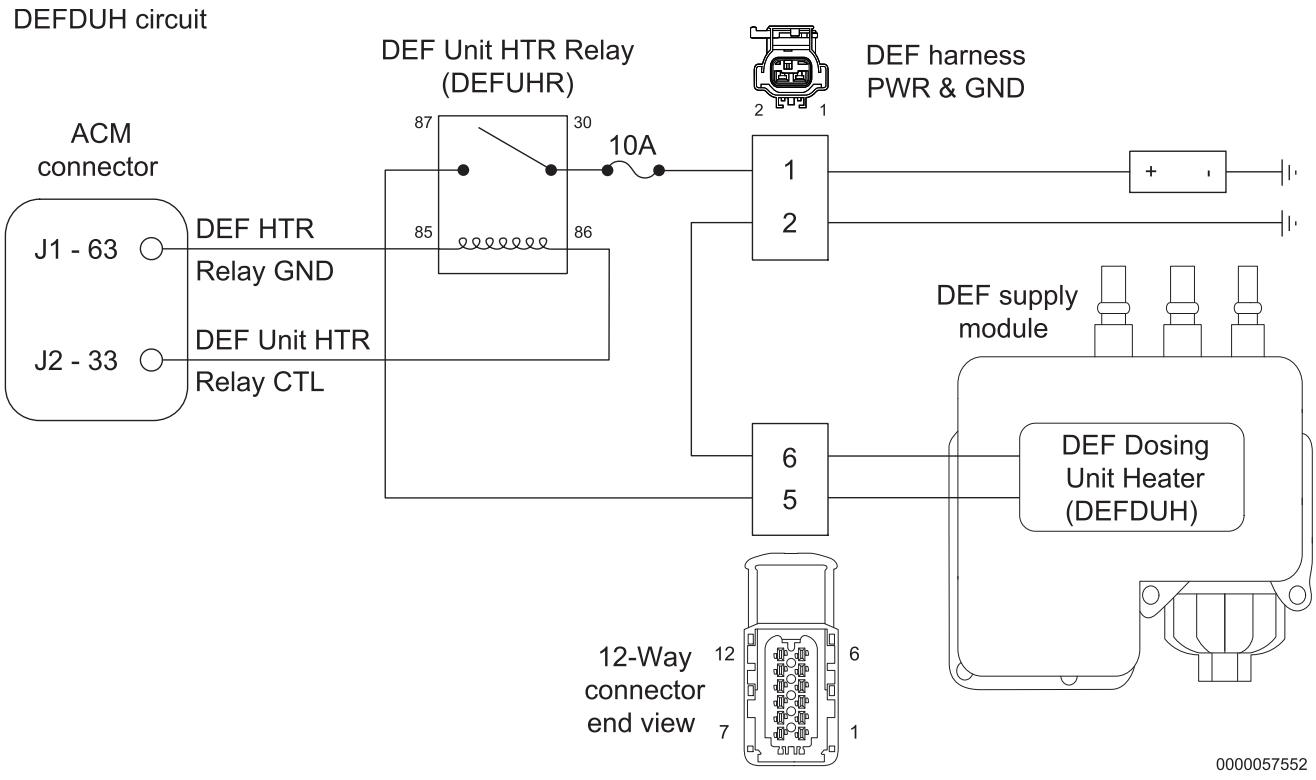


Figure 229 DEFDUH Circuit Diagram

Possible Causes

- DEFDUH power circuit short to PWR
- Failed DEF unit heater relay
- Failed DEF supply module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3361 (DEFSP); SPN 5746 FMI 3, 4 (DEFUHR). Is EST DTC list free of SPN 3361 and SPN 5746 FMI 3, 4?	Yes: Go to step 2. No: Repair SPN 3361; and SPN 5746 FMI 3, 4. After repairs are complete, retest for SPN 5745 FMI 3.

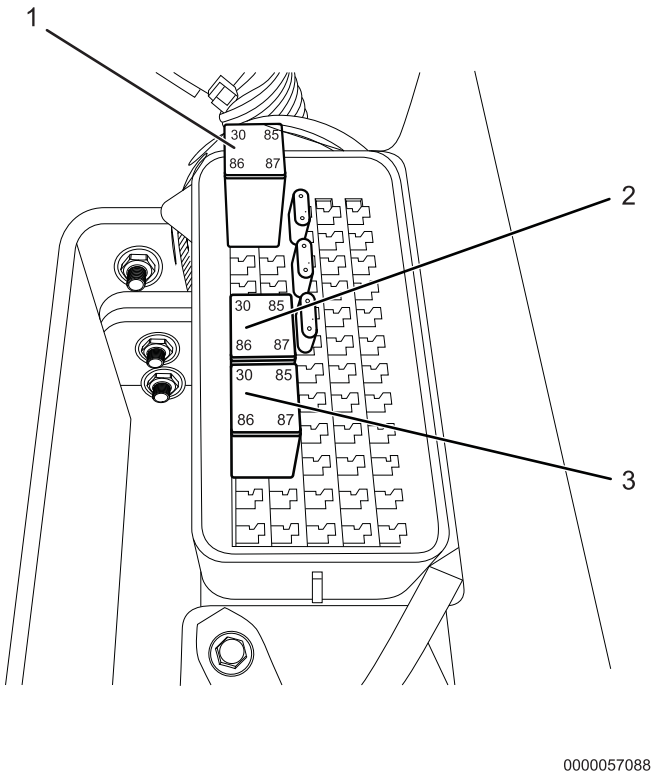


Figure 230 Power Distribution Module (PDM) Fuses and Relays

1. DEF Line Heater Relay
2. DEF Unit HTR Relay
3. Switched Ignition Relay

Step	Action	Decision
2	Check for failed (stuck closed) DEF Unit HTR Relay (DEFUHR). Key OFF, remove DEFUHR. Install relay into Breakout Harness ZTSE4908. Using a DMM, check resistance between pins 30 and 87. Is resistance greater than 10,000 ohms?	Yes: Go to step 3. No: Replace DEFUHR. After repairs are complete, retest for SPN 5745 FMI 3.

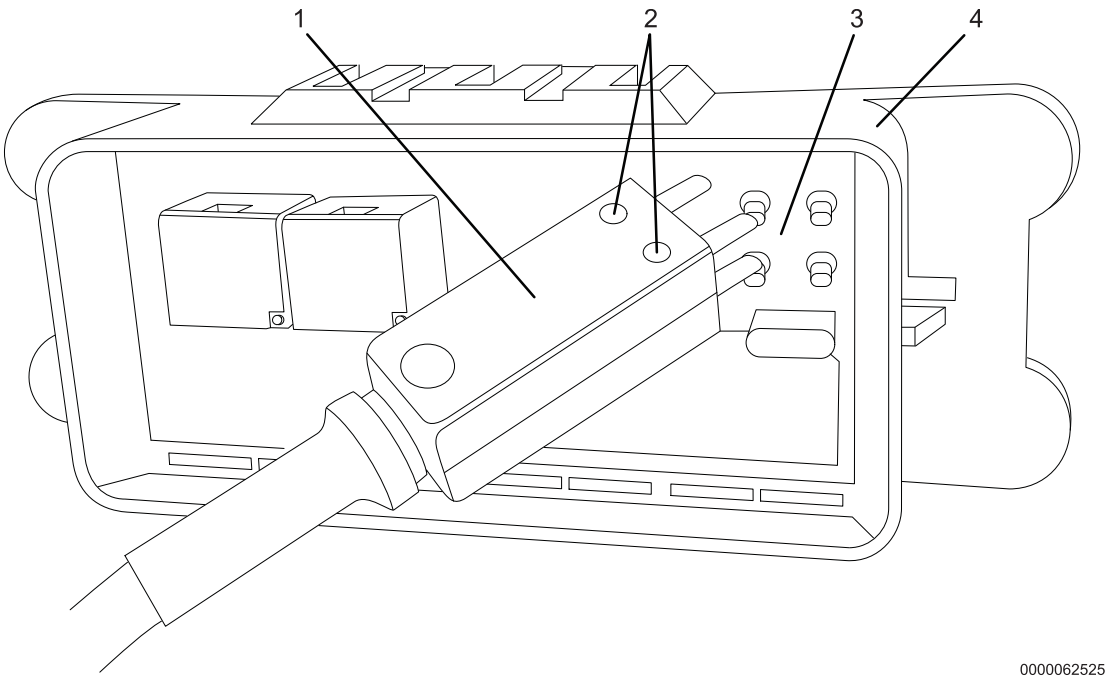


Figure 231 Installation of Breakout Harness ZTSE4908 (typical)

1. Breakout Harness ZTSE4908
2. Dimples
3. Relay socket
4. Power Distribution Module (PDM)

CAUTION: For correct diagnosis, Breakout Harness ZTSE4908 Must be installed with the dimples toward the top of the Power Distribution Module (PDM). Reversed installation Will result in incorrect measurements.

Step	Action	Decision
3	Check for short to PWR in the DEFDUH power circuit. With DEFUHR removed install Breakout Harness ZTSE4908 in its place. Key-On Engine-Off (KOEO) using a DMM measure voltage between pin-87 and a known good ground. Is voltage less than 0.5 volts?	Yes: Replace DEF supply module. After repairs are complete, retest for SPN 5745 FMI 3. No: Repair short to PWR in DEFDUH power circuit between pin-87 of DEFUHR and DEF supply module pin-5. After repairs are complete, retest for SPN 5745 FMI 3

NOTE: After performing all diagnostic steps, if SPN 5745 FMI 3 remains, verify each step was completed correctly, and the proper decision was made. Notify supervisor for further action.

SPN 5745 FMI 4- DEFDUH Out of Range LOW

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
DEF supply module temperature is too low when heater is commanded On.	DEF supply module temperature does not rise by at least 9°F (5°C) within a predetermined time when the heater is commanded On.	Inactive: SPN 3361 FMI 2 (DEFSP); SPN 5746 FMI 3, 4 (DEFUHR); SPN 5798 FMI 2 (DEFDUH Temp). Initial temperature at Key ON < 25°F (-4°C). DEF supply module heater is commanded ON. The diagnostic has not previously completed during this key cycle.	Immediate

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the DEF supply module temperature is too low when the heater is in the ON position. DEF injection into the aftertreatment system will be disabled, and engine torque will be reduced if the engine is operated for an extended period of time with this fault code active.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 3361 (DEFSP); SPN 4337 FMI 2 (DEFSP Temp); SPN 5746 FMI 3, 4 (DEFUHR); and SPN 5798 FMI 2 (DEFDUH Temp).

Drive Cycle to Determine Fault Status

Drive Cycle 28 in 2013 HD-OBD Diagnostic Reference Manual.

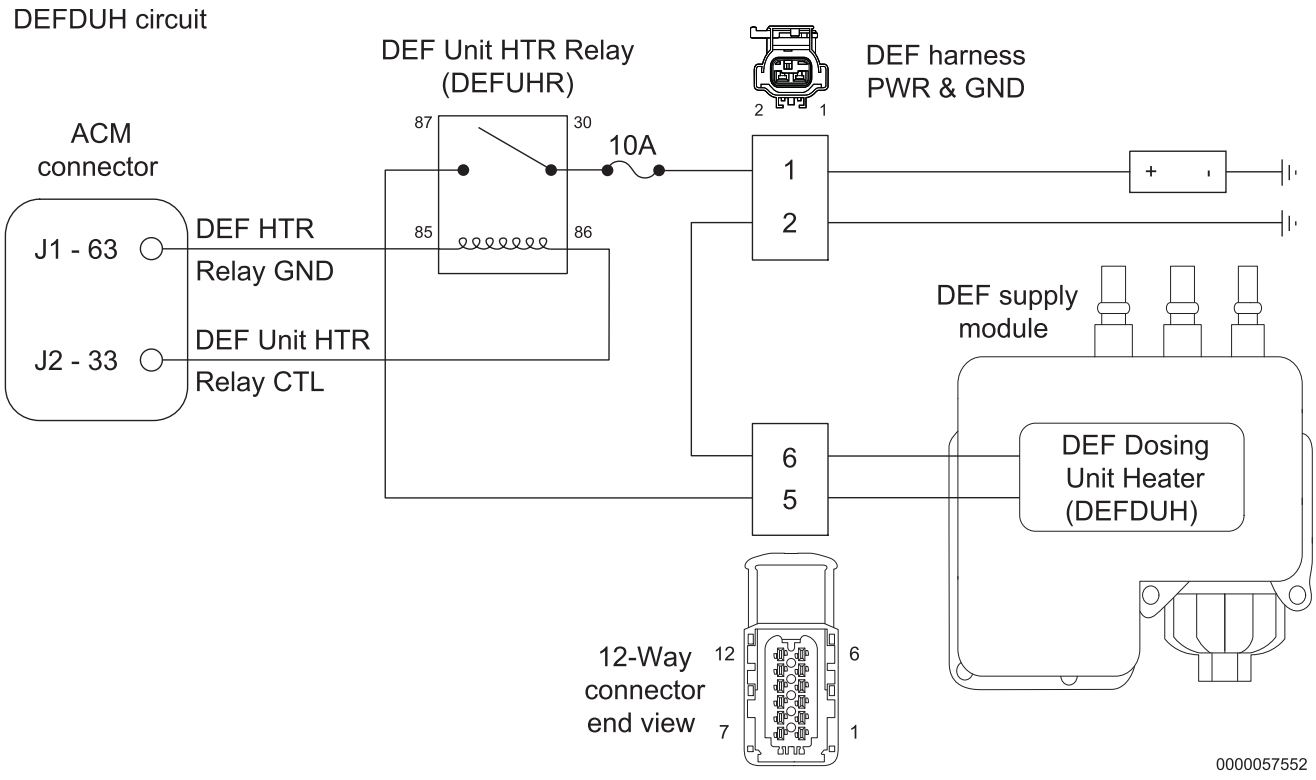


Figure 232 DEFDUH Circuit Diagram

Possible Causes

- Diesel Exhaust Fluid Dosing Unit Heater (DEFDUH) power circuit Open or high resistance
- DEFDUH power circuit short to GND
- DEFDUH GND circuit Open or high resistance
- Failed DEF Unit HTR Relay (DEFUHR)
- Failed DEF supply module
- Blown fuse or Open power circuit to DEFUHR

Step	Action	Decision
1	Using EST with ServiceMaxx software, check Diagnostic Trouble Code (DTC) list for SPN 3361 FMI 2 (DEFSP); SPN 4337 FMI 2 (DEFSP Temp); SPN 5746 FMI 3, 4 (DEFUHR); SPN 5798 FMI 2 (DEFDUH Temp). Is DTC list free of SPN 3361 FMI 2; SPN 4337 FMI 2; SPN 5746 FMI 3, 4; and SPN 5798 FMI 2?	Yes: Go to step 2. No: Repair SPN 3361 FMI 2; SPN 4337 FMI 2; SPN 5746 FMI 3, 4; and SPN 5798 FMI 2. After repairs are complete, retest for SPN 5745 FMI 4.

Step	Action	Decision
2	Inspect connections at Diesel Exhaust Fluid (DEF) supply module. Key OFF, disconnect DEF supply module connector. Check DEF supply module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DEF supply module connector, harness, and terminals clean and undamaged?	Yes: Go to step 3. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 5745 FMI 4.

NOTE: Verify batteries are fully charged and connections are clean.

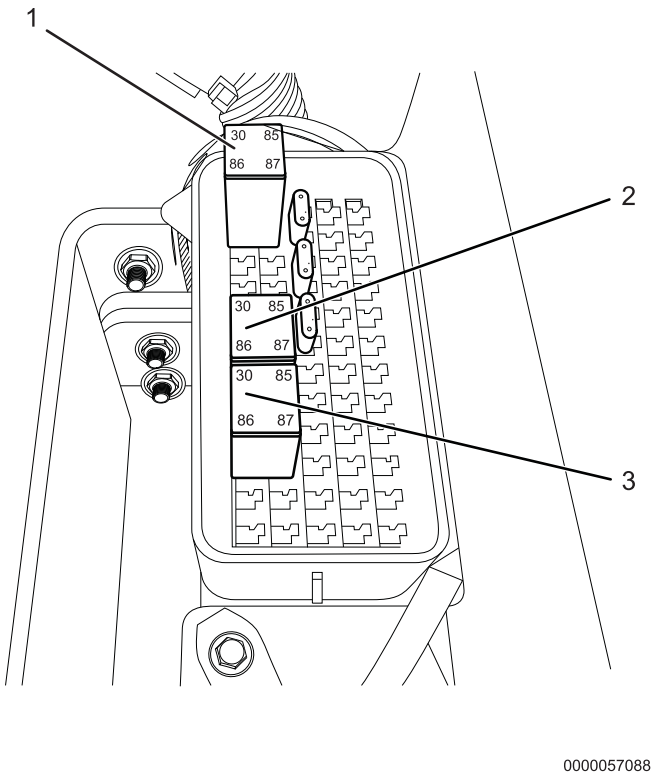


Figure 233 Power Distribution Module (PDM) Fuses and Relays

1. DEF Line Heater Relay
2. DEF Unit HTR Relay
3. Switched Ignition Relay

Step	Action	Decision
3	Determine if the DEF Unit HTR Relay (DEFUHR) fuse is blown. Key OFF, remove and inspect DEF unit HTR relay 10 amp fuse. Using a DMM, measure resistance of the fuse. Is the resistance of DEFUHR fuse less than 1 Ohm?	Yes: Reinstall DEF unit HTR relay 10 amp fuse. Go to step 7. No: Go to step 4.

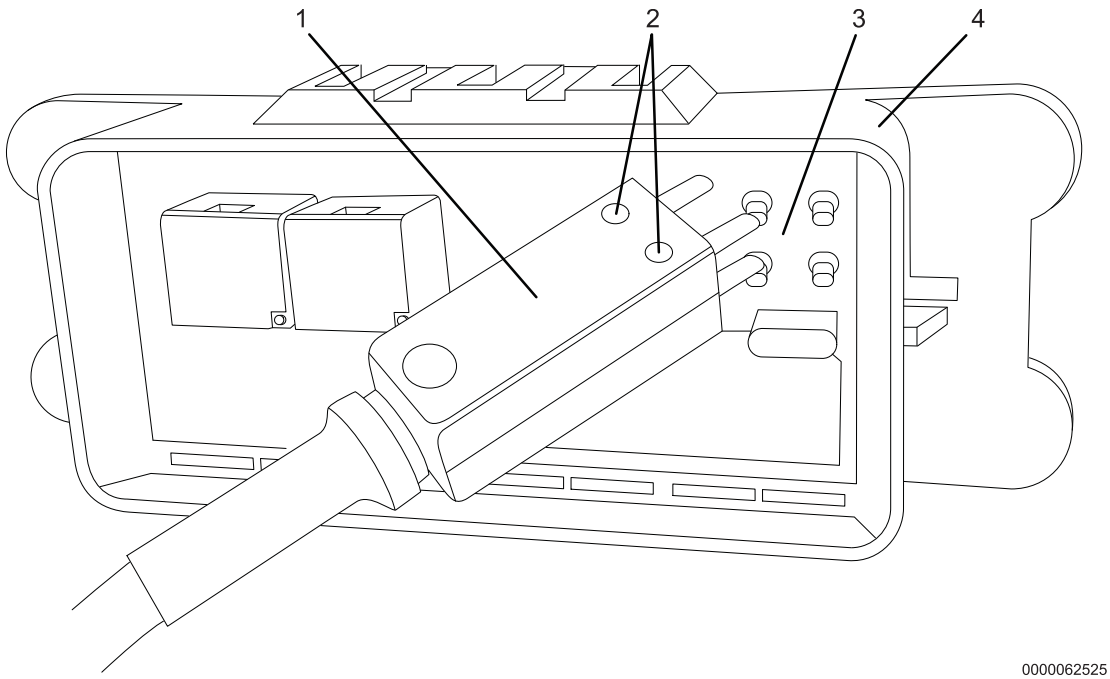


Figure 234 Installation of Breakout Harness ZTSE4908 (typical)

1. Breakout Harness ZTSE4908
2. Dimples
3. Relay socket
4. Power Distribution Module (PDM)

CAUTION: For correct diagnosis, Breakout Harness ZTSE4908 Must be installed with the dimples toward the top of the Power Distribution Module (PDM). Reversed installation Will result in incorrect measurements.

Step	Action	Decision
4	Check Diesel Engine Fluid Dosing Unit Heater (DEFDUH) power circuit for short to GND between DEF supply module pin-5 and DEF unit HTR relay pin-87. Key OFF, remove DEFUHR. Install Breakout Harness ZTSE4908 into PDM. check resistance between pin-87 of breakout harness and GND. Is resistance greater than 1000 ohms?	Yes: Go to step 5. No: Repair short to GND between DEF supply module pin-5 and DEFUHR pin-87, and replace fuse. After repairs are complete, retest for SPN 5745 FMI 4.

Step	Action	Decision
5	Check DEFUHR power circuit for short to GND. With Key OFF and Breakout Harness ZTSE4908 installed in PDM, check resistance between pin-30 of breakout harness and GND. Is resistance greater than 1000 ohms?	Yes: Go to step 6. No: Repair short to GND in DEFUHR power circuit between DEFUHR pin-30 and DEF Harness PWR & GND pin-1, and replace fuse. After repairs are complete, retest for SPN 5745 FMI 4.

Step	Action	Decision
6	Check DEFDUH for a short. Key OFF, install Breakout Harness 18-909-01 to DEF supply module and leave vehicle harness disconnected. Using a DMM, check resistance between terminals 5 and 6. Is resistance between 1 and 5 ohms?	Yes: Replace fuse and retest for SPN 5745 FMI 4. No: Replace DEF supply module and replace DEFUHR fuse. After repairs are complete, retest for SPN 5745 FMI 4.

Step	Action	Decision
7	Check DEFDUH for an Open. Key OFF, install Breakout Harness 18-909-01 to DEF supply module and leave vehicle harness disconnected. Using a DMM, check resistance between terminals 5 and 6. Is resistance between 1 and 5 ohms?	Yes: Go to step 8. No: Replace DEF supply module. After repairs are complete, retest for SPN 5745 FMI 4.

Step	Action	Decision
8	Check DEFUHR for proper supply voltage. Key OFF, remove DEFUHR. Install DEFUHR into Breakout Harness ZTSE4908 and plug harness into PDM. Key ON, using a DMM, check voltage between DEFUHR terminal 30 and a known good ground. Is voltage within 0.5 volts of battery voltage?	Yes: Go to step 9. No: Repair Open or high resistance in power circuit to DEFUHR terminal 30. After repairs are complete, retest for SPN 5745 FMI 4

Step	Action	Decision
9	Check for failed DEFUHR (stuck open). Key ON, using a jumper wire, connect pins 30 and 86 of Breakout Harness ZTSE4908. Using a DMM, check voltage between pin-87 and a known good ground. Is voltage within 0.5 volts of battery voltage?	Yes: Go to step 10. No: Replace DEFUHR. After repairs are complete, retest for SPN 5745 FMI 4

Step	Action	Decision
10	Check DEFDUH power circuit for an Open. Key OFF, install Breakout Harness 18-909-01 between DEF supply module and supply module harness. Key ON, with jumper wire at Breakout Harness ZTSE4908 still connected, use a DMM to check voltage at DEF supply module terminal 5 and GND. Is voltage within 0.5 volts of battery voltage?	Yes: Repair Open in DEFDUH ground circuit between DEF Harness PWR & GND connector pin-2 and DEF supply module pin-6. After repairs are complete, retest SPN 5745 FMI 4.
		No: Repair Open in DEFDUH power circuit between DEFUHR pin-87 and DEF supply module pin-5. After repairs are complete, retest for SPN 5745 FMI 4.

NOTE: After performing all diagnostic steps, if SPN 5745 FMI 4 remains, verify each step was completed correctly, and the proper decision was made. Notify supervisor for further action.

SPN 5745 FMI 18 - DEFDUH below Warning Temperature

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
DEF supply module failed to reach target temperature within a predetermined time from the start of DEF supply module heating.	DEF supply module heating is active for between 10 an 120 minutes (specific time depends on initial temperature), and supply module temperature remains less than 25°F (-4°C).	Inactive: SPN 3361 FMI 2 (DEFSP); SPN 4337 FMI 2 (DEFSP Temp); SPN 5746 FMI 3 and 4 (DEFUHR). Heating of the DEF supply module is required. A valid DEF supply module temperature value is available, and a valid DEF supply module heater temperature value is available from the DEF supply module. Ambient air temperature < 41°F (5°C).	Immediate

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects that the DEF supply module has failed to rise to greater than 25°F (-4 °C) after a predetermined time. Diesel exhaust fluid injection into the aftertreatment system will be disabled. Engine torque will be reduced if the engine is operated for a limited period of time with the fault code active. Engine torque will be severely reduced, and vehicle speed will be limited after extended engine operation with fault code active.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 171 FMI 2, 3, and 4; SPN 3361 FMI 2 (DEFSP); SPN 4337 FMI 2 (DEFSP Temp); SPN 5745 FMI 3, 4 (DEFDUH); SPN 5746 FMI 3,4 (DEFUHR).

Drive Cycle to Determine Fault Status

Drive Cycle 29 in 2013 HD-OBD Diagnostic Reference Manual.

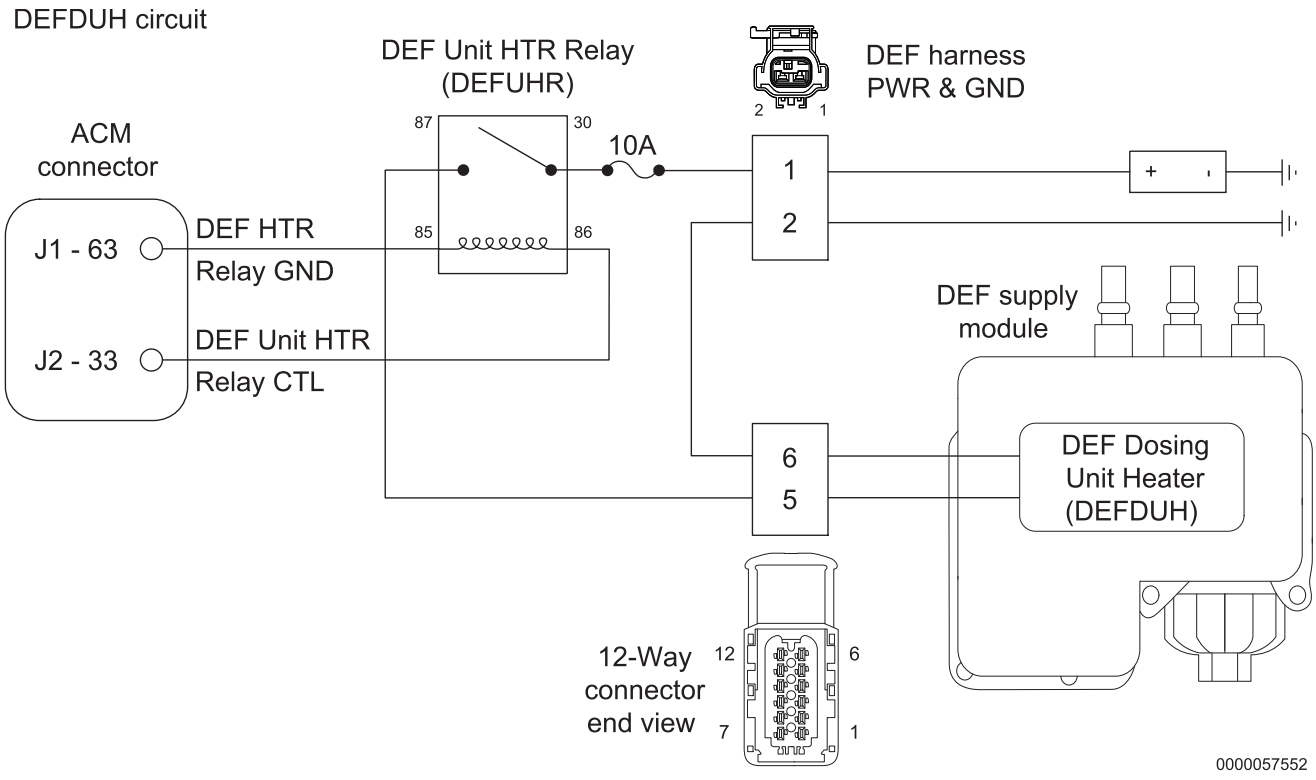


Figure 235 DEFDUH Circuit Diagram

Possible Causes

- DEFDUH GND circuit high resistance
- DEFDUH power circuit high resistance
- Failed DEF supply module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™, check Diagnostic Trouble Code (DTC) list for SPN 171 FMI 2, 3, 4 (AAT); SPN 3361 FMI 2 (DEFSP); SPN 4337 FMI 2 (DEFSP Temp); SPN 5745 FMI 3, 4 (DEFDUH); SPN 5746 FMI 3, 4 (DEFUHR). Is EST DTC list free of SPN 171 FMI 2, 3, and 4; SPN 3361 FMI 2; SPN 4337 FMI 2; SPN 5745 FMI 3, 4; and SPN 5746 FMI 3, 4?	Yes: Go to step 2. No: Repair SPN 171 FMI 2, 3, 4; SPN 3361 FMI 2; SPN 4337 FMI 2; SPN 5745 FMI 3, 4; SPN 5746 FMI 3, 4. After repairs are complete, retest for SPN 5745 FMI 18.

Step	Action	Decision
2	Check DEFDUH GND circuit for high resistance. Key OFF, connect Breakout Harness 18-909-01 to DEF supply module harness, and leave module disconnected. Using a DMM, measure resistance between pin-6 of Breakout Harness 18-909-01 and a known good ground. Is resistance less than 5 ohms?	Yes: Go to step 3. No: Repair high resistance in DEFDUH GND circuit between DEF supply module pin-6 and GND. When repairs are complete, retest for SPN 5745 FMI 18.

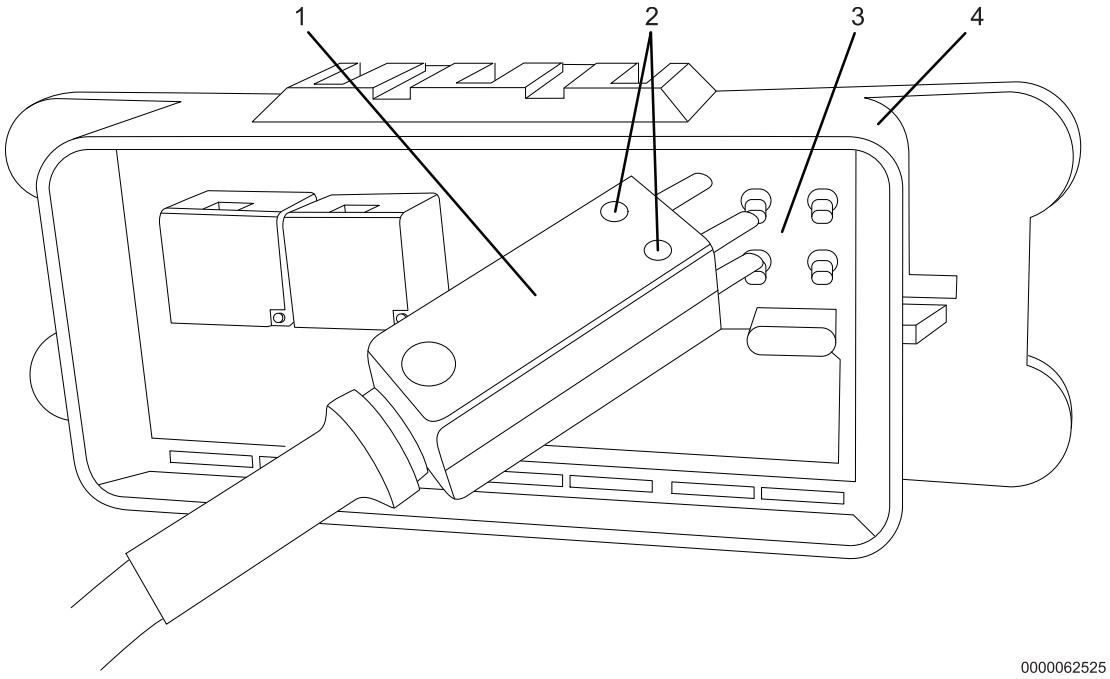


Figure 236 Installation of Breakout Harness ZTSE4908 (typical)

1. Breakout Harness ZTSE4908
2. Dimples
3. Relay socket
4. Power Distribution Module (PDM)

CAUTION: For correct diagnosis, Breakout Harness ZTSE4908 Must be installed with the dimples toward the top of the Power Distribution Module (PDM). Reversed installation Will result in incorrect measurements.

Step	Action	Decision
3	Check DEFDUH power circuit for high resistance. Key OFF, remove DEFUHR. Install Breakout Harness ZTSE4908 into PDM, and leave relay disconnected. Using a DMM, measure resistance between pin-5 of Breakout Harness 18-909-01 and pin-87 of Breakout Harness ZTSE4908. Is resistance less than 5 ohms?	Yes: Go to step 4. No: Repair high resistance in DEFUHR power circuit between pin-5 of DEF supply module connector and pin-87 of DEFUHR. When repairs are complete, retest for SPN 5745 FMI 18.

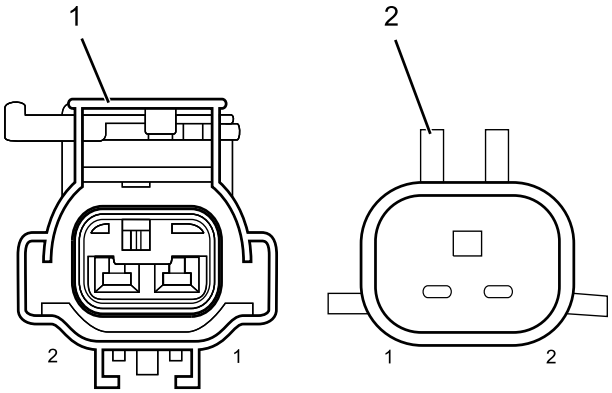


Figure 237 DEF Harness PWR and GND connector view

1. Female connector
2. Male connector

Step	Action	Decision
4	Check DEFDUH relay power circuit for high resistance. Key OFF, disconnect DEF harness PWR and GND connector and install Breakout Harness ZTSE4760A to female side. Using a DMM, measure resistance between pin-30 of Breakout Harness ZTSE4908 and pin-1 of Breakout Harness ZTSE4760A. Is resistance less than 5 ohms?	Yes: Replace the DEF supply module. When repairs are complete, retest for SPN 5745 FMI 18. No: Repair high resistance in DEFUHR power circuit between DEF harness PWR and GND pin-1 and DEFUHR pin-30. When repairs are complete, retest for SPN 5745 FMI 18.

NOTE: After performing all diagnostic steps, if SPN 5745 FMI 18 remains, verify each step was completed correctly, and the proper decision was made. Notify supervisor for further action.

SPN 5798 FMI 2 - DEFDUH temperature erratic, intermittent, or incorrect

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Exhaust Fluid Dosing Unit Heater (DEFDUH) temperature sensor is in-range but not rational.	Difference between DEFDUH temperature at Key ON and Inlet Air Temperature (IAT) at Key ON > 72°F (40°C) Difference between DEFDUH temperature at Key ON and coolant temperature at Key ON > 72°F (40°C)	Engine is cold soaked 10 hours Inactive: SPN 3361 FMI 2 (DEF supply pump) Block heater not detected Valid DEF supply module temperature value is available Valid DEFDUH temperature value is available Diagnostic has not previously completed during this key cycle	Immediate

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Diesel Exhaust Fluid Dosing Unit Heater (DEFDUH) temperature differs from the engine coolant temperature and the inlet air temperature (IAT) by more than 72°F (40°C) at Key ON.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 110 FMI 2, 3, 4 (ECT1); SPN 172 FMI 2, 3, 4 (IAT); SPN 3361 FMI 2, 3, 4, 31 (DEF Supply Pump); SPN 4076 FMI 2, 3, 4 (ECT2).

Drive Cycle to Determine Fault Status

Drive Cycle 10 then 2 in 2013 HD-OBD Diagnostic Reference Manual.

DEFSP circuit

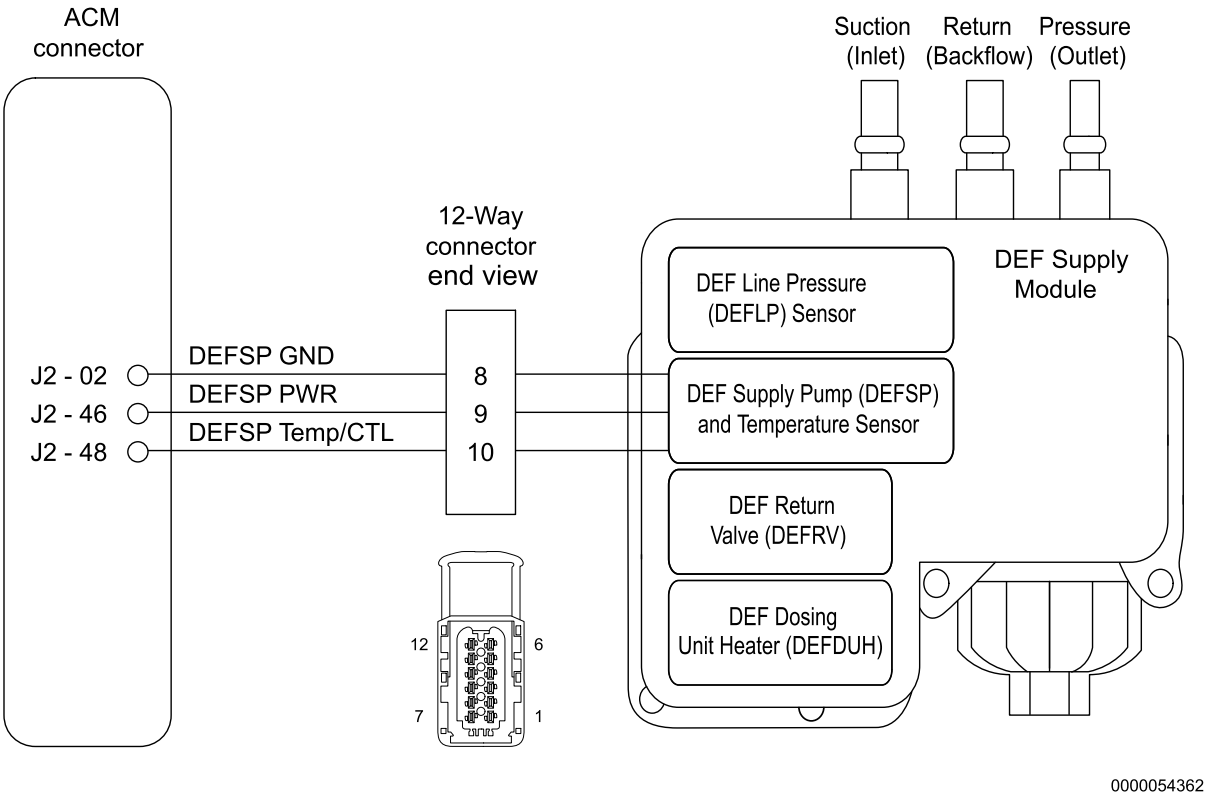


Figure 238 Diesel Exhaust Fluid (DEF) Supply Pump Circuit Diagram

Possible Causes

- DEFSP Temp / CTL circuit intermittent short to GND
- DEFSP Temp / CTL circuit intermittent short to PWR
- DEFSP Temp / CTL circuit intermittent Open or high resistance
- Failed DEF supply module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 110 FMI 2, 3, 4 (ECT1); SPN 172 FMI 2, 3, 4 (IAT); SPN 3361 FMI 2, 3, 4, 31 (DEF Supply Pump); SPN 4076 FMI 2, 3, 4 (ECT2). Is EST DTC list free of SPN 110 FMI 2, 3, 4; SPN 172 FMI 2, 3, 4; SPN 3361 FMI 2, 3, 4, 31; SPN 4076 FMI 2, 3, 4?	Yes: Go to step 2. No: Repair SPN 110 FMI 2, 3, 4; SPN 172 FMI 2, 3, 4; SPN 3361 FMI 2, 3, 4, 31; SPN 4076 FMI 2, 3, 4. After repairs are complete, retest for SPN 5798 FMI 2.

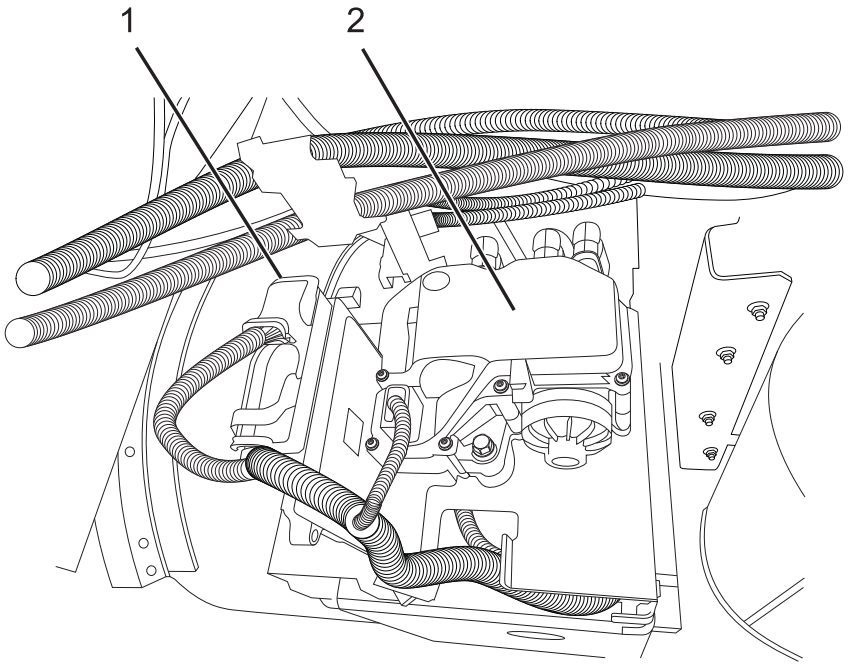


Figure 239 DEF Supply Module Location (typical)

1. Aftertreatment Control Module (ACM)
2. Diesel Exhaust Fluid (DEF) supply module

Step	Action	Decision
2	Inspect connections at DEF supply module. Key OFF, disconnect DEF supply module connectors. Check DEF supply module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DEF supply module connectors, harnesses, and terminals clean and undamaged?	Yes: Go to step 3 No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 5798 FMI 2

Step	Action	Decision
3	Inspect connections at Aftertreatment Control Module (ACM). Key OFF, disconnect ACM connectors. Check ACM and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the ACM connectors, harnesses, and terminals clean and undamaged?	Yes: Go to step 4 No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 5798 FMI 2.

Step	Action	Decision
4	Check for intermittent short to GND in DEFSP Temp / CTL circuit. Connect Breakout Harness 18-909-01 to DEF supply module harness, and leave DEF supply module disconnected. Key OFF, with ACM disconnected, use a DMM to measure resistance between Breakout Harness pin-10 and a known good ground. Is resistance greater than 1000 ohms?	Yes: Go to step 5 No: Repair intermittent short to GND between DEF supply module pin-10 and ACM pin J2-48. After repairs are complete, retest for SPN 5798 FMI 2.

Step	Action	Decision
5	Check for intermittent short to PWR in DEFSP Temp / CTL circuit. Connect Breakout Harness 18-909-01 to DEF supply module harness, and leave supply module disconnected. Key-On Engine-Off (KOEO), with ACM disconnected, use a DMM to measure voltage between Breakout Harness pin-10 and a known good ground. Is voltage less than 1 volt?	Yes: Go to step 6. No: Repair intermittent short to PWR between DEF supply module pin-10 and ACM pin J2-48. After repairs are complete, retest for SPN 5798 FMI 2.

Step	Action	Decision
6	Check for intermittent Open or high resistance in DEFSP Temp / CTL circuit. Connect Breakout Harness 18-909-01 to DEF supply module harness, and leave supply module disconnected. Connect 180-Pin Breakout Box and ACM Breakout Harness 18-100-01 to ACM harness, and leave ACM disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness pin-10 and Breakout Box pin J2-48. Is resistance less than 5 ohms?	Yes: Replace the DEF supply module. After repairs are complete, retest for SPN 5798 FMI 2. No: Repair intermittent Open or high resistance between DEF supply module pin-10 and ACM pin J2-48. After repairs are complete, retest for SPN 5798 FMI 2.

NOTE: After performing all diagnostic steps, if SPN 5798 FMI 2 remains, verify each step was completed correctly, and the proper decision was made. Notify supervisor for further action.

SPN 5798 FMI 10- DEFDUH Temperature abnormal rate of change

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Exhaust Fluid Dosing Unit Heater (DEFDUH) temperature is in range but not rational (not heating).	Difference between maximum and minimum DEFDUH temperature < 9°F (5°C) within 10 minutes.	Inactive: SPN 3361 FMI 2 (DEFSP); SPN 5746 FMI 3,4 (DEFUHR); SPN 5798 FMI 2, 4 (DEFDUH Temp). Valid DEF supply module temperature value is available Valid DEFDUH temperature value is available Initial DEF supply module heater temperature at Key ON < 25°F (-4°C) DEF supply module heater is active Diagnostic has not previously completed during this key cycle Key-On Engine-Running (KOER)	Immediate

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Diesel Exhaust Fluid Dosing Unit Heater (DEFDUH) is not heating properly.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 171 FMI 2, 3, 4 (AAT); SPN 3361 FMI 2 (DEFSP Signal); SPN 4337 FMI 2 (DEFSP Temp); SPN 5745 (DEFDUH); SPN 5746 (DEFUHR); SPN 5798 (DEFDUH Temp)

Drive Cycle to Determine Fault Status

Drive Cycle 28 in 2013 HD-OBD Diagnostic Reference Manual.

DEFSP circuit

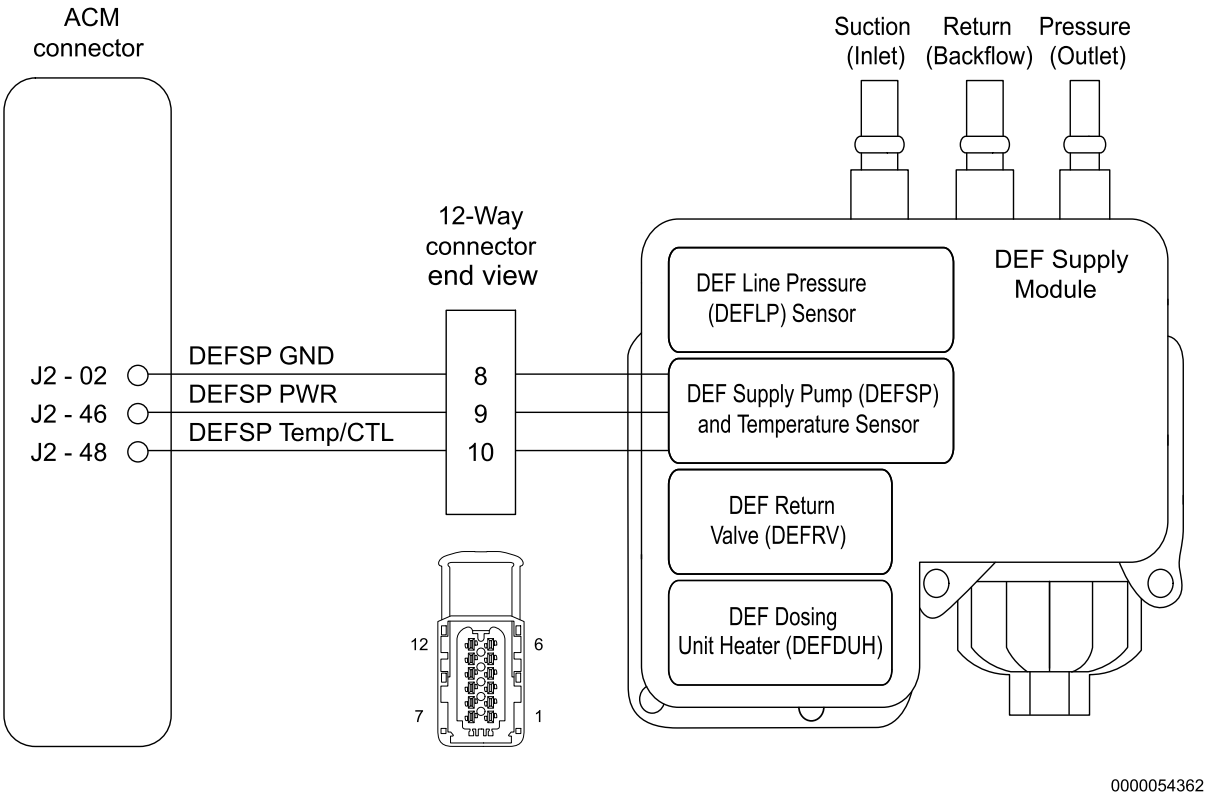


Figure 240 Diesel Exhaust Fluid (DEF) Supply Pump Circuit Diagram

Possible Causes

- DEFSP Temp / CTL circuit intermittent short to GND
- DEFSP Temp / CTL circuit intermittent short to PWR
- DEFSP Temp circuit / CTL intermittent Open or high resistance
- Failed DEF supply module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 171 FMI 2, 3, 4 (AAT); SPN 3361 FMI 2 (DEFSP Signal); SPN 4337 FMI 2 (DEFSP Temp); SPN 5745 (DEFDUH); SPN 5746 (DEFUHR); SPN 5798 (DEFDUH Temp). Is EST DTC list free of SPN 171 FMI 2, 3, 4; SPN 3361 FMI 2; SPN 4337 FMI 2; SPN 5745; SPN 5746; SPN 5798?	Yes: Go to step 2. No: Repair SPN 171 FMI 2, 3, 4; SPN 3361 FMI 2; SPN 4337 FMI 2; SPN 5745; SPN 5746; SPN 5798. After repairs are complete, retest for SPN 5798 FMI 10.

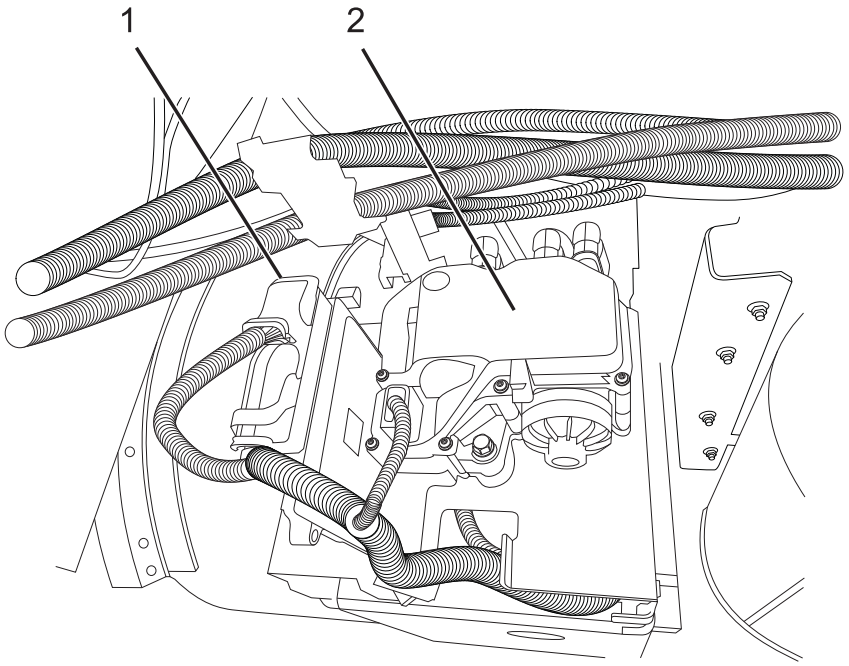


Figure 241 DEF Supply Module Location (typical)

1. Aftertreatment Control Module (ACM)
2. Diesel Exhaust Fluid (DEF) supply module

Step	Action	Decision
2	Inspect connections at DEF supply module. Key OFF, disconnect DEF supply module connectors. Check DEF supply module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DEF supply module connectors, harnesses, and terminals clean and undamaged?	Yes: Go to step 3. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 5798 FMI 10.

Step	Action	Decision
3	Inspect connections at Aftertreatment Control Module (ACM). Key OFF, disconnect ACM connectors. Check ACM and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Leave connector J2 unplugged. Are the ACM connectors, harnesses, and terminals clean and undamaged?	Yes: Go to step 4. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 5798 FMI 10.

Step	Action	Decision
4	Check for intermittent short to GND in DEFSP Temp / CTL circuit. Connect Breakout Harness 18-909-01 to DEF supply module harness, and leave DEF supply module disconnected. Key OFF, with ACM disconnected, use a DMM to measure resistance between Breakout Harness pin-10 and a known good ground. Is resistance greater than 1000 ohms?	Yes: Go to step 5. No: Repair intermittent short to GND in DEFSP Temp / CTL circuit between DEF supply module pin-10 and ACM pin J2-48.. After repairs are complete, retest for SPN 5798 FMI 10.

Step	Action	Decision
5	Check for intermittent short to PWR in DEFSP Temp / CTL circuit. Connect Breakout Harness 18-909-01 to DEF supply module harness, and leave supply module disconnected. Key-On Engine-Off (KOEO), with ACM disconnected, use a DMM to measure voltage between Breakout Harness pin-10 and a known good ground. Is voltage less than 1 volt?	Yes: Go to step 6. No: Repair intermittent short to PWR between DEF supply module pin-10 and ACM pin J2-48. After repairs are complete, retest for SPN 5798 FMI 10.

Step	Action	Decision
6	Check for intermittent Open or high resistance in DEFSP Temp / CTL circuit. Connect Breakout Harness 18-909-01 to DEF supply module harness, and leave DEF supply module disconnected. Connect 180-Pin Breakout Box and ACM Breakout Harness 18-100-01 to ACM harness, and leave ACM disconnected. Using a DMM, measure resistance between Breakout Harness pin-10 and Breakout Box pin J2-48. Is resistance less than 5 ohms?	Yes: Replace DEF supply module. After repairs are complete, retest for SPN 5798 FMI 10. No: Repair intermittent Open or high resistance between DEF supply module pin-10 and ACM pin J2-48. After repairs are complete, retest for SPN 5798 FMI 10.

NOTE: After performing all diagnostic steps, if SPN 5798 FMI 10 remains, verify each step was completed correctly, and the proper decision was made. Notify supervisor for further action.

DEFDV (Diesel Exhaust Fluid Doser Valve)

SPN	FMI	Condition	Possible Causes	Actions
5394	2	DEFDC signal erratic, intermittent, or incorrect	• Exhaust Leak(s) • Contaminated Diesel Exhaust Fluid (DEF) • DEF tank, supply module, or doser valve line or connection loose, leaking, frozen, or damaged • Failed Diesel Exhaust Fluid Doser Valve (DEFDV) • Restricted DEF supply module filter • Restricted DEFDV	Step-Based Diagnostics (page 632)
5394	5	DEFDC open load / circuit (short)	• Failed DEFDV • DEFDV-1 circuit Open or high resistance • DEFDV-1 short to GND • DEFDV-2 circuit Open or high resistance • DEFDV-2 short to GND • DEFDV-1 shorted to DEFDV-2 • DEFDV-2 short to PWR	Step-Based Diagnostics (page 635)
5394	7	DEF Dosing Valve - Mechanical system not responding	• DEF tank, supply module, or doser valve line or connection loose, leaking, or damaged • DEFDV mechanical failure (stuck open or closed)	Step-Based Diagnostics (page 638)

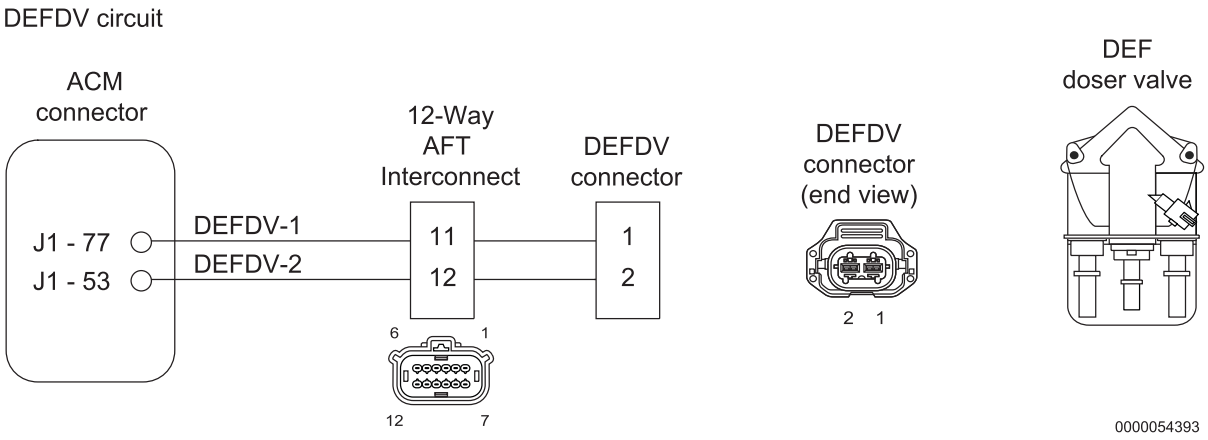


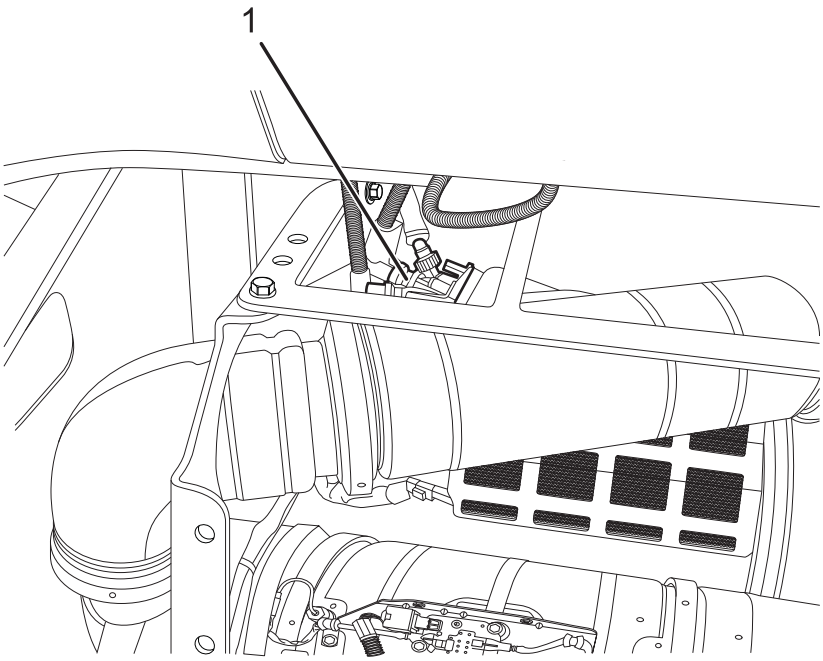
Figure 242 DEFDV Circuit Diagram

Overview

The aftertreatment Diesel Exhaust Fluid Doser Valve (DEFDV) is controlled by the Aftertreatment Control Module (ACM). When the ACM commands DEF dosing, it opens the doser valve and allows DEF to be sprayed into the exhaust stream.

Tools Required

- 180-Pin Breakout Box 00-00956-08
- SCR (ACM) Breakout Harness 18-100-01
- Breakout Harness ZTSE4828
- DEF Refractometer 5025
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)



0000054404

Figure 243 DEFDV Location (Typical)

1. Diesel Exhaust Fluid Doser Valve (DEFDV)

SPN 5394 FMI 2 - DEFDC signal erratic, intermittent or incorrect

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Exhaust Fluid Doser Valve (DEFDV) signal data erratic, intermittent, or incorrect.	NOx conversion rate less than ACM predetermined value	DPF Filter Regeneration procedure running Key-On Engine-Running (KOER)	1 event

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Nitrogen Oxides (NOx) conversion rate of the aftertreatment system is less than expected.. DEF injection into the aftertreatment system is disabled, and engine torque will be reduced if fault is active for an extended period of time.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 3361 FMI 2, 3, and 4 (DEFSP), SPN 3363 FMI 3, 4, and 7 (DEFTHC), SPN 4340 FMI 3 and 5 (DEFPLH), SPN 4342 FMI 3 and 5 (DEFRLH), SPN 4344 FMI 3 and 5 (DEFSLH), and SPN 5394 FMI 5 and 7 (DEFDV).

Faults Facts

The monitor for this fault code runs only during DPF Filter Regeneration Procedure.

This fault is used to assist in troubleshooting the following fault codes: SPN 4094 FMI 31 (AFT System), SPN 4364 FMI 18 (AFT System), and SPN 4794 FMI 31 (AFT System).

Drive Cycle to Determine Fault Status

Drive Cycle 27 in 2013 HD-OBD Diagnostic Reference Manual.

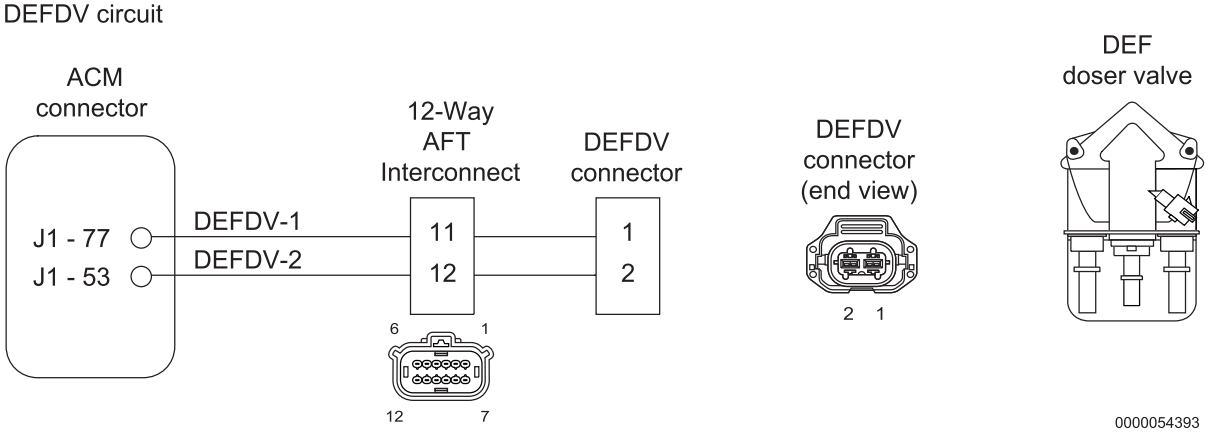


Figure 244 DEFDV Circuit Diagram

Possible Causes

- Exhaust Leak(s)

- Contaminated Diesel Exhaust Fluid (DEF)
- DEF tank, supply module, or doser valve line or connection loose, leaking, frozen, or damaged
- Failed Diesel Exhaust Fluid Doser Valve (DEFDV)
- Restricted DEF supply module filter
- Restricted DEFDV

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3361 FMI 2, 3, and 4 (DEFSP); SPN 3363 FMI 3, 4, and 7 (DEFTHC); SPN 4340 FMI 3 and 5 (DEFPLH); SPN 4342 FMI 3 and 5 (DEFRLH); SPN 4344 FMI 3 and 5 (DEFSLH); and SPN 5394 FMI 5 and 7 (DEFDV). Is EST DTC list free of SPN 3361 FMI 2, 3, and 4; SPN 3363 FMI 3, 4, and 7; SPN 4340 FMI 3 and 5; SPN 4342 FMI 3 and 5; SPN 4344 FMI 3 and 5; and SPN 5394 FMI 5 and 7?	Yes: Go to step 2. No: Repair SPN 3361 FMI 2, 3, and 4; SPN 3363 FMI 3, 4, and 7; SPN 4340 FMI 3 and 5; SPN 4342 FMI 3 and 5; SPN 4344 FMI 3 and 5; and SPN 5394 FMI 5 and 7. After repairs are complete, retest for SPN 5394 FMI 2.

Step	Action	Decision
2	Inspect exhaust system for leaks and physical damage. Is exhaust system free of leaks and physical damage?	Yes: Go to step 3. No: Repair leaks or physical damage. After repairs are complete, retest for SPN 5394 FMI 2.

Step	Action	Decision
3	Check Diesel Exhaust Fluid (DEF) tank, DEF supply module, and DEF Doser Valve (DEFDV) lines and connections for: cracks and pitting; and loose, leaking, or damaged connections. Are DEF tank, DEF supply module, and DEFDV lines and connections in good condition?	Yes: Go to step 4. No: Repair or replace failed line or connection. After repairs are complete, retest for SPN 5394 FMI 2.

Step	Action	Decision
4	Inspect DEF tank and lines for frozen DEF. Are the DEF tank and lines free of frozen DEF?	Yes: Go to step 5. No: Repair or replace failed line or connection. After repairs are complete, retest for SPN 5394 FMI 2.

Step	Action	Decision
5	Check DEF quality. Obtain a sample of DEF. Visually inspect for contamination and use DEF Refractometer 5025 to test urea concentration of DEF fluid. Is urea concentration between 30 - 34 percent and Not contaminated?	Yes: Go to step 6. No: Drain the DEF tank, flush with distilled water, and fill with new and / or known good DEF. After repairs are complete, retest for SPN 5394 FMI 2.

Step	Action	Decision
6	Verify correct DEFDV operation. Using EST, do the DEF Doser Pump Override Test (page 98). Is the DEFDV operating correctly?	Yes: Replace DEF supply module filter and clean DEF supply module using 18-200-01. Repeat step 6. If DEFDV still does not operate correctly, replace DEFDV. After repairs are complete, retest for SPN 5394 FMI 2. No: Replace DEFDV. After repairs are complete, retest for SPN 5394 FMI 2.

NOTE: After doing all diagnostic steps, if SPN 5394 FMI 2 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 5394 FMI 5 - DEFDC open load / circuit (short)

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Exhaust Fluid Doser Valve (DEFDV) current below normal or open circuit. Open signal voltage detected at the DEFDV.	Resistance between DEFDV-1 or DEFDV-2 and ground < 0.2 ohms Resistance between pin J1-53 and pin J1-77 > 1,000,000 ohms Resistance between DEFDV-2 and battery positive < 0.2 ohms	DEFDV command is OFF	2 seconds

Fault Overview

Fault codes sets when the Aftertreatment Control Module (ACM) detects that the Diesel Exhaust Fluid Doser Valve (DEFDV) circuit is open or shorted. DEF injection into the aftertreatment system is disabled, and engine torque will be reduced if fault is active for a limited period of time. Engine torque will be severely reduced and vehicle speed limited after extended engine operation with this fault code active.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 27 in 2013 HD-OBD Diagnostic Reference Manual.

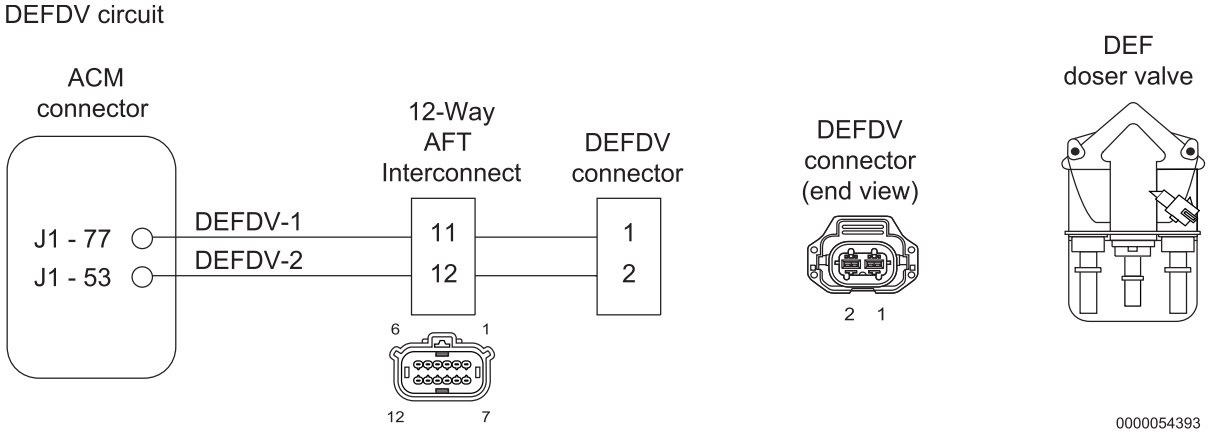


Figure 245 DEFDV Circuit Diagram

Possible Causes

- Failed DEFDV
- DEFDV-1 circuit Open or high resistance
- DEFDV-1 short to GND
- DEFDV-2 circuit Open or high resistance
- DEFDV-2 short to GND
- DEFDV-1 shorted to DEFDV-2
- DEFDV-2 short to PWR

Step	Action	Decision
1	Inspect connections at Diesel Exhaust Fluid Doser Valve (DEFDV). KeyOFF, disconnect DEFDV. Check DEFDV and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DEFDV connector, Harness, and terminals clean and undamaged?	Yes: Go to step 2. No: Repair connector, Harness, or terminal damage. After repairs are complete, retest for SPN 5394 FMI 5.

Step	Action	Decision
2	Check DEFDV-1 circuit for short to ground. Connect Breakout Harness ZTSE4828 to DEFDV and leave DEFDV disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness ZTSE4828 pin-1 and a known good ground. Is resistance greater than 1000 ohms?	Yes: Go to step 3. No: Repair short to ground between DEFDV connector pin-1 and Aftertreatment Control Module (ACM) connector pin J1-77. After repairs are complete, retest for SPN 5394 FMI 5.

Step	Action	Decision
3	Check DEFDV-2 circuit for short to ground. Connect Breakout Harness ZTSE4828 to DEFDV and leave DEFDV disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness ZTSE4828 pin-2 and a known good ground. Is resistance greater than 1000 ohms?	Yes: Go to step 4. No: Repair short to ground between DEFDV connector pin-2 and ACM connector pin J1-53. After repairs are complete, retest for SPN 5394 FMI 5.

Step	Action	Decision
4	Inspect connections at the Aftertreatment Control Module (ACM). Key OFF, disconnect ACM. Check ACM and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the ACM connector, Harness, and terminals clean and undamaged?	Yes: Go to step 5. Repair connector, Harness, or terminal damage. After repairs are complete, retest for SPN 5394 FMI 5.

Step	Action	Decision
5	Check DEFDV-1 circuit for Open or high resistance. Connect Breakout Harness ZTSE4828 to DEFDV and leave DEFDV disconnected. Connect 180-pin Breakout Box with SCR (ACM) Breakout Harness 18-100-01 to ACM and leave module disconnected. Use a DMM to measure resistance from Breakout Harness ZTSE4828 pin-1 and 180-pin Breakout Box pin J1-77. Is resistance less than 5 ohms?	Yes: Go to step 6. No: Repair Open between DEFDV connector pin-1 and ACM connector pin J1-77. After repairs are complete, retest for SPN 5394 FMI 5.

Step	Action	Decision
6	Check DEFDV-2 circuit for Open or high resistance. Connect Breakout Harness ZTSE4828 to DEFDV and leave DEFDV disconnected. Connect 180-pin Breakout Box with SCR (ACM) Breakout Harness 18-100-01 to ACM and leave module disconnected. Key OFF, use a DMM to measure resistance from Breakout Harness ZTSE4828 pin-2 and 180-pin Breakout Box pin J1-53. Is resistance less than 5 ohms?	Yes: Go to step 7. No: Repair Open between DEFDV connector pin-2 and ACM connector pin J1-53. After repairs are complete, retest for SPN 5394 FMI 5.

Step	Action	Decision
7	Check for DEFDV-1 circuit shorted to DEFDV-2 circuit. Connect Breakout Harness ZTSE4828 to DEFDV connector and leave DEFDV disconnected. Key OFF, with ACM disconnected, use a DMM to measure resistance between Breakout Harness ZTSE4828 pin-1 and pin-2. Is resistance greater than 1000 ohms?	Yes: Go to step 8. No: Repair short between DEFDV connector pin-1 and pin-2. After repairs are complete, retest for SPN 5394 FMI 5.

Step	Action	Decision
8	Check DEFDV-2 circuit for short to power. Key-On Engine-Off (KOEO), with Breakout Harness ZTSE4828 connected to DEFDV, use a DMM to measure voltage between Breakout Harness ZTSE4828 pin-2 and a known good ground. Is voltage less than 4 volts?	Yes: Replace DEFDV. After repairs are complete, retest for SPN 5394 FMI 5. No: Repair short to power between DEFDV pin-2 and ACM connector J1-53. After repairs are complete, retest for SPN 5394 FMI 5.

NOTE: After doing all diagnostic steps, if SPN 5394 FMI 5 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 5394 FMI 7- DEF Dosing Valve - Mechanical system not responding

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Exhaust Fluid Dosing Valve is mechanically stuck closed or open based on the minimum pressure variation during injection.	Difference between the maximum and minimum DEF supply pressure within one injection cycle < 4 psi (30 kPa) (gauge) for greater than or equal to 2 out of 3 times within each set of diagnostic tests.	Inactive: SPN 3361 FMI 3 and 4; SPN 4334 FMI 2, 3, 4, 16, and 18; and SPN 5394 FMI 5. Exhaust temperature ≥ 32°F (0°C) for 10 seconds Key-On Engine-Running (KOER) Exhaust Mass flow rate ≥ 50 g/hr DEF dosing command ≥ 9.8 % DEF dosing command ≤ 88.2 % Supply Module Pressure ≥ 58 psi (400 kPa) (gauge)	0 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects a mechanical failure of the Diesel Exhaust Fluid Doser Valve (DEFDV). DEF injection into the aftertreatment system is disabled, and engine torque will be reduced if fault is active for an extended period of time.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 27 in 2013 HD-OBD Diagnostic Reference Manual.

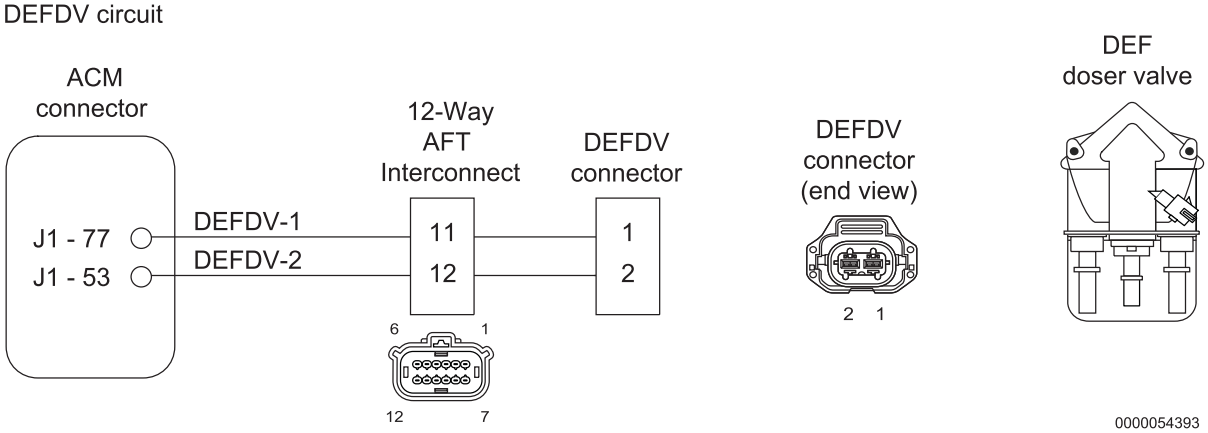


Figure 246 DEFDV Circuit Diagram

Possible Causes

- DEF tank, supply module, or doser valve line or connection loose, leaking, or damaged

- DEFDV mechanical failure (stuck open or closed)

Step	Action	Decision
1	Check Diesel Exhaust Fluid (DEF) tank, DEF supply module, and DEF Doser Valve (DEFDV) lines and connections for: cracks and pitting; and loose, leaking, or damaged connections. Are DEF tank, DEF supply module, and DEFDV lines and connections in good condition?	Yes: Perform the DEF Doser Pump Override Test (page 98). No: Repair or replace failed line or connection. After repairs are complete, retest for SPN 5394 FMI 7.

NOTE: After doing all diagnostic steps, if SPN 5394 FMI 7 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

DEFLHR (Diesel Exhaust Fluid Line Heater Relay)

SPN	FMI	Condition	Possible Causes	Actions
5491	3	DEFLHR short to PWR (Open or High Resistance)	• DEF L-HTR Relay CTL short to PWR • DEF L-HTR Relay CTL Open or high resistance • DEF L-HTR Relay GND Open or high resistance • Failed DEF Line Heater Relay (DEFLHR)	Step-Based Diagnostics (page 643)
5491	4	DEFLHR short to GND	• DEF L-HTR Relay CTL circuit short to GND • DEF L-HTR Relay GND shorted to DEF L-HTR Relay CTL • Failed DEF Line Heater Relay (DEFLHR)	Step-Based Diagnostics (page 648)

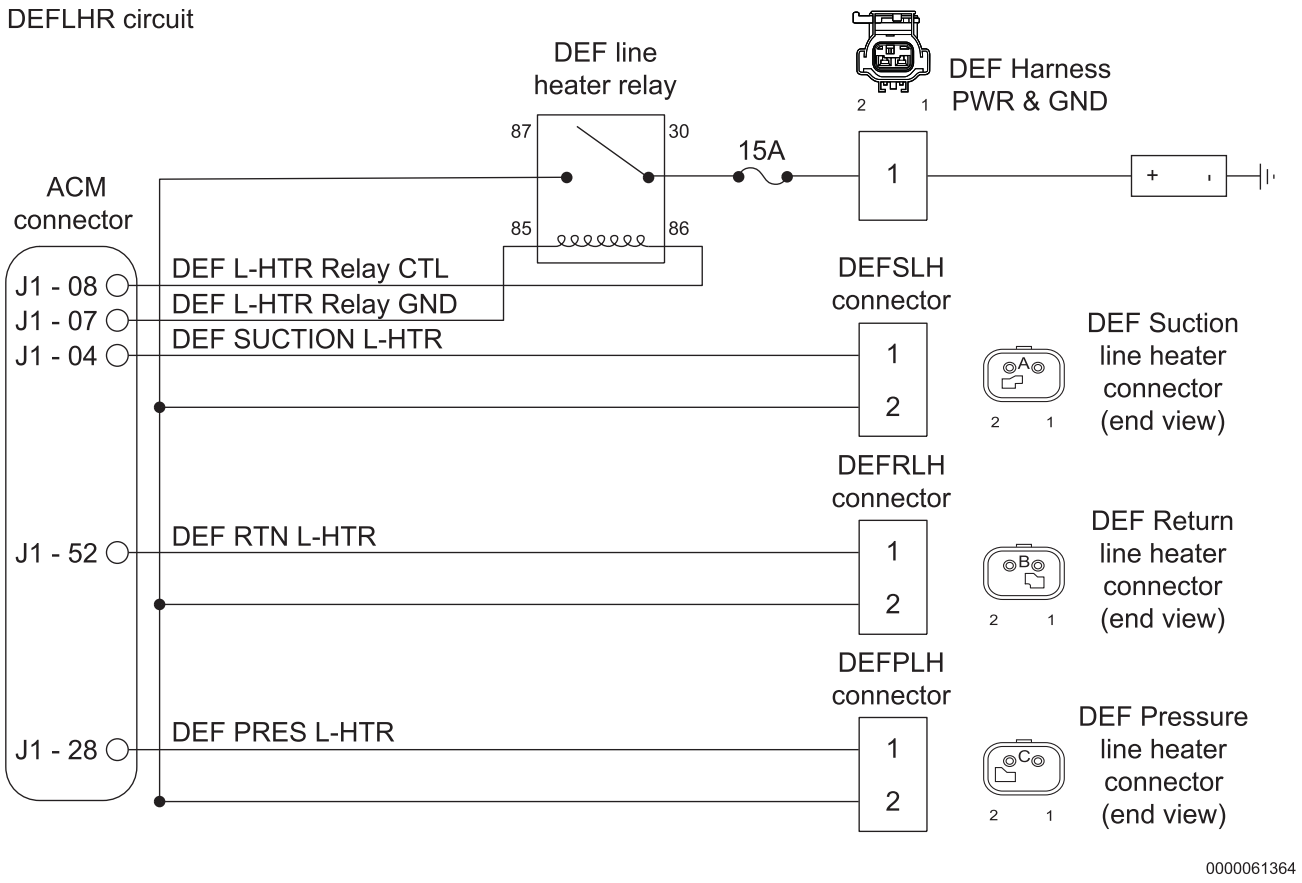


Figure 247 DEFLHR Circuit Diagram

NOTE: See latest version of Navistar N13 Engine and Aftertreatment Wiring Schematic Form 0000002203 for additional circuit information.

Overview

The Diesel Exhaust Fluid Line Heater Relay (DEFLHR) is used to control the DEF Suction Line Heater (DEFSLH), DEF Pressure Line Heater (DEFPLH) and DEF Return Line Heater (DEFRLH), which are wrapped around the DEF suction, pressure, and return lines. The Aftertreatment Control Module (ACM) turns the line heaters on by controlling the DEFLHR. This is done by sending power through the DEF L-HTR Relay CTL circuit to the DEFLHR. The DEFLHR is constantly grounded by the ACM through DEF-L HTR Relay GND.

Tools Required

- 180-Pin Breakout Box 00-00956-08
- ACM Breakout Harness 18-100-01
- Breakout Harness ZTSE4908
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

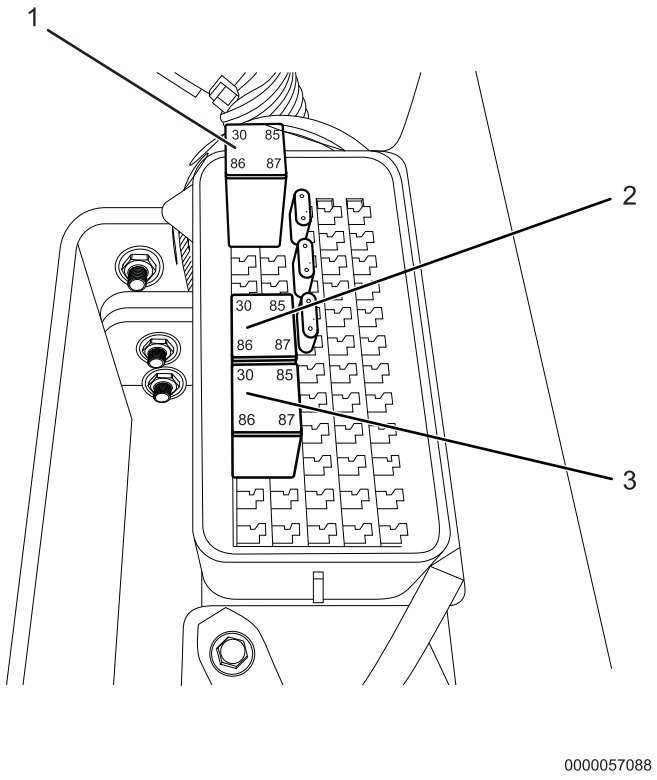


Figure 248 DEFLHR Location

1. DEF Line Heater Relay (DEFLHR)
2. DEF Unit HTR Relay (DEFUHR)
3. Switched Ignition Relay

SPN 5491 FMI 3 - DEFLHR short to PWR (Open or High Resistance)

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Exhaust Fluid Line Heater Relay (DEFLHR) circuit is shorted to PWR, Open, or high resistance.	Resistance between DEF L-HTR Relay CTL and DEF L-HTR Relay GND > 500,000 Ohms OR DEF L-HTR Relay CTL is shorted to PWR.	DEFLHR commanded ON Key ON.	3 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the voltage signal from the Diesel Exhaust Fluid Line Heater Relay (DEFLHR) is high or open circuit.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

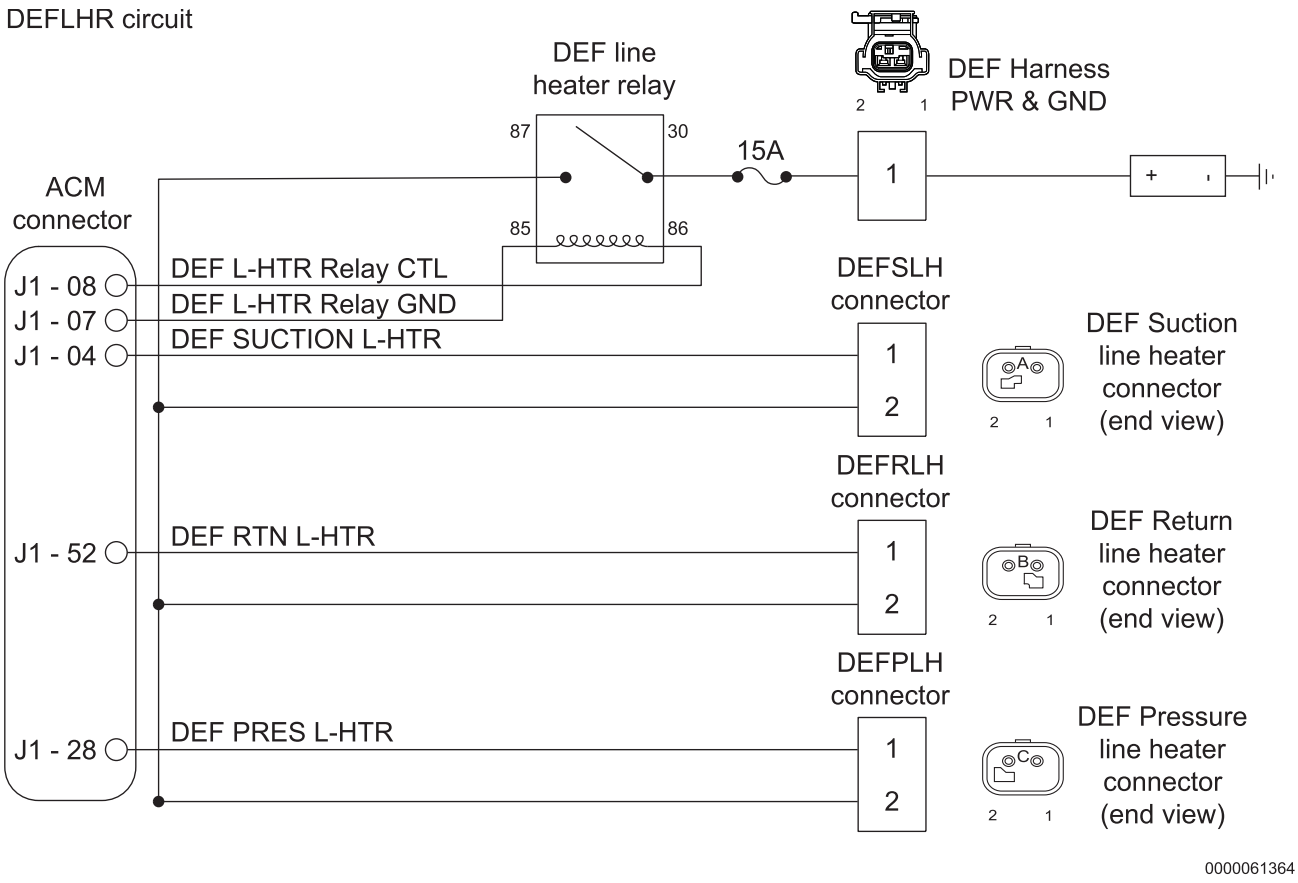


Figure 249 DEFLHR Circuit Diagram

Possible Causes

- DEF L-HTR Relay CTL short to PWR
- DEF L-HTR Relay CTL Open or high resistance
- DEF L-HTR Relay GND Open or high resistance
- Failed DEF Line Heater Relay

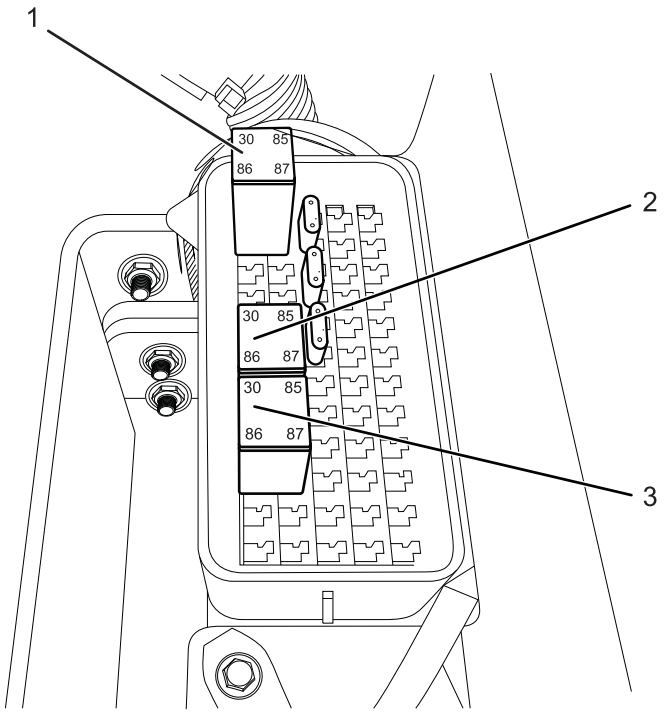


Figure 250 DEFLHR Location

1. DEF Line Heater Relay (DEFLHR)
2. DEF Unit HTR Relay (DEFUHR)
3. Switched Ignition Relay

Step	Action	Decision
1	Check Power Distribution Module (PDM) fuse(s) and relay(s) for blown fuses; loose, missing, or intermittent connections. Are all fuses and relays securely attached and in good condition?	Yes: Go to step 2. No: Secure or replace failed fuse(s) or relay(s) to PDM connector. After repairs are complete, retest for SPN 5491 FMI 3.

Step	Action	Decision
2	Check for a failed DEF Line Heater Relay (DEFLHR). Remove the DEFLHR. Install DEFLHR into breakout harness ZTSE4908 and leave harness disconnected from PDM. Using a DMM, check resistance between pin-85 and pin-86. Is resistance between 100 and 300 ohms?	Yes: Go to step 3. No: Replace DEFLHR. After repairs are complete, retest for SPN 5491 FMI 3.

Step	Action	Decision
3	Inspect connections at Aftertreatment Control Module (ACM). Key OFF, disconnect ACM connectors. Check ACM and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Leave connector J1 unplugged. Are the ACM connectors, harnesses, and terminals clean and undamaged?	Yes: Go to step 4. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 5491 FMI 3.

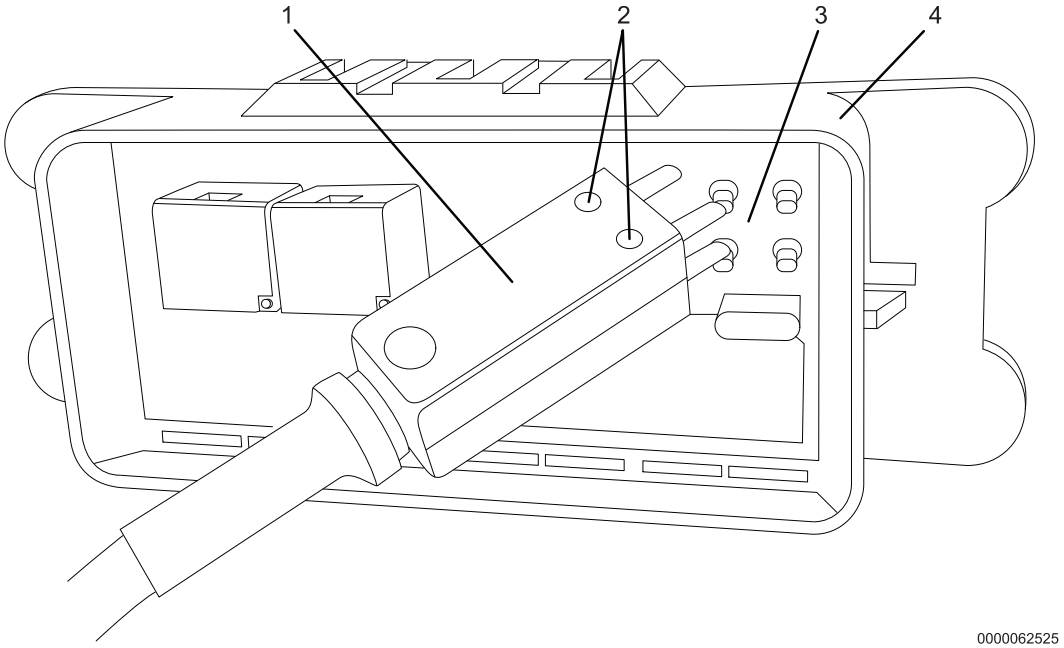


Figure 251 Installation of Breakout Harness ZTSE4908 (typical)

1. Breakout Harness ZTSE4908
2. Dimples
3. Relay socket
4. Power Distribution Module (PDM)

CAUTION: For correct diagnosis, Breakout Harness ZTSE4908 Must be installed with the dimples toward the top of the Power Distribution Module (PDM). Reversed installation Will result in incorrect measurements.

Step	Action	Decision
4	Check DEF L-HTR Relay CTL circuit for a short to PWR. Install breakout harness ZTSE4908 into PDM and leave relay disconnected. With J1 disconnected from ACM. Key-On Engine-Off (KOEO), use a DMM to measure voltage between pin-86 and a known good ground. Is voltage less than 0.5 volt?	Yes: Go to step 4. No: Repair short to PWR in DEF L-HTR Relay CTL circuit between DEFLHR pin-86 and ACM pin J1-08. When repairs are complete, retest for SPN 5491 FMI 3.

Step	Action	Decision
5	Check DEF Line Heater Relay CTL circuit for an Open or high resistance. Install 180-pin breakout box with Breakout Harness 18-100-01 to vehicle harness, leave ACM disconnected. Key OFF, with ZTSE4908 installed and relay disconnected, use a DMM to measure resistance between pin-86 and ACM pin J1-08. Is resistance less than 5 ohms?	Yes: Repair Open or high resistance in DEF L-HTR Relay GND circuit between DEFLHR pin-85 and ACM pin J1-07. When repairs are complete, retest for SPN 5491 FMI 3.
		No: Repair Open or high resistance in DEF L-HTR Relay CTL circuit between DEFLHR pin-86 and ACM pin J1-08. When repairs are complete, retest for SPN 5491 FMI 3.

NOTE: After performing all diagnostic steps, if SPN 5491 FMI 3 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 5491 FMI 4- DEFLHR short to GND

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Exhaust Fluid Line Heater Relay (DEFLHR) voltage below normal or shorted to GND.	Resistance between DEF L-HTR Relay CTL circuit and ground < 0.2 Ohms	DEFLHR commanded ON Key ON	3 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the signal voltage from the Diesel Exhaust Fluid Line Heater Relay (DEFLHR) is lower than expected.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

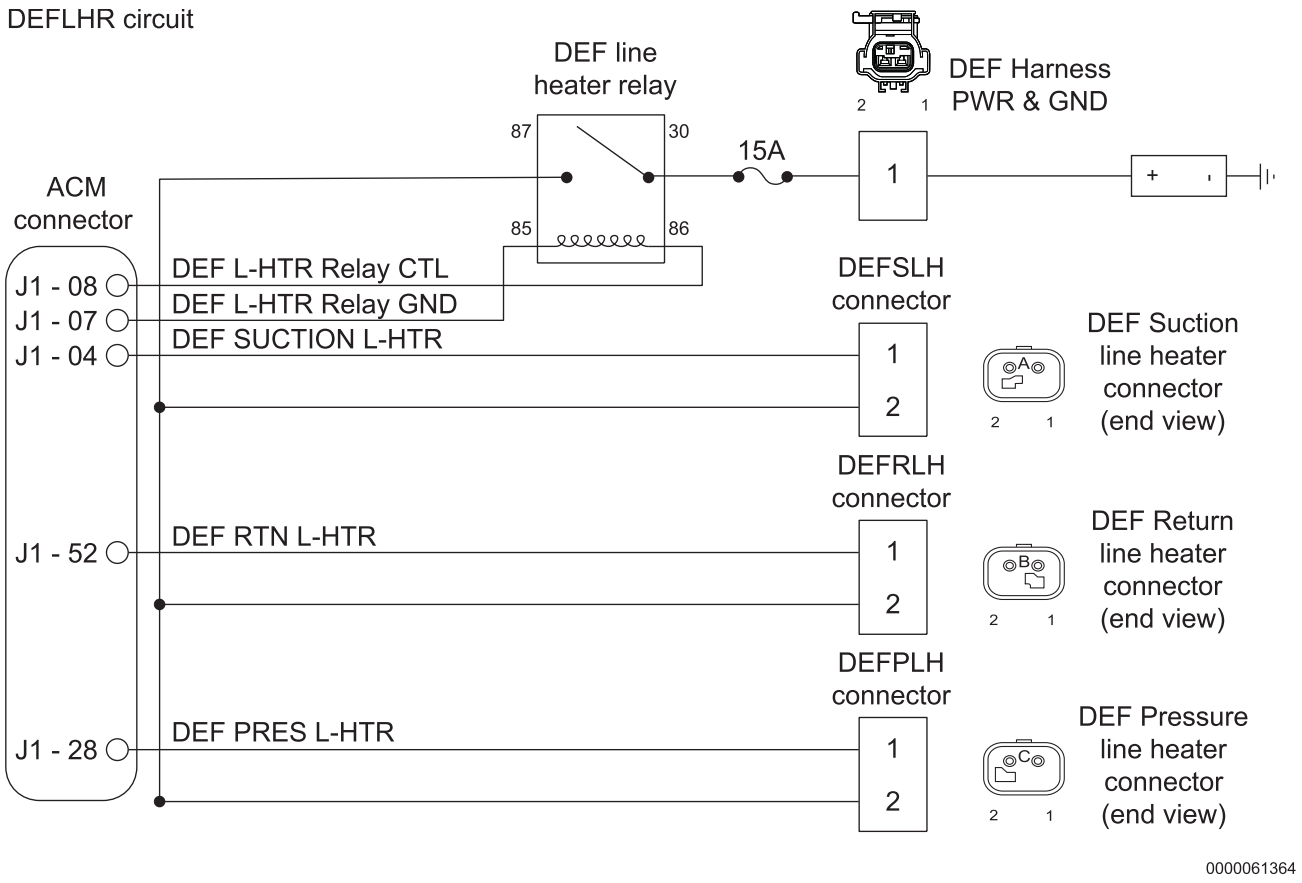


Figure 252 DEFLHR Circuit Diagram

Possible Causes

- DEF L-HTR Relay CTL circuit short to GND
- DEF L-HTR Relay CTL shorted to DEF L-HTR Relay GND
- Failed DEF Line Heater Relay (DEFLHR)

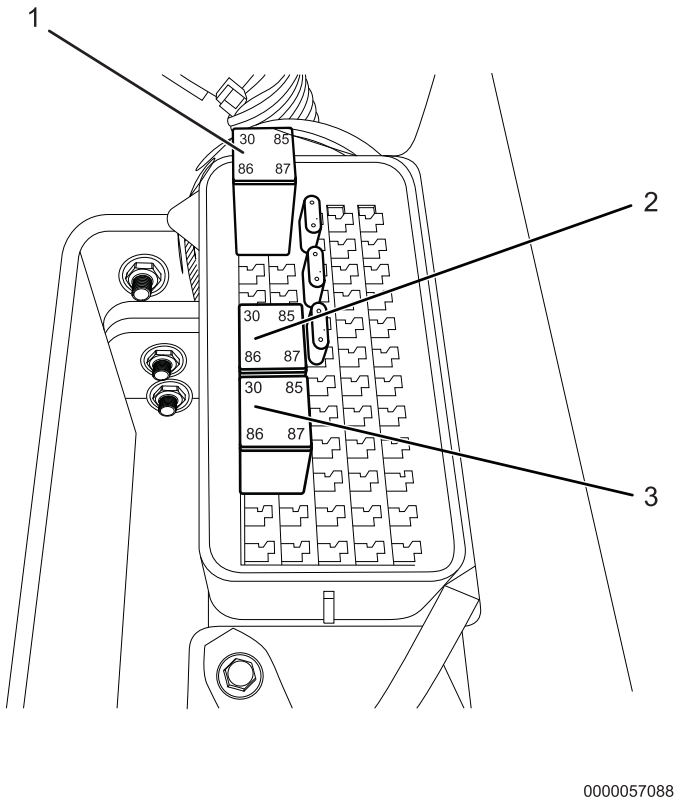


Figure 253 DEFLHR Location

1. DEF Line Heater Relay (DEFLHR)
2. DEF Unit HTR Relay (DEFUHR)
3. Switched Ignition Relay

Step	Action	Decision
1	Check Power Distribution Module (PDM) fuse(s) and relay(s) for blown fuses; loose, missing, or intermittent connections. Are all fuses and relays securely attached and in good condition?	Yes: Go to step 2. No: Secure or replace failed fuse(s) or relay(s) to PDM connector. After repairs are complete, retest for SPN 5491 FMI 4.

Step	Action	Decision
2	Check for a failed DEF Line Heater Relay (DEFLHR). Remove the DEFLHR. Install relay into Breakout Harness ZTSE4908 and leave disconnected from PDM. Using a DMM, check resistance between pin-85 and pin-86. Is the resistance between 100 and 300 ohms?	Yes: Go to step 3. No: Replace DEFLHR. After repairs are complete, retest for SPN 5491 FMI 4.

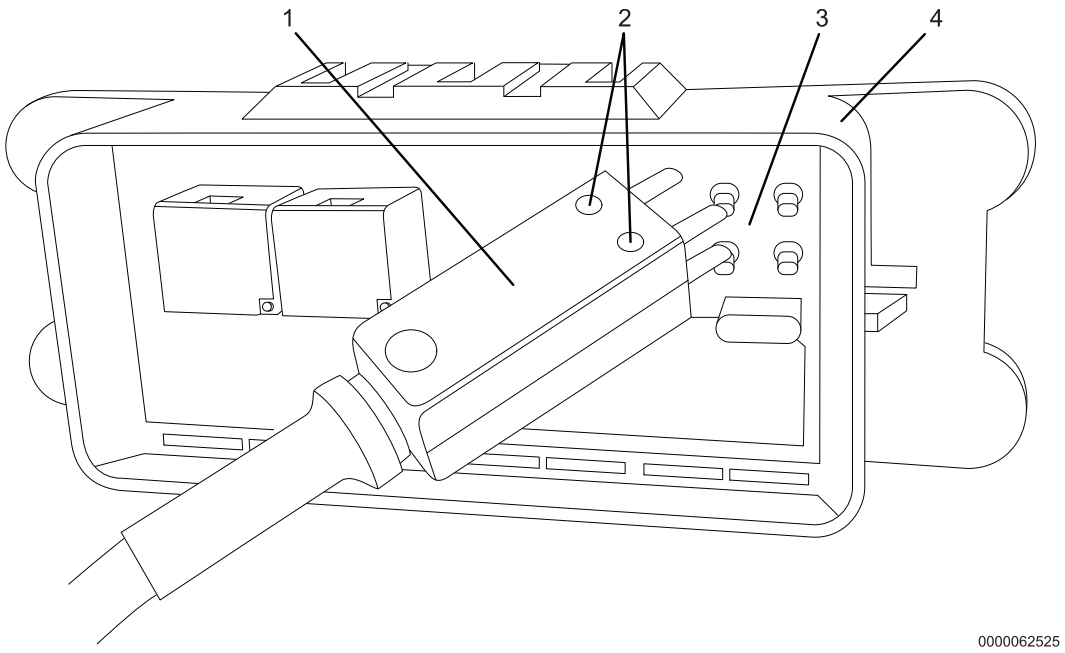


Figure 254 Installation of Breakout Harness ZTSE4908 (typical)

1. Breakout Harness ZTSE4908
2. Dimples
3. Relay socket
4. Power Distribution Module (PDM)

CAUTION: For correct diagnosis, Breakout Harness ZTSE4908 Must be installed with the dimples toward the top of the Power Distribution Module (PDM). Reversed installation Will result in incorrect measurements.

Step	Action	Decision
3	Check for DEF L-HTR Relay CTL shorted to DEF L-HTR Relay GND. Install Breakout Harness ZTSE4908 into PDM, leaving relay disconnected. Using a DMM, Key OFF check resistance between pin-85 and pin-86. Is resistance less than 100 ohms?	Yes: Repair short between DEF L-HTR CTL and DEF L-HTR Relay GND circuits. After repairs are complete, retest for SPN 5491 FMI 4.
		No: Repair short to GND in DEF L-HTR Relay CTL circuit between DEFLHR pin-86 and ACM pin J1-08. After repairs are complete, retest for SPN 5491 FMI 4.

NOTE: After performing all diagnostic steps, if SPN 5491 FMI 4 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

DEFLP (Diesel Exhaust Fluid Line Pressure) Sensor

SPN	FMI	Condition	Possible Causes	Actions
4334	2	DEFLP signal erratic, intermittent, or incorrect	• Debris in DEF tank / restricted DEF tank screen • DEF tank, supply module, or doser valve line, or connection loose, leaking, or damaged • Failed Diesel Exhaust Fluid (DEF) supply module • Restricted DEF suction, pressure, or return line • Restricted DEF supply module filter	Step-Based Diagnostics (page 655)
4334	3	DEFLP signal Out of Range HIGH	• DEFLP signal circuit short to PWR • Failed DEF supply module • SIG GND circuit Open or high resistance	Step-Based Diagnostics (page 659)
4334	4	DEFLP signal Out of Range LOW	• DEFLP signal circuit short to GND • DEFLP signal circuit Open or high resistance • Failed DEF supply module • VREF-4 circuit Open or high resistance	Step-Based Diagnostics (page 662)

4334	16	DEFLP above Maximum Pressure	• Failed DEF supply module • Restricted DEF return line	Step-Based Diagnostics (page 665)
4334	18	DEFLP below normal operating range	• Debris in DEF tank / restricted DEF tank screen • DEF tank, supply module, or doser valve line, or connection loose, leaking, or damaged • Failed DEF supply module • Low DEF tank level • Restricted DEF suction line	Step-Based Diagnostics (page 668)

DEF: AP Circuit

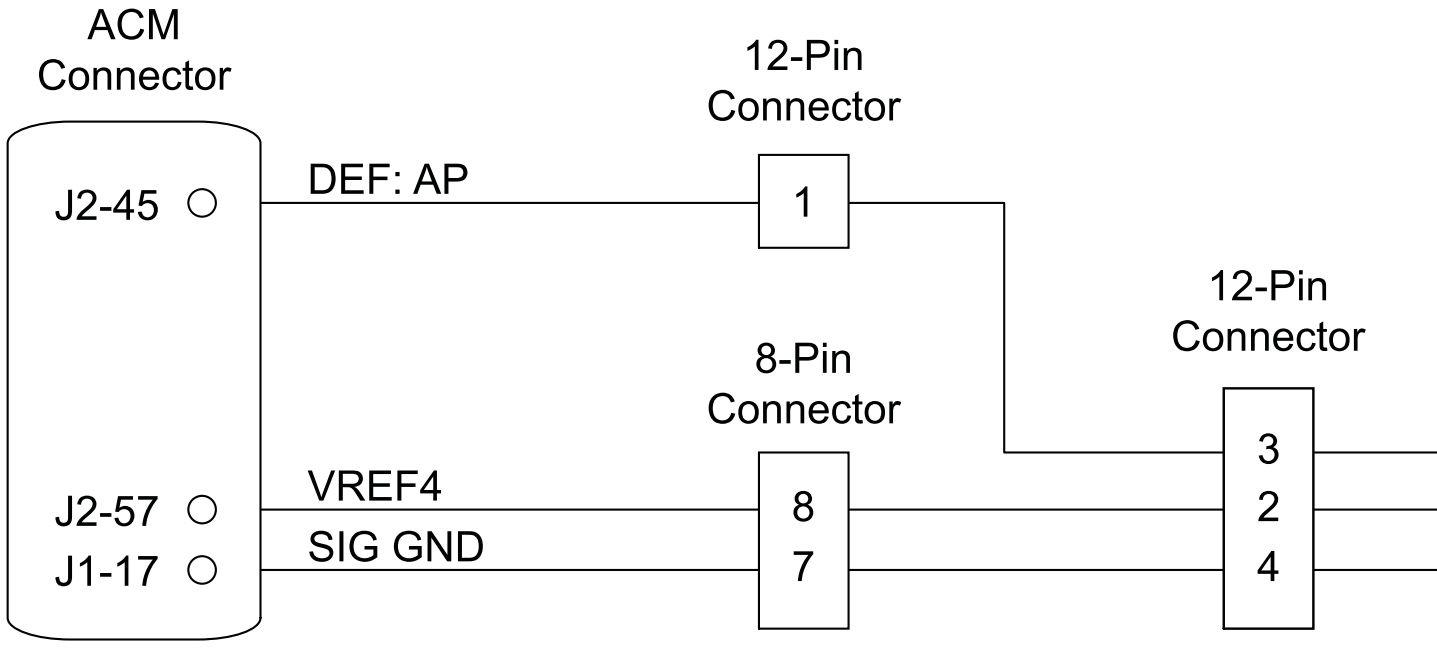


Figure 255 DEFLP Sensor Circuit Diagram

NOTE: See latest version of Navistar N13 Engine and Aftertreatment Wiring Schematic Form 0000002203 for additional circuit information.

Overview

The Diesel Exhaust Fluid Line Pressure (DEFLP) sensor measures DEF pressure from the DEF Supply Pump (DEFSP). When DEF pressure is high, the signal from the DEFLP sensor is high. The DEFLP sensor is located within the DEF Supply Module and is a non-serviceable component.

Tools Required

- 180-Pin Breakout Box 00-00956-08
- SCR (ACM) Breakout Harness 18-100-01
- Breakout Harness 18-909-01
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

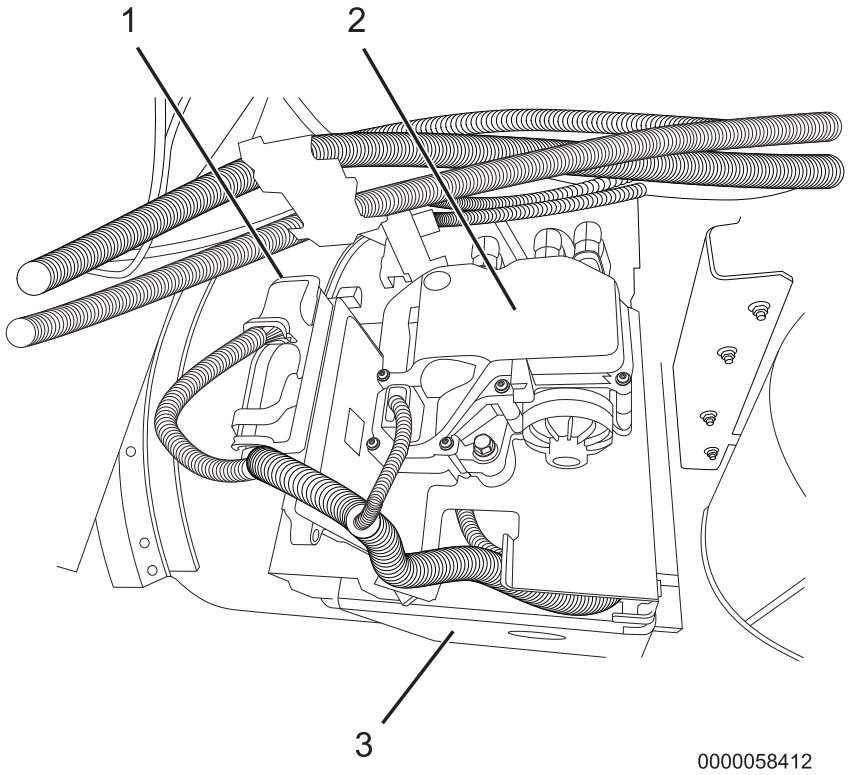


Figure 256 DEF Supply Module Location (Typical)

1. Aftertreatment Control Module (ACM)
2. Diesel Exhaust Fluid (DEF) supply module
3. DEF tank

SPN 4334 FMI 2 - DEFLP signal erratic, intermittent or incorrect

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Exhaust Fluid Line Pressure (DEFLP) sensor signal is erratic, intermittent, or incorrect.	DEF supply module pump pressure measured after priming > 160 psi (1,100 kPa) (gauge) OR DEF supply module pump pressure < 102 psi (700 kPa) (gauge) OR DEF supply module pump pressure measured at start of priming > 7 psi (50 kPa) (gauge) OR DEF supply module pump pressure < -7 psi (-50 kPa) (gauge).	DEF supply module filled with DEF. Pressure > 29 psi (200 kPa) DEF tank has been defrosted. DEF supply line has been defrosted. DEF supply module has been defrosted, or DEF supply module defrost is not required. Engine Running Inactive: SPN 3361 FMI 3 and 4 (DEFSP); SPN 4334 FMI 3 and 4 (DEFLP); SPN 4376 FMI 3 and 4 (DEFRV)	240 seconds

Fault Overview

Fault code sets when the Diesel Exhaust Fluid (DEF) supply module is unable to maintain the commanded diesel exhaust fluid pressure. Engine torque will be reduced if fault is active for an extended period of time.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 4334 FMI 3 and 4 (DEFLP)

Drive Cycle to Determine Fault Status

Drive Cycle 27 in 2013 HD-OBD Diagnostic Reference Manual.

DEF: AP Circuit

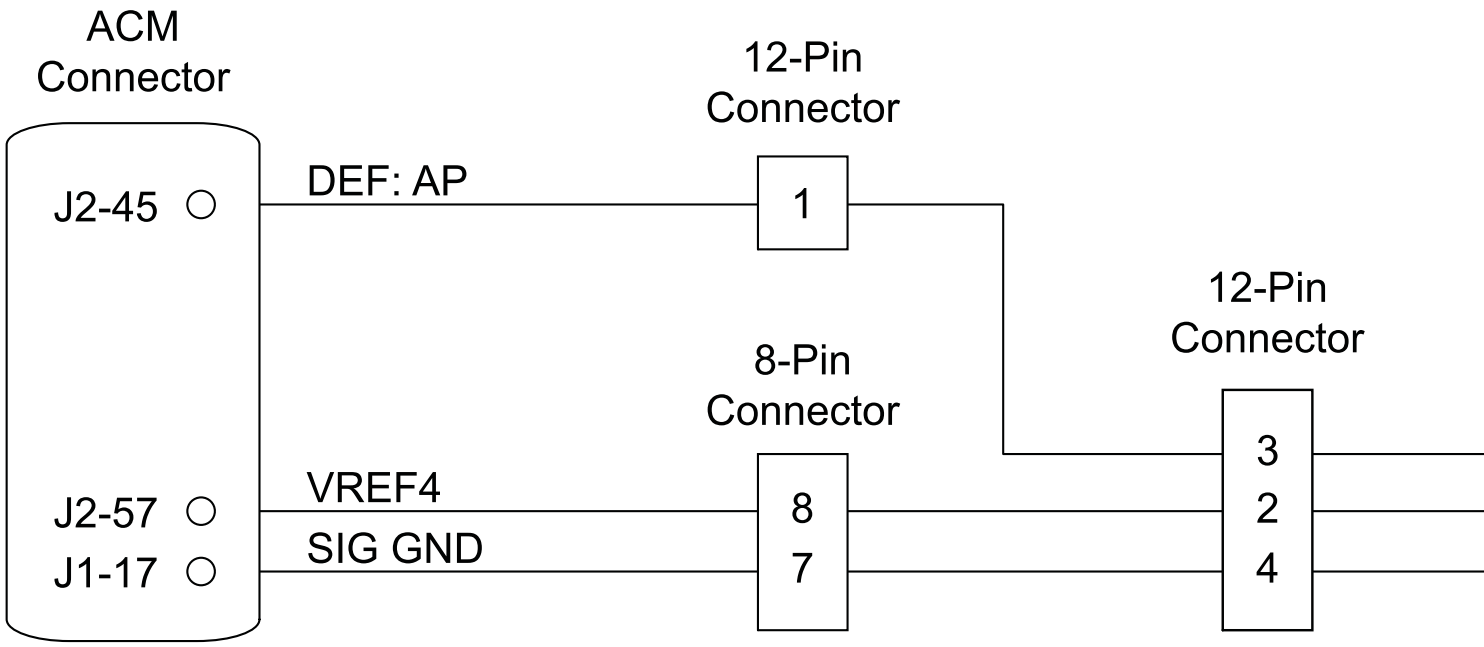


Figure 257 DEFLP Sensor Circuit Diagram

Possible Causes

- Debris in DEF tank / restricted DEF tank screen
- DEF tank, supply module, or doser valve line or connection loose, leaking, or damaged
- Failed Diesel Exhaust Fluid (DEF) supply module
- Restricted DEF suction, pressure, or return line
- Restricted DEF supply module filter

Step	Action	Decision
1	Using Electronic Service Tool (EST) with Service Maxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 4334 FMI 3 and 4 (DEFLP). Is EST DTC list free of SPN 4334 FMI 3 and 4?	Yes: Go to step 2. No: Repair SPN 4334 FMI 3 and 4. After repairs are complete, retest for SPN 4334 FMI 2.

Step	Action	Decision
2	Inspect connections at Diesel Exhaust Fluid (DEF) supply module. Key OFF, disconnect DEF supply module connector. Check DEF supply module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DEF supply module connector, harness, and terminals clean and undamaged?	Yes: Go to step 3. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 4334 FMI 2.

Step	Action	Decision
3	Check Diesel Exhaust Fluid (DEF) tank for debris or foreign particles. Also check DEF tank vent for restrictions or fluid crystallization. Are the DEF tank and DEF tank vent clean and free of debris, restrictions, and fluid crystallization?	Yes: Go to step 4. No: Drain DEF tank, flush with distilled water, and fill with new and / or known good DEF. After repairs are complete, retest for SPN 4334 FMI 2.

Step	Action	Decision
4	Check Diesel Exhaust Fluid (DEF) tank, DEF supply module, and DEF Doser Valve (DEFDV) lines and connections for: cracks and pitting; loose, leaking, or damaged connections. Are the DEF tank, DEF supply module, and DEFDV lines and connections in good condition, not cracked, leaking, or damaged?	Yes: Go to step 5. No: Repair or replace failed line or connection. After repairs are complete retest for SPN 4334 FMI 2.

Step	Action	Decision
5	Check DEF supply module for restrictions. Unscrew DEF supply module filter cap, and remove filter from supply module. Inspect DEF supply module filter for restrictions and debris. Is the DEF supply module filter free of debris and restrictions?	Yes: Go to step 6. No: Replace DEF supply module filter and clean DEF supply module using 18-200-01. After repairs are complete, retest for SPN 4334 FMI 2.

Step	Action	Decision
6	Check for failed Diesel Exhaust Fluid Line Pressure (DEFLP) sensor. Key OFF, disconnect DEF supply module pressure line at DEFDV and place appropriate container under vehicle to catch DEF. Key ON, using EST with ServiceMaxx, load the Signals session and monitor DEF Line Pressure signal. Is DEFLP signal 0 psi ± 10 psi?	Yes: Go to step 7. No: Replace the DEF supply module. After repairs are complete, retest for SPN 4334 FMI 2.

Step	Action	Decision
7	Check DEF supply module suction line for restrictions. Disconnect both ends of suction line and blow compressed air through the line. Does compressed air flow freely through the suction line?	Yes: Go to step 8. No: Clean or replace DEF supply module suction line. After repairs are complete, retest for SPN 4334 FMI 2.

Step	Action	Decision
8	Check DEF supply module return line for restrictions. Disconnect both ends of return line and blow compressed air through the line. Does compressed air flow freely through the return line?	Yes: Go to step 9. No: Clean or replace DEF supply module return line. After repairs are complete, retest for SPN 4334 FMI 2.

Step	Action	Decision
9	Check DEF supply module pressure line for restrictions. Disconnect both ends of pressure line and blow compressed air through the line. Does compressed air flow freely through the pressure line?	Yes: Retest for SPN 4334 FMI 2. No: Clean or replace DEF supply module pressure line. After repairs are complete, retest for SPN 4334 FMI 2.

NOTE: After performing all diagnostic steps, if SPN 4334 FMI 2 remains, verify each step was completed correctly, and the proper decision was made. Notify supervisor for further action.

SPN 4334 FMI 3- DEFLP signal Out of Range HIGH

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Exhaust Fluid Line Pressure (DEFLP) sensor signal is high.	DEFLP > 4.75 volts [189 psi (1,300 kPa gauge)]	Key ON	8 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the signal from the Diesel Exhaust Fluid Line Pressure (DEFLP) sensor is greater than 4.75 volts for 8 seconds. DEF injection into the aftertreatment system is disabled. Engine torque will be reduced if fault is active for an extended period of time.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 3512 FMI 14 (VREF-4)

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

DEF: AP Circuit

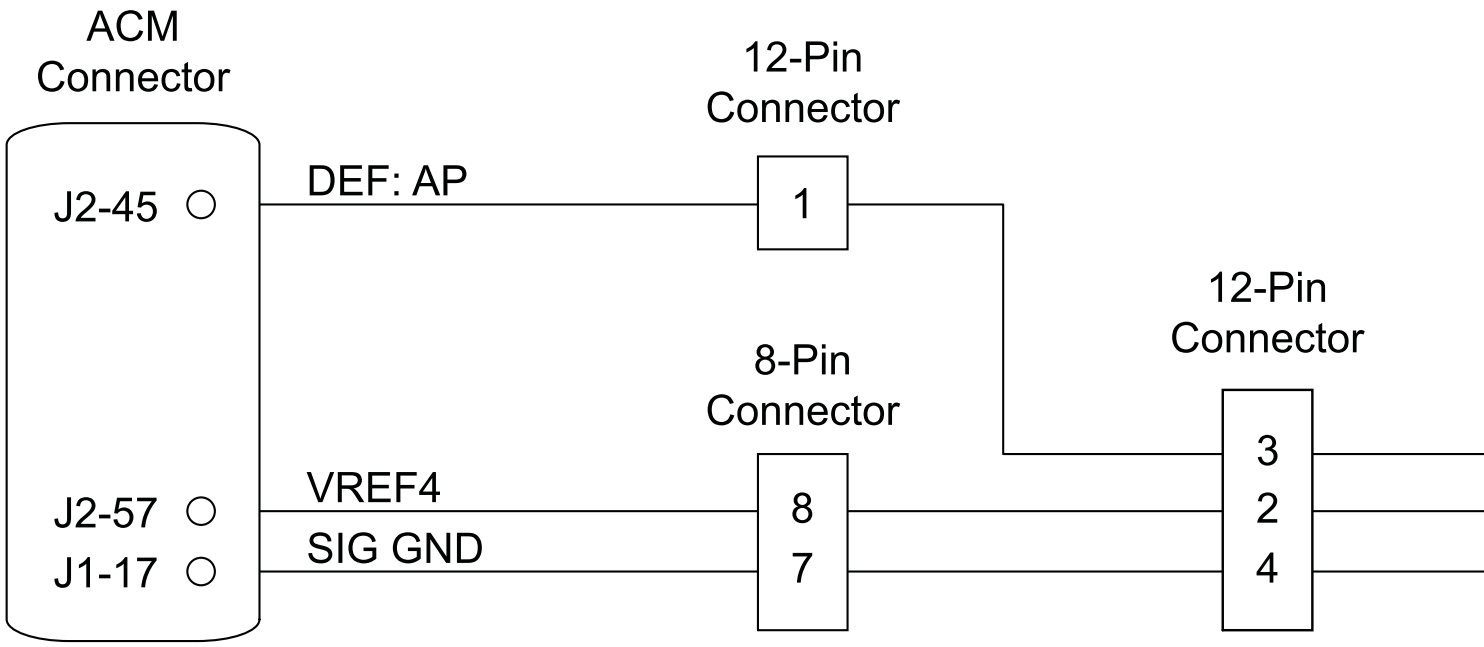


Figure 258 DEFLP Sensor Circuit Diagram

Possible Causes

- DEFLP signal circuit short to PWR
- Failed DEF supply module
- SIG GND circuit Open or high resistance

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™software, check Diagnostic Trouble Code (DTC) list for SPN 3512 FMI 14 (VREF-4). Is EST DTC list free of SPN 3512 FMI 14?	Yes: Go to step 2. No: Repair SPN 3512 FMI 14. After repairs are complete, retest for SPN 4334 FMI 3.

Step	Action	Decision
2	Inspect connections at Diesel Exhaust Fluid (DEF) supply module. Key OFF, disconnect DEF supply module connector. Check DEF supply module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DEF supply module connector, harness, and terminals clean and undamaged?	Yes: Go to step 3. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 4334 FMI 3.

Step	Action	Decision
3	Check DEFLP signal circuit for short to power. Key-On Engine-Off (KOEO), with Breakout Harness 18-909-01 connected to DEF supply module, use a DMM to measure voltage between DEF supply module pin-3 and a known good ground. Is voltage less than 4.75 volts?	Yes: Go to step 4. No: Repair short to power between DEF supply module connector pin-3 and ACM connector pin J2-45. After repairs are complete, retest for SPN 4334 FMI 3.

Step	Action	Decision
4	Check SIG GND circuit for Open or high resistance. Connect Breakout Harness 18-909-01 to DEF supply module and leave DEF supply module disconnected. Connect 180-pin Breakout Box with SCR (ACM) Breakout Harness 18-100-01 (96-pin) to ACM and leave ACM disconnected. Use a DMM to measure resistance from Breakout Harness 18-909-01 pin-4 and 180-pin Breakout Box pin J1-17. Is resistance less than 5 ohms?	Yes: Replace DEF supply module. After repairs are complete, retest for SPN 4334 FMI 3. No: Repair Open or high resistance between DEF supply module pin-4 and ACM connector pin J1-17. After repairs are complete, retest for SPN 4334 FMI 3.

NOTE: After performing all diagnostic steps, if SPN 4334 FMI 3 remains, verify each step was completed correctly, and the proper decision was made. Notify supervisor for further action.

SPN 4334 FMI 4- DEFLP signal Out of Range LOW

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Exhaust Fluid Line Pressure (DEFLP) sensor signal is low.	DEFLP < 0.25 volts [15 psi (100 kPa gauge)]	Key ON	8 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the signal from the Diesel Exhaust Fluid Line Pressure (DEFLP) sensor is less than 0.25 volts for 8 seconds. DEF injection into the aftertreatment system is disabled. Engine torque will be reduced if fault is active for an extended period of time.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 3512 FMI 14 (VREF-4)

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

DEF: AP Circuit

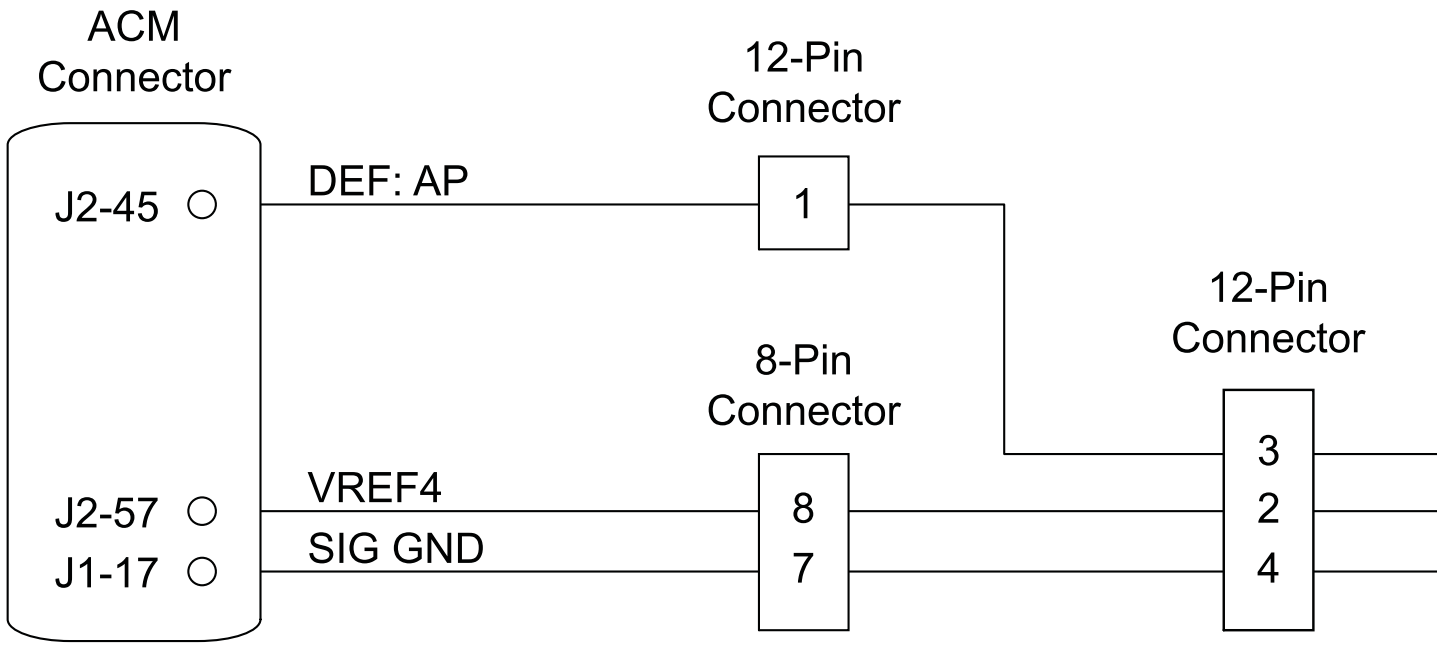


Figure 259 DEFLP Sensor Circuit Diagram

Possible Causes

- DEFLP signal circuit short to GND
- DEFLP signal circuit Open or high resistance
- Failed DEF supply module
- VREF-4 circuit Open or high resistance

Step	Action	Decision
1	Using Electronic Service Tool (EST) with Service Maxx™software, check Diagnostic Trouble Code (DTC) list for SPN 3512 FMI 14 (VREF-4). Is EST DTC list free of SPN 3512 FMI 14?	Yes: Go to step 2. No: Repair SPN 3512 FMI 14. After repairs are complete, retest for SPN 4334 FMI 2.

Step	Action	Decision
2	Inspect connections at Diesel Exhaust Fluid (DEF) supply module. Key OFF, disconnect DEF supply module connector. Check DEF supply module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DEF supply module connector, harness, and terminals clean and undamaged?	Yes: Go to step 3. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 4334 FMI 4.

Step	Action	Decision
3	Check DEFLP signal circuit for short to ground. Connect Breakout Harness 18-909-01 to DEF supply module and leave DEF supply module disconnected. Use a DMM to measure resistance between Breakout Harness 18-909-01 pin-3 and a known good ground. Is resistance greater than 1000 ohms?	Yes: Go to step 4. No: Repair short to ground between DEF supply module connector pin-3 and ACM connector pin J2-45. After repairs are complete, retest for SPN 4334 FMI 4.

Step	Action	Decision
4	Check VREF-4 circuit for Open or high resistance. Connect Breakout Harness 18-909-01 to DEF supply module and leave DEF supply module disconnected. Connect 180-pin Breakout Box with SCR (ACM) Breakout Harness 18-100-01 (58-pin) to ACM and leave ACM disconnected. Use a DMM to measure resistance from Breakout Harness 18-909-01 pin-2 and 180-pin Breakout Box pin J2-57. Is resistance less than 5 ohms?	Yes: Go to step 5. No: Repair Open or high resistance between DEF supply module pin-2 and ACM connector pin J2-57. After repairs are complete, retest for SPN 4334 FMI 4.

Step	Action	Decision
5	Check DEFLP signal circuit for Open or high resistance. Connect Breakout Harness 18-909-01 to DEF supply module and leave DEF supply module disconnected. Connect 180-pin Breakout Box with SCR (ACM) Breakout Harness 18-100-01 (58-pin) to ACM and leave ACM disconnected. Use a DMM to measure resistance from Breakout Harness 18-909-01 pin-3 and 180-pin Breakout Box pin J2-45. Is resistance less than 5 ohms?	Yes: Replace DEF supply module. After repairs are complete, retest for SPN 4334 FMI 4. No: Repair Open or high resistance between DEF supply module pin-3 and ACM connector pin J2-45. After repairs are complete, retest for SPN 4334 FMI 4.

NOTE: After performing all diagnostic steps, if SPN 4334 FMI 4 remains, verify each step was completed correctly, and the proper decision was made. Notify supervisor for further action.

SPN 4334 FMI 16- DEFLP above Maximum Pressure

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Blockage in the DEF supply module return line has been detected.	DEFLP > 160 psi (1,100 kPa) (gauge)	Inactive: SPN 3361 FMI 3 and 4 (DEFSP); SPN 4334 FMI 2, 3, and 4 (DEFLP) Key ON DEF supply module defrost not required or DEF supply module defrost is completed.	20 seconds

Fault Overview

Fault code sets when the Diesel Exhaust Fluid Line Pressure (DEFLP) sensor detects pressure in the DEF supply module is above 160 psi (1100 kPa) for more than 20 seconds. Engine torque will be reduced if fault is active for a limited period of time. Engine torque will be severely reduced, and vehicle speed limited if fault is active for an extended period of time.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 1761 (DEFTLT), SPN 3031 (DEFTLT), SPN 3361 (DEFSP), SPN 3362 (DEFSP), SPN 3363 FMI (DEFTHC), SPN 4376 (DEFRV), SPN 5394 (DEFDV), SPN 5491 (DEFLHR), SPN 5745 (DEFDUH), SPN 5746 (DEFUHR), SPN 5798 (DEFDUH)

Drive Cycle to Determine Fault Status

Drive Cycle 27 in 2013 HD-OBD Diagnostic Reference Manual.

DEF: AP Circuit

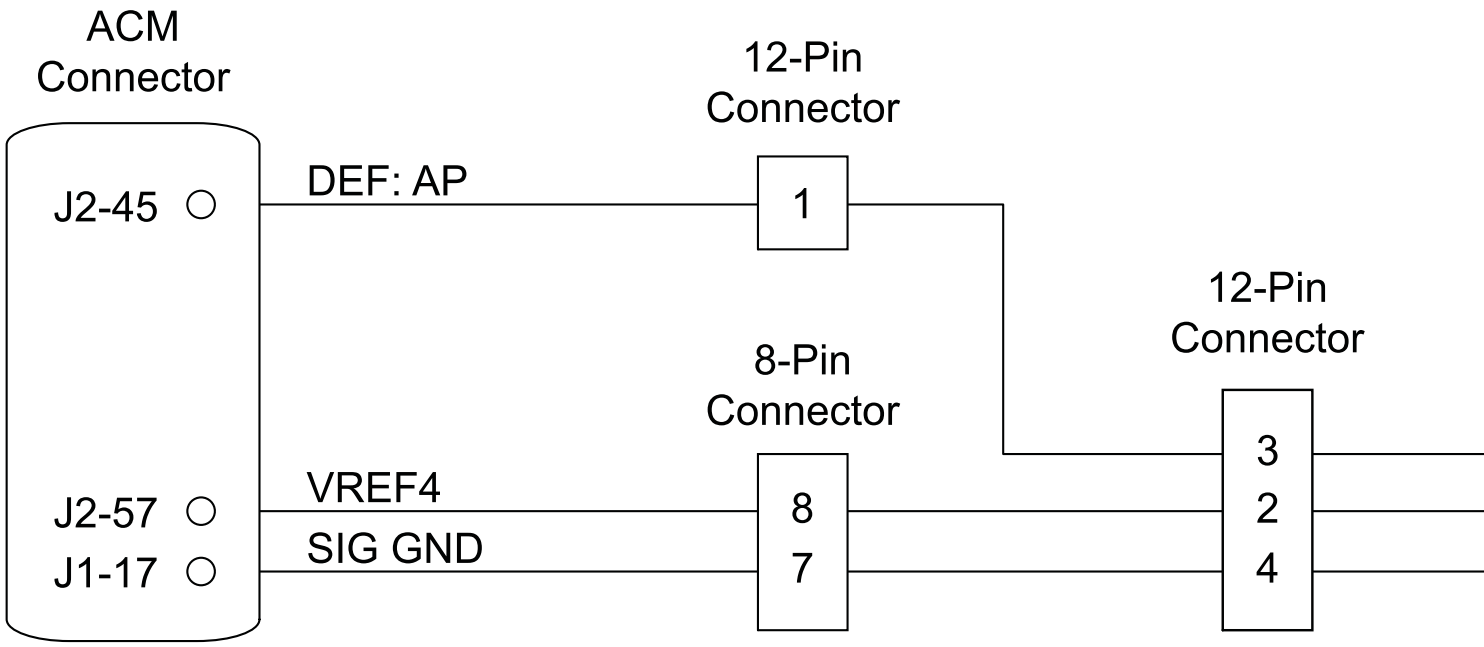


Figure 260 DEFLP Sensor Circuit Diagram

Possible Causes

- Failed DEF supply module
- Restricted DEF return line

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 1761 (DEFTLT), SPN 3031 (DEFTLT), SPN 3361 (DEFSP), SPN 3362 (DEFSP), SPN 3363 FMI (DEFTHC), SPN 4376 (DEFRV), SPN 5394 (DEFDV), SPN 5491 (DEFLHR), SPN 5745 (DEFDUH), SPN 5746 (DEFUHR), and SPN 5798 (DEFDUH). Is EST DTC list free of SPN 1761, SPN 3031, SPN 3361, SPN 3362, SPN 3363 FMI, SPN 4376, SPN 5394, SPN 5491, SPN 5745, SPN 5746, and SPN 5798?	Yes: Go to step 2. No: Repair SPN 1761, SPN 3031, SPN 3361, SPN 3362, SPN 3363 FMI, SPN 4376, SPN 5394, SPN 5491, SPN 5745, SPN 5746, and SPN 5798. After repairs are complete, retest for SPN 4334 FMI 16.

Step	Action	Decision
2	Inspect connections at Diesel Exhaust Fluid (DEF) supply module. Key OFF, disconnect DEF supply module connector. Check DEF supply module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DEF supply module connector, harness, and terminals clean and undamaged?	Yes: Go to step 3. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 4334 FMI 16.

Step	Action	Decision
3	Check DEF supply module return line for restrictions. Disconnect both ends of return line and blow compressed air through the line. Does compressed air flow freely through the return line?	Yes: Clean DEF supply module using 18-200-01 and perform drive cycle 27. If SPN 4334 FMI 16 is still active, replace DEF supply module. After repairs are complete, retest for SPN 4334 FMI 16. No: Clean or replace DEF supply module return line. After repairs are complete, retest for SPN 4334 FMI 16.

NOTE: After performing all diagnostic steps, if SPN 4334 FMI 16 remains, verify each step was completed correctly, and the proper decision was made. Notify supervisor for further action.

SPN 4334 FMI 18- DEFLP below normal operating range

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Low Diesel Exhaust Fluid Line Pressure (DEFLP) signal.	DEFLP < 102 psi (700 kPa) (gauge)	Inactive: SPN 3361 FMI 3 and 4 (DEFSP); SPN 4334 FMI 2, 3, and 4 (DEFLP) DEF tank has been defrosted. DEF supply module has been filled with DEF fluid. DEF supply module suction line has been defrosted. DEF supply module has been defrosted. Engine-Running	200 seconds

Fault Overview

Fault code sets when the Diesel Exhaust Fluid Line Pressure (DEFLP) sensor detects the DEF supply module is unable to build or maintain adequate pressure. Engine torque will be reduced if fault is active for a limited period of time. Engine torque will be severely reduced, and vehicle speed limited if fault is active for an extended period of time.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 1761 (DEFTLT), SPN 3031 (DEFTLT), SPN 3361 (DEFSP), SPN 3362 (DEFSP), SPN 3363 FMI (DEFTHC), SPN 4376 (DEFRV), SPN 5394 (DEFDV), SPN 5491 (DEFLHR), SPN 5745 (DEFDUH), SPN 5746 (DEFUHR), SPN 5798 (DEFDUH)

Drive Cycle to Determine Fault Status

Drive Cycle 27 in 2013 HD-OBD Diagnostic Reference Manual.

DEF: AP Circuit

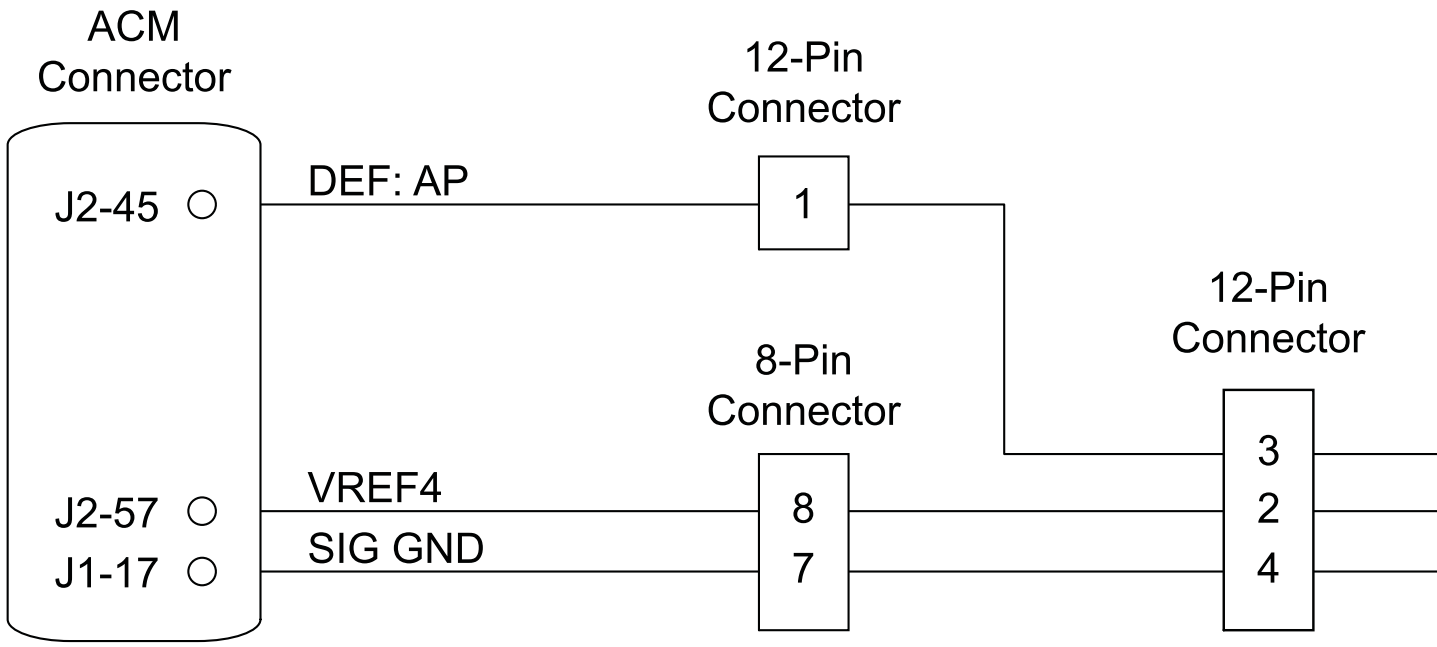


Figure 261 DEFLP Sensor Circuit Diagram

Possible Causes

- Debris in DEF tank / restricted DEF tank screen
- DEF tank, supply module, or doser valve line or connection loose, leaking, or damaged
- Failed DEF supply module
- Low DEF tank level
- Restricted DEF suction line

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 1761 (DEFTLT), SPN 3031 (DEFTLT), SPN 3361 (DEFSP), SPN 3362 (DEFSP), SPN 3363 FMI (DEFTHC), SPN 4376 (DEFRV), SPN 5394 (DEFDV), SPN 5491 (DEFLHR), SPN 5745 (DEFDUH), SPN 5746 (DEFUHR), and SPN 5798 (DEFDUH). Is EST DTC list free of SPN 1761, SPN 3031, SPN 3361, SPN 3362, SPN 3363 FMI, SPN 4376, SPN 5394, SPN 5491, SPN 5745, SPN 5746, and SPN 5798?	Yes: Go to step 2. No: Repair SPN 1761, SPN 3031, SPN 3361, SPN 3362, SPN 3363 FMI, SPN 4376, SPN 5394, SPN 5491, SPN 5745, SPN 5746, and SPN 5798. After repairs are complete, retest for SPN 4334 FMI 18.

Step	Action	Decision
2	Check DEF tank level. Read DEF level using the vehicle instrument panel gauge and perform a visual inspection of fluid level in the DEF tank. Is DEF tank fluid level below 1/2 tank?	Yes: Fill DEF tank with appropriate diesel exhaust fluid. After repairs are complete, retest for SPN 4334 FMI 18.
		No: Go to step 3.

Step	Action	Decision
3	Check Diesel Exhaust Fluid (DEF) tank for debris or foreign particles. Also check DEF tank vent for restrictions or fluid crystallization. Are the DEF tank and DEF tank vent clean and free of debris, restrictions, and fluid crystallization?	Yes: Go to step 4.
		No: Drain DEF tank, flush with distilled water, and fill with new and / or known good DEF. After repairs are complete, retest for SPN 4334 FMI 18.

Step	Action	Decision
4	Check Diesel Exhaust Fluid (DEF) tank, DEF supply module, and DEF Doser Valve (DEFDV) lines and connections for: cracks and pitting; loose, leaking, or damaged connections. Are the DEF tank, DEF supply module and DEFDV lines and connections in good condition, not cracked, leaking, or damaged?	Yes: Go to step 5.
		No: Repair or replace failed line or connection. After repairs are complete retest for SPN 4334 FMI 18.

Step	Action	Decision
5	Check DEF supply module suction line for restrictions. Disconnect both ends of suction line and blow compressed air through the line. Does compressed air flow freely through the suction line?	Yes: Go to step 6.
		No: Clean or replace DEF supply module suction line. After repairs are complete, retest for SPN 4334 FMI 18.

Step	Action	Decision
6	Check DEF tank fluid pickup screen for restrictions. Remove DEF tank pickup assembly (see Exhaust Aftertreatment System with DPF and SCR Service Manual). Inspect the DEF tank fluid pickup screen for restrictions or buildup. Is the DEF tank fluid pickup screen free of restrictions?	Yes: Replace DEF supply module. After repairs are complete, retest for SPN 4334 FMI 18.
		No: Clean or replace DEF tank fluid pickup screen. Drain, clean, and fill the DEF tank. Clean DEF supply module using 18-200-01. After repairs are complete, retest for SPN 4334 FMI 18.

NOTE: After performing all diagnostic steps, if SPN 4334 FMI 18 remains, verify each step was completed correctly, and the proper decision was made. Notify supervisor for further action.

DEFPLH (Diesel Exhaust Fluid Pressure Line Heater)

SPN	FMI	Condition	Possible Causes	Actions
4344	3	DEFL1HC short to PWR	• DEF PRES L-HTR circuit short to power • Failed Diesel Exhaust Fluid Line Heater Relay (DEFLHR) • DEF Pressure Line Heater (DEFPLH) PWR circuit shorted to PWR between DEFLHR pin-87 and DEFPLH pin-2	Step-Based Diagnostics (page 674)
4344	5	DEFL1HC open load / circuit	• Failed Diesel Exhaust Fluid Pressure Line Heater (DEFPLH) • DEF Press L-HTR circuit Open or high resistance • DEF Press L-HTR circuit short to GND • DEFPLH power circuit Open or high resistance • DEFPLH power circuit short to GND • Blown fuse or Open power circuit to DEF Line Heater Relay (DEFLHR)	Step-Based Diagnostics (page 678)

- Failed DEFLHR

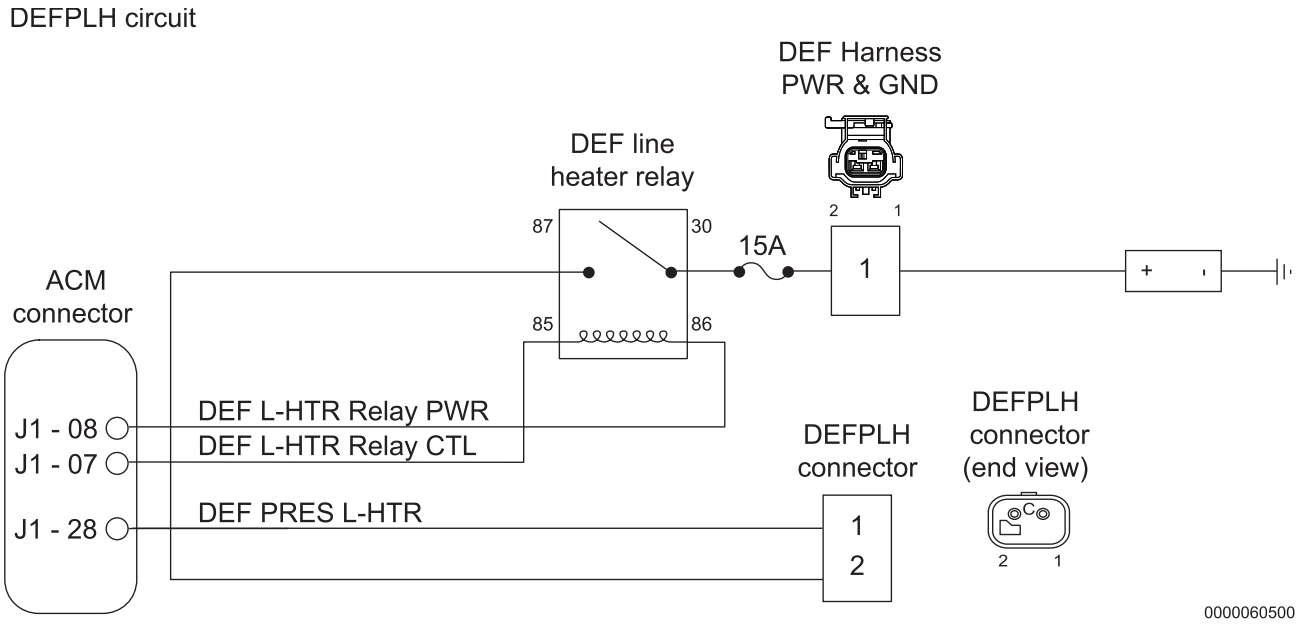


Figure 262 DEFPLH Circuit Diagram

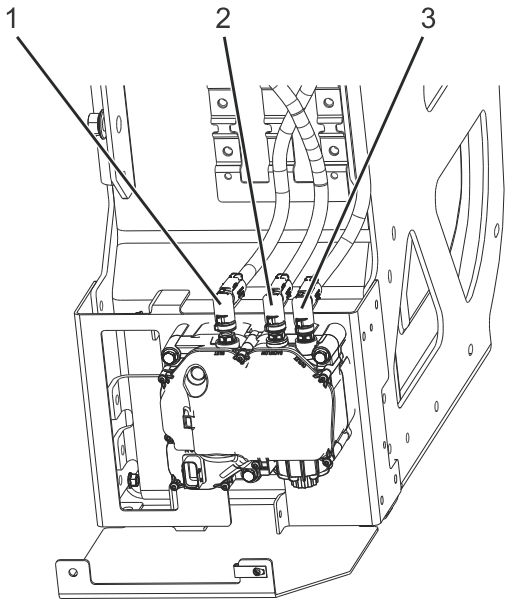
NOTE: See latest version of N13 Engine and Aftertreatment Wiring Schematic Form 0000002203 for additional circuit information.

Overview

The Diesel Exhaust Fluid Pressure Line Heater (DEFPLH) is used to maintain proper DEF temperature during cold conditions. The DEFPLH is wrapped around the pressure line between DEF Doser Valve (DEFDV) and the DEF supply module. When DEF temperature is too low, the Aftertreatment Control Module (ACM) turns on the DEF Line Heater Relay (DEFLHR) allowing power to be sent to the DEFPLH.

Tools Required

- 180-Pin Breakout Box 00-00956-08
- ACM Breakout Harness 18-100-01
- Breakout Harness 18-047-01
- Breakout Harness ZTSE4908
- Digital Multimeter (DMM)
- Standard test light
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)



0000054407

Figure 263 DEF Supply Module Line Routing

1. DEF supply module suction line
2. DEF supply module return (backflow) line
3. DEF supply module pressure line

SPN 4344 FMI 3- Diesel Exhaust Fluid Line 1 Heater Circuit (DEFL1HC) Short to PWR

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Exhaust Fluid Pressure Line Heater (DEFPLH) current is greater than expected.	DEFPLH current > 0.5 A	Key ON The DEF Line Heater Relay (DEFLHR) command OFF.	3 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects current from the Diesel Exhaust Fluid Pressure Line Heater (DEFPLH) is greater than 0.5 amps. Engine torque will be reduced, and vehicle speed will be limited after extended engine operation with this fault code active.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 5491 (DEFLHR)

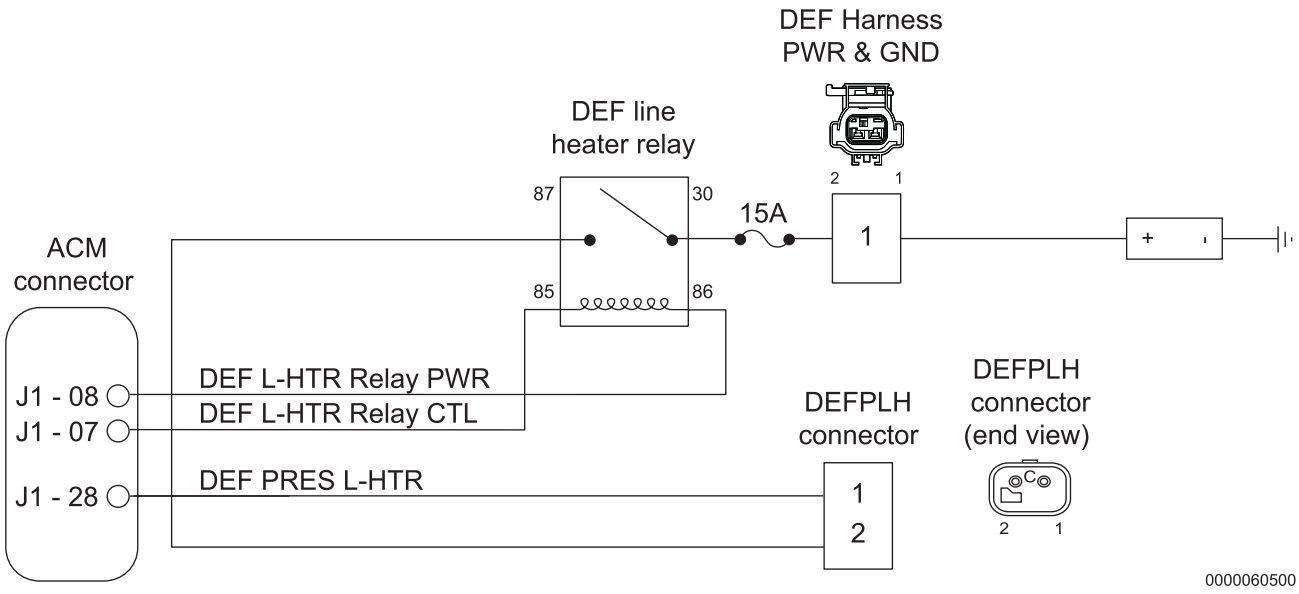
Fault Facts

Diesel Exhaust Fluid Return Line Heater (DEFRLH), DEF Pressure Line Heater (DEFPLH), and DEF Suction Line Heater (DEFSLH) share a common power circuit. If more than one DEF line heater fault is set, suspect a common power circuit problem.

Drive Cycle to Determine Fault Status

Drive Cycle 29 in 2013 HD-OBD Diagnostic Reference Manual.

DEFPLH circuit



Possible Causes

- DEF PRES L-HTR circuit short to power
- Failed Diesel Exhaust Fluid Line Heater Relay (DEFLHR)
- DEF Pressure Line Heater (DEFPLH) PWR circuit shorted to PWR between DEFLHR pin-87 and DEFPLH pin-2

NOTE: DEFRLH, DEFPLH, and DEFSLH share a common power circuit. If more than one DEF line heater fault is set, suspect a common power circuit problem.

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 5491 (DEFLHR). Is EST DTC list free of SPN 5491?	Yes: Go to step 2. No: Repair SPN 5491. After repairs are complete, retest for SPN 4344 FMI 3.

Step	Action	Decision
2	Inspect connections at Diesel Exhaust Fluid Pressure Line Heater (DEFPLH). Key OFF, disconnect DEFPLH. Check DEFPLH and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DEFPLH connector, harness, and terminals clean and undamaged?	Yes: Go to step 3. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 4344 FMI 3.

Step	Action	Decision
3	Determine if DEF PRES L-HTR circuit is shorted to power. Connect Breakout Harness 18-047-01 to vehicle harness and leave DEFPLH disconnected. Key ON, use a DMM to measure voltage between Breakout Harness pin-1 and a known good ground. Is Breakout Harness pin-1 voltage 0.5 volts or less?	Yes: Go to step 4. No: Repair short to PWR between Aftertreatment Control Module (ACM) pin J1-28 and DEFPLH connector pin-1. After repairs are complete, retest for SPN 4344 FMI 3.

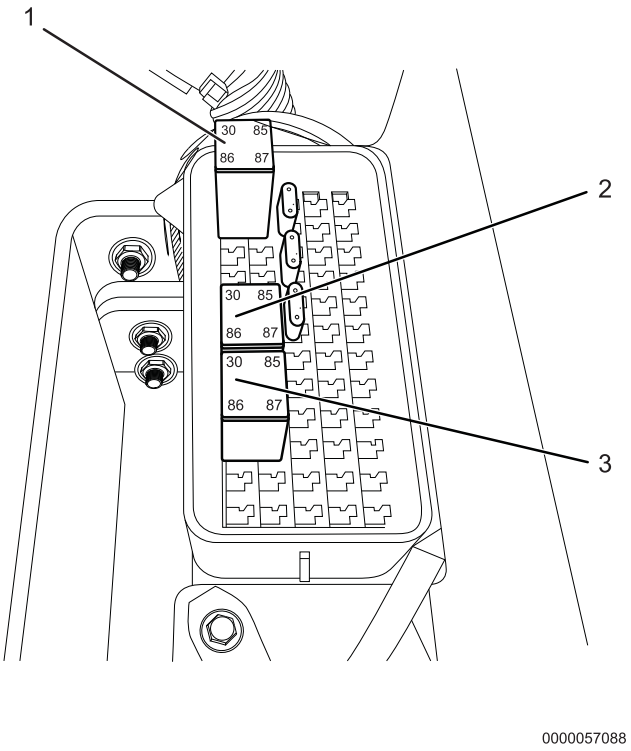


Figure 265 Power Distribution Module (PDM) Fuses and Relays

1. DEF Line Heater Relay
2. DEF Unit HTR Relay
3. Switched Ignition Relay

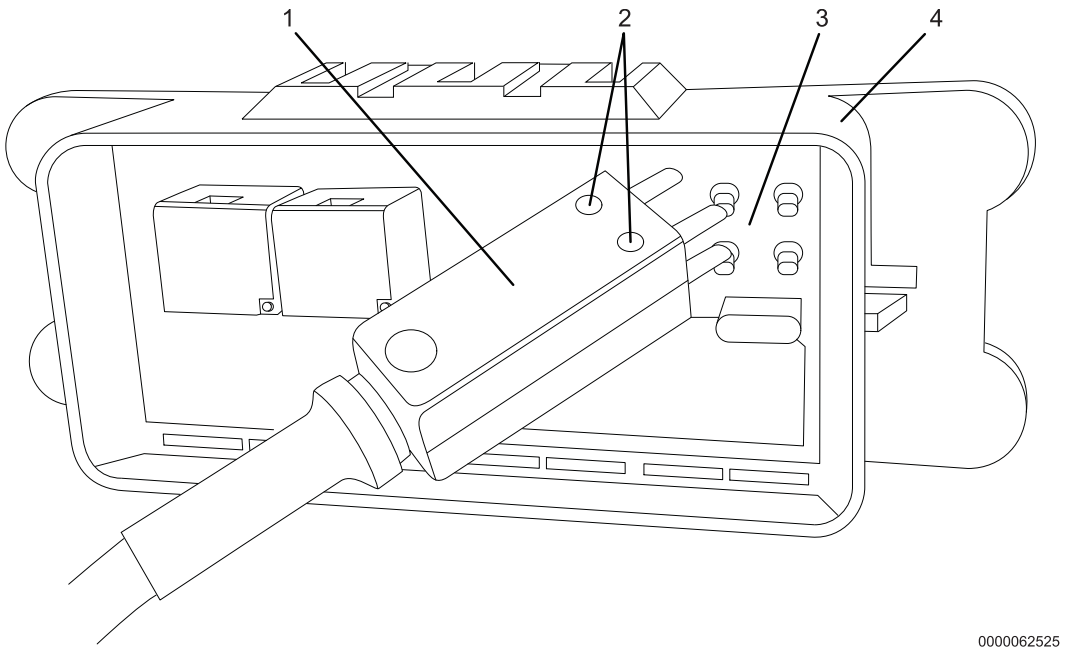


Figure 266 Installation of Breakout Harness ZTSE4908 (typical)

1. Breakout Harness ZTSE4908
2. Dimples
3. Relay socket
4. Power Distribution Module (PDM)

CAUTION: For correct diagnosis, Breakout Harness ZTSE4908 MUST be installed with the dimples toward the top of the PDM. Reversed installation WILL result in incorrect measurements.

Step	Action	Decision
4	Determine if DEF Line Heater Relay (DEFLHR) has failed. Key OFF, remove DEFLHR and install Breakout Harness ZTSE4908, leaving relay disconnected. Key ON, measure voltage at Power Distribution Module (PDM) terminal 87 for the DEFLHR. Is PDM terminal 87 for DEFLHR voltage 0.5 volts or more?	Yes: Repair short to power between PDM terminal 87 for the DEFLHR and the DEFPLH connector pin-2. After repairs are complete, retest for SPN 4344 FMI 3.
		No: Replace the DEFLHR. After repairs are complete, retest for SPN 4344 FMI 3.

NOTE: After performing all diagnostic steps, if SPN 4344 FMI 3 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 4344 FMI 5 - Diesel Exhaust Fluid Line 1 Heater Circuit (DEFL1HC) Open load / circuit

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Exhaust Fluid Pressure Line Heater (DEFPLH) circuit Open. Current less than expected.	DEFPLH current < 0.3 A	Key ON The DEF Line Heater Relay (DEFLHR) command ON.	3 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects current from the Diesel Exhaust Fluid Pressure Line Heater (DEFPLH) is less than 0.3 amps. Engine torque will be reduced and vehicle speed will be limited after extended engine operation with this fault code active.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 5491 (DEFLHR)

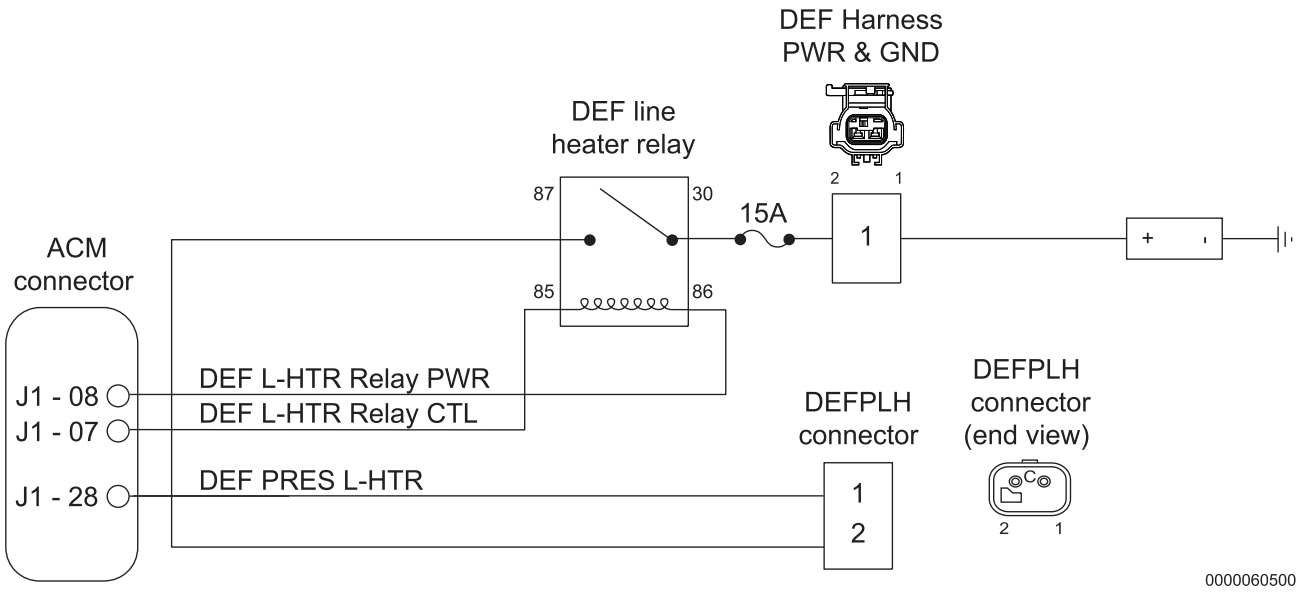
Fault Facts

Diesel Exhaust Fluid Return Line Heater (DEFRLH), DEF Pressure Line Heater (DEFPLH), and DEF Suction Line Heater (DEFSLH) share a common power circuit. If more than one DEF line heater fault is set, suspect a common power circuit problem.

Drive Cycle to Determine Fault Status

Drive cycle 29 in 2013 HD-OBD Diagnostic Reference Manual.

DEFPLH circuit



Possible Causes

- Failed Diesel Exhaust Fluid Press Line Heater (DEFPLH)
- DEF Press L-HTR circuit Open or high resistance
- DEF Press L-HTR circuit short to GND
- DEFPLH power circuit Open or high resistance
- DEFPLH power circuit short to GND
- Blown fuse or Open power circuit to DEF Line Heater Relay (DEFLHR)
- Failed DEFLHR

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 5491 (DEFLHR). Is EST DTC list free of SPN 5491?	Yes: Go to step 2. No: Repair SPN 5491. After repairs are complete, retest for SPN 4344 FMI 5.

Step	Action	Decision
2	Inspect connections at Diesel Exhaust Fluid Pressure Line Heater (DEFPLH). Key OFF, disconnect DEFPLH. Check DEFPLH and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DEFPLH connector, harness, and terminals clean and undamaged?	Yes: Go to step 3. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 4344 FMI 5.

NOTE: Verify batteries are fully charged and connections are clean.

Step	Action	Decision
3	Determine if DEFPLH is receiving power. Connect Breakout Harness 18-047-01 to vehicle harness and leave DEFPLH disconnected. Using EST with ServiceMaxx software, select Tests > KOEO Aftertreatment Tests > DEF Line Heater Test. Run test and measure voltage between Breakout Harness pin-2 and a known good ground. Is voltage within 0.5 volts of battery voltage?	Yes: Go to step 9. No: Go to step 4.

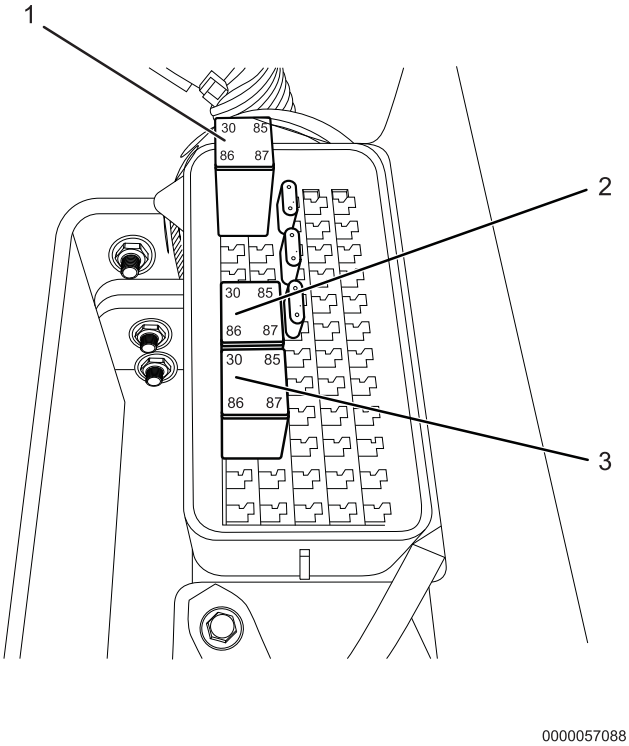


Figure 268 Power Distribution Module (PDM) Fuses and Relays

1. DEF Line Heater Relay
2. DEF Unit HTR Relay
3. Switched Ignition Relay

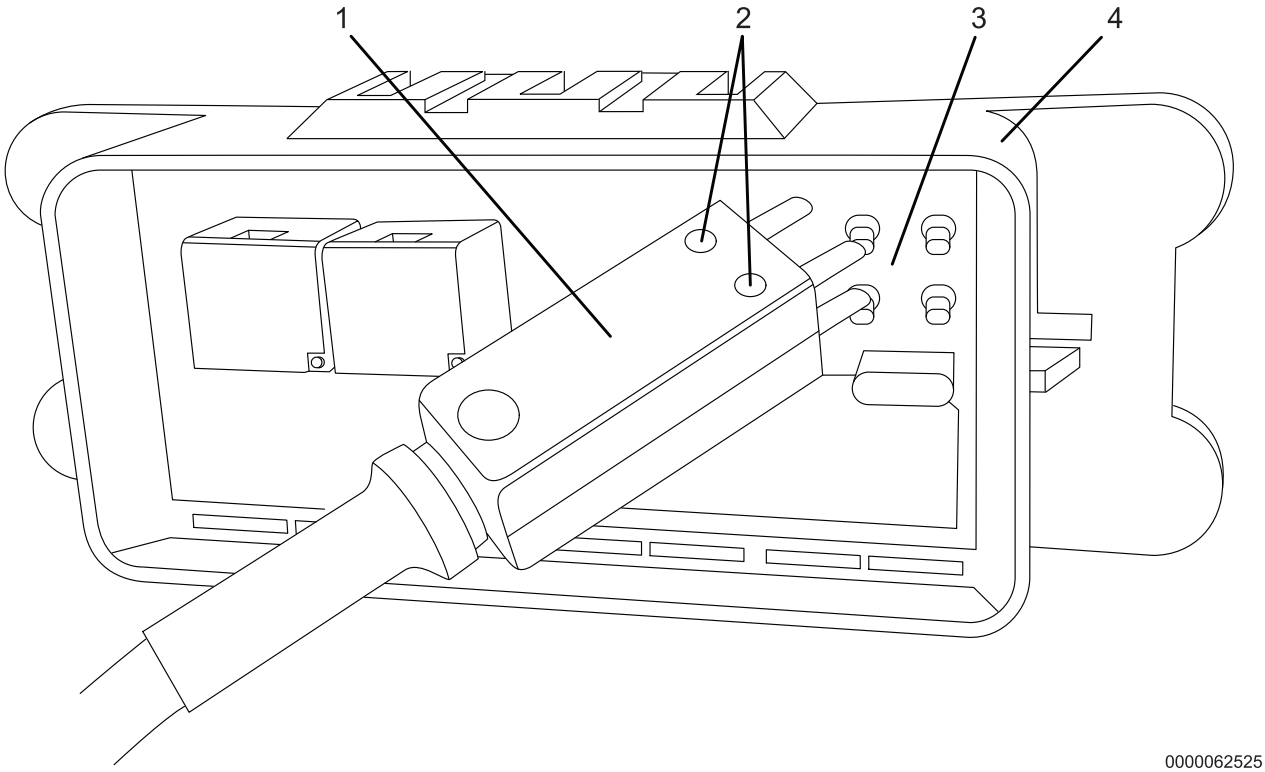


Figure 269 Installation of Breakout Harness ZTSE4908 (typical)

1. Breakout Harness ZTSE4908
2. Dimples
3. Relay socket
4. Power Distribution Module (PDM)

CAUTION: For correct diagnosis, Breakout Harness ZTSE4908 MUST be installed with the dimples toward the top of the PDM. Reversed installation WILL result in incorrect measurements.

Step	Action	Decision
4	Test DEFLHR PWR circuit and fuse. Remove DEFLHR. Install Breakout Harness ZTSE4908 and leave DEFLHR disconnected. Connect test light between breakout harness pin-30 and known good ground. Does test light illuminate and is the fuse in good condition and not blown?	Yes: Go to step 8. No: Go to step 5.

Step	Action	Decision
5	Check for PWR at DEFLHR 15 amp fuse. KOEO, using a DMM check for voltage between vehicle side of DEFLHR 15 amp fuse and a known good ground. Is voltage within 0.5 volts of battery voltage.	Yes: Got to step 6.
		No: Repair Open between DEFLHR 15 amp fuse and vehicle PWR. After repairs are complete retest for SPN 4344 FMI 5.

Step	Action	Decision
6	With DEFPLH disconnected. Replace DEFLHR 15 amp fuse. Does the DEFLHR 15 amp fuse blow immediately when replaced?	Yes: Repair short to GND between DEFLHR 15 amp fuse and DEFLHR pin-30. After repairs are complete, retest for SPN 4344 FMI 5.
		No: Go to step 7.

Step	Action	Decision
7	Check for short to GND between DEFLHR pin-87 and DEFPLH. Install DEFLHR. Using Electronic Service Tool (EST) with ServiceMaxx™ software, select KOEO Aftertreatment Tests > DEF Line Heater Test. Run DEF Line Heater Test. Inspect to see if DEFLHR 15 amp fuse blows when DEF line heaters are actuated ON. Does the DEFLHR 15 amp fuse blow when DEF line heaters are actuated ON?	Yes: Repair short to GND between DEFLHR pin-87 and DEFPLH, DEF Suction Line Heater (DEFSLH), or DEF Return Line Heater (DEFRLH). After repairs are complete, retest for SPN 4344 FMI 5.
		No: Repair Open or high resistance between DEFLHR pin-87 and DEFPLH, DEF Suction Line Heater (DEFSLH), or DEF Return Line Heater (DEFRLH). After repairs are complete, retest for SPN 4344 FMI 5.

Step	Action	Decision
8	Check for Open or high resistance circuit between DEFPLH connector pin-2 and DEFLHR pin-87. Connect Breakout Harness 18-047-01 to vehicle harness and leave DEFPLH disconnected. Key OFF, with Breakout Harness ZTSE4908 connected to Power Distribution Module (PDM) and DEFLHR disconnected, measure resistance between Breakout Harness ZTSE4908 pin-87 and Breakout Harness 18-047-01 pin-2. Is resistance less than 5 ohms?	Yes: Replace the DEFLHR. After repairs are complete, retest for SPN 4344 FMI 5.
		No: Repair Open or high resistance between DEFPLH pin-2 and DEFLHR pin-87. After repairs are complete, retest for SPN 4344 FMI 5.

Step	Action	Decision
9	Inspect connections at Aftertreatment Control Module (ACM). Key OFF, disconnect ACM. Check ACM and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the ACM connector, harness, and terminals clean and undamaged?	Yes: Go to step 10. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 4344 FMI 5.

Step	Action	Decision
10	Measure for Open or high resistance in DEF PRES L-HTR circuit. Connect 180-pin Breakout Box with Breakout Harness 18-100-01 to vehicle harness and leave ACM disconnected. Key OFF, with Breakout Harness 18-047-01 connected to vehicle harness and DEFPLH disconnected, measure resistance between Breakout Harness 18-100-01 pin J1-28 and Breakout Harness 18-047-01 pin-1. Is resistance less than 5 ohms?	Yes: Go to step 11. No: Repair Open or high resistance between ACM connector pin J1-28 and DEFPLH connector pin-1. After repairs are complete, retest for SPN 4344 FMI 5.

Step	Action	Decision
11	Measure for short to GND in DEF PRES L-HTR circuit with ACM disconnected. Key OFF, with Breakout Harness 18-047-01 connected to vehicle harness and DEFPLH disconnected. Measure resistance between Breakout Harness 18-047-01 pin-1 and a known good ground. Is resistance greater than 1000 ohms?	Yes: Replace DEFPLH. After repairs are complete, retest for SPN 4344 FMI 5. No: Repair short to GND between ACM connector pin J1-28 and DEFPLH connector pin-1. After repairs are complete, retest for SPN 4344 FMI 5.

NOTE: After performing all diagnostic steps, if SPN 4344 FMI 5 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

DEFRLH (Diesel Exhaust Fluid Return Line Heater)

SPN	FMI	Condition	Possible Causes	Actions
4342	3	DEFL2HC short to PWR	• DEF RTN L-HTR circuit short to power • Failed Diesel Exhaust Fluid Line Heater Relay (DEFLHR) • DEF Return Line Heater (DEFRLH) PWR circuit shorted to PWR between DEFLHR pin-87 and DEFRLH pin-2	Step-Based Diagnostics (page 687)
4342	5	DEFL2HC open load / circuit	• Failed Diesel Exhaust Fluid Return Line Heater (DEFRLH) • DEF RTN L-HTR circuit Open or high resistance • DEF RTN L-HTR circuit short to GND • DEFRLH power circuit Open or high resistance • DEFRLH power circuit short to GND • Blown fuse or Open power circuit to DEF Line Heater Relay (DEFLHR)	Step-Based Diagnostics (page 691)

- Failed DEFLHR

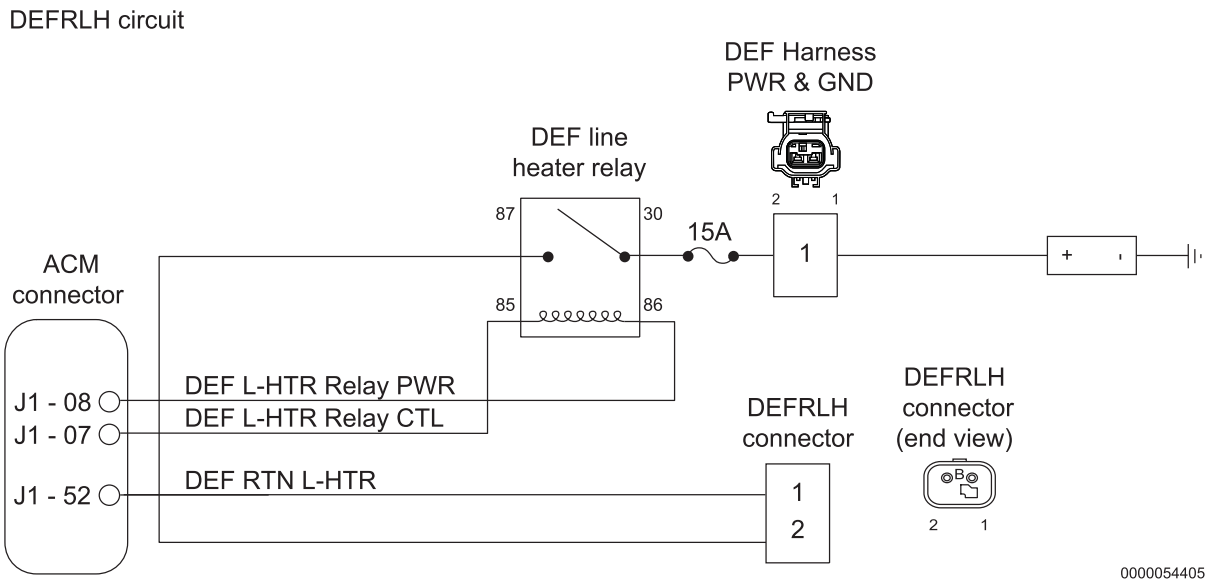


Figure 270 Diesel Exhaust Fluid Return Line Heater (DEFRLH) Circuit Diagram

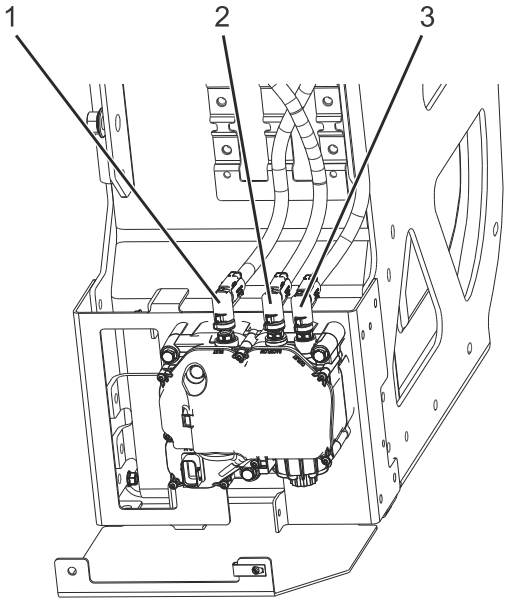
NOTE: See latest version of N13 Engine and Aftertreatment Wiring Schematic Form 0000002203 for additional circuit information.

Overview

The Diesel Exhaust Fluid Return Line Heater (DEFRLH) is used to prevent DEF freezing during cold conditions. The DEFRLH is wrapped around the return line between the DEF tank and the DEF supply module. When DEF temperature is too low, the Aftertreatment Control Module (ACM) turns on the DEF Line Heater Relay (DEFLHR) allowing power to be sent to the DEFRLH.

Tools Required

- 180-Pin Breakout Box 00-00956-08
- ACM Breakout Harness 18-100-01
- Breakout Harness 18-046-01
- Breakout Harness ZTSE4908
- Digital Multimeter (DMM)
- Standard test light
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)



0000054407

Figure 271 DEF Supply Module Line Routing

1. DEF supply module suction line
2. DEF supply module return (backflow) line
3. DEF supply module pressure line

SPN 4342 FMI 3- Diesel Exhaust Fluid Line 2 Heater Circuit (DEFL2HC) Short to PWR

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Exhaust Fluid Return Line Heater (DEFRLH) current greater than expected.	DEFRLH current > 0.5 A	Key ON DEF Line Heater Relay (DEFLHR) command OFF.	3 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects current from the Diesel Exhaust Fluid Return Line Heater (DEFRLH) is greater than 0.5 amps. Engine torque will be reduced and vehicle speed will be limited after extended engine operation with this fault code active.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 5491 (DEFLHR)

Fault Facts

Diesel Exhaust Fluid Return Line Heater (DEFRLH), DEF Pressure Line Heater (DEFPLH), and DEF Suction Line Heater (DEFSLH) share a common power circuit. If more than one DEF line heater fault is set, suspect a common power circuit problem.

Drive Cycle to Determine Fault Status

Drive Cycle 29 in 2013 HD-OBD Diagnostic Reference Manual.

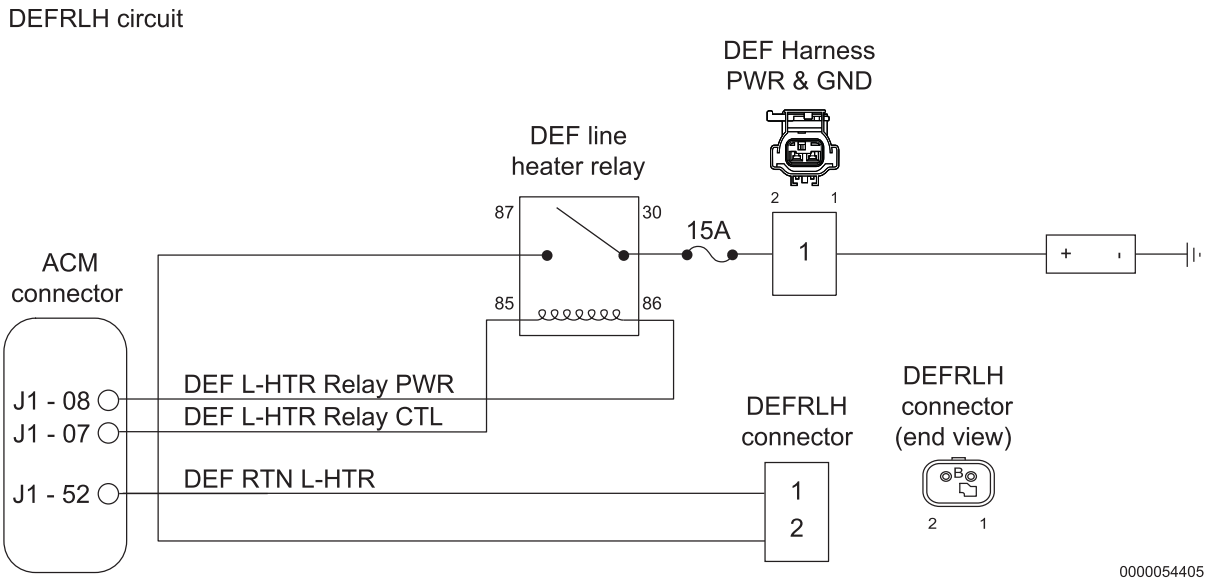


Figure 272 Diesel Exhaust Fluid Return Line Heater (DEFRLH) Circuit Diagram

Possible Causes

- DEF RTN L-HTR circuit short to power
- Failed Diesel Exhaust Fluid Line Heater Relay (DEFLHR)
- DEF Return Line Heater (DEFRLH) PWR circuit shorted to PWR between DEFLHR pin-87 and DEFRLH pin-2

NOTE: DEFRLH, DEF Pressure Line Heater (DEFPLH), and DEF Suction Line Heater (DEFSLH) share a common power circuit. If more then one DEF line heater fault is set, suspect a common power circuit problem.

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 5491 (DEFLHR). Is EST DTC list free of SPN 5491?	Yes: Go to step 2. No: Repair SPN 5491. After repairs are complete, retest for SPN 4342 FMI 3.

Step	Action	Decision
2	Inspect connections at Diesel Exhaust Fluid Return Line Heater (DEFRLH). Key OFF, disconnect DEFRLH. Check DEFRLH and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DEFRLH connector, harness, and terminals clean and undamaged?	Yes: Go to step 3. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 4342 FMI 3.

Step	Action	Decision
3	Determine if DEF RTN L-HTR circuit is shorted to power. Connect Breakout Harness 18-046-01 to vehicle harness and leave DEFRLH disconnected. Key ON, use a DMM to measure voltage between Breakout Harness pin-1 and a known good ground. Is Breakout Harness pin-1 voltage 0.5 volts or less?	Yes: Go to step 4. No: Repair short to PWR between Aftertreatment Control Module (ACM) pin J1-52 and DEFRLH connector pin-1. After repairs are complete, retest for SPN 4342 FMI 3.

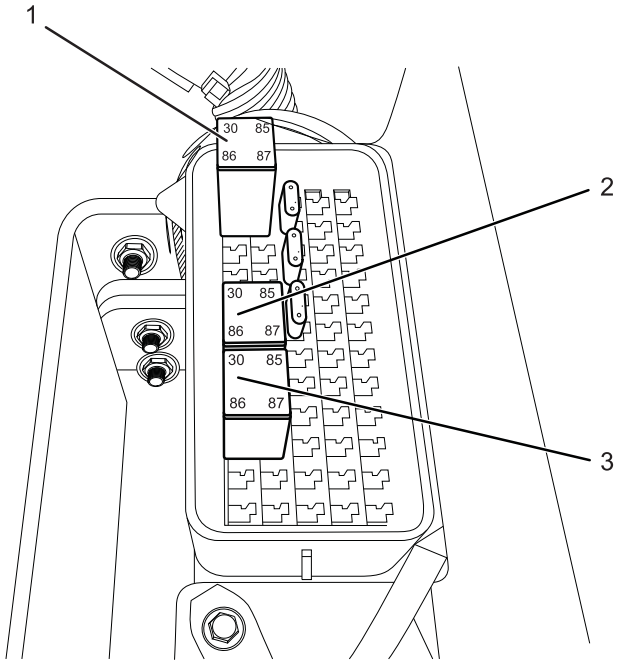


Figure 273 Power Distribution Module (PDM) Fuses and Relays (Typical)

1. DEF Line Heater Relay
2. DEF Unit HTR Relay
3. Switched Ignition Relay

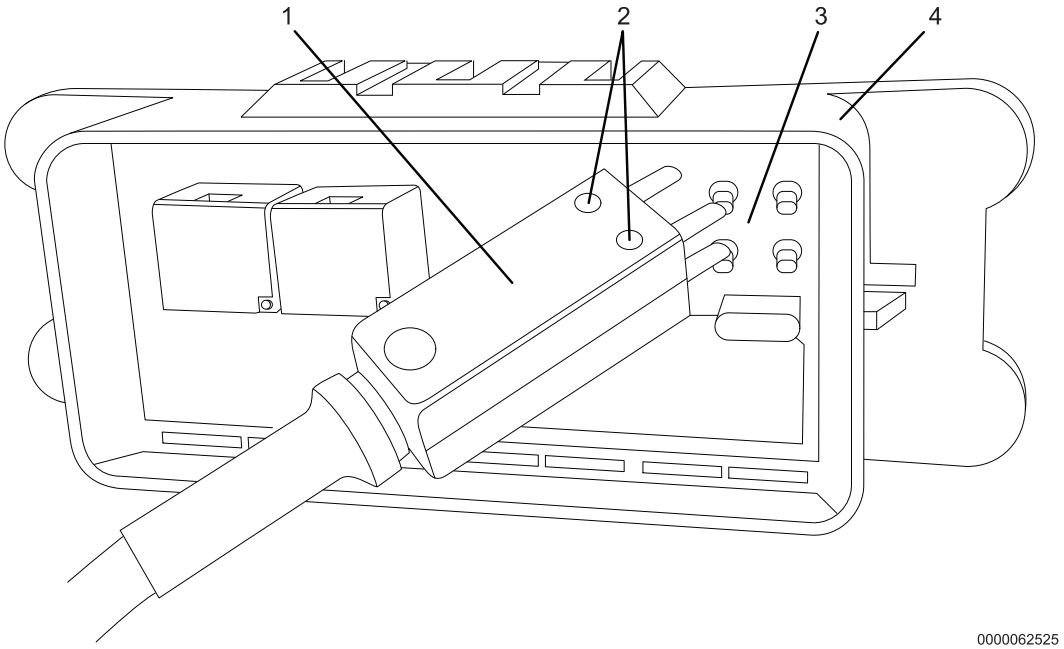


Figure 274 Installation of Breakout Harness ZTSE4908 (typical)

1. Breakout Harness ZTSE4908
2. Dimples
3. Relay socket
4. Power Distribution Module (PDM)

CAUTION: For correct diagnosis, Breakout Harness ZTSE4908 MUST be installed with the dimples toward the top of the PDM. Reversed installation WILL result in incorrect measurements.

Step	Action	Decision
4	Determine if DEFLHR has failed. Key OFF, remove DEFLHR. Install Breakout Harness ZTSE4908, leaving DEFLHR disconnected. Key ON, measure voltage at Power Distribution Module (PDM) terminal 87 for the DEFLHR. Is PDM terminal 87 for DEFLHR voltage 0.5 volts or more?	Yes: Repair short to power between PDM terminal 87 for DEFLHR and the DEFRLH connector pin-2. After repairs are complete, retest for SPN 4342 FMI 3.
		No: Replace the DEFLHR. After repairs are complete, retest for SPN 4342 FMI 3.

NOTE: After performing all diagnostic steps, if SPN 4342 FMI 3 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 4342 FMI 5 - Diesel Exhaust Fluid Line 2 Heater Circuit (DEFL2HC) Open load / circuit

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Exhaust Fluid Return Line Heater (DEFRLH) circuit Open. Current less than expected.	DEFRLH current < 0.3 A	Key ON The DEF Line Heater Relay (DEFLHR) commanded ON.	3 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects current from the Diesel Exhaust Fluid Return Line Heater (DEFRLH) is less than 0.3 amps. Engine torque will be reduced and vehicle speed will be limited after extended engine operation with this fault code active.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 5491 (DEFLHR)

Fault Facts

Diesel Exhaust Fluid Return Line Heater (DEFRLH), DEF Pressure Line Heater (DEFPLH), and DEF Suction Line Heater (DEFSLH) share a common power circuit. If more than one DEF line heater fault is set, suspect a common power circuit problem.

Drive Cycle to Determine Fault Status

Drive cycle 29 in 2013 HD-OBD Diagnostic Reference Manual.

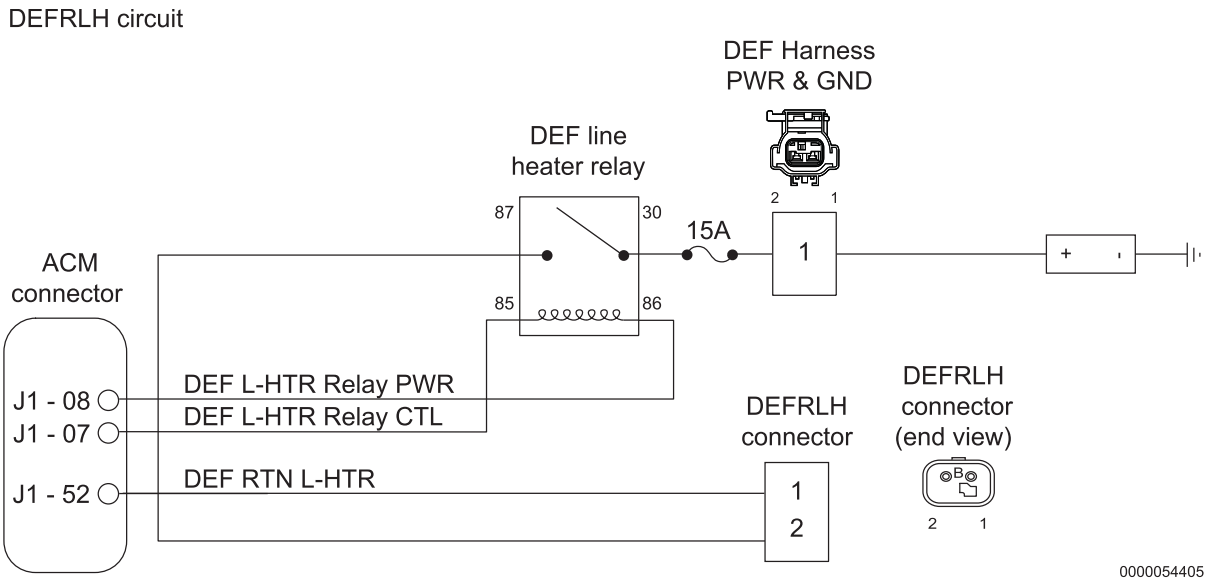


Figure 275 Diesel Exhaust Fluid Return Line Heater (DEFRLH) Circuit Diagram

Possible Causes

- Failed Diesel Exhaust Fluid Return Line Heater (DEFRLH)
- DEF RTN L-HTR circuit Open or high resistance
- DEF RTN L-HTR circuit short to GND
- DEFRLH power circuit Open or high resistance
- DEFRLH power circuit short to GND
- Blown fuse or Open power circuit to DEF Line Heater Relay (DEFLHR)
- Failed DEFLHR

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 5491 (DEFLHR). Is EST DTC list free of SPN 5491?	Yes: Go to step 2. No: Repair SPN 5491. After repairs are complete, retest for SPN 4342 FMI 5.

Step	Action	Decision
2	Inspect connections at Diesel Exhaust Fluid Return Line Heater (DEFRLH). Key OFF, disconnect DEFRLH. Check DEFRLH and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DEFRLH connector, harness, and terminals clean and undamaged?	Yes: Go to step 3. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 4342 FMI 5.

NOTE: Verify batteries are fully charged and connections are clean.

Step	Action	Decision
3	Determine if DEFRLH is receiving power. Connect Breakout Harness 18-046-01 to vehicle harness and leave DEFRLH disconnected. Using EST with ServiceMaxx software, select Tests > KOEO Aftertreatment Tests > DEF Line Heater Test. Run test and measure voltage between Breakout Harness 18-046-01 pin-2 and a known good ground. Is voltage within 0.5 volts of battery voltage?	Yes: Go to step 9. No: Go to step 4.

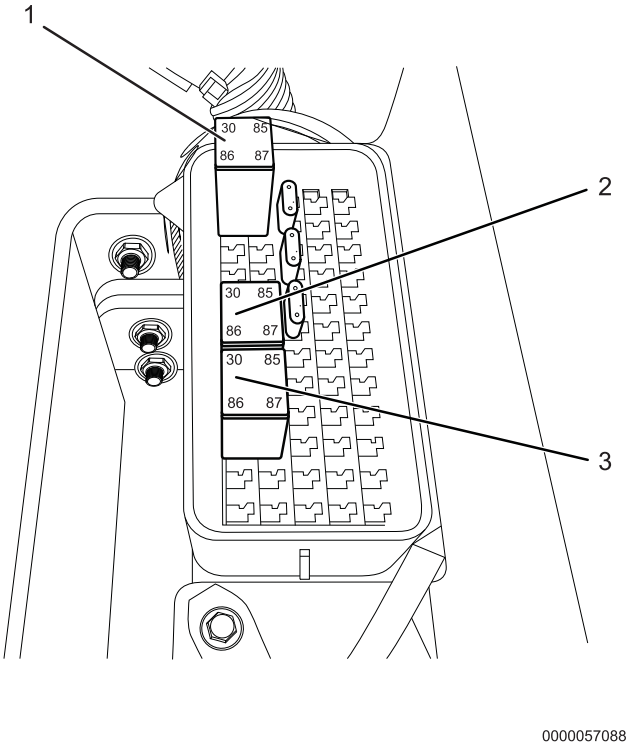


Figure 276 Power Distribution Module (PDM) Fuses and Relays (Typical)

1. DEF Line Heater Relay
2. DEF Unit HTR Relay
3. Switched Ignition Relay

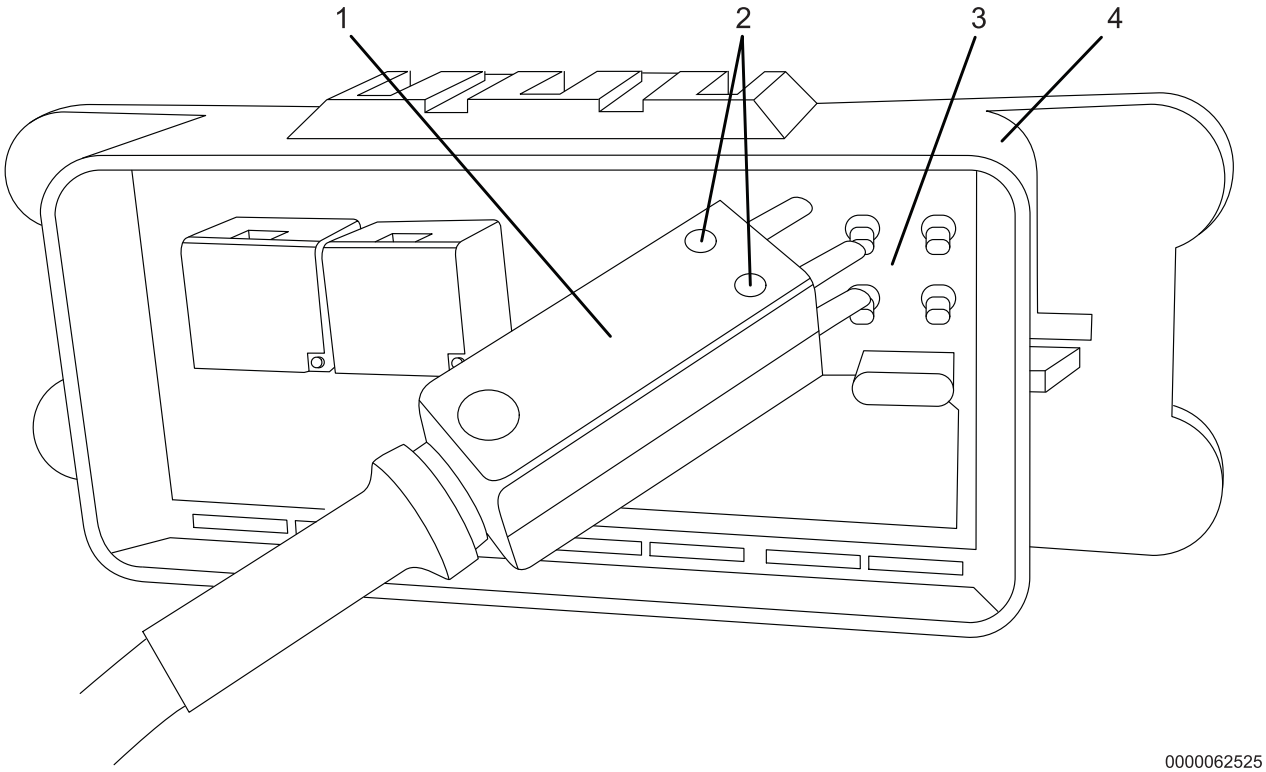


Figure 277 Installation of Breakout Harness ZTSE4908 (typical)

1. Breakout Harness ZTSE4908
2. Dimples
3. Relay socket
4. Power Distribution Module (PDM)

CAUTION: For correct diagnosis, Breakout Harness ZTSE4908 MUST be installed with the dimples toward the top of the PDM. Reversed installation WILL result in incorrect measurements.

Step	Action	Decision
4	Test DEFLHR PWR circuit and fuse. Remove DEFLHR. Install Breakout Harness ZTSE4908 and leave DEFLHR disconnected. Connect test light between a known good ground and pin-30 of the DEFLHR. Does test light illuminate and is DEF line heater relay 15 amp fuse in good condition and not blown?	Yes: Go to step 8. No: Go to step 5.

Step	Action	Decision
5	Check for PWR at DEFLHR 15 amp fuse. KOEO, using a DMM check for voltage between vehicle side of DEFLHR 15 amp fuse and a known good ground. Is voltage within 0.5 volts of battery voltage.	Yes: Got to step 6.
		No: Repair Open or high resistance between DEFLHR 15 amp fuse and vehicle PWR. After repairs are complete retest for SPN 4342 FMI 5.

Step	Action	Decision
6	Check for short to GND between DEF line heater relay 15 amp fuse and DEF line heater relay. With DEF line heater relay disconnected. Remove and Replace DEF line heater relay 15 amp fuse. Does the DEF line heater relay 15 amp fuse blow when replaced?	Yes: Repair short to GND between DEF line heater relay 15 amp fuse and DEF line heater relay pin-30. After repairs are complete, retest for SPN 4342 FMI 5.
		No: Repair short GND between DEF line heater relay and DEFRLH, DEF Pressure Line Heater (DEFPLH), or DEF Suction Line Heater (DEFSLH). After repairs are complete, retest for SPN 4342 FMI 5.

Step	Action	Decision
7	Check for short to GND between DEFLHR pin-87 and DEFRLH. Install DEFLHR. Using Electronic Service Tool (EST) with ServiceMaxx™ software, select KOEO Aftertreatment Tests > DEF Line Heater Test. Run DEF Line Heater Test. Inspect to see if DEFLHR 15 amp fuse blows when DEF line heaters are actuated ON. Does the DEFLHR 15 amp fuse blow when DEF line heaters are actuated ON?	Yes: Repair short GND between DEFLHR pin-87 and DEFRLH, DEF Pressure Line Heater (DEFPLH), or DEF Suction Line Heater (DEFSLH). After repairs are complete, retest for SPN 4342 FMI 5.
		No: Repair Open or high resistance between DEFLHR pin-87 and DEFRLH, DEF Suction Line Heater (DEFSLH), or DEF Pressure Line Heater (DEFRLH). After repairs are complete, retest for SPN 4342 FMI 5.

Step	Action	Decision
8	Check for an Open or high resistance circuit between DEFRLH connector pin-2 and DEFLHR pin-87. Connect Breakout Harness 18-046-01 to vehicle harness and leave DEFRLH disconnected. Key OFF, with Breakout Harness ZTSE4908 connected to Power Distribution Module (PDM), measure resistance between Breakout Harness ZTSE4908 pin-87 and Breakout Harness 18-046-01 pin-2. Is resistance less than 5 ohms?	Yes: Replace the DEFLHR. After repairs are complete, retest for SPN 4342 FMI 5. No: Repair Open or high resistance between DEFRLH pin-2 and DEFLHR pin-87. After repairs are complete, retest for SPN 4342 FMI 5.

Step	Action	Decision
9	Inspect connections at Aftertreatment Control Module (ACM). Key OFF, disconnect ACM. Check ACM and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the ACM connector, harness, and terminals clean and undamaged?	Yes: Go to step 10. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 4342 FMI 5.

Step	Action	Decision
10	Measure for Open or high resistance in DEF RTN L-HTR circuit. Connect 180-pin Breakout Box with Breakout Harness 18-100-01 to vehicle harness and leave ACM disconnected. Key OFF, with Breakout Harness 18-046-01 connected to vehicle harness and DEFRLH disconnected, measure resistance between Breakout Harness 18-100-01 pin J1-52 and Breakout Harness 18-046-01 pin-1. Is resistance less than 5 ohms?	Yes: Go to step 11. No: Repair Open or high resistance between ACM connector pin J1-52 and DEFRLH connector pin-1. After repairs are complete, retest for SPN 4342 FMI 5.

Step	Action	Decision
11	Measure for short to GND in DEF RTN L-HTR circuit with ACM disconnected. Key OFF, with Breakout Harness 18-046-01 connected to vehicle harness and DEFRLH disconnected, measure resistance between Breakout Harness 18-046-01 pin-1 and a known good ground. Is resistance greater than 1000 ohms?	Yes: Replace DEFRLH. After repairs are complete, retest for SPN 4342 FMI 5. No: Repair short to GND between ACM connector pin J1-52 and DEFRLH connector pin-1. After repairs are complete, retest for SPN 4342 FMI 5.

NOTE: After performing all diagnostic steps, if SPN 4342 FMI 5 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

DEFRV (Diesel Exhaust Fluid Return Valve)

SPN	FMI	Condition	Possible Causes	Actions
4376	3	DEF Return Valve short to PWR (Open or high resistance)	• High resistance or open in DEFRV GND circuit • High resistance or open in DEFRV CTL circuit • Short to PWR in DEFRV CTL circuit • Failed DEFRV	Step-Based Diagnostics(page 700)
4376	4	DEF Return Valve short to GND	• Short to GND in DEFRV CTL circuit • DEFRV GND shorted to DEFRV CTL • Failed DEFRV	Step-Based Diagnostics(page 703)
4376	7	DEF Return Valve - Mechanical system not responding or out of adjustment	• Blocked DEF lines or fittings, or incorrect connections • Failed DEFRV • Restriction in DEF tank	Step-Based Diagnostics(page 706)

DEFRV circuit

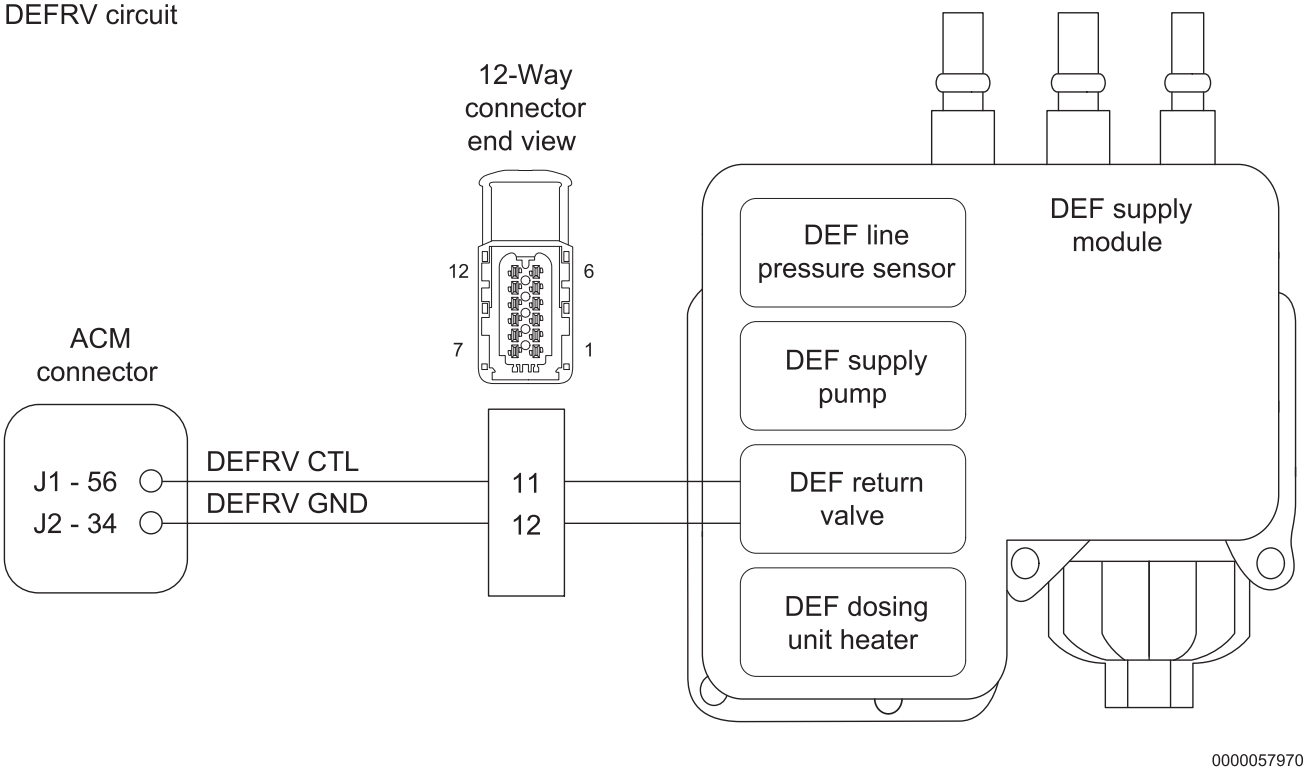


Figure 278 DEFRV Circuit Diagram

NOTE: See latest version of N13 with SCR (EPA 10) with HD-OBD Engine and Aftertreatment Wiring Schematic Form 0000002203 for additional circuit information.

Overview

The Diesel Exhaust Fluid return Valve (DEFRV) controls DEF flow through the DEF supply module. When the DEFRV is energized DEF is returned to the DEF tank through the DEF return line. The DEFRV is not serviceable individually and is part of the DEF supply module.

Tools Required

- 180-Pin Breakout Box 00-00956-08
- ACM Breakout Harness 18-100-01
- Breakout Harness 18-909-01
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

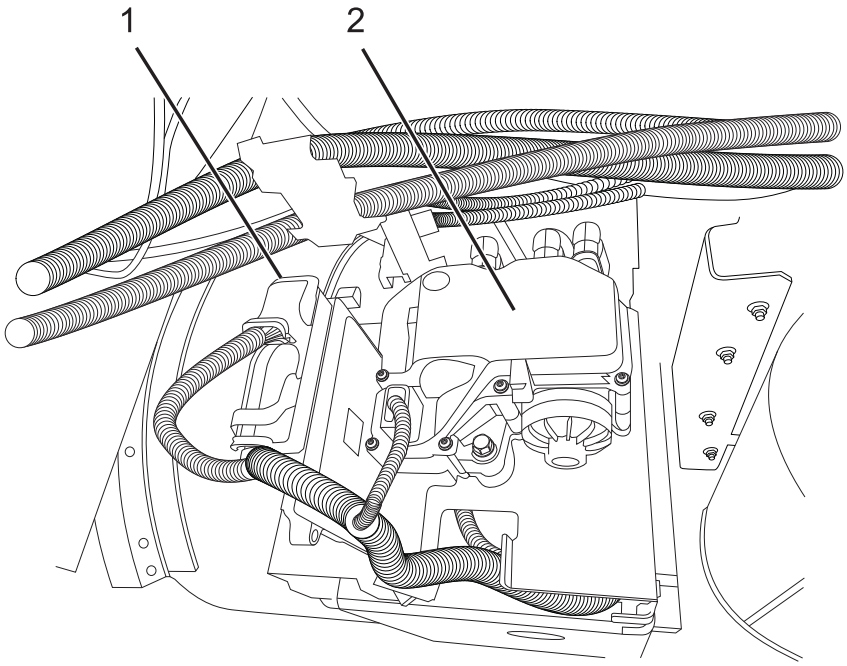


Figure 279 DEF supply module location

1. Aftertreatment Control Module (ACM)
2. DEF supply module

SPN 4376 FMI 3- DEF Return Valve short to PWR (Open or High Resistance)

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Exhaust Fluid Return Valve (DEFRV) voltage above normal, shorted to high source, or Open. High signal voltage detected.	The resistance between the DEFRV CTL circuit and ground > 500,000 Ohms	Key ON DEFRV commanded ON	2 second

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects that the Diesel Exhaust Fluid Return Valve (DEFRV) voltage is more than expected for 1 second. Engine torque will be reduced if the engine is operated for an extended period of time with this fault active.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Fault Fact

The Diesel Exhaust Fluid Return Valve (DEFRV) is internal to the DEF supply module and is not serviceable individually. If fault is active, the dosing system may not be able to purge, and DEF may be left in the lines. DEF remaining in the lines can freeze and cause the Selective Catalytic Reduction (SCR) system to become damaged in cold weather.

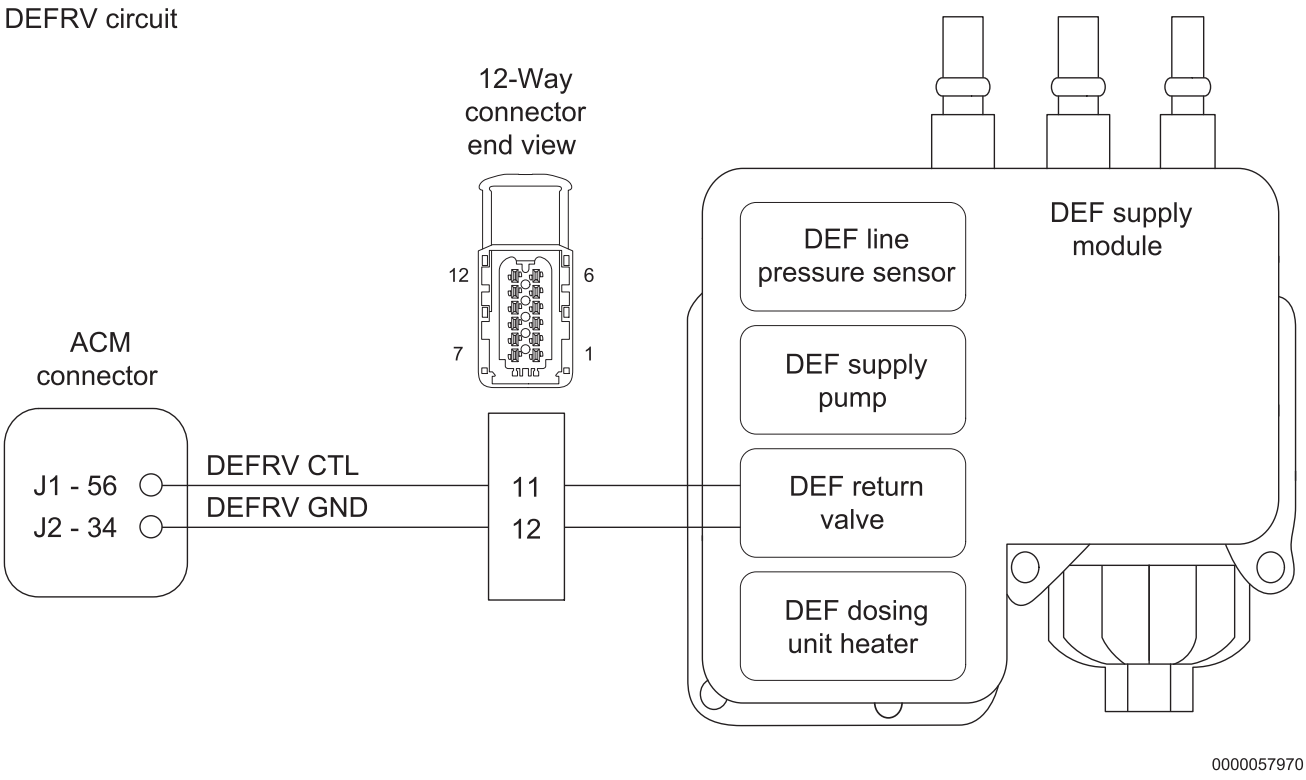


Figure 280 DEFRV Circuit Diagram

Possible Causes

- High resistance or Open in DEFRV CTL circuit
- High resistance or Open in DEFRV GND circuit
- Short to PWR in DEFRV CTL circuit
- Failed DEFRV

Step	Action	Decision
1	Inspect connections at Diesel Exhaust Fluid (DEF) supply module. Key OFF, disconnect DEF supply module connector. Check DEF supply module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DEF supply module connector, harness, and terminals clean and undamaged?	Yes: Go to step 2. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 4376 FMI 3.

Step	Action	Decision
2	Check for failed Diesel Exhaust Fluid Return Valve (DEFRV). Key OFF, connect Breakout Harness 18-909-01 to DEF supply module, and leave vehicle harness disconnected. Measure resistance between DEFRV CTL pin-11 and DEFRV GND pin-12. Is resistance between 5 and 10 ohms?	Yes: Go to step 3. No: Replace DEF supply module. After repairs are complete, retest for SPN 4376 FMI 3.

Step	Action	Decision
3	Check DEFRV CTL for short to PWR. Connect Breakout Harness 18-909-01 between DEF supply module and vehicle harness. Key-On Engine-Off (KOEO) measure voltage between DEFRV CTL pin-11 and a known good ground. Is voltage less than 0.5 volts?	Yes: Go to step 4. No: Repair short to power in DEFRV CTL circuit. After repairs are complete, retest for SPN 4376 FMI 3.

Step	Action	Decision
4	Inspect connections at Aftertreatment control module (ACM). Key OFF, disconnect ACM connector. Check ACM and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the ACM connector, harness, and terminals clean and undamaged?	Yes: Go to step 5. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 4376 FMI 3.

Step	Action	Decision
5	Check DEFRV CTL circuit for high resistance or Open. Connect 180-pin Breakout Box with Breakout Harness 18-100-01 to ACM vehicle harness, and leave ACM disconnected. Disconnect Breakout Harness 18-909-01 from DEF supply module, and leave connected to vehicle harness. Use a DMM to measure resistance from Breakout Harness 18-909-01 pin-12 and 180-pin Breakout Box pin J2-34. Is resistance less than 5 ohms?	Yes: Repair Open or high resistance in DEFRV CTL circuit between ACM J1-56 and supply module pin-11. After repairs are complete, retest for SPN 4376 FMI 3. No: Repair Open or high resistance in DEFRV GND circuit between ACM J2-34 and supply module pin-12. After repairs are complete, retest for SPN 4376 FMI 3.

NOTE: After performing all diagnostic steps, if SPN 4376 FMI 3 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 4376 FMI 4- DEF Return Valve short to GND

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Exhaust Fluid Return Valve (DEFRV) - Voltage below normal, or shorted to low source. Low signal voltage detected.	Resistance between DEFRV CTL and GND < 0.2 ohms	Key ON DEFRV commanded ON	2 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects Diesel Exhaust Fluid Return Valve (DEFRV) voltage is less than expected value for 1 second. Diesel Exhaust Fluid (DEF) injection into the aftertreatment system is disabled. Engine torque will be reduced if the engine is operated for an extended period of time with this fault active.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Fault Fact

The DEFRV is internal to the DEF supply module and is not serviceable individually. If fault is active, the dosing system may not be able to purge and DEF may be left in the lines. DEF lines can freeze and cause the Selective Catalytic Reduction (SCR) system to become damaged in cold weather.

DEFRV circuit

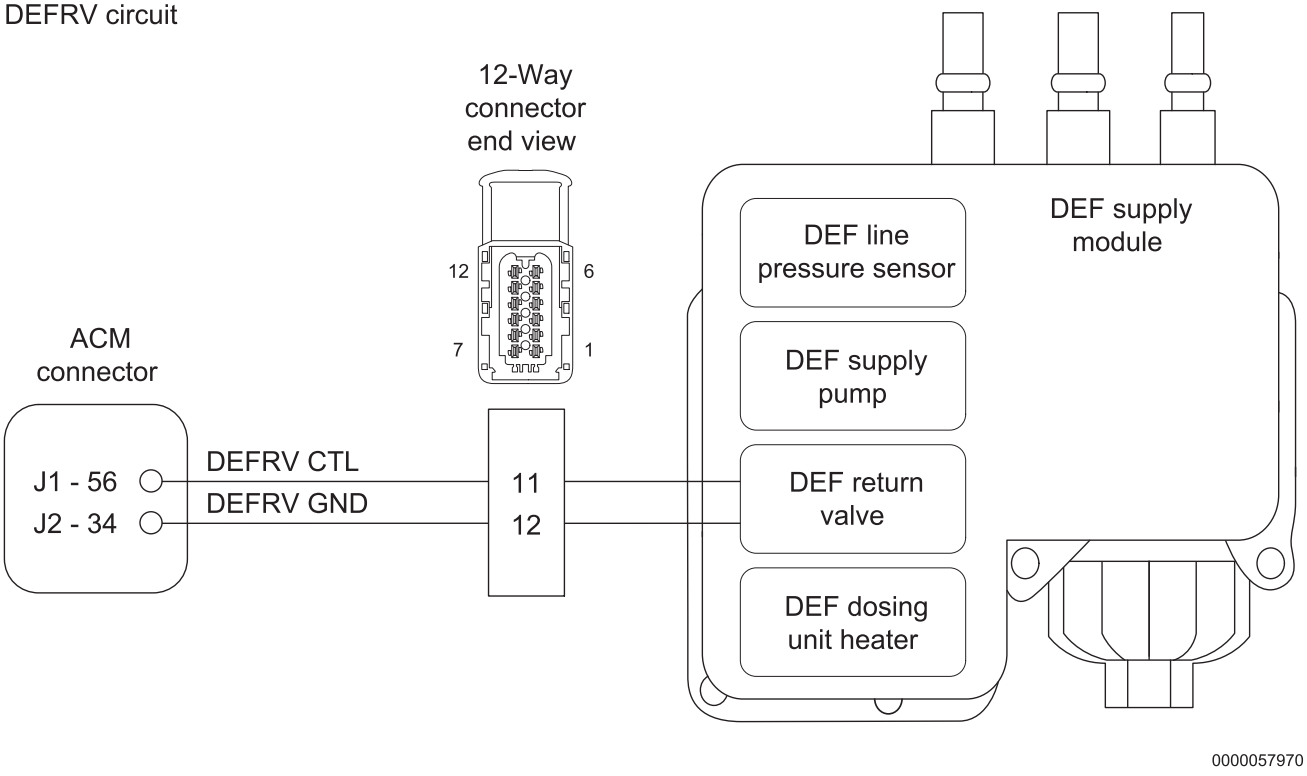


Figure 281 DEFRV Circuit Diagram

Possible Causes

- Short to GND in DEFRV CTL circuit
- DEFRV CTL shorted to DEFRV GND
- Failed DEFRV

Step	Action	Decision
1	Check for failed Diesel Exhaust Fluid Return Valve (DEFRV). Connect Breakout Harness 18-909-01 to DEF supply module, and leave vehicle harness disconnected. Measure resistance between DEFRV CTL pin-11 and DEFRV GND pin-12. Is resistance greater than 5 ohms?	Yes: Go to step 2. No: Replace DEF supply module. After repairs are complete, retest for SPN 4376 FMI 4.

Step	Action	Decision
2	Check for short between DEFRV CTL and DEFRV GND circuits. Connect Breakout Harness 18-909-01 and leave DEF supply module disconnected. Key OFF, measure resistance between Breakout Harness pin-11 and pin-12. Is resistance greater than 1000 ohms?	Yes: Repair short to GND between DEFRV pin-11 and ACM pin J1-56. After repairs are complete, retest for SPN 4376 FMI 4.
		No: Repair short between DEFRV CTL and DEFRV GND circuits. After repairs are complete, retest for SPN 4376 FMI 4.

NOTE: After performing all diagnostic steps, if SPN 4376 FMI 4 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 4376 FMI 7- DEF Return Valve - Mechanical system not responding or out of adjustment

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
The DEFRV is commanded open, but the DEF doser pressure does not drop as expected.	The DEF supply module pressure after the return valve is opened for 5 seconds > 72.5 psi (500 kPa)	Key ON Inactive: SPN 3361 FMI 3, 4 (DEFSP); SPN 4334 FMI 2, 3, 4 (DEFLP); SPN 4376 FMI 3, 4 (DEFRV) DEF supply pump command ≥ 5 % (pump ON) DEF supply module pressure sampled when the return valve was opened > 101.5 psi (700 kPa) DEFRV commanded ON	0 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects that the Diesel Exhaust Fluid Return Valve (DEFRV) is commanded open, but the DEF doser pressure does not drop as expected.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 4334 FMI 2, 3, 4, 16, and 18 (DEFLP); and SPN 4376 FMI 3 and 4 (DEFRV)

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Fault Fact

The DEFRV is internal to the DEF supply module and is not serviceable individually. If fault is active, the dosing system may not be able to purge, and DEF may be left in the lines. DEF lines can freeze and cause the Selective Catalytic Reduction (SCR) system to become damaged in cold weather.

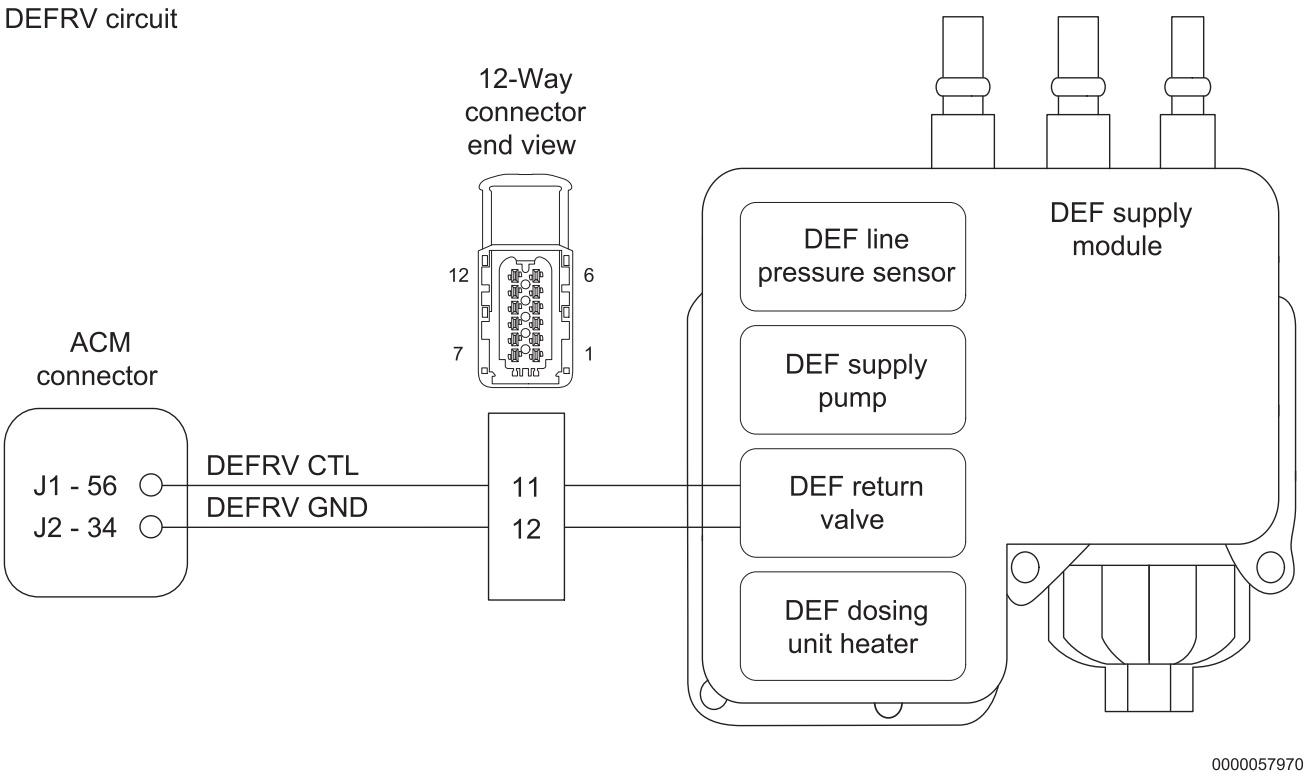


Figure 282 DEFRV Circuit Diagram

Possible Causes

- Restricted DEF return line or fittings, or incorrect connections
- Restriction in DEF tank
- Failed DEFRV

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check for SPN 4334 FMI 2, 3, 4, 16, and 18 (DEFLP); and SPN 4376 FMI 3 and 4 (DEFRV). Is EST DTC list free of SPN 4334 FMI 2, 3, 4, 16, and 18; and SPN 4376 FMI 3 and 4?	Yes: Go to step 2. No: Repair SPN 4334 FMI 2, 3, 4, 16, and 18; and SPN 4376 FMI 3 and 4. After repairs are complete, retest for SPN 4376 FMI 7.

Step	Action	Decision
2	Check DEF supply module return line for restrictions. Disconnect both ends of return line and blow compressed air through the line. Does compressed air flow freely through the return line?	Yes: Go to step 3. No: Clean or replace DEF supply module return line. After repairs are complete, retest for SPN 4376 FMI 7.

Step	Action	Decision
3	Check Diesel Exhaust Fluid (DEF) tank for debris, foreign particles, or ice. Also check DEF tank vent for restrictions or fluid crystallization. Are the DEF tank and DEF tank vent clean and free of debris, restrictions, and fluid crystallization?	Yes: Replace DEF supply module. After repairs are complete, retest for SPN 4376 FMI 7.
		No: Drain the DEF tank, flush with distilled water, and fill with new and / or known good DEF. Clean DEF supply module using 18-200-01. After repairs are complete, retest for SPN 4376 FMI 7.

NOTE: After performing all diagnostic steps, if SPN 4376 FMI 7 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

DEFSLH (Diesel Exhaust Fluid Suction Line Heater)

SPN	FMI	Condition	Possible Causes	Actions
4340	3	DEFL3HC short to PWR	• DEF Suction L-HTR circuit short to power • Failed Diesel Exhaust Fluid Line Heater Relay (DEFLHR) • DEF Suction Line Heater (DEFSLH) PWR circuit shorted to PWR between DEFLHR pin-87 and DEFSLH pin-2	Step-Based Diagnostics (page 712)
4340	5	DEFL3HC open load / circuit	• Failed Diesel Exhaust Fluid Suction Line Heater (DEFSLH) • DEF Suction L-HTR circuit Open or high resistance • DEF Suction L-HTR circuit short to GND • DEFSLH power circuit Open or high resistance • DEFSLH power circuit short to GND • Blown fuse or Open power circuit to DEF Line Heater Relay (DEFLHR)	Step-Based Diagnostics (page 716)

- Failed DEFLHR

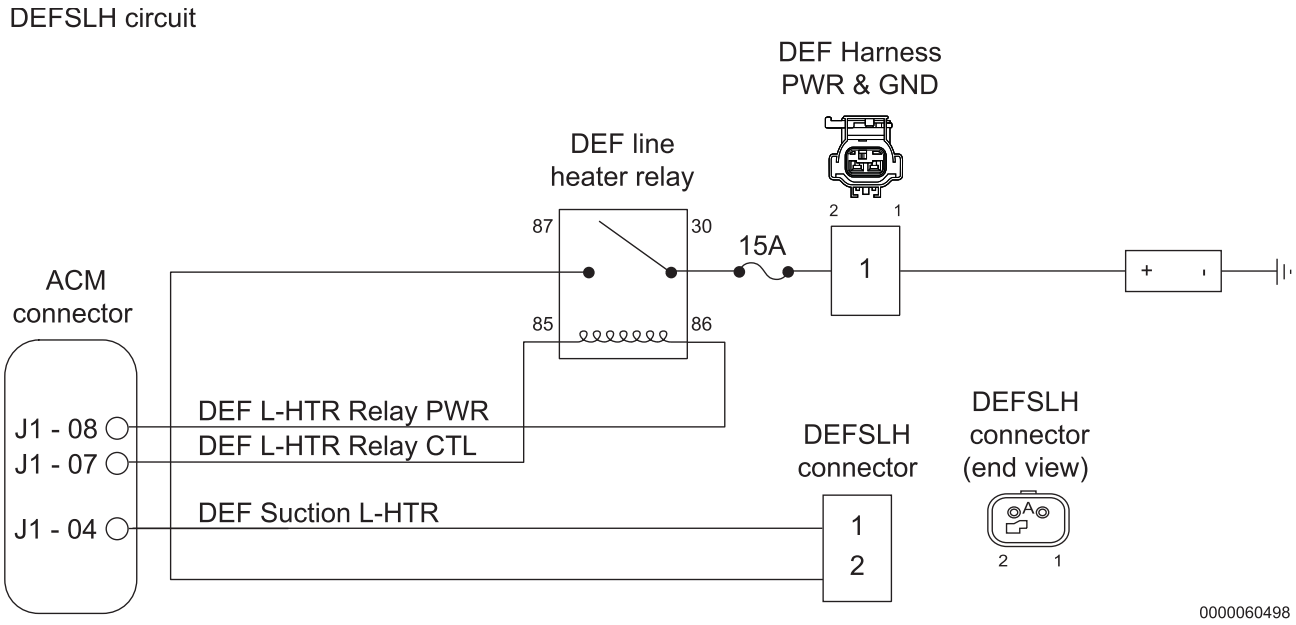


Figure 283 DEFSLH Circuit Diagram

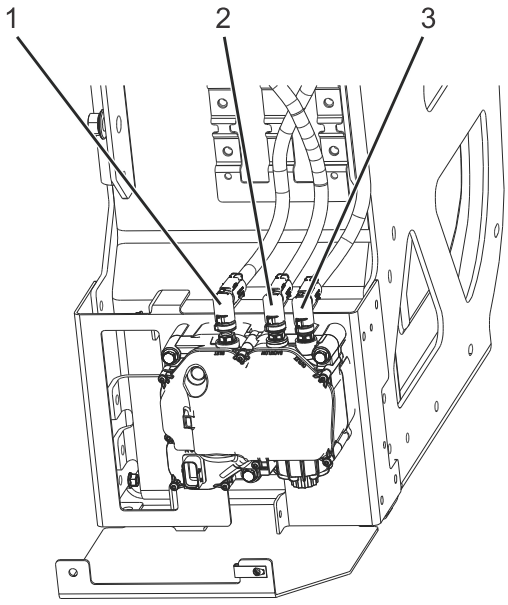
NOTE: See latest version of N13 Engine and Aftertreatment Wiring Schematic Form 0000002203 for additional circuit information.

Overview

The Diesel Exhaust Fluid Suction Line Heater (DEFSLH) is used to maintain proper DEF temperature during cold conditions. The DEFSLH is wrapped around the suction line between DEF tank and the DEF supply module. When DEF temperature is too low, the Aftertreatment Control Module (ACM) turns on the DEF Line Heater Relay (DEFLHR) allowing power to be sent to the DEFSLH.

Tools Required

- 180-Pin Breakout Box 00-00956-08
- ACM Breakout Harness 18-100-01
- Breakout Harness 18-045-01
- Breakout Harness ZTSE4908
- Digital Multimeter (DMM)
- Standard test light
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)



0000054407

Figure 284 DEF Supply Module Line Routing

1. DEF supply module suction line
2. DEF supply module return (backflow) line
3. DEF supply module pressure line

SPN 4340 FMI 3- Diesel Exhaust Fluid Line 3 Heater Circuit (DEFL3HC) Short to PWR

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Exhaust Fluid Suction Line Heater (DEFSLH) current is greater than expected.	DEFSLH current > 0.5 A	Key ON The DEF Line Heater Relay (DEFLHR) command OFF.	3 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects current from the Diesel Exhaust Fluid Suction Line Heater (DEFSLH) is greater than 0.5 amps. Engine torque will be reduced, and vehicle speed will be limited after extended engine operation with this fault code active.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 5491 (DEFLHR)

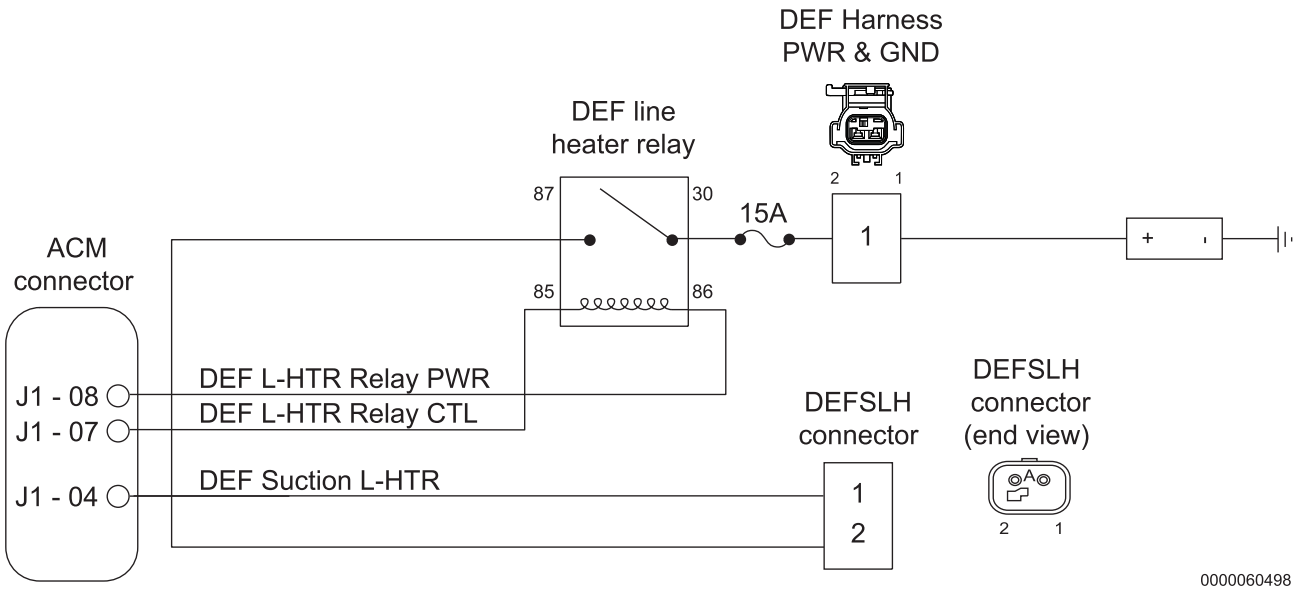
Fault Facts

Diesel Exhaust Fluid Return Line Heater (DEFRLH), DEF Pressure Line Heater (DEFPLH), and DEF Suction Line Heater (DEFSLH) share a common power circuit. If more than one DEF line heater fault is set, suspect a common power circuit problem.

Drive Cycle to Determine Fault Status

Drive Cycle 29 in 2013 HD-OBD Diagnostic Reference Manual.

DEFSLH circuit



Possible Causes

- DEF Suction L-HTR circuit short to power
- Failed Diesel Exhaust Fluid Line Heater Relay (DEFLHR)
- DEF Suction Line Heater (DEFSLH) PWR circuit shorted to PWR between DEFLHR pin-87 and DEFSLH pin-2

NOTE: DEFRLH, DEFPLH, and DEFSLH share a common power circuit. If more than one DEF line heater fault is set, suspect a common power circuit problem.

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 5491 (DEFLHR). Is EST DTC list free of SPN 5491?	Yes: Go to step 2. No: Repair SPN 5491. After repairs are complete, retest for SPN 4340 FMI 3.

Step	Action	Decision
2	Inspect connections at Diesel Exhaust Fluid Suction Line Heater (DEFSLH). Key OFF, disconnect DEFSLH. Check DEFSLH and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DEFSLH connector, harness, and terminals clean and undamaged?	Yes: Go to step 3. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 4340 FMI 3.

Step	Action	Decision
3	Determine if DEF Suction L-HTR circuit is shorted to PWR. Connect Breakout Harness 18-045-01 to vehicle harness and leave DEFSLH disconnected. Key ON, use a DMM to measure voltage between Breakout Harness pin-1 and a known good ground. Is Breakout Harness pin-1 voltage 0.5 volts or less?	Yes: Go to step 4. No: Repair short to PWR between Aftertreatment Control Module (ACM) pin J1-04 and DEFSLH connector pin-1. After repairs are complete, retest for SPN 4340 FMI 3.

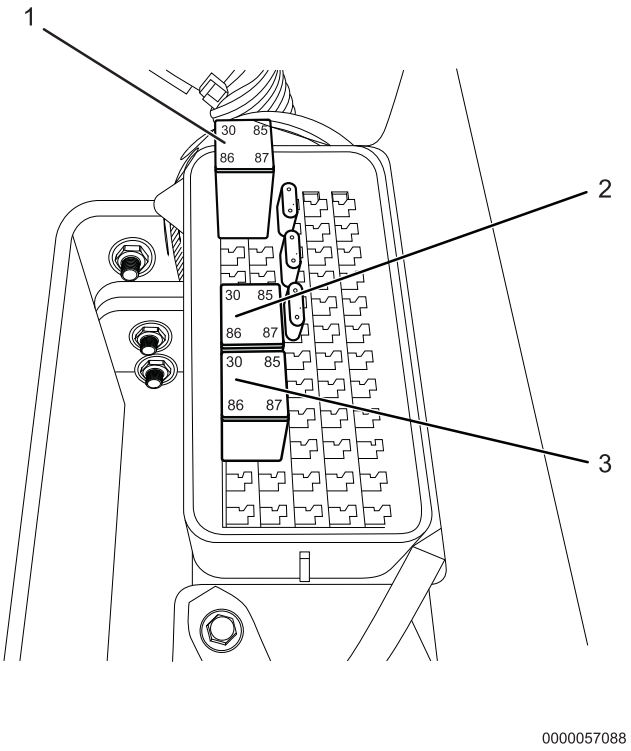


Figure 286 Power Distribution Module (PDM) Fuses and Relays

1. DEF Line Heater Relay
2. DEF Unit HTR Relay
3. Switched Ignition Relay

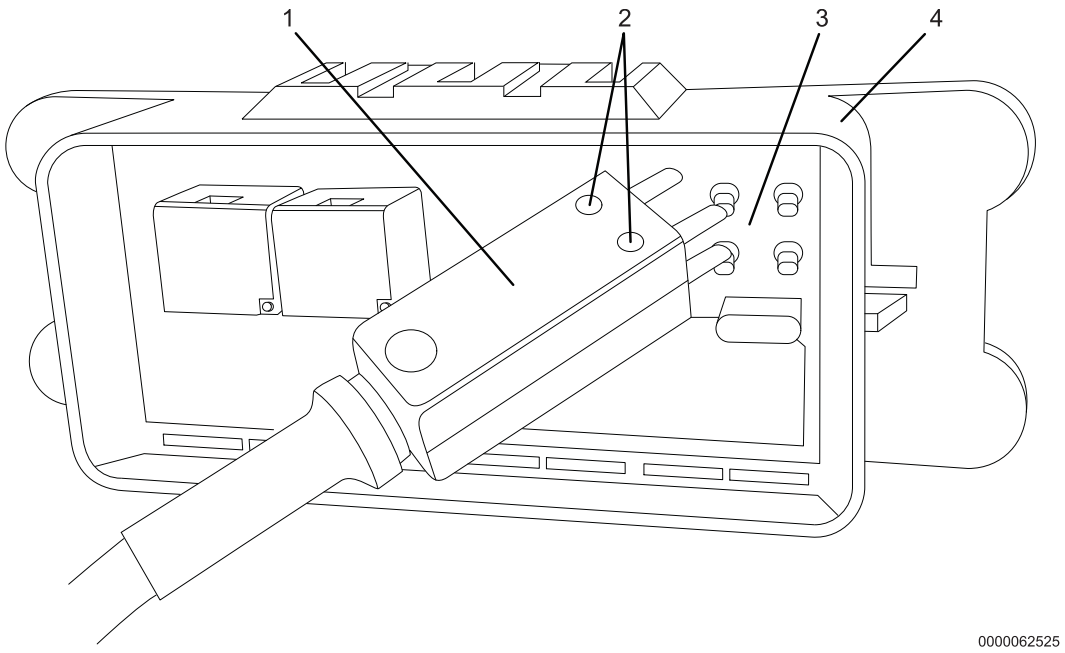


Figure 287 Installation of Breakout Harness ZTSE4908 (typical)

1. Breakout Harness ZTSE4908
2. Dimples
3. Relay socket
4. Power Distribution Module (PDM)

CAUTION: For correct diagnosis, Breakout Harness ZTSE4908 MUST be installed with the dimples toward the top of the PDM. Reversed installation WILL result in incorrect measurements.

Step	Action	Decision
4	Determine if DEF Line Heater Relay (DEFLHR) has failed. Key OFF, remove DEFLHR. Install Breakout Harness ZTSE4908, leaving DEFLHR disconnected. Key ON, measure voltage at Power Distribution Module (PDM) terminal 87 for the DEFLHR. Is PDM terminal 87 for DEFLHR voltage 0.5 volts or more?	Yes: Repair short to power between PDM terminal 87 for the DEFLHR and the DEFSLH connector pin-2. After repairs are complete, retest for SPN 4340 FMI 3.
		No: Replace the DEFLHR. After repairs are complete, retest for SPN 4340 FMI 3.

NOTE: After performing all diagnostic steps, if SPN 4340 FMI 3 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 4340 FMI 5 - Diesel Exhaust Fluid Line 3 Heater Circuit (DEFL3HC) Open load / circuit

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Exhaust Fluid Suction Line Heater (DEFSLH) circuit Open. Current less than expected.	DEFSLH current < 0.3 A	Key ON The DEF Line Heater Relay (DEFLHR) command ON.	3 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects current from the Diesel Exhaust Fluid Suction Line Heater (DEFSLH) is less than 0.3 amps. Engine torque will be reduced and vehicle speed will be limited after extended engine operation with this fault code active.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 5491 (DEFLHR)

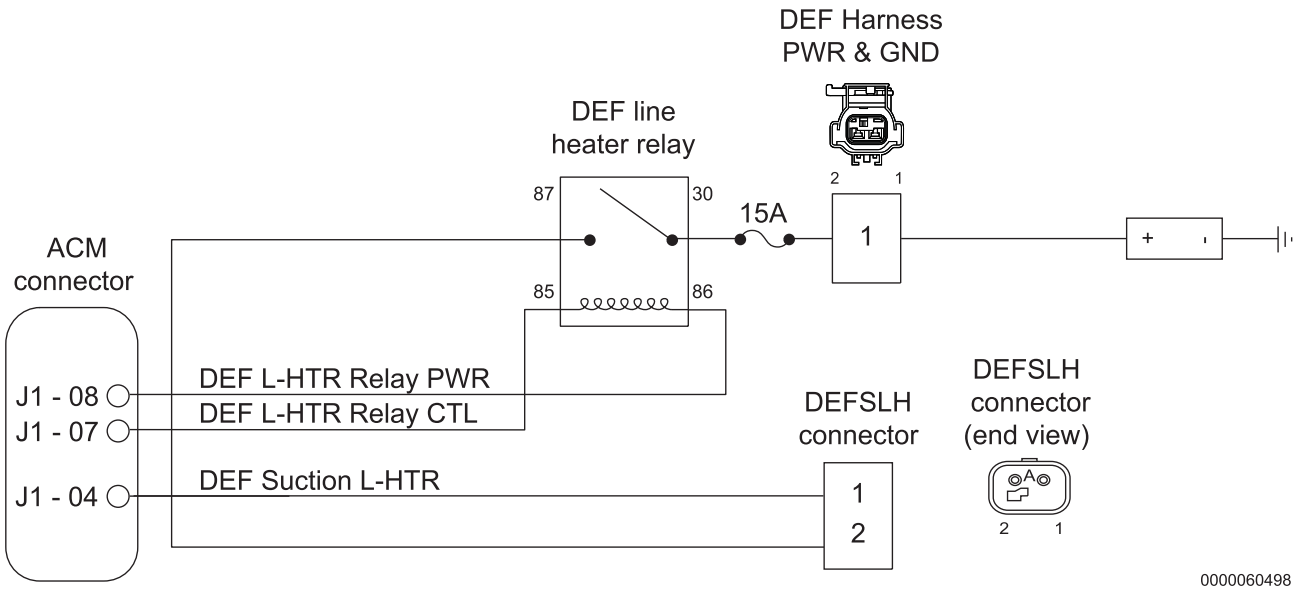
Fault Facts

Diesel Exhaust Fluid Return Line Heater (DEFRLH), DEF Pressure Line Heater (DEFPLH), and DEF Suction Line Heater (DEFSLH) share a common power circuit. If more than one DEF line heater fault is set, suspect a common power circuit problem.

Drive Cycle to Determine Fault Status

Drive cycle 29 in 2013 HD-OBD Diagnostic Reference Manual.

DEFSLH circuit



Possible Causes

- Failed Diesel Exhaust Fluid Suction Line Heater (DEFSLH)
- DEF Suction L-HTR circuit Open or high resistance
- DEF Suction L-HTR circuit short to GND
- DEFSLH power circuit Open or high resistance
- DEFSLH power circuit short to GND
- Blown fuse or Open power circuit to DEF Line Heater Relay (DEFLHR)
- Failed DEFLHR

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 5491 (DEFLHR). Is EST DTC list free of SPN 5491?	Yes: Go to step 2. No: Repair SPN 5491. After repairs are complete, retest for SPN 4340 FMI 5.

Step	Action	Decision
2	Inspect connections at Diesel Exhaust Fluid Suction Line Heater (DEFSLH). Key OFF, disconnect DEFSLH. Check DEFSLH and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DEFSLH connector, harness, and terminals clean and undamaged?	Yes: Go to step 3. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 4340 FMI 5.

NOTE: Verify batteries are fully charged and connections are clean.

Step	Action	Decision
3	Determine if DEFSLH is receiving power. Connect Breakout Harness 18-045-01 to DEFSLH and leave DEFSLH disconnected. Using EST with ServiceMaxx software, select Tests > KOEO Aftertreatment Tests > DEF Line Heater Test. Run test and measure voltage between Breakout Harness pin-2 and a known good ground. Is voltage within 0.5 volts of battery voltage?	Yes: Go to step 9. No: Go to step 4.

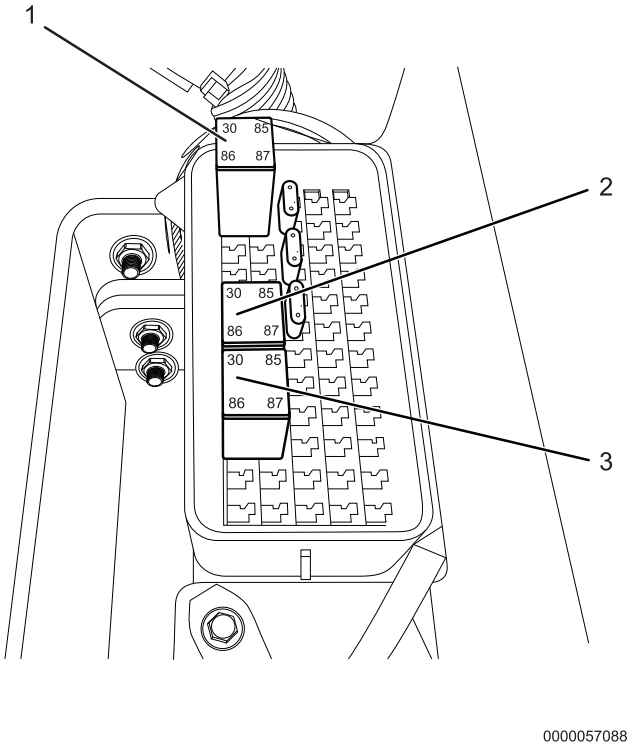


Figure 289 Power Distribution Module (PDM) Fuses and Relays

1. DEF Line Heater Relay
2. DEF Unit HTR Relay
3. Switched Ignition Relay

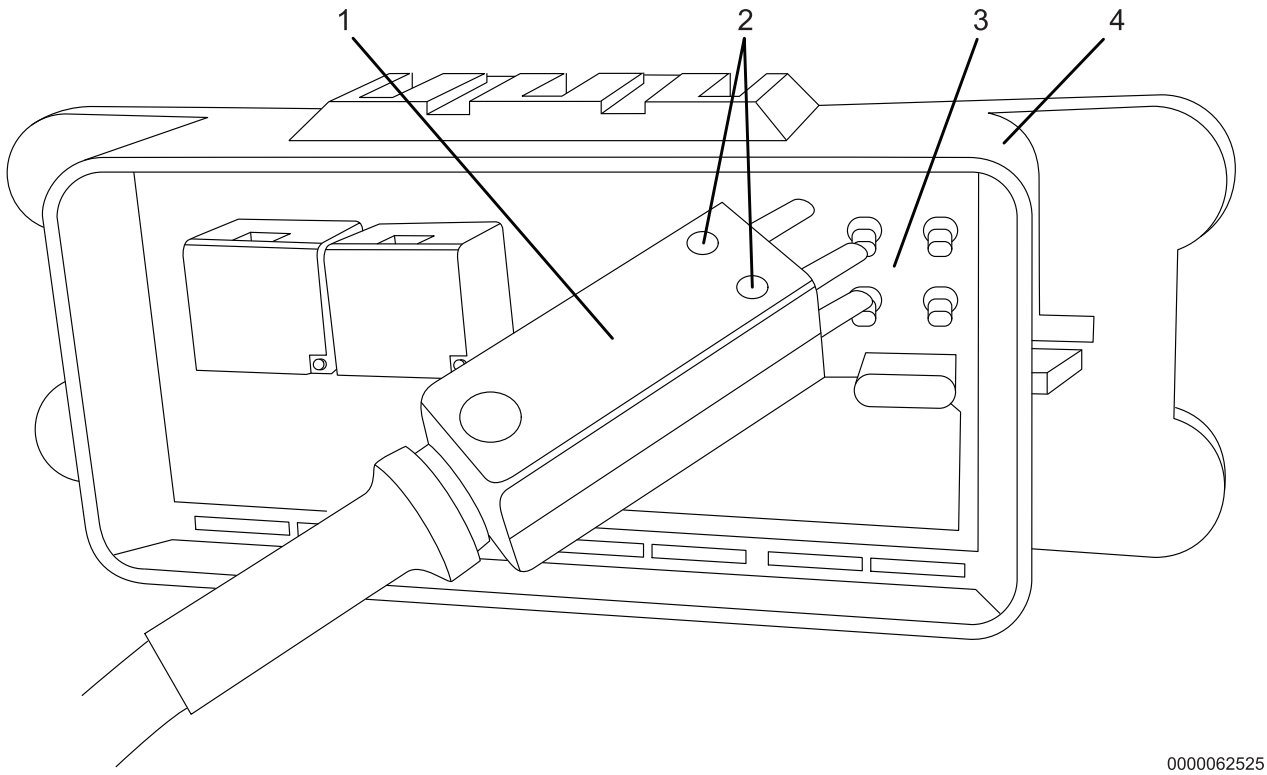


Figure 290 Installation of Breakout Harness ZTSE4908 (typical)

1. Breakout Harness ZTSE4908
2. Dimples
3. Relay socket
4. Power Distribution Module (PDM)

CAUTION: For correct diagnosis, Breakout Harness ZTSE4908 MUST be installed with the dimples toward the top of the PDM. Reversed installation WILL result in incorrect measurements.

Step	Action	Decision
4	Test DEFLHR PWR circuit and fuse. Remove DEFLHR. Install Breakout Harness ZTSE4908 to vehicle harness and leave DEFLHR disconnected. Connect test light between Breakout Harness pin-30 and a known good ground. Does test light illuminate and is the fuse in good condition and not blown?	Yes: Go to step 8. No: Go to step 5.

Step	Action	Decision
5	Check for PWR at DEFLHR 15 amp fuse. KOEO, using a DMM check for voltage between vehicle side of DEFLHR 15 amp fuse and a known good ground. Is voltage within 0.5 volts of battery voltage.	Yes: Got to step 6.
		No: Repair Open or high resistance between DEFLHR 15 amp fuse and vehicle PWR. After repairs are complete retest for SPN 4340 FMI 5.

Step	Action	Decision
6	With DEFSLH disconnected. Replace DEFLHR 15 amp fuse. Does the DEFLHR fuse blow immediately when replaced?	Yes: Repair short to GND between DEFLHR 15 amp fuse and DEFLHR pin-30. After repairs are complete, retest for SPN 4340 FMI 5.
		No: Go to step 7.

Step	Action	Decision
7	Check for short to GND between DEFLHR pin-87 and DEFSLH. Install DEFLHR. Using EST with ServiceMaxx™ software, select KOEO Aftertreatment Tests > DEF Line Heater Test. Run DEF Line Heater Test. Inspect to see if DEFLHR 15 amp fuse blows when DEF line heaters are actuated ON. Does the DEFLHR 15 amp fuse blow when DEF line heaters are actuated ON?	Yes: Repair short to GND between DEFLHR pin-87 and DEFSLH, DEF Pressure Line Heater (DEFPLH), or DEF Return Line Heater (DEFRLH). After repairs are complete, retest for SPN 4340 FMI 5.
		No: Repair Open or high resistance between DEFLHR pin-87 and DEFSLH, DEF Pressure Line Heater (DEFPLH), or DEF Return Line Heater (DEFRLH). After repairs are complete, retest for SPN 4340 FMI 5.

Step	Action	Decision
8	Check for Open or high resistance circuit between DEFSLH connector pin-2 and DEFLHR pin-87. Connect Breakout Harness 18-045-01 to vehicle harness and leave DEFSLH disconnected. Key OFF, with Breakout Harness ZTSE4908 connected to Power Distribution Module (PDM), measure resistance between Breakout Harness ZTSE4908 pin-87 and Breakout Harness 18-045-01 pin-2. Is resistance less than 5 ohms?	Yes: Replace the DEFLHR. After repairs are complete, retest for SPN 4340 FMI 5.
		No: Repair Open or high resistance between DEFSLH pin-2 and DEFLHR pin-87. After repairs are complete, retest for SPN 4340 FMI 5.

Step	Action	Decision
9	Inspect connections at Aftertreatment Control Module (ACM). Key OFF, disconnect ACM. Check ACM and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the ACM connector, harness, and terminals clean and undamaged?	Yes: Go to step 10. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 4340 FMI 5.

Step	Action	Decision
10	Measure for Open or high resistance in DEF Suction L-HTR circuit. Connect 180-pin Breakout Box with Breakout Harness 18-100-01 to vehicle harness and leave ACM disconnected. Key OFF, with Breakout Harness 18-045-01 connected to vehicle harness and DEFSLH disconnected, measure resistance between Breakout Harness 18-100-01 pin J1-04 and Breakout Harness 18-045-01 pin-1. Is resistance less than 5 ohms?	Yes: Go to step 11. No: Repair Open or high resistance between ACM connector J1-04 and DEFSLH connector pin-1. After repairs are complete, retest for SPN 4340 FMI 5.

Step	Action	Decision
11	Measure for short to GND in DEF Suction L-HTR circuit with ACM disconnected. Key OFF, with Breakout Harness 18-045-01 to vehicle harness and DEFSLH disconnected. Measure resistance between Breakout Harness 18-045-01 pin-1 and a known good ground. Is resistance greater than 1000 ohms?	Yes: Replace DEFSLH. After repairs are complete, retest for SPN 4340 FMI 5. No: Repair short to GND between ACM connector J1-04 and DEFSLH connector pin-1. After repairs are complete, retest for SPN 4340 FMI 5.

NOTE: After performing all diagnostic steps, if SPN 4340 FMI 5 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

DEFSP (Diesel Exhaust Fluid Supply Pump)

SPN	FMI	Condition	Possible Causes	Actions
3361	2	DEFSP signal erratic, intermittent or incorrect	• Failed Diesel Exhaust Fluid (DEF) supply module • DEFSP Temp / CTL circuit high resistance • DEFSP Temp / CTL circuit intermittent short to GND • DEFSP GND circuit high resistance • Power Distribution Module (PDM) loose fuse or relay	Step-Based Diagnostics (page 726)
3361	3	DEFSP signal Out of Range HIGH	• Failed DEF supply module • DEFSP Temp / CTL circuit short to PWR • DEFSP GND circuit high resistance or Open	Step-Based Diagnostics (page 730)
3361	4	DEFSP signal Out of Range LOW	• Failed DEF supply module • DEFSP Temp / CTL circuit Open or high resistance • DEFSP Temp / CTL circuit short to GND • DEFSP PWR circuit Open or high resistance	Step-Based Diagnostics (page 733)
3362	31	DEF dosing unable to prime	• Low DEF tank level • Failed DEF line heater • DEF tank, supply module, or doser valve line or connection loose, leaking, or damaged • Failed DEF supply module	Step-Based Diagnostics (page 736)

			• Reversed DEF suction and return lines between DEF supply module and DEF tank. • Debris in DEF tank • DEF supply module suction line restricted	
4337	2	DEF Supply Module Temperature erratic, intermittent, or incorrect	• DEFSP Temp / CTL circuit intermittent short to GND • DEFSP Temp / CTL circuit intermittent short to PWR • DEFSP Temp / CTL circuit intermittent Open or high resistance • Failed DEF Supply Module	Step-Based Diagnostics (page 740)
4337	10	DEF Supply Module Temperature abnormal rate of change	• DEFSP Temp / CTL circuit intermittent short to GND • DEFSP Temp / CTL circuit intermittent short to PWR • DEFSP Temp / CTL circuit intermittent Open or high resistance • Failed DEF Supply Module	Step-Based Diagnostics (page 744)

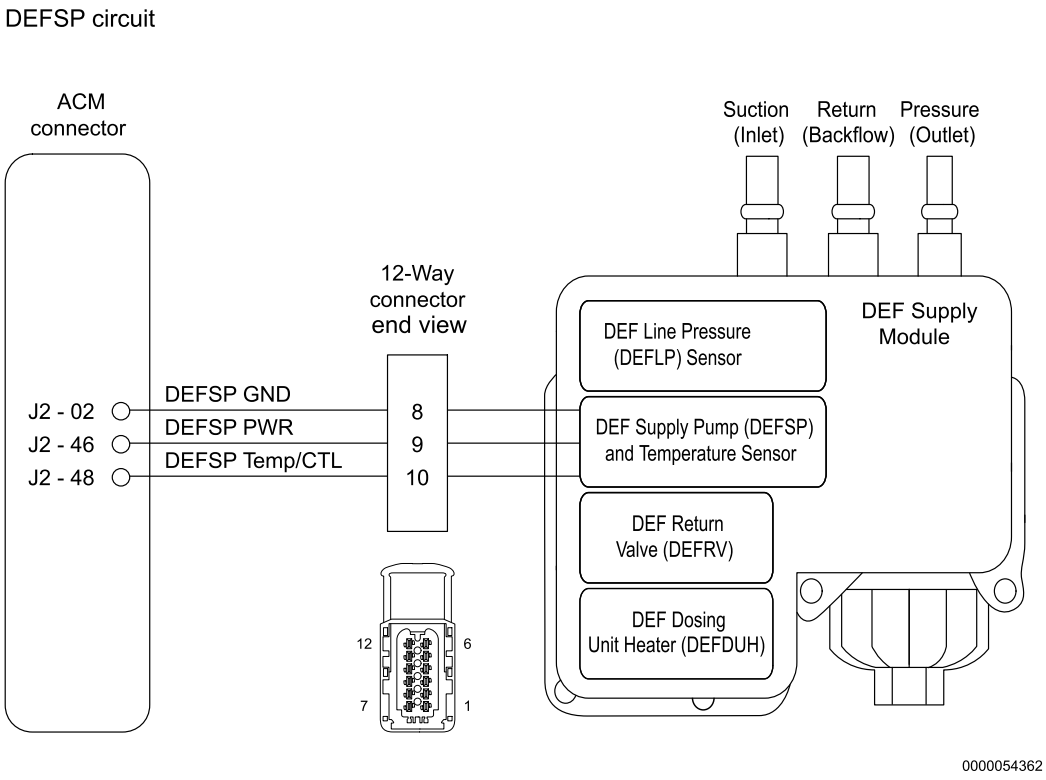


Figure 291 DEFSP Circuit Diagram

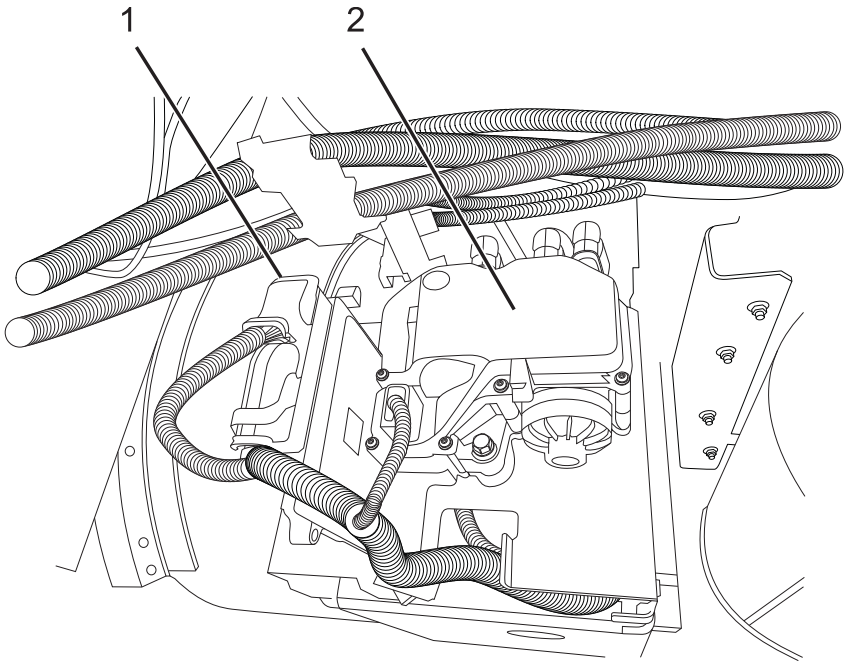
NOTE: See latest version of N13 with SCR Engine and Aftertreatment Wiring Schematic Form 0000002203 for additional circuit information.

Overview

The Diesel Exhaust Fluid Supply Pump (DEFSP) is controlled using a PWM signal from the Aftertreatment Control Module (ACM). The DEFSP is installed in the DEF Supply Module and is a non-serviceable component. The DEF Supply Module has an internal temperature sensor used to monitor DEFSP temperature. When DEFSP temperature is too high, the ACM will deactivate the DEFSP.

Tools Required

- 180-Pin Breakout Box 00-00956-08
- ACM Breakout Harness 18-100-01
- Supply Module Breakout Harness 18-909-01
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)



0000054368

Figure 292 DEF Supply Module Location

1. Aftertreatment Control Module (ACM)
2. Diesel Exhaust Fluid (DEF) supply module

SPN 3361 FMI 2 - DEFSP signal erratic, intermittent or incorrect

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Loss of communication or invalid data from Diesel Exhaust Fluid Supply Pump (DEFSP).	Aftertreatment Control module (ACM) loses J1939 CAN data link communications with DEFSP or DEFSP temperature erratic.	Key ON Supply module in temperature feedback mode	0 seconds

Fault Overview

Fault code sets when the Diesel Exhaust Fluid Supply Pump (DEFSP) temperature is not communicated to the Aftertreatment Control Module (ACM) or is erratic. DEF injection into the exhaust system is disabled, and engine torque is reduced if fault is active for an extended period of time.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 3361 FMI 3 (DEFSP).

Drive Cycle to Determine Fault Status

Drive Cycle 1 then 5 in 2013 HD-OBD Diagnostic Reference Manual.

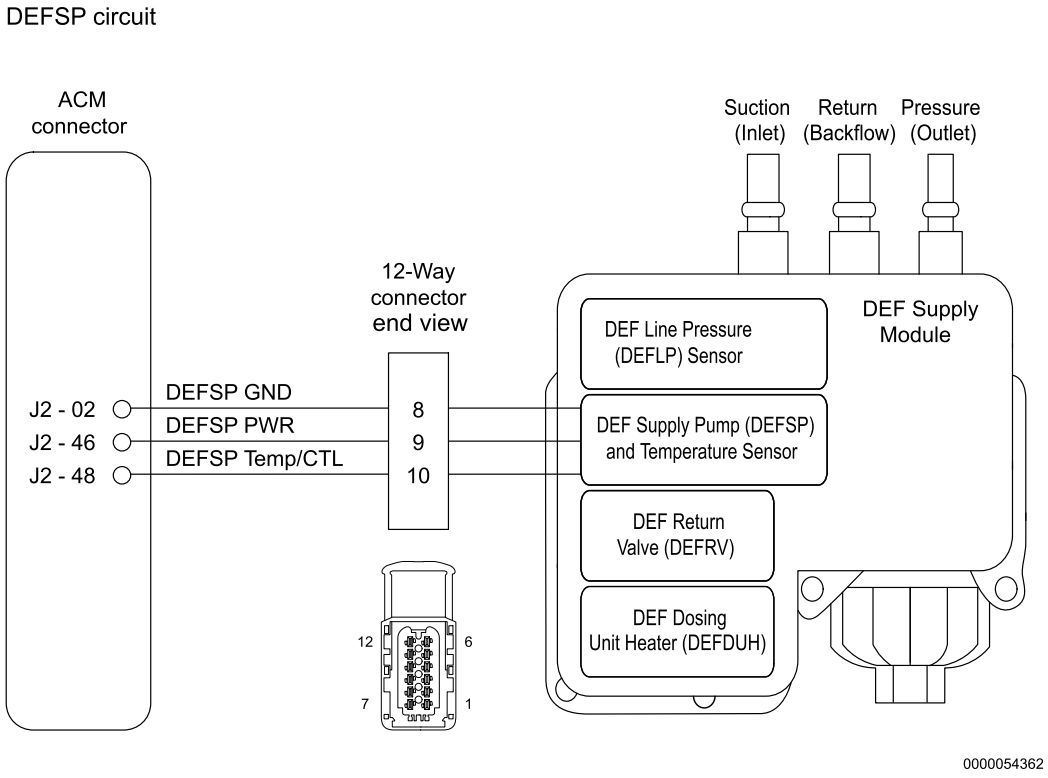


Figure 293 DEFSP Circuit Diagram

Possible Causes

- Failed Diesel Exhaust Fluid (DEF) supply module
- DEFSP Temp / CTL circuit high resistance
- DEFSP Temp / CTL circuit intermittent short to GND
- DEFSP GND circuit high resistance
- Power Distribution Module (PDM) loose fuse or relay

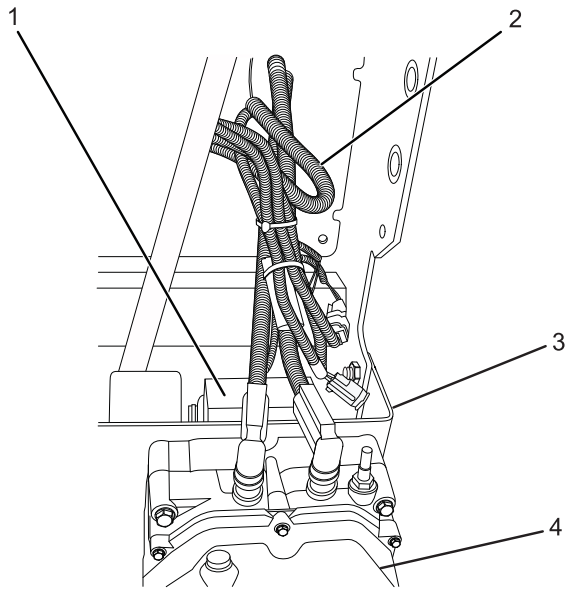


Figure 294 PDM Location (typical)

1. Power Distribution Module (PDM)
2. Diesel Exhaust Fluid (DEF) tank assembly
3. DEF supply module bracket
4. DEF supply module

Step	Action	Decision
1	Check Power Distribution Module (PDM) fuse(s) and relay(s) for blown fuses; loose, missing, or intermittent connections. Are all fuses and relays securely attached and in good condition?	Yes: Go to step 2. No: Secure or replace failed fuse(s) or relay(s) to PDM connector. After repairs are complete, retest for SPN 3361 FMI 2.

Step	Action	Decision
2	Inspect connections at Diesel Exhaust Fluid (DEF) supply module. Key OFF, disconnect DEF supply module connector. Check DEF supply module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DEF supply module connector, harness, and terminals clean and undamaged?	Yes: Go to step 3. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3361 FMI 2.

Step	Action	Decision
3	Check DEFSP Temp / CTL circuit for intermittent short to GND. Connect Breakout Harness 18-909-01 to DEF supply module and leave supply module disconnected. Use a DMM to measure resistance between Breakout Harness 18-909-01 pin-10 and a known good ground. Is resistance greater than 1000 ohms?	Yes: Go to step 4. No: Repair intermittent short to ground between DEF supply module connector pin–10 and ACM connector J2 pin-48. After repairs are complete, retest for SPN 3361 FMI 2.

Step	Action	Decision
4	Inspect connections at Aftertreatment Control Module (ACM). Key OFF, disconnect ACM. Check ACM and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the ACM connector, harness, and terminals clean and undamaged?	Yes: Go to step 5. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3361 FMI 2.

Step	Action	Decision
5	Check DEFSP Temp / CTL circuit for high resistance. Connect Breakout Harness 18-909-01 to DEF supply module and leave supply module disconnected. Connect 180-pin Breakout Box with ACM Breakout Harness 18-100-01 to Aftertreatment Control Module (ACM) and leave module disconnected. Use a DMM to measure resistance from Breakout Harness 18-909-01 pin-10 and 180-pin Breakout Box pin J2-48. Is resistance less than 5 ohms?	Yes: Go to step 6. No: Repair high resistance between DEF supply module pin–10 and ACM connector J2 pin–48. After repairs are complete, retest for SPN 3361 FMI 2

Step	Action	Decision
6	Check DEFSP GND circuit for high resistance. Connect Breakout Harness 18-909-01 to DEF supply module and leave supply module disconnected. Connect 180-pin Breakout Box with ACM Breakout Harness 18-100-01 to Aftertreatment Control Module (ACM) and leave module disconnected. Use a DMM to measure resistance from Breakout Harness 18-909-01 pin-8 and 180-pin Breakout Box pin J2-02. Is resistance less than 5 ohms?	Yes: Replace DEF supply module. After repairs are complete, retest for SPN 3361 FMI 2. No: Repair high resistance between DEF supply module pin-8 and ACM connector J2 pin–2. After repairs are complete, retest for SPN 3361 FMI 2.

NOTE: After doing all diagnostic steps, if SPN 3361 FMI 2 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3361 FMI 3 - DEFSP signal Out of Range HIGH

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
DEFSP Temp / CTL circuit voltage signal above normal, shorted to high source, or Open.	DEFSP Temp / CTL circuit voltage signal > 8.5 V	The DEF pump motor command is ON. The system has passed the DEF supply module temperature reading phase, and start controlling the DEF pump motor. DEF supply module power channel is ON. The DEF supply module power command is OFF.	4 seconds 2 seconds (Only when the DEF Supply Module power command is OFF)

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the voltage signal from the Diesel Exhaust Fluid Supply Pump (DEFSP) is too high. DEF injection into the exhaust system is disabled, and engine torque is reduced if fault is active for an extended period of time.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

DEFSP circuit

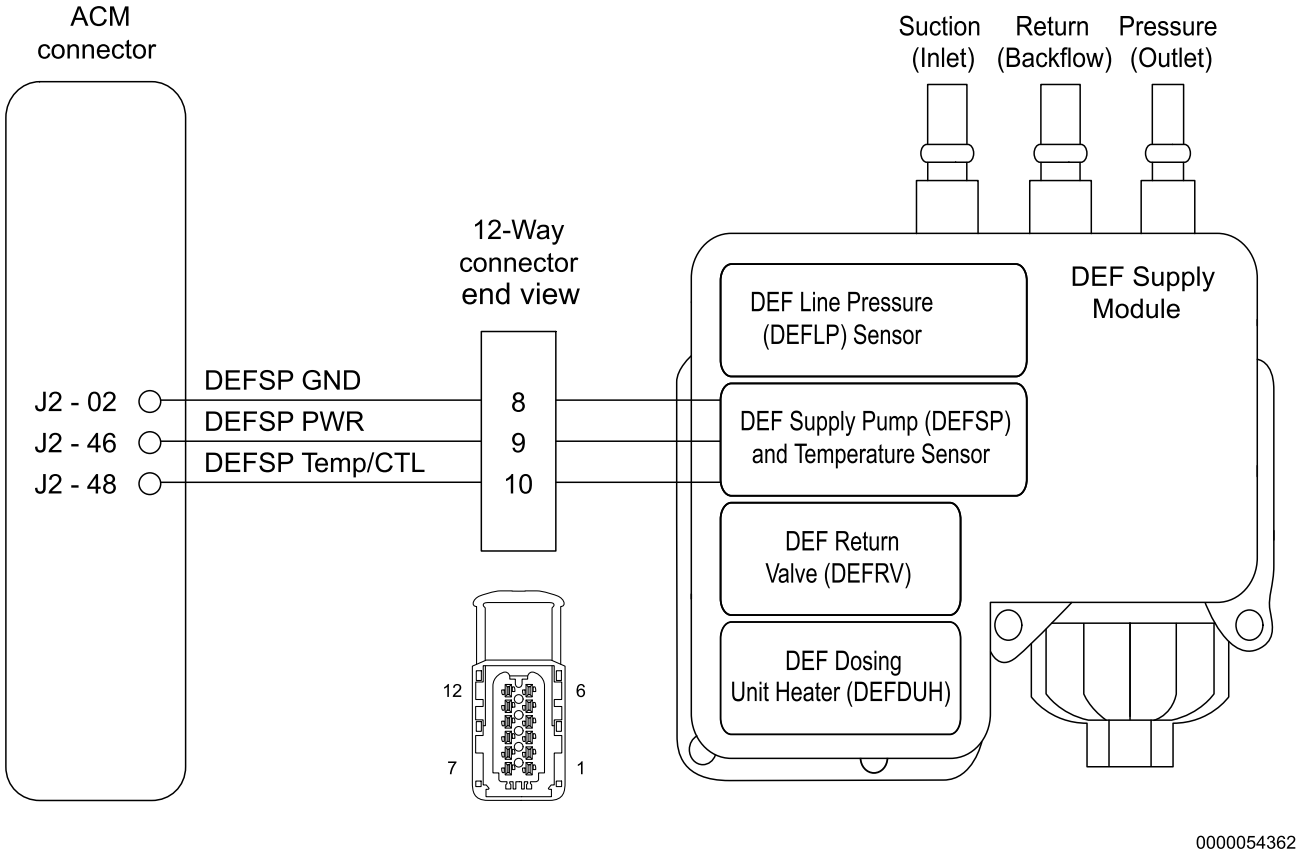


Figure 295 DEFSP Circuit Diagram

Possible Causes

- Failed DEF supply module
- DEFSP Temp / CTL circuit short to PWR
- DEFSP GND circuit high resistance or Open

Step	Action	Decision
1	Inspect connections at Diesel Exhaust Fluid (DEF) supply module. Key OFF, disconnect DEF supply module 12-way connector. Check DEF supply module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DEF supply module connector, harness, and terminals clean and undamaged?	Yes: Go to step 2. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3361 FMI 3.

Step	Action	Decision
2	Check DEFSP Temp / CTL circuit for short to PWR. Key-On Engine-Off (KOEO), with Breakout Harness 18-909-01 connected to Diesel Exhaust Fluid (DEF) supply module, use a DMM to measure voltage between DEF supply module pin-10 and a known good ground. Is voltage less than 8.5 volts?	Yes: Go to step 3. No: Repair short to PWR between DEF supply module connector pin-10 and ACM connector J2-48. After repairs are complete, retest for SPN 3361 FMI 3.

Step	Action	Decision
3	Check DEFSP GND circuit for high resistance or Open. Connect Breakout Harness 18-909-01 to DEF supply module and leave supply module disconnected. Connect 180-pin Breakout Box with ACM Breakout Harness 18-100-01 to Aftertreatment Control Module (ACM) and leave module disconnected. Use a DMM to measure resistance from Breakout Harness 18-909-01 pin-8 and 180-pin Breakout Box pin J2-02. Is resistance less than 5 ohms?	Yes: Replace DEF supply module. After repairs are complete, retest for SPN 3361 FMI 3. No: Repair high resistance or Open between DEF supply module pin-8 and ACM connector J2-02. After repairs are complete, retest for SPN 3361 FMI 3.

NOTE: After doing all diagnostic steps, if SPN 3361 FMI 3 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3361 FMI 4 - DEFSP signal Out of Range LOW

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
DEFSP Temp / CTL circuit voltage signal below normal or shorted to low source.	DEFSP Temp / CTL circuit voltage signal < 4.8 V	The system has passed the DEF Supply Module temperature reading phase, and start controlling the DEF pump motor. DEF Supply Module power channel is ON. The DEF Supply Module power command is ON.	4 seconds 2 seconds (Only when the DEF Supply Module power command is ON)

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the voltage signal from the Diesel Exhaust Fluid Supply Pump (DEFSP) is too low. DEF injection into the exhaust system is disabled, and engine torque is reduced if fault is active for an extended period of time.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

DEFSP circuit

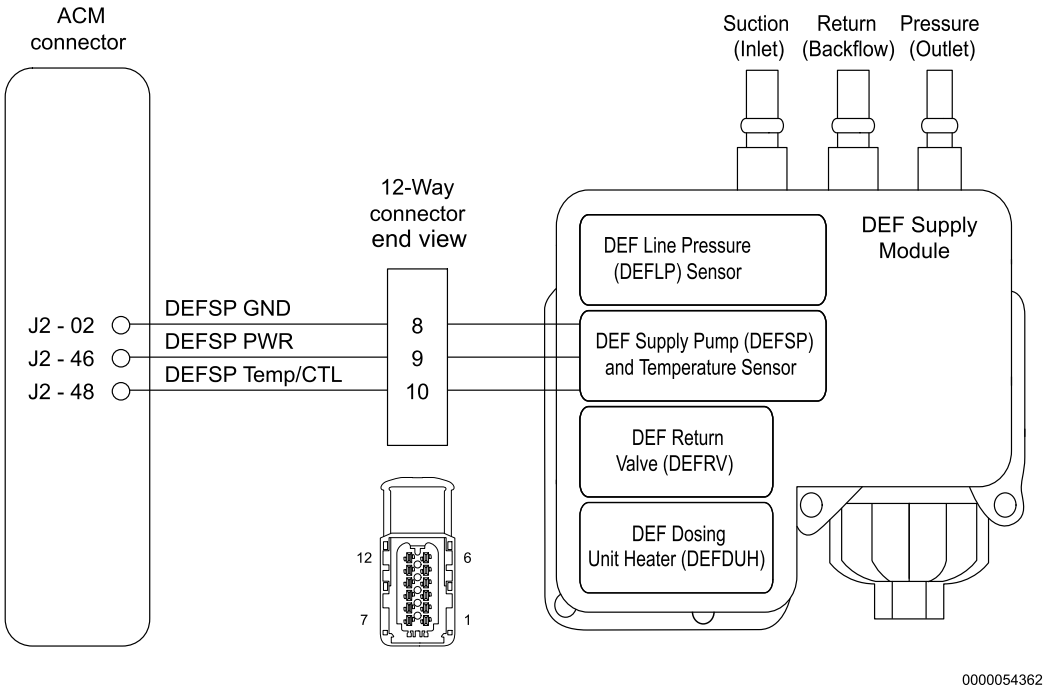


Figure 296 DEFSP Circuit Diagram

Step	Action	Decision
1	Inspect connections at Diesel Exhaust Fluid (DEF) supply module. Key OFF, disconnect DEF supply module 12-way connector. Check DEF supply module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DEF supply module connector, harness, and terminals clean and undamaged?	Yes: Go to step 2. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3361 FMI 4.

Step	Action	Decision
2	Check DEFSP Temp / CTL circuit for short to GND. Connect Breakout Harness 18-909-01 to DEF supply module and leave supply module disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness 18-909-01 pin-10 and a known good ground. Is resistance greater than 1000 ohms?	Yes: Go to step 3. No: Repair short to ground between DEF supply module connector pin-10 and ACM connector J2-48. After repairs are complete, retest for SPN 3361 FMI 4.

Step	Action	Decision
3	Check DEFSP PWR circuit for high resistance or Open. Connect Breakout Harness 18-909-01 to DEF supply module and leave supply module disconnected. Connect 180-pin Breakout Box with ACM Breakout Harness 18-100-01 to Aftertreatment Control Module (ACM) harness, and leave module disconnected. Key OFF, use a DMM to measure resistance from Breakout Harness 18-909-01 pin-9 and 180-pin Breakout Box pin J2-46. Is resistance less than 5 ohms?	Yes: Go to step 4. No: Repair high resistance or Open between DEF supply module connector pin-9 and ACM connector J2-46. After repairs are complete, retest for SPN 3361 FMI 4.

Step	Action	Decision
4	Check DEFSP Temp / CTL circuit for high resistance or Open. Connect Breakout Harness 18-909-01 to DEF supply module and leave supply module disconnected. Connect 180-pin Breakout Box with ACM Breakout Harness 18-100-01 to Aftertreatment Control Module (ACM) harness, and leave module disconnected. Use a DMM to measure resistance from Breakout Harness 18-909-01 test pin-10 and 180-pin Breakout Box test J2-48. Is resistance less than 5 ohms?	Yes: Replace DEF supply module. After repairs are complete, retest for SPN 3361 FMI 4. No: Repair high resistance or Open between DEF supply module connector pin 10 and ACM connector J2-48. After repairs are complete, retest for SPN 3361 FMI 4.

NOTE: After doing all diagnostic steps, if SPN 3361 FMI 4 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3362 FMI 31 - DEF dosing unable to prime

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Checks whether the DEF dosing system fails to prime after a calibrated number of attempts.	DEF supply pressure does not exceed 29 PSI (200 kPa) within 200 seconds from the time DEF Supply Module has begun filling with DEF, or 200 seconds has elapsed since the DEF Supply Module has begun filling with DEF. DEF supply pressure does not remain between 116 PSI (800 kPa) and 145 PSI (1,000 kPa) for 3 seconds or longer for more than 5 times.	DEF Supply Module has begun filling with DEF Inactive: SPN 3361 FMI 3 and 4 (DEFSP), and SPN 4334 FMI 2, 3, and 4 (DEFLP).	0 seconds

Fault Overview

Fault code sets when the Diesel Exhaust Fluid Supply Pump (DEFSP) is unable to successfully build pressure or prime after multiple attempts.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 1761 FMI 1 an 18 (DEFTLT), SPN 3363 FMI 7, 16, and 18 (DEFTHC), and SPN 4334 FMI 2, 16, and 18 (DEFLP).

Drive Cycle to Determine Fault Status

Drive Cycle 30 in 2013 HD-OBD Diagnostic Reference Manual.

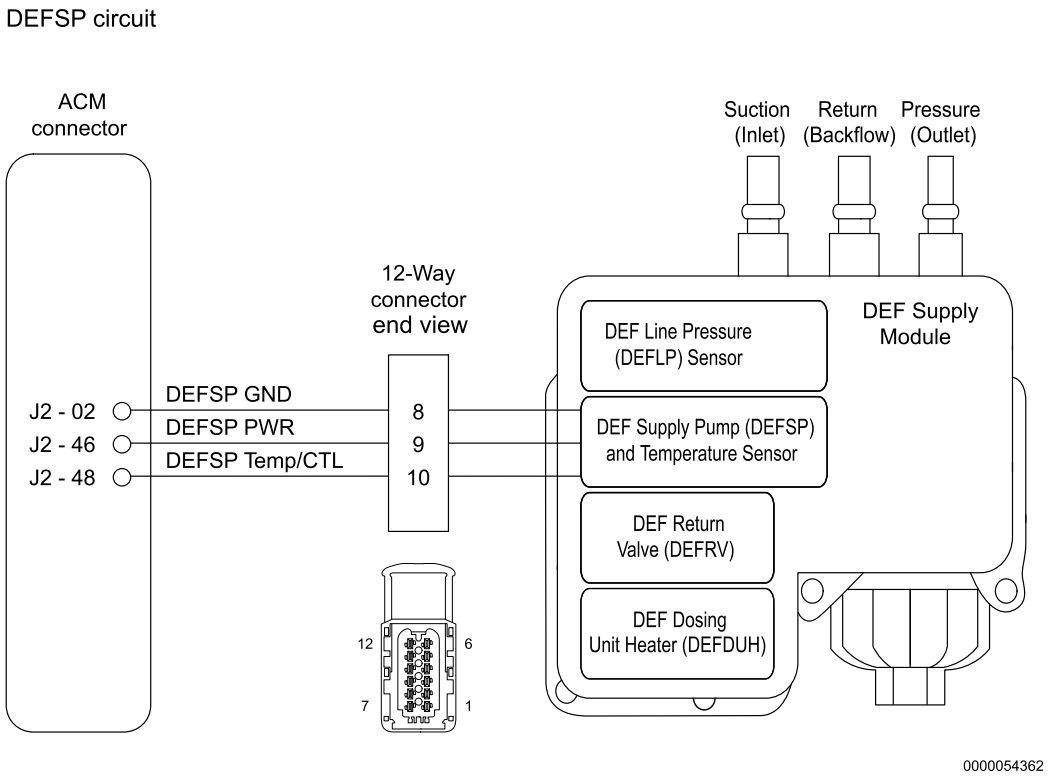


Figure 297 DEFSP Circuit Diagram

NOTE: Fault may set if the Diesel Exhaust Fluid (DEF) supply module was not allowed to shut down and purge fully following a recalibration of the Engine Control Module (ECM). A full key cycle that allows the dosing unit to purge, followed by a priming cycle, should correct this issue.

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 1761 FMI 1 and SPN 1761 FMI 18 (DEFTLT). Is EST DTC list free of 1761 FMI 1 and 18 (DEFTLT)?	Yes: Go to step 2. No: Repair SPN 1761 FMI 1 and 18. After repairs are complete, retest for SPN 3362 FMI 31.

Step	Action	Decision
2	Check DEF tank for debris or foreign particles. Also check DEF tank vent for restrictions or fluid crystallization. Are the DEF tank and DEF tank vent clean and free of debris, restrictions, and fluid crystallization?	Yes: Go to step 3. No: Drain the DEF tank, flush with distilled water, and fill with new and/or known good DEF. After repairs are complete, retest for SPN 3362 FMI 31.

Step	Action	Decision
3	Check for DEF line heater related faults. Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3363 FMI 7, 16, and 18 (DEFTHC). Is EST DTC list free of SPN 3363 FMI 7, 16, and 18 (DEFTHC)?	Yes: Go to step 4. No: Repair SPN 3363 FMI 7, 16, and 18. After repairs are complete, retest for SPN 3362 FMI 31.

Step	Action	Decision
4	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 4334 FMI 2, 16, and 18 (DEFLP). Is EST DTC list free of SPN 4334 FMI 2, 16, and 18 (DEFLP) ?	Yes: Go to step 5. No: Repair SPN 4334 FMI 2, 16, and 18. After repairs are complete, retest for SPN 3362 FMI 31.

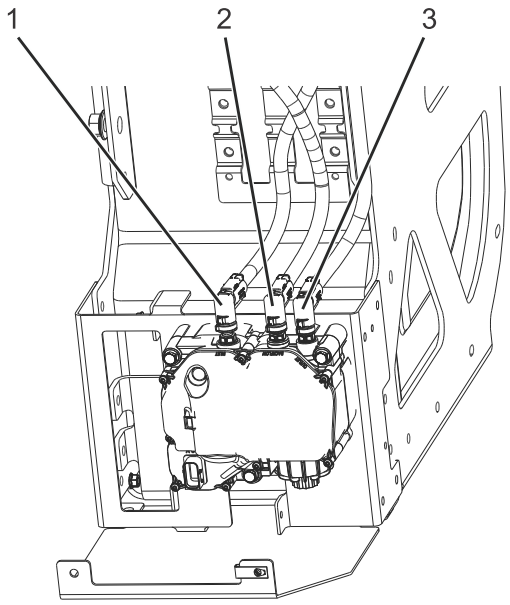


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Figure 298 DEF Supply Module Line Routing

1. DEF supply module suction line
2. DEF supply module return line
3. DEF supply module pressure line

Step	Action	Decision
5	Check DEF suction and return line are not reversed between DEF supply module and DEF tank. Verify suction and return lines are not swapped at DEF supply module or DEF tank. Are DEF suction and return lines correctly routed?	Yes: Go to step 6. No: Connect DEF suction and return lines to correct locations. After repairs are complete, retest for SPN 3362 FMI 31.

Step	Action	Decision
6	Check DEF tank, DEF supply module, and DEF doser valve lines and connections for: cracks and pitting; and loose, leaking, or damaged connections. Are DEF tank, DEF supply module, and DEF doser valve lines and connections in good condition?	Yes: Go to step 7. No: Repair or replace failed line or connection. After repairs are complete, retest for SPN 3362 FMI 31.

Step	Action	Decision
7	Check DEF supply module suction line for restrictions. Disconnect both ends of the suction line and blow compressed air through the supply line. Does compressed air flow freely through suction line?	Yes: Clean DEF supply module using 18-200-01 and perform drive cycle 30. See DEF Supply Module Flush (page 107). If SPN 3362 FMI 31 is still active, replace DEF supply module. After repairs are complete, retest for SPN 3362 FMI 31. No: Clean or replace DEF supply module suction line. After repairs are complete, retest for SPN 3362 FMI 31.

NOTE: After doing all diagnostic steps, if SPN 3362 FMI 31 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 4337 FMI 2- DEF Supply Module Temperature erratic, intermittent, or incorrect

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Exhaust Fluid (DEF) supply module temperature is in range but not rational	Difference between DEF supply module temperature at Key ON and Inlet Air Temperature (IAT) at Key ON > 72°F (40°C) Difference between DEF supply module temperature at Key ON and coolant temperature at Key ON > 72°F (40°C)	Engine is cold soaked 10 hours Inactive: SPN 3361 FMI 2 (DEF supply pump) Block heater not detected Valid DEF supply module temperature value is available Valid DEF Dosing Unit Heater (DEFDUH) temperature value is available Diagnostic has not previously completed during this key cycle	Immediate

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Diesel Exhaust Fluid (DEF) supply module temperature differs from the engine coolant temperature and the inlet air temperature (IAT) by more than 72°F (40°C) at Key ON.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 110 FMI 2, 3, 4 (ECT1); SPN 172 FMI 2, 3, 4 (IAT); SPN 3361 FMI 2, 3, 4, 31 (DEF Supply Pump); SPN 4076 FMI 2, 3, 4 (ECT2).

Drive Cycle to Determine Fault Status

Drive Cycle 10 then 2 in 2013 HD-OBD Diagnostic Reference Manual.

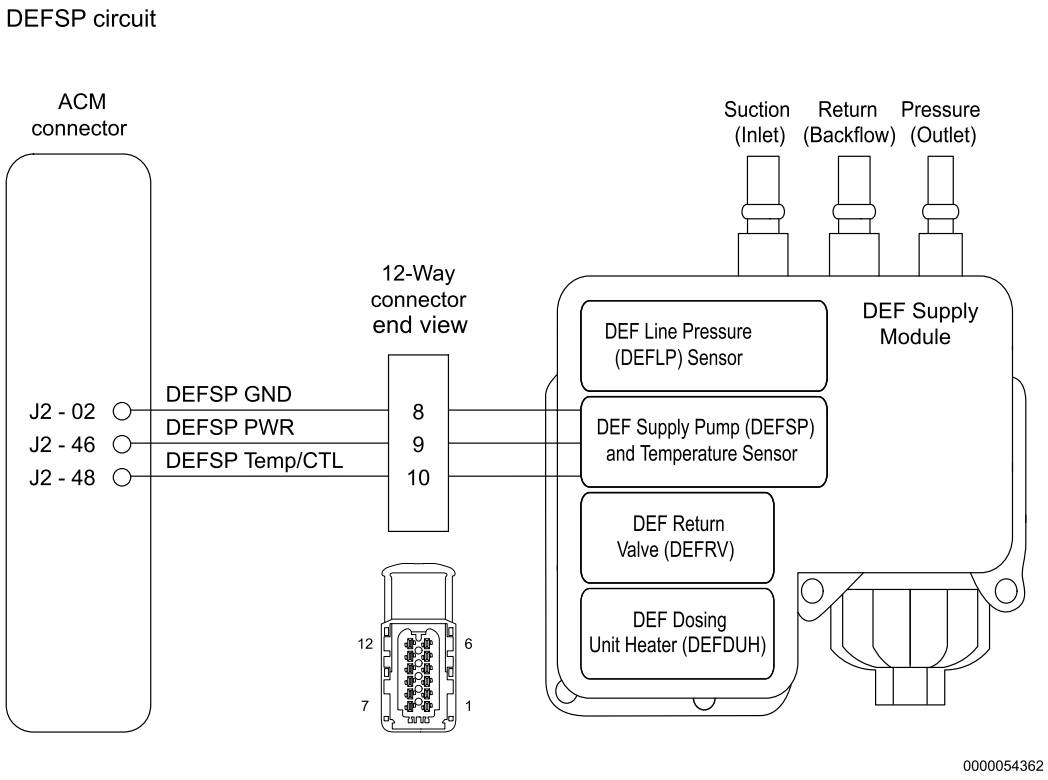


Figure 299 DEF (Diesel Exhaust Fluid) Supply Pump Circuit Diagram

Possible Causes

- DEFSP Temp / CTL circuit intermittent short to GND
- DEFSP Temp / CTL circuit intermittent short to PWR
- DEFSP Temp / CTL circuit intermittent Open or high resistance
- Failed DEF supply module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 110 FMI 2, 3, 4 (ECT1); SPN 172 FMI 2, 3, 4 (IAT); SPN 3361 FMI 2, 3, 4, 31 (DEF Supply Pump); SPN 4076 FMI 2, 3, 4 (ECT2). Is EST DTC list free of SPN 110 FMI 2, 3, 4; SPN 172 FMI 2, 3, 4; SPN 3361 FMI 2, 3, 4, 31; SPN 4076 FMI 2, 3, 4?	Yes: Go to step 2. No: Repair SPN 110 FMI 2, 3, 4; SPN 172 FMI 2, 3, 4; SPN 3361 FMI 2, 3, 4, 31; SPN 4076 FMI 2, 3, 4. After repairs are complete, retest for SPN 4337 FMI 2.

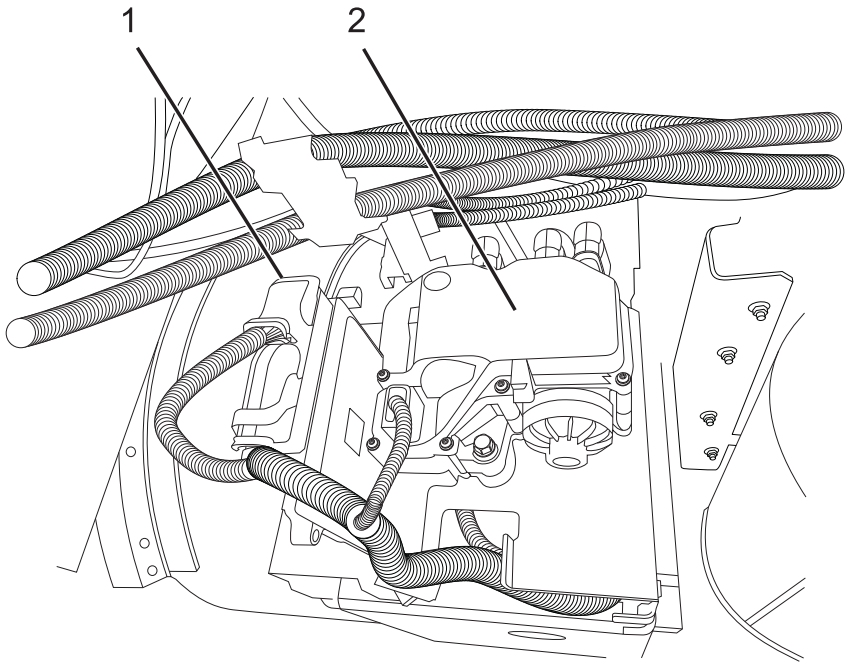


Figure 300 DEF Supply Module Location (typical)

1. Aftertreatment Control Module (ACM)
2. Diesel Exhaust Fluid (DEF) supply module

Step	Action	Decision
2	Inspect connections at DEF supply module. Key OFF, disconnect DEF supply module connectors. Check DEF supply module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DEF supply module connectors, harnesses, and terminals clean and undamaged?	Yes: Go to step 3. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 4337 FMI 2.

Step	Action	Decision
3	Inspect connections at Aftertreatment Control Module (ACM). Key OFF, disconnect ACM connectors. Check ACM and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the ACM connectors, harnesses, and terminals clean and undamaged?	Yes: Go to step 4. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 4337 FMI 2.

Step	Action	Decision
4	Check for intermittent short to GND in DEFSP Temp / CTL circuit. Connect Breakout Harness 18-909-01 to DEF supply module harness, and leave DEF supply module disconnected. Key OFF, with ACM disconnected, use a DMM to measure resistance between Breakout Harness pin-10 and a known good ground. Is resistance greater than 1000 ohms?	Yes: Go to step 5. No: Repair intermittent short to GND between DEFSP pin-10 and ACM pin J2-48. After repairs are complete, retest for SPN 4337 FMI 2.

Step	Action	Decision
5	Check for intermittent short to PWR in DEFSP Temp / CTL circuit. Connect Breakout Harness 18-909-01 to DEF supply module harness, and leave DEF supply module disconnected. Key-On Engine-Off (KOEO), with ACM disconnected, use a DMM to measure voltage between Breakout Harness pin-10 and a known good ground. Is voltage less than 1 volt?	Yes: Go to step 6. No: Repair intermittent short to PWR between DEFSP pin-10 and ACM pin J2-48. After repairs are complete, retest for SPN 4337 FMI 2.

Step	Action	Decision
6	Check for intermittent Open or high resistance in DEFSP Temp / CTL circuit. Connect Breakout Harness 18-909-01 to DEF supply module harness, and leave DEF supply module disconnected. Connect 180-Pin Breakout Box and ACM Breakout Harness 18-100-01 to ACM harness, and leave ACM disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness pin-10 and Breakout Box pin J2-48. Is resistance less than 5 ohms?	Yes: Replace the DEF supply module. After repairs are complete, retest for SPN 4337 FMI 2. No: Repair intermittent Open or high resistance between DEFSP pin-10 and ACM pin J2-48. After repairs are complete, retest for SPN 4337 FMI 2.

NOTE: After performing all diagnostic steps, if SPN 4337 FMI 2 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 4337 FMI 10 - DEF Supply Module Temperature abnormal rate of change

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Exhaust Fluid (DEF) supply module temperature is in range but not rational (not heating)	Difference between maximum and minimum DEF supply module temperature is < 9°F (5°C) within 10 minutes.	Inactive: SPN 3361 FMI 2 (DEFSP Signal); SPN 4337 FMI 2 (DEFSP Temp); SPN 5746 FMI 3, 4 (DEFUHR) Valid DEF supply module temperature value is available Valid DEF Dosing Unit Heater (DEFDUH) temperature value is available Initial DEF supply module heater temperature at Key ON < 25°F (-4°C) DEF supply module heater is active Diagnostic has not previously completed during this key cycle Key-On Engine-Running (KOER)	Immediate

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Diesel Exhaust Fluid (DEF) supply module is not heating properly.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 171 FMI 2, 3, 4 (AAT); SPN 3361 FMI 2 (DEFSP Signal); SPN 4337 FMI 2 (DEFSP Temp); SPN 5745 (DEFDUH); SPN 5746 (DEFUHR); SPN 5798 (DEFDUH Temperature)

Drive Cycle to Determine Fault Status

Drive Cycle 28 in 2013 HD-OBD Diagnostic Reference Manual.

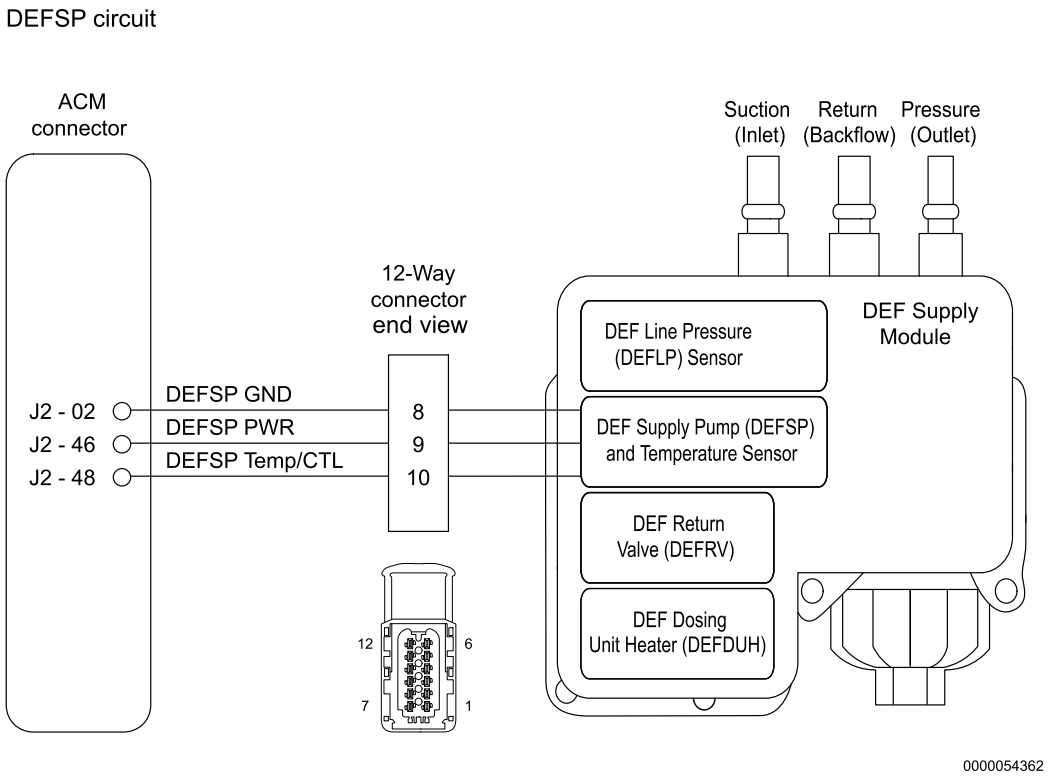


Figure 301 DEF (Diesel Exhaust Fluid) Supply Pump Circuit Diagram

Possible Causes

- DEFSP Temp / CTL circuit intermittent short to GND
- DEFSP Temp / CTL circuit intermittent short to PWR
- DEFSP Temp / CTL circuit intermittent Open or high resistance
- Failed DEF supply module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 171 FMI 2, 3, 4 (AAT); SPN 3361 FMI 2 (DEFSP Signal); SPN 4337 FMI 2 (DEFSP Temp); SPN 5745 (DEFDUH); SPN 5746 (DEFUHR); SPN 5798 (DEFDUH Temp). Is EST DTC list free of SPN 171 FMI 2, 3, 4; SPN 3361 FMI 2; SPN 4337 FMI 2; SPN 5745; SPN 5746; SPN 5798?	Yes: Go to step 2. No: Repair SPN 171 FMI 2, 3, 4; SPN 3361 FMI 2; SPN 4337 FMI 2; SPN 5745; SPN 5746; SPN 5798. After repairs are complete, retest for SPN 4337 FMI 10.

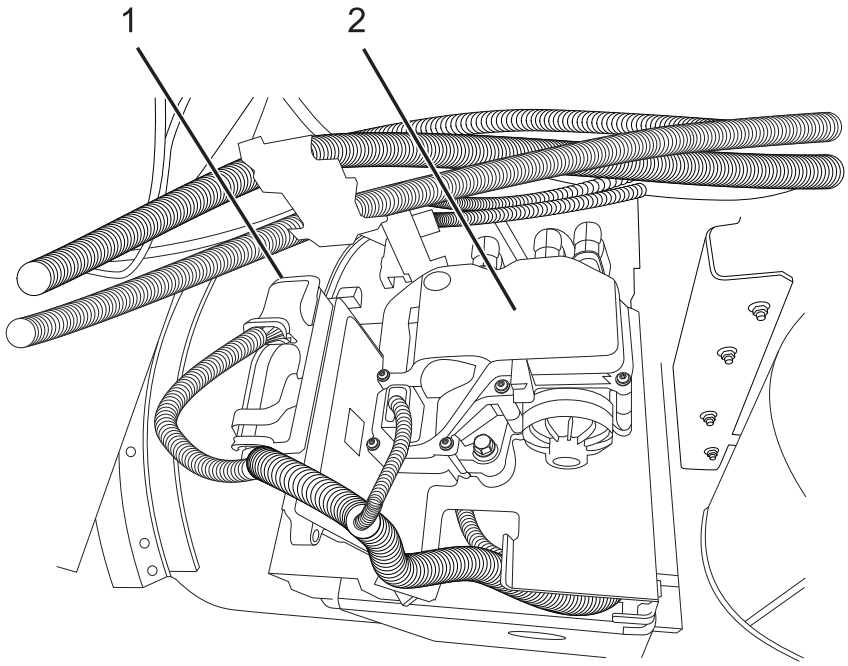


Figure 302 DEF Supply Module Location (typical)

1. Aftertreatment Control Module (ACM)
2. Diesel Exhaust Fluid (DEF) supply module

Step	Action	Decision
2	Inspect connections at DEF supply module. Key OFF, disconnect DEF supply module connectors. Check DEF supply module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DEF supply module connectors, harnesses, and terminals clean and undamaged?	Yes: Go to step 3. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 4337 FMI 10.

Step	Action	Decision
3	Inspect connections at Aftertreatment Control Module (ACM). Key OFF, disconnect ACM connectors. Check ACM and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the ACM connectors, harnesses, and terminals clean and undamaged?	Yes: Go to step 4. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 4337 FMI 10.

Step	Action	Decision
4	Check for intermittent short to GND in DEFSP Temp / CTL circuit. Connect Breakout Harness 18-909-01 to DEF supply module harness, and leave DEF supply module disconnected. Key OFF, with ACM disconnected, use a DMM to measure resistance between Breakout Harness pin-10 and a known good ground. Is resistance greater than 1000 ohms?	Yes: Go to step 5. No: Repair intermittent short to GND between DEFSP pin-10 and ACM pin J2-48. After repairs are complete, retest for SPN 4337 FMI 10.

Step	Action	Decision
5	Check for intermittent short to PWR in DEFSP Temp / CTL circuit. Connect Breakout Harness 18-909-01 to DEF supply module harness, and leave DEF supply module disconnected. Key-On Engine-Off (KOEO), with ACM disconnected, use a DMM to measure voltage between Breakout Harness pin-10 and a known good ground. Is voltage less than 1 volt?	Yes: Go to step 6. No: Repair intermittent short to PWR between DEFSP pin-10 and ACM pin J2-48. After repairs are complete, retest for SPN 4337 FMI 10.

Step	Action	Decision
6	Check for Open or high resistance in DEFSP Temp / CTL circuit. Connect Breakout Harness 18-909-01 to DEF supply module harness, and leave DEF supply module disconnected. Connect 180-Pin Breakout Box and ACM Breakout Harness 18-100-01 to ACM harness and leave ACM disconnected. Key OFF, use a DMM measure resistance between Breakout Harness pin-10 and Breakout Box pin J2-48. Is resistance less than 5 ohms?	Yes: Replace the DEF Supply module. After repairs are complete, retest for SPN 4337 FMI 10. No: Repair Open or high resistance between DEFSP pin-10 and ACM pin J2-48. After repairs are complete, retest for SPN 4337 FMI 10.

NOTE: After performing all diagnostic steps, if SPN 4337 FMI 10 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

DEFTHC (Diesel Exhaust Fluid Tank Heater Valve)

SPN	FMI	Condition	Possible Causes	Actions
3363	3	DEFTHC short to PWR (Open or high resistance)	• DEFTHC CTL short to PWR • DEFTHC CTL Open or high resistance • DEFTHC GND Open or high resistance • Failed Diesel Exhaust Fluid Tank Heater Valve (DEFTHC)	Step-Based Diagnostics (page 751)
3363	4	DEFTHC short to GND	• DEFTHC CTL short to GND • DEFTHC GND shorted to DEFTHC CTL • Failed DEFTHC	Step-Based Diagnostics (page 753)
3363	7	DEFTHC Mechanical system not responding	• Failed DEFTHC (stuck closed) • Coolant line from DEFTHC to DEF tank leaking, damaged, kinked, or restricted • Coolant supply line to DEFTHC leaking, damaged, kinked, or restricted • Low engine coolant level	Step-Based Diagnostics (page 755)
3363	16	DEFTHC stuck on fault	• Failed DEFTHC (stuck open) • DEFTHC installed incorrectly (missing, bypassed, or reversed) • Failed Diesel Exhaust Fluid Tank Level and Temperature (DEFTLT) sensor module	Step-Based Diagnostics (page 758)

			• Auxiliary DEF tank heater installed	
3363	18	DEFTHC unable to thaw frozen DEF	• Failed DEFTHC (stuck closed) • Coolant line from DEFTHC to DEF tank leaking, damaged, kinked, or restricted • Coolant supply line to DEFTHC leaking, damaged, kinked, or restricted • Low engine coolant level	Step-Based Diagnostics (page 761)

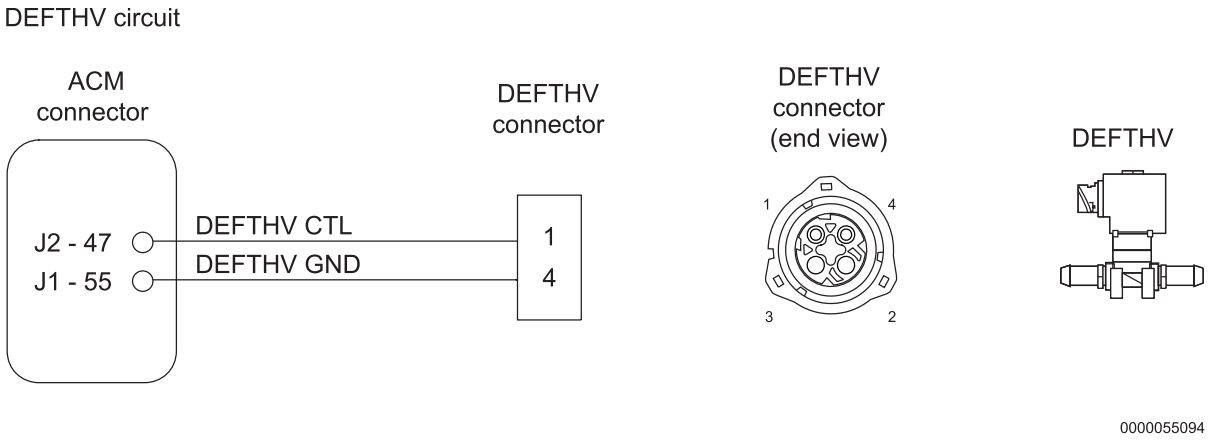


Figure 303 DEFTHC Circuit Diagram

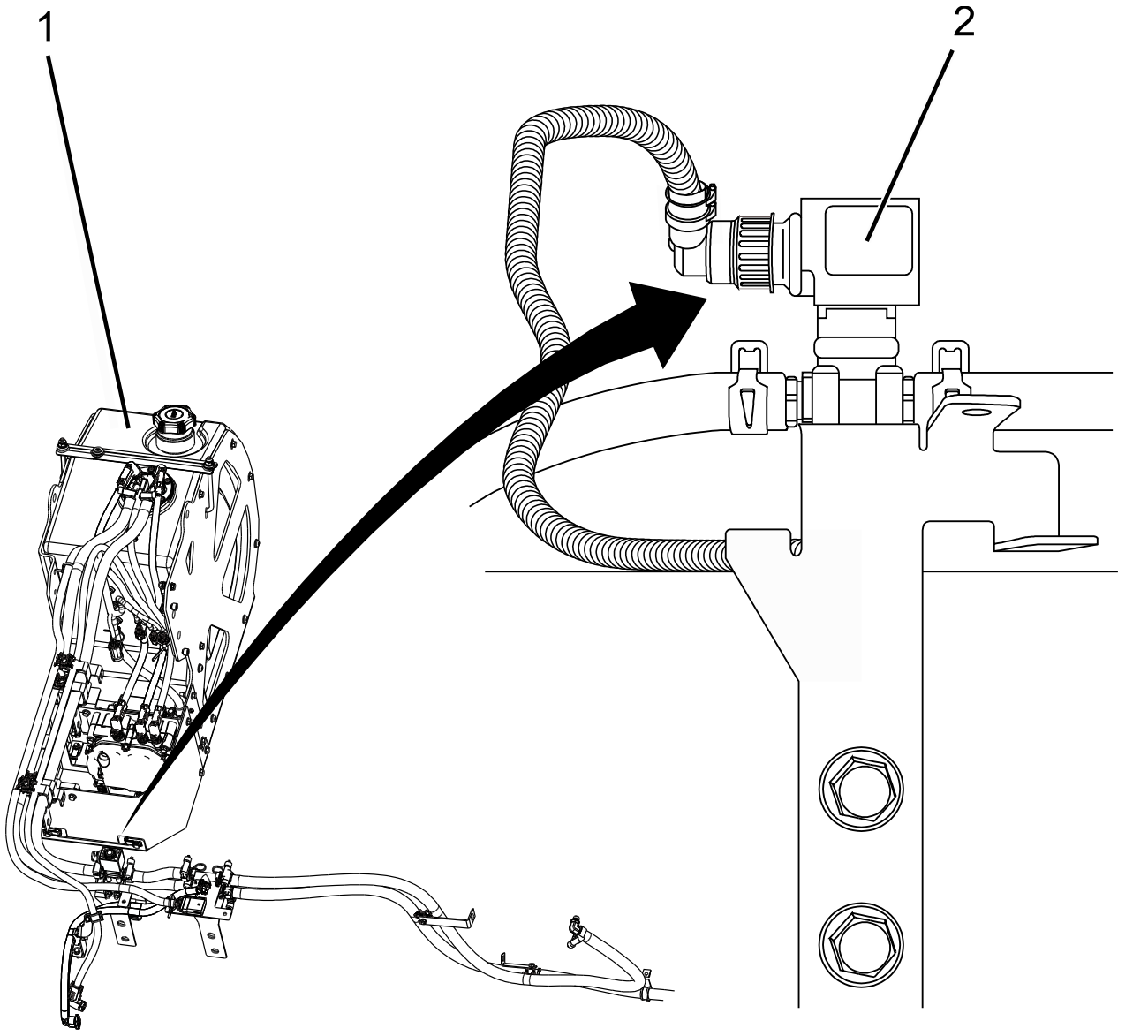
Overview

The Diesel Exhaust Fluid Tank Heater Valve (DEFTHC) controls the flow of coolant to the DEF tank to thaw or prevent freezing of the DEF. When DEF temperature is low, the Aftertreatment Control Module (ACM) commands the DEFTHC open to allow coolant flow to the DEF tank. The ACM opens the DEFTHC by sending power through the DEFTHC CTL circuit. The DEFTHC GND circuit is constantly grounded through the ACM.

Tools Required

- 180-Pin Breakout Box 00-00956-08
- ACM Breakout Harness 18-100-01
- Breakout Harness ZTSE4827
- Infrared Thermometer ZTSE4799
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software

- Interface cable (RP1210B compliant supporting J1939 and J1708)



0000057654

Figure 304 DEFTHC Location (Typical)

1. Diesel Exhaust Fluid (DEF) tank
2. Diesel Exhaust Fluid Tank Heater Valve (DEFTHC)

SPN 3363 FMI 3 - DEFTHC short to PWR (Open or high resistance)

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Exhaust Fluid Tank Heater Valve (DEFTHC) control line is shorted to high source or open.	The resistance between DEFTHC GND and DEFTHC CTL > 500,000 ohms	Key ON	3 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the voltage signal from the Diesel Exhaust Fluid Tank Heater Valve (DEFTHC) is high or open circuit. DEF tank heating is disabled. Engine torque will be reduced if fault is active for an extended period of time.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

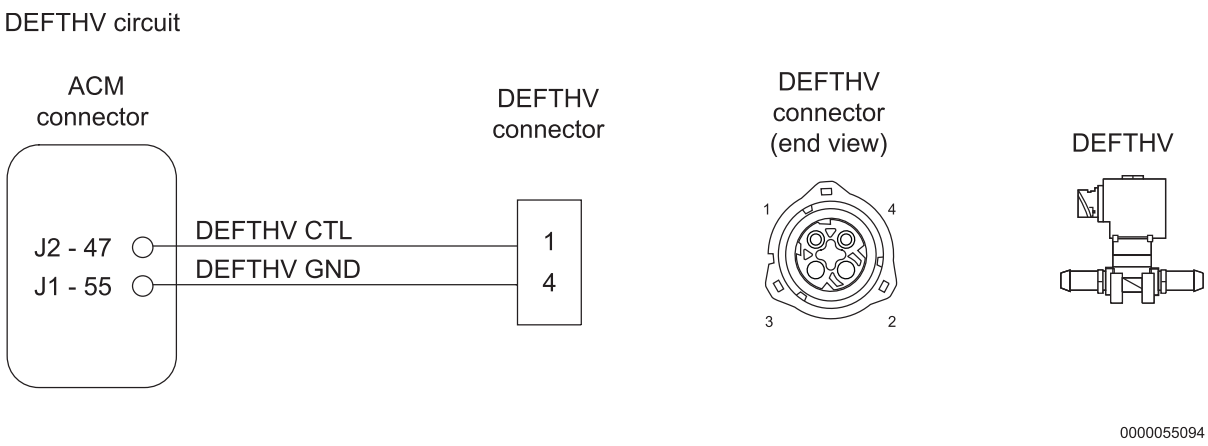


Figure 305 DEFTHC Circuit Diagram

Possible Causes

- DEFTHC CTL short to PWR
- DEFTHC CTL Open or high resistance
- DEFTHC GND Open or high resistance
- Failed DEFTHC

Step	Action	Decision
1	Inspect connections at Diesel Exhaust Fluid Tank Heater Valve (DEFTHC). Key OFF, disconnect DEFTHC. Check DEFTHC and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DEFTHC connector, harness, and terminals clean and undamaged?	Yes: Go to step 2. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3363 FMI 3.

Step	Action	Decision
2	Check DEFTHC CTL circuit for short to power. Connect Breakout Harness ZTSE4827 to DEFTHC connector and leave DEFTHC disconnected. Key-On Engine-Off (KOEO), measure voltage between Breakout Harness ZTSE4827 pin-1 and a known good ground. Is voltage less than 4 volts?	Yes: Go to step 3. No: Repair short to power between DEFTHC pin-1 and Aftertreatment Control Module (ACM) connector J2-47. After repairs are complete, retest for SPN 3363 FMI 3.

Step	Action	Decision
3	Check DEFTHC CTL circuit for Open or high resistance. Connect Breakout Harness ZTSE4827 to DEFTHC connector and leave DEFTHC disconnected. Connect 180-Pin Breakout Box and ACM Breakout Harness 18-100-01 to ACM harness and leave ACM disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness ZTSE4827 pin-1 and Breakout Box pin J2-47. Is resistance less than 5 ohms?	Yes: Go to step 4. No: Repair Open or high resistance between DEFTHC pin-1 and ACM connector J2-47. After repairs are complete, retest for SPN 3363 FMI 3.

Step	Action	Decision
4	Check DEFTHC GND circuit for Open or high resistance. Connect Breakout Harness ZTSE4827 to DEFTHC connector and leave DEFTHC disconnected. Connect 180-Pin Breakout Box and ACM Breakout Harness 18-100-01 to ACM harness and leave ACM disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness ZTSE4827 pin-4 and Breakout Box pin J1-55. Is resistance less than 5 ohms?	Yes: Replace DEFTHC. After repairs are complete, retest for SPN 3363 FMI 3. No: Repair Open or high resistance between DEFTHC pin-4 and ACM connector J1-55. After repairs are complete, retest for SPN 3363 FMI 3.

NOTE: After performing all diagnostic steps, if SPN 3363 FMI 3 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3363 FMI 4 - DEFTHC short to GND

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
DEFT T HTR CTL is shorted to ground.	The resistance between DEFTHC CTL and ground < 5 ohms	Key ON The Diesel Exhaust Fluid Tank Heater Valve (DEFTHC) is commanded ON.	3 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the voltage signal from the Diesel Exhaust Fluid Tank Heater Valve (DEFTHC) is low. DEF tank heating is disabled. Engine torque will be reduced if fault is active for an extended period of time.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

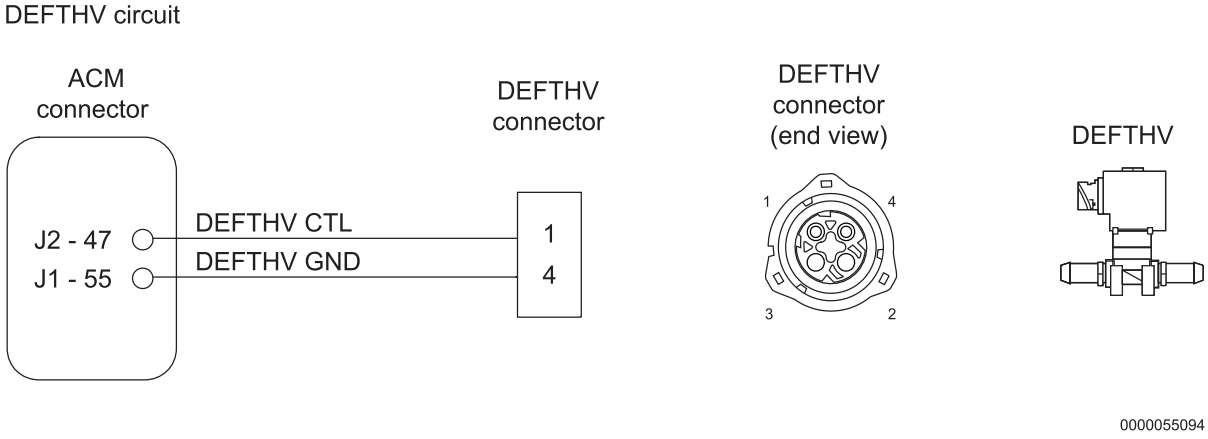


Figure 306 DEFTHC Circuit Diagram

Possible Causes

- DEFTHC CTL short to GND
- DEFTHC GND shorted to DEFTHC CTL
- Failed DEFTHC

Step	Action	Decision
1	Inspect connections at Diesel Exhaust Fluid Tank Heater Valve (DEFTHC). Key OFF, disconnect DEFTHC. Check DEFTHC and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DEFTHC connector, harness, and terminals clean and undamaged?	Yes: Go to step 2. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3363 FMI 4.

Step	Action	Decision
2	Check DEFTHC CTL circuit for short to ground. Connect Breakout Harness ZTSE4827 to DEFTHC connector and leave DEFTHC disconnected. Key OFF, use a DMM to measure resistance between Breakout harness ZTSE4827 pin-1, and a known good ground. Is resistance greater than 1000 ohms?	Yes: Go to step 3. No: Repair short to ground between DEFTHC connector pin-1 and ACM J2 connector pin-47. After repairs are complete, retest for SPN 3363 FMI 4.

Step	Action	Decision
3	Determine if DEFTHC GND circuit is shorted to DEFTHC CTL circuit. Connect Breakout Harness ZTSE4827 to DEFTHC connector and leave DEFTHC disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness ZTSE4827 pin-1 and pin-4. Is resistance greater than 1000 ohms?	Yes: Replace DEFTHC. After repairs are complete, retest for SPN 3363 FMI 4. No: Repair short between DEFTHC connector pin-1 and pin-4. After repairs are complete, retest for SPN 3363 FMI 4.

NOTE: After performing all diagnostic steps, if SPN 3363 FMI 4 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3363 FMI 7- DEFTHC Mechanical system not responding

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
The monitor checks whether the DEF tank temperature does not rise when DEF tank heating is active.	The DEF tank temperature change < 4°F (2°C)	Key-On Engine-Running (KOER) Inactive: SPN 3031 FMI 2, 3, and 4, SPN 3363 FMI 3, and 4. DEF tank temperature between 50°F (10°C) and -31°F (-35°C) Coolant temperature > 158°F (70°C) Ambient air temperature > -22°F (-30°C) DEF tank heater commanded ON	0 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) commands the Diesel Exhaust Fluid Tank Heater Valve (DEFTHC) ON and the signal from the DEF Tank Level and Temperature (DEFTLT) sensor module does not show an increase in DEF temperature.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 3031 FMI 2, 3, and 4 (DEFTLT), SPN 3363 FMI 3, and 4 (DEFTHC), SPN 4340 FMI 3, and 5 (DEFPLH), SPN 4342 FMI 5 (DEFRLH), SPN 4344 FMI 3, and 5 (DEFSLH), SPN 5745 FMI 3 and 4 (DEFDUH).

Drive Cycle to Determine Fault Status

Drive Cycle 23 in 2013 HD-OBD Diagnostic Reference Manual.

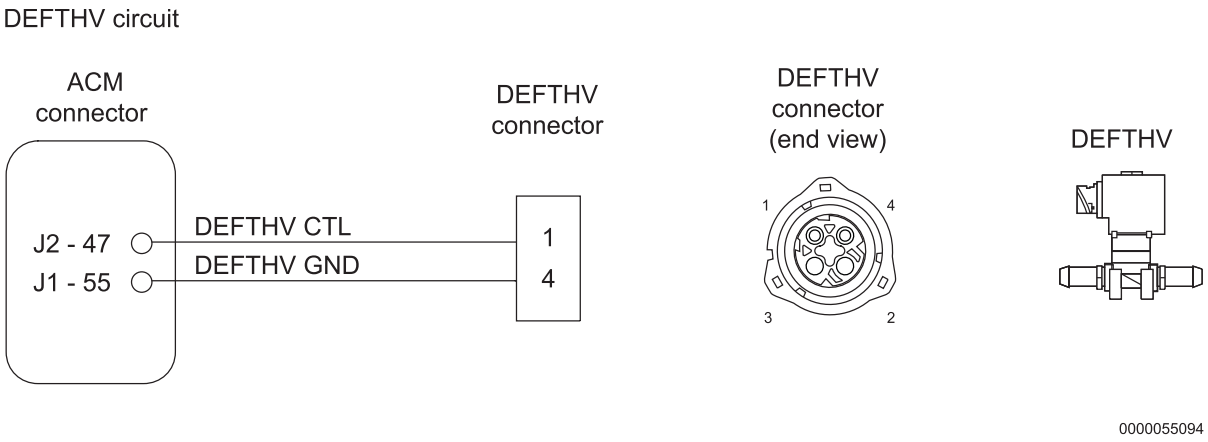


Figure 307 DEFTHC Circuit Diagram

Possible Causes

- Failed DEFTHC (stuck closed)
- Coolant line from DEFTHC to DEF tank leaking, damaged, kinked, or restricted
- Coolant supply line to DEFTHC leaking, damaged, kinked, or restricted
- Low engine coolant level

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3031 FMI 2, 3, and 4 (DEFTLT); SPN 3363 FMI 3 and 4 (DEFTHC); SPN 4340 FMI 3 and 5 (DEFPLH); SPN 4342 FMI 5 (DEFRLH); SPN 4344 FMI 3 and 5 (DEFSLH); and SPN 5745 FMI 3 and 4 (DEFDUH). Is EST DTC list free of SPN 3031 FMI 2, 3, and 4; SPN 3363 FMI 3 and 4; SPN 4340 FMI 3 and 5; SPN 4342 FMI 5; SPN 4344 FMI 3 and 5; and SPN 5745 FMI 3 and 4?	Yes: Go to step 2. No: Repair SPN 3031 FMI 2, 3, and 4; SPN 3363 FMI 3 and 4; SPN 4340 FMI 3 and 5; SPN 4342 FMI 5; SPN 4344 FMI 3 and 5; and SPN 5745 FMI 3 and 4. After repairs are complete, retest for SPN 3363 FMI 7.

Step	Action	Decision
2	Check engine coolant level. Is engine coolant at the correct level?	Yes: Go to step 2. No: Add engine coolant as necessary. After repairs are complete, retest for SPN 3363 FMI 7.

Step	Action	Decision
3	Check coolant line from DEFTHC to DEF tank for leaks or damage; kinks or restrictions; loose connections; and leaking seals or gaskets. Is coolant line from DEFTHC to DEF tank unrestricted and in good condition?	Yes: Go to step 4.
		No: Repair or replace leaking or damaged coolant line from DEFTHC to DEF tank, fittings, or seals. Check engine coolant level and add as necessary. After repairs are complete, retest for SPN 3363 FMI 7.

Step	Action	Decision
4	Check coolant supply line to DEFTHC for leaks or damage; kinks or restrictions; loose connections; and leaking seals or gaskets. Is coolant line from DEFTHC to DEF tank unrestricted and in good condition?	Yes: Replace DEFTHC. After repairs are complete, retest for SPN 3363 FMI 7.
		No: Repair or replace leaking or damaged coolant line from DEFTHC to DEF tank, fittings, or seals. Check engine coolant level and add as necessary. After repairs are complete, retest for SPN 3363 FMI 7.

NOTE: After performing all diagnostic steps, if SPN 3363 FMI 7 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3363 FMI 16 - DEFTHC stuck On fault

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Exhaust Fluid (DEF) tank heater circuit OK but DEF temperature above normal operating range.	Aftertreatment Control Module (ACM) determines Diesel Exhaust Fluid Tank Heater Valve (DEFTHC) is ON when commanded OFF.	Key ON DEF tank temperature > 170°F (77°C)	0 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) determines the Diesel Exhaust Fluid Tank Heater Valve (DEFTHC) is ON when commanded OFF due to DEF tank temperature above 170°F (77°C). Engine torque will be reduced if fault is active for an extended period of time.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 3031 FMI 2, 3, and 4 (DEFTLT), SPN 3363 FMI 3, and 4 (DEFTHC).

Fault Facts

If there is a problem with the DEFTHC, such as the valve stuck open, coolant leaking past the valve seat, or the valve is incorrectly installed, it can take long periods of operation at high load before tank temperature gradually increases to the fault code threshold of 170°F (77°C). When the temperature drops below 167°F (75°C) due to a stopped engine, overnight parking, or reduced coolant temperature, the fault code will go inactive while the root cause of the issue is still present.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

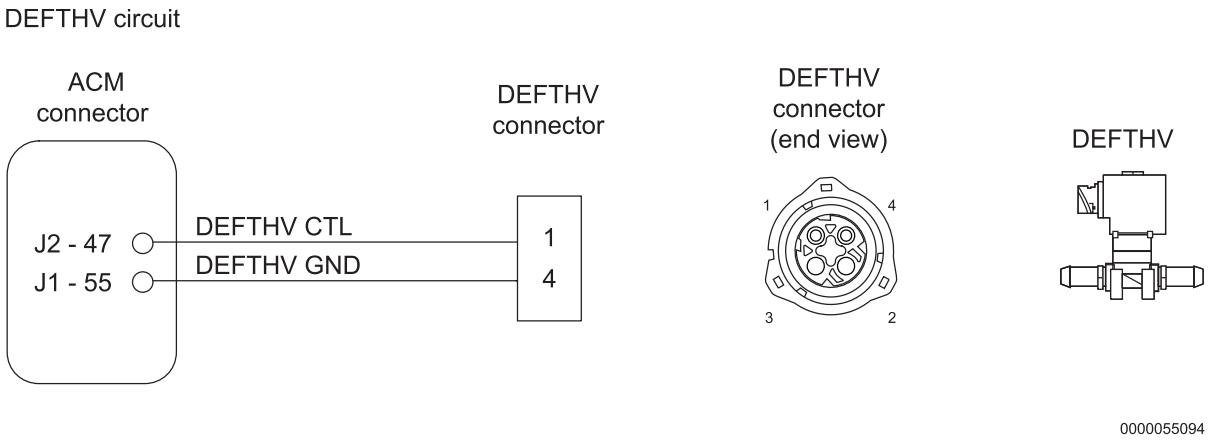


Figure 308 DEFTHC Circuit Diagram

Possible Causes

- Failed DEFTHC (stuck open)
- DEFTHC installed incorrectly (missing, bypassed, or reversed)
- Failed Diesel Exhaust Fluid Tank Level and Temperature (DEFTLT) sensor module
- Auxiliary DEF tank heater installed

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3031 FMI 2, 3, and 4 (DEFTLT); SPN 3363 FMI 3, and 4 (DEFTHC). Is EST DTC list free of SPN 3031 FMI 2, 3, and 4; SPN 3363 FMI 3, and 4?	Yes: Go to step 2. No: Repair SPN 3031 FMI 2, 3, and 4; SPN 3363 FMI 3, and 4. After repairs are complete, retest for SPN 3363 FMI 16.

Step		Decision
2	Inspect vehicle for an auxiliary Diesel Exhaust Fluid (DEF) tank heater. Is vehicle free of an auxiliary DEF tank heater?	Yes: Go to step 3. No: Remove auxiliary DEF tank heater. After repairs are complete, retest for SPN 3363 FMI 16.

Step	Action	Decision
3	Check for failed Diesel Exhaust Fluid Tank Level and Temperature (DEFTLT) sensor module. Using EST with ServiceMaxx software, load the signals session and monitor the DEF Tank Temp signal. Measure DEF tank temperature using Infrared Thermometer ZTSE4799 from the bottom of the DEF tank. Is EST reading within 18°F (10°C) of Infrared Thermometer reading?	Yes: Go to step 4. No: Replace DEFTLT sensor. After repairs are complete, retest for SPN 3363 FMI 16.

Step	Action	Decision
4	Verify Diesel Exhaust Fluid Tank Heater Valve (DEFTHC) is installed correctly (not missing, bypassed, or reversed). Is the DEFTHC installed correctly?	Yes: Replace DEFTHC. After repairs are complete, retest for SPN 3363 FMI 16.
		No: Install DEFTHC correctly (see Exhaust System Service Manual). After repairs are complete, retest for SPN 3363 FMI 16.

NOTE: After performing all diagnostic steps, if SPN 3363 FMI 16 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3363 FMI 18 - DEFTHC unable to thaw frozen DEF

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Exhaust Fluid (DEF) tank temperature has failed to reach a target threshold within a predetermined time after heating is commanded.	The DEF tank temperature remains less than 19°F (-7°C) after the DEF tank heating is commanded active.	Key-On Engine-Running (KOER) Inactive: SPN 3031 FMI 2, 3, and 4, SPN 3363 FMI 3, and 4. DEF tank temperature between 50°F (10°C) and -31°F (-35°C) Coolant temperature > 158°F (70°C) Ambient air temperature > -22°F (-30°C) DEF tank heater commanded ON	0 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) determines the Diesel Exhaust Fluid Tank Heater Valve (DEFTHC) has been on long enough to thaw the DEF, but the DEF dosing system is unable to prime.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 3031 FMI 2, 3, and 4 (DEFTLT), SPN 3363 FMI 3, and 4 (DEFTHC).

Drive Cycle to Determine Fault Status

Drive Cycle 24 in 2013 HD-OBD Diagnostic Reference Manual.

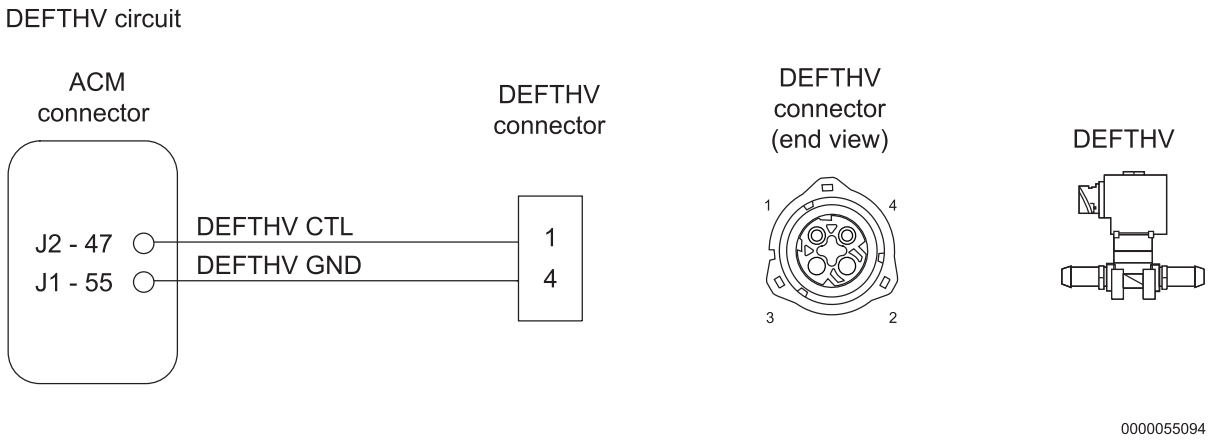


Figure 309 DEFTHC Circuit Diagram

Possible Causes

- Failed DEFTHC (stuck closed)
- Coolant line from DEFTHC to DEF tank leaking, damaged, kinked, or restricted
- Coolant supply line to DEFTHC leaking, damaged, kinked, or restricted
- Low engine coolant level

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3031 FMI 2, 3, and 4 (DEFTLT), SPN 3363 FMI 3, and 4 (DEFTHC). Is EST DTC list free of SPN 3031 FMI 2, 3, and 4; SPN 3363 FMI 3, and 4?	Yes: Go to step 2. No: Repair SPN 3031 FMI 2, 3, and 4; SPN 3363 FMI 3, and 4. After repairs are complete, retest for SPN 3363 FMI 18.

Step	Action	Decision
2	Check engine coolant level. Is engine coolant at the correct level?	Yes: Go to step 3. No: Add engine coolant as necessary. After repairs are complete, retest for SPN 3363 FMI 18.

Step	Action	Decision
3	Check coolant line from DEFTHC to DEF tank for leaks or damage; kinks or restrictions; loose connections; and leaking seals or gaskets. Is coolant line from DEFTHC to DEF tank unrestricted and in good condition?	Yes: Go to step 4.
		No: Repair or replace leaking or damaged coolant line from DEFTHC to DEF tank, fittings, or seals. Check engine coolant level and add as necessary. After repairs are complete, retest for SPN 3363 FMI 18.

Step	Action	Decision
4	Check coolant supply line to DEFTHC for leaks or damage; kinks or restrictions; loose connections; and leaking seals or gaskets. Is coolant line from DEFTHC to DEF tank unrestricted and in good condition?	Yes: Replace DEFTHC. After repairs are complete, retest for SPN 3363 FMI 18.
		No: Repair or replace leaking or damaged coolant line from DEFTHC to DEF tank, fittings, or seals. Check engine coolant level and add as necessary. After repairs are complete, retest for SPN 3363 FMI 18.

NOTE: After performing all diagnostic steps, if SPN 3363 FMI 18 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

DEFTLT (Diesel Exhaust Fluid Tank Level and Temperature) Sensor Module

SPN	FMI	Condition	Possible Causes	Actions
1761	1	DEFTL Inducement (Level 3 - 5)	• Low DEF tank level • Failed Diesel Exhaust Fluid Tank Level and Temperature (DEFTLT) sensor module	Step-Based Diagnostics (page 768)
1761	3	DEFTL signal Out of Range HIGH	• Failed DEFTLT sensor module	Step-Based Diagnostics (page 771)
1761	4	DEFTL signal Out of Range LOW	• Failed DEFTLT sensor module	Step-Based Diagnostics (page 773)
1761	10	DEF Level abnormal rate of change	• Failed DEFTLT sensor module	Step-Based Diagnostics (page 775)
1761	11	DEFTL signal erratic, intermittent, or incorrect	• Failed DEFTLT sensor module • SWBAT circuit intermittent short to GND or high resistance • Power Distribution Module (PDM) loose fuse or relay • GND circuit intermittent high resistance	Step-Based Diagnostics (page 778)
1761	17	DEFTL Inducement Level 1	• Low DEF tank level • Failed DEFTLT sensor module	Step-Based Diagnostics (page 781)
1761	18	DEFTL Inducement Level 2	• Low DEF tank level • Failed DEFTLT sensor module	Step-Based Diagnostics (page 784)

1761	19	DEFTL not detected on J1939	• SWBAT circuit short to GND or Open • CAN-AH circuit Open or short to GND • CAN-AL circuit Open or short to GND • CAN-AH circuit short to power • CAN-AL circuit short to power • GND circuit Open or high resistance • CAN-AH short to CAN-AL • Failed DEFTLT sensor module	Step-Based Diagnostics (page 787)
3031	2	DEFTT signal erratic, intermittent or incorrect	• Failed DEFTLT sensor module • SWBAT circuit intermittent short to GND or high resistance • Power Distribution Module (PDM) loose fuse or relay • GND circuit intermittent high resistance	Step-Based Diagnostics (page 791)
3031	3	DEFTT signal Out of Range HIGH	• Failed DEFTLT sensor module	Step-Based Diagnostics (page 794)
3031	4	DEFTT signal Out of Range LOW	• Failed DEFTLT sensor module	Step-Based Diagnostics (page 796)
3031	9	Diesel Exhaust Fluid Tank Temperature (DEFTT) signal erratic intermittent or incorrect	• Failed DEFTLT sensor module • SWBAT circuit intermittent short to GND or high resistance • Power Distribution Module (PDM) loose fuse or relay	Step-Based Diagnostics (page 798)

- GND circuit intermittent high resistance or Open

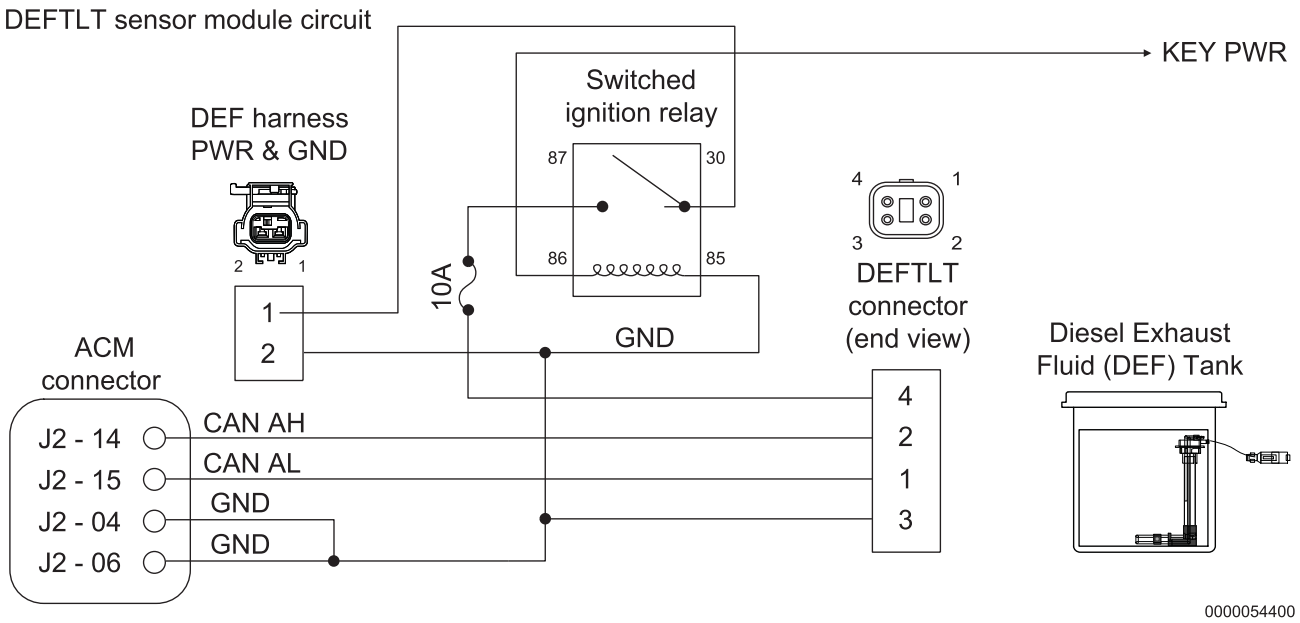


Figure 310 DEFTLT Sensor Module Circuit Diagram

NOTE: See latest version of N13 with SCR Engine and Aftertreatment Wiring Schematic Form 0000002203 for additional circuit information.

Overview

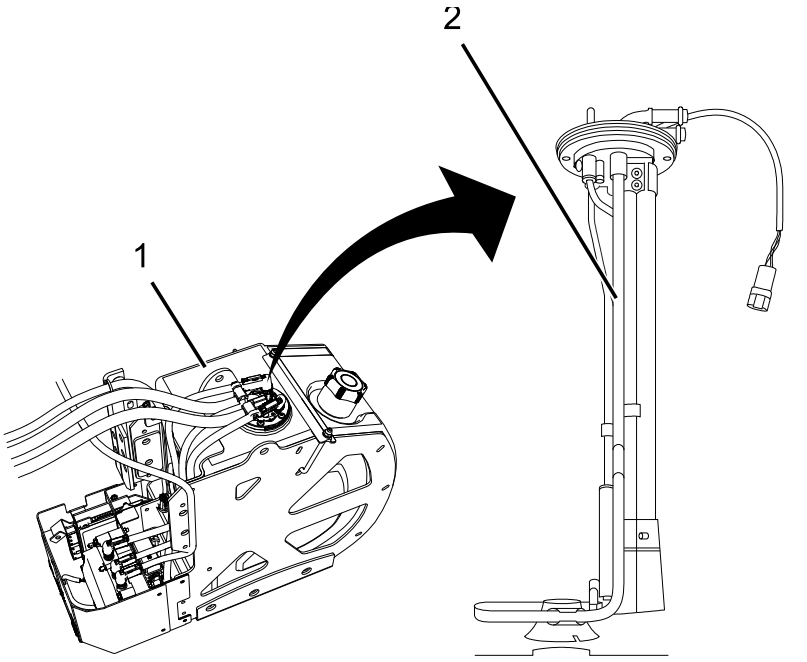
The Diesel Exhaust Fluid Tank Level and Temperature (DEFTLT) sensor module is a combination sensor used to monitor DEF tank level and temperature. The DEFTLT sensor module is installed inside the DEF tank and is a smart sensor that communicates to the Aftertreatment Control Module (ACM) through the J1939 Private CAN.

DEF Tank Level Inducement (Level 1–5).

- **Level 1**: SPN 1761 FMI 17 active, no lamp
- **Level 2**: SPN 1761 FMI 18 active, no lamp
- **Level 3**: SPN 1761 FMI 1 active, no lamp
- **Level 4–5** SPN 1761 FMI 1 active, Red Stop Lamp (RSL) active

Tools Required

- 180-Pin Breakout Box 00-00956-08
- ACM Breakout Harness 18-100-01
- Breakout Harness 18-124-01
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)



0000057022

Figure 311 DEFTLT location

1. Diesel Exhaust Fluid (DEF) tank
2. Diesel Exhaust Fluid Tank Level and Temperature (DEFTLT) sensor module

SPN 1761 FMI 1- DEFTL Inducement (Level 3–5)

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Exhaust Fluid (DEF) level below critical threshold. Level 3 through 5 inducement.	DEF tank level < 2.2%	Key ON	0 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Diesel Exhaust Fluid Tank Level (DEFTL) is less than 2.2% full. Engine torque will be reduced if fault is active for a limited period of time. Engine torque will be severely reduced after extended engine operation with the fault code active.

Malfunction Indicator Lamp (MIL) Reaction

Level 3, no lamp will illuminate. Levels 4 or 5, Red Stop Lamp will illuminate.

Associated Faults

SPN 1761 FMI 3, 4, and 19 (DEFTLT).

Fault Facts

This fault may become active during control module programming. To fix this fault, finish programming, then cycle ignition switch.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

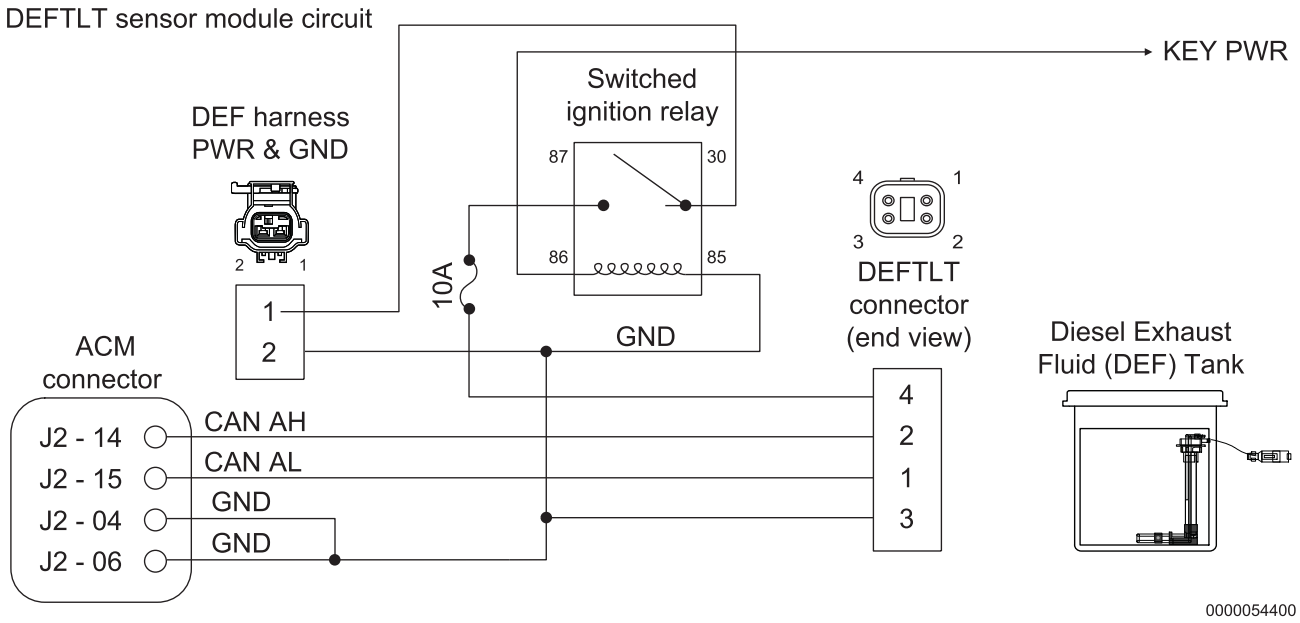


Figure 312 DEFTLT Sensor Module Circuit Diagram

Possible Causes

- Low DEF tank level
- Failed Diesel Exhaust Fluid Tank Level and Temperature (DEFTLT) sensor module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 1761 FMI 3, 4, and 19 (DEFTLT). Is EST DTC list free of SPN 1761 FMI 3, 4, and 19?	Yes: Go to step 2. No: Repair SPN 1761 FMI 3, 4, and 19. After repairs are complete, retest for SPN 1761 FMI 1.

Step	Action	Decision
2	Inspect Diesel Exhaust Fluid (DEF) tank and lines for damage and leaks. Are the DEF tank and lines free of damage and not leaking?	Yes: Go to step 3. No: Repair damaged or leaking DEF tank and lines. After repairs are complete, retest for SPN 1761 FMI 1.

Step	Action	Decision
3	Check DEF tank level. Read DEF level using the vehicle instrument panel gauge and perform a visual inspection of fluid level in the DEF tank. Is DEF tank fluid level above 1/2 tank?	Yes: Replace DEFTLT sensor module. After repairs are complete, retest for SPN 1761 FMI 1.
		No: Fill DEF tank with appropriate diesel exhaust fluid. After repairs are complete, retest for SPN 1761 FMI 1.

NOTE: After doing all diagnostic steps, if SPN 1761 FMI 1 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 1761 FMI 3 - Diesel Exhaust Fluid Tank Level (DELFT) signal Out of Range High

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Exhaust Fluid (DEF) tank level sensor circuit voltage above normal or shorted to high source.	The Aftertreatment Control Module (ACM) detects the DEF tank level signal voltage is greater than 4.5 V for more than 1 second.	Key ON	1 second

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Diesel Exhaust Fluid Tank Level (DEFTL) signal voltage is greater than 4.5 volts for more than 1 second. Engine torque will be reduced if fault is active for a limited period of time. Engine torque will be severely reduced after extended engine operation with the fault code active.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

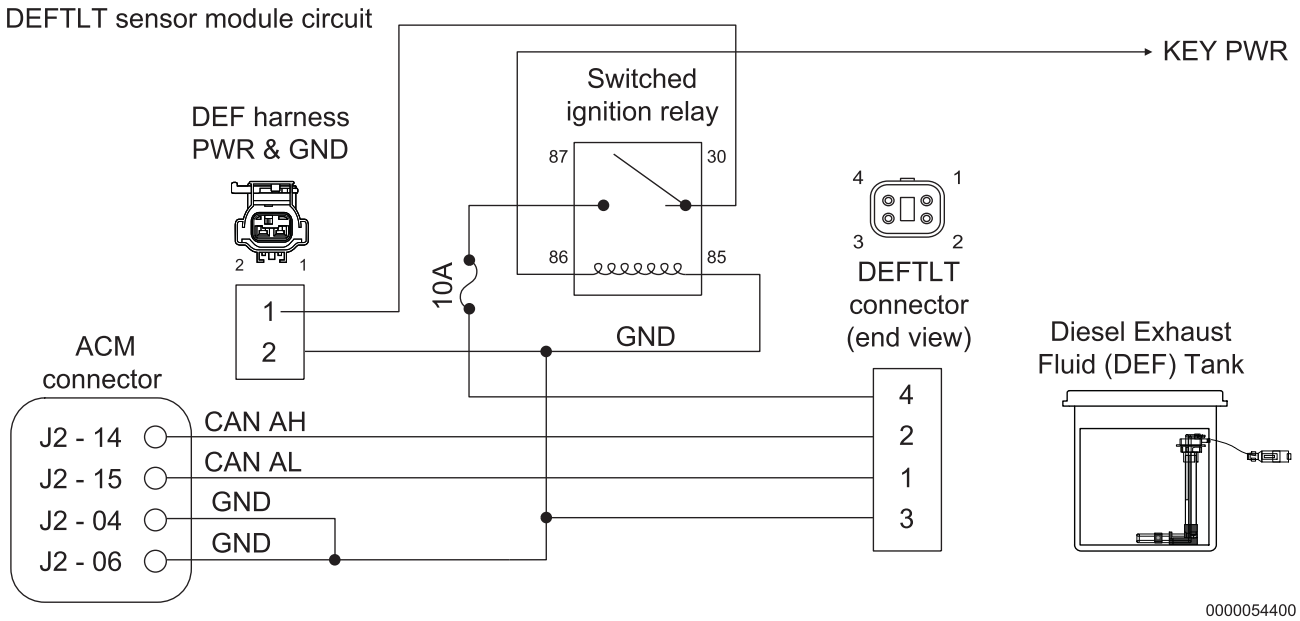


Figure 313 DEFTLT Sensor Module Circuit Diagram

Possible Causes

- Failed DEFTLT sensor module

Step	Action	Decision
1	Inspect connections at Diesel Exhaust Fluid Tank Level Temperature (DEFTLT) sensor module. Key OFF, disconnect DEFTLT sensor module. Check DEFTLT sensor module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DEFTLT sensor module connector, harness, and terminals clean and undamaged?	Yes: Replace DEFTLT sensor module. After repairs are complete, retest for SPN 1761 FMI 3. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 1761 FMI 3.

NOTE: After doing all diagnostic steps, if SPN 1761 FMI 3 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 1761 FMI 4 - Diesel Exhaust Fluid Tank Level (DELFT) signal Out of Range Low

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Exhaust Fluid (DEF) tank level sensor circuit voltage below normal or shorted to low source.	The Aftertreatment Control Module (ACM) detects the DEF tank level signal voltage is less than 0.25 V for more than 1 second.	Key ON	1 second

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Diesel Exhaust Fluid Tank Level (DEFTL) signal voltage is less than 0.25 volts for more than 1 second. Engine torque will be reduced if fault is active for a limited period of time.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

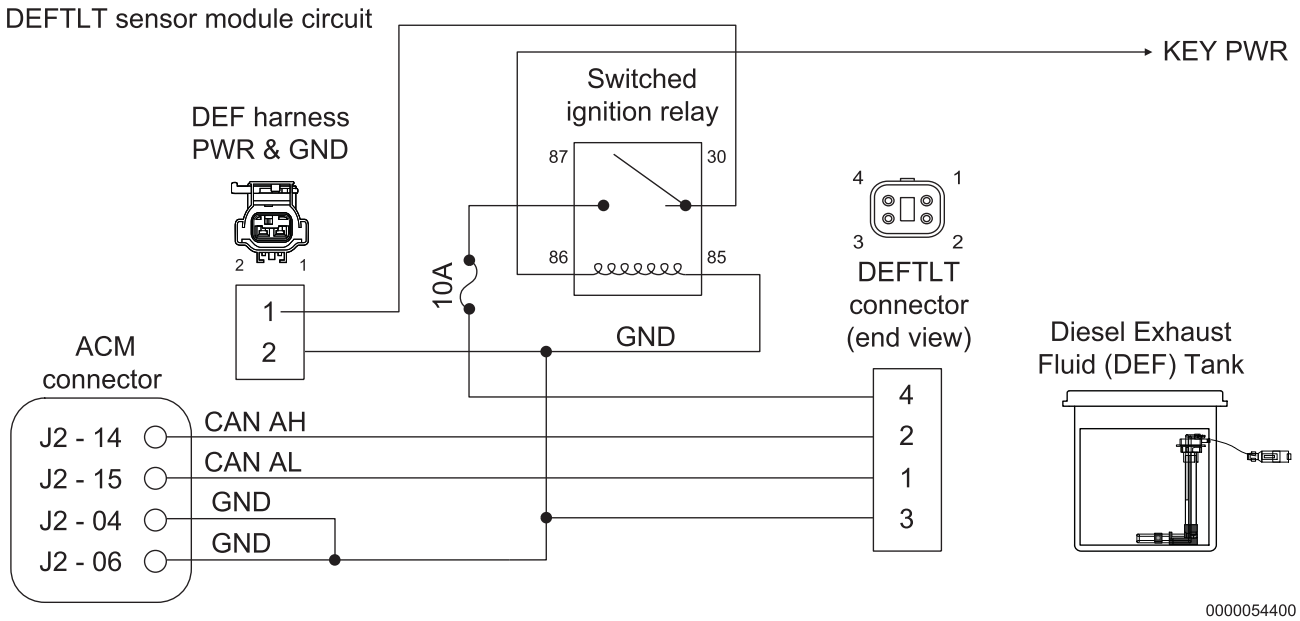


Figure 314 DEFTLT Sensor Module Circuit Diagram

Possible Causes

- Failed DEFTLT sensor module

Step	Action	Decision
1	Inspect connections at Diesel Exhaust Fluid Tank Level Temperature (DEFTLT) sensor module. Key OFF, disconnect DEFTLT sensor module. Check DEFTLT sensor module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DEFTLT sensor module connector, harness, and terminals clean and undamaged?	Yes: Replace DEFTLT sensor module. After repairs are complete, retest for SPN 1761 FMI 4. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 1761 FMI 4.

NOTE: After doing all diagnostic steps, if SPN 1761 FMI 4 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 1761 FMI 10 - Diesel Exhaust Fluid (DEF) Level abnormal rate of change

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Exhaust Fluid (DEF) tank level sensor circuit abnormal rate of change. A valid DEF tank level reading has not been received.	DEF tank level reading was invalid for an extended period of time.	Key ON	2 events

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Diesel Exhaust Fluid Tank Level (DEFTL) signal is invalid for an extended period of time. Engine torque will be reduced if fault is active for a limited period of time.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 1761 FMI 3, 4, and 19 (DEFTLT).

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

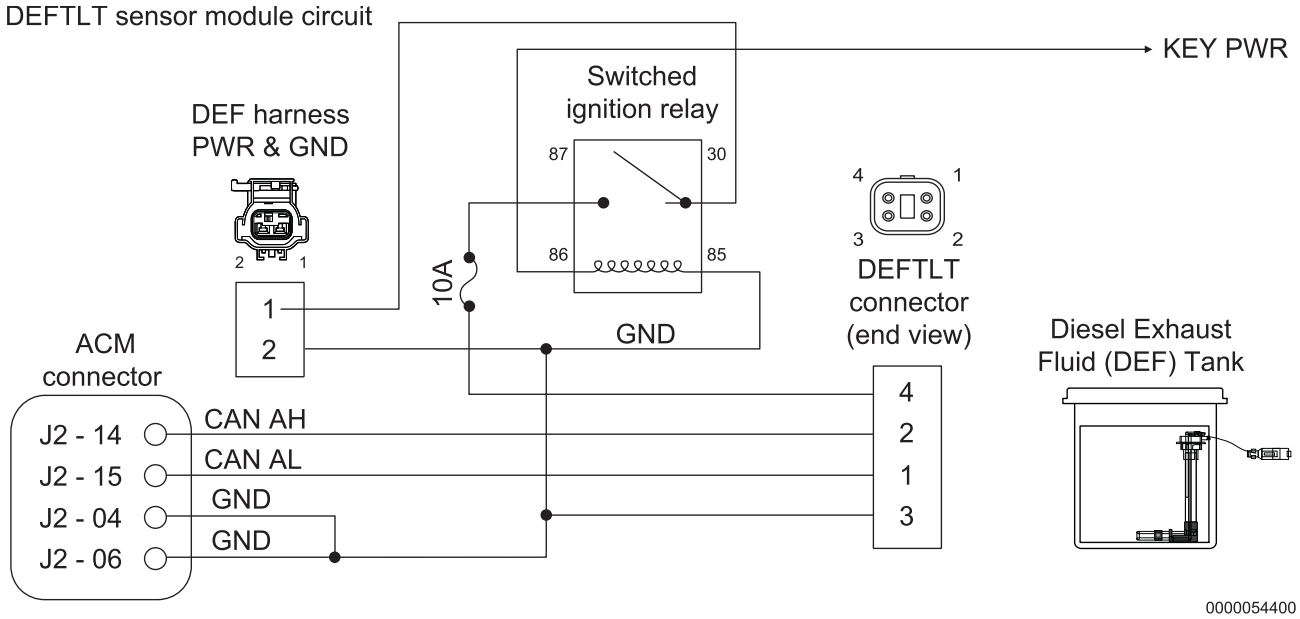


Figure 315 DEFTLT Sensor Module Circuit Diagram

Possible Causes

- Failed DEFTLT sensor module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 1761 FMI 3, 4, and 19 (DEFTLT). Is EST DTC list free of SPN 1761 FMI 3, 4, and 19?	Yes: Go to step 2. No: Repair SPN 1761 FMI 3, 4, and 19. After repairs are complete, retest for SPN 1761 FMI 10.

Step	Action	Decision
2	Inspect connections at Diesel Exhaust Fluid Tank Level Temperature (DEFTLT) sensor module. Key OFF, disconnect DEFTLT sensor module. Check DEFTLT sensor module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DEFTLT sensor module connector, harness, and terminals clean and undamaged?	Yes: Replace DEFTLT sensor module. After repairs are complete, retest for SPN 1761 FMI 10. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 1761 FMI 10.

NOTE: After doing all diagnostic steps, if SPN 1761 FMI 10 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 1761 FMI 11 - Diesel Exhaust Fluid Tank Level (DEFTL) signal erratic intermittent or incorrect

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Exhaust Fluid (DEF) tank level sensor circuit abnormal rate of change. A valid DEF tank level reading has not been received.	DEF tank level reading was invalid for an extended period of time.	Key ON	2 events

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Diesel Exhaust Fluid Tank Level (DEFTL) signal is invalid for an extended period of time. Engine torque will be reduced if fault is active for a limited period of time.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 1761 FMI 3, 4, and 19 (DEFTLT).

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

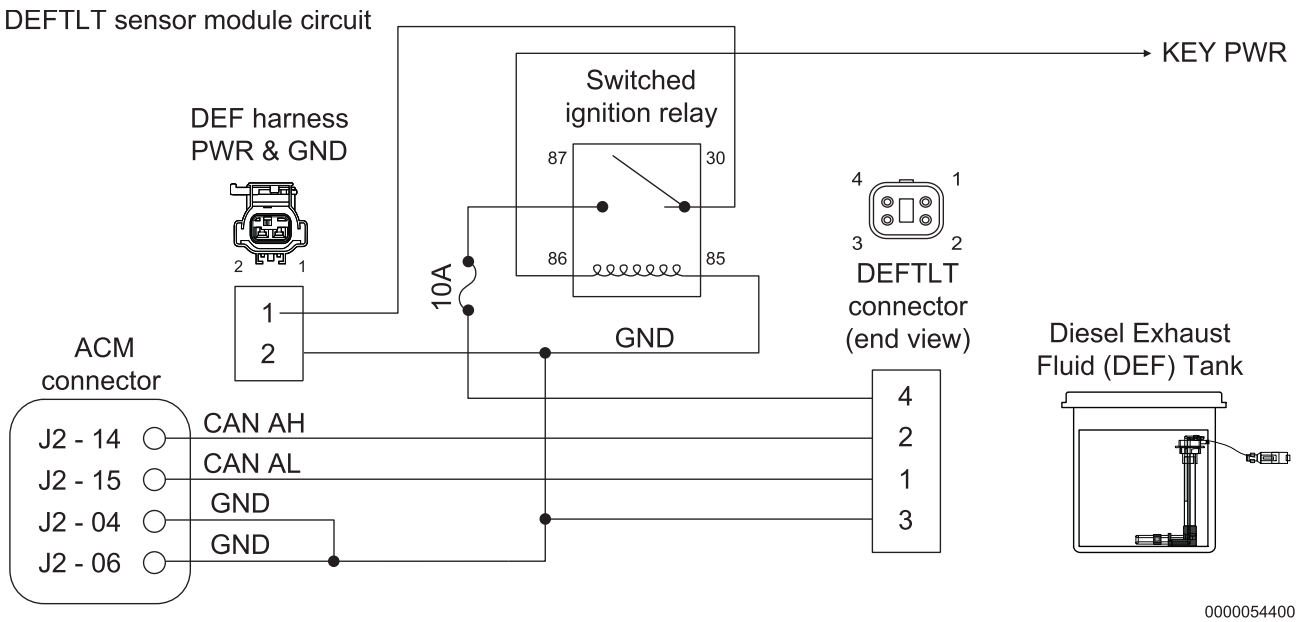


Figure 316 DEFTLT Sensor Module Circuit Diagram

Possible Causes

- Failed DEFTLT sensor module

- SWBAT circuit intermittent short to GND or high resistance
- Power Distribution Module (PDM) loose fuse or relay
- GND circuit intermittent high resistance or Open

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 1761 FMI 3, 4, and 19 (DEFTLT). Is EST DTC list free of SPN 1761 FMI 3, 4, and 19?	Yes: Go to step 2. Repair SPN 1761 FMI 3, 4, and 19. After repairs are complete, retest for SPN 1761 FMI 11

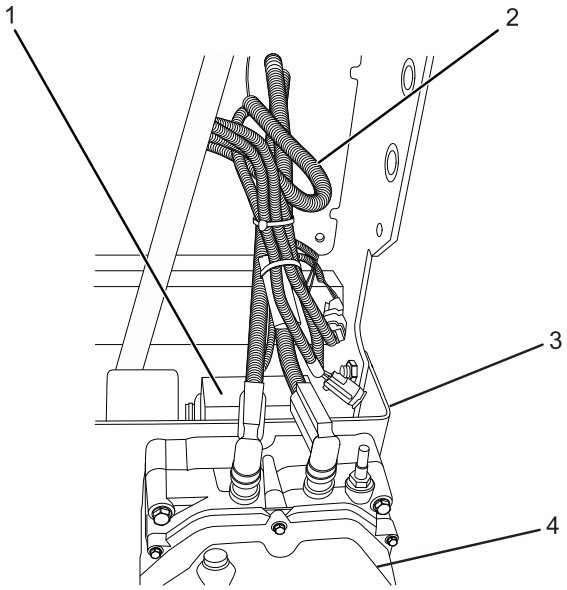


Figure 317 PDM Location (typical)

1. Power Distribution Module (PDM)
2. Diesel Exhaust Fluid (DEF) tank assembly
3. DEF supply module bracket
4. DEF supply module

Step	Action	Decision
2	Check Power Distribution Module (PDM) fuse(s) and relay(s) for blown fuses; loose, missing, or intermittent connections. Are all fuses and relays securely attached and in good condition?	Yes: Go to step 3. No: Secure or replace failed fuse(s) or relay(s) to PDM connector. After repairs are complete, retest for SPN retest for SPN 1761 FMI 11.

NOTE: Verify batteries are fully charged and connections are clean.

Step	Action	Decision
3	Inspect connections at Diesel Exhaust Fluid Tank Level Temperature (DEFTLT) sensor module. Key OFF, disconnect DEFTLT sensor module. Check DEFTLT sensor module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DEFTLT sensor module connector, harness, and terminals clean and undamaged?	Yes: Go to step 4. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 1761 FMI 11.

NOTE: If more than one of the following sensor modules fail (or set a fault), suspect a common power circuit, ground circuit, or Switched Ignition Relay problem. The following components share power and ground circuits with the DEFTLT sensor module:

- NOx OUT sensor module
- NOx IN sensor module
- Ammonia (NH_3) Sensor Module
- SCR Temperature Sensor Module
- DOC / DPF temperature sensor module

NOTE: Verify batteries are fully charged and connections are clean.

Step	Action	Decision
4	Check voltage to the DEFTLT sensor module. Key-On Engine-Off (KOEO), with Breakout Harness 18-124-01 connected to DEFTLT sensor module, use a DMM to measure voltage between DEFTLT sensor module pin-3 and pin-4. Is voltage within 0.5 volts of battery voltage?	Yes: Replace DEFTLT sensor module. After repairs are complete, retest for SPN 1761 FMI 11. No: Go to step 5.

Step	Action	Decision
5	Check SWBAT circuit for intermittent high resistance or short to ground. Connect Breakout Harness 18–124–01 and leave DEFTLT sensor module disconnected. (KOEO), measure voltage between Breakout Harness 18-124-01 pin-4 and a known good ground (wiggle test may be necessary if code is inactive or pending). Is voltage within 0.5 volts of battery voltage?	Yes: Repair high resistance between DEFTLT sensor module pin-3 and ground. After repairs are complete, retest for SPN 1761 FMI 11. No: Repair high resistance or short to ground between DEFTLT sensor module pin-4 and switched ignition relay pin-87. After repairs are complete, retest for SPN 1761 FMI 11.

NOTE: After doing all diagnostic steps, if SPN 1761 FMI 11 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 1761 FMI 17 - DEFTL Inducement (Level 1)

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Exhaust Fluid (DEF) level below critical threshold. Level 1 inducement.	DEF tank level < 10%	Key ON	0 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects that the Diesel Exhaust Fluid Tank Level (DEFTL) is less than 10% full. Engine torque will be reduced if fault is active for a limited period of time.

Malfunction Indicator Lamp (MIL) Reaction

When fault is active, MIL will not illuminate.

Associated Faults

SPN 1761 FMI 3, 4, and 19 (DEFTLT).

Fault Facts

This fault may become active during control module programming. To fix this fault, finish programming, then cycle ignition switch.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

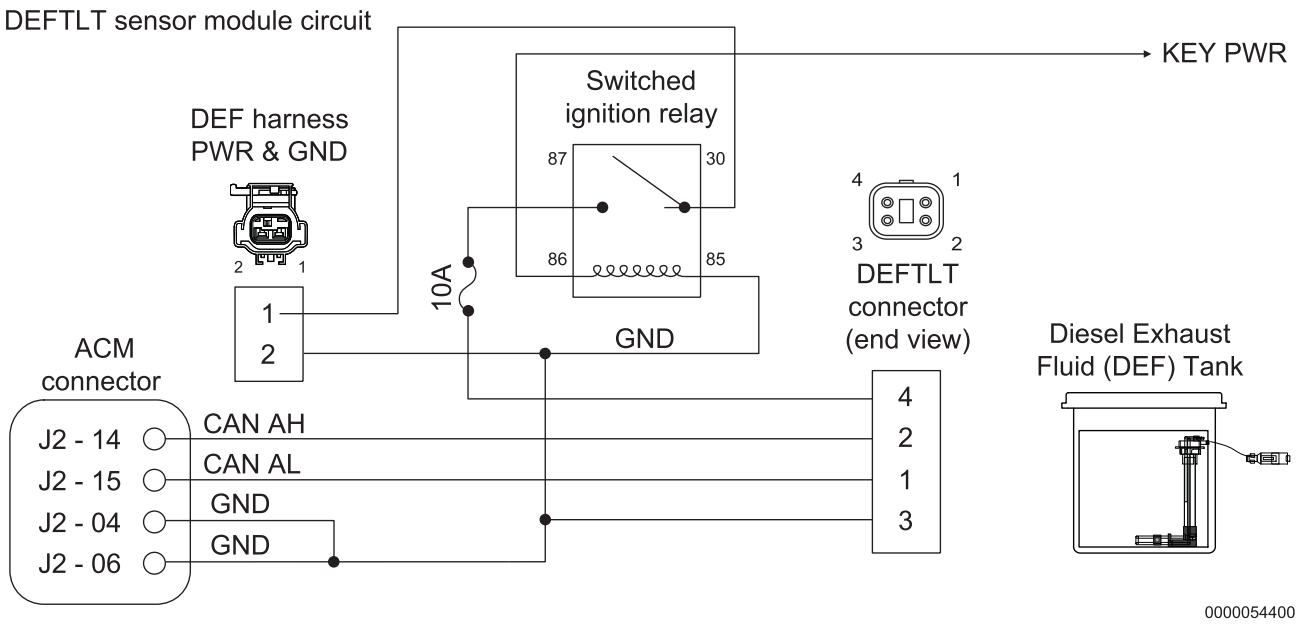


Figure 318 DEFTLT Sensor Module Circuit Diagram

Possible Causes

- Low DEF tank level
- Failed DEFTLT sensor module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 1761 FMI 3, 4, and 19 (DEFTLT). Is EST DTC list free of SPN 1761 FMI 3, 4, and 19?	Yes: Go to step 2. No: Repair SPN 1761 FMI 3, 4, and 19. After repairs are complete, retest for SPN 1761 FMI 17.

Step	Action	Decision
2	Inspect Diesel Exhaust Fluid (DEF) tank and lines for damage and leaks. Are the DEF tank and lines free of damage and not leaking?	Yes: Go to step 3. No: Repair damaged or leaking DEF tank and lines. After repairs are complete, retest for SPN 1761 FMI 17.

Step	Action	Decision
3	Check DEF tank level. Read DEF level using the vehicle instrument panel gauge and do visual inspection of fluid level in the DEF tank. Is DEF tank fluid level below 1/2 tank?	Yes: Fill DEF tank with appropriate diesel exhaust fluid. After repairs are complete, retest for SPN 1761 FMI 17. No: Go to step 4.

Step	Action	Decision
4	Inspect connections at Diesel Exhaust Fluid Tank Level and Temperature (DEFTLT) sensor module. Key OFF, disconnect DEFTLT sensor module. Check DEFTLT sensor module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DEFTLT sensor module connector, harness, and terminals clean and undamaged?	Yes: Replace DEFTLT sensor module. After repairs are complete, retest for SPN 1761 FMI 17. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 1761 FMI 17.

NOTE: After doing all diagnostic steps, if SPN 1761 FMI 17 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 1761 FMI 18 - DEFTL Inducement (Level 2)

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Exhaust Fluid (DEF) level below critical threshold. Level 2 inducement.	DEF tank level < 5.6%	Key ON	0 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Diesel Exhaust Fluid Tank Level (DEFTL) is less than 5.6% full. Engine torque will be reduced if fault is active for a limited period of time.

Malfunction Indicator Lamp (MIL) Reaction

When fault is active, MIL will not illuminate.

Associated Faults

SPN 1761 FMI 3, 4, and 19 (DEFTLT).

Fault Facts

This fault may become active during control module programming. To fix this fault, finish programming, then cycle ignition switch.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

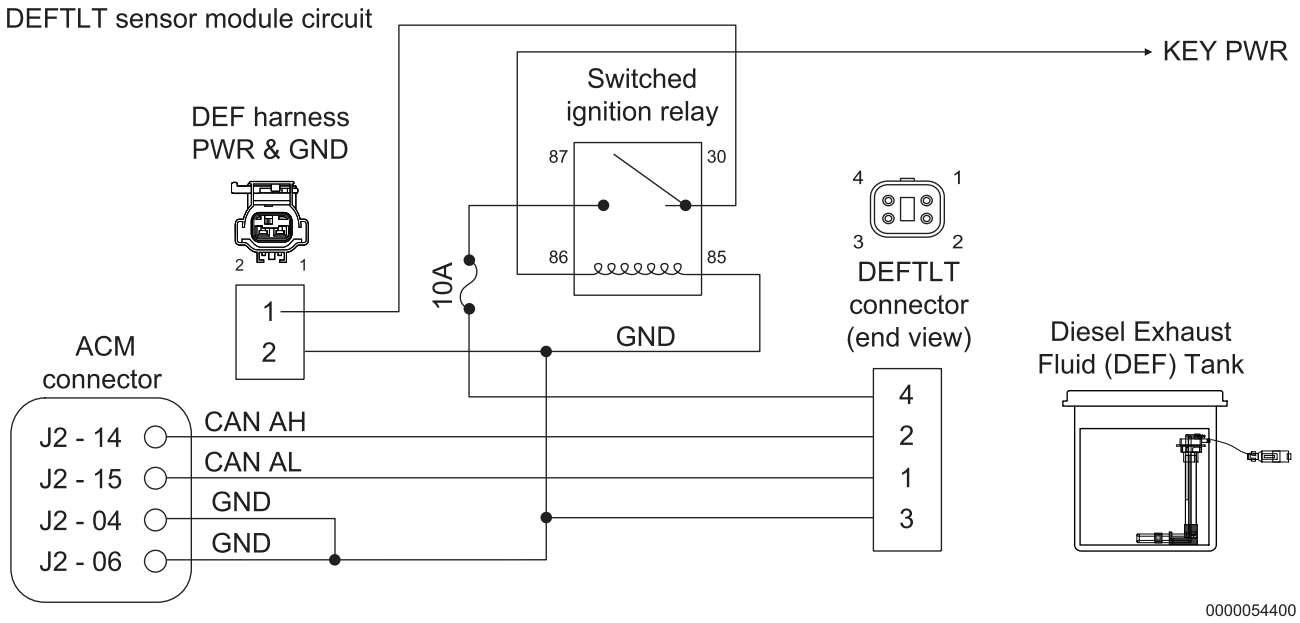


Figure 319 DEFTLT Sensor Module Circuit Diagram

Possible Causes

- Low DEF tank level
- Failed DEFTLT sensor module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 1761 FMI 3, 4, and 19 (DEFTLT). Is EST DTC list free of SPN 1761 FMI 3, 4, and 19?	Yes: Go to step 2. Repair SPN 1761 FMI 3, 4, and 19. After repairs are complete, retest for SPN 1761 FMI 18.

Step	Action	Decision
2	Inspect Diesel Exhaust Fluid (DEF) tank and lines for damage and leaks. Are the DEF tank and lines free of damage and not leaking?	Yes: Go to step 3. No: Repair damaged or leaking DEF tank and lines. After repairs are complete, retest for SPN 1761 FMI 18.

Step	Action	Decision
3	Check DEF tank level. Read DEF level using the vehicle instrument panel gauge and do visual inspection of fluid level in the DEF tank. Is DEF tank fluid level above 1/2 tank?	Yes: Go to step 4. No: Fill DEF tank with appropriate diesel exhaust fluid. After repairs are complete, retest for SPN 1761 FMI 18.

Step	Action	Decision
4	Inspect connections at Diesel Exhaust Fluid Tank Level and Temperature (DEFTLT) sensor module. Key OFF, disconnect DEFTLT sensor module. Check DEFTLT sensor module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DEFTLT sensor module connector, harness, and terminals clean and undamaged?	Yes: Replace DEFTLT sensor module. After repairs are complete, retest for SPN 1761 FMI 18. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 1761 FMI 18.

NOTE: After doing all diagnostic steps, if SPN 1761 FMI 18 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 1761 FMI 19 - Diesel Exhaust Fluid Tank Level Temperature (DEFTLT) not detected on J1939

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
DEFTLT signal not detected on J1939 Controller Area Network (CAN).	ACM loses J1939 data link communications with DEFTLT sensor module	Key ON	2 events

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) loses J1939 data link communications with the Diesel Exhaust Fluid Tank Level and Temperature (DEFTLT) sensor module. Engine torque will be reduced if fault is active for a limited period of time. Engine torque will be severely reduced and vehicle speed will be limited after extended engine operation with this fault code active.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

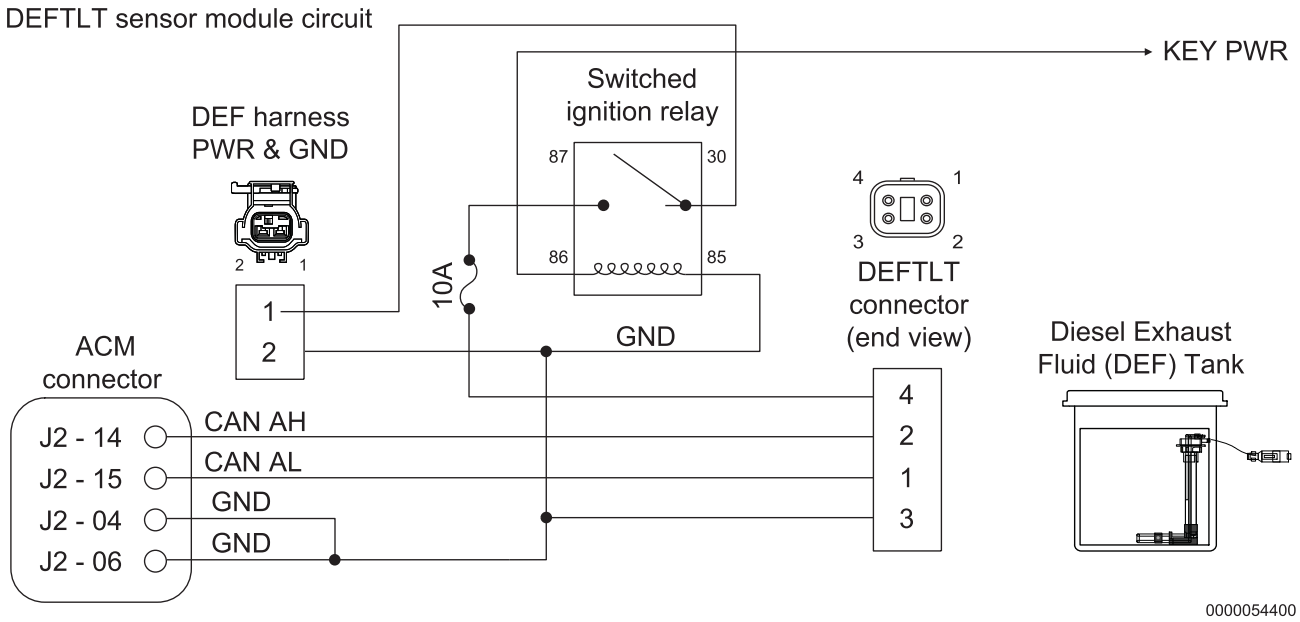


Figure 320 DEFTLT Sensor Module Circuit Diagram

Possible Cause

- SWBAT circuit short to GND or Open
- CAN-AH circuit Open or short to GND
- CAN-AL circuit Open or short to GND

- CAN-AH circuit short to power
- CAN-AL circuit short to power
- GND circuit Open or high resistance
- CAN-AH short to CAN-AL
- Failed DEFTLT sensor module

NOTE: If more than one of the following sensor modules fail (or set a fault), suspect a common power circuit, ground circuit, or Switched Ignition Relay problem. The following components share power and ground circuits: DOC / DPF temperature sensor module, SCR temperature sensor module, Ammonia Sensor Module, NOx OUT sensor module, NOx IN sensor module, and DEFTLT sensor module.

NOTE: Verify batteries are fully charged and connections are clean.

Step	Action	Decision
1	Inspect connections at Diesel Exhaust Fluid Tank Level Temperature (DEFTLT) sensor module. Key OFF, disconnect DEFTLT sensor module. Check DEFTLT sensor module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DEFTLT sensor module connector, harness, and terminals clean and undamaged?	Yes: Go to step 2. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 1761 FMI 19.

Step	Action	Decision
2	Check voltage to the DEFTLT sensor module. Key-On Engine-Off (KOEO), with Breakout Harness 18-124-01 connected between DEFTLT sensor module and vehicle harness, use a DMM to measure voltage between DEFTLT module pin-3 and pin-4. Is voltage within 0.5 volts of battery voltage?	Yes: Go to step 4. No: Go to step 3.

Step	Action	Decision
3	Check SWBAT circuit for Open or short to ground. KOEO, with Breakout Harness 18-124-01 connected between DEFTLT sensor module and vehicle harness, use a DMM to measure voltage between DEFTLT pin-4 and a known good ground. (wiggle test may be necessary if code is inactive or pending). Is voltage within 0.5 volts of battery voltage?	Yes: Repair Open or high resistance between DEFTLT sensor module connector pin-3 and ground. After repairs are complete, retest for SPN 1761 FMI 19. No: Repair Open or high resistance between DEFTLT sensor module connector pin-4 and switched ignition relay pin 87. After repairs are complete, retest for SPN 1761 FMI 19.

Step	Action	Decision
4	Check CAN-AH circuit for Open or short to GND. KOEO, with Breakout Harness 18-124-01 connected between DEFTLT sensor module and vehicle harness, use a DMM to measure voltage between Breakout Harness pin-2 and a known good ground. Is voltage greater than 1 volt?	Yes: Go to step 5. No: Repair Open or short to ground between DEFTLT sensor module connector pin-2 and ACM connector J2-14. After repairs are complete, retest for SPN 1761 FMI 19.

Step	Action	Decision
5	Check CAN-AH circuit for short to power. KOEO, with Breakout Harness 18-124-01 connected between DEFTLT sensor module and vehicle harness, use a DMM to measure voltage between Breakout Harness pin-2 and a known good ground. Is voltage less than 4 volts?	Yes: Go to Step 6. No: Repair short to power between DEFTLT sensor module connector pin-2 and ACM connector J2-14. After repairs are complete, retest for SPN 1761 FMI 19.

Step	Action	Decision
6	Check CAN-AL circuit for Open or short to GND. KOEO, with Breakout Harness 18-124-01 connected between DEFTLT sensor module and vehicle harness, use a DMM to measure voltage between Breakout Harness pin-1 and a known good ground. Is voltage greater than 1 volt?	Yes: Go to step 7. No: Repair Open or short to ground between SCR temperature sensor module connector pin-1 and ACM connector J2-15. After repairs are complete, retest for SPN 1761 FMI 19.

Step	Action	Decision
7	Check CAN-AL circuit for short to power. KOEO, with Breakout Harness 18-124-01 connected between DEFTLT sensor module and vehicle harness, use a DMM to measure voltage between Breakout Harness pin-1 and a known good ground. Is voltage less than 4 volts?	Yes: Go to step 8. No: Repair short to power between SCR temperature sensor module connector pin-1 and ACM connector J2-15. After repairs are complete, retest for SPN 1761 FMI 19.

Step	Action	Decision
8	Check CAN-AL circuit for short to CAN-AH. Key OFF, with Breakout Harness 18-124-01 connected between DEFTLT sensor module and vehicle harness, use a DMM to measure resistance between Breakout Harness pin-1 and pin-2. Is resistance greater than 50 ohms?	Yes: Replace DEFTLT sensor module. After repairs are complete, retest for SPN 1761 FMI 19. No: Repair short between DEFTLT sensor module connector pin-1 and pin-2. After repairs are complete, retest for SPN 1761 FMI 19.

NOTE: After doing all diagnostic steps, if SPN 1761 FMI 19 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3031 FMI 2 - Diesel Exhaust Fluid Tank Temperature (DEFTT) signal erratic intermittent or incorrect

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
DEF tank temperature sensor is in range but not rational	Difference between the DEF tank temperature sensor and the Ambient Air Temperature (AAT) sensor is more than 54°F (30°C) at initial Key ON.	Key ON, after a 10 hour (engine off) cold soak Inactive: SPN 3031 FMI 3 and 4 (DEFTT)	0 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects that the DEF tank temperature sensor is in range but not rational.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 3031 FMI 3 and 4 (DEFTLT), and SPN 171 (AAT).

Drive Cycle to Determine Fault Status

Drive Cycle 10 then 2 in 2013 HD-OBD Diagnostic Reference Manual.

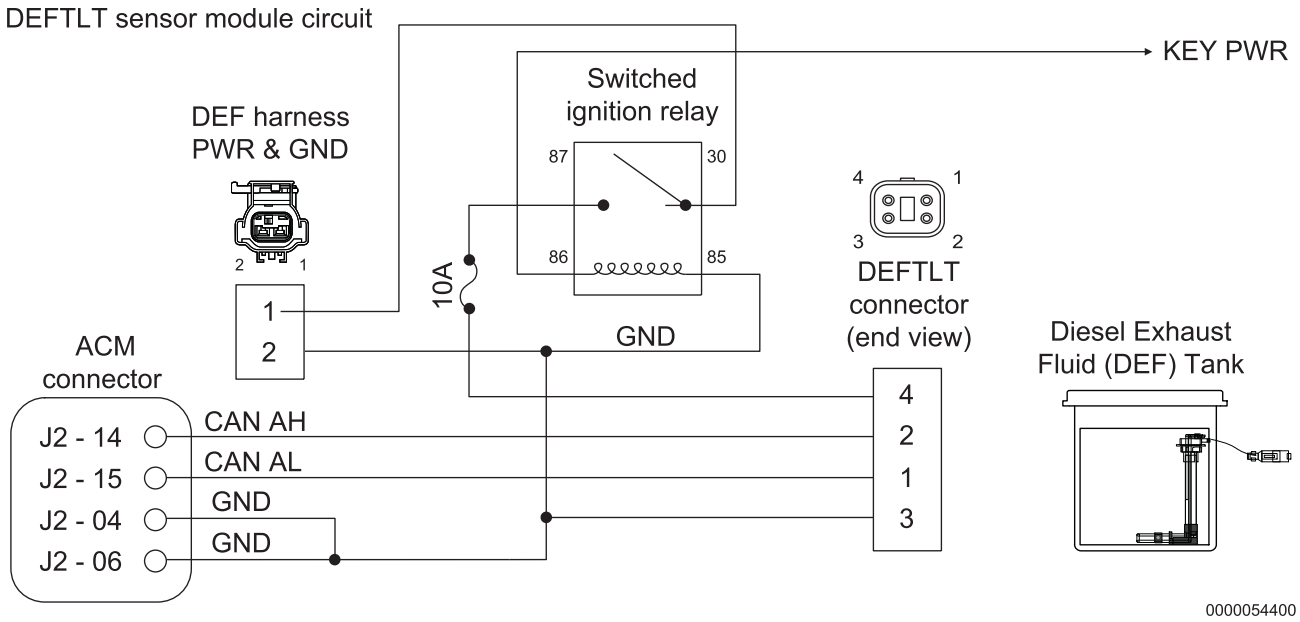


Figure 321 DEFTLT Sensor Module Circuit Diagram

Possible Causes

- Failed DEFTLT sensor module

- SWBAT circuit intermittent short to GND or high resistance
- Power Distribution Module (PDM) loose fuse or relay
- GND circuit intermittent high resistance or Open

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3031 FMI 3 and 4 (DEFTLT); and SPN 171 (AAT). Is EST DTC list free of SPN 3031 FMI 3 and 4; and SPN 171 ?	Yes: Go to step 2. Repair SPN 3031 FMI 3 and 4; and SPN 171. After repairs are complete, retest for SPN 3031 FMI 2.

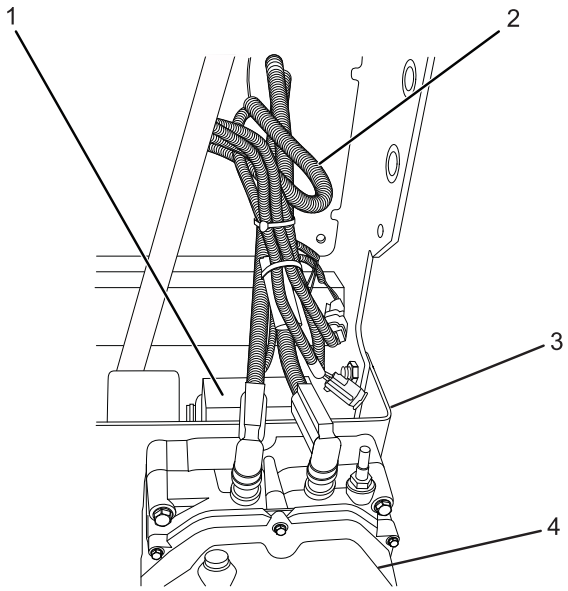


Figure 322 PDM Location (typical)

1. Power Distribution Module (PDM)
2. Diesel Exhaust Fluid (DEF) tank assembly
3. DEF supply module bracket
4. DEF supply module

Step	Action	Decision
2	Check Power Distribution Module (PDM) fuse(s) and relay(s) for blown fuses; loose, missing, or intermittent connections. Are all fuses and relays securely attached and in good condition?	Yes: Go to step 3. No: Secure or replace failed fuse(s) or relay(s) to PDM connector. After repairs are complete, retest for SPN retest for SPN 3031 FMI 2.

NOTE: Verify batteries are fully charged and connections are clean.

Step	Action	Decision
3	Inspect connections at Diesel Exhaust Fluid Tank Level Temperature (DEFTLT) sensor module. Key OFF, disconnect DEFTLT sensor module. Check DEFTLT sensor module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DEFTLT sensor module connector, harness, and terminals clean and undamaged?	Yes: Go to step 4. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3031 FMI 2.

NOTE: If more than one of the following sensor modules fail (or set a fault), suspect a common power circuit, ground circuit, or Switched Ignition Relay problem. The following components share power and ground circuits with the DEFTLT sensor module:

- NOx OUT sensor module
- NOx IN sensor module
- Ammonia (NH_3) Sensor Module
- SCR Temperature Sensor Module
- DOC / DPF temperature sensor module

NOTE: Verify batteries are fully charged and connections are clean.

Step	Action	Decision
4	Check voltage to the DEFTLT sensor module. Key-On Engine-Off (KOEO), with Breakout Harness 18-124-01 connected to DEFTLT sensor module, use a DMM to measure voltage between DEFTLT sensor module pin-3 and pin-4. Is voltage within 0.5 volts of battery voltage?	Yes: Replace DEFTLT sensor module. After repairs are complete, retest for SPN 3031 FMI 2. No: Go to step 5.

Step	Action	Decision
5	Check SWBAT circuit for intermittent high resistance or short to ground. Connect Breakout Harness 18–124–01 and leave DEFTLT sensor module disconnected. KOEO, measure voltage between Breakout Harness 18-124-01 pin-4 and a known good ground (wiggle test may be necessary if code is inactive or pending). Is voltage within 0.5 volts of battery voltage?	Yes: Repair Open or high resistance between DEFTLT sensor module pin-3 and ground. After repairs are complete, retest for SPN 3031 FMI 2. No: Repair high resistance or short to ground between DEFTLT sensor module pin-4 and switched ignition relay pin-87. After repairs are complete, retest for SPN 3031 FMI 2.

NOTE: After doing all diagnostic steps, if SPN 3031 FMI 2 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3031 FMI 3 - Diesel Exhaust Fluid Tank Temperature (DEFTT) signal Out of Range High

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Exhaust Fluid (DEF) tank temperature sensor circuit voltage above normal or shorted to high source.	The Aftertreatment Control Module (ACM) detects the DEF tank temperature sensor voltage is greater than 4.7 V for more than 1 seconds.	Key ON	1 second

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Diesel Exhaust Fluid Tank Temperature (DEFTT) signal voltage is greater than 4.5 volts for more than 1 second. Engine torque will be reduced if fault is active for a limited period of time. Engine torque will be severely reduced after extended engine operation with the fault code active.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

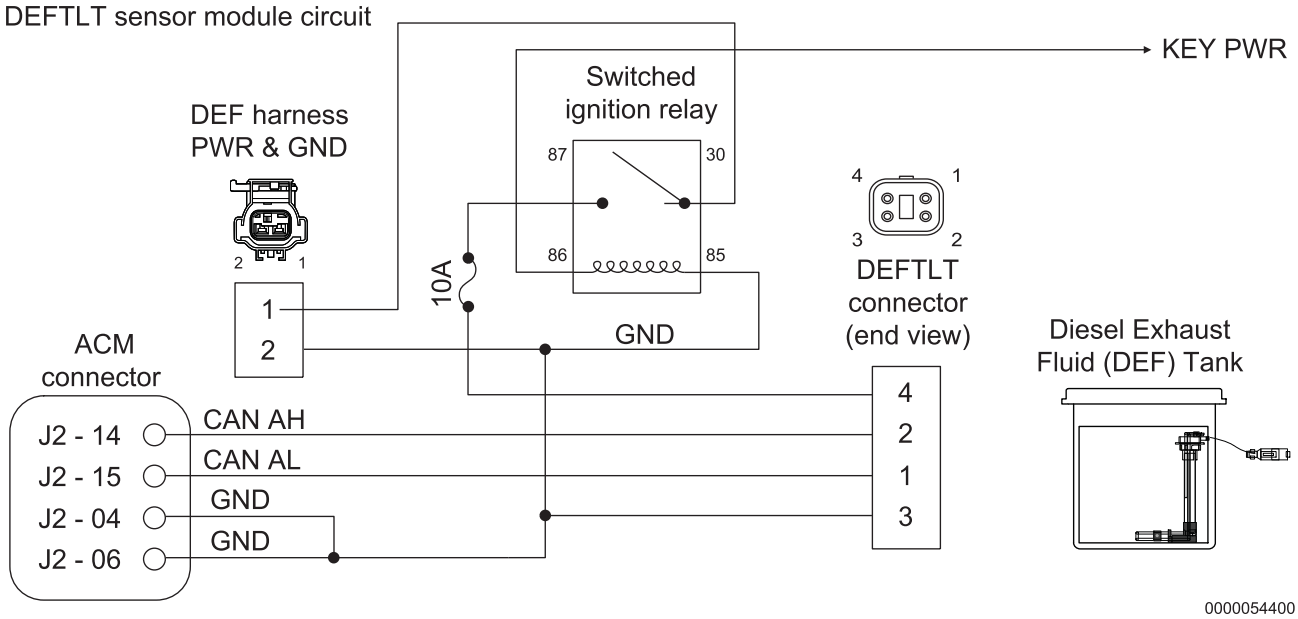


Figure 323 DEFTLT Sensor Module Circuit Diagram

Possible Causes

- Failed DEFTLT sensor module

Step	Action	Decision
1	Inspect connections at Diesel Exhaust Fluid Tank Level Temperature (DEFTLT) sensor module. Key OFF, disconnect DEFTLT sensor module. Check DEFTLT sensor module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DEFTLT sensor module connector, harness, and terminals clean and undamaged?	Yes: Replace DEFTLT sensor module. After repairs are complete, retest for SPN 3031 FMI 3. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3031 FMI 3.

NOTE: After doing all diagnostic steps, if SPN 3031 FMI 3 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3031 FMI 4 - Diesel Exhaust Fluid Tank Temperature (DEFTT) signal Out of Range Low

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Exhaust Fluid (DEF) tank temperature sensor circuit voltage below normal or shorted to low source.	The Aftertreatment Control Module (ACM) detects the DEF tank temperature signal voltage is less than 0.2 V for more than 1 second.	Key ON	1 second

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Diesel Exhaust Fluid Tank Temperature (DEFTT) signal voltage is less than 0.2 volts for more than 1 second. Engine torque will be reduced if fault is active for a limited period of time.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

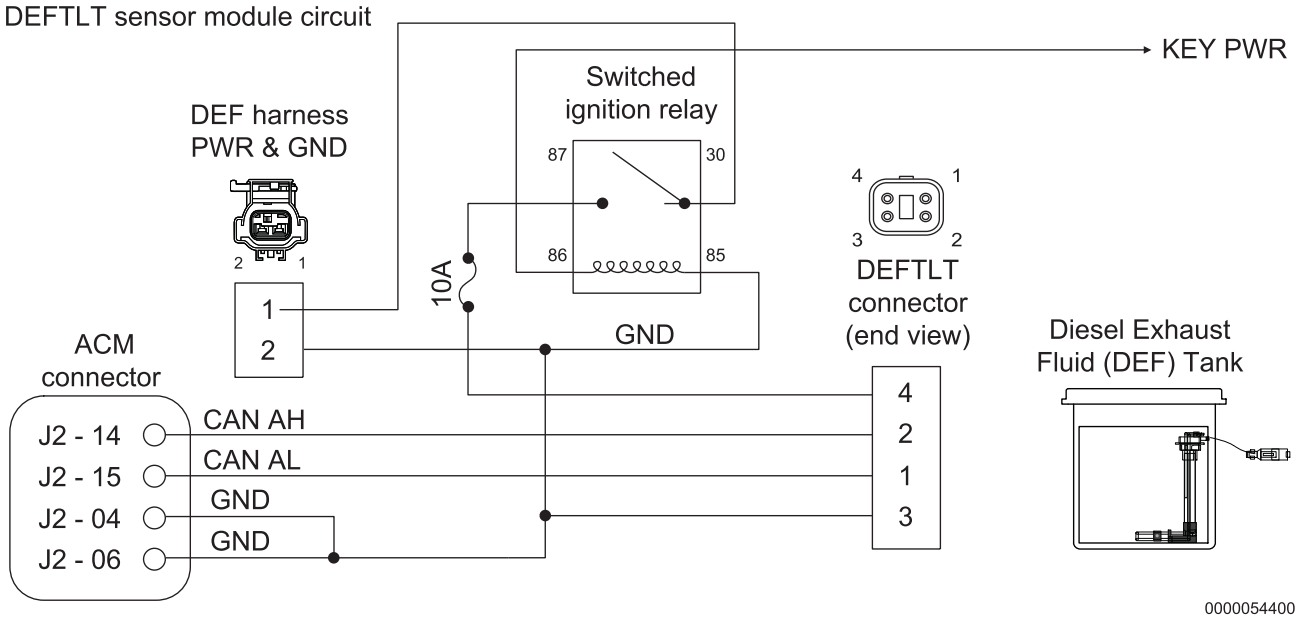


Figure 324 DEFTLT Sensor Module Circuit Diagram

Possible Causes

- Failed DEFTLT sensor module

Step	Action	Decision
1	Inspect connections at Diesel Exhaust Fluid Tank Level Temperature (DEFTLT) sensor module. Key OFF, disconnect DEFTLT sensor module. Check DEFTLT sensor module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DEFTLT sensor module connector, harness, and terminals clean and undamaged?	Yes: Replace DEFTLT sensor module. After repairs are complete, retest for SPN 3031 FMI 4.
		No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3031 FMI 4.

NOTE: After doing all diagnostic steps, if SPN 3031 FMI 4 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3031 FMI 9 - Diesel Exhaust Fluid Tank Temperature (DEFTT) signal erratic intermittent or incorrect

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Loss of communication or invalid data from Diesel Exhaust Fluid Tank Level Temperature sensor module (DEFTLT).	Difference between the DEF tank temperature sensor and the Ambient Air Temperature (AAT) sensor is more than 54°F (30°C) at initial Key ON.	Key ON, after an 10 hour (engine off) cold soak	0 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) loses J1939 data link communications with the Diesel Exhaust Fluid Tank Level and Temperature (DEFTLT) sensor module. Engine torque will be reduced if fault is active for a limited period of time.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 3031 FMI 3 and 4; and SPN 171 (AAT).

Drive Cycle to Determine Fault Status

Drive Cycle 10 then 2 in 2013 HD-OBD Diagnostic Reference Manual.

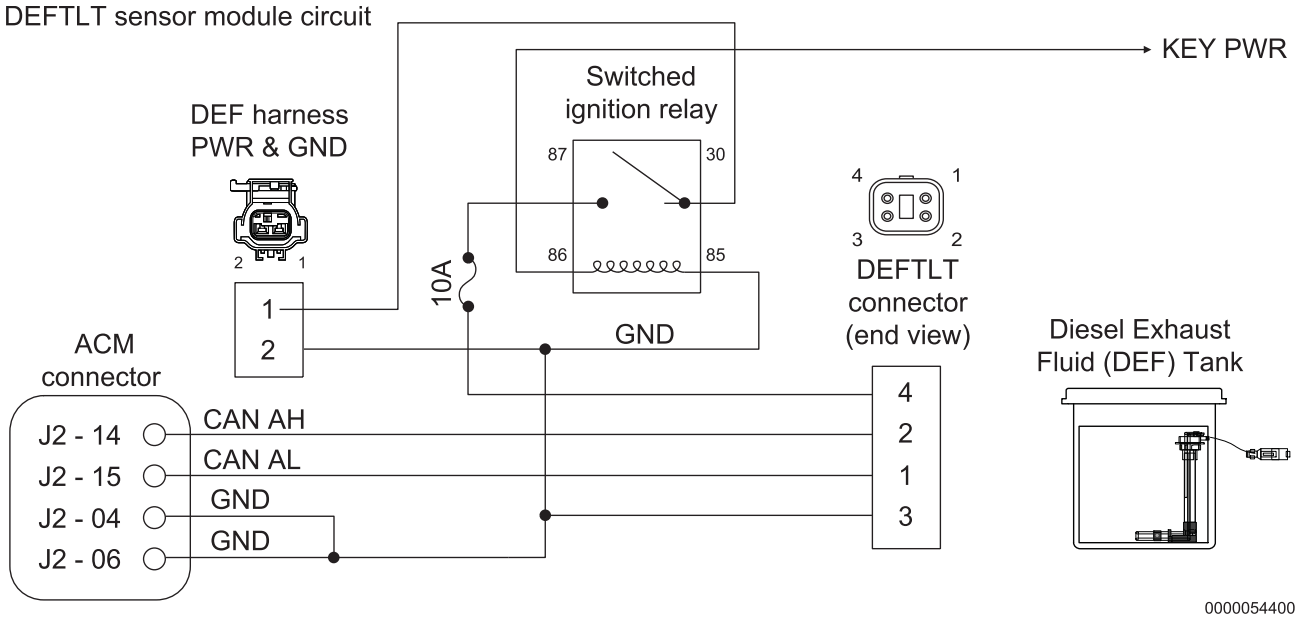


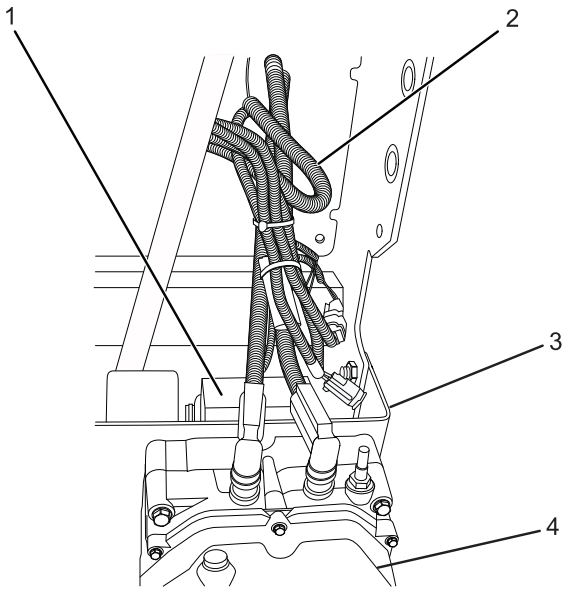
Figure 325 DEFTLT Sensor Module Circuit Diagram

Possible Causes

- Failed DEFTLT sensor module

- SWBAT circuit intermittent short to GND or high resistance
- Power Distribution Module (PDM) loose fuse or relay
- GND circuit intermittent high resistance or Open

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3031 FMI 3 and 4 (DEFTLT); and SPN 171 (AAT). Is EST DTC list free of SPN 3031 FMI 3 and 4; and SPN 171?	Yes: Go to step 2. Repair SPN 3031 FMI 3 and 4; and SPN 171. After repairs are complete, retest for SPN 3031 FMI 9.



0000041928

Figure 326 PDM Location (typical)

1. Power Distribution Module (PDM)
2. Diesel Exhaust Fluid (DEF) tank assembly
3. DEF supply module bracket
4. DEF supply module

Step	Action	Decision
2	Check Power Distribution Module (PDM) fuse(s) and relay(s) for blown fuses; loose, missing, or intermittent connections. Are all fuses and relays securely attached and in good condition?	Yes: Go to step 3. No: Secure or replace failed fuse(s) or relay(s) to PDM connector. After repairs are complete, retest for SPN retest for SPN 3031 FMI 9.

NOTE: Verify batteries are fully charged and connections are clean.

Step	Action	Decision
3	Inspect connections at Diesel Exhaust Fluid Tank Level Temperature (DEFTLT) sensor module. Key OFF, disconnect DEFTLT sensor module. Check DEFTLT sensor module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DEFTLT sensor module connector, harness, and terminals clean and undamaged?	Yes: Go to step 4. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3031 FMI 9.

NOTE: If more than one of the following sensor modules fail (or set a fault), suspect a common power circuit, ground circuit, or Switched Ignition Relay problem. The following components share power and ground circuits with the DEFTLT sensor module:

- NOx OUT sensor module
- NOx IN sensor module
- Ammonia (NH_3) Sensor Module
- SCR Temperature Sensor Module
- DOC / DPF temperature sensor module

NOTE: Verify batteries are fully charged and connections are clean.

Step	Action	Decision
4	Check voltage to the DEFTLT sensor module. Key-On Engine-Off (KOEO), with Breakout Harness 18-124-01 connected to DEFTLT sensor module, use a DMM to measure voltage between DEFTLT sensor module pin-3 and pin-4. Is voltage within 0.5 volts of battery voltage?	Yes: Replace DEFTLT sensor module. After repairs are complete, retest for SPN 3031 FMI 9. No: Go to step 5.

Step	Action	Decision
5	Check SWBAT circuit for intermittent high resistance or short to ground. Connect Breakout Harness 18-124-01 and leave DEFTLT sensor module disconnected. KOEO, measure voltage between Breakout Harness 18-124-01 pin-4 and a known good ground (wiggle test may be necessary if code is inactive or pending). Is voltage within 0.5 volts of battery voltage?	Yes: Repair Open or high resistance between DEFTLT sensor module pin-3 and ground. After repairs are complete, retest for SPN 3031 FMI 9. No: Repair high resistance or short to ground between DEFTLT sensor module pin-4 and switched ignition relay pin-87. After repairs are complete, retest for SPN 3031 FMI 9.

NOTE: After doing all diagnostic steps, if SPN 3031 FMI 9 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

DEFUHR (Diesel Exhaust Fluid Unit Heater Relay)

SPN	FMI	Condition	Possible Causes	Actions
5746	3	DEF Unit Heater Relay short to PWR (Open or High Resistance)	• DEF Unit HTR Relay CTL short to power • DEF Unit HTR Relay CTL Open or high resistance • DEF Unit HTR Relay GND Open or high resistance • Failed DEF Unit HTR Relay (DEFUHR)	Step-Based Diagnostics (page 804)
5746	4	DEF Unit Heater Relay short to GND	• DEF Unit HTR Relay CTL circuit short to GND • DEF Unit HTR Relay GND shorted to DEF Unit HTR Relay CTL • Failed DEF Unit HTR Relay (DEFUHR)	Step-Based Diagnostics (page 808)

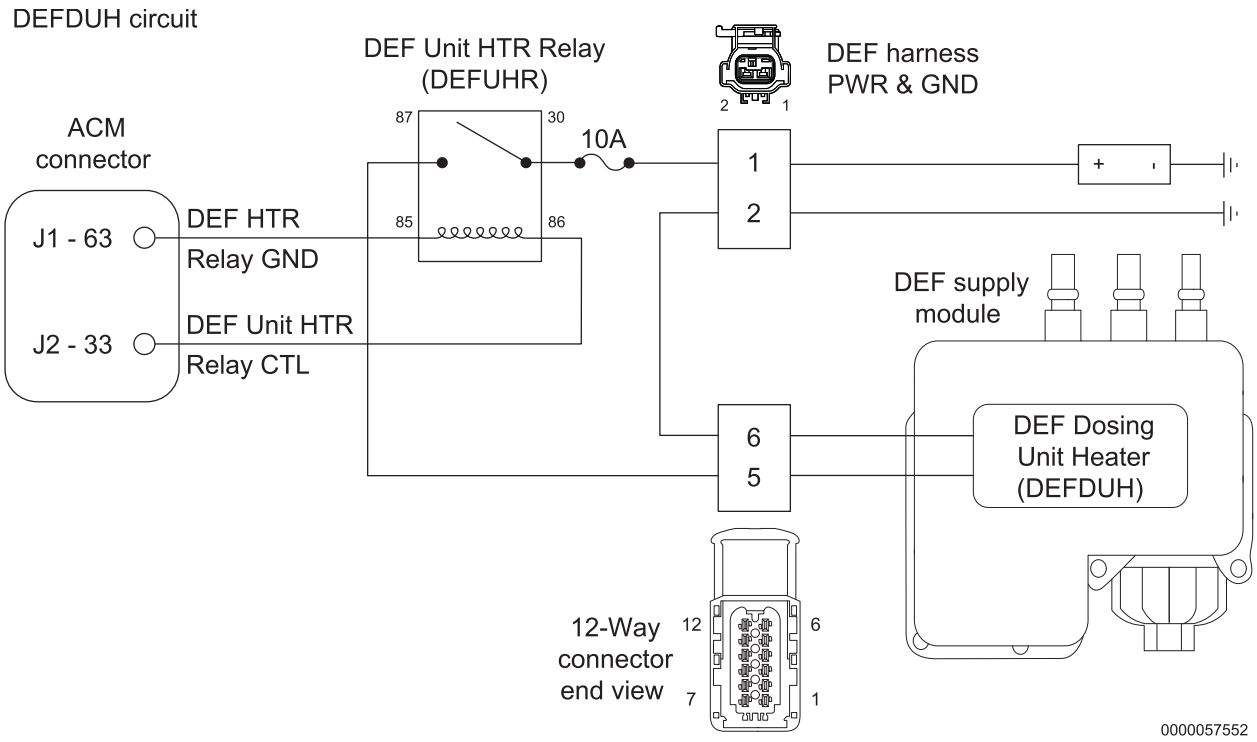


Figure 327 DEFUHR Circuit Diagram

NOTE: See latest version of Navistar N13 Engine and Aftertreatment Wiring Schematic Form 0000002203 for additional circuit information.

Overview

The Diesel Exhaust Fluid Unit HTR Relay (DEFUHR) is used to control the DEF Dosing Unit Heater (DEFDUH), which is installed in the DEF supply module. The Aftertreatment Control Module (ACM) turns the DEFDUH on by controlling the DEFUHR PWR.

Tools Required

- 180-Pin Breakout Box 00-00956-08
- ACM Breakout Harness 18-100-01
- Breakout Harness ZTSE4908
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

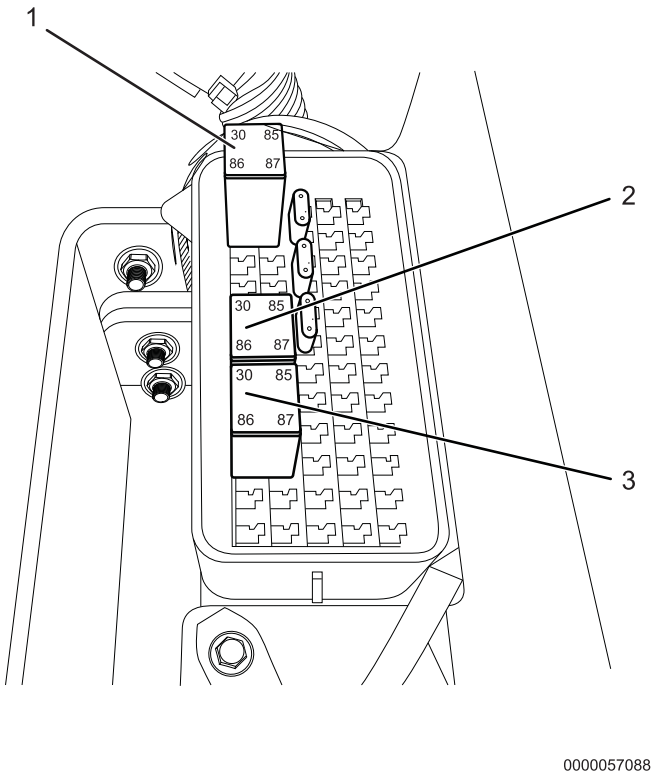


Figure 328 DEFUHR Location

1. DEF Line Heater Relay (DEFLHR)
2. DEF Unit HTR Relay (DEFUHR)
3. Switched Ignition Relay

SPN 5746 FMI 3 - DEF Dosing Unit Heater Relay short to PWR (Open or high resistance)

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Exhaust Fluid Unit HTR Relay (DEFUHR) circuit is shorted to PWR, Open, or high resistance.	Resistance between DEF Unit HTR Relay CTL and DEF Unit HTR Relay GND > 500,000 Ohms, or DEF Unit HTR Relay CTL is shorted to power.	DEFUHR command ON Key ON.	300 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the voltage signal from the Diesel Exhaust Fluid Unit HTR Relay (DEFUHR) voltage signal is high.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

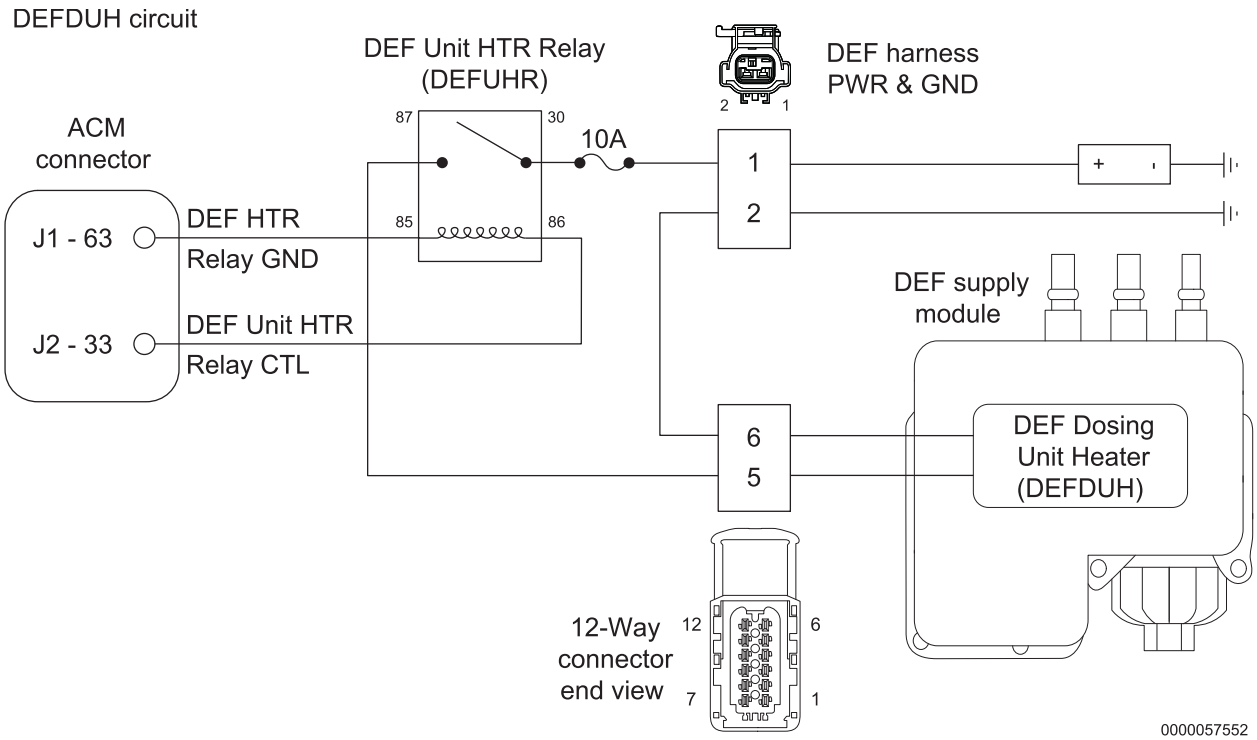


Figure 329 DEFUHR Circuit Diagram

Possible Causes

- DEF Unit HTR Relay CTL short to PWR

- DEF Unit HTR Relay CTL Open or high resistance
- DEF Unit HTR Relay GND Open or high resistance
- Failed DEF Unit HTR Relay (DEFUHR)

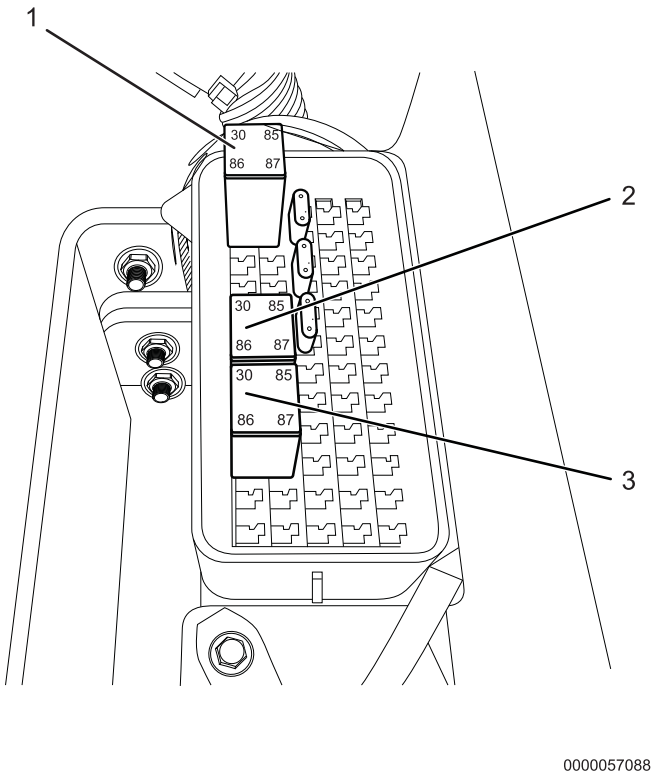


Figure 330 DEFUHR Location

1. DEF Line Heater Relay (DEFLHR)
2. DEF Unit HTR Relay (DEFUHR)
3. Switched Ignition Relay

Step	Action	Decision
1	Check Power Distribution Module (PDM) fuse(s) and relay(s) for blown fuses; loose, missing, or intermittent connections. Are all fuses and relays securely attached and in good condition?	Yes: Go to step 2. No: Secure or replace failed fuse(s) or relay(s) to PDM connector. After repairs are complete, retest for SPN 5746 FMI 3.

Step	Action	Decision
2	Check for a failed DEF Unit HTR Relay (DEFUHR). Remove the DEFUHR. Install DEFUHR into Breakout Harness ZTSE4908 and leave harness disconnected from PDM. Using a DMM, check resistance between pin-85 and pin-86. Is resistance less than 300 ohms?	Yes: Go to step 3. No: Replace DEFUHR. After repairs are complete, retest for SPN 5746 FMI 3.

Step	Action	Decision
3	Inspect connections at Aftertreatment Control Module (ACM). Key OFF, disconnect ACM connectors. Check ACM and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Leave connector J2 unplugged. Are the ACM connectors, harnesses, and terminals clean and undamaged?	Yes: Go to step 4. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 5746 FMI 3.

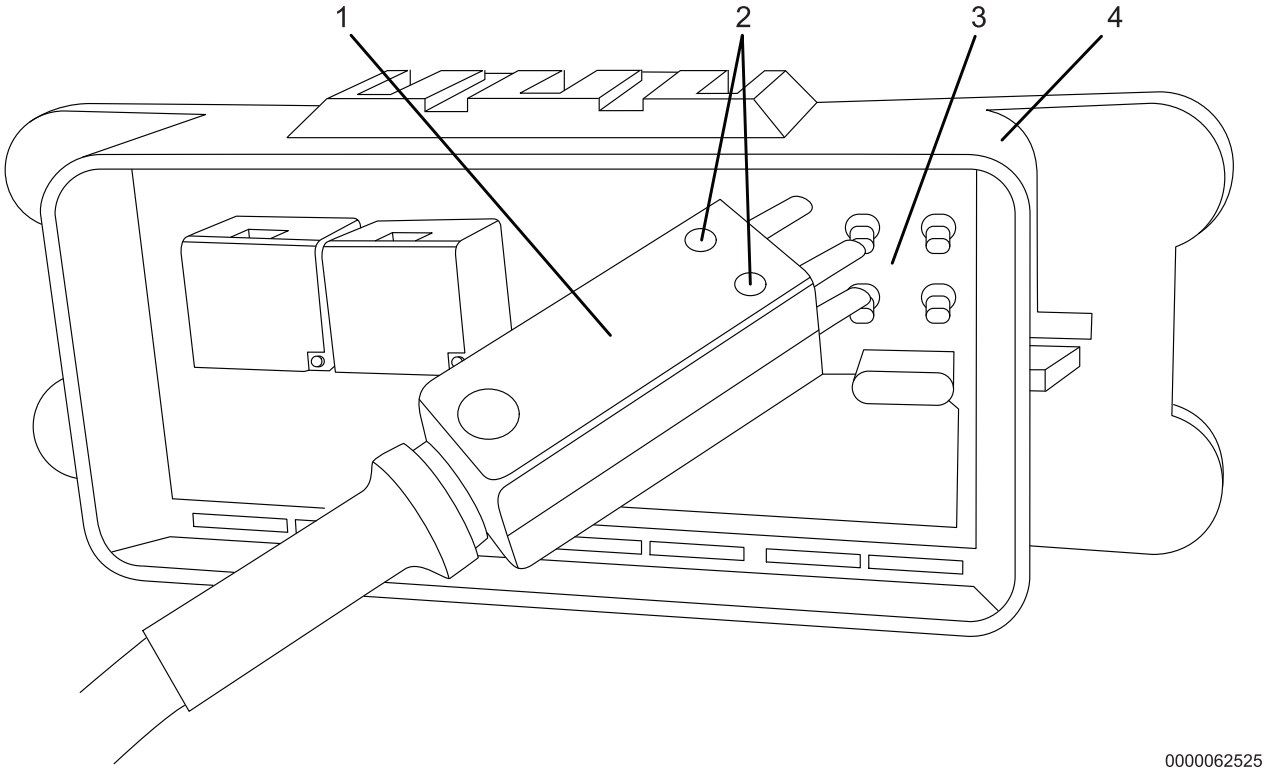


Figure 331 Installation of Breakout Harness ZTSE4908 (typical)

1. Breakout Harness ZTSE4908
2. Dimples
3. Relay socket
4. Power Distribution Module (PDM)

CAUTION: For correct diagnosis, Breakout Harness ZTSE4908 MUST be installed with the dimples toward the top of the Power Distribution Module (PDM). Reversed installation WILL result in incorrect measurements.

Step	Action	Decision
4	Check DEF Unit HTR relay CTL circuit for a short to PWR. Install Breakout Harness ZTSE4908 into Power Distribution Module (PDM). Disconnect connector J2 from ACM. Using a DMM, Key-On Engine-Off (KOEO), measure voltage between pin-86 and a known good ground. Is voltage less than 0.5 volt?	Yes: Go to step 5. No: Repair short to PWR between DEFUHR pin-86 and ACM pin J2-33. When repairs are complete, retest for SPN 5746 FMI 3.

Step	Action	Decision
5	Check DEF Unit HTR relay CTL circuit for an Open or high resistance. Install 180-pin Breakout Box with Breakout Harness 18-100-01 to vehicle harness J2, leave ACM disconnected. With Breakout Harness ZTSE4908 installed, use a DMM to measure resistance between Breakout Harness pin-86 and Breakout Box pin J2-33. Is resistance less than 5 ohms?	Yes: Repair Open or high resistance between DEFUHR pin-85 and ACM pin J1-63. When repairs are complete, retest for SPN 5746 FMI 3. No: Repair Open or high resistance between DEFUHR pin-86 and ACM pin J2-33. When repairs are complete, retest for SPN 5746 FMI 3.

NOTE: After performing all diagnostic steps, if SPN 5746 FMI 3 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 5746 FMI 4- DEF Dosing Unit Heater Relay short to GND

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Exhaust Fluid Unit HTR Relay (DEFUHR) voltage below normal or shorted to GND.	Resistance between the DEF Unit HTR Relay CTL circuit and ground < 0.2 Ohms	DEFUHR commanded ON Key ON	300 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the signal voltage from the Diesel Exhaust Fluid Unit HTR Relay (DEFUHR) is lower than expected.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

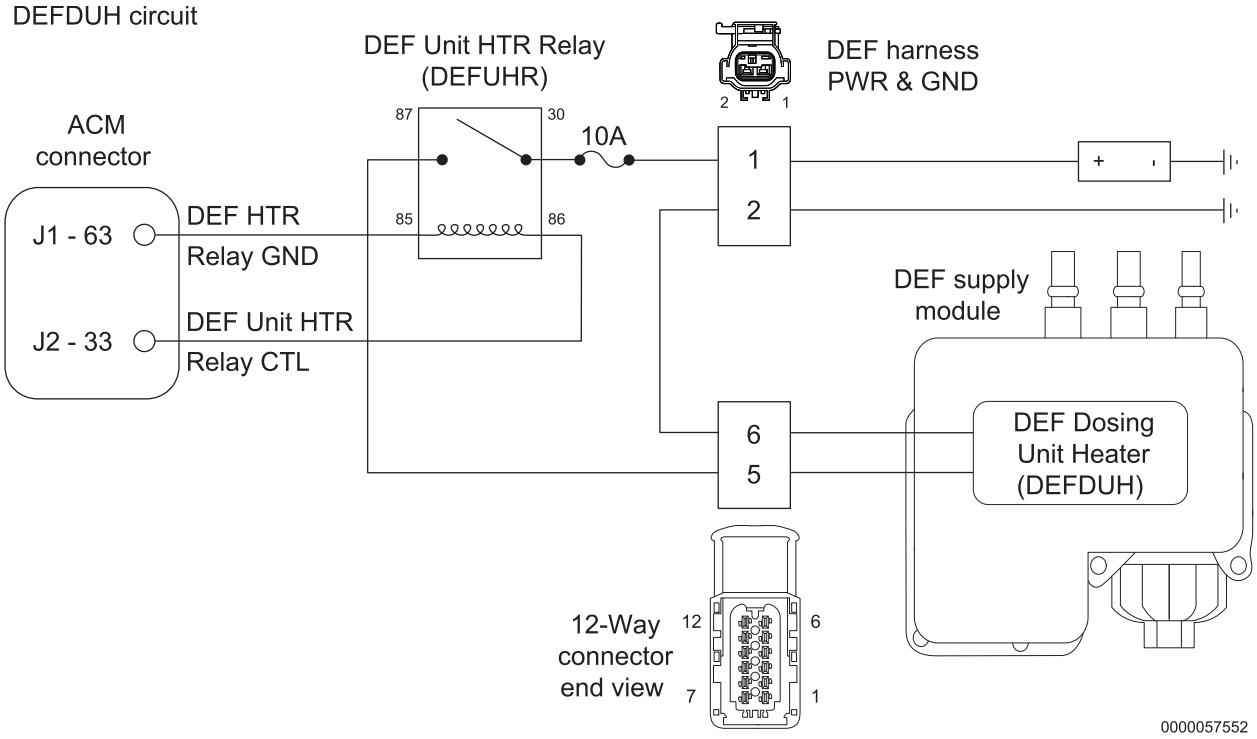


Figure 332 DEFUHR Circuit Diagram

Possible Causes

- DEF Unit HTR Relay CTL circuit short to GND
- DEF Unit HTR Relay GND shorted to DEF Unit HTR Relay CTL

- Failed DEF Unit HTR Relay (DEFUHR)

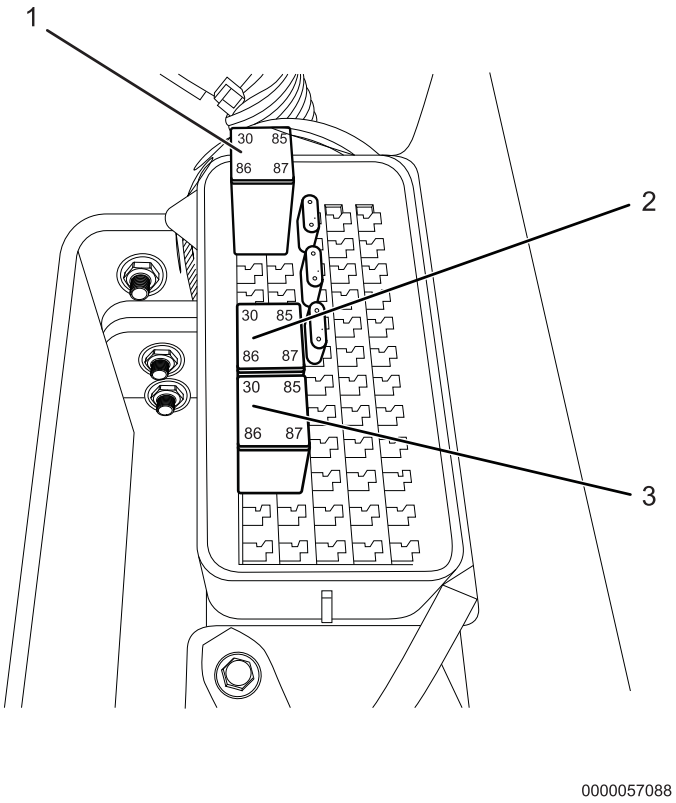


Figure 333 DEFUHR Location

1. DEF Line Heater Relay (DEFLHR)
2. DEF Unit HTR Relay (DEFUHR)
3. Switched Ignition Relay

Step	Action	Decision
1	Check Power Distribution Module (PDM) fuse(s) and relay(s) for blown fuses; loose, missing, or intermittent connections. Are all fuses and relays securely attached and in good condition?	Yes: Go to step 2.
		No: Secure or replace failed fuse(s) or relay(s) to PDM connector. After repairs are complete, retest for SPN 5746 FMI 4.

Step	Action	Decision
2	Check for a failed DEF Unit HTR Relay (DEFUHR). Remove the DEFUHR. Install relay into Breakout Harness ZTSE4908 and leave disconnected from PDM. Using a DMM, check resistance between pin-85 and pin-86. Is the resistance between 100 and 300 ohms?	Yes: Go to step 3.
		No: Replace DEFUHR. After repairs are complete, retest for SPN 5746 FMI 4.

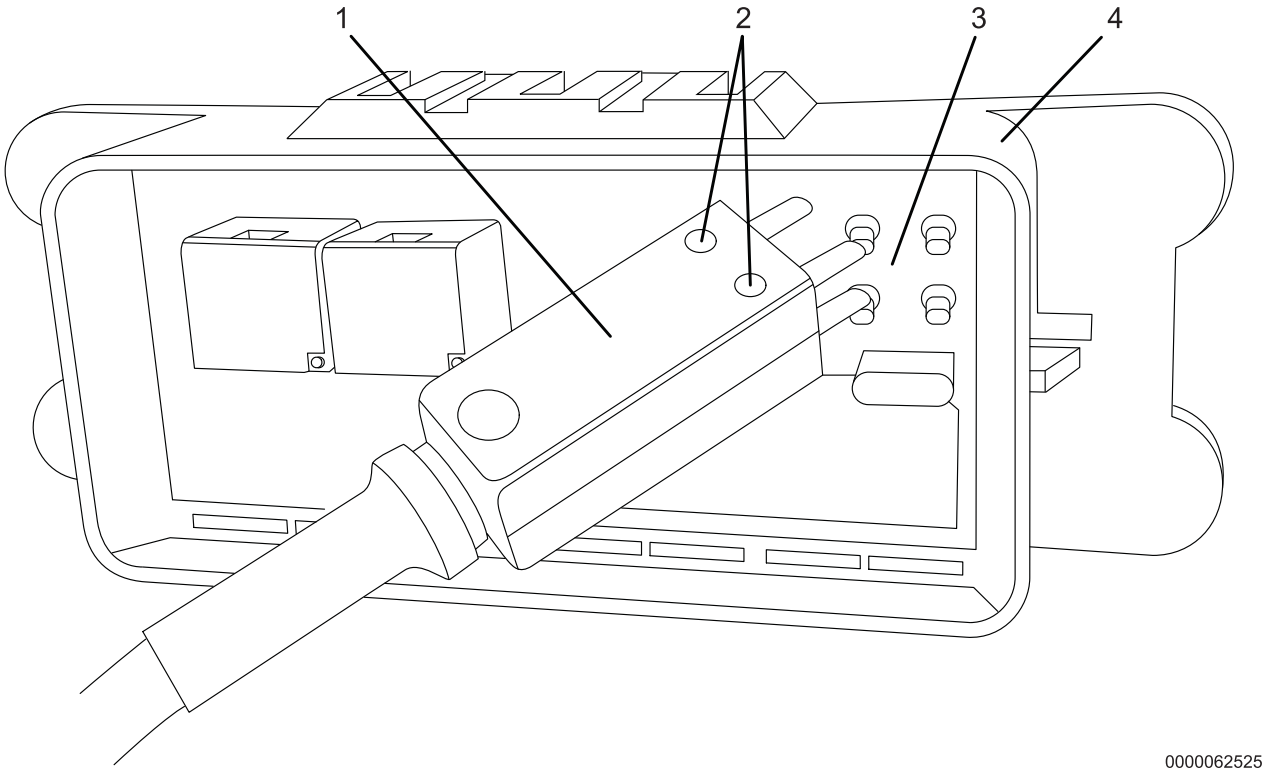


Figure 334 Installation of Breakout Harness ZTSE4908 (typical)

1. Breakout Harness ZTSE4908
2. Dimples
3. Relay socket
4. Power Distribution Module (PDM)

CAUTION: For correct diagnosis, Breakout Harness ZTSE4908 Must be installed with the dimples toward the top of the Power Distribution Module (PDM). Reversed installation Will result in incorrect measurements.

Step	Action	Decision
3	Check for DEF Unit HTR Relay CTL shorted to DEF Unit HTR Relay GND. Install Breakout Harness ZTSE4908 into PDM. Using a DMM, Key OFF check resistance between pin-85 and pin-86. Is resistance less than 100 ohms?	Yes: Repair short between DEFUHR pin-86 and ACM pin J2-33, and DEFUHR pin-85 and ACM pin J1-63. When repairs are complete, retest for SPN 5746 FMI 4.
		No: Repair short to GND in DEF Unit HTR Relay CTL circuit between DEFUHR pin-86 and ACM pin J2-33. After repairs are complete, retest for SPN 5746 FMI 4.

NOTE: After performing all diagnostic steps, if SPN 5746 FMI 4 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

DOC / DPF Temperature Sensor Module

SPN	FMI	Condition	Possible Causes	Actions
5742	3	DOC / DPF Temperature Sensor Module Out of Range HIGH	• Failed DOC / DPF temperature sensor module • Incorrect Battery Wiring (in series instead of in parallel) • Charging voltage excessive	Step-Based Diagnostics (page 814)
5742	4	DOC / DPF Temperature Sensor Module Out of Range LOW	• Failed DOC / DPF temperature sensor module • GND circuit intermittent Open or high resistance • SWBAT circuit intermittent short to ground or Open	Step-Based Diagnostics (page 817)
5742	11	DOC / DPF Temperature Sensor Module signal erratic, intermittent, or incorrect	• Missing, damaged, or restricted air flow across DOC / DPF temperature sensor module • SWBAT circuit intermittent Open or short to GND • GND circuit intermittent Open or short to PWR • Failed DOC / DPF temperature sensor module	Step-Based Diagnostics (page 820)
5742	16	DOC / DPF Temperature Sensor Module above Maximum Temperature	• Missing, damaged, or restricted air flow across DOC / DPF temperature sensor module • Exhaust leak(s) • Failed DOC / DPF temperature sensor module	Step-Based Diagnostics (page 823)

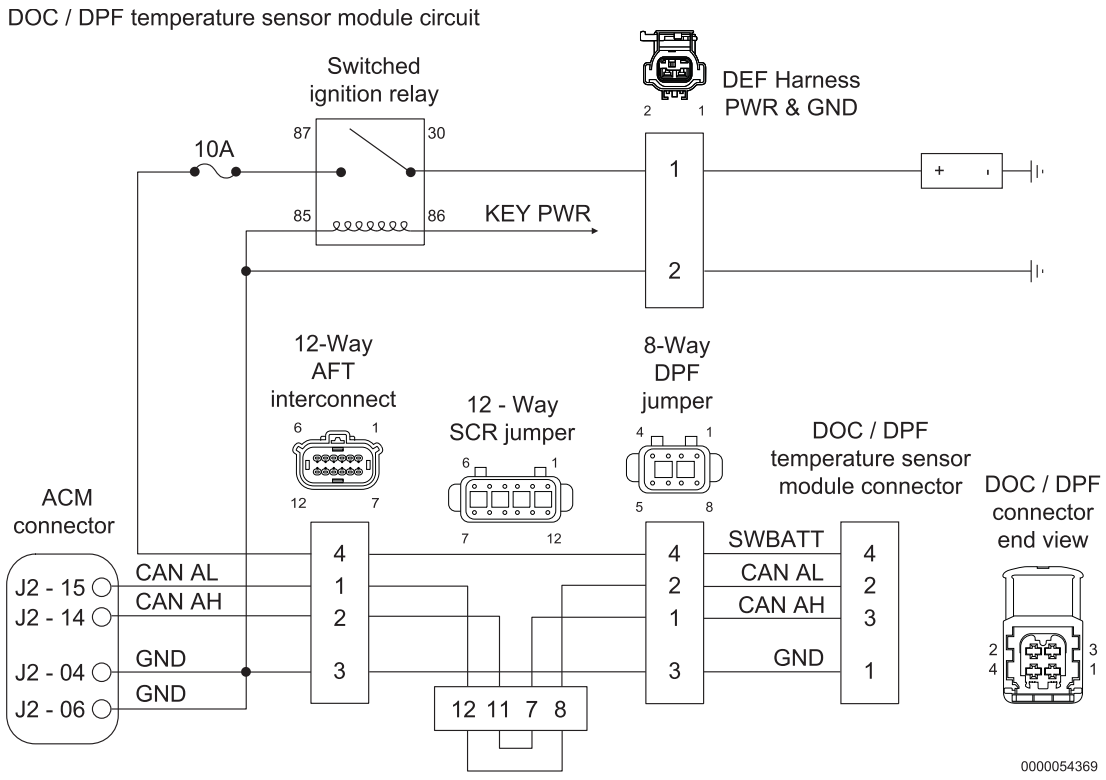


Figure 335 DOC / DPF Temperature Sensor Module Circuit Diagram

NOTE: See latest version of Navistar N13 Engine and Aftertreatment Wiring Schematic Form 0000002203 for additional circuit information.

Overview

The DOC / DPF temperature sensor module monitors aftertreatment Diesel Particulate Filter (DPF) and Diesel Oxidation Catalyst (DOC) temperature. The DOC / DPF temperature sensor module monitors signals from the DOC Inlet Temperature (DOCIT), DPF Inlet Temperature (DPFIT), and DPF Outlet Temperature (DPFOT) sensors, and communicates these signals to the Aftertreatment Control Module (ACM) over the Controller Area Network (CAN. Engine torque will be reduced and vehicle speed will be limited after extended engine operation with the fault active.

Tools Required

- 180-Pin Breakout Box 00-00956-08
- Breakout Harness 18-100-01
- Breakout Harness 18-649-01
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

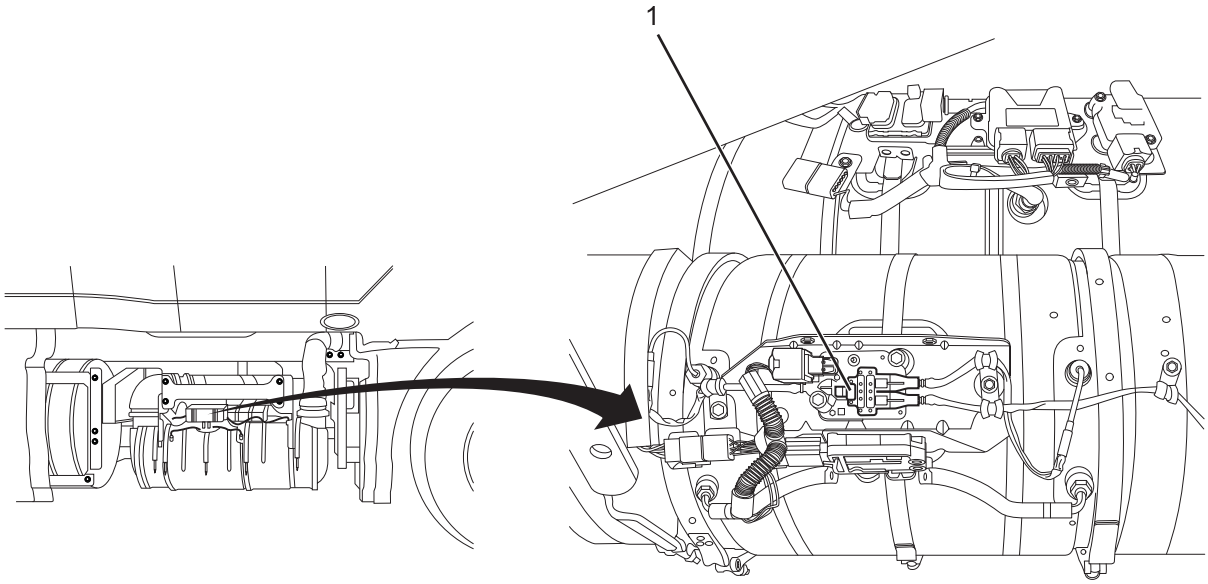


Figure 336 DOC / DPF Temperature Sensor Module Location

1. DOC / DPF Temperature Sensor Module

SPN 5742 FMI 3- DOC / DPF Temperature Sensor Module Out of Range HIGH

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
The Diesel Oxidation Catalyst (DOC) / Diesel Particulate Filter (DPF) temperature sensor module has detected high supply voltage.	DOC / DPF temperature sensor module supply voltage > 18 V ± 1 V	Key ON	3.8 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the DOC / DPF temperature sensor module signal voltage is high.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN's 168 FMI 16 (ACM).

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

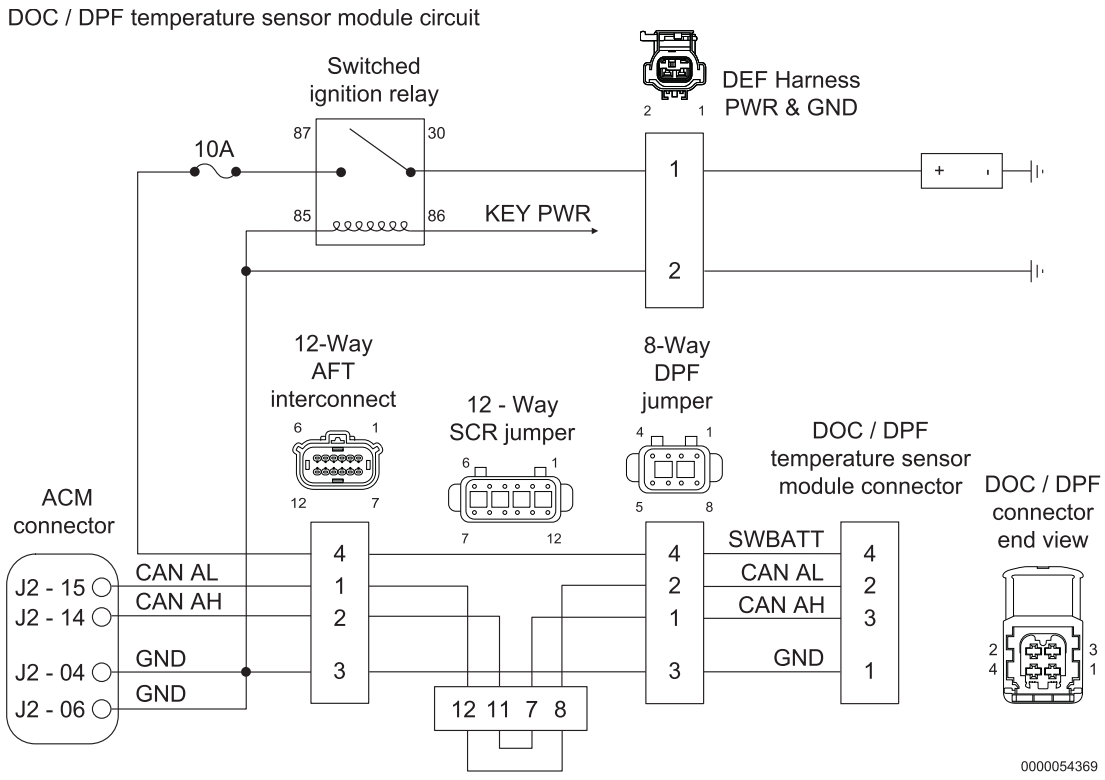


Figure 337 DOC / DPF Temperature Sensor Module Circuit Diagram

Possible Causes

- Failed DOC / DPF temperature sensor module
- Incorrect battery wiring (in series instead of in parallel)
- Charging voltage excessive

Step	Action	Decision
1	Inspect connections at Diesel Oxidation Catalyst / Diesel Particulate Filter (DOC / DPF) temperature sensor module. Key OFF, disconnect DOC / DPF temperature sensor module connector. Check DOC / DPF temperature sensor module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DOC / DPF temperature sensor module connector, harness, and terminals clean and undamaged?	Yes: Go to step 2. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 5742 FMI 3.

NOTE: Verify charging system is charging at specified voltage.

Step	Action	Decision
2	Check for PWR to the DOC / DPF temperature sensor module. Connect 18-649-01 to vehicle harness and leave DOC / DPF temperature sensor module disconnected. Key-On Engine-Off (KOEO) use a DMM to measure voltage between breakout harness pin-1 and pin-4. Is voltage between pin-1 and pin-4 within 0.5 volts of battery voltage?	Yes: Replace DOC / DPF temperature sensor module. After repairs are complete, retest for SPN 5742 FMI 3
		No: Repair incorrect Battery Wiring. After repairs are complete, retest for SPN 5742 FMI 3

NOTE: After performing all diagnostic steps, if SPN 5742 FMI 3 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 5742 FMI 4 - DOC / DPF Temperature Sensor Module Out of Range LOW

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
The Diesel Oxidation Catalyst (DOC) / Diesel Particulate Filter (DPF) temperature sensor module has detected low supply voltage.	DOC / DPF temperature sensor module supply voltage < 6.3 V ± 0.3 V	Key ON	3.8 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the DOC / DPF temperature sensor module signal voltage is low.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN's 168 FMI 18 (ACM).

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

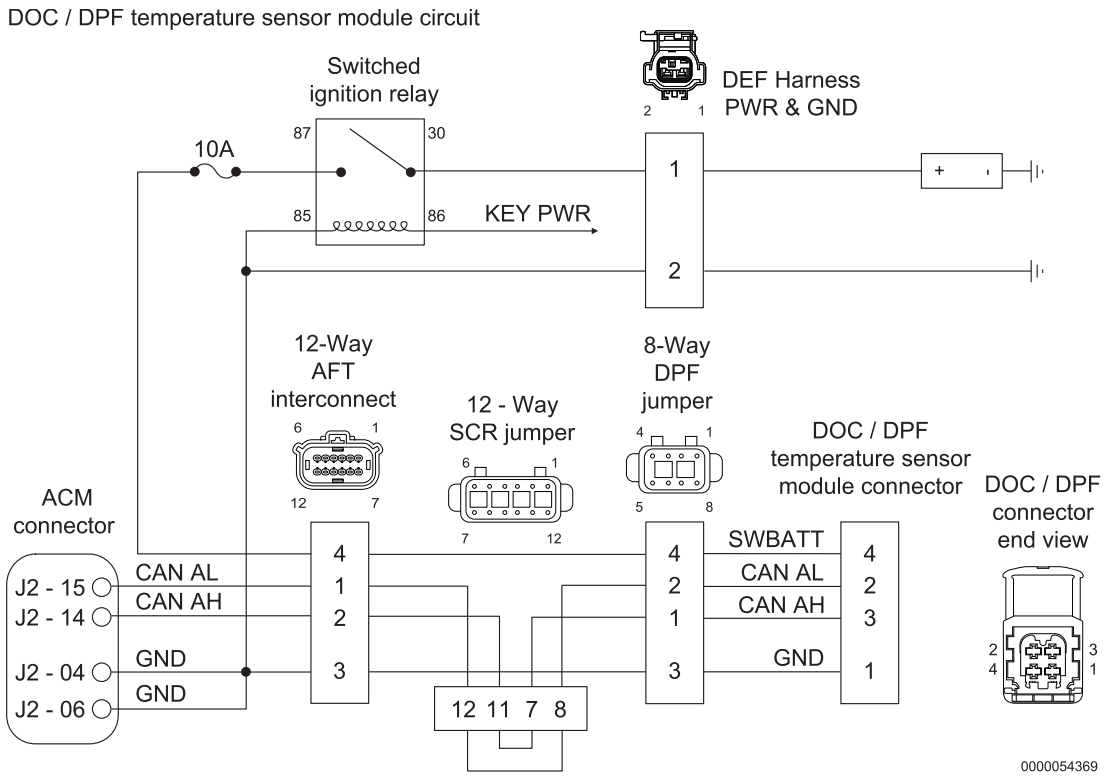


Figure 338 DOC / DPF Temperature Sensor Module Circuit Diagram

Possible causes

- Failed DOC / DPF temperature sensor module
- GND circuit intermittent Open or high resistance
- SWBAT circuit intermittent short to ground or Open

Step	Action	Decision
1	Inspect connections at Diesel Oxidation Catalyst / Diesel Particulate Filter (DOC / DPF) temperature sensor module. Key OFF, disconnect DOC / DPF temperature sensor module connector. Check DOC / DPF temperature sensor module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DOC / DPF temperature sensor module connector, harness, and terminals clean and undamaged?	Yes: Go to step 2. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 5742 FMI 4.

NOTE: Verify batteries are fully charged and connections are clean.

Step	Action	Decision
2	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 168 FMI 16 and 18. Is EST DTC list free of SPN 168 FMI 16 and 18?	Yes: Go to step 3. No: Repair SPN 168 FMI 16 and 18. After repairs are complete, retest for SPN 5742 FMI 4.

Step	Action	Decision
3	Check DOC / DPF temperature sensor module circuit for battery voltage and ground. With DOC / DPF temperature sensor module connector disconnected, connect Breakout Harness 18-649-01. Key ON, use a DMM to measure voltage between DOC / DPF temperature sensor module pin-4 and pin-1. Is voltage within 0.5 volts of battery voltage?	Yes: Replace DOC / DPF temperature sensor module. After repairs are complete, retest for SPN 5742 FMI 4 No: Go to step 4.

Step	Action	Decision
4	Check SWBAT circuit for Open or short to ground. With DOC / DPF temperature sensor module connector disconnected, connect Breakout Harness 18-649-01. Key-On Engine-Off (KOEO), use a DMM to measure voltage between DOC / DPF temperature sensor module pin-4 and a known good ground. Is voltage within 0.5 volts of battery voltage?	Yes: Repair Open or high resistance in GND circuit between DOC / DPF temperature sensor module connector pin-1 and ground. After repairs are complete, retest for SPN 5742 FMI 4 No: Repair Open or short to ground in SWBAT circuit between DOC / DPF temperature sensor module connector pin-4 and switched ignition relay pin-87. After repairs are complete, retest for SPN 5742 FMI 4.

NOTE: After performing all diagnostic steps, if SPN 5742 FMI 4 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 5742 FMI 11 - DOC / DPF Temperature Sensor Module signal erratic, intermittent, or incorrect

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
The Diesel Oxidation Catalyst (DOC) / Diesel Particulate Filter (DPF) temperature sensor module has detected an intermittent power supply voltage drop that results in a reset internal to the module.	DOC / DPF temperature sensor module > 302°F (150°C) and the number of DOC / DPF temperature sensor module power reset events within a 300 second window is ≥ 5 counts.	Key ON	0 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the number of DOC / DPF temperature sensor module power reset events within a 300 second window is ≥ 5 counts. Active and parked regeneration is disabled. Exhaust Gas Recirculation (EGR) valve operation will be disabled.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN's 168 FMI 16 and 18 (ACM PWR).

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

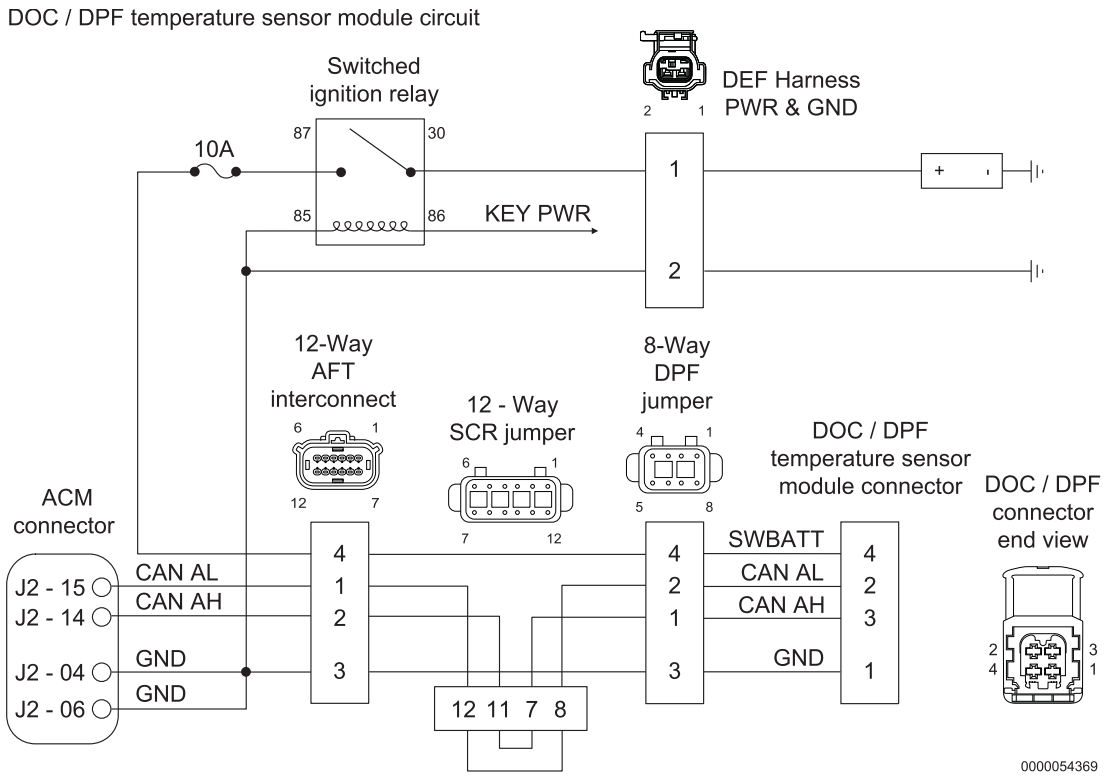


Figure 339 DOC / DPF Temperature Sensor Module Circuit Diagram

Possible Causes

- Missing, damaged, or restricted air flow across DOC / DPF temperature sensor module
- SWBAT circuit intermittent Open or short to GND
- GND circuit intermittent Open or short to PWR
- Failed DOC / DPF temperature sensor module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 168 FMI 16 and 18 (ACM PWR). Is EST DTC list free of SPN 168 FMI 16, and 18?	Yes: Go to step 2. No: Repair SPN 168 FMI 16, and 18. After repairs are complete, retest for SPN 5742 FMI 11.

Step	Action	Decision
2	Inspect for damaged or missing Diesel Oxidation Catalyst / Diesel Particulate Filter (DOC / DPF) temperature sensor module heat shield. Check for air flow restrictions around DOC / DPF temperature sensor module (mud, aftermarket shields, flaps, or brackets installed. Is DOC / DPF temperature sensor module heat shield free of air restrictions and is not missing or damaged?	Yes: Go to step 3. No: Remove air restriction, or replace or repair DOC / DPF temperature sensor module heat shield. After repairs are complete, retest for SPN 5742 FMI 11.

Step	Action	Decision
3	Inspect connections at DOC / DPF temperature sensor module. Key OFF, disconnect DOC / DPF temperature sensor module. Check DOC / DPF temperature sensor module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DOC / DPF temperature sensor module connector, harness, and terminals clean and undamaged?	Yes: Go to step 4. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 5742 FMI 11.

Step	Action	Decision
4	Check SWBAT circuit for intermittent Open or short to ground. With DOC / DPF temperature sensor module connector disconnected, connect Breakout Harness 18-649-01. Key ON, use a DMM to measure voltage between DOC / DPF temperature sensor module pin-4 and a known good ground. Is voltage within 0.5 volts of battery voltage?	Yes: Go to step 5. No: Repair Open or short to ground in SWBAT circuit between DOC / DPF temperature sensor module connector pin-4 and switched ignition relay pin-87. After repairs are complete, retest for SPN 5742 FMI 11.

Step	Action	Decision
5	Check GND circuit for intermittent Open or short to PWR. With DOC / DPF temperature sensor module connector disconnected, connect Breakout Harness 18-649-01. Key-On Engine-Off (KOEO), use a DMM to measure voltage between DOC / DPF temperature sensor module pin-1 and pin-4. (Wiggle test may be required). Is voltage within 0.5 volts of battery voltage?	Yes: Replace DOC / DPF temperature sensor module. After repairs are complete, retest for SPN 5742 FMI 11. No: Repair intermittent, Open or short to PWR in GND circuit between DOC / DPF temperature sensor module connector pin-1 and GND. After repairs are complete, retest for SPN 5742 FMI 11.

NOTE: After performing all diagnostic steps, if SPN 5742 FMI 11 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 5742 FMI 16 - DOC / DPF Temperature Sensor Module above Maximum Temperature

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Oxidation Catalyst (DOC) / Diesel Particulate Filter (DPF) temperature sensor module data valid, but above normal operating range (moderately severe level). Signal has exceeded the maximum temperature limit.	DOC / DPF temperature sensor module > 302°F (150°C)	Key ON	4.2 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the DOC / DPF temperature sensor module signal is greater than 302˚F (150˚C). Active and parked regeneration is disabled. Exhaust Gas Recirculation (EGR) valve operation will be disabled.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Fault Facts

This fault will go inactive after the DOC / DPF temperature sensor module temperature drops below the warning limit, and will likely be inactive when the vehicle is in the shop. For this reason, these diagnostics must be used for both active and inactive fault codes.

Inspect for overheated aftertreatment components, cracked exhaust system welds, leaking exhaust system seams, or other damage.

Associated Faults

SPN 3242 FMI 0, 15, 16 (DPFIT); SPN 3246 FMI 0, 15, 16 (DPFOT); and SPN 4765 FMI 0, 15, 16 (DOCIT).

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

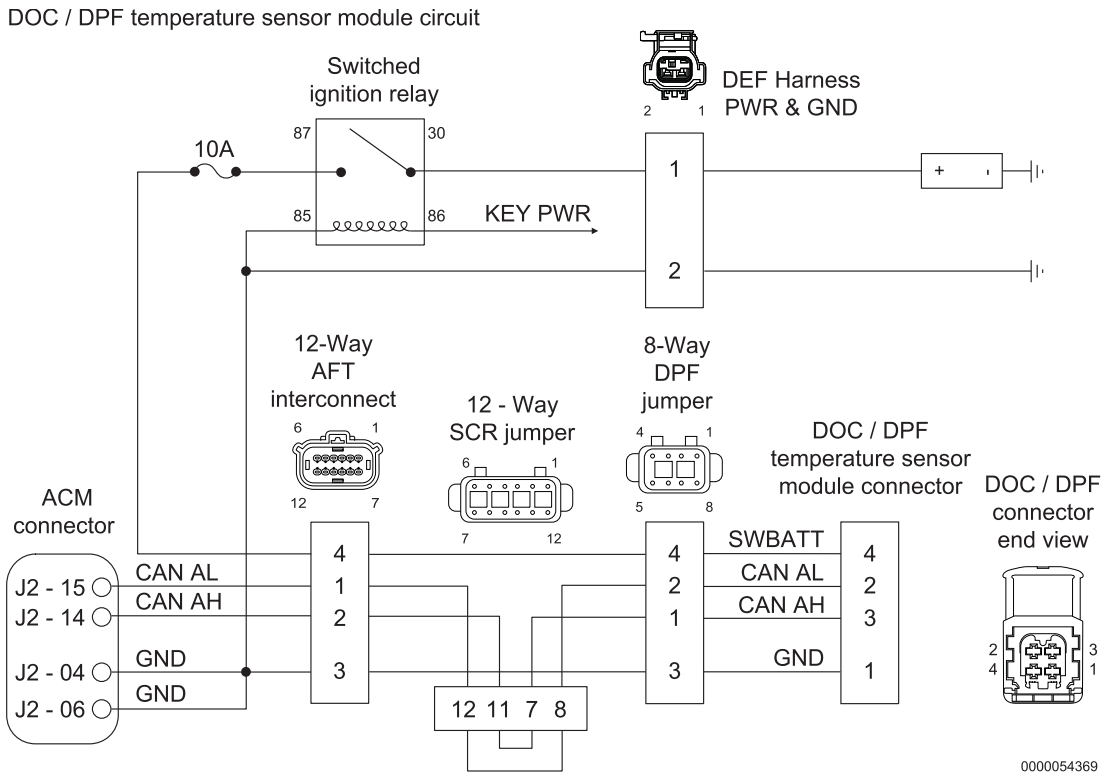


Figure 340 DOC / DPF Temperature Sensor Module Circuit Diagram

Possible Causes

- Missing, damaged, or restricted air flow across DOC / DPF temperature sensor module
- Exhaust leak(s)
- Failed DOC / DPF temperature sensor module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3242 FMI 0, 15, 16 (DPFIT); SPN 3246 FMI 0, 15, 16 (DPFOT); and SPN 4765 FMI 0, 15, 16 (DOCIT). Is EST DTC list free of SPN 3242 FMI 0, 15, 16; SPN 3246 FMI 0, 15, 16; and SPN 4765 FMI 0, 15, 16?	Yes: Go to step 2. No: Repair SPN 3242 FMI 0, 15, 16; SPN 3246 FMI 0, 15, 16; and SPN 4765 FMI 0, 15, 16. After repairs are complete, retest for SPN 5742 FMI 16.

Step	Action	Decision
2	Inspect for damaged or missing Diesel Oxidation Catalyst / Diesel Particulate Filter (DOC / DPF) temperature sensor module heat shield. Check for air flow restrictions around DOC / DPF temperature sensor module (mud, aftermarket shields, flaps, or brackets installed. Is DOC / DPF temperature sensor module heat shield free of air restrictions and is not missing or damaged?	Yes: Go to step 3. No: Remove air restriction, or replace or repair DOC / DPF temperature sensor module heat shield. After repairs are complete, retest for SPN 5742 FMI 16.

Step	Action	Decision
3	Inspect exhaust system for leaks and physical damage. Is the exhaust system free of leaks and physical damage?	Yes: Replace DOC / DPF temperature sensor module. After repairs are complete, retest for SPN 5742 FMI 16. No: Repair or replace damaged exhaust components. Refer to Fault Facts. After repairs are complete, retest for SPN 5742 FMI 16.

NOTE: After performing all diagnostic steps, if SPN 5742 FMI 16 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

DOCIT Sensor (Diesel Oxidation Catalyst Inlet Temperature)

SPN	FMI	Condition	Possible Causes	Actions
4765	0	DOCIT above Critical Temperature	• Leaking fuel injector • Lube oil leak to exhaust • Fuel leak to exhaust • Leaking or stuck Open Aftertreatment Fuel Injector (AFTFI) • Leaking or stuck Open Aftertreatment Fuel Shutoff Valve (AFTFSV) • Failed DOC / DPF temperature sensor module	Step-Based Diagnostics (page 830)
4765	2	DOCIT signal erratic, intermittent, or incorrect	• Failed DOC / DPF temperature sensor module	Step-Based Diagnostics (page 834)
4765	3	DOCIT signal Out-of-Range HIGH	• Failed DOC / DPF temperature sensor module	Step-Based Diagnostics (page 836)
4765	4	DOCIT signal Out-of-Range LOW	• Failed DOC / DPF temperature sensor module	Step-Based Diagnostics (page 837)
4765	15	DOCIT above Warning Temperature	• Leaking fuel injector • Lube oil leak to exhaust • Fuel leak to exhaust • Leaking or stuck Open Aftertreatment	Step-Based Diagnostics (page 838)

			Fuel Injector (AFTFI) • Leaking or stuck Open Aftertreatment Fuel Shutoff Valve (AFTFSV) • Failed DOC / DPF temperature sensor module	
4765	16	DOCIT above Maximum Temperature	• Leaking fuel injector • Lube oil leak to exhaust • Fuel leak to exhaust • Leaking or stuck Open Aftertreatment Fuel Injector (AFTFI) • Leaking or stuck Open Aftertreatment Fuel Shutoff Valve (AFTFSV) • Failed DOC / DPF temperature sensor module	Step-Based Diagnostics (page 842)

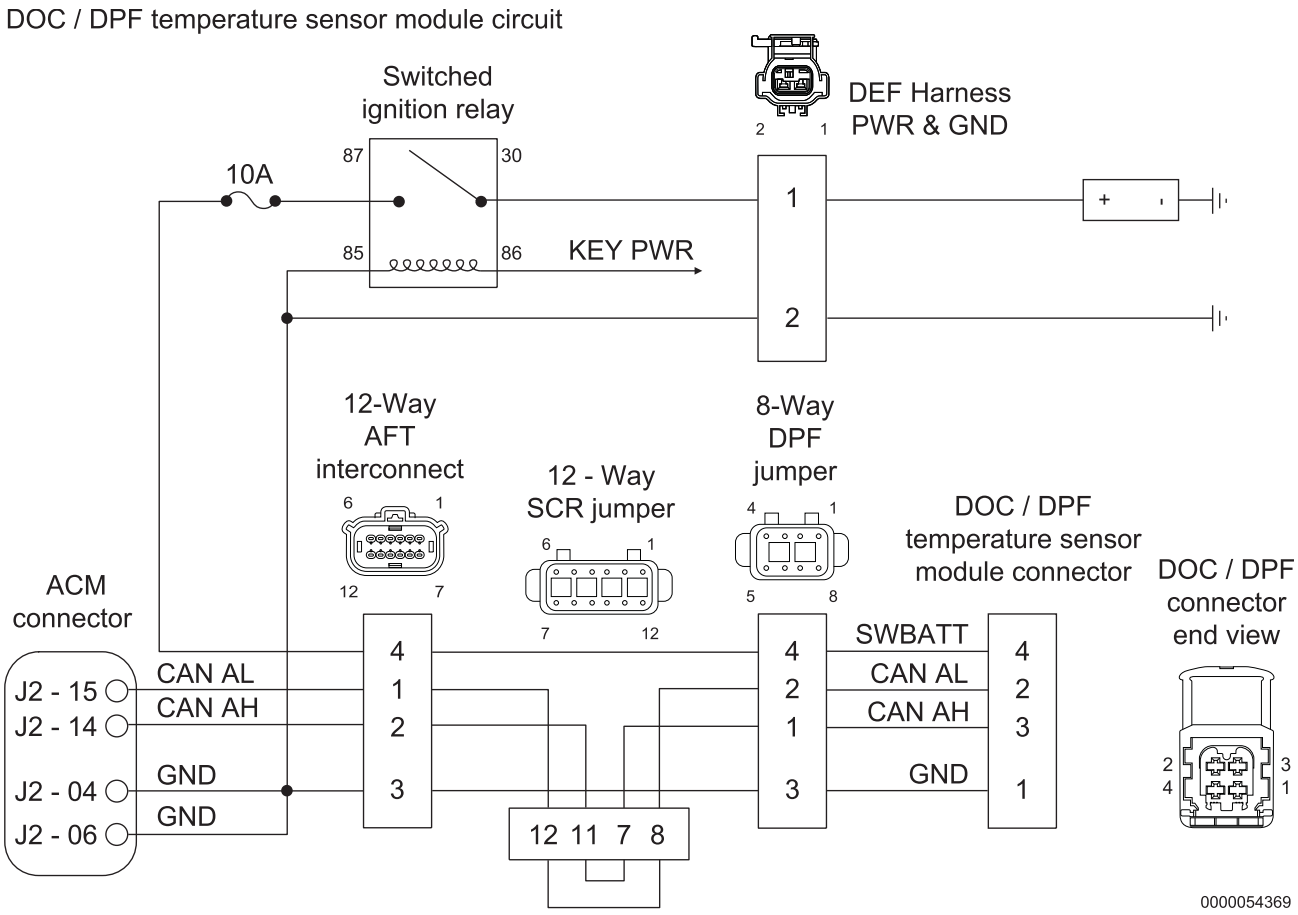


Figure 341 DOC / DPF Temperature Sensor Module Circuit Diagram

NOTE: See latest version of Navistar N13 Engine and Aftertreatment Wiring Schematic Form 0000002203 for additional circuit information.

Overview

The Diesel Oxidation Catalyst Inlet Temperature (DOCIT) sensor measures the exhaust temperature at the inlet of the DOC. The DOC / DPF temperature sensor module is a smart device that communicates with the Aftertreatment Control Module (ACM) via the Controller Area Network (CAN). The DOCIT sensor is part of the DOC / DPF temperature sensor module and is not serviceable individually.

Tools Required

- 180-Pin Breakout Box 00-00956-08
- ACM Breakout Harness 18-100-01
- Digital Multimeter (DMM)
- Breakout Harness 18-649-01
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

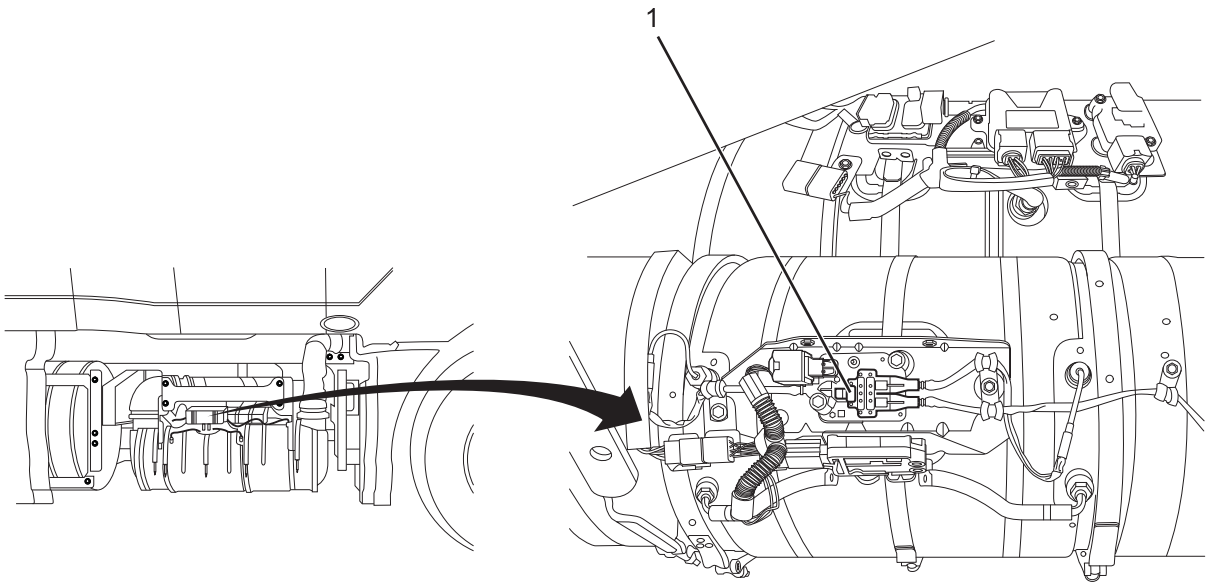


Figure 342 DOC / DPF Temperature Sensor Module Location

1. DOC / DPF Temperature Sensor Module

SPN 4765 FMI 0 DOCIT Above Critical Temperature

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Oxidation Catalyst Inlet Temperature (DOCIT) sensor has exceeded maximum temperature limit.	DOCIT > 1268°F (687°C) for more than 20 seconds.	Key-On Engine-Running (KOER)	25 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Diesel Oxidation Catalyst Inlet Temperature (DOCIT) reading is greater than 1268°F (687°C) for more than 20 seconds.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 1322-1328 FMI 31 (CYL Balance); SPN 4765 FMI 2, 3, and 4 (DOCIT); and SPN 5742 FMI 3, 4, 11, and 16 (DOC / DPF temp sensor module).

Fault Facts

If aftertreatment system has had excess fuel, oil, coolant, metal, or other contamination; inspect the entire aftertreatment system for causal damage before reinstalling. Inspect for overheated aftertreatment components, cracked exhaust system welds, leaking exhaust system seams, or other damage. This fault will go inactive after the DOCIT drops below the warning limit, and will likely be inactive when the vehicle is in the shop. For this reason, these diagnostics must be used for both active and inactive fault codes.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Leaking fuel injector
- Lube oil leak to exhaust
- Fuel leak to exhaust
- Leaking or stuck Open Aftertreatment Fuel Injector (AFTFI)
- Leaking or stuck Open Aftertreatment Fuel Shutoff Valve (AFTFSV)
- Failed DOC / DPF temperature sensor module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 1322-1328 FMI 31 (CYL Balance); SPN 4765 FMI 2, 3, and 4 (DOCIT); and SPN 5742 FMI 3, 4, 11, and 16 (DOC / DPF temp sensor module). Is EST DTC list free of SPN 1322-1328 FMI 31; SPN 4765 FMI 2, 3, and 4; and SPN 5742 FMI 3, 4, 11, and 16?	Yes: Go to step 2. No: Repair SPN 1322-1328 FMI 31; SPN 4765 FMI 2, 3, and 4; and SPN 5742 FMI 3, 4, 11, and 16. After repairs are complete, retest for SPN 4765 FMI 0.

WARNING: Warning: To prevent personal injury or death, shift transmission to park or neutral, set parking brake, and block wheels before doing diagnostic or service procedures.

Step	Action	Decision
2	Compare Diesel Oxidation Catalyst Inlet Temperature (DOCIT) sensor to Diesel Particulate Filter Inlet (DPFIT) and DPF Outlet Temperature (DPFOT) sensor temperatures. Perform Hot Run Sensor Comparison Test (page 96). Is the DOCIT, DPFIT, and DPFOT difference with in 77°F (43°C) of each other?	Yes: Go to step 3. No: Replace DOC / DPF temperature sensor module. After repairs are complete, retest for SPN 4765 FMI 0.

Step	Action	Decision
3	Determine if the engine has a mechanical cylinder balance problem (compression loss). Perform Crankcase Pressure Test (page 236). Does engine have excessive crankcase pressure?	Yes: Repair base engine compression imbalance. After repairs are complete, retest for SPN 4765 FMI 0. No: Go to step 4

Step	Action	Decision
4	Determine if engine has a fuel injector problem. Perform Multiple Cylinder Cutout Test (page 241). Did one or more cylinders have significant speed difference(s) than the others?	Yes: Go to step 5. No: Go to step 6.

Step	Action	Decision
5	Inspect for failed valve train components. Remove upper valve cover (see Engine Service Manual). Inspect for bent valves, fallen bridges, and valves out of adjustment. Is valve train free of failed valve train components?	Yes: Replace injector suspected by Multiple Cylinder Cutout Test. After repairs are complete, retest for SPN 4765 FMI 0. No: Repair failed valve train components. After repairs are complete retest for SPN 4765 FMI 0.

Step	Action	Decision
6	Inspect the turbocharger exhaust outlet for oil or fuel in the aftertreatment system from the engine. Remove exhaust plumbing from the turbocharger outlet. Was the turbocharger exhaust outlet free of oil and fuel contamination?	Yes: Go to step 7. No: Repair fuel or lube oil leak to exhaust. See Fuel to Exhaust (page 174), and see Lube Oil to Exhaust (page 163). After repairs are complete, retest for SPN 4765 FMI 0.

Step	Action	Decision
7	Check for leaking or stuck open Aftertreatment Fuel Shutoff Valve (AFTFSV). Perform AFT Fuel Shutoff Valve Leak Test (page 121). Is the AFT Fuel Injector (AFTFI) dry and free of fuel?	Yes: Go to step 8. No: Replace AFTFSV. After repairs are complete, retest for SPN 4765 FMI 0.

Step	Action	Decision
8	Check for leaking or stuck open AFTFI. Perform AFT Fuel Injector Leak Test (page 120). Is the AFTFI dry and free of fuel?	Yes: Go to step 9. No: Replace AFTFI. After repairs are complete, retest for SPN 4765 FMI 0.

Step	Action	Decision
9	Check for failed AFT fuel flow. Perform AFT Dosing System Test (page 118). Was 225 to 500 ml of fuel dispensed within 2.5 minutes?	Yes: Go to step 10. No: Replace AFTFI. Refer to Fault Facts. After repairs are complete, retest for SPN 4765 FMI 0.

Step	Action	Decision
10	Test for black smoke from the exhaust. Idle the engine and snap the throttle to 100 percent. Perform this test multiple times, if necessary. Is the exhaust free of black smoke?	Yes: Go to step 11. No: Inspect DOC / DPF system for failed or damaged component. Refer to Fault Facts. After repairs are complete, retest for SPN 4765 FMI 0.

Step	Action	Decision
11	Remove the Diesel Oxidation Catalyst (DOC). Inspect the DOC. Check the DOC face for soot accumulation, face plugging, or damage. Are less than 50 percent of the cells on the intake face completely blocked by soot?	Yes: Reinstall DOC and perform a Parked Regeneration. After repairs are complete, retest for SPN 4765 FMI 0.
		No: Clean or replace DOC. Refer to Fault Facts. After repairs are complete, retest for SPN 4765 FMI 0.

NOTE: After performing all diagnostic steps, if SPN 4765 FMI 0 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 4765 FMI 2 DOCIT signal erratic, intermittent, or incorrect

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
The Diesel Oxidation Catalyst Inlet Temperature (DOCIT) is not changing with engine operating conditions (in-range but not rational).	Average temperature difference across Diesel Oxidation Catalyst (DOC) between -76°F (-60°C) and 131°F (55°C)	Key-On Engine-Running (KOER) Time since last active regeneration > 600 seconds Exhaust flow between 200 g/sec and 1,000 g/sec DOCIT between 217°F (103°C) and 1112°F (600°C) Inactive: SPN 3242 FMI 3 and 4 (DPFIT); SPN 3246 FMI 3 and 4 (DPFOT); SPN 3480 FMI 2, 3, 4, and 17 (AFTFP1); SPN 3482 FMI 2, 3, 4, and 7 (AFTFSV); SPN 3490 FMI 3, 4, and 7 (AFTPAV); SPN 3556 FMI 2 and 5 (AFT System); SPN 4765 FMI 3 and 4 (DOCIT); SPN 5742 FMI 3, 4, 11, and 16 (DOC / DPF Temp Sensor Module)	300 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the difference between the Diesel Oxidation Catalyst Inlet Temperature (DOCIT) and Diesel Particulate Filter Inlet Temperature (DPFIT) readings do not match expected values for engine operating conditions. Diesel Exhaust Fluid (DEF) injection into the aftertreatment system is disabled. Active and parked regeneration of the DPF will be disabled. Engine torque will be reduced if the engine is operated for an extended period of time with this fault active.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 3242 FMI 3 and 4 (DPFIT); SPN 3246 FMI 3 and 4 (DPFOT); SPN 3480 FMI 2, 3, 4, and 17 (AFTFP1); SPN 3482 FMI 2, 3, 4, and 7 (AFTFSV); SPN 3490 FMI 3, 4, and 7 (AFTPAV); SPN 3556 FMI 2 and 5 (AFT System); SPN 4765 FMI 3 and 4 (DOCIT); SPN 5742 FMI 3, 4, 11, and 16 (DOC / DPF Temp Sensor Module)

Drive Cycle to Determine Fault Status

Drive Cycle 31 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Failed DOC / DPF temperature sensor module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3242 FMI 3 and 4 (DPFIT); SPN 3246 FMI 3 and 4 (DPFOT); SPN 3480 FMI 2, 3, 4, and 17 (AFTFP1); SPN 3482 FMI 2, 3, 4, and 7 (AFTFSV); SPN 3490 FMI 3, 4, and 7 (AFTPAV); SPN 3556 FMI 2 and 5 (AFT System); SPN 4765 FMI 3 and 4 (DOCIT); SPN 5742 FMI 3, 4, 11, and 16 (DOC / DPF Temp Sensor Module) Is EST DTC list free of SPN 3242 FMI 3 and 4; SPN 3246 FMI 3 and 4; SPN 3480 FMI 2, 3, 4, and 17; SPN 3482 FMI 2, 3, 4, and 7; SPN 3490 FMI 3, 4, and 7; SPN 3556 FMI 2 and 5; SPN 4765 FMI 3 and 4; SPN 5742 FMI 3, 4, 11, and 16?	Yes: Replace DOC / DPF temperature sensor module. After repairs are complete, retest for SPN 4765 FMI 2. No: Repair SPN 3242 FMI 3 and 4; SPN 3246 FMI 3 and 4; SPN 3480 FMI 2, 3, 4, and 17; SPN 3482 FMI 2, 3, 4, and 7; SPN 3490 FMI 3, 4, and 7; SPN 3556 FMI 2 and 5; SPN 4765 FMI 3 and 4; SPN 5742 FMI 3, 4, 11, and 16. After repairs are complete, retest for SPN 4765 FMI 2.

NOTE: After performing all diagnostic steps, if SPN 4765 FMI 2 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 4765 FMI 3 DOCIT signal Out of Range HIGH

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
DOC / DPF temperature sensor module detects short to power, or Open in Diesel Oxidation Catalyst Inlet Temperature (DOCIT) circuit.	DOCIT sensor input voltage ≥ 5 volts OR DOCIT ≥ 10 Ohms	Key-On Engine-Running (KOER)	16 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects that the Diesel Oxidation Catalyst Inlet Temperature (DOCIT) sensor signal voltage is greater than expected. Diesel Exhaust Fluid (DEF) injection into the aftertreatment system is disabled. Active and parked regeneration of the DPF will be disabled. Engine torque will be reduced if the engine is operated for an extended period of time with this fault active.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Failed DOC / DPF temperature sensor module

Step	Action	Decision
1		

NOTE: After performing all diagnostic steps, if SPN 4765 FMI 3 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 4765 FMI 4 DOCIT signal Out of Range LOW

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
DOC / DPF temperature sensor module detects short to ground in Diesel Oxidation Catalyst Inlet Temperature (DOCIT) circuit.	DOCIT signal ≤ 1 volt	Key-On Engine-Running (KOER)	16 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Diesel Oxidation Catalyst Inlet Temperature (DOCIT) sensor signal voltage is less than 1 volt for more than 2 seconds. Active and parked regeneration of the DPF will be disabled. Engine torque will be reduced if the engine is operated for an extended period of time with this fault active.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Failed DOC / DPF temperature sensor module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 5742 FMI 3, 4, 11, and 16 (DOC / DPF Temp Sensor Module) Is EST DTC list free of SPN 5742 FMI 3, 4, 11, and 16?	Yes: Replace DOC / DPF temperature sensor module. After repairs are complete, retest for SPN 4765 FMI 4.
		No: Repair SPN 5742 FMI 3, 4, 11, and 16. After repairs are complete, retest for SPN 4765 FMI 4.

NOTE: After performing all diagnostic steps, if SPN 4765 FMI 4 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 4765 FMI 15 DOCIT Above Warning Temperature

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
The Diesel Oxidation Catalyst Inlet Temperature (DOCIT) sensor reading has exceeded the maximum temperature limit (least severe level).	DOCIT > 1220°F (660°C) for 5 seconds on five separate occasions	Key-On Engine-Running (KOER)	20 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Diesel Oxidation Catalyst Inlet Temperature (DOCIT) reading is greater than 1220°F (660°C) for 5 seconds on five separate occasions. Active and parked regeneration will be disabled.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 1322–1328 FMI 31 (CYL Balance); SPN 4765 FMI 2, 3, and 4 (DOCIT); and SPN 5742 FMI 3, 4, 11, and 16 (DOC / DPF temperature sensor module).

Fault Facts

If aftertreatment system has had excess fuel, oil, coolant, metal, or other contamination; inspect the entire aftertreatment system for causal damage before reinstalling. Inspect for overheated aftertreatment components, cracked exhaust system welds, leaking exhaust system seams, or other damage. This fault will go inactive after the DOCIT drops below the warning limit, and will likely be inactive when the vehicle is in the shop. For this reason, these diagnostics must be used for both active and inactive fault codes.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Leaking fuel injector
- Lube oil leak to exhaust
- Fuel leak to exhaust
- Leaking or stuck Open Aftertreatment Fuel Injector (AFTFI)
- Leaking or stuck Open Aftertreatment Fuel Shutoff Valve (AFTFSV)
- Failed DOC / DPF temperature sensor module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 1322-1328 FMI 31 (CYL Balance); SPN 4765 FMI 2, 3, and 4 (DOCIT); and SPN 5742 FMI 3, 4, 11, and 16 (DOC / DPF temp sensor module). Is EST DTC list free of SPN 1322-1328 FMI 31; SPN 4765 FMI 2, 3, and 4; and SPN 5742 FMI 3, 4, 11, and 16?	Yes: Go to step 2. No: Repair SPN 1322-1328 FMI 31; SPN 4765 FMI 2, 3, and 4; and SPN 5742 FMI 3, 4, 11, and 16. After repairs are complete, retest for SPN 4765 FMI 15.

WARNING: Warning: To prevent personal injury or death, shift transmission to park or neutral, set parking brake, and block wheels before doing diagnostic or service procedures.

Step	Action	Decision
2	Compare Diesel Oxidation Catalyst Inlet Temperature (DOCIT) sensor to Diesel Particulate Filter Inlet (DPFIT) and DPF Outlet Temperature (DPFOT) sensor temperatures. Perform Hot Run Sensor Comparison Test (page 96). Is the DOCIT, DPFIT, and DPFOT difference with in 77°F (43°C) of each other?	Yes: Go to step 3. No: Replace DOC / DPF temperature sensor module. After repairs are complete, retest for SPN 4765 FMI 15.

Step	Action	Decision
3	Determine if the engine has a mechanical cylinder balance problem (compression loss). Perform Crankcase Pressure Test (page 236). Does engine have excessive crankcase pressure?	Yes: Repair base engine compression imbalance. After repairs are complete, retest for SPN 4765 FMI 15. No: Go to step 4

Step	Action	Decision
4	Determine if engine has a fuel injector problem. Perform Multiple Cylinder Cutout Test (page 241). Did one or more cylinders have significant speed difference(s) than the others?	Yes: Go to step 5. No: Go to step 6.

Step	Action	Decision
5	Inspect for failed valve train components. Remove upper valve cover (see Engine Service Manual). Inspect for bent valves, fallen bridges, and valves out of adjustment. Is valve train free of failed valve train components?	Yes: Replace injector suspected by Multiple Cylinder Cutout Test. After repairs are complete, retest for SPN 4765 FMI 15. No: Repair failed valve train components. After repairs are complete retest for SPN 4765 FMI 15.

Step	Action	Decision
6	Inspect the turbocharger exhaust outlet for oil or fuel in the aftertreatment system from the engine. Remove exhaust plumbing from the turbocharger outlet. Was the turbocharger exhaust outlet free of oil and fuel contamination?	Yes: Go to step 7. No: Repair fuel or lube oil leak to exhaust. See Fuel to Exhaust (page 174), and see Lube Oil to Exhaust (page 163). After repairs are complete, retest for SPN 4765 FMI 15.

Step	Action	Decision
7	Check for leaking or stuck open Aftertreatment Fuel Shutoff Valve (AFTFSV). Perform AFT Fuel Shutoff Valve Leak Test (page 121). Is the AFT Fuel Injector (AFTFI) dry and free of fuel?	Yes Go to step 8. No: Replace AFTFSV. After repairs are complete, retest for SPN 4765 FMI 15.

Step	Action	Decision
8	Check for leaking or stuck open AFTFI. Perform AFT Fuel Injector Leak Test (page 120). Is the AFTFI dry and free of fuel?	Yes: Go to step 9. No: Replace AFTFI. After repairs are complete, retest for SPN 4765 FMI 15.

Step	Action	Decision
9	Check for failed AFT fuel flow. Perform AFT Dosing System Test (page 118). Was 225 to 500 ml of fuel dispensed within 2.5 minutes?	Yes: Go to step 10. No: Replace AFTFI. After repairs are complete, retest for SPN 4765 FMI 15.

Step	Action	Decision
10	Test for black smoke from the exhaust. Idle the engine and snap the throttle to 100 percent. Perform this test multiple times, if necessary. Is the exhaust free of black smoke?	Yes: Go to step 11. No: Inspect DOC / DPF system for failed or damaged component. After repairs are complete, retest for SPN 4765 FMI 15.

Step	Action	Decision
11	Remove the Diesel Oxidation Catalyst (DOC). Check the DOC for soot accumulation, face plugging, or damage. Are less than 50 percent of the cells on the intake face completely blocked by soot?	Yes: Reinstall DOC and perform a Parked Regeneration. After repairs are complete, retest for SPN 4765 FMI 15.
		No: Clean or replace DOC. After repairs are complete, retest for SPN 4765 FMI 15.

NOTE: After performing all diagnostic steps, if SPN 4765 FMI 15 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 4765 FMI 16 DOCIT Above Maximum Temperature

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
The Diesel Oxidation Catalyst Inlet Temperature (DOCIT) sensor has exceeded the maximum temperature limit (moderately severe level).	DOCIT > 1274°F (690°C) for 60 seconds.	Key-On Engine-Running (KOER)	20 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Diesel Oxidation Catalyst Inlet Temperature (DOCIT) reading is greater than 1274°F (690°C) for 60 seconds. Active and parked regeneration will be disabled. Engine shutdown will occur 30 seconds after the fault becomes active (except emergency vehicle calibrations).

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 1322-1328 FMI 31 (CYL Balance); SPN 4765 FMI 2, 3, and 4 (DOCIT); and SPN 5742 FMI 3, 4, 11, and 16 (DOC / DPF temp sensor module).

Fault Facts

If aftertreatment system has had excess fuel, oil, coolant, metal, or other contamination; inspect the entire aftertreatment system for causal damage before reinstalling. Inspect for overheated aftertreatment components, cracked exhaust system welds, leaking exhaust system seams, or other damage. This fault will go inactive after the DOCIT drops below the warning limit, and will likely be inactive when the vehicle is in the shop. For this reason, these diagnostics must be used for both active and inactive fault codes.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Leaking fuel injector
- Lube oil leak to exhaust
- Fuel leak to exhaust
- Leaking or stuck Open Aftertreatment Fuel Injector (AFTFI)
- Leaking or stuck Open Aftertreatment Fuel Shutoff Valve (AFTFSV)
- Failed DOC / DPF temperature sensor module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 1322-1328 FMI 31 (CYL Balance); SPN 4765 FMI 2, 3, and 4 (DOCIT); and SPN 5742 FMI 3, 4, 11, and 16 (DOC / DPF temp sensor module). Is EST DTC list free of SPN 1322-1328 FMI 31; SPN 4765 FMI 2, 3, and 4; and SPN 5742 FMI 3, 4, 11, and 16?	Yes: Go to step 2. No: Repair SPN 1322-1328 FMI 31; SPN 4765 FMI 2, 3, and 4; and SPN 5742 FMI 3, 4, 11, and 16. After repairs are complete, retest for SPN 4765 FMI 16.

WARNING: Warning: To prevent personal injury or death, shift transmission to park or neutral, set parking brake, and block wheels before doing diagnostic or service procedures.

Step	Action	Decision
2	Compare Diesel Oxidation Catalyst Inlet Temperature (DOCIT) sensor to Diesel Particulate Filter Inlet (DPFIT) and DPF Outlet Temperature (DPFOT) sensor temperatures. Using (EST) with ServiceMaxx™ software, perform Hot Run Sensor Comparison Test (page 96). Is the DOCIT, DPFIT, and DPFOT difference with in 77°F (43°C) of each other?	Yes: Go to step 3. No: Replace DOC / DPF temperature sensor module. After repairs are complete, retest for SPN 4765 FMI 16.

Step	Action	Decision
3	Determine if the engine has a mechanical cylinder balance problem (compression loss). Perform Crankcase Pressure Test (page 236). Does engine have excessive crankcase pressure?	Yes: Repair base engine compression imbalance. After repairs are complete, retest for SPN 4765 FMI 16. No: Go to step 4

Step	Action	Decision
4	Determine if engine has a fuel injector problem. Perform Multiple Cylinder Cutout Test (page 241). Did one or more cylinders have significant speed difference(s) than the others?	Yes: Go to step 5. No: Go to step 6.

Step	Action	Decision
5	Inspect for failed valve train components. Remove upper valve cover (see Engine Service Manual). Inspect for bent valves, fallen bridges, and valves out of adjustment. Is valve train free of failed valve train components?	Yes: Replace injector suspected by Multiple Cylinder Cutout Test. After repairs are complete, retest for SPN 4765 FMI 16. No: Repair failed valve train components. After repairs are complete retest for SPN 4765 FMI 16.

Step	Action	Decision
6	Inspect the turbocharger exhaust outlet for oil or fuel in the aftertreatment system from the engine. Remove exhaust plumbing from the turbocharger outlet. Was the turbocharger exhaust outlet free of oil and fuel contamination?	Yes: Go to step 7. No: Repair fuel or lube oil leak to exhaust. See Fuel to Exhaust (page 174), and see Lube Oil to Exhaust (page 163). After repairs are complete, retest for SPN 4765 FMI 16.

Step	Action	Decision
7	Check for leaking or stuck open Aftertreatment Fuel Shutoff Valve (AFTFSV). Perform AFT Fuel Shutoff Valve Leak Test (page 121). Is the AFT Fuel Injector (AFTFI) dry and free of fuel?	Yes: Go to step 8. No: Replace AFTFSV. After repairs are complete, retest for SPN 4765 FMI 16.

Step	Action	Decision
8	Check for leaking or stuck open AFTFI. Perform AFT Fuel Injector Leak Test (page 120). Is the AFTFI dry and free of fuel?	Yes: Go to step 9. No: Replace AFTFI. After repairs are complete, retest for SPN 4765 FMI 16.

Step	Action	Decision
9	Check for failed AFT fuel flow. Perform AFT Dosing System Test (page 118). Was 225 to 500 ml of fuel dispensed within 2.5 minutes?	Yes: Go to step 10. No: Replace AFTFI. After repairs are complete, retest for SPN 4765 FMI 16.

Step	Action	Decision
10	Test for black smoke from the exhaust. Idle the engine and snap the throttle to 100 percent. Perform this test multiple times, if necessary. Is the exhaust free of black smoke?	Yes: Go to step 11. No: Inspect DOC/DPF system for failed or damaged component. After repairs are complete, retest for SPN 4765 FMI 16.

Step	Action	Decision
11	Remove the Diesel Oxidation Catalyst (DOC). Check the DOC face for soot accumulation, face plugging, or damage. Are less than 50 percent of the cells on the intake face completely blocked by soot?	Yes: Reinstall DOC and perform a Parked Regeneration. After repairs are complete, retest for SPN 4765 FMI 16.
		No: Clean or replace DOC. After repairs are complete, retest for SPN 4765 FMI 16.

NOTE: After performing all diagnostic steps, if SPN 4765 FMI 16 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

DPFDP (Diesel Particulate Filter Differential Pressure) / Outlet Pressure Sensor

SPN	FMI	Condition	Possible Causes	Actions
3251	2	DPFDP signal erratic, intermittent, or incorrect	• DPFDP circuit high resistance • Leaking or Restricted DPFDP hoses • Failed DPFDP sensor	Step-Based Diagnostics (page 850)
3251	3	DPFDP signal Out of Range HIGH	• SIG GND Open or high resistance • DPFDP shorted to PWR • Failed DPFDP Sensor Module	Step-Based Diagnostics (page 853)
3251	4	DPFDP signal Out of Range LOW	• VREF-4 circuit Open or high resistance • DPFDP circuit shorted to GND • DPFDP circuit Open or high resistance • Failed DPFDP Sensor Module	Step-Based Diagnostics (page 855)
3610	2	DPFOP signal erratic, intermittent, or incorrect	• DPFOP circuit high resistance • Leaking or Restricted DPFDP / outlet pressure sensor module hoses • Failed DPFDP/ outlet pressure sensor module	Step-Based Diagnostics (page 858)

3610	3	DPFOP signal Out of Range HIGH	• SIG GND Open or high resistance • DPFOP shorted to PWR • Failed DPFDP / outlet pressure sensor module	Step-Based Diagnostics (page 861)
3610	4	DPFOP signal Out of Range LOW	• VREF-4 circuit Open or high resistance • DPFOP circuit shorted to GND • DPFOP circuit Open or high resistance • Failed DPFDP/ outlet pressure Sensor Module	Step-Based Diagnostics (page 863)

DPF Differential Pressure / Outlet Pressure circuit

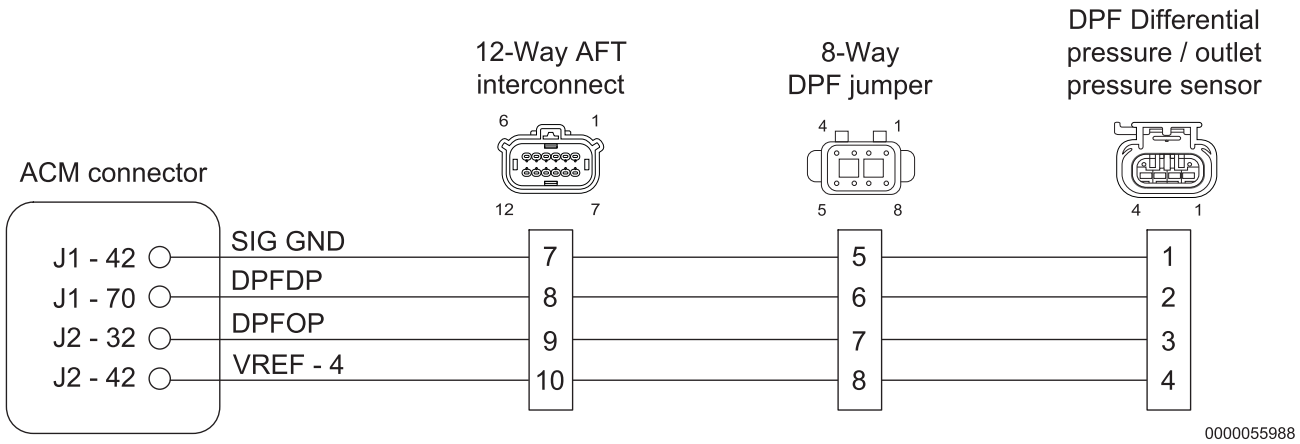


Figure 343 DPFDP / Outlet Pressure Sensor Module Circuit Diagram

NOTE: See latest version of Navistar N13 Engine and Aftertreatment Wiring Schematic Form 0000002203 for additional circuit information.

Overview

The Diesel Particulate Filter Differential Pressure (DPFDP) / outlet pressure sensor module measures the pressure difference between the inlet pressure and outlet pressure of the DPF, and the outlet pressure of the DPF. Aftertreatment regeneration will not run with DPFDP / outlet pressure sensor module fault codes present.

Tools Required

- 180-Pin Breakout Box 00-00956-08
- Breakout Harness 18-100-01
- Breakout Harness 12-575-01
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

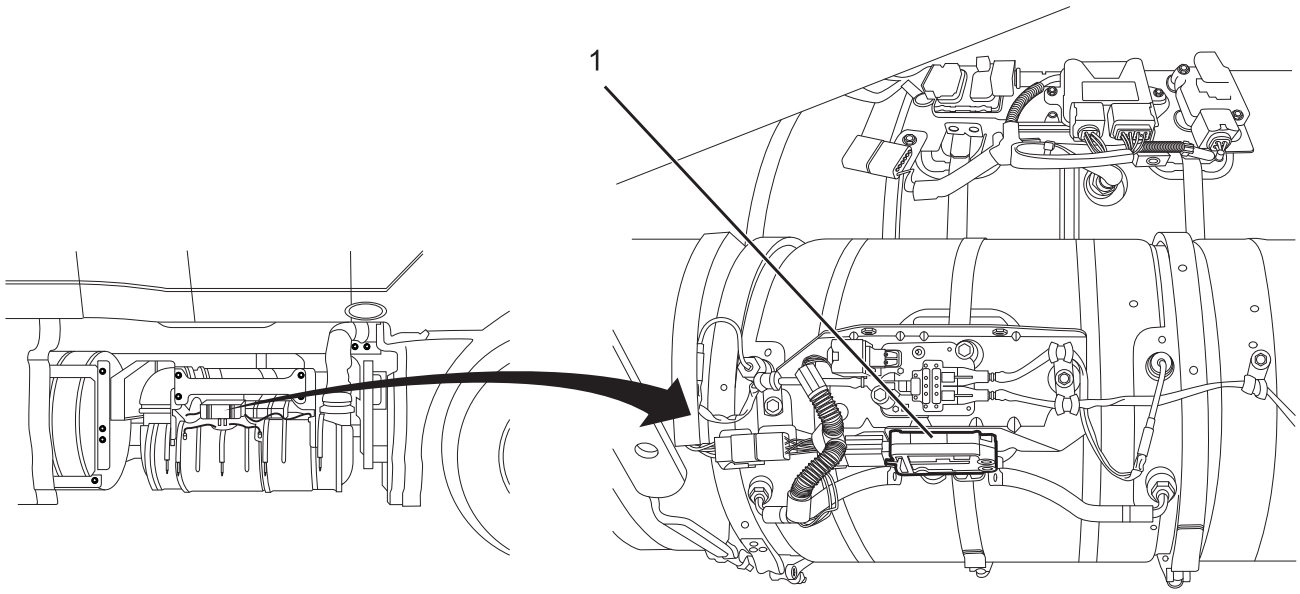


Figure 344 DPFDP / Outlet Pressure Sensor Module Location

1. Diesel Particulate Filter Differential Pressure (DPFDP) / outlet pressure sensor module

SPN 3251 FMI 2 - DPFDP signal erratic, intermittent, or incorrect

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Particulate Filter Differential Pressure (DPFDP) sensor Key ON check indicates signal in-range but not rational or stuck in range.	Absolute value of DPFDP > 0.25 psi (1.5 kPa) Range of DPFDP since last monitor decision when Enable Conditions are met < 0.15 psi (1 kpa)	Inactive: SPN 3251 FMI 3, 4 Engine Speed ≤ 200 RPM Elapsed time since key ON > 1 sec Range of exhaust volumetric flow since last monitor > 0.4 m3/sec DPFDP sensor signal not saturated at high exhaust flow: (DPFDP <= 5.1 psi (35 kpa) OR (Exhaust flow <= 1 m3/sec) Key-On Engine-Running (KOER)	Immediate

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the aftertreatment Diesel Particulate Filter Differential Pressure (DPFDP) is greater than 0.25 psi (1.5 kpa), is not changing with engine conditions, or range since last monitor < 0.15 psi (1 kpa).

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 3251 FMI 3, 4 (DPFDP); SPN 3512 FMI 14 (VREF-4)

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

DPF Differential Pressure / Outlet Pressure circuit

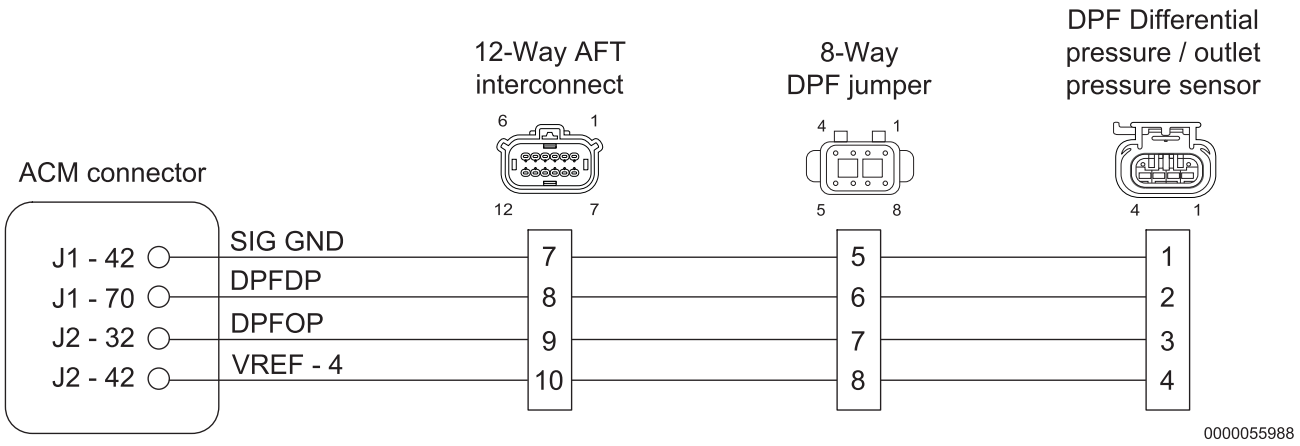


Figure 345 DPFDP / Outlet Pressure Sensor Module Circuit Diagram

Possible Causes

- DPFDP circuit high resistance
- Leaking or Restricted DPFDP / outlet pressure sensor module hoses
- Failed DPFDP / outlet pressure sensor module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3251 FMI 3 and 4 (DPFDP); SPN 3512 FMI 14 (VREF-4). Is EST DTC list free of SPN 3251 FMI 3 and 4; SPN 3512 FMI 14?	Yes: Go to step 2. No: Repair SPN 3251 FMI 3 and 4; SPN 3512 FMI 14. After repairs are complete, retest for SPN 3251 FMI 2.

Step	Action	Decision
2	Inspect hoses and tube connections at the DPFDP / outlet pressure sensor module. Check sensor, tubes, and passages for leaks, restrictions, and damage. Are the DPFDP / outlet pressure sensor module connections free of leaks, restrictions, and damage?	Yes: Go to step 3. No: Repair leaking, restricted or damaged hoses and connections. After repairs are complete, retest for SPN 3251 FMI 2.

Step	Action	Decision
3	Inspect connections at DPFDP / outlet pressure sensor module. Key OFF, disconnect DPFDP / outlet pressure sensor module. Check DPFDP / outlet pressure sensor module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DPFDP / outlet pressure sensor module connector, harness, and terminals clean and undamaged?	Yes: Go to step 4. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3251 FMI 2.

Step	Action	Decision
4	Inspect connections at Aftertreatment Control Module (ACM). Key OFF, disconnect ACM. Check ACM and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the ACM connector, harness, and terminals clean and undamaged?	Yes: Go to step 5. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3251 FMI 2.

Step	Action	Decision
5	Check DPFDP circuit for high resistance. Connect Breakout Harness 12-575-01 to DPFDP / outlet pressure sensor module connector and leave sensor disconnected. Connect 180-Pin Breakout Box and Breakout Harness 18-100-01(96-pin) to ACM and leave disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness pin-2 and Breakout Box pin J1-70. Is resistance less than 5 ohms?	Yes: Replace the DPFDP / outlet pressure sensor module. After repairs are complete retest for SPN 3251 FMI 2. No: Repair the high resistance between the DPFDP / outlet pressure sensor module connector pin-2 and ACM connector pin J1-70. After repairs are complete retest for SPN 3251 FMI 2.

NOTE: After performing all diagnostic steps, if SPN 3251 FMI 2 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3251 FMI 3 - DPFDP signal Out of Range HIGH

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Particulate Filter Differential Pressure (DPFDP) sensor reading greater than specified operating range for a specified amount of time.	Aftertreatment DPF Differential Pressure sensor value > 4.25 volts	Key ON	2 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects that the aftertreatment Diesel Particulate Filter Differential Pressure signal voltage is greater than 4.75 volts for more than 2 seconds.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Fault

SPN 3512 FMI 14 (VREF-4)

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

DPF Differential Pressure / Outlet Pressure circuit

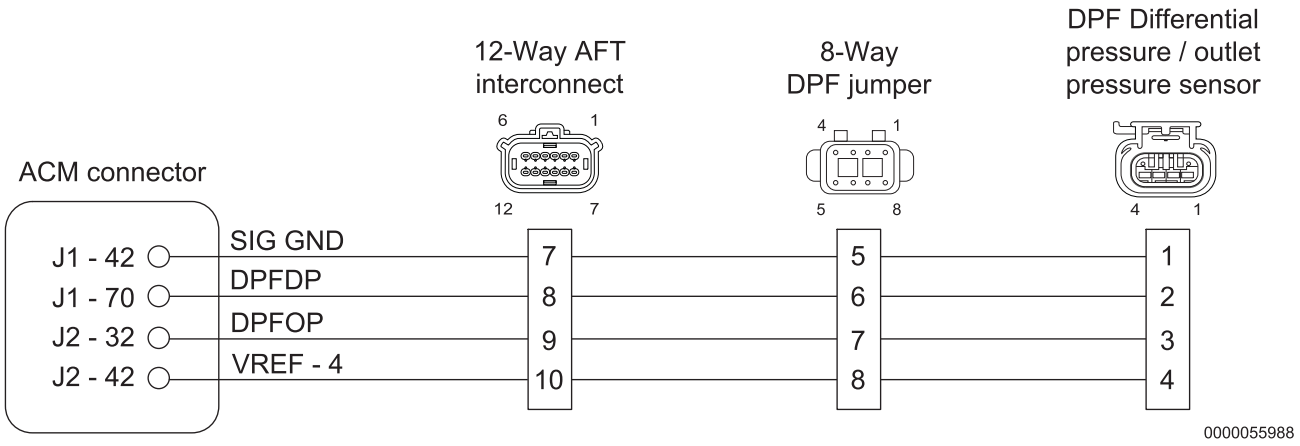


Figure 346 DPFDP / Outlet Pressure Sensor Module Circuit Diagram

Possible Causes

- SIG GND Open or high resistance
- DPFDP shorted to PWR
- Failed DPFDP / outlet sensor module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3512 FMI 14 (VREF-4). Is EST DTC list free of SPN 3512 FMI 14?	Yes: Go to step 2. No: Repair SPN 3512 FMI 14. After repairs are complete, retest for SPN 3251 FMI 3.

Step	Action	Decision
2	Inspect connections at DPFDP / outlet pressure sensor module. Key OFF, disconnect DPFDP / outlet pressure sensor module. Check DPFDP / outlet pressure sensor module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DPFDP / outlet pressure sensor module connector, harness, and terminals clean and undamaged?	Yes: Go to step 3. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3251 FMI 3.

Step	Action	Decision
3	Check DPFDP circuit for Short to power. Key-On Engine-Off, with Breakout Harness 12-575-01 connected to DPFDP / outlet pressure sensor module, use a DMM to measure voltage between DPFDP / outlet pressure sensor module pin-2 and a known good ground. Is voltage at pin-2 less than 4.7 volts?	Yes: Go to step 4. No: Repair short to power between DPFDP / outlet pressure sensor module connector pin-2 and ACM connector pin J1-70. After repairs are complete retest for SPN 3251 FMI 3.

Step	Action	Decision
4	Check SIG GND circuit for Open or high resistance. Key OFF, Connect Breakout Harness 12-575-01 to DPFDP / outlet pressure sensor module and leave disconnected. Connect 180-pin Breakout Box with Breakout Harness 18-100-01 (96-pin) to ACM and leave ACM disconnected. Use a DMM to measure resistance from Breakout Harness 12-575-01 pin-1 to 180-pin Breakout Box pin J1-42. Is resistance less than 5 ohms?	Yes: Replace the DPFDP sensor module. After repairs are complete retest for SPN 3251 FMI 3. No: Repair Open or high resistance between DPFDP / outlet pressure sensor module connector pin-1 and ACM connector pin J1-42. After repairs are complete, retest for SPN 3251 FMI 3.

NOTE: After performing all diagnostic steps, if SPN 3251 FMI 3 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3251 FMI 4- DPFDP signal Out of Range LOW

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Particulate Filter Differential Pressure (DPFDP) signal voltage is less than 0.25 V for more than 2 seconds.	DPFDP < 0.25 volts	Key ON	2 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the aftertreatment Diesel Particulate Filter Differential Pressure signal voltage is greater than 0.25 volts for more than 2 seconds.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 3512 FMI 14 (VREF-4)

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

DPF Differential Pressure / Outlet Pressure circuit

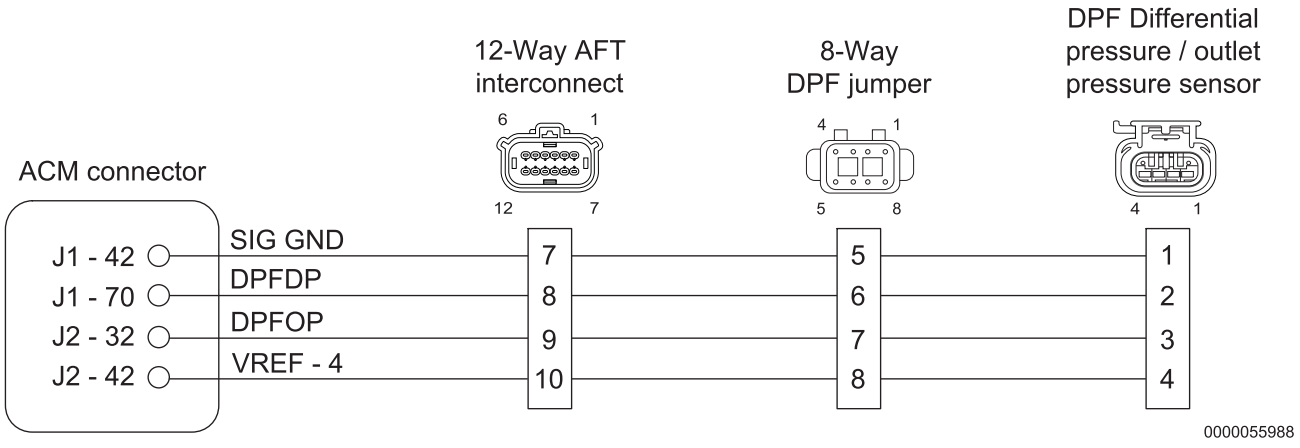


Figure 347 DPFDP / Outlet Pressure Sensor Module Circuit Diagram

Possible Causes

- VREF-4 circuit Open or high resistance
- DPFDP circuit shorted to GND
- DPFDP circuit Open or high resistance
- Failed DPFDP / outlet pressure sensor module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3512 FMI 14 (VREF-4). Is EST DTC list free of SPN 3512 FMI 14?	Yes: Go to step 2. No: Repair SPN 3512 FMI 14. After repairs are complete, retest for SPN 3480 FMI 4.

Step	Action	Decision
2	Inspect connections at DPFDP / outlet pressure sensor module. Key OFF, disconnect DPFDP sensor. Check DPFDP / outlet pressure sensor module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DPFDP / outlet pressure sensor module connector, harness, and terminals clean and undamaged?	Yes: Go to step 3. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3251 FMI 4.

Step	Action	Decision
3	Check DPFDP circuit for Short to ground. KOEO, with Breakout Harness 12-575-01 connected to DPFDP / outlet pressure sensor module connector and leave sensor disconnected. Use a DMM to measure resistance between DPFDP / outlet pressure sensor module connector pin-2 and a known good ground. Is resistance greater than 1000 ohms?	Yes: Go to step 4. No: Repair the short to GND between DPFDP / outlet pressure sensor module connector pin-2 and ACM connector pin J1-70. After repairs are complete retest for SPN 3251 FMI 4.

Step	Action	Decision
4	Check VREF-4 circuit for Open or high resistance. Connect Breakout Harness 12-575-01 to DPFDP / outlet pressure sensor module connector and leave sensor disconnected. Connect 180-pin Breakout Box with Breakout Harness 18-100-01 (58-pin) to ACM connector and leave ACM disconnected. Use a DMM to measure resistance between Breakout Harness 12-575-01 pin-4 and 180-pin Breakout Box pin J2-42. Is resistance less than 5 ohms?	Yes: Go to step 5. No: Repair Open or high resistance between DPFDP / outlet pressure sensor module connector pin-4 and ACM connector pin J2-42. After repairs are complete, retest for SPN 3251 FMI 4.

Step	Action	Decision
5	Check DPFDP signal circuit for Open or high resistance. Connect Breakout Harness 12-575-01 to DPFDP / outlet pressure sensor module connector and leave sensor disconnected. Connect 180-pin Breakout Box with Breakout Harness 18-100-01 (96-pin) to ACM and leave ACM disconnected. Use a DMM to measure resistance between Breakout Harness 12-575-01 pin-2 and 180-pin Breakout Box pin J1-70. Is resistance less than 5 ohms?	Yes: Replace DPFDP / outlet pressure sensor module. After repairs are complete, retest for SPN 3251 FMI 4.
		No: Repair Open or high resistance between DPFDP / outlet pressure sensor module pin-2 and ACM connector pin J1-70. After repairs are complete, retest for SPN 3251 FMI 4.

NOTE: After performing all diagnostic steps, if SPN 3251 FMI 4 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3610 FMI 2- DPFOP Signal Erratic, Intermittent, or Incorrect

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Particulate Filter (DPF) outlet pressure sensor stuck in-range, in-range but not rational, or in-range but reading inappropriately high.	Range of DPF outlet pressure since last monitor decision when Enable Conditions are met < 0.15 psi (1 kPa) Absolute Value of DPF outlet pressure > 0.2 psi (1.5 kPa) DPF outlet pressure greater than expected DPF outlet pressure between 0.2 psi (1.5 kPa) and -0.2 psi (-1.5 kPa) (Exhaust flow > 0.4 m3/sec) OR (Exhaust flow >= 0.35 m3/sec and increasing)	Inactive: SPN 3610 FMI 3, 4 Range of exhaust volumetric flow since last decision > 0.55 m3/sec DPF outlet pressure sensor signal not saturated at high exhaust flow: (DPF outlet pressure ≤ 35 kPa) OR (Exhaust flow ≤ 1 m3/sec) Engine is Running Engine Speed ≤ 200 RPM Elapsed time since Key ON > 1 sec. Exhaust flow > 0.4 m3/sec OR Exhaust flow >= 0.35 m3/sec and increasing	30 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Diesel Particulate Filter (DPF) outlet pressure is greater than 0.22 psi or less than -0.22 psi at initial key ON, stuck in-range, in-range but not rational, or in-range but reading inappropriately high. Engine torque will be reduced if the engine is operated for an extended period of time with this fault active.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 3512 FMI 14 (VREF-4); SPN 3610 FMI 3, 4 (DPFOP)

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

DPF Differential Pressure / Outlet Pressure circuit

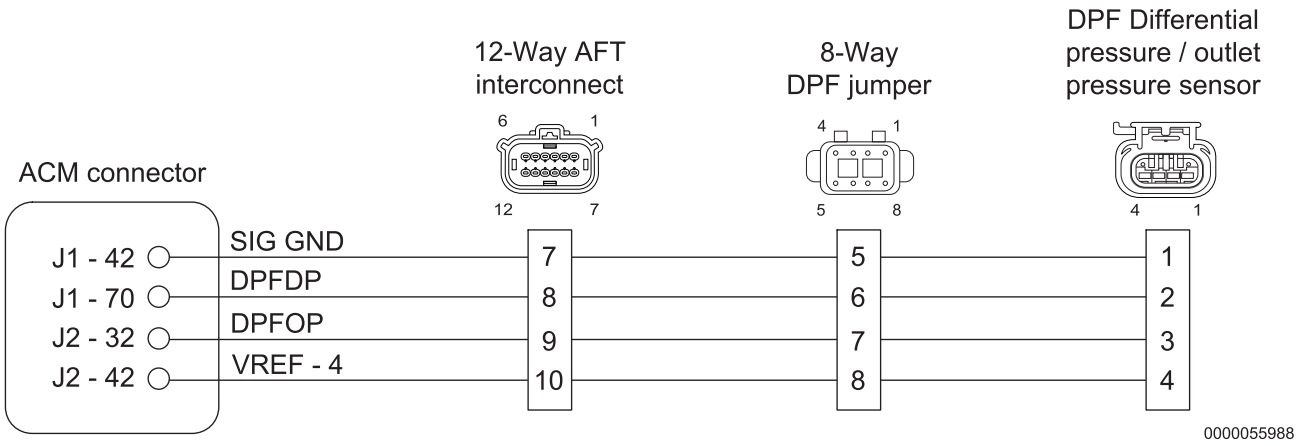


Figure 348 DPFDP / Outlet Pressure Sensor Module Circuit Diagram

Possible Causes

- DPFOP circuit high resistance
- Leaking or Restricted DPFDP / outlet pressure sensor module hoses
- Failed DPFDP / outlet pressure sensor module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3512 FMI 14 (VREF-4); SPN 3610 FMI 3 and 4 (DPFOP). Is EST DTC list free of SPN 3512 FMI 14; SPN 3610 FMI 3 and 4?	Yes: Go to step 2. No: Repair SPN 3512 FMI 14; SPN 3610 FMI 3 and 4. After repairs are complete, retest for SPN 3610 FMI 2.

Step	Action	Decision
2	Inspect hoses and tube connections at the DPFDP / outlet pressure sensor module. Check DPFDP / outlet pressure sensor, tubes, and passages for leaks, restrictions, and damage. Are the DPFDP / outlet pressure sensor module connections free of leaks, restrictions, and damage?	Yes: Go to step 3. No: Repair leaking, restricted, or damaged hoses and connections. After repairs are complete, retest for SPN 3610 FMI 2.

Step	Action	Decision
3	Inspect connections at DPFDP / outlet pressure sensor module. Key OFF, disconnect DPFDP / outlet pressure sensor module. Check DPFDP / outlet pressure sensor module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DPFDP / outlet pressure sensor module connector, harness, and terminals clean and undamaged?	Yes: Go to step 4. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3610 FMI 2.

Step	Action	Decision
4	Inspect connections at Aftertreatment Control Module (ACM). Key OFF, disconnect ACM. Check ACM and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the ACM connector, harness, and terminals clean and undamaged?	Yes: Go to step 5. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3610 FMI 2.

Step	Action	Decision
5	Check DPFOP circuit for high resistance. Connect Breakout Harness 12-575-01 to DPFDP / outlet pressure sensor module connector and leave DPFDP / outlet pressure sensor module disconnected. Connect 180-Pin Breakout Box and Breakout Harness 18-100-01 to ACM and leave disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness pin-3 and Breakout Box pin J2-32. Is resistance less than 5 ohms?	Yes: Replace the DPFDP / outlet pressure sensor module. After repairs are complete retest for SPN 3251 FMI 2. No: Repair high resistance between the DPFDP / outlet pressure sensor module connector pin-3 and ACM connector pin J2-32. After repairs are complete retest for SPN 3610 FMI 2.

NOTE: After performing all diagnostic steps, if SPN 3610 FMI 2 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3610 FMI 3 - DPFOP Sensor Circuit Voltage Above Normal or Shorted High

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
DPF outlet pressure sensor circuit voltage above normal or shorted to high source.	DPF outlet pressure sensor value > 4.75 V	Key ON	2 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects Diesel Particulate Filter (DPF) outlet pressure signal voltage is greater than 4.75 V for more than 2 seconds.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 3512 FMI 14 (VREF-4)

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

DPF Differential Pressure / Outlet Pressure circuit

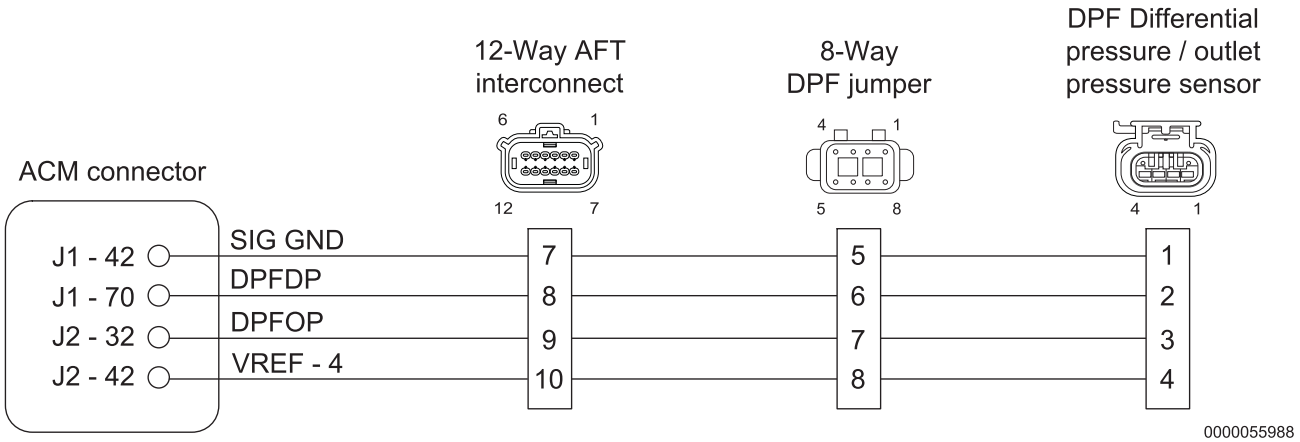


Figure 349 DPFDP / Outlet Pressure Sensor Module Circuit Diagram

Possible Causes

- SIG GND Open or high resistance
- DPFOP shorted to PWR
- Failed DPFDP / outlet pressure sensor module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3512 FMI 14 (VREF-4). Is EST DTC list free of SPN 3512 FMI 14?	Yes: Go to step 2. No: Repair SPN 3512 FMI 14. After repairs are complete, retest for SPN 3610 FMI 3.

Step	Action	Decision
2	Inspect connections at DPFDP / outlet pressure sensor module. Key OFF, disconnect DPFDP / outlet pressure sensor. Check DPFDP / outlet pressure sensor and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DPFDP / outlet pressure sensor module connector, harness, and terminals clean and undamaged?	Yes: Go to step 3. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3610 FMI 3.

Step	Action	Decision
3	Check DPFOP circuit for Short to power. Key-On Engine-Off (KOEO), with Breakout Harness 12-575-01 connected to DPFDP / outlet pressure sensor module, use a DMM to measure voltage between DPFDP / outlet pressure sensor module pin-3 and a known good ground. Is voltage at pin-3 less than 4.7 volts?	Yes: Go to step 4. No: Repair short to power between DPFDP / outlet pressure sensor module connector pin-3 and ACM connector pin J2-32. After repairs are complete retest for SPN 3610 FMI 3.

Step	Action	Decision
4	Check SIG GND circuit for Open or high resistance. Key OFF, Connect Breakout Harness 12-575-01 to DPFDP / outlet pressure sensor module and leave disconnected. Connect 180-pin Breakout Box with Breakout Harness 18-100-01 (96-pin) to ACM and leave ACM disconnected. Use a DMM to measure resistance from Breakout Harness 12-575-01 pin-1 to 180-pin Breakout Box pin J1-42. Is resistance less than 5 ohms?	Yes: Replace the DPFDP / outlet pressure sensor module. After repairs are complete retest for SPN 3251 FMI 3. No: Repair Open or high resistance between DPFDP / outlet pressure sensor module pin-1 and ACM connector pin J1-42. After repairs are complete, retest for SPN 3251 FMI 3.

NOTE: After performing all diagnostic steps, if SPN 3610 FMI 3 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3610 FMI 4- DPFOP Out of Range Signal Low

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Particulate Filter Differential Pressure (DPFDP) / outlet pressure signal voltage is less than expected.	DPF outlet pressure sensor value < 0.25 V	Key ON	2 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the aftertreatment diesel particulate filter outlet pressure signal voltage is less than 0.25 V for more than 2 seconds. Active and stationary regeneration of the diesel particulate filter will be disabled. Engine torque will be reduced if the engine is operated for an extended period of time with this fault active.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 3512 FMI 14 (VREF-4)

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

DPF Differential Pressure / Outlet Pressure circuit

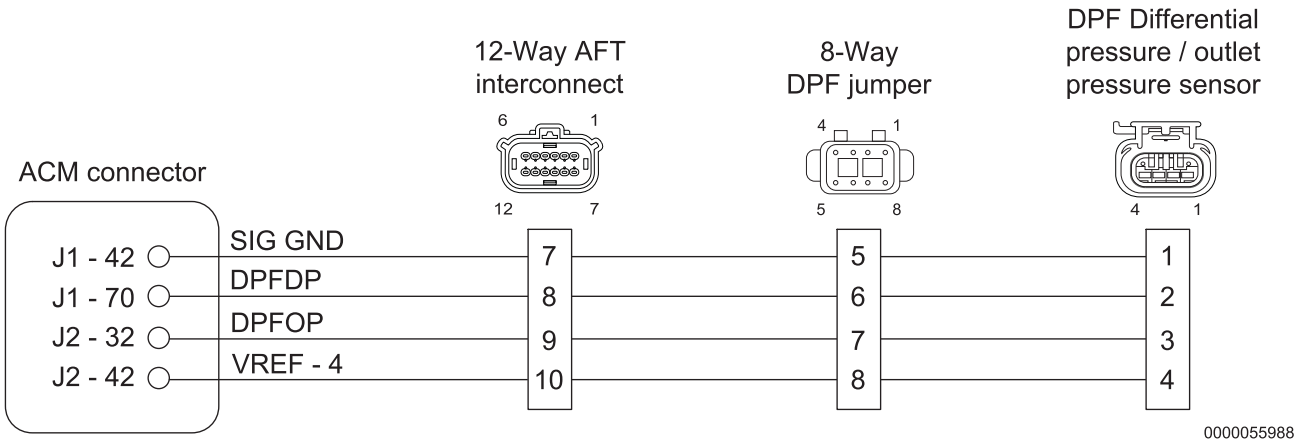


Figure 350 DPFDP / Outlet Pressure Sensor Module Circuit Diagram

Possible Causes

- VREF-4 circuit Open or high resistance
- DPFOP circuit shorted to GND
- DPFOP circuit Open or high resistance

- Failed DPFDP / outlet pressure Sensor Module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3512 FMI 14 (VREF-4). Is EST DTC list free of SPN 3512 FMI 14?	Yes: Go to step 2. No: Repair SPN 3512 FMI 14. After repairs are complete, retest for SPN 3610 FMI 4.

Step	Action	Decision
2	Inspect connections at DPFDP / outlet pressure sensor module. Key OFF, disconnect DPFDP / outlet pressure sensor module. Check DPFDP / outlet pressure sensor module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DPFDP / outlet pressure sensor module connector, harness, and terminals clean and undamaged?	Yes: Go to step 3. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3610 FMI 4.

Step	Action	Decision
3	Check DPFOP circuit for Short to ground. Key OFF, with Breakout Harness 12-575-01 connected to DPFDP / outlet pressure sensor module connector and leave sensor disconnected. Use a DMM to measure resistance between DPFDP / outlet pressure sensor module pin-3 and a known good ground. Is resistance greater than 1000 ohms?	Yes: Go to step 4. No: Repair short to GND between DPFDP / outlet pressure sensor module connector pin-3 and ACM connector pin J2-32. After repairs are complete retest for SPN 3610 FMI 4.

Step	Action	Decision
4	Check VREF-4 circuit for Open or high resistance. Connect Breakout Harness 12-575-01 to DPFDP / outlet pressure sensor module connector and leave sensor disconnected. Connect 180-pin Breakout Box with Breakout Harness 18-100-01 (58-pin) to ACM connector and leave ACM disconnected. Use a DMM to measure resistance between Breakout Harness 12-575-01 pin-4 and 180-pin Breakout Box pin J2-42? Is resistance less than 5 ohms?	Yes: Go to step 5. No: Repair Open or high resistance between DPFDP / outlet pressure sensor module connector pin-4 and ACM connector pin J2-42. After repairs are complete, retest for SPN 3610 FMI 4.

Step	Action	Decision
5	Check DPFOP signal circuit for Open or high resistance. Connect Breakout Harness 12-575-01 to DPFDP / outlet pressure sensor module connector and leave sensor disconnected. Connect 180-pin Breakout Box with Breakout Harness 18-100-01 (58-pin) to ACM and leave ACM disconnected. Use a DMM to measure resistance between Breakout Harness 12-575-01 pin-3 and 180-pin Breakout Box pin J2-32. Is resistance less than 5 ohms?	Yes: Replace DPFDP / outlet pressure sensor module. After repairs are complete, retest for SPN 3610 FMI 4. No: Repair Open or high resistance between DPFOP pin-3 and ACM connector J2-32. After repairs are complete, retest for SPN 3610 FMI 4.

NOTE: After performing all diagnostic steps, if SPN 3610 FMI 4 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

DPFIT Sensor (Diesel Particulate Filter Inlet Temperature)

SPN	FMI	Condition	Possible Causes	Actions
3242	0	DPFIT above Critical Temperature	• Leaking fuel injector • Lube oil leak to exhaust • Fuel leak to exhaust • Leaking or stuck Open Aftertreatment Fuel Injector (AFTFI) • Leaking or stuck Open Aftertreatment Fuel Shutoff Valve (AFTFSV) • Failed DOC / DPF temperature sensor module	Step-Based Diagnostics (page 871)
3242	2	DPFIT signal erratic, intermittent, or incorrect	• Failed DOC / DPF temperature sensor module	Step-Based Diagnostics (page 875)
3242	3	DPFIT signal Out of Range HIGH	• Failed DOC / DPF temperature sensor module	Step-Based Diagnostics (page 877)
3242	4	DPFIT signal Out of Range LOW	• Failed DOC / DPF temperature sensor module	Step-Based Diagnostics (page 878)
3242	15	DPFIT above Warning Temperature	• Leaking fuel injector • Lube oil leak to exhaust • Fuel leak to exhaust • Leaking or stuck Open Aftertreatment	Step-Based Diagnostics (page 879)

SPN	FMI	Condition	Possible Causes	Actions
			Fuel Injector (AFTFI) • Leaking or stuck Open Aftertreatment Fuel Shutoff Valve (AFTFSV) • Failed DOC / DPF temperature sensor module	
3242	16	DPFIT above Maximum Temperature	• Leaking fuel injector • Lube oil leak to exhaust • Fuel leak to exhaust • Leaking or stuck Open Aftertreatment Fuel Injector (AFTFI) • Leaking or stuck Open Aftertreatment Fuel Shutoff Valve (AFTFSV) • Failed DOC / DPF temperature sensor module	Step-Based Diagnostics (page 883)
4766	0	DPFIT above Critical Temperature	• Leaking fuel injector • Lube oil leak to exhaust • Fuel leak to exhaust • Leaking or stuck Open Aftertreatment Fuel Injector (AFTFI)	Step-Based Diagnostics(page 887)

SPN	FMI	Condition	Possible Causes	Actions
			• Leaking or stuck Open Aftertreatment Fuel Shutoff Valve (AFTFSV) • Failed DOC / DPF temperature sensor module	
4766	15	DPFIT above Warning Temperature	• Leaking fuel injector • Lube oil leak to exhaust • Fuel leak to exhaust • Leaking or stuck Open Aftertreatment Fuel Injector (AFTFI) • Leaking or stuck Open Aftertreatment Fuel Shutoff Valve (AFTFSV) • Failed DOC / DPF temperature sensor module	Step-Based Diagnostics(page 891)
4766	16	DPFIT above Maximum Temperature	• Leaking fuel injector • Lube oil leak to exhaust • Fuel leak to exhaust • Leaking or stuck Open Aftertreatment Fuel Injector (AFTFI) • Leaking or stuck Open Aftertreatment	Step-Based Diagnostics(page 895)

SPN	FMI	Condition	Possible Causes	Actions
			Fuel Shutoff Valve (AFTFSV) • Failed DOC / DPF temperature sensor module	

DOC / DPF temperature sensor module circuit

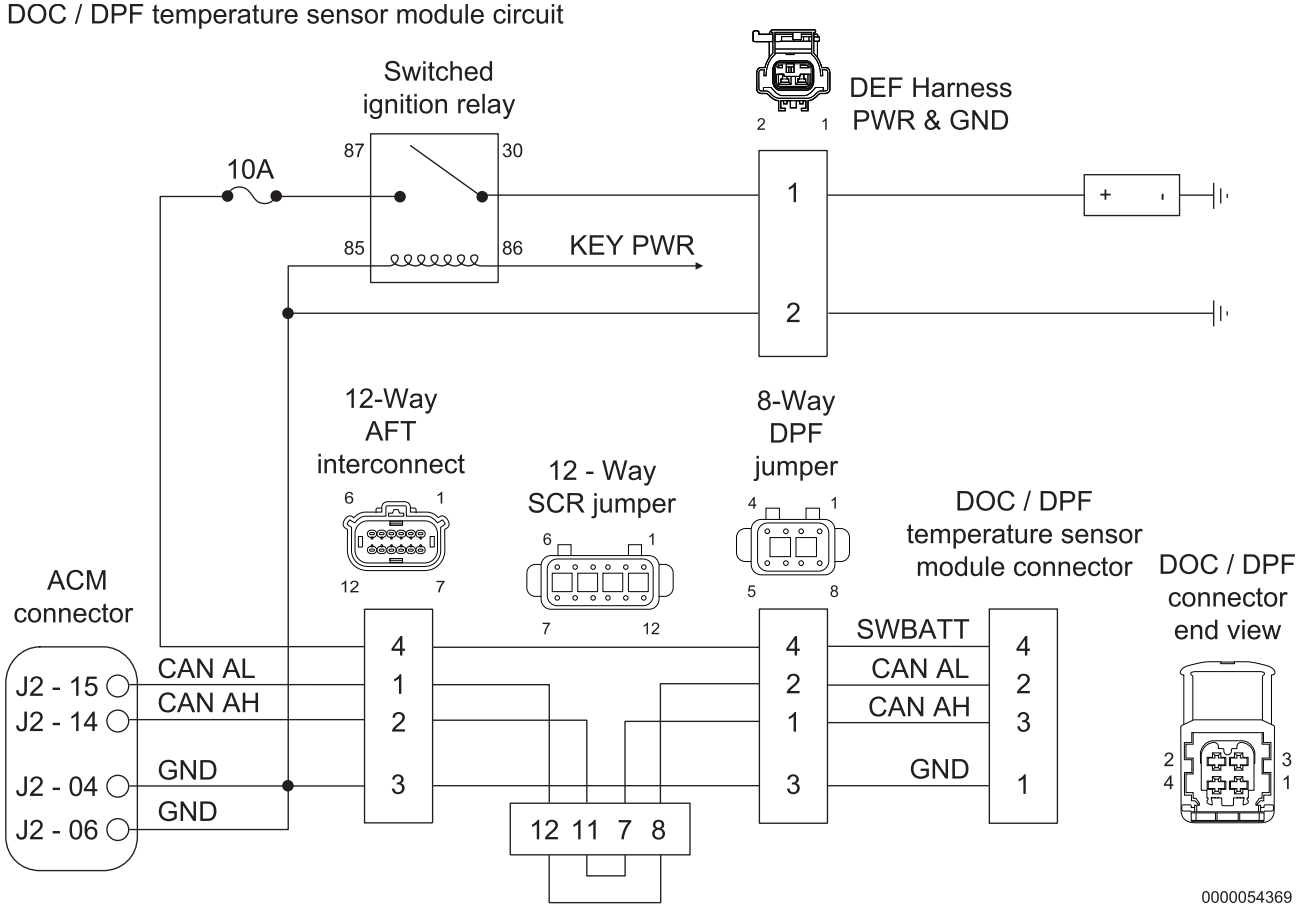


Figure 351 DOC / DPF Temperature Sensor Module Circuit Diagram

NOTE: See latest version of N13 with SCR Engine and Aftertreatment Wiring Schematic Form 0000002203 for additional circuit information.

Overview

The Diesel Particulate Filter Inlet Temperature (DPFIT) sensor measures the exhaust temperature at the inlet of the DPF. The DOC / DPF temperature sensor module is a smart device that communicates with the Aftertreatment Control Module (ACM) via the Controller Area Network (CAN). The DPFIT sensor is part of the DOC / DPF temperature sensor module and is not serviceable individually.

Tools Required

- 180-Pin Breakout Box 00-00956-08
- ACM Breakout Harness 18-100-01
- Breakout Harness 18-649-01
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

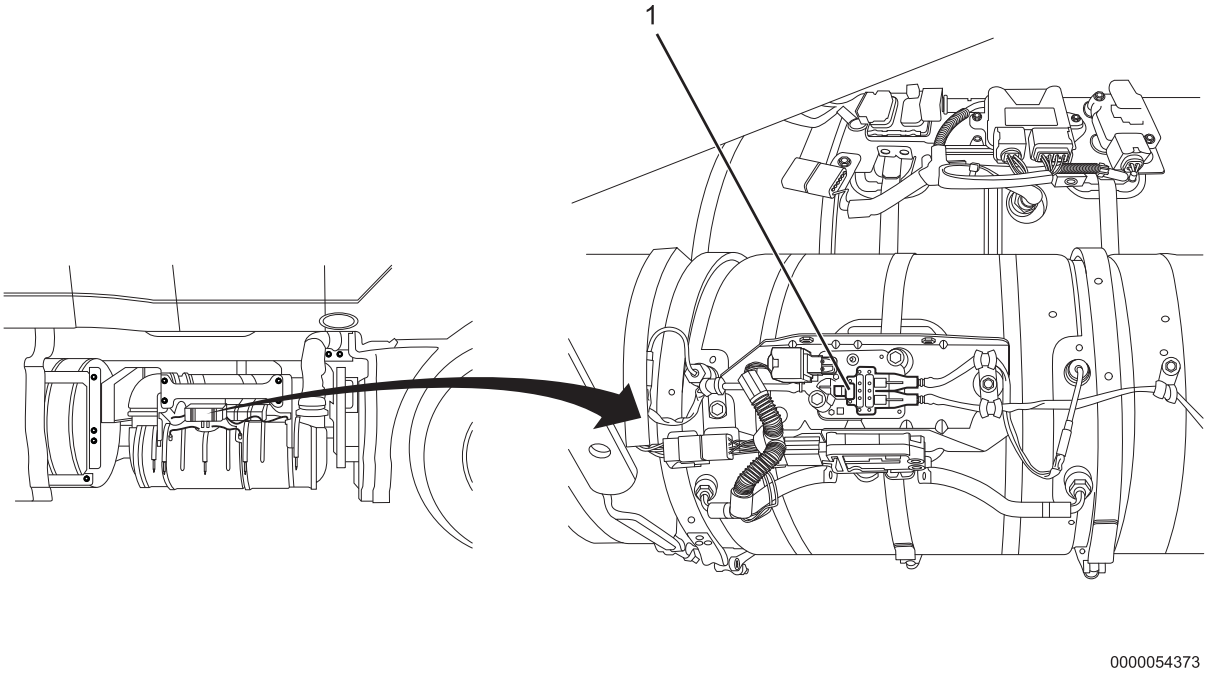


Figure 352 DOC / DPF Temperature Sensor Module Location

1. DOC / DPF Temperature Sensor Module

SPN 3242 FMI 0 DPFIT above Critical Temperature

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Particulate Filter Inlet Temperature (DPFIT) sensor reading has exceeded maximum temperature.	DPFIT > 1472°F (800°C) for more than 20 seconds.	Key-On Engine-Running (KOER)	25 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Diesel Particulate Filter Inlet Temperature (DPFIT) reading is greater than 1472°F (800°C) for more than 20 seconds. Active and parked aftertreatment diesel particulate filter regeneration will be disabled.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 1322-1328 FMI 31 (CYL Balance); SPN 3242 FMI 2, 3, and 4 (DPFIT); SPN 5742 FMI 3, 4, 11, and 16 (DOC / DPF temperature sensor module).

Fault Facts

If aftertreatment system has had excess fuel, oil, coolant, metal, or other contamination; inspect the entire aftertreatment system for causal damage before reinstalling. Inspect for overheated aftertreatment components, cracked exhaust system welds, leaking exhaust system seams, or other damage. This fault will go inactive after the DPFIT drops below the warning limit, and will likely be inactive when the vehicle is in the shop. For this reason, these diagnostics must be used for both active and inactive fault codes.

Drive Cycle to Determine Fault Status

Drive Cycle 1 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Leaking fuel injector
- Lube oil leak to exhaust
- Fuel leak to exhaust
- Leaking or stuck Open Aftertreatment Fuel Injector (AFTFI)
- Leaking or stuck Open Aftertreatment Fuel Shutoff Valve (AFTFSV)
- Failed DOC / DPF temperature sensor module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 1322-1328 FMI 31 (CYL Balance); SPN 3242 FMI 2, 3, and 4 (DPFIT); and SPN 5742 FMI 3, 4, 11, and 16 (DOC / DPF temp sensor module). Is EST DTC list free of SPN 1322-1328 FMI 31; SPN 3242 FMI 2, 3, and 4; and SPN 5742 FMI 3, 4, 11, and 16?	Yes: Go to step 2. No: Repair SPN 1322-1328 FMI 31; SPN 3242 FMI 2, 3, and 4; and SPN 5742 FMI 3, 4, 11, and 16. After repairs are complete, retest for SPN 3242 FMI 0.

WARNING: Warning: To prevent personal injury or death, shift transmission to park or neutral, set parking brake, and block wheels before doing diagnostic or service procedures.

Step	Action	Decision
2	Compare Diesel Oxidation Catalyst Inlet Temperature (DOCIT) sensor to Diesel Particulate Filter Inlet (DPFIT) and DPF Outlet Temperature (DPFOT) sensor temperatures. Perform Hot Run Sensor Comparison Test (page 96). Is the DOCIT, DPFIT, and DPFOT difference with in 77°F (43°C) of each other?	Yes: Go to step 3. No: Replace DOC / DPF temperature sensor module. After repairs are complete, retest for SPN 3242 FMI 0.

Step	Action	Decision
3	Determine if the engine has a mechanical cylinder balance problem (compression loss). Perform Crankcase Pressure Test (page 236). Does engine have excessive crankcase pressure?	Yes: Repair base engine compression imbalance. After repairs are complete, retest for SPN 3242 FMI 0. No: Go to step 4

Step	Action	Decision
4	Determine if engine has a fuel injector problem. Perform Multiple Cylinder Cutout Test (page 241). Did one or more cylinders have significant speed difference(s) than the others?	Yes: Go to step 5. No: Go to step 6.

Step	Action	Decision
5	Inspect for failed valve train components. Remove upper valve cover (see Engine Service Manual). Inspect for bent valves, fallen bridges, and valves out of adjustment. Is valve train free of failed valve train components?	Yes: Replace injector suspected by Multiple Cylinder Cutout Test. After repairs are complete, retest for SPN 3242 FMI 0. No: Repair failed valve train components. After repairs are complete retest for SPN 3242 FMI 0.

Step	Action	Decision
6	Inspect the turbocharger exhaust outlet for oil or fuel in the aftertreatment system from the engine. Remove exhaust plumbing from the turbocharger outlet. Was the turbocharger exhaust outlet free of oil and fuel contamination?	Yes: Go to step 7. No: Repair fuel or lube oil leak to exhaust. See Fuel to Exhaust (page 174), and see Lube Oil to Exhaust (page 163). After repairs are complete, retest for SPN 3242 FMI 0.

Step	Action	Decision
7	Check for leaking or stuck open Aftertreatment Fuel Shutoff Valve (AFTFSV). Perform AFT Fuel Shutoff Valve Leak Test (page 121). Is the AFT Fuel Injector (AFTFI) dry and free of fuel?	Yes: Go to step 8. No: Replace AFTFSV. After repairs are complete, retest for SPN 3242 FMI 0.

Step	Action	Decision
8	Check for leaking or stuck open AFTFI. Perform AFT Fuel Injector Leak Test (page 120). Is the AFTFI dry and free of fuel?	Yes: Go to step 9. No: Replace AFTFI. After repairs are complete, retest for SPN 3242 FMI 0.

Step	Action	Decision
9	Check for failed AFT fuel flow. Perform AFT Dosing System Test (page 118). Was 225 to 500 ml of fuel dispensed within 2.5 minutes?	Yes: Go to step 10. No: Replace AFTFI. Refer to Fault Facts. After repairs are complete, retest for SPN 3242 FMI 0.

Step	Action	Decision
10	Test for black smoke from the exhaust. Idle the engine and snap the throttle to 100 percent. Perform this test multiple times, if necessary. Is the exhaust free of black smoke?	Yes: Go to step 11. No: Inspect DOC / DPF system for failed or damaged components. Refer to Fault Facts. After repairs are complete, retest for SPN 3242 FMI 0.

Step	Action	Decision
11	Remove the Diesel Oxidation Catalyst (DOC). Inspect the DOC. Check the DOC face of the for soot accumulation, face plugging, or damage. Are less than 50 percent of the cells on the intake face completely blocked by soot?	Yes: Reinstall DOC and perform a Parked Regeneration. After repairs are complete, retest for SPN 3242 FMI 0.
		No: Clean or replace DOC. Refer to Fault Facts. After repairs are complete, retest for SPN 3242 FMI 0.

NOTE: After performing all diagnostic steps, if SPN 3242 FMI 0 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3242 FMI 2 DPFIT signal erratic, intermittent, or incorrect

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
The Diesel Particulate Filter Inlet Temperature (DPFIT) is not changing with engine operating conditions (in-range but not rational).	Average temperature drop across Diesel Oxidation Catalyst (DOC) > 99°F (55°C) OR < -108°F (-60°C) Average temperature drop across Diesel Particulate Filter (DPF) > 99°F (55°C) OR < -108°F (-60°C)	Key-On Engine-Running (KOER) Time since last active regeneration > 600 seconds Exhaust flow between 200 g/sec and 1,000 g/sec DPFIT between 217°F (103°C) and 1112°F (600°C) Inactive: SPN 3242 FMI 3 and 4 (DPFIT); SPN 3246 FMI 3 and 4 (DPFOT); SPN 3480 FMI 2, 3, 4, and 17 (AFTFP1); SPN 3482 FMI 2, 3, 4, and 7 (AFTFSV); SPN 3490 FMI 3, 4, and 7 (AFTPAV); SPN 3556 FMI 2 and 5 (AFT System); SPN 4765 FMI 3 and 4 (DOCIT); SPN 5742 FMI 3, 4, 11, and 16 (DOC / DPF Temp Sensor Module)	300 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the difference between the Diesel Particulate Filter Inlet Temperature (DPFIT) sensor and Diesel Particulate Filter Outlet Temperature (DPFOT) sensor readings do not match expected values for engine operating conditions.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 3242 FMI 3 and 4 (DPFIT); SPN 3246 FMI 3 and 4 (DPFOT); SPN 3480 FMI 2, 3, 4, and 17 (AFTFP1); SPN 3482 FMI 2, 3, 4, and 7 (AFTFSV); SPN 3490 FMI 3, 4, and 7 (AFTPAV); SPN 3556 FMI 2 and 5 (AFT System); SPN 4765 FMI 3 and 4 (DOCIT); SPN 5742 FMI 3, 4, 11, and 16 (DOC / DPF Temp Sensor Module)

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Failed DOC / DPF temperature sensor module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3242 FMI 3 and 4 (DPFIT); SPN 3246 FMI 3 and 4 (DPFOT); SPN 3480 FMI 2, 3, 4, and 17 (AFTFP1); SPN 3482 FMI 2, 3, 4, and 7 (AFTFSV); SPN 3490 FMI 3, 4, and 7 (AFTPAV); SPN 3556 FMI 2 and 5 (AFT System); SPN 4765 FMI 3 and 4 (DOCIT); SPN 5742 FMI 3, 4, 11, and 16 (DOC / DPF Temp Sensor Module) Is EST DTC list free of SPN 3242 FMI 3 and 4; SPN 3246 FMI 3 and 4; SPN 3480 FMI 2, 3, 4, and 17; SPN 3482 FMI 2, 3, 4, and 7; SPN 3490 FMI 3, 4, and 7; SPN 3556 FMI 2 and 5; SPN 4765 FMI 3 and 4; SPN 5742 FMI 3, 4, 11, and 16?	Yes: Replace DOC / DPF temperature sensor module. After repairs are complete, retest for SPN 3242 FMI 2. No: Repair SPN 3242 FMI 3 and 4; SPN 3246 FMI 3 and 4; SPN 3480 FMI 2, 3, 4, and 17; SPN 3482 FMI 2, 3, 4, and 7; SPN 3490 FMI 3, 4, and 7; SPN 3556 FMI 2 and 5; SPN 4765 FMI 3 and 4; SPN 5742 FMI 3, 4, 11, and 16. After repairs are complete, retest for SPN 3242 FMI 2.

NOTE: After performing all diagnostic steps, if SPN 3242 FMI 2 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3242 FMI 3 DPFIT signal Out of Range HIGH

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
DOC / DPF temperature sensor module detects short to power or Open in Diesel Particulate Filter Inlet Temperature (DPFIT) circuit.	DPFIT sensor input voltage ≥ 5 volts OR DPFIT impedance ≥ 10 Ohms	Key ON	16 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects that the Diesel Particulate Filter Inlet Temperature (DPFIT) sensor signal voltage is greater than expected.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 5742 FMI 3, 4, 11, and 16 (DOC / DPF temperature sensor module).

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Failed DOC / DPF temperature sensor module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 5742 FMI 3, 4, 11, and 16 (DOC / DPF Temp Sensor Module) Is EST DTC list free of SPN 5742 FMI 3, 4, 11, and 16?	Yes: Replace DOC / DPF temperature sensor module. After repairs are complete, retest for SPN 3242 FMI 3.
		No: Repair SPN 5742 FMI 3, 4, 11, and 16. After repairs are complete, retest for SPN 3242 FMI 3.

NOTE: After performing all diagnostic steps, if SPN 3242 FMI 3 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3242 FMI 4 DPFIT signal Out of Range LOW

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
DOC / DPF temperature sensor module short to ground Diesel Particulate Filter Inlet Temperature (DPFIT) sensor circuit.	DPFIT sensor signal ≤ 1 volt	Key-On Engine-Running (KOER)	16 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Diesel Particulate Filter Inlet Temperature (DPFIT) sensor signal voltage is less than 1 volt for more than 2 seconds.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 5742 FMI 3, 4, 11, and 16 (DOC / DPF temperature sensor module).

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Failed DOC / DPF temperature sensor module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 5742 FMI 3, 4, 11, and 12 (DOC / DPF Temp Sensor Module) Is EST DTC list free of SPN 5742 FMI 3, 4, 11, and 16?	Yes: Replace DOC / DPF temperature sensor module. After repairs are complete, retest for SPN 3242 FMI 3.
		No: Repair SPN 5742 FMI 3, 4, 11, and 16. After repairs are complete, retest for SPN 3242 FMI 3.

NOTE: After performing all diagnostic steps, if SPN 3242 FMI 4 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3242 FMI 15 - DPFIT Above Warning Temperature

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Particulate Filter Inlet Temperature (DPFIT) sensor reading has exceeded maximum temperature (least severe level).	DPFIT > 1247°F (675°C) for 5 seconds on five separate occasions	Key-On Engine-Running (KOER)	20 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Diesel Particulate Filter Inlet Temperature (DPFIT) reading is greater than 1247°F (675°C) for 5 seconds on five separate occasions. Active and parked regeneration will be disabled.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 1322-1328 FMI 31 (CYL Balance); SPN 3242 FMI 2, 3, and 4 (DPFIT); and SPN 5742 FMI 3, 4, 11, and 16 (DOC / DPF temp sensor module)

Fault Facts

If aftertreatment system has had excess fuel, oil, coolant, metal, or other contamination; inspect the entire aftertreatment system for causal damage before reinstalling. Inspect for overheated aftertreatment components, cracked exhaust system welds, leaking exhaust system seams, or other damage. This fault will go inactive after the DPFIT drops below the warning limit, and will likely be inactive when the vehicle is in the shop. For this reason, these diagnostics must be used for both active and inactive fault codes.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Leaking fuel injector
- Lube oil leak to exhaust
- Fuel leak to exhaust
- Leaking or stuck Open Aftertreatment Fuel Injector (AFTFI)
- Leaking or stuck Open Aftertreatment Fuel Shutoff Valve (AFTFSV)
- Failed DOC / DPF temperature sensor module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 1322-1328 FMI 31 (CYL Balance); SPN 3242 FMI 2, 3, and 4 (DPFIT); and SPN 5742 FMI 3, 4, 11, and 16 (DOC / DPF temp sensor module). Is EST DTC list free of SPN 1322-1328 FMI 31; SPN 3242 FMI 2, 3, and 4; and SPN 5742 FMI 3, 4, 11, and 16?	Yes: Go to step 2. No: Repair SPN 1322-1328 FMI 31; SPN 3242 FMI 2, 3, and 4; and SPN 5742 FMI 3, 4, 11, and 16. After repairs are complete, retest for SPN 3242 FMI 15.

WARNING: Warning: To prevent personal injury or death, shift transmission to park or neutral, set parking brake, and block wheels before doing diagnostic or service procedures.

Step	Action	Decision
2	Compare Diesel Oxidation Catalyst Inlet Temperature (DOCIT) sensor to Diesel Particulate Filter Inlet (DPFIT) and DPF Outlet Temperature (DPFOT) sensor temperatures. Perform Hot Run Sensor Comparison Test (page 96). Is the DOCIT, DPFIT, and DPFOT difference with in 77°F (43°C) of each other?	Yes: Go to step 3. No: Replace DOC / DPF temperature sensor module. After repairs are complete, retest for SPN 3242 FMI 15.

Step	Action	Decision
3	Determine if the engine has a mechanical cylinder balance problem (compression loss). Perform Crankcase Pressure Test (page 236). Does engine have excessive crankcase pressure?	Yes: Repair base engine compression imbalance. After repairs are complete, retest for SPN 3242 FMI 15. No: Go to step 4

Step	Action	Decision
4	Determine if engine has a fuel injector problem. Perform Multiple Cylinder Cutout Test (page 241). Did one or more cylinders have significant speed difference(s) than the others?	Yes: Go to step 5. No: Go to step 6.

Step	Action	Decision
5	Inspect for failed valve train components. Remove upper valve cover (see Engine Service Manual). Inspect for bent valves, fallen bridges, and valves out of adjustment. Is valve train free of failed valve train components?	Yes: Replace injector suspected by Multiple Cylinder Cutout Test. After repairs are complete, retest for SPN 3242 FMI 15. No: Repair failed valve train components. After repairs are complete retest for SPN 3242 FMI 15.

Step	Action	Decision
6	Inspect the turbocharger exhaust outlet for oil or fuel in the aftertreatment system from the engine. Remove exhaust plumbing from the turbocharger outlet. Was the turbocharger exhaust outlet free of oil and fuel contamination?	Yes: Go to step 7. No: Repair fuel or lube oil leak to exhaust. See Fuel to Exhaust (page 174), and see Lube Oil to Exhaust (page 163). After repairs are complete, retest for SPN 3242 FMI 15.

Step	Action	Decision
7	Check for leaking or stuck open Aftertreatment Fuel Shutoff Valve (AFTFSV). Perform AFT Fuel Shutoff Valve Leak Test (page 121). Is the AFT Fuel Injector (AFTFI) dry and free of fuel?	Yes: Go to step 8. No: Replace AFTFSV. After repairs are complete, retest for SPN 3242 FMI 15.

Step	Action	Decision
8	Check for leaking or stuck open AFTFI. Perform AFT Fuel Injector Leak Test (page 120). Is the AFTFI dry and free of fuel?	Yes: Go to step 9. No: Replace AFTFI. After repairs are complete, retest for SPN 3242 FMI 15.

Step	Action	Decision
9	Check for failed AFT fuel flow. Perform AFT Dosing System Test (page 118). Was 225 to 500 ml of fuel dispensed within 2.5 minutes?	Yes: Go to step 10. No: Replace AFTFI. Refer to Fault Facts. After repairs are complete, retest for SPN 3242 FMI 15.

Step	Action	Decision
10	Test for black smoke from the exhaust. Idle the engine and snap the throttle to 100 percent. Perform this test multiple times, if necessary. Is the exhaust free of black smoke?	Yes: Go to step 11. No: Inspect DOC / DPF system for failed or damaged components. Refer to Fault Facts. After repairs are complete, retest for SPN 3242 FMI 15.

Step	Action	Decision
11	Remove the Diesel Oxidation Catalyst (DOC). Inspect the DOC. Check the DOC face for soot accumulation, face plugging, or damage. Are less than 50 percent of the cells on the intake face completely blocked by soot or damaged?	Yes: Reinstall DOC and perform a Parked Regeneration. After repairs are complete, retest for SPN 3242 FMI 15.
		No: Clean or replace DOC. Refer to Fault Facts. After repairs are complete, retest for SPN 3242 FMI 15.

NOTE: After performing all diagnostic steps, if SPN 3242 FMI 15 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3242 FMI 16 - DPFIT Above Maximum Temperature

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Particulate Filter Inlet Temperature (DPFIT) sensor reading has exceeded maximum temperature (moderately severe level).	DPFIT > 1202°F (650°C) for 85 seconds OR Difference between the Diesel Oxidation Catalyst Inlet Temperature (DOCIT) and the DPFIT is greater than 689°F (365°C) for 50 seconds.	Key-On Engine-Running (KOER)	2 events

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Diesel Particulate Filter Inlet Temperature (DPFIT) reading is greater than 1269°F (687°C) for 90 seconds on five separate occasions. Active and parked regeneration will be disabled.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 1322-1328 FMI 31 (CYL Balance); SPN 5742 FMI 3, 4, 11, and 16 (DOC / DPF temp sensor module)

Fault Facts

If aftertreatment system has had excess fuel, oil, coolant, metal, or other contamination; inspect the entire aftertreatment system for causal damage before reinstalling. Inspect for overheated aftertreatment components, cracked exhaust system welds, leaking exhaust system seams, or other damage. This fault will go inactive after the DPFIT drops below the warning limit, and will likely be inactive when the vehicle is in the shop. For this reason, these diagnostics must be used for both active and inactive fault codes.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Leaking fuel injector
- Lube oil leak to exhaust
- Fuel leak to exhaust
- Leaking or stuck Open Aftertreatment Fuel Injector (AFTFI)
- Leaking or stuck Open Aftertreatment Fuel Shutoff Valve (AFTFSV)
- Failed DOC / DPF temperature sensor module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 1322-1328 FMI 31 (CYL Balance); SPN 3242 FMI 2, 3, and 4 (DPFIT); and SPN 5742 FMI 3, 4, 11, and 16 (DOC / DPF temp sensor module). Is EST DTC list free of SPN 1322-1328 FMI 31; SPN 3242 FMI 2, 3, and 4; and SPN 5742 FMI 3, 4, 11, and 16?	Yes: Go to step 2. No: Repair SPN 1322-1328 FMI 31; SPN 3242 FMI 2, 3, and 4; and SPN 5742 FMI 3, 4, 11, and 16. After repairs are complete, retest for SPN 3242 FMI 16.

WARNING: Warning: To prevent personal injury or death, shift transmission to park or neutral, set parking brake, and block wheels before doing diagnostic or service procedures.

Step	Action	Decision
2	Compare Diesel Oxidation Catalyst Inlet Temperature (DOCIT) sensor to Diesel Particulate Filter Inlet (DPFIT) and DPF Outlet Temperature (DPFOT) sensor temperatures. Perform Hot Run Sensor Comparison Test (page 96). Is the DOCIT, DPFIT, and DPFOT difference within 77°F (43°C) of each other?	Yes: Go to step 3. No: Replace DOC / DPF temperature sensor module. After repairs are complete, retest for SPN 3242 FMI 16.

Step	Action	Decision
3	Determine if the engine has a mechanical cylinder balance problem (compression loss). Perform Crankcase Pressure Test (page 236). Does engine have excessive crankcase pressure?	Yes: Repair base engine compression imbalance. After repairs are complete, retest for SPN 3242 FMI 16. No: Go to step 4

Step	Action	Decision
4	Determine if engine has a fuel injector problem. Perform Multiple Cylinder Cutout Test (page 241). Did one or more cylinders have significant speed difference(s) than the others?	Yes: Go to step 5. No: Go to step 6.

Step	Action	Decision
5	Inspect for failed valve train components. Remove upper valve cover (see Engine Service Manual). Inspect for bent valves, fallen bridges, and valves out of adjustment. Is valve train free of failed valve train components?	Yes: Replace injector suspected by Multiple Cylinder Cutout Test. After repairs are complete, retest for SPN 3242 FMI 16. No: Repair failed valve train components. After repairs are complete retest for SPN 3242 FMI 16.

Step	Action	Decision
6	Inspect the turbocharger exhaust outlet for oil or fuel in the aftertreatment system from the engine. Remove exhaust plumbing from the turbocharger outlet. Was the turbocharger exhaust outlet free of oil and fuel contamination?	Yes: Go to step 7. No: Repair fuel or lube oil leak to exhaust. See Fuel to Exhaust (page 174), and see Lube Oil to Exhaust (page 163). After repairs are complete, retest for SPN 3242 FMI 16.

Step	Action	Decision
7	Check for leaking or stuck open Aftertreatment Fuel Shutoff Valve (AFTFSV). Perform AFT Fuel Shutoff Valve Leak Test (page 121). Is the AFT Fuel Injector (AFTFI) dry and free of fuel?	Yes: Go to step 8. No: Replace AFTFSV. After repairs are complete, retest for SPN 3242 FMI 16.

Step	Action	Decision
8	Check for leaking or stuck open AFTFI. Perform AFT Fuel Injector Leak Test (page 120). Is the AFTFI dry and free of fuel?	Yes: Go to step 9. No: Replace AFTFI. After repairs are complete, retest for SPN 3242 FMI 16.

Step	Action	Decision
9	Check for failed AFT fuel flow. Perform AFT Dosing System Test (page 118). Was 225 to 500 ml of fuel dispensed within 2.5 minutes?	Yes: Go to step 10. No: Replace AFTFI. Refer to Fault Facts. After repairs are complete, retest for SPN 3242 FMI 16.

Step	Action	Decision
10	Test for black smoke from the exhaust. Idle the engine and snap the throttle to 100 percent. Perform this test multiple times, if necessary. Is the exhaust free of black smoke?	Yes: Go to step 11. No: Inspect DOC / DPF system for failed or damaged components. Refer to Fault Facts. After repairs are complete, retest for SPN 3242 FMI 16.

Step	Action	Decision
11	Remove the Diesel Oxidation Catalyst (DOC). Inspect the DOC. Check the intake face of the DOC for soot accumulation, face plugging, or damage. Are less than 50 percent of the cells on the intake face completely blocked by soot or damaged?	Yes: Reinstall DOC and perform a Parked Regeneration. After repairs are complete, retest for SPN 3242 FMI 16.
		No: Clean or replace DOC. Refer to Fault Facts. After repairs are complete, retest for SPN 3242 FMI 16.

NOTE: After performing all diagnostic steps, if SPN 3242 FMI 16 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 4766 FMI 0 DPFIT Above Critical Temperature (DPFIT)

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
The Diesel Oxidation Catalyst Outlet Temperature (DPFIT) sensor reading has exceeded the maximum temperature.	DPFIT > 1472°F (800°C) for more than 20 seconds.	Key-On Engine-Running (KOER)	25 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Diesel Oxidation Catalyst Outlet Temperature (DPFIT) reading is greater than 1472°F (800°C) for more than 20 seconds. Active and parked aftertreatment diesel particulate filter regeneration will be disabled.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 1322-1328 FMI 31 (CYL Balance); SPN 3242 FMI 2, 3, and 4 (DPFIT); and SPN 5742 FMI 3, 4, 11, and 16 (DOC / DPF temperature sensor module).

Fault Facts

If aftertreatment system has had excess fuel, oil, coolant, metal, or other contamination; inspect the entire aftertreatment system for casual damage before reinstalling. Inspect for overheated aftertreatment components, cracked exhaust system welds, leaking exhaust system seams, or other damage. This fault will go inactive after the DPFIT drops below the warning limit, and will likely be inactive when the vehicle is in the shop. For this reason, these diagnostics must be used for both active and inactive fault codes.

Drive Cycle to Determine Fault Status

Drive Cycle 1 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Leaking fuel injector
- Lube oil leak to exhaust
- Fuel leak to exhaust
- Leaking or stuck Open Aftertreatment Fuel Injector (AFTFI)
- Leaking or stuck Open Aftertreatment Fuel Shutoff Valve (AFTFSV)
- Failed DOC / DPF temperature sensor module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 1322-1328 FMI 31 (CYL Balance); SPN 3242 FMI 2, 3, and 4 (DPFIT); and SPN 5742 FMI 3, 4, 11, and 16 (DOC / DPF temp sensor module). Is EST DTC list free of SPN 1322-1328 FMI 31; SPN 3242 FMI 2, 3, and 4; and SPN 5742 FMI 3, 4, and 16?	Yes: Go to step 2. No: Repair SPN 1322-1328 FMI 31; SPN 3242 FMI 2, 3, and 4; and SPN 5742 FMI 3, 4, and 16. After repairs are complete, retest for SPN 4766 FMI 0.

WARNING: Warning: To prevent personal injury or death, shift transmission to park or neutral, set parking brake, and block wheels before doing diagnostic or service procedures.

Step	Action	Decision
2	Compare Diesel Oxidation Catalyst Inlet Temperature (DOCIT), Diesel Particulate Filter Inlet Temperature (DPFIT), and DPF Outlet Temperature (DPFOT). Perform Hot Run Sensor Comparison Test (page 96). Is the DOCIT, DPFIT, and DPFOT difference with in 77 °F (43 °C) of each other?	Yes: Go to step 3. No: Replace DOC / DPF temperature sensor module. Refer to Fault Facts. After repairs are complete, retest for SPN 4766 FMI 0.

Step	Action	Decision
3	Determine if the engine has a mechanical cylinder balance problem (compression loss). Perform Crankcase Pressure Test (page 236). Does engine have excessive crankcase pressure?	Yes: Repair base engine compression imbalance. After repairs are complete, retest for SPN 4766 FMI 0. No: Go to step 4

Step	Action	Decision
4	Determine if engine has a fuel injector problem. Perform Multiple Cylinder Cutout Test (page 241). Did one or more cylinders have significant speed difference(s) than the others?	Yes: Go to step 5. No: Go to step 6.

Step	Action	Decision
5	Inspect for failed valve train components. Remove upper valve cover (see Engine Service Manual). Inspect for bent valves, fallen bridges, and valves out of adjustment. Is valve train free of failed valve train components?	Yes: Replace injector suspected by Multiple Cylinder Cutout Test. After repairs are complete, retest for SPN 4766 FMI 0. No: Repair failed valve train components. After repairs are complete retest for SPN 4766 FMI 0.

Step	Action	Decision
6	Inspect the turbocharger exhaust outlet for oil or fuel in the aftertreatment system from the engine. Remove exhaust plumbing from the turbocharger outlet. Was the turbocharger exhaust outlet free of oil and fuel contamination?	Yes: Go to step 7. No: Repair fuel or lube oil leak to exhaust. See Fuel to Exhaust (page 174), and see Lube Oil to Exhaust (page 163). After repairs are complete, retest for SPN 4766 FMI 0.

Step	Action	Decision
8	Check for leaking or stuck open Aftertreatment Fuel Shutoff Valve (AFTFSV). Perform AFT Fuel Shutoff Valve Leak Test (page 121). Is the AFT Fuel Injector (AFTFI) dry and free of fuel?	Yes: Go to step 9. No: Replace AFTFSV. After repairs are complete, retest for SPN 4766 FMI 0.

Step	Action	Decision
9	Check for leaking or stuck open AFTFI. Perform AFT Fuel Injector Leak Test (page 120). Is the AFTFI dry and free of fuel?	Yes: Go to step 10. No: Replace AFTFI. After repairs are complete, retest for SPN 4766 FMI 0.

Step	Action	Decision
10	Check for failed AFT fuel flow. Perform AFT Dosing System Test (page 118). Was 225 to 500 ml of fuel dispensed within 2.5 minutes?	Yes: Go to step 11. No: Replace AFTFI. Refer to Fault Facts. After repairs are complete, retest for SPN 4766 FMI 0.

Step	Action	Decision
11	Test for black smoke from the exhaust. Idle the engine and snap the throttle to 100 percent. Perform this test multiple times, if necessary. Is the exhaust free of black smoke?	Yes: Go to step 12. No: Inspect DOC / DPF system for failed or damaged component. Refer to Fault Facts. After repairs are complete, retest for SPN 4766 FMI 0.

Step	Action	Decision
13	Remove the Diesel Oxidation Catalyst (DOC). Check the DOC face for soot accumulation, face plugging, or damage. Are less than 50 percent of the cells on the intake face completely blocked by soot?	Yes: Reinstall DOC and perform a Parked Regeneration. After repairs are complete, retest for SPN 4766 FMI 0.
		No: Clean or replace DOC. Refer to Fault Facts. After repairs are complete, retest for SPN 4766 FMI 0.

NOTE: After performing all diagnostic steps, if SPN 4766 FMI 0 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 4766 FMI 15 - DPFIT Above Warning Temperature (DPFIT)

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
The Diesel Oxidation Catalyst Outlet Temperature (DPFIT) sensor reading has exceeded the maximum temperature (least severe level).	DPFIT > 1247°F (675°C) for 5 seconds on five separate occasions	Key-On Engine-Running (KOER)	20 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Diesel Oxidation Catalyst Outlet Temperature (DPFIT) reading is greater than 1247°F (675°C) for 5 seconds on five separate occasions. Active and parked regeneration will be disabled.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 1322-1328 FMI 31 (CYL Balance); SPN 3242 FMI 2, 3, and 4; and SPN 5742 FMI 3, 4, 11, and 16 (DOC / DPF temp sensor module)

Fault Facts

If aftertreatment system has had excess fuel, oil, coolant, metal, or other contamination; inspect the entire aftertreatment system for casual damage before reinstalling. Inspect for overheated aftertreatment components, cracked exhaust system welds, leaking exhaust system seams, or other damage. This fault will go inactive after the DPFIT drops below the warning limit, and will likely be inactive when the vehicle is in the shop. For this reason, these diagnostics must be used for both active and inactive fault codes.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Leaking fuel injector
- Lube oil leak to exhaust
- Fuel leak to exhaust
- Leaking or stuck Open Aftertreatment Fuel Injector (AFTFI)
- Leaking or stuck Open Aftertreatment Fuel Shutoff Valve (AFTFSV)
- Failed DOC / DPF temperature sensor module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 1322-1328 FMI 31 (CYL Balance); SPN 3242 FMI 2, 3, and 4 (DPFIT); and SPN 5742 FMI 3, 4, 11, and 16 (DOC / DPF temp sensor module). Is EST DTC list free of SPN 1322-1328 FMI 31; SPN 3242 FMI 2, 3, and 4; and SPN 5742 FMI 3, 4, and 16?	Yes: Go to step 2. No: Repair SPN 1322-1328 FMI 31; SPN 3242 FMI 2, 3, and 4; and SPN 5742 FMI 3, 4, and 16. After repairs are complete, retest for SPN 4766 FMI 15.

WARNING: Warning: To prevent personal injury or death, shift transmission to park or neutral, set parking brake, and block wheels before doing diagnostic or service procedures.

Step	Action	Decision
2	Compare Diesel Oxidation Catalyst Inlet Temperature (DOCIT), Diesel Particulate Filter Inlet Temperature (DPFIT), and DPF Outlet Temperature (DPFOT). Perform Hot Run Sensor Comparison Test (page 96). Is the DOCIT, DPFIT, and DPFOT difference with in 77°F (43°C) of each other?	Yes: Go to step 3. No: Replace DOC / DPF temperature sensor module. Refer to Fault Facts. After repairs are complete, retest for SPN 4766 FMI 15.

Step	Action	Decision
3	Determine if the engine has a mechanical cylinder balance problem (compression loss). Perform Crankcase Pressure Test (page 236). Does engine have excessive crankcase pressure?	Yes: Repair base engine compression imbalance. After repairs are complete, retest for SPN 4766 FMI 15. No: Go to step 4

Step	Action	Decision
4	Determine if engine has a fuel injector problem. Perform Multiple Cylinder Cutout Test (page 241). Did one or more cylinders have significant speed difference(s) than the others?	Yes: Go to step 5. No: Go to step 6.

Step	Action	Decision
5	Inspect for failed valve train components. Remove upper valve cover (see Engine Service Manual). Inspect for bent valves, fallen bridges, and valves out of adjustment. Is valve train free of failed valve train components?	Yes: Replace injector suspected by Multiple Cylinder Cutout Test. After repairs are complete, retest for SPN 4766 FMI 15. No: Repair failed valve train components. After repairs are complete retest for SPN 4766 FMI 15.

Step	Action	Decision
6	Inspect the turbocharger exhaust outlet for oil or fuel in the aftertreatment system from the engine. Remove exhaust plumbing from the turbocharger outlet. Was the turbocharger exhaust outlet free of oil and fuel contamination?	Yes: Go to step 7. No: Repair fuel or lube oil leak to exhaust. See Fuel to Exhaust (page 174), and see Lube Oil to Exhaust (page 163). After repairs are complete, retest for SPN 4766 FMI 15.

Step	Action	Decision
7	Check for leaking or stuck open Aftertreatment Fuel Shutoff Valve (AFTFSV). Perform AFT Fuel Shutoff Valve Leak Test (page 121). Is the AFT Fuel Injector (AFTFI) dry and free of fuel?	Yes: Go to step 8. No: Replace AFTFSV. After repairs are complete, retest for SPN 4766 FMI 15.

Step	Action	Decision
8	Check for leaking or stuck open AFTFI. Perform AFT Fuel Injector Leak Test (page 120). Is the AFTFI dry and free of fuel?	Yes: Go to step 9. No: Replace AFTFI. After repairs are complete, retest for SPN 4766 FMI 15.

Step	Action	Decision
9	Check for failed AFT fuel flow. Perform AFT Dosing System Test (page 118). Was 225 to 500 ml of fuel dispensed within 2.5 minutes?	Yes: Go to step 10. No: Replace AFTFI. Refer to Fault Facts. After repairs are complete, retest for SPN 4766 FMI 15.

Step	Action	Decision
10	Test for black smoke from the exhaust. Idle the engine and snap the throttle to 100 percent. Perform this test multiple times, if necessary. Is the exhaust free of black smoke?	Yes: Go to step 11. No: Inspect DOC / DPF system for failed or damaged component. Refer to Fault Facts. After repairs are complete, retest for SPN 4766 FMI 15.

Step	Action	Decision
11	Remove the Diesel Oxidation Catalyst (DOC). Inspect the DOC. Check the DOC face for soot accumulation, face plugging, or damage. Are less than 50 percent of the cells on the intake face completely blocked by soot or damaged?	Yes: Reinstall DOC and perform a Parked Regeneration. After repairs are complete, retest for SPN 4766 FMI 15.
		No: Clean or replace DOC. Refer to Fault Facts. After repairs are complete, retest for SPN 4766 FMI 15.

NOTE: After performing all diagnostic steps, if SPN 4766 FMI 15 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 4766 FMI 16 DPFIT Above Maximum Temperature (DPFIT)

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
The Diesel Oxidation Catalyst Outlet Temperature (DPFIT) sensor reading has exceeded the maximum temperature (moderately severe level).	DPFIT > 1202°F (650°C) for 85 seconds OR Difference between the Diesel Oxidation Catalyst Inlet Temperature (DOCIT) and the Diesel Particulate Filter Inlet Temperature (DPFIT) is greater than (689°F) (365°C) for 50 seconds.	Key-On Engine-Running (KOER)	2 events

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Diesel Oxidation Catalyst Outlet Temperature (DPFIT) reading is greater than 1269°F (687°C) for 90 seconds on five separate occasions. Active and parked regeneration will be disabled.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 1322-1328 FMI 31 (CYL Balance); SPN 3242 FMI 2, 3, and 4; and SPN 5742 FMI 3, 4, 11, and 16 (DOC / DPF temp sensor module)

Fault Facts

If aftertreatment system has had excess fuel, oil, coolant, metal, or other contamination; inspect the entire aftertreatment system for casual damage before reinstalling. Inspect for overheated aftertreatment components, cracked exhaust system welds, leaking exhaust system seams, or other damage. This fault will go inactive after the DPFIT drops below the warning limit, and will likely be inactive when the vehicle is in the shop. For this reason, these diagnostics must be used for both active and inactive fault codes.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Leaking fuel injector
- Lube oil leak to exhaust
- Fuel leak to exhaust
- Leaking or stuck Open Aftertreatment Fuel Injector (AFTFI)
- Leaking or stuck Open Aftertreatment Fuel Shutoff Valve (AFTFSV)
- Failed DOC / DPF temperature sensor module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 1322-1328 FMI 31 (CYL Balance); SPN 3242 FMI 2, 3, and 4 (DPFIT); and SPN 5742 FMI 3, 4, 11, and 16 (DOC / DPF temp sensor module). Is EST DTC list free of SPN 1322-1328 FMI 31; SPN 3242 FMI 2, 3, and 4; and SPN 5742 FMI 3, 4, and 16?	Yes: Go to step 2. No: Repair SPN 1322-1328 FMI 31; SPN 3242 FMI 2, 3, and 4; and SPN 5742 FMI 3, 4, and 16. After repairs are complete, retest for SPN 4766 FMI 16.

WARNING: Warning: To prevent personal injury or death, shift transmission to park or neutral, set parking brake, and block wheels before doing diagnostic or service procedures.

Step	Action	Decision
2	Compare Diesel Oxidation Catalyst Inlet Temperature (DOCIT), Diesel Particulate Filter Inlet Temperature (DPFIT), and DPF Outlet Temperature (DPFOT). Perform Hot Run Sensor Comparison Test (page 96). Is the DOCIT, DPFIT, and DPFOT difference within 77°F (43°C) of each other?	Yes: Go to step 3. No: Replace DOC / DPF temperature sensor module. Refer to Fault Facts. After repairs are complete, retest for SPN 4766 FMI 16.

Step	Action	Decision
3	Determine if the engine has a mechanical cylinder balance problem (compression loss). Perform Crankcase Pressure Test (page 236). Does engine have excessive crankcase pressure?	Yes: Repair base engine compression imbalance. After repairs are complete, retest for SPN 4766 FMI 16. No: Go to step 4

Step	Action	Decision
4	Determine if engine has a fuel injector problem. Perform Multiple Cylinder Cutout Test (page 241). Did one or more cylinders have significant speed difference(s) than the others?	Yes: Go to step 5. No: Go to step 6.

Step	Action	Decision
5	Inspect for failed valve train components. Remove upper valve cover (see Engine Service Manual). Inspect for bent valves, fallen bridges, and valves out of adjustment. Is valve train free of failed valve train components?	Yes: Replace injector suspected by Multiple Cylinder Cutout Test. After repairs are complete, retest for SPN 4766 FMI 16. No: Repair failed valve train components. After repairs are complete retest for SPN 4766 FMI 16.

Step	Action	Decision
6	Inspect the turbocharger exhaust outlet for oil or fuel in the aftertreatment system from the engine. Remove exhaust plumbing from the turbocharger outlet. Was the turbocharger exhaust outlet free of oil and fuel contamination?	Yes: Go to step 7. No: Repair fuel or lube oil leak to exhaust. See Fuel to Exhaust (page 174), and see Lube Oil to Exhaust (page 163). After repairs are complete, retest for SPN 4766 FMI 16.

Step	Action	Decision
7	Check for leaking or stuck open Aftertreatment Fuel Shutoff Valve (AFTFSV). Perform AFT Fuel Shutoff Valve Leak Test (page 121). Is the AFT Fuel Injector (AFTFI) dry and free of fuel?	Yes: Go to step 8. No: Replace AFTFSV. After repairs are complete, retest for SPN 4766 FMI 16.

Step	Action	Decision
8	Check for leaking or stuck open AFTFI. Perform AFT Fuel Injector Leak Test (page 120). Is the AFTFI dry and free of fuel?	Yes: Go to step 9. No: Replace AFTFI. After repairs are complete, retest for SPN 4766 FMI 16.

Step	Action	Decision
9	Check for failed AFT fuel flow. Perform AFT Dosing System Test (page 118). Was 225 to 500 ml of fuel dispensed within 2.5 minutes?	Yes: Go to step 10. No: Replace AFTFI. Refer to Fault Facts. After repairs are complete, retest for SPN 4766 FMI 16.

Step	Action	Decision
10	Test for black smoke from the exhaust. Idle the engine and snap the throttle to 100 percent. Perform this test multiple times, if necessary. Is the exhaust free of black smoke?	Yes: Go to step 11. No: Inspect DOC / DPF system for failed or damaged component. Refer to Fault Facts. After repairs are complete, retest for SPN 4766 FMI 16.

Step	Action	Decision
11	Remove the Diesel Oxidation Catalyst (DOC). Check the DOC face for soot accumulation, face plugging, or damage. Are less than 50 percent of the cells on the intake face completely blocked by soot or damaged?	Yes: Reinstall DOC and perform a Parked Regeneration. After repairs are complete, retest for SPN 4766 FMI 16.
		No: Clean or replace DOC. Refer to Fault Facts. After repairs are complete, retest for SPN 4766 FMI 16.

NOTE: After performing all diagnostic steps, if SPN 4766 FMI 16 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

DPFOT Sensor (Diesel Particulate Filter Outlet Temperature)

SPN	FMI	Condition	Possible Causes	Actions
3246	0	DPFOT above Critical Temperature	• Leaking fuel injector • Lube oil leak to exhaust • Fuel leak to exhaust • Leaking or stuck Open Aftertreatment Fuel Injector (AFTFI) • Leaking or stuck Open Aftertreatment Fuel Shutoff Valve (AFTFSV) • Failed DOC / DPF temperature sensor module	Step-Based Diagnostics (page 904)
3246	2	DPFOT signal erratic, intermittent, or incorrect	• Failed DOC / DPF temperature sensor module	Step-Based Diagnostics (page 908)
3246	3	DPFOT signal Out of Range HIGH	• Failed DOC / DPF temperature sensor module	Step-Based Diagnostics (page 910)
3246	4	DPFOT signal Out of Range LOW	• Failed DOC / DPF temperature sensor module	Step-Based Diagnostics (page 911)
3246	15	DPFOT above Warning Temperature	• Leaking fuel injector • Lube oil leak to exhaust • Fuel leak to exhaust • Leaking or stuck Open Aftertreatment	Step-Based Diagnostics (page 912)

SPN	FMI	Condition	Possible Causes	Actions
			Fuel Injector (AFTFI) • Leaking or stuck Open Aftertreatment Fuel Shutoff Valve (AFTFSV) • Failed DOC / DPF temperature sensor module	

SPN	FMI	Condition	Possible Causes	Actions
3246	16	DPFOT Above Maximum Temperature	• Leaking fuel injector • Lube oil leak to exhaust • Fuel leak to exhaust • Leaking or stuck Open Aftertreatment Fuel Injector (AFTFI) • Leaking or stuck Open Aftertreatment Fuel Shutoff Valve (AFTFSV) • Failed DOC / DPF temperature sensor module	Step-Based Diagnostics (page 916)

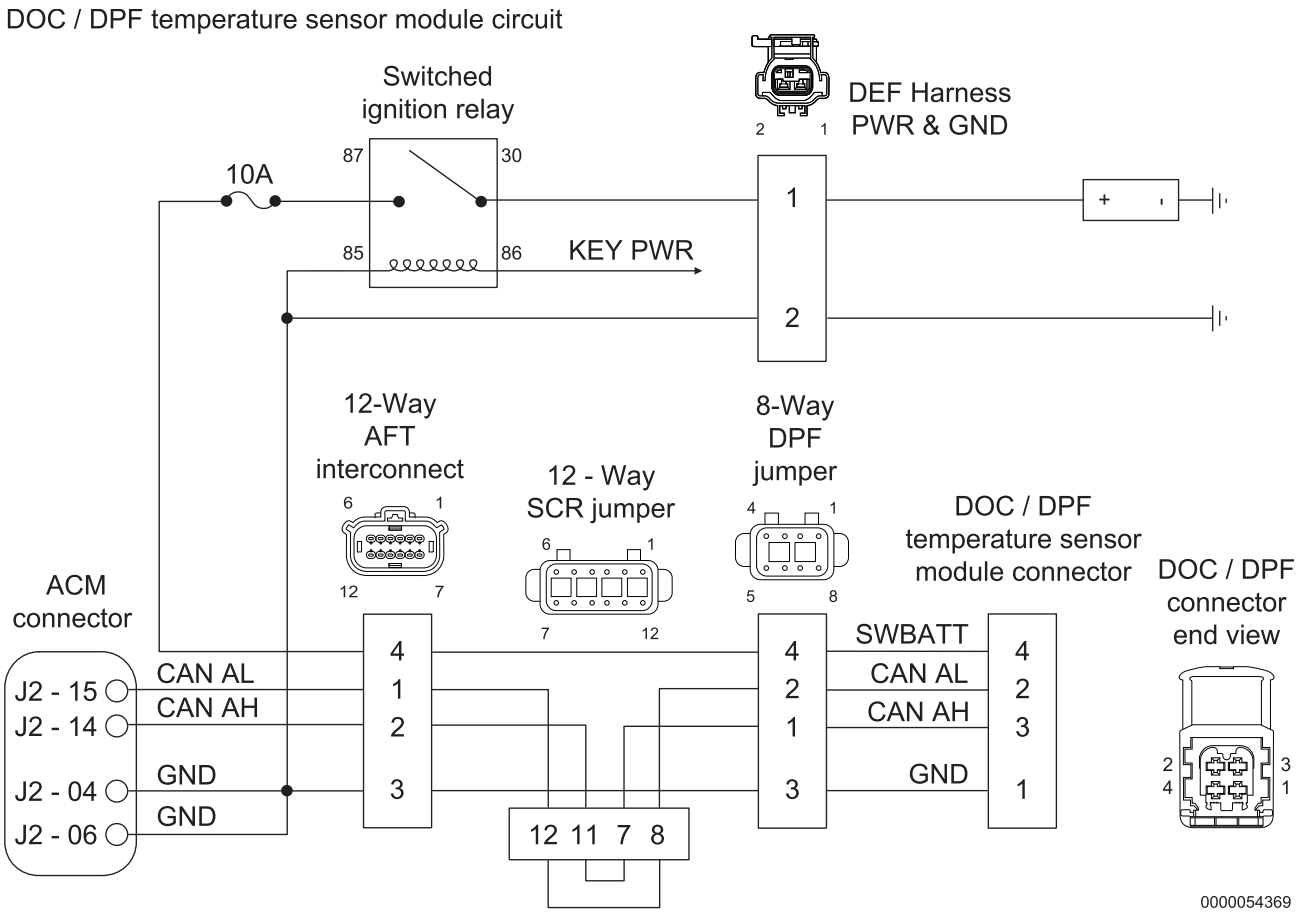


Figure 353 DOC / DPF Temperature Sensor Module Circuit Diagram

NOTE: See latest version of Navistar N13 Engine and Aftertreatment Wiring Schematic Form 0000002203 for additional circuit information.

Overview

The Diesel Particulate Filter Outlet Temperature (DPFOT) sensor measures the exhaust temperature at the outlet of the DPF. The DOC / DPF temperature sensor module is a smart device that communicates with the Aftertreatment Control Module (ACM) via the Controller Area Network (CAN). The DPFOT sensor is part of the DOC / DPF temperature sensor module and is not serviceable individually.

Tools Required

- 180-Pin Breakout Box 00-00956-08
- ACM Breakout Harness 18-100-01
- Breakout Harness 18-649-01
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

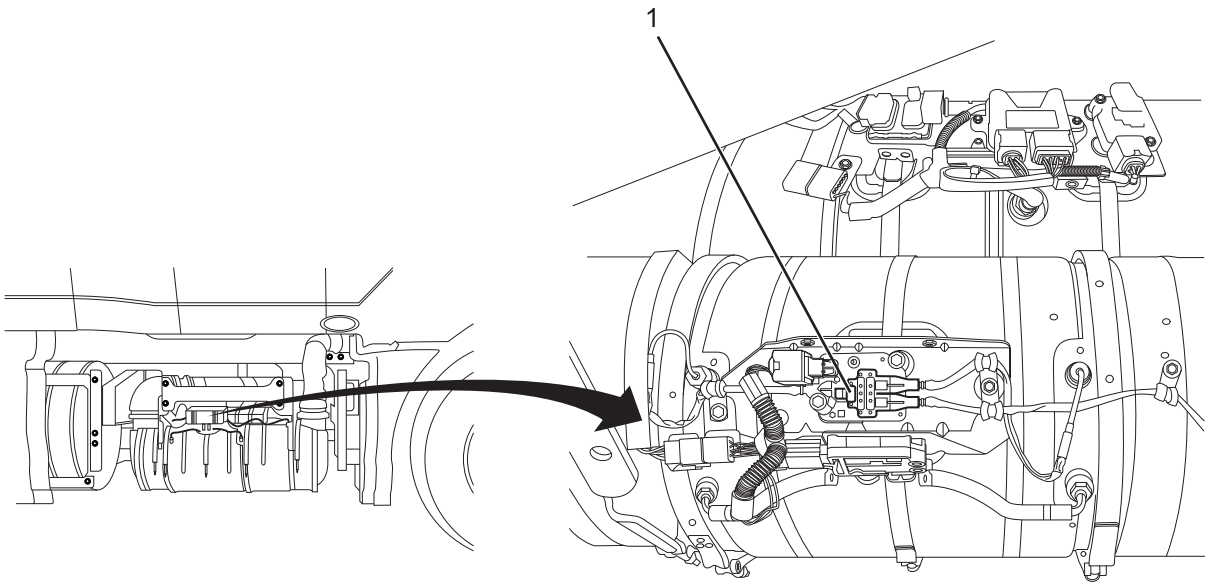


Figure 354 DOC / DPF Temperature Sensor Module Location

1. DOC / DPF Temperature Sensor Module

SPN 3246 FMI 0 DPFOT above Critical Temperature

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Particulate Filter Outlet Temperature (DPFOT) sensor reading has exceeded maximum temperature limit.	DPFOT > 1472°F (800°C) for more than 20 seconds.	Key-On Engine-Running (KOER)	25 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Diesel Particulate Filter Outlet Temperature (DPFOT) reading is greater than 1472°F (800°C) for more than 20 seconds.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 1322-1328 FMI 31 (CYL Balance); SPN 3246 FMI 2, 3, and 4; SPN 5742 FMI 3, 4, 11, and 16 (DOC / DPF temp sensor module).

Fault Facts

If aftertreatment system has had excess fuel, oil, coolant, metal, or other contamination, inspect the entire aftertreatment system for causal damage before re-installing.

Inspect for overheated aftertreatment components, cracked exhaust system welds, leaking exhaust system seams, or other damage.

This fault will go inactive after the DPFOT drops below the warning limit, and will likely be inactive when the vehicle is in the shop. For this reason, these diagnostics must be used for both active and inactive fault codes.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Leaking fuel injector
- Lube oil leak to exhaust
- Fuel leak to exhaust
- Leaking or stuck Open Aftertreatment Fuel Injector (AFTFI)
- Leaking or stuck Open Aftertreatment Fuel Shutoff Valve (AFTFSV)
- Failed DOC / DPF temperature sensor module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 1322-1328 FMI 31 (CYL Balance); SPN 3246 FMI 2, 3, and 4 (DPFOT); SPN 5742 FMI 3, 4, 11, and 16 (DOC / DPF temp sensor module). Is EST DTC list free of SPN 1322-1328 FMI 31; SPN 3246 FMI 2, 3, and 4; SPN 5742 FMI 3, 4, 11, and 16?	Yes: Go to step 2. No: Repair SPN 1322-1328 FMI 31; SPN 3246 FMI 2, 3, and 4; SPN 5742 FMI 3, 4, 11, and 16. After repairs are complete, retest for SPN 3246 FMI 0.

WARNING: Warning: To prevent personal injury or death, shift transmission to park or neutral, set parking brake, and block wheels before doing diagnostic or service procedures.

Step	Action	Decision
2	Compare Diesel Oxidation Catalyst Inlet Temperature (DOCIT) sensor to Diesel Particulate Filter Inlet (DPFIT) and DPF Outlet Temperature (DPFOT) sensor temperatures. Perform Hot Run Sensor Comparison Test (page 96). Is the DOCIT, DPFIT, and DPFOT difference with in 77°F (43°C) of each other?	Yes: Go to step 3. No: Replace DOC / DPF temperature sensor module. After repairs are complete, retest for SPN 3246 FMI 0.

Step	Action	Decision
3	Determine if the engine has a mechanical cylinder balance problem (compression loss). Perform Crankcase Pressure Test (page 236). Does engine have excessive crankcase pressure?	Yes: Repair base engine compression imbalance. After repairs are complete, retest for SPN 3246 FMI 0. No: Go to step 4

Step	Action	Decision
4	Determine if engine has a fuel injector problem. Perform Multiple Cylinder Cutout Test (page 241). Did one or more cylinders have significant speed difference(s) than the others?	Yes: Go to step 5. No: Go to step 6.

Step	Action	Decision
5	Inspect for failed valve train components. Remove upper valve cover (see Engine Service Manual). Inspect for bent valves, fallen bridges, and valves out of adjustment. Is valve train free of failed valve train components?	Yes: Replace injector suspected by Multiple Cylinder Cutout Test. After repairs are complete, retest for SPN 3246 FMI 0. No: Repair failed valve train components. After repairs are complete retest for SPN 3246 FMI 0.

Step	Action	Decision
6	Inspect the turbocharger exhaust outlet for oil or fuel in the aftertreatment system from the engine. Remove exhaust plumbing from the turbocharger outlet. Was the turbocharger exhaust outlet free of oil and fuel contamination?	Yes: Go to step 7. No: Repair fuel or lube oil leak to exhaust. See Fuel to Exhaust (page 174), and see Lube Oil to Exhaust (page 163). After repairs are complete, retest for SPN 3246 FMI 0.

Step	Action	Decision
7	Check for leaking or stuck open Aftertreatment Fuel Shutoff Valve (AFTFSV). Perform AFT Fuel Shutoff Valve Leak Test (page 121). Is the AFT Fuel Injector (AFTFI) dry and free of fuel?	Yes: Go to step 8. No: Replace AFTFSV. After repairs are complete, retest for SPN 3246 FMI 0.

Step	Action	Decision
8	Check for leaking or stuck open AFTFI. Perform AFT Fuel Injector Leak Test (page 120). Is the AFTFI dry and free of fuel?	Yes: Go to step 9. No: Replace AFTFI. After repairs are complete, retest for SPN 3246 FMI 0.

Step	Action	Decision
9	Check for failed AFT fuel flow. Perform AFT Dosing System Test (page 118). Was 225 to 500 ml of fuel dispensed within 2.5 minutes?	Yes: Go to step 10. No: Replace AFTFI. Refer to Fault Facts. After repairs are complete, retest for SPN 3246 FMI 0.

Step	Action	Decision
10	Test for black smoke from the exhaust. Idle the engine and snap the throttle to 100 percent. Perform this test multiple times, if necessary. Is the exhaust free of black smoke?	Yes: Go to step 11. No: Inspect DOC / DPF system for failed or damaged components. Refer to Fault Facts. After repairs are complete, retest for SPN 3246 FMI 0.

Step	Action	Decision
11	Remove the Diesel Oxidation Catalyst (DOC). Inspect the DOC. Check the DOC face for soot accumulation, face plugged, or damage. Is less than 50 percent of the cells on the intake face completely blocked by soot and undamaged?	Yes: Reinstall DOC and perform a Parked Regeneration. After repairs are complete, retest for SPN 3246 FMI 0.
		No: Clean or replace DOC. Refer to Fault Facts. After repairs are complete, retest for SPN 3246 FMI 0.

NOTE: After performing all diagnostic steps, if SPN 3246 FMI 0 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3246 FMI 2 DPFOT signal erratic, intermittent, or incorrect

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Particulate Filter Outlet Temperature (DPFOT) is not changing with engine operating conditions (in-range but not rational).	Average temperature drop across Diesel Oxidation Catalyst (DOC) > 99°F (55°C) OR < -108°F (-60°C) Average temperature drop across Diesel Particulate Filter (DPF) > 99°F (55°C) OR < -108°F (-60°C)	Key-On Engine-Running (KOER) Time since last active regeneration > 600 seconds Exhaust flow between 200 g/sec and 1,000 g/sec DPFOT between 217°F (103°C) and 1112°F (600°C) Inactive: SPN 3242 FMI 3 and 4 (DPFIT); SPN 3246 FMI 3 and 4 (DPFOT); SPN 3480 FMI 2, 3, 4, and 17 (AFTFP1); SPN 3482 FMI 2, 3, 4, and 7 (AFTFSV); SPN 3490 FMI 3, 4, and 7 (AFTPAV); SPN 3556 FMI 2 and 5 (AFT System); SPN 4765 FMI 3 and 4 (DOCIT); SPN 5742 FMI 3, 4, 11, and 16 (DOC / DPF Temp Sensor Module)	300 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Diesel Particulate Filter Outlet Temperature (DPFOT) reading is not changing with engine operating conditions.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 3242 FMI 3 and 4 (DPFIT); SPN 3246 FMI 3 and 4 (DPFOT); SPN 3480 FMI 2, 3, 4, and 17 (AFTFP1); SPN 3482 FMI 2, 3, 4, and 7 (AFTFSV); SPN 3490 FMI 3, 4, and 7 (AFTPAV); SPN 3556 FMI 2 and 5 (AFT System); SPN 4765 FMI 3 and 4 (DOCIT); SPN 5742 FMI 3, 4, 11, and 16 (DOC / DPF Temp Sensor Module)

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Failed DOC / DPF temperature sensor module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3242 FMI 3 and 4 (DPFIT); SPN 3246 FMI 3 and 4 (DPFOT); SPN 3480 FMI 2, 3, 4, and 17 (AFTFP1); SPN 3482 FMI 2, 3, 4, and 7 (AFTFSV); SPN 3490 FMI 3, 4, and 7 (AFTPAV); SPN 3556 FMI 2 and 5 (AFT System); SPN 4765 FMI 3 and 4 (DOCIT); SPN 5742 FMI 3, 4, 11, and 16 (DOC / DPF Temp Sensor Module) Is EST DTC list free of SPN 3242 FMI 3 and 4; SPN 3246 FMI 3 and 4; SPN 3480 FMI 2, 3, 4, and 17; SPN 3482 FMI 2, 3, 4, and 7; SPN 3490 FMI 3, 4, and 7; SPN 3556 FMI 2 and 5; SPN 4765 FMI 3 and 4; SPN 5742 FMI 3, 4, 11, and 16?	Yes: Replace DOC / DPF temperature sensor module. After repairs are complete, retest for SPN 3246 FMI 2. No: Repair SPN 3242 FMI 3 and 4; SPN 3246 FMI 3 and 4; SPN 3480 FMI 2, 3, 4, and 17; SPN 3482 FMI 2, 3, 4, and 7; SPN 3490 FMI 3, 4, and 7; SPN 3556 FMI 2 and 5; SPN 4765 FMI 3 and 4; SPN 5742 FMI 3, 4, 11, and 16. After repairs are complete, retest for SPN 3246 FMI 2.

NOTE: After performing all diagnostic steps, if SPN 3246 FMI 2 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3246 FMI 3 DPFOT signal Out of Range HIGH

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
DOC / DPF temperature sensor module detects short to power, or Open in Diesel Particulate Filter Outlet Temperature (DPFOT) sensor circuit.	DPFOT sensor input voltage ≥ 5 volts OR DPFOT ≥ 10 Ohms	Key-On Engine-Running (KOER)	16 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Diesel Particulate Filter Outlet Temperature (DPFOT) sensor signal voltage is greater than expected.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 5742 FMI 3, 4, 11, and 16 (DOC / DPF temperature sensor module).

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Failed DOC / DPF temperature sensor module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 5742 FMI 3, 4, 11, and 16 (DOC / DPF Temp Sensor Module) Is EST DTC list free of SPN 5742 FMI 3, 4, 11, and 16?	Yes: Replace DOC / DPF temperature sensor module. After repairs are complete, retest for SPN 3246 FMI 3.
		No: Repair SPN 5742 FMI 3, 4, 11, and 16. After repairs are complete, retest for SPN 3246 FMI 3.

NOTE: After performing all diagnostic steps, if SPN 3246 FMI 3 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3246 FMI 4 DPFOT signal Out of Range LOW

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
DOC / DPF temperature sensor module short to ground in Diesel Particulate Filter Outlet Temperature (DPFOT) sensor circuit.	DPFOT signal ≤ 1 V	Key-On Engine-Running (KOER)	16 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Diesel Particulate Filter Outlet Temperature (DPFOT) sensor signal voltage is less than 1 volt for more than 2 seconds.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 5742 FMI 3, 4, 11, and 16 (DOC / DPF temp sensor module).

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Failed DOC / DPF temperature sensor module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 5742 FMI 3, 4, 11, and 16 (DOC / DPF Temp Sensor Module) Is EST DTC list free of SPN 5742 FMI 3, 4, 11, and 16?	Yes: Replace DOC / DPF temperature sensor module. After repairs are complete, retest for SPN 3246 FMI 4.
		No: Repair SPN 5742 FMI 3, 4, 11, and 16. After repairs are complete, retest for SPN 3246 FMI 4.

NOTE: After performing all diagnostic steps, if SPN 3246 FMI 4 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3246 FMI 15 DPFOT Above Warning Temperature

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Particulate Filter Outlet Temperature (DPFOT) sensor reading has exceeded maximum temperature (least severe level).	DPFOT > 1247°F (675°C) for 5 seconds.	Key ON	5 events

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Diesel Particulate Filter Outlet Temperature (DPFOT) reading is greater than 1247°F (675°C) for 5 seconds.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 1322-1328 FMI 31 (CYL Balance); SPN 3246 FMI 2, 3, and 4; and SPN 5742 FMI 3, 4, 11, and 16 (DOC / DPF temp sensor module).

Fault Facts

If aftertreatment system has had excess fuel, oil, coolant, metal, or other contamination, inspect the entire aftertreatment system for causal damage before re-installing.

Inspect for overheated aftertreatment components, cracked exhaust system welds, leaking exhaust system seams, or other damage.

This fault will go inactive after the DPFOT drops below the warning limit, and will likely be inactive when the vehicle is in the shop. For this reason, these diagnostics must be used for both active and inactive fault codes.

Drive Cycle to Determine Fault Status

Drive Cycle 1 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Leaking fuel injector
- Lube oil leak to exhaust
- Fuel leak to exhaust
- Leaking or stuck Open Aftertreatment Fuel Injector (AFTFI)
- Leaking or stuck Open Aftertreatment Fuel Shutoff Valve (AFTFSV)
- Failed DOC / DPF temperature sensor module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 1322-1328 FMI 31 (CYL Balance); SPN 3246 FMI 2, 3, and 4 (DPFOT); and SPN 5742 FMI 3, 4, 11, and 16 (DPF). Is EST DTC list free of SPN 1322-1328 FMI 31; SPN 3246 FMI 2, 3, and 4; and SPN 5742 FMI 3, 4, 11, and 16?	Yes: Go to step 2. No: Repair SPN 1322-1328 FMI 31; SPN 3246 FMI 2, 3, and 4; and SPN 5742 FMI 3, 4, 11, and 16. After repairs are complete, retest for SPN 3246 FMI 15.

WARNING: Warning: To prevent personal injury or death, shift transmission to park or neutral, set parking brake, and block wheels before doing diagnostic or service procedures.

Step	Action	Decision
2	Compare Diesel Oxidation Catalyst Inlet Temperature (DOCIT) sensor to Diesel Particulate Filter Inlet (DPFIT) and DPF Outlet Temperature (DPFOT) sensor temperatures. Perform Hot Run Sensor Comparison Test (page 96). Is the DOCIT, DPFIT, and DPFOT difference with in 77°F (43°C) of each other?	Yes: Go to step 3. No: Replace DOC / DPF temperature sensor module. After repairs are complete, retest for SPN 3246 FMI 15.

Step	Action	Decision
3	Determine if the engine has a mechanical cylinder balance problem (compression loss). Perform Crankcase Pressure Test (page 236). Does engine have excessive crankcase pressure?	Yes: Repair base engine compression imbalance. After repairs are complete, retest for SPN 3246 FMI 15. No: Go to step 4

Step	Action	Decision
4	Determine if engine has a fuel injector problem. Perform Multiple Cylinder Cutout Test (page 241). Did one or more cylinders have significant speed difference(s) than the others?	Yes: Go to step 5. No: Go to step 6.

Step	Action	Decision
5	Inspect for failed valve train components. Remove upper valve cover (see Engine Service Manual). Inspect for bent valves, fallen bridges, and valves out of adjustment. Is valve train free of failed valve train components?	Yes: Replace injector suspected by Multiple Cylinder Cutout Test. After repairs are complete, retest for SPN 3246 FMI 15. No: Repair failed valve train components. After repairs are complete retest for SPN 3246 FMI 15.

Step	Action	Decision
6	Inspect the turbocharger exhaust outlet for oil or fuel in the aftertreatment system from the engine. Remove exhaust plumbing from the turbocharger outlet. Was the turbocharger exhaust outlet free of oil and fuel contamination?	Yes: Go to step 7. No: Repair fuel or lube oil leak to exhaust. See Fuel to Exhaust (page 174), and see Lube Oil to Exhaust (page 163). After repairs are complete, retest for SPN 3246 FMI 15.

Step	Action	Decision
7	Check for leaking or stuck open Aftertreatment Fuel Shutoff Valve (AFTFSV). Perform AFT Fuel Shutoff Valve Leak Test (page 121). Is the AFT Fuel Injector (AFTFI) dry and free of fuel?	Yes: Go to step 8. No: Replace AFTFSV. After repairs are complete, retest for SPN 3246 FMI 15.

Step	Action	Decision
8	Check for leaking or stuck open AFTFI. Perform AFT Fuel Injector Leak Test (page 120). Is the AFTFI dry and free of fuel?	Yes: Go to step 9. No: Replace AFTFI. After repairs are complete, retest for SPN 3246 FMI 15.

Step	Action	Decision
9	Check for failed AFT fuel flow. Perform AFT Dosing System Test (page 118). Was 225 to 500 ml of fuel dispensed within 2.5 minutes?	Yes: Go to step 10. No: Replace AFTFI. Refer to Fault Facts. After repairs are complete, retest for SPN 3246 FMI 15.

Step	Action	Decision
10	Test for black smoke from the exhaust. Idle the engine, and snap the throttle to 100 percent. Perform this test multiple times, if necessary. Is the exhaust free of black smoke?	Yes: Go to step 11. No: Inspect DOC / DPF system for failed or damaged components. Refer to Fault Facts. After repairs are complete, retest for SPN 3246 FMI 15.

Step	Action	Decision
11	Remove the Diesel Oxidation Catalyst (DOC). Inspect the DOC. Check the DOC face for soot accumulation, face plugged, or damage. Is less than 50 percent of the cells on the intake face completely blocked by soot and undamaged?	Yes: Reinstall DOC and perform a Parked Regeneration. After repairs are complete, retest for SPN 3246 FMI 15.
		No: Clean or replace DOC. Refer to Fault Facts. After repairs are complete, retest for SPN 3246 FMI 15.

NOTE: After performing all diagnostic steps, if SPN 3246 FMI 15 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3246 FMI 16 DPFOT Above Maximum Temperature

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Particulate Filter Outlet Temperature (DPFOT) sensor reading has exceeded maximum temperature (moderately severe).	DPFOT > 1269°F (687°C) for 90 seconds.	Key ON Active regeneration not occurring	0 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Diesel Particulate Filter Outlet Temperature (DPFOT) reading is greater than 1269°F (687°C) for 90 seconds. Active and parked regeneration of the DPF will be disabled.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 1322-1328 FMI 31 (CYL Balance); SPN 3246 FMI 2, 3, and 4 (DPFOT); and SPN 5742 FMI 3, 4, 11, and 16 (DOC / DPF temp sensor module).

Fault Facts

If aftertreatment system has had excess fuel, oil, coolant, metal, or other contamination, inspect the entire aftertreatment system for causal damage before re-installing.

Inspect for overheated aftertreatment components, cracked exhaust system welds, leaking exhaust system seams, or other damage.

This fault will go inactive after the DPFOT drops below the warning limit, and will likely be inactive when the vehicle is in the shop. For this reason, these diagnostics must be used for both active and inactive fault codes.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Leaking fuel injector
- Lube oil leak to exhaust
- Fuel leak to exhaust
- Leaking or stuck Open Aftertreatment Fuel Injector (AFTFI)
- Leaking or stuck Open Aftertreatment Fuel Shutoff Valve (AFTFSV)
- Failed DOC / DPF temperature sensor module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 1322-1328 FMI 31 (CYL Balance); SPN 3246 FMI 2, 3, and 4 (DPFOT); and SPN 5742 FMI 3, 4, 11, and 16 (DPF). Is EST DTC list free of SPN 1322-1328 FMI 31; SPN 3246 FMI 2, 3, and 4; and SPN 5742 FMI 3, 4, 11, and 16?	Yes: Go to step 2. No: Repair SPN 1322-1328 FMI 31; SPN 3246 FMI 2, 3, and 4; and SPN 5742 FMI 3, 4, 11, and 16. After repairs are complete, retest for SPN 3246 FMI 16.

WARNING: Warning: To prevent personal injury or death, shift transmission to park or neutral, set parking brake, and block wheels before doing diagnostic or service procedures.

Step	Action	Decision
2	Compare Diesel Oxidation Catalyst Inlet Temperature (DOCIT) sensor to Diesel Particulate Filter Inlet (DPFIT) and DPF Outlet Temperature (DPFOT) sensor temperatures. Perform Hot Run Sensor Comparison Test (page 96). Is the DOCIT, DPFIT, and DPFOT difference with in 77°F (43°C) of each other?	Yes: Go to step 3. No: Replace DOC / DPF temperature sensor module. After repairs are complete, retest for SPN 3246 FMI 16.

Step	Action	Decision
3	Determine if the engine has a mechanical cylinder balance problem (compression loss). Perform Crankcase Pressure Test (page 236). Does engine have excessive crankcase pressure?	Yes: Repair base engine compression imbalance. After repairs are complete, retest for SPN 3246 FMI 16. No: Go to step 4

Step	Action	Decision
4	Determine if engine has a fuel injector problem. Perform Multiple Cylinder Cutout Test (page 241). Did one or more cylinders have significant speed difference(s) than the others?	Yes: Go to step 5. No: Go to step 6.

Step	Action	Decision
5	Inspect for failed valve train components. Remove upper valve cover (see Engine Service Manual). Inspect for bent valves, fallen bridges, and valves out of adjustment. Is valve train free of failed valve train components?	Yes: Replace injector suspected by Multiple Cylinder Cutout Test. After repairs are complete, retest for SPN 3246 FMI 16. No: Repair failed valve train components. After repairs are complete retest for SPN 3246 FMI 16.

Step	Action	Decision
6	Inspect the turbocharger exhaust outlet for oil or fuel in the aftertreatment system from the engine. Remove exhaust plumbing from the turbocharger outlet. Was the turbocharger exhaust outlet free of oil and fuel contamination?	Yes: Go to step 7. No: Repair fuel or lube oil leak to exhaust. See Fuel to Exhaust (page 174), and see Lube Oil to Exhaust (page 163). After repairs are complete, retest for SPN 3246 FMI 16.

Step	Action	Decision
7	Check for leaking or stuck open Aftertreatment Fuel Shutoff Valve (AFTFSV). Perform AFT Fuel Shutoff Valve Leak Test (page 121). Is the AFT Fuel Injector (AFTFI) dry and free of fuel?	Yes: Go to step 8. No: Replace AFTFSV. After repairs are complete, retest for SPN 3246 FMI 16.

Step	Action	Decision
8	Check for leaking or stuck open AFTFI. Perform AFT Fuel Injector Leak Test (page 120). Is the AFTFI dry and free of fuel?	Yes: Go to step 9. No: Replace AFTFI. After repairs are complete, retest for SPN 3246 FMI 16.

Step	Action	Decision
9	Check for failed AFT fuel flow. Perform AFT Dosing System Test (page 118). Was 225 to 500 ml of fuel dispensed within 2.5 minutes?	Yes: Go to step 10. No: Replace AFTFI. Refer to Fault Facts. After repairs are complete, retest for SPN 3246 FMI 16.

Step	Action	Decision
10	Test for black smoke from the exhaust. Idle the engine, and snap the throttle to 100 percent. Perform this test multiple times, if necessary. Is the exhaust free of black smoke?	Yes: Go to step 11. No: Inspect DOC / DPF system for failed or damaged components. Refer to Fault Facts. After repairs are complete, retest for SPN 3246 FMI 16.

Step	Action	Decision
11	Remove the Diesel Oxidation Catalyst (DOC). Inspect the DOC. Check the DOC face for soot accumulation, face plugged, or damage. Is less than 50 percent of the cells on the intake face completely blocked by soot and undamaged?	Yes: Reinstall DOC and perform a Parked Regeneration. After repairs are complete, retest for SPN 3246 FMI 16.
		No: Clean or replace DOC. Refer to Fault Facts. After repairs are complete, retest for SPN 3246 FMI 16.

NOTE: After performing all diagnostic steps, if SPN 3246 FMI 16 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

DPF System (Diesel Particulate Filter)

SPN	FMI	Condition	Possible Causes	Actions
3719	0	DPF Soot Load - Highest (level 3/3)	• Engine performance problem • Engine mechanical • Regen inhibited • Failed DPFDP / outlet pressure sensor module • Restricted DPFDP / outlet pressure sensor hose(s)	Step-Based Diagnostics (page 924)
3719	15	DPF Soot Load - Lowest (level 1/3)	• Engine performance problem • Engine mechanical • Regen inhibited • Failed DPFDP / outlet pressure sensor module • Restricted DPFDP / outlet pressure sensor hose(s)	Step-Based Diagnostics (page 928)
3719	16	DPF Soot Load - Moderate (level 2/3)	• Engine performance problem • Engine mechanical • Regen inhibited • Failed DPFDP / outlet pressure sensor module • Restricted DPFDP / outlet pressure sensor hose(s)	Step-Based Diagnostics (page 932)
3936	0	DPF Soot Load - Severe De-Rate	• Engine performance problem • Failed fuel injector • Engine mechanical fault • Regen inhibited • Restricted DPFDP hoses • Failed DPFDP sensor	Step-Based Diagnostics (page 935)

3936	7	DPF System - DPF exceeded maximum temperature threshold - replace DPF	• Leaking or stuck open Aftertreatment Fuel Injector (AFTFI) • Leaking fuel injector • Fuel leak to exhaust • Lube oil leak to exhaust • Failed Diesel Oxidation Catalyst and Diesel Particulate Filter (DOC / DPF) temperature sensor module (malfunctioning in-range)	Step-Based Diagnostics (page 940)
3936	14	DOC/DPF Temperature Module (Incorrect Part)	• Incorrect DOC / DPF temperature sensor module installed	Step-Based Diagnostics (page 943)
3936	15	DPF System above Warning Pressure	• Engine performance problem • Failed fuel injector • Engine mechanical fault • Regen inhibited • Restricted DPFDP hoses • Failed DPFDP sensor	Step-Based Diagnostics (page 945)
5319	31	DPF incomplete Regeneration	• Low engine performance • Failed fuel injector • Engine mechanical • Oil leak to exhaust • Failed DPFDP / outlet pressure sensor • Restricted DPFDP / outlet pressure sensor hose(s) • Damaged or failed Diesel Oxidation Catalyst (DOC) • Restricted DOC (soot accumulation) • Failed AFTFI • Failed AFTFSV	Step-Based Diagnostics (page 949)
5397	31	DPF regenerations are occurring too frequently	• Low engine performance • Failed fuel injector • Engine mechanical • Failed Diesel Particulate Filter Differential Pressure (DPFDP) / outlet pressure sensor • Restricted DPFDP / outlet pressure sensor hose(s)	Step-Based Diagnostics (page 955)

	• DPF restricted, damaged, or contaminated • Diesel Oxidation Catalyst (DOC) restricted, damaged, or contaminated

Overview

The Diesel Particulate Filter (DPF) system is used to reduce soot released into the exhaust aftertreatment system. The DPF is used in conjunction with the Diesel Oxidation Catalyst (DOC) to reduce soot. The process of reducing soot to ash is called regeneration (regen). Regen can be active, stationary, or passive. Passive regen needs no input from the ACM to work. Active happens when the ACM commands the truck to regen, and the truck goes into a regen strategy. Stationary regen is used when an operator manually tells the ACM to begin the regen process. This can be accomplished by either manually pushing an override button inside the cab, or through the use of ServiceMaxx. The DOC and DPF can be serviced separately.

Tools Required

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

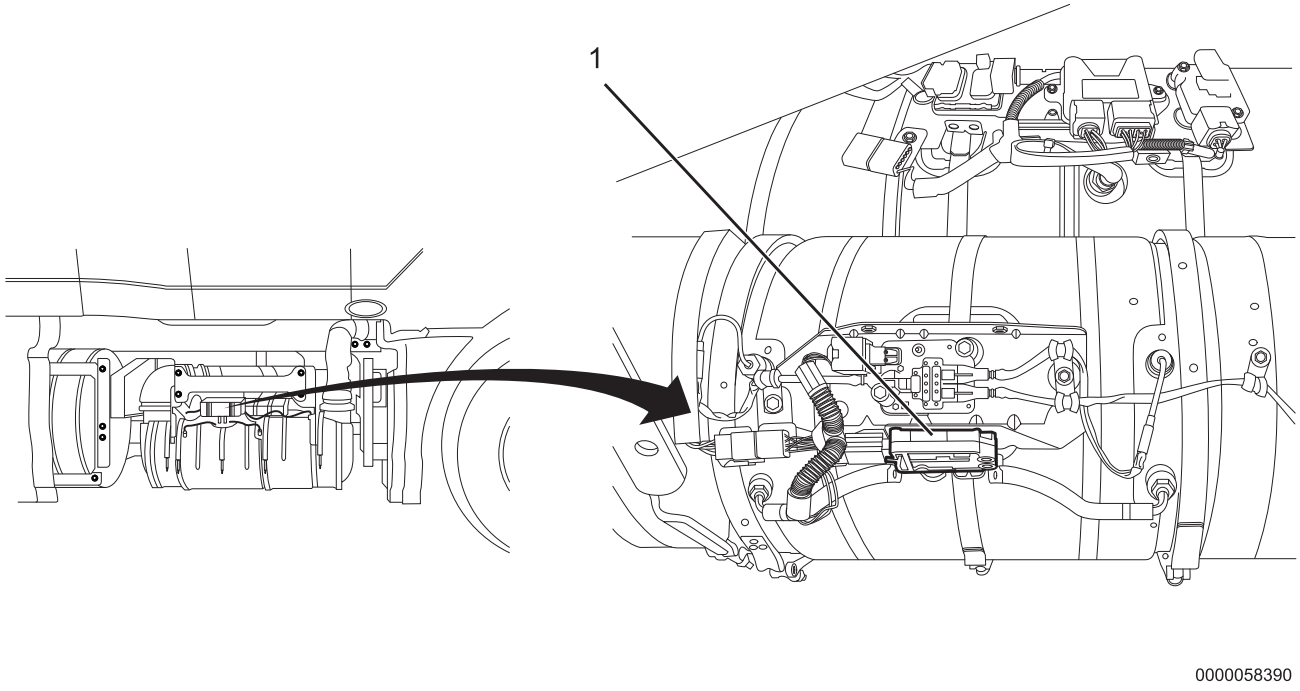


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Figure 355 DPFDP / Outlet Pressure Sensor Module Location

1. DPFDP / outlet pressure sensor module

SPN 3719 FMI 0- DPF Soot Load - Highest (level 3/3)

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Particulate Filter Differential Pressure (DPFDP) sensor data valid, but above normal operating range (most severe level).	DPFDP sensor has exceeded the recommended pressure limits.	Key-ON Engine-Running (KOER) Engine Speed > 500 rpm	1 event

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the soot load of the Diesel Particulate Filter (DPF) has exceeded the maximum operating limits. Torque output of the engine will be reduced as soot load increases. Active and parked regeneration of the aftertreatment system will be disabled. See AFT System Overview (page 342) for additional information.

Malfunction Indicator Lamp (MIL) Reaction

When fault is active, MIL will not illuminate.

Associated Faults

SPN 94 (FDP); SPN 102 (IMP); SPN 157 (FRP); SPN 651-656 (INJ/CYL); SPN 3242 FMI 2, 3, and 4 (DPFIT); SPN 3246 FMI 2, 3, and 4 (DPFOT); SPN 3480 (AFTFP1); SPN 3482 (AFTFSV); SPN 3556 (AFT); SPN 4765 FMI 2, 3, and 4 (DOCIT); SPN 5541 (TC1TOP)

Drive Cycle to Determine Fault Status

Drive Cycle 25 then 1 in 2013 HD-OBD Diagnostic Reference Manual.

Fault Facts

This fault code may indicate exhaust temperature exiting the turbocharger are not high enough to actively regenerate the aftertreatment system. Driving the vehicle with long-term increased load may increase exhaust temperatures and decrease aftertreatment regeneration frequency.

Possible Causes

- Engine performance problem
- Engine mechanical
- Regen inhibited
- Failed DPFDP / outlet pressure sensor module
- Restricted DPFDP / outlet pressure sensor hose(s)

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3242 FMI 2, 3, and 4 (DPFIT); SPN 3246 FMI 2, 3, and 4 (DPFOT); 3480 (AFTFP1); SPN 3482 (AFTFSV); SPN 3556 (AFT); and SPN 4765 FMI 2, 3, and 4 (DOCIT). Is EST DTC list free of SPN 3242 FMI 2, 3, and 4; SPN 3246 FMI 2, 3, and 4; SPN 3480; SPN 3482; SPN 3556; and SPN 4765 FMI 2, 3, and 4?	Yes: Go to step 2. No: Repair SPN 3242 FMI 2, 3, and 4; SPN 3246 FMI 2, 3, and 4; SPN 3480; SPN 3482; SPN 3556; and SPN 4765 FMI 2, 3, and 4. After repairs are complete, retest for SPN 3719 FMI 0.

Step	Action	Decision
2	Check for engine performance problems. Using EST with ServiceMaxx™ software, check DTC list for SPN 94 (FDP), SPN 102 (IMP), SPN 157 (FRP), SPN 651-656 (INJ / CYL), and SPN 5541 (TC1TOP). Is EST DTC list free of SPN 94, SPN 102, SPN 157, SPN 651-656, and SPN 5541?	Yes: Go to step 3. No: Repair SPN 94, SPN 102, SPN 157, SPN 651-656, and SPN 5541. After repairs are complete, retest for SPN 3719 FMI 0.

Step	Action	Decision
3	Determine if a regen inhibitor is inhibiting regeneration of the aftertreatment system. Using EST with ServiceMaxx software, go to Procedures > KOER Aftertreatment Procedures > DPF Filter Regeneration > Inhibitors > and click Begin Test. Does DPF Filter Regeneration procedure run without any active Inhibitors?	Yes: Retest for SPN 3719 FMI 0. Go to step 4. No: Correct active regen inhibitors ((page 347) and ServiceMaxx Aftertreatment DPF Filter Regeneration Inhibitors tab). After repairs are complete, retest for SPN 3719 FMI 0.

Step	Action	Decision
4	Inspect connections at Diesel Particulate Filter Differential Pressure (DPFDP) / outlet pressure sensor. Key OFF, disconnect DPFDP / outlet pressure sensor. Check DPFDP / outlet pressure sensor and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DPFDP / outlet pressure sensor connector, harness, and terminals clean and undamaged?	Yes: Go to step 5. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3719 FMI 0.

Step	Action	Decision
5	Monitor DPFDP / outlet pressure sensor signal. Key-On Engine-Running, using EST with ServiceMaxx software, load the Signals session and monitor DPFDP. Is DPFDP below 0.5 psi (normal operation)?	Yes: Go to step 7. No: Go to step 6.

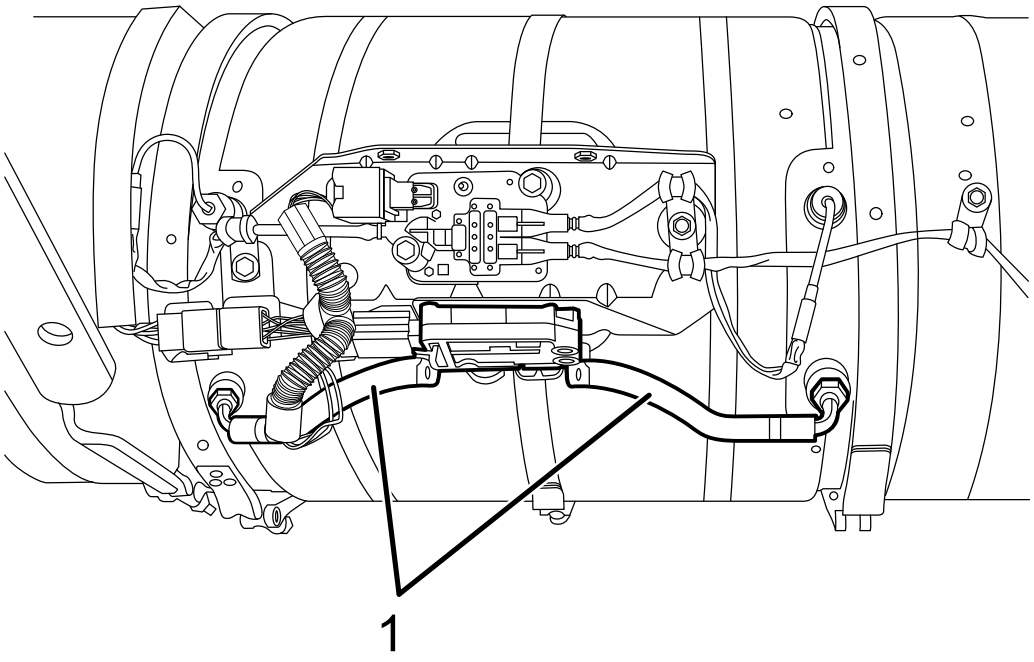

Figure 356 DPFDP / Outlet Pressure Sensor Hoses Location

1. DPFDP / outlet pressure sensor hoses

Step	Action	Decision
6	Check DPFDP / outlet pressure sensor hoses for correct routing and restrictions. Inspect the DPFDP / outlet pressure sensor hoses for improper routing, restrictions, or damage. Are the DPFDP / outlet pressure sensor hoses routed correctly, free of damage, and unrestricted?	Yes: Replace DPFDP / outlet pressure sensor. After repairs are complete, retest for SPN 3719 FMI 0.
		No: Repair or replace DPFDP / outlet pressure sensor hose(s). After repairs are complete, retest for SPN 3719 FMI 0.

Step	Action	Decision
7	Determine if the engine has a mechanical cylinder balance problem (compression loss). Perform Crankcase Pressure Test (page 236). Does engine have excessive crankcase pressure?	Yes: Repair base engine compression imbalance. After repairs are complete, retest for SPN 3719 FMI 0.
		No: Go to step 8

Step	Action	Decision
8	Determine if engine has a fuel injector problem. Perform Multiple Cylinder Cutout Test (page 241). Did one or more cylinders have significant speed difference(s) than the others?	Yes: Go to step 9. No: Go to step 10.

Step	Action	Decision
9	Inspect for failed valve train components. Remove upper valve cover (see Engine Service Manual). Inspect for bent valves, fallen bridges, and valves out of adjustment. Is valve train free of failed valve train components?	Yes: Replace injector suspected by Multiple Cylinder Cutout Test. After repairs are complete, retest for SPN 3719 FMI 0. No: Repair failed valve train components. After repairs are complete retest for SPN 3719 FMI 0.

Step	Action	Decision
10	Determine if vehicle has an engine performance related driveability problem. Test drive the vehicle. Does engine have a performance problem.	Yes: Perform Engine Symptoms Diagnostics. After repairs are complete, retest for SPN 3719 FMI 0.

NOTE: After performing all diagnostic steps, if SPN 3719 FMI 0 remains, verify each step was completed correctly, and the proper decision was made. Notify supervisor for further action.

SPN 3719 FMI 15- DPF Soot Load - Lowest (level 1/3)

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
DPF Differential Pressure / outlet pressure sensor data valid, but above normal operating range (least severe level).	DPF Differential Pressure / outlet pressure sensor has exceeded the recommended limits.	Key-On Engine-Running (KOER) Engine Speed > 500 rpm	1 event

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the soot load of the Diesel Particulate Filter (DPF) has exceeded operating limits. Torque output of the engine will be reduced as soot load increases. See AFT System Overview (page 342) for additional information.

Malfunction Indicator Lamp (MIL) Reaction

When fault is active, MIL will not illuminate.

Associated Faults

SPN 94 (FDP); SPN 102 (IMP); SPN 157 (FRP); SPN 651-656 (INJ/CYL); SPN 3242 FMI 2, 3, and 4 (DPFIT); SPN 3246 FMI 2, 3, and 4 (DPFOT); SPN 3480 (AFTFP1); SPN 3482 (AFTFSV); SPN 3556 (AFT); SPN 4765 FMI 2, 3, and 4 (DOCIT); SPN 5541 (TC1TOP)

Drive Cycle to Determine Fault Status

Drive Cycle 1 in 2013 HD-OBD Diagnostic Reference Manual.

Fault Facts

This fault code may indicate exhaust temperature exiting the turbocharger are not high enough to actively regenerate the aftertreatment system. Driving the vehicle with long-term increased load may increase exhaust temperatures and decrease aftertreatment regeneration frequency.

Possible Causes

- Engine performance problem
- Engine mechanical
- Regen inhibited
- Failed DPFDP / outlet pressure sensor module
- Restricted DPFDP / outlet pressure sensor hose(s)

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3242 FMI 2, 3, and 4 (DPFIT); SPN 3246 FMI 2, 3, and 4 (DPFOT); SPN 3480 (AFTFP1); SPN 3482 (AFTFSV); SPN 3556 (AFT); and SPN 4765 FMI 2, 3, and 4 (DOCIT). Is EST DTC list free of SPN 3242 FMI 2, 3, and 4; SPN 3246 FMI 2, 3, and 4; SPN 3480; SPN 3482; SPN 3556; and SPN 4765 FMI 2, 3, and 4?	Yes: Go to step 2. No: Repair SPN 3242 FMI 2, 3, and 4; SPN 3246 FMI 2, 3, and 4; SPN 3480; SPN 3482; SPN 3556; and SPN 4765 2, 3, and 4. After repairs are complete, retest for SPN 3719 FMI 15.

Step	Action	Decision
2	Check for engine performance problems. Using EST with ServiceMaxx™ software, check DTC list for SPN 94 (FDP), SPN 102 (IMP), SPN 157 (FRP), SPN 651-656 (INJ / CYL), and SPN 5541 (TC1TOP). Is EST DTC list free of SPN 94, SPN 102, SPN 157, SPN 651-656, and SPN 5541?	Yes: Go to step 3. No: Repair SPN 94, SPN 102, SPN 157, SPN 651-656, and SPN 5541. After repairs are complete, retest for SPN 3719 FMI 15.

Step	Action	Decision
3	Determine if a regen inhibitor is inhibiting regeneration of the aftertreatment system. Using EST with ServiceMaxx software, go to Procedures > KOER Aftertreatment Procedures > DPF Filter Regeneration > Inhibitors > and click Begin Test. Does DPF Filter Regeneration procedure run without any active Inhibitors?	Yes: Retest for SPN 3719 FMI 15. Go to step 4. No: Correct active regen inhibitors ((page 347) and ServiceMaxx Aftertreatment DPF Filter Regeneration Inhibitors tab). After repairs are complete, retest for SPN 3719 FMI 15.

Step	Action	Decision
4	Inspect connections at Diesel Particulate Filter Differential Pressure (DPFDP) / outlet pressure sensor. Key OFF, disconnect DPFDP / outlet pressure sensor. Check DPFDP / outlet pressure sensor and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DPFDP / outlet pressure sensor connector, harness, and terminals clean and undamaged?	Yes: Go to step 5. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3719 FMI 15.

Step	Action	Decision
5	Monitor DPFDP / outlet pressure sensor signal. Key-On Engine-Running, using EST with ServiceMaxx software, load the Signals session and monitor DPFDP. Is DPFDP below 0.5 psi (normal operation)?	Yes: Go to step 7. No: Go to step 6.

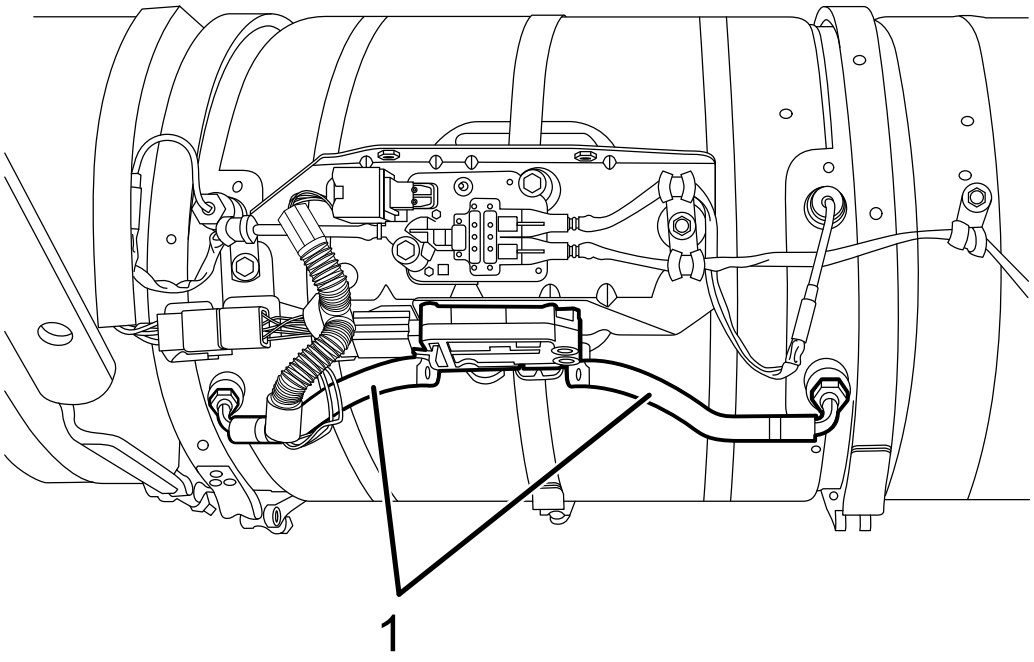

Figure 357 DPFDP / Outlet Pressure Sensor Hoses Location

1. Diesel Particulate Filter Differential Pressure (DPFDP) / outlet pressure sensor hoses

Step	Action	Decision
6	Check DPFDP / outlet pressure sensor hoses for correct routing and restrictions. Inspect the DPFDP / outlet pressure sensor hoses for improper routing, restrictions, or damage. Are the DPFDP / outlet pressure sensor hoses routed correctly, free of damage, and unrestricted?	Yes: Replace DPFDP / outlet pressure sensor. After repairs are complete, retest for SPN 3719 FMI 15.
		No: Repair or replace DPFDP / outlet pressure sensor hose(s). After repairs are complete, retest for SPN 3719 FMI 15.

Step	Action	Decision
7	Determine if the engine has a mechanical cylinder balance problem (compression loss). Perform Crankcase Pressure Test (page 236). Does engine have excessive crankcase pressure?	Yes: Repair base engine compression imbalance. After repairs are complete, retest for SPN 3719 FMI 15.
		No: Go to step 8

Step	Action	Decision
8	Determine if engine has a fuel injector problem. Perform Multiple Cylinder Cutout Test (page 241). Did one or more cylinders have significant speed difference(s) than the others?	Yes: Go to step 9. No: Go to step 10.

Step	Action	Decision
9	Inspect for failed valve train components. Remove upper valve cover (see Engine Service Manual). Inspect for bent valves, fallen bridges, and valves out of adjustment. Is valve train free of failed valve train components?	Yes: Replace injector suspected by Multiple Cylinder Cutout Test. After repairs are complete, retest for SPN 3719 FMI 15. No: Repair failed valve train components. After repairs are complete retest for SPN 3719 FMI 15.

Step	Action	Decision
10	Determine if vehicle has an engine performance related driveability problem. Test drive the vehicle. Does engine have a performance problem.	Yes: Perform Engine Symptoms Diagnostics. After repairs are complete, retest for SPN 3719 FMI 15.

NOTE: After performing all diagnostic steps, if SPN 3719 FMI 15 remains, verify each step was completed correctly, and the proper decision was made. Notify supervisor for further action.

SPN 3719 FMI 16- DPF Soot Load - Moderate (level 2/3)

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
DPF Differential Pressure / outlet pressure sensor data valid, but above normal operating range (moderately severe level).	DPF Differential Pressure / outlet pressure sensor has exceeded the recommended limits.	Key-On Engine-Running (KOER) Engine Speed > 500 rpm	1 event

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the soot load of the Diesel Particulate Filter (DPF) has exceeded operating limits. Torque output of the engine will be reduced as soot load increases. Active and parked regeneration of the aftertreatment system will be disabled. See AFT System Overview (page 342) for additional information.

Malfunction Indicator Lamp (MIL) Reaction

This fault does not illuminate the MIL when active.

Associated Faults

SPN 94 (FDP); SPN 102 (IMP); SPN 157 (FRP); SPN 651-656 (INJ/CYL); SPN 3242 FMI 2, 3, and 4 (DPFIT); SPN 3246 FMI 2, 3, and 4 (DPFOT); SPN 3480 (AFTFP1); SPN 3482 (AFTFSV); SPN 3556 (AFT); SPN 4765 FMI 2, 3, and 4 (DOCIT); SPN 5541 (TC1TOP)

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Fault Facts

This fault code may indicate exhaust temperature exiting the turbocharger are not high enough to actively regenerate the aftertreatment system. Driving the vehicle with long-term increased load may increase exhaust temperatures and decrease aftertreatment regeneration frequency.

Possible Causes

- Engine performance problem
- Engine mechanical
- Regen inhibited
- Failed DPFDP / outlet pressure sensor module
- Restricted DPFDP / outlet pressure sensor hose(s)

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3242 FMI 2, 3, and 4 (DPFIT); SPN 3246 FMI 2, 3, and 4 (DPFOT); SPN 3480 (AFTFP1); SPN 3482 (AFTFSV); SPN 3556 (AFT); and SPN 4765 FMI 2, 3, and 4 (DOCIT). Is EST DTC list free of SPN 3242 FMI 2, 3, and 4; SPN 3246 FMI 2, 3, and 4; SPN 3480; SPN 3482; SPN 3556; and SPN 4765 FMI 2, 3, and 4?	Yes: Go to step 2. No: Repair SPN 3242 FMI 2, 3, and 4; SPN 3246 FMI 2, 3, and 4; SPN 3480; SPN 3482; SPN 3556; and SPN 4765 FMI 2, 3, and 4. After repairs are complete, retest for SPN 3719 FMI 16.

Step	Action	Decision
2	Check for engine performance problems. Using EST with ServiceMaxx™ software, check DTC list for SPN 94 (FDP), SPN 102 (IMP), SPN 157 (FRP), SPN 651-656 (INJ / CYL), and SPN 5541 (TC1TOP). Is EST DTC list free of SPN 94, SPN 102, SPN 157, SPN 651-656, and SPN 5541?	Yes: Go to step 3. No: Repair SPN 94, SPN 102, SPN 157, SPN 651-656, and SPN 5541. After repairs are complete, retest for SPN 3719 FMI 16.

Step	Action	Decision
3	Determine if a regen inhibitor is inhibiting regeneration of the aftertreatment system. Using EST with ServiceMaxx software, go to Procedures > KOER Aftertreatment Procedures > DPF Filter Regeneration > Inhibitors > and click Begin Test. Does DPF Filter Regeneration procedure run without any active Inhibitors?	Yes: Retest for SPN 3719 FMI 15. Go to step 4. No: Correct active regen inhibitors ((page 347) and ServiceMaxx Aftertreatment DPF Filter Regeneration Inhibitors tab). After repairs are complete, retest for SPN 3719 FMI 16.

Step	Action	Decision
4	Inspect connections at Diesel Particulate Filter Differential Pressure (DPFDP) / outlet pressure sensor. Key OFF, disconnect DPFDP / outlet pressure sensor. Check DPFDP / outlet pressure sensor and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DPFDP / outlet pressure sensor connector, harness, and terminals clean and undamaged?	Yes: Go to step 5. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3719 FMI 16.

Step	Action	Decision
5	Monitor DPFDP / outlet pressure sensor signal. Key-On Engine-Running, using EST with ServiceMaxx software, load the Signals session and monitor DPFDP. Is DPFDP below 0.5 psi (normal operation)?	Yes: Go to step 7. No: Go to step 6.

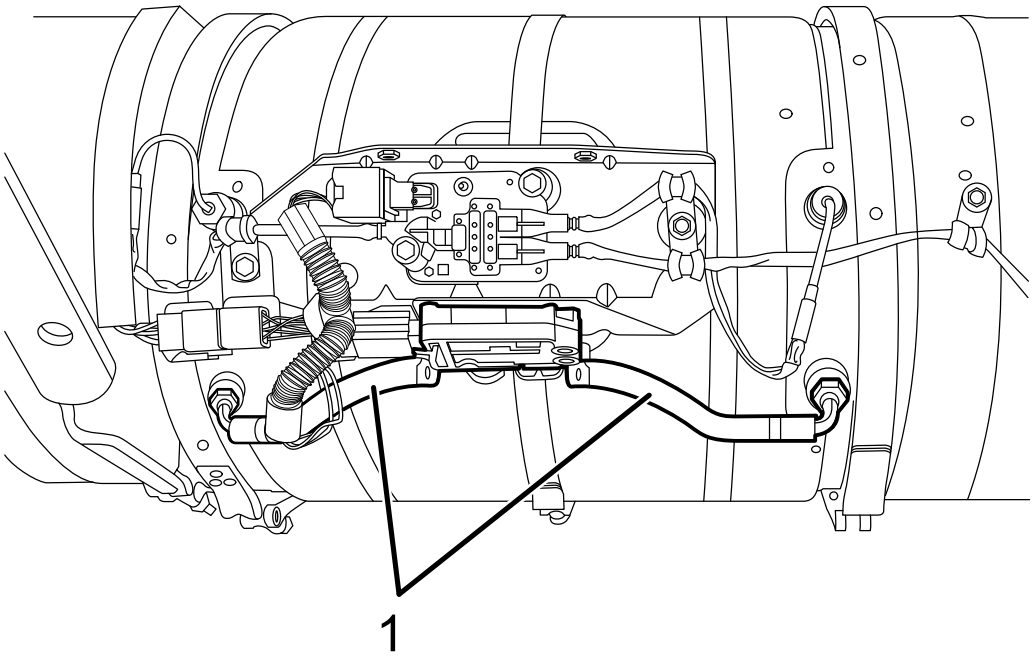

Figure 358 DPFDP / Outlet Pressure Sensor Hoses Location

1. Diesel Particulate Filter Differential Pressure (DPFDP) / outlet pressure sensor hoses

Step	Action	Decision
6	Check DPFDP / outlet pressure sensor hoses for correct routing and restrictions. Inspect the DPFDP / outlet pressure sensor hoses for improper routing, restrictions, or damage. Are the DPFDP / outlet pressure sensor hoses routed correctly, free of damage, and unrestricted?	Yes: Replace DPFDP / outlet pressure sensor. After repairs are complete, retest for SPN 3719 FMI 16.
		No: Repair or replace DPFDP / outlet pressure sensor hose(s). After repairs are complete, retest for SPN 3719 FMI 16.

Step	Action	Decision
7	Determine if the engine has a mechanical cylinder balance problem (compression loss). Perform Crankcase Pressure Test (page 236). Does engine have excessive crankcase pressure?	Yes: Repair base engine compression imbalance. After repairs are complete, retest for SPN 3719 FMI 16.
		No: Go to step 8

Step	Action	Decision
8	Determine if engine has a fuel injector problem. Perform Multiple Cylinder Cutout Test (page 241). Did one or more cylinders have significant speed difference(s) than the others?	Yes: Go to step 9. No: Go to step 10.

Step	Action	Decision
9	Inspect for failed valve train components. Remove upper valve cover (see Engine Service Manual). Inspect for bent valves, fallen bridges, and valves out of adjustment. Is valve train free of failed valve train components?	Yes: Replace injector suspected by Multiple Cylinder Cutout Test. After repairs are complete, retest for SPN 3719 FMI 16. No: Repair failed valve train components. After repairs are complete retest for SPN 3719 FMI 16.

Step	Action	Decision
10	Determine if vehicle has an engine performance related driveability problem. Test drive the vehicle. Does engine have a performance problem.	Yes: Perform Engine Symptoms Diagnostics. After repairs are complete, retest for SPN 3719 FMI 16.

NOTE: After performing all diagnostic steps, if SPN 3719 FMI 16 remains, verify each step was completed correctly, and the proper decision was made. Notify supervisor for further action.

SPN 3936 FMI 0 DPF Soot Load - Severe De-Rate

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
DPF Differential Pressure / Outlet Pressure sensor data valid, but above normal operating range (severe de-rate).	DPF Differential Pressure / Outlet Pressure sensor has exceeded the recommended limits.	Key-On Engine-Running (KOER)	1 event

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the soot load of the Diesel Particulate Filter (DPF) has exceeded the maximum operating limits for an extended period of time. Torque output of the engine will be reduced as soot load increases. Active regeneration of the aftertreatment system will be disabled.

Malfunction Indicator Lamp (MIL) Reaction

Red Stop Lamp Active

Associated Faults

SPN 94 (FDP); SPN 102 (IMP); SPN 157 (FRP); SPN 651-656 (INJ / CYL); SPN 3242 FMI 2, 3, and 4 (DPFIT); SPN 3246 FMI 2, 3, and 4 (DPFOT); SPN 3480 (AFTFP1); SPN 3482 (AFTFSV); SPN 3556 (AFT); SPN 4765 FMI 2, 3, and 4 (DOCIT); SPN 5541 (TC1TOP)

Fault Facts

This fault code indicates exhaust temperatures exiting the turbocharger are Not high enough. Repeated occurrences of this fault code may indicate the engine requires frequent regeneration of the aftertreatment system. To passively regenerate the aftertreatment system, operate the engine under higher load and higher rpm.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Engine performance problem
- Failed fuel injector
- Engine mechanical fault
- Regen inhibited
- Restricted DPFDP hoses
- Failed DPFDP sensor

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3242 FMI 2, 3, and 4 (DPFIT); SPN 3246 FMI 2, 3, and 4 (DPFOT); 3480 (AFTFP1); SPN 3482 (AFTFSV); SPN 3556 (AFT); and SPN 4765 FMI 2, 3, and 4 (DOCIT). Is EST DTC list free of SPN 3242 FMI 2, 3, and 4; SPN 3246 FMI 2, 3, and 4; SPN 3480; SPN 3482; SPN 3556; and SPN 4765 FMI 2, 3, and 4?	Yes: Go to step 2. No: Repair SPN 3242 FMI 2, 3, and 4; SPN 3246 FMI 2, 3, and 4; SPN 3480; SPN 3482; SPN 3556; and SPN 4765 FMI 2, 3, and 4. After repairs are complete, retest for SPN 3936 FMI 0.

Step	Action	Decision
2	Check for engine performance problems. Using EST with ServiceMaxx™ software, check DTC list for SPN 94 (FDP), SPN 102 (IMP), SPN 157 (FRP), SPN 651-656 (INJ / CYL), and SPN 5541 (TC1TOP). Is EST DTC list free of SPN 94, SPN 102, SPN 157, SPN 651-656, and SPN 5541?	Yes: Go to step 3. No: Repair SPN 94, SPN 102, SPN 157, SPN 651-656, and SPN 5541. After repairs are complete, retest for SPN 3936 FMI 0.

Step	Action	Decision
3	Determine if a regen inhibitor is inhibiting regeneration of the aftertreatment system. Using EST with ServiceMaxx software, go to Procedures > KOER Aftertreatment Procedures > DPF Filter Regeneration > Inhibitors > and click Begin Test. Does DPF Filter Regeneration procedure run without any active Inhibitors?	Yes: Go to step 4. No: Correct active regen inhibitors ((page 347) and ServiceMaxx Aftertreatment DPF Filter Regeneration Inhibitors tab). After repairs are complete, retest for SPN 3936 FMI 0.

Step	Action	Decision
4	Inspect connections at DPF Differential Pressure (DPFDP) / outlet pressure sensor. Key OFF, disconnect DPFDP / outlet pressure sensor. Check DPFDP / outlet pressure sensor and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DPFDP / outlet pressure sensor connector, harness, and terminals clean and undamaged?	Yes: Go to step 5. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3936 FMI 0.

Step	Action	Decision
5	Monitor DPFDP / outlet pressure sensor signal. Key-On Engine-Off, using EST with ServiceMaxx software, load the Signals session and monitor DPFDP.	Yes: Go to step 7. No: Go to step 6.

	Is DPFDP below 0.5 psi? (normal operation)	

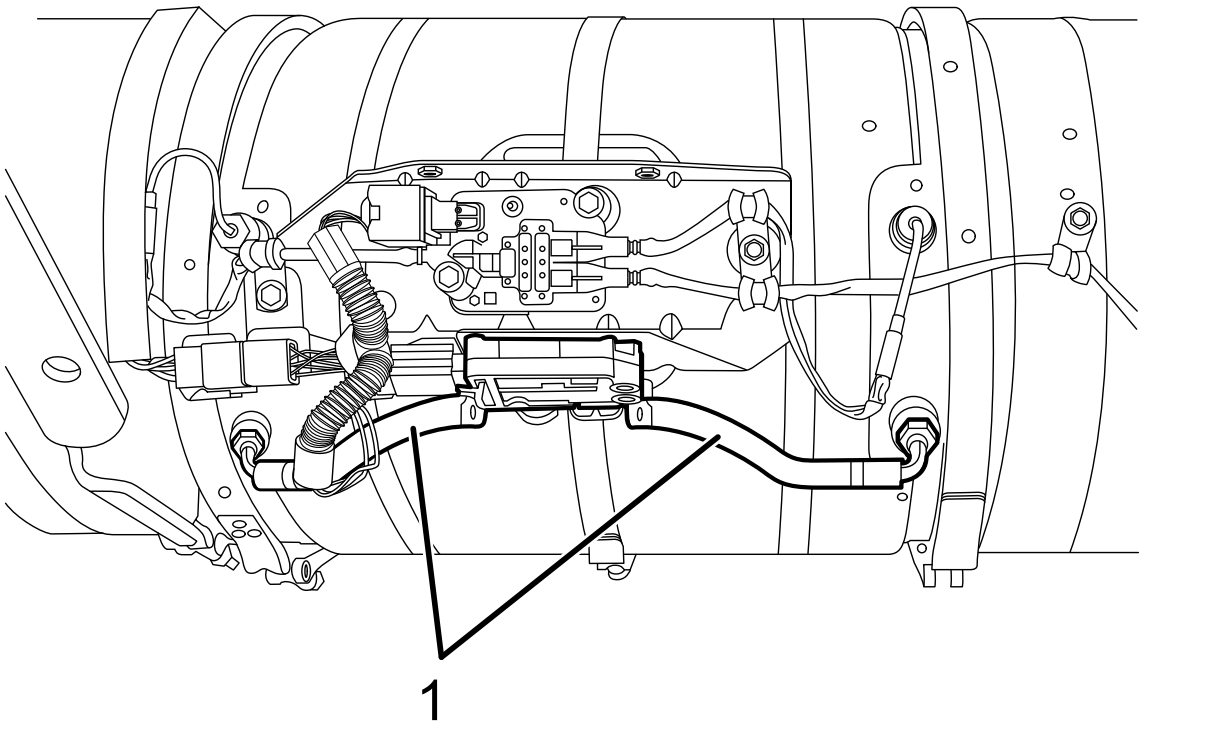

Figure 359 DPFDP Sensor and Hoses

1. DPFDP / outlet pressure hoses

Step	Action	Decision
6	Check DPFDP sensor hoses for correct routing and restrictions. Inspect the DPFDP sensor hoses for kinks, improper hose routing, restrictions, or damage. Are the DPFDP sensor hoses routed correctly, free of damage, and unrestricted?	Yes: Replace DPF Differential Pressure / Outlet Pressure sensor. After repairs are complete, retest for SPN 3936 FMI 0.
		No: Repair or replace DPFDP sensor hose(s). After repairs are complete, retest for SPN 3936 FMI 0.

Step	Action	Decision
7	Determine if the engine has a mechanical cylinder balance problem (compression loss). Perform Crankcase Pressure Test (page 236). Does engine have excessive crankcase pressure?	Yes: Repair base engine compression imbalance. After repairs are complete, retest for SPN 3936 FMI 0.
		No: Go to step 8

Step	Action	Decision
8	Determine if engine has a fuel injector problem. Perform Multiple Cylinder Cutout Test (page 241). Did one or more cylinders have significant speed difference(s) than the others?	Yes: Go to step 9. No: Go to step 10.

Step	Action	Decision
9	Inspect for failed valve train components. Remove upper valve cover (see Engine Service Manual). Inspect for bent valves, fallen bridges, and valves out of adjustment. Is valve train free of failed valve train components?	Yes: Replace injector suspected by Multiple Cylinder Cutout Test. After repairs are complete, retest for SPN 3936 FMI 0. No: Repair failed valve train components. After repairs are complete retest for SPN 3936 FMI 0.

Step	Action	Decision
10	Determine if vehicle has an engine performance related driveability problem. Test drive the vehicle. Does engine have a performance problem?	Yes: PerformEngine Symptoms Diagnostics . After repairs are complete, retest for SPN 3936 FMI 0 No: Retest for SPN 3936 FMI 0.

NOTE: After performing all diagnostic steps, if SPN 3936 FMI 0 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3936 FMI 7 DPF System - DPF exceeded maximum temperature threshold - replace DPF

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Particulate Filter (DPF) may have been damaged due to an extreme over temperature event.	Diesel Particulate Filter Outlet Temperature (DPFOT) sensor reading > 1710°F (950°C) for 30 seconds. OR Difference between Diesel Particulate Filter Inlet Temperature (DPFIT) and DPFOT > 1890°F (1050°C) for 30 seconds.	Inactive: SPN 3242 FMI 2, 3, and 4 (DPFIT); SPN 3246 FMI 2, 3, and 4 (DPFOT); SPN 5742 FMI 3, 4, 11, and 12 (DOC / DPF temp sensor module). Key-On Engine-Running (KOER).	30 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Diesel Particulate Filter Outlet Temperature (DPFOT) sensor reading exceeds 1742°F (950°C) for 30 seconds, or the difference between the Diesel Particulate Filter Inlet Temperature sensor (DPFIT) and DPFOT sensor is greater than 1922°F (1050°C) for 30 seconds.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 5742 FMI 3, 4, and 16 (DOC / DPF temp sensor module)

Fault Facts

If aftertreatment system has had excess fuel, oil, coolant, metal, or other contamination, inspect the entire aftertreatment system for causal damage before reinstalling.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Leaking or stuck open Aftertreatment Fuel Injector (AFTFI)
- Leaking or stuck open Aftertreatment Fuel Shutoff Valve (AFTFSV)
- Leaking fuel injector
- Fuel leak to exhaust
- Lube oil leak to exhaust
- Failed Diesel Oxidation Catalyst and Diesel Particulate Filter (DOC / DPF) temperature sensor module (malfunctioning in-range)

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 5742 FMI 3, 4, and 16 (DOC / DPF Temp sensor module). Is EST DTC list free of SPN 5742 FMI 3, 4, and 16?	Yes: Go to step 2. No: Repair SPN 5742 FMI 3, 4, and 16. After repairs are complete, retest for SPN 3936 FMI 7.

Step	Action	Decision
2	Determine if the engine has a mechanical cylinder balance problem (compression loss). Perform Crankcase Pressure Test (page 236). Does engine have excessive crankcase pressure?	Yes: Repair base engine compression imbalance. After repairs are complete, retest for SPN 3936 FMI 7. No: Go to step 3

Step	Action	Decision
3	Determine if engine has a fuel injector problem. Perform Multiple Cylinder Cutout Test (page 241). Did one or more cylinders have significant speed difference(s) than the others?	Yes: Go to step 4. No: Go to step 5.

Step	Action	Decision
4	Inspect for failed valve train components. Remove upper valve cover (see Engine Service Manual). Inspect for bent valves, fallen bridges, and valves out of adjustment. Is valve train free of failed valve train components?	Yes: Replace injector suspected by Multiple Cylinder Cutout Test. After repairs are complete, retest for SPN 3936 FMI 7. No: Repair failed valve train components. After repairs are complete retest for SPN 3936 FMI 7.

Step	Action	Decision
5	Check for fuel or lube oil leak to exhaust. Remove exhaust plumbing from turbocharger outlet (see Engine Service Manual). Inspect turbocharger outlet for signs of fuel and lube oil leaks to exhaust system. Is the turbocharger outlet free of signs of fuel and lube oil leaks to the exhaust system?	Yes: Go to step 6. No: Repair Fuel Leak to Exhaust (page 174) or Lube Oil Leak to Exhaust (page 163). After repairs are complete, retest for SPN 3936 FMI 7.

Step	Action	Decision
6	Check for leaking or stuck open Aftertreatment Fuel Shutoff Valve (AFTFSV). Perform AFT Fuel Shutoff Valve Leak Test (page 121). Is the AFT Fuel Injector (AFTFI) dry and free of fuel?	Yes: Go to step 7. No: Replace AFTFI. After repairs are complete, retest for SPN 3936 FMI 7.

Step	Action	Decision
7	Check for leaking or stuck open AFTFI. Perform AFT Fuel Injector Leak Test (page 120). Is the AFT Fuel Injector (AFTFI) dry and free of fuel?	Yes: Go to step 8. No: Replace AFTFI. After repairs are complete, retest for SPN 3936 FMI 7.

Step	Action	Decision
8	Check for failed AFT fuel flow. Perform AFT Dosing System Test (page 118). Was 225 to 500 ml of fuel dispensed within 2.5 minutes?	Yes: Replace DOC/ DPF temperature sensor module. After repairs are complete, retest for SPN 3936 FMI 7. No: Replace AFTFI. Refer to Fault Facts. After repairs are complete, retest for SPN 3936 FMI 7.

NOTE: After performing all diagnostic steps, if SPN 3936 FMI 7 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3936 FMI 14 - DOC/DPF Temperature Module (Incorrect Part)

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Calibration mismatch between DOC / DPF Temperature sensor module and Aftertreatment Control Module (ACM).	Diesel Particulate Filter Outlet Temperature (DPFOT) sensor signal < 0.1 volts.	Key ON.	2 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Diesel Particulate Filter Outlet Temperature (DPFOT) sensor signal voltage is less than 0.1 volts for more than 2 seconds. A default value is used for the DPFOT sensor, and the engine will be disabled. Active and parked regeneration of the aftertreatment system will be disabled, and the Exhaust Gas Recirculation (EGR) valve closed.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Incorrect DOC / DPF temperature sensor module installed

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3936 FMI 14. Is SPN 3936 FMI 14 active?	Yes: Install correct DOC / DPF Temperature sensor module. After repairs are complete, retest for SPN 3936 FMI 14.

NOTE: After performing all diagnostic steps, if SPN 3936 FMI 14 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3936 FMI 15 DPF System above Warning Pressure

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
DPF Differential Pressure / Outlet Pressure sensor signal in range, but above normal (least severe level).	DPF Differential Pressure / Outlet Pressure sensor has exceeded the recommended limits.	Key-On Engine-Running (KOER). Inactive: SPN 3251 FMI 2, 3, and 4. Engine Speed > 500 rpm.	30 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the soot load of the Diesel Particulate Filter (DPF) has exceeded the maximum operating limits. The Exhaust Gas Recirculation (EGR) valve will be disabled.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 94 (FDP); SPN 102 (IMP); SPN 157 (FRP); SPN 651-656 (INJ / CYL); SPN 5541 (TC1TOP): SPN 3242 FMI 2, 3, and 4 (DPFIT); SPN 3246 2, 3, and 4 (DPFOT); SPN 4765 2, 3, and 4 (DOCIT); SPN 3251 FMI 2, 3, and 4 (DPFDP / Outlet Pressure)

Fault Facts

This fault code indicates exhaust temperatures exiting the turbocharger are Not high enough to actively regenerate the aftertreatment system due to light load.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Engine performance problem
- Failed fuel injector
- Engine mechanical fault
- Regen inhibited
- Restricted DPFDP hoses
- Failed DPFDP sensor

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3242 FMI 2, 3, and 4 (DPFIT); SPN 3246 FMI 2, 3, and 4 (DPFOT); 3480 (AFTFP1); SPN 3482 (AFTFSV); SPN 3556 (AFT); and SPN 4765 FMI 2, 3, and 4 (DOCIT). Is EST DTC list free of SPN 3242 FMI 2, 3, and 4; SPN 3246 FMI 2, 3, and 4; SPN 3480; SPN 3482; SPN 3556; and SPN 4765 FMI 2, 3, and 4?	Yes: Go to step 2. No: Repair SPN 3242 FMI 2, 3, and 4; SPN 3246 FMI 2, 3, and 4; SPN 3480; SPN 3482; SPN 3556; and SPN 4765 FMI 2, 3, and 4. After repairs are complete, retest for SPN 3936 FMI 15.

Step	Action	Decision
2	Check for engine performance problems. Using EST with ServiceMaxx™ software, check DTC list for SPN 94 (FDP), SPN 102 (IMP), SPN 157 (FRP), SPN 651-656 (INJ / CYL), and SPN 5541 (TC1TOP). Is EST DTC list free of SPN 94, SPN 102, SPN 157, SPN 651-656, and SPN 5541?	Yes: Go to step 3. No: Repair SPN 94, SPN 102, SPN 157, SPN 651-656, and SPN 5541. After repairs are complete, retest for SPN 3936 FMI 15.

Step	Action	Decision
3	Determine if a regen inhibitor is inhibiting regeneration of the aftertreatment system. Using EST with ServiceMaxx software, go to Procedures > KOER Aftertreatment Procedures > DPF Filter Regeneration > Inhibitors > and click Begin Test. Does DPF Filter Regeneration procedure run without any active Inhibitors?	Yes: Go to step 4. No: Correct active regen inhibitors ((page 347) and ServiceMaxx Aftertreatment DPF Filter Regeneration Inhibitors tab). After repairs are complete, retest for SPN 3936 FMI 15.

Step	Action	Decision
4	Inspect connections at DPF Differential Pressure (DPFDP) / outlet pressure sensor. Key OFF, disconnect DPFDP / outlet pressure sensor. Check DPFDP / outlet pressure sensor and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DPFDP / outlet pressure sensor connector, harness, and terminals clean and undamaged?	Yes: Go to step 5. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3936 FMI 15.

Step	Action	Decision
5	Monitor DPFDP / outlet pressure sensor signal. Key-On Engine-Off (KOEO), using EST with ServiceMaxx software, load the Signals session and monitor DPFDP. Is DPFDP below 0.5 psi? (normal operation)	Yes: Go to step 7. No: Go to step 6.

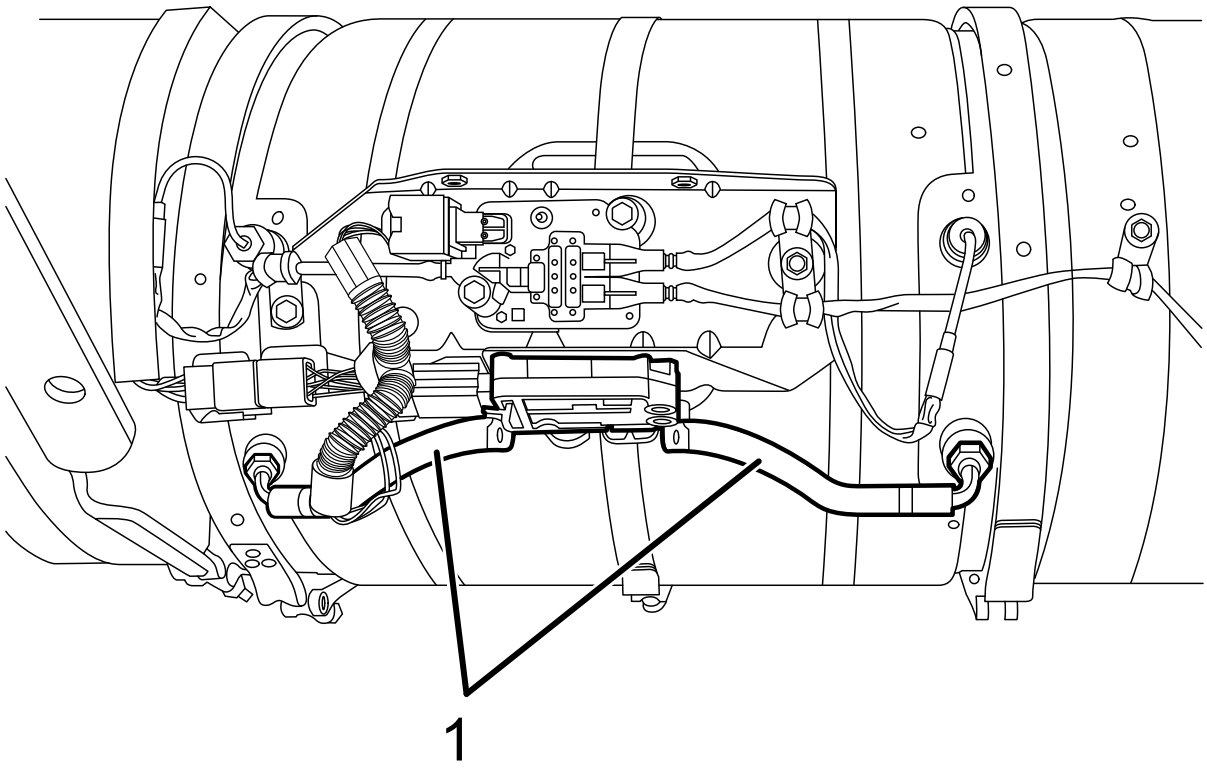

Figure 360 DPFDP Sensor and Hoses

1. DPFDP / outlet pressure hoses

Step	Action	Decision
6	Check DPFDP sensor hoses for correct routing and restrictions. Inspect the DPFDP sensor hoses for kinks, improper hose routing, restrictions, or damage. Are the DPFDP sensor hoses routed correctly, free of damage, and unrestricted?	Yes: Replace DPF Differential Pressure / Outlet Pressure sensor. After repairs are complete, retest for SPN 3936 FMI 15.
		No: Repair or replace DPFDP sensor hose(s). After repairs are complete, retest for SPN 3936 FMI 15.

Step	Action	Decision
7	Determine if the engine has a mechanical cylinder balance problem (compression loss). Perform Crankcase Pressure Test (page 236). Does engine have excessive crankcase pressure?	Yes: Repair base engine compression imbalance. After repairs are complete, retest for SPN 3936 FMI 15.
		No: Go to step 8

Step	Action	Decision
8	Determine if engine has a fuel injector problem. Perform Multiple Cylinder Cutout Test (page 241). Did one or more cylinders have significant speed difference(s) than the others?	Yes: Go to step 9. No: Go to step 10.

Step	Action	Decision
9	Inspect for failed valve train components. Remove upper valve cover (see Engine Service Manual). Inspect for bent valves, fallen bridges, and valves out of adjustment. Is valve train free of failed valve train components?	Yes: Replace injector suspected by Multiple Cylinder Cutout Test. After repairs are complete, retest for SPN 3936 FMI 15. No: Repair failed valve train components. After repairs are complete retest for SPN 3936 FMI 15.

Step	Action	Decision
10	Determine if vehicle has an engine performance related driveability problem. Test drive the vehicle. Does engine have a performance problem?	Yes: Perform Engine Symptoms Diagnostics . After repairs are complete, retest for SPN 3936 FMI 15 No: Retest for SPN 3936 FMI 15.

NOTE: After performing all diagnostic steps, if SPN 3936 FMI 15 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 5319 FMI 31 - DPF Incomplete Regeneration

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Incomplete regeneration of the aftertreatment system has been detected.	Diesel Particulate Filter Differential Pressure (DPFDP) / outlet pressure sensor module has exceeded the recommended limits after successful completion of an active regeneration.	Key-On Engine-Running (KOER) Inactive: SPN 3242 FMI 2, 3, and 4 (DPFIT); SPN 3246 FMI 2, 3, and 4 (DPFOT); SPN 3251 FMI 2, 3, and 4 (DPFDP / outlet pressure); SPN 3480 FMI 2, 3, 4, and 17 (AFTFP1); SPN 3482 FMI 2, 3, 4, and 7 (AFTFSV); SPN 3490 FMI 3, 4 (AFTPAV); SPN 3556 FMI 2 and 5 (AFT); SPN 3610 FMI 2, 3, and 4 (DPFDP / outlet pressure); SPN 4765 FMI 2, 3, and 4(DOCIT); SPN 5742 3, 4, and 11(DOC / DPF temp sensor module) Active regeneration of the aftertreatment system is requested DPF was not recently replaced	0 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the soot load of the Diesel Particulate Filter (DPF) is too high following successful active regeneration of the aftertreatment system.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 27 (EGR), SPN 1173 (TC2CIT), SPN 1177 (TC2CIP), SPN 1189 (TC2WC)

SPN 94 (FDP); SPN 102 (IMP); SPN 157 (FRP); SPN 651-656 (INJ/CYL); SPN 3055 (FRP); SPN 3482 FMI 7 (AFTFSV); SPN 5541 (TC1TOP)

SPN 3251 FMI 2, 3, and 4 (DPFDP / outlet pressure); SPN 3482 FMI 2 (AFTFSV); SPN 3556 FMI 18 (AFTFP1)

Fault Facts

If aftertreatment system has had excess fuel, oil, coolant, metal, or other contamination; inspect the entire aftertreatment system for causal damage before re-installing. Inspect for overheated aftertreatment components, cracked exhaust system welds, leaking exhaust system seams, or other damage. Excessive ash accumulation in the Diesel Particulate Filter (DPF) will cause frequent regenerations of the aftertreatment system. If all step-based diagnostics have been completed with no failure found, inspect the ash load of the DPF.

Drive Cycle to Determine Fault Status

Drive Cycle 1 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Low engine performance
- Failed fuel injector
- Engine mechanical
- Oil leak to exhaust
- Failed Diesel Particulate Filter Differential Pressure (DPFDP) / outlet pressure sensor
- Restricted DPFDP / outlet pressure sensor hose(s)
- Damaged or failed Diesel Oxidation Catalyst (DOC)
- Restricted DOC (soot accumulation)
- Failed AFTFI
- Failed AFTFSV

Step	Action	Decision
1	Using EST, check DTC list for SPN 27 (EGR); SPN 1173 (TC2CIT); SPN 1177 (TC2CIP); and SPN 1189 (TC2WC). Is EST DTC list free of SPN 27; SPN 1173; SPN 1177; and SPN 1189?	Yes: Go to step 2. No: Repair SPN 27; SPN 1173; SPN 1177; and SPN 1189. After repairs are complete, retest for SPN 5319 FMI 31.

Step	Action	Decision
2	Using EST with ServiceMaxx™ software, check DTC list for SPN 94 (FDP); SPN 102 (IMP); SPN 157 (FRP); SPN 651-656 (INJ / CYL); SPN 3482 FMI 7; and SPN 5541 (TC1TOP). Is EST DTC list free of SPN 94; SPN 102; SPN 157; SPN 651-656; SPN 3055; SPN 3482 FMI 7; and SPN 5541?	Yes: Go to step 3. No: Repair SPN 94; SPN 102; SPN 157; SPN 651-656; SPN 3482 FMI 7; and SPN 5541. After repairs are complete, retest for SPN 5319 FMI 31.

Step	Action	Decision
3	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3251 FMI 2, 3, and 4 (DPFDP / outlet pressure sensor); SPN 3482 FMI 2 (AFTFSV); and SPN 3556 FMI 18 (AFTFP1). Is EST DTC list free of SPN 3251 FMI 2, 3, and 4; SPN 3482 FMI 2; and SPN 3556 FMI 18?	Yes: Go to step 4. No: Repair SPN 3251 FMI 2, 3, and 4; SPN 3482 FMI 2; and SPN 3556 FMI 18. After repairs are complete, retest for SPN 5319 FMI 31.

Step	Action	Decision
4	Inspect connections at Diesel Particulate Filter Differential Pressure (DPFDP) / outlet pressure sensor module. Key OFF, disconnect DPFDP / outlet pressure sensor module. Check DPFDP / outlet pressure sensor module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DPFDP / outlet pressure sensor module connector, harness, and terminals clean and undamaged?	Yes: Go to step 5. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 5319 FMI 31.

Step	Action	Decision
5	Monitor DPFDP signal following active regeneration of the aftertreatment system. Key-On Engine-Off (KOEO), using EST with ServiceMaxx software, load the Signals session and monitor DPFDP. Is DPFDP below 0.5 psi?	Yes: Go to step 7. No: Go to step 6.

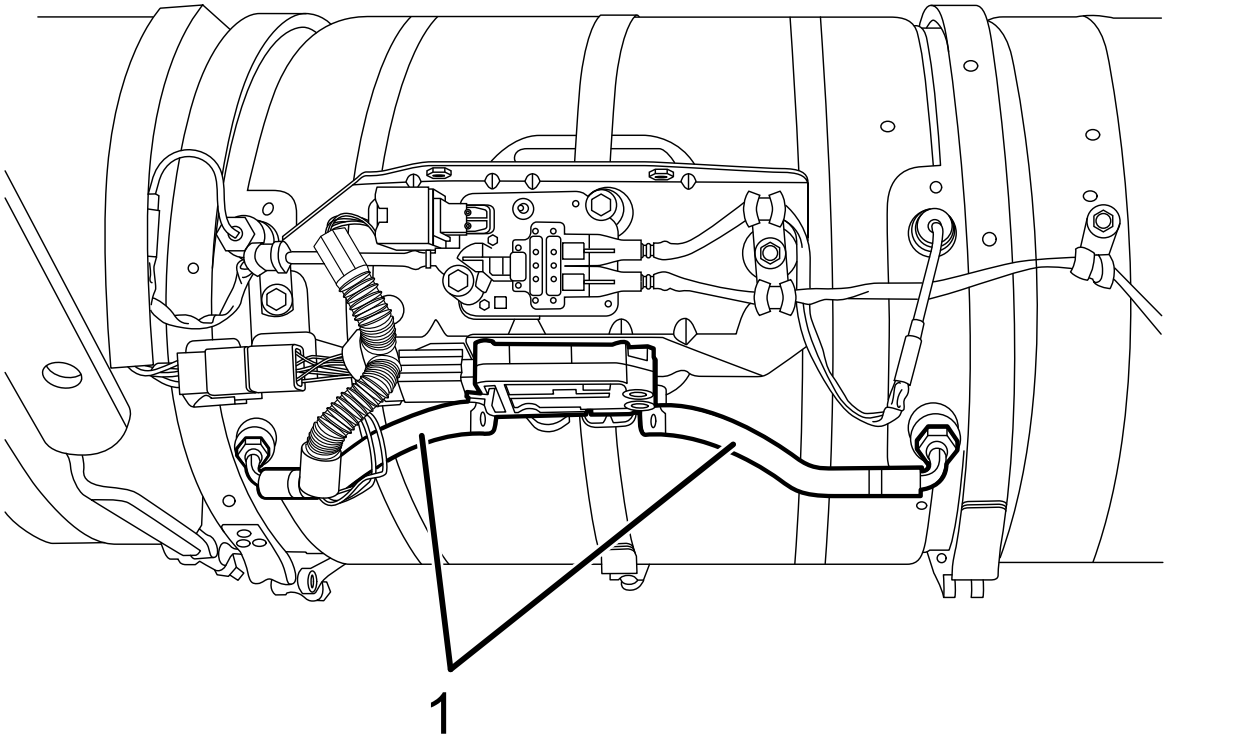

Figure 361 DPFDP / Outlet Pressure Sensor Hoses Locations

1. Diesel Particulate Filter Differential Pressure (DPFDP) / outlet pressure sensor hoses (2)

Step	Action	Decision
6	Check DPFDP / outlet pressure sensor module hoses for correct routing and restrictions. Inspect the DPFDP / outlet pressure sensor module hoses for kinks, improper hose routing, restrictions, or damage. Are the DPFDP / outlet pressure sensor module hoses routed correctly, free of damage, and unrestricted?	Yes: Replace DPFDP / outlet Pressure sensor. After repairs are complete, retest for SPN 5319 FMI 31. No: Repair or replace DPFDP / outlet pressure sensor hose(s). After repairs are complete, retest for SPN 5319 FMI 31.

Step	Action	Decision
7	Determine if the engine has a mechanical cylinder balance problem (compression loss). Perform Crankcase Pressure Test (page 236). Does engine have excessive crankcase pressure?	Yes: Repair base engine compression imbalance. After repairs are complete, retest for SPN 5319 FMI 31. No: Go to step 8

Step	Action	Decision
8	Determine if engine has a fuel injector problem. Perform Multiple Cylinder Cutout Test (page 241). Did one or more cylinders have significant speed difference(s) than the others?	Yes: Go to step 9. No: Go to step 10.

Step	Action	Decision
9	Inspect for failed valve train components. Remove upper valve cover (see Engine Service Manual). Inspect for bent valves, fallen bridges, and valves out of adjustment. Is valve train free of failed valve train components?	Yes: Replace injector suspected by Multiple Cylinder Cutout Test. After repairs are complete, retest for SPN 5319 FMI 31. No: Repair failed valve train components. After repairs are complete retest for SPN 5319 FMI 31.

Step	Action	Decision
10	Check for lube oil leak to exhaust. Perform Lube Oil Leak to Exhaust (page 163). Was the exhaust free of lube oil contamination?	Yes: Go to step 11. No: Repair lube oil leak to exhaust. After repairs are complete, retest for SPN 5319 FMI 31.

Step	Action	Decision
11	Check for failed Aftertreatment Fuel Shutoff Valve (AFTFSV). Perform AFT Fuel Shutoff Valve Leak Test (page 121). Is the AFT Fuel Injector (AFTFI) dry and free of fuel?	Yes: Go to step 12. No: Replace AFTFSV. After repairs are complete, retest for SPN 5319 FMI 31.

Step	Action	Decision
12	Check for failed AFTFI. Perform AFT Fuel Injector Leak Test (page 120). Is the AFTFI dry and free of fuel?	Yes: Go to step 13. No: Replace AFTFI. After repairs are complete, retest for SPN 5319 FMI 31.

Step	Action	Decision
13	Check for failed AFT fuel flow. Perform AFT Dosing System Test (page 118). Was 225 ml to 500 ml of fuel dispensed within 2.5 minutes?	Yes: Clean or replace DOC. Refer to fault facts. After repairs are complete, retest for SPN 5319 FMI 31. No: Replace AFTFI. Refer to Fault Facts. After repairs are complete, retest for SPN 5319 FMI 31.

NOTE: After performing all diagnostic steps, if SPN 5319 FMI 31 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 5397 FMI 31 DPF Regenerations are Occurring too Frequently

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
DPF system active regeneration occurring more frequently than intended.	Time since last active regeneration of the DPF completed and the next active regeneration is requested < 5 hrs. Number of failed decisions out of the last 3 updates made >=2	Inactive: SPN 3242 FMI 2, 3, 4 (DPFIT); SPN 3246 FMI 2, 3, 4 (DPFOT); SPN 3251 FMI 0, 2, 3, 4 (DPFDP / outlet pressure); SPN 3480 FMI 2, 3, 4,17 (AFTFP1); SPN 3482 FMI 2, 3, 4, 7 (AFTFSV); SPN 3490 FMI 3, 4 (AFTPAV); SPN 3556 FMI 2, 5, 18 (AFT); SPN 3597 2 (ECM); SPN 3610 FMI 2, 3, 4 (DPFDP / outlet pressure); SPN 3936 FMI 7, 15 (DPF System); SPN 4765 FMI 2, 3, 4 (DOCIT); SPN 4796 FMI 31 (DOC); SPN 5298 FMI 17, 18 (DOC); SPN 5319 FMI 31 (DPF); SPN 5742 FMI 3, 4, 11, 12 (DOC / DPF Temperature Sensor Module) Engine speed > 200 RPM Last active regeneration did not abort due to detection of malfunction with Aftertreatment system The system detects the DPF is no longer new	Immediate

Fault Overview

Fault code sets when Aftertreatment Control Module (ACM) detects the time between the completion of a successful active regeneration and the request for another active regeneration is less than 5 hours.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 3251 FMI 2, 3, 4 (DPFDP)

Fault Facts

An excessive ash accumulation condition reduces the soot holding capability of the Diesel Particulate Filter (DPF) and will cause frequent aftertreatment regenerations.

Drive Cycle to Determine Fault Status

Drive Cycle 1 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Low engine performance
- Failed fuel injector
- Engine mechanical
- Failed Diesel Particulate Filter Differential Pressure (DPFDP) / outlet pressure sensor
- Restricted DPFDP / outlet pressure sensor hose(s)
- DPF restricted, damaged, or contaminated
- Diesel Oxidation Catalyst (DOC) restricted, damaged, or contaminated

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3251 FMI 2, 3, and 4 (DPFDP / outlet pressure). Is EST DTC list free of SPN 3251 FMI 2, 3, and 4?	Yes: Go to step 2. No: Repair SPN 3251 FMI 2, 3, and 4. After repairs are complete, retest for SPN 5397 FMI 31.

Step	Action	Decision
2	Inspect connections at Diesel Particulate Filter Differential Pressure (DPFDP) / outlet pressure sensor. Key OFF, disconnect DPFDP / outlet pressure sensor. Check DPFDP / outlet pressure sensor and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DPFDP / outlet pressure sensor connector, harness, and terminals clean and undamaged?	Yes: Go to step 3. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 5397 FMI 31.

Step	Action	Decision
3	Monitor DPFDP signal. Key-On Engine-Running (KOER), using EST with ServiceMaxx software, load the Signals session and monitor DPFDP. Bring engine to high idle. Is DPFDP below 0.5 psi?	Yes: Go to step 5. No: Go to step 4.

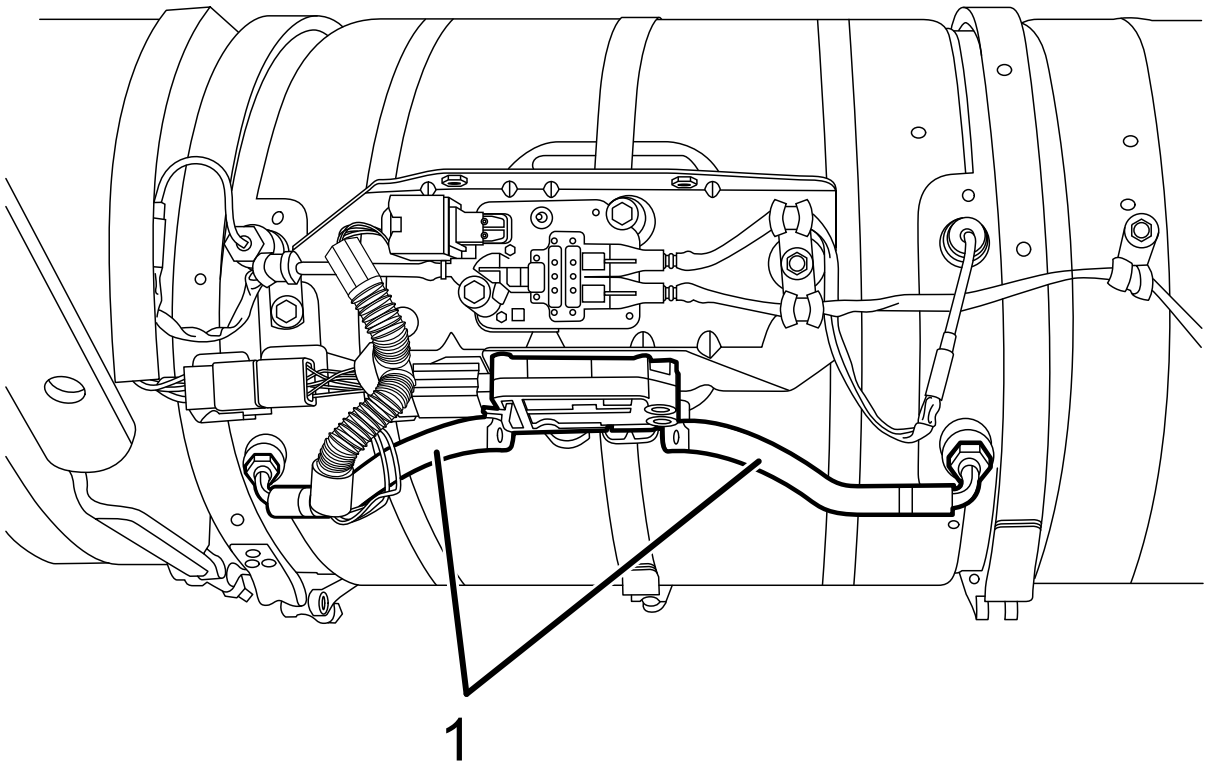

Figure 362 DPFDP / Outlet Pressure Sensor Hose(s) Location

1. Diesel Particulate Filter Differential Pressure (DPFDP) / outlet pressure sensor hose(s)

Step	Action	Decision
4	Check DPFDP sensor hoses for correct routing and restrictions. Inspect the DPFDP sensor hoses for kinks, improper hose routing, restrictions, or damage. Are the DPFDP sensor hoses routed correctly, free of damage, and unrestricted?	Yes: Replace DPF Differential Pressure / Outlet Pressure sensor. After repairs are complete, retest for SPN 5397 FMI 31.
		No: Repair or replace DPFDP sensor hose(s). After repairs are complete, retest for SPN 5397 FMI 31.

Step	Action	Decision
5	Determine if the engine has a mechanical cylinder balance problem (compression loss). Perform Crankcase Pressure Test (page 236). Does engine have excessive crankcase pressure?	Yes: Repair base engine compression imbalance. After repairs are complete, retest for SPN 5397 FMI 31.
		No: Go to step 6

Step	Action	Decision
6	Determine if engine has a fuel injector problem. Perform Multiple Cylinder Cutout Test (page 241). Did one or more cylinders have significant speed difference(s) than the others?	Yes: Go to step 7. No: Go to step 8.

Step	Action	Decision
7	Inspect for failed valve train components. Remove upper valve cover (see Engine Service Manual). Inspect for bent valves, fallen bridges, and valves out of adjustment. Is valve train free of failed valve train components?	Yes: Replace injector suspected by Multiple Cylinder Cutout Test. After repairs are complete, retest for SPN 5397 FMI 31. No: Repair failed valve train components. After repairs are complete retest for SPN 5397 FMI 31.

Step	Action	Decision
8	Inspect Diesel Oxidation Catalyst (DOC) for restrictions, damage, or contamination. Remove the DOC (see Exhaust System Service Manual). Check DOC for restrictions; oil and coolant contamination; and cracks or damage to cells in the DOC. Is the DOC unrestricted, free of damage, and free of contamination?	Yes: Go to step 9. No: Clean or replace DOC. After repairs are complete, retest for SPN 5397 FMI 31.

Step	Action	Decision
9	Inspect Diesel Particulate Filter (DPF) for restrictions, damage, or contamination. Remove the DPF (see Exhaust System Service Manual). Check DPF for restrictions; oil and coolant contamination; and cracks or damage. Is the DPF unrestricted, free of damage, and free of contamination?	Yes: Retest for SPN 5397 FMI 31. No: Clean or replace DPF. After repairs are complete, retest for SPN 5397 FMI 31.

NOTE: After performing all diagnostic steps, if SPN 5397 FMI 31 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

EBPV (Exhaust Back Pressure Valve)

SPN	FMI	Condition	Possible Causes	Actions
5542	15	TC1TOP above desired	• Restricted Exhaust • Stuck or sticking closed EBPV	Circuit Checks (page 961)
5542	16	EBP Above Desired during CSER	• Face plugged/damaged DPF • Face plugged/damaged DOC • Stuck or sticking EBPV • Biased TC1TOP sensor • Failed ACV	Step-Based Diagnostics (page 963)
5542	17	TC1TOP below desired — Check Exhaust Back Pressure Valve	• EBPV not closing when commanded	Circuit Checks (page 961)
5542	18	EBP Below Desired during CSER	• Damaged / leaking exhaust system • Restricted / leaking air supply to Air Control Valve (ACV) • Restricted or leaking air supply to EBPV • Stuck or sticking EBPV • Failed TC1TOP sensor (internal to ACV) • Failed EBPV actuator • Failed ACV	Step-Based Diagnostics (page 966)
5543	3	EBPV short to PWR	• EBPV circuit short to PWR • Failed EBPV	Circuit Checks (page 961)

5543	4	EBPV short to GND	• EBPV circuit short to GND • Failed EBPV	Circuit Checks (page 961)
5543	5	EBPV open load/circuit	• EBPC circuit OPEN • Failed EBPV	Circuit Checks (page 961)

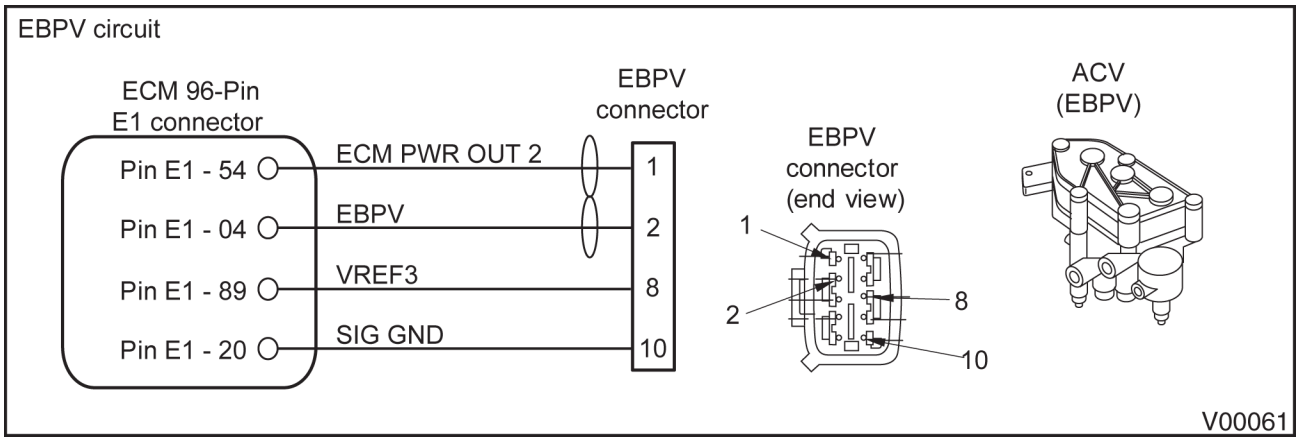

Figure 363 Exhaust Back Pressure Valve (EBPV) circuit diagram

NOTE: See latest version of N13 Engine and Aftertreatment Wiring Schematic Form 0000002203 for additional circuit information.

Overview

The Exhaust Back Pressure Valve (EBPV) is used to increase exhaust back pressure and raise the exhaust temperature to aid in the regeneration process. During operation, the EBPV closes restricting exhaust flow. This increases the load on the engine and causes exhaust temperatures to rise. When the Electronic Control Module (ECM) wants to close the EBPV, a signal is sent to the Air Control Module (ACV), and air pressure is sent to the EBPV closing the valve. The ECM monitors the Turbocharger 1 Turbine Outlet Pressure (TC1TOP) sensor, located within the ACV, to regulate air pressure to the EBPV.

Tools Required

- 180-Pin Breakout Box 00-00956-08
- 2010 MaxxForce 11 & 13 Harness Kit 00-01462-00
- 3-Banana Plug Harness ZTSE4498
- 500 Ohm Resistor Harness ZTSE4497
- Big Bore Terminal Test Probe Kit ZTSE4899
- Breakout Harness ZTSE6003 (EBPV)
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

Note: The EBPV, TC1TOP, and TC2WC circuits share the same connector to the ACV assembly.

Connector Voltage Check – EBPV Disconnected

NOTE: Excessive backpressure in the exhaust system, such as a restricted Diesel Oxidation Catalyst (DOC), could set this fault. Check for exhaust system damage and proper aftertreatment system operation before performing electrical checks.

Connect Breakout Harness ZTSE6003 to EBPV engine harness, and leave EBPV disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	B+	If < B+, check for OPEN or high resistance. Do Harness Resistance Check (page 962).
2 to GND	3.5 V ± 1.0 V	If < 2.5 V, check for OPEN or high resistance, Do Harness Resistance Check (page 962).
8 to GND	5 V ± 0.5 V	If > 5.5 V, check VREF for short to PWR. If < 4.5 V, check VREF for OPEN or short to GND. Do Harness Resistance Check (page 962).
If measurements are within specifications, do Operational Voltage Check.		

Operational Voltage Check

NOTE: Ensure air tanks have at least 90 psi (621 kPa) of pressure.

1. Connect Breakout Harness ZTSE6003 between EBPV and engine harness.
2. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests > KOEO Tests > Actuator Test. Select Exhaust Back Pressure Valve from the drop-down menu.
3. Command Exhaust Back Pressure Valve to 5%.
4. Use DMM to measure voltage.
5. Command Exhaust Back Pressure Valve to 95%.
6. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
2 to GND	5% = 12 V ± 2.0 V	If < 10 V, check for OPEN circuit.
2 to GND	95% = 1 V ± 1 V	If > 2 V, check for OPEN circuit or failed EBPV.

Actuator Resistance Check

Turn ignition switch to OFF. Connect Breakout Harness ZTSE6003 to EBPV and leave engine harness disconnected. Use DMM to measure resistance.

Test Point	Specifications	Comment
1 to 2	4 Ω to 8 Ω	If not within specification, replace the EBPV.
If measurements are within specifications, go to Harness Resistance Check.		

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with Breakout Harness 00-01468-00 to ECM E1 connector and leave ECM disconnected. Connect Breakout Harness ZTSE6003 to vehicle harness and leave EBPV disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
1 to E1-54	< 5 Ω	If > 5 Ω, check for OPEN circuit.
2 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
2 to E1-04	< 5 Ω	If > 5 Ω, check for OPEN circuit.
8 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
8 to E1-89	< 5 Ω	If > 5 Ω, check for OPEN circuit.
10 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
10 to E1-20	< 5 Ω	If > 5 Ω, check for OPEN circuit.
If voltage and resistance checks are within specifications, check for DTCs. If DTC returns, replace EBPV.		

SPN 5542 FMI 16 EBP Above Desired during CSER

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Cold Start Emission Reduction Exhaust Back Pressure (EBP) Monitor - Exhaust Back Pressure Above Desired.	EBP greater than expected.	CSER Warm up: On Engine running Ambient Air Temp > 14°F (-10°C) Engine Coolant Temp > 14°F (-10°C) Exhaust Back Pressure Valve (EBPV) Set Point > 1%	10 seconds

Fault Overview

Fault code sets when the Engine Control Module (ECM) detects EBP greater than expected during Cold Start Emission Reduction.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 108 (ECM SELF (BARO)); SPN 3719 (DPF Soot Load); SPN 3936 FMI 15 (DPF system); SPN 5541 (TC1TOP); SPN 5543 (EBPV)

Fault Facts

CSER is a strategy within the ECM that monitors the SCR catalyst brick temp and using various engine components, it works to keep the SCRIT above minimum temps for emission reduction through the catalyst.

Drive Cycle to Determine Fault Status

Drive Cycle 18 then 13 in 2013 HD-OBD Diagnostic Reference Manual.

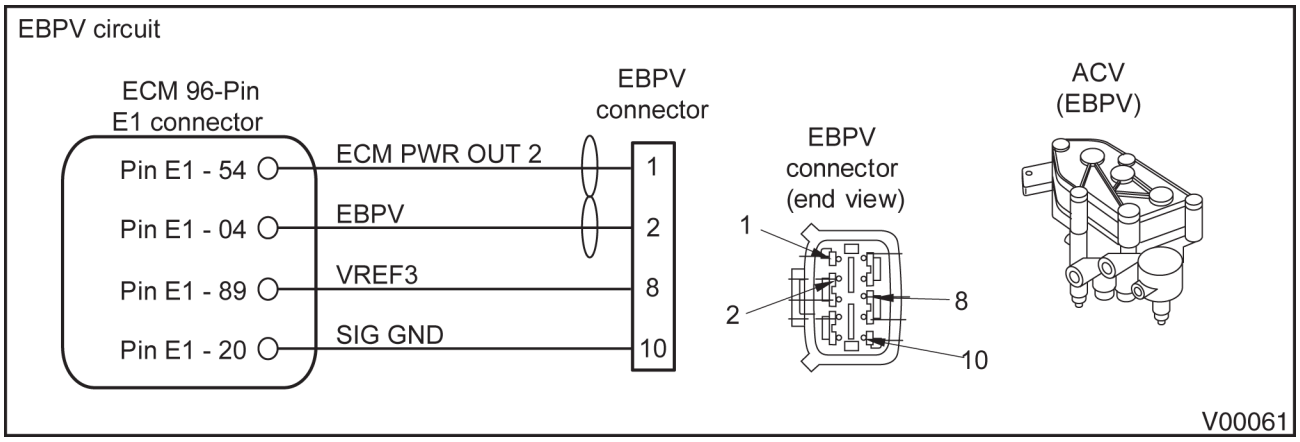

Figure 364 Exhaust Back Pressure Valve (EBPV) circuit diagram

Possible Causes

- Stuck or sticking EBPV
- Failed TC1TOP sensor (internal to Air Control Valve [ACV])
- Failed ACV

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 108 (ECM SELF [BARO]); SPN 3719 (DPF Soot Load); SPN 3936 FMI 15 (DPF system); SPN 5541 (TC1TOP); SPN 5543 (EBPV). Is EST DTC list free of SPN 108; SPN 3936 FMI 15; SPN 5541; SPN 5543?	Yes: Go to step 2. No: Repair SPN 108; SPN 3936 FMI 15; SPN 5541; SPN 5543. After repairs are complete, retest for SPN 5542 FMI 16.

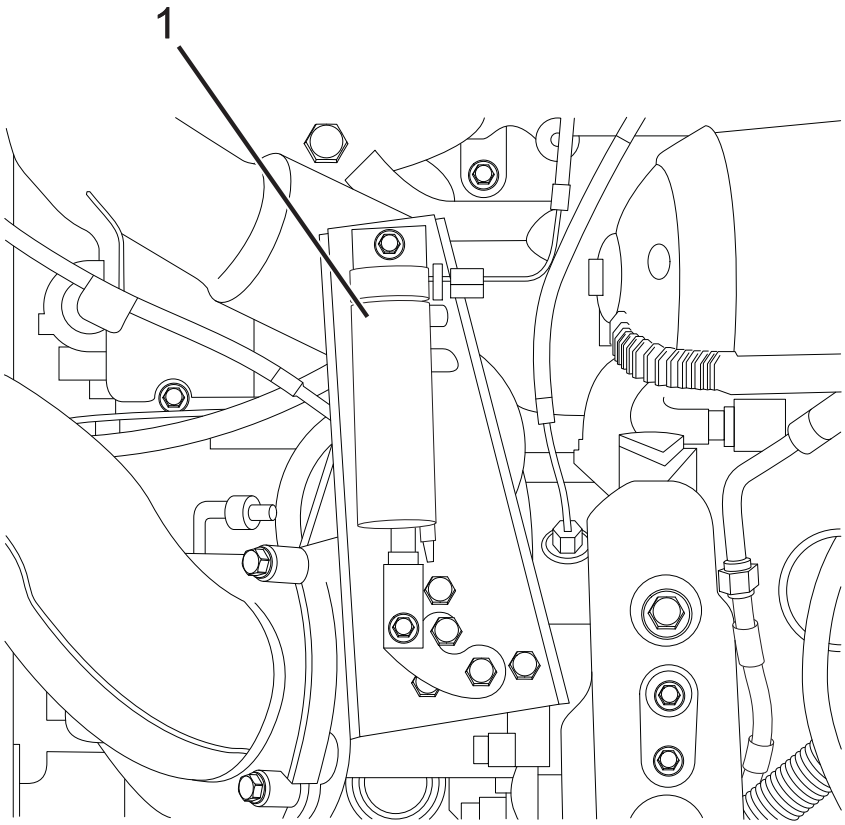

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Figure 365 EBPV location

1. Exhaust Back Pressure Valve (EBPV)

Step	Action	Decision
2	Check for Stuck or Sticking Exhaust Back Pressure Valve (EBPV). Perform Exhaust Back Pressure Valve (EBPV) test (page 213). Does EBPV pass the Exhaust Back Pressure Valve (EBPV) test?	Yes: Replace Air Control Valve (ACV). After repairs are complete, retest for SPN 5542 FMI 16.
		No: Repair EBPV assembly (according to the Exhaust Back Pressure Valve test). After repairs are complete, retest for SPN 5542 FMI 16.

NOTE: After performing all diagnostic steps, if SPN 5542 FMI 16 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 5542 FMI 18 EBP Below Desired during CSER

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Exhaust Back Pressure (EBP) less than expected during Cold Start Emission Reduction (CSER).	EBP less than expected.	CSER Warm up: On Engine running Ambient Air Temp (AAT) > 14°F (-10°C) Engine coolant temp > 14°F (-10°C) EBP Set Point > 1%	20 seconds

Fault Overview

Fault code sets when Engine Control Module (ECM) detects Exhaust Back Pressure (EBP) is less than expected during Cold Start Emission Reduction (CSER).

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 108 (ECM SELF (BARO)); SPN 5541 (TC1TOP); SPN 5543 (EBPV)

Fault Facts

CSER is a strategy within the ECM that monitors the SCR catalyst brick temp and using various engine components, it works to keep the SCRIT above minimum temps for emission reduction through the catalyst.

Drive Cycle to Determine Fault Status

Drive Cycle 18 then 13 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Damaged / leaking exhaust system
- Restricted / leaking air supply to Air Control Valve (ACV)
- Restricted or leaking air supply to EBPV
- Stuck or sticking EBPV
- Failed TC1TOP sensor (internal to ACV)
- Failed EBPV actuator
- Failed ACV

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 108 (ECM SELF [BARO]); SPN 5541 (TC1TOP); SPN 5543 (EBPV). Is EST DTC list free of SPN 108; SPN 5541; SPN 5543?	Yes: Go to step 2. No: Repair SPN 108; SPN 5541; SPN 5543. After repairs are complete, retest for SPN 5542 FMI 18.

Step	Action	Decision
2	Inspect exhaust system for leaks or damage. Inspect for cracked exhaust system welds, leaking exhaust system seams, or other damage. Is the exhaust system leaking or damaged?	Yes: Repair or replace leaking or damaged exhaust components. After repairs are complete, retest for SPN 5542 FMI 18. No: Go to step 3.

NOTE: Ensure air tanks have at least 90 psi (621 kPa) of pressure.

Step	Action	Decision
3	Inspect air supply to Air Control Valve (ACV). Inspect for leaking, restricted, or damaged air supply to the ACV. Is air supply to the ACV leaking, restricted, or damaged?	Yes: Repair or replace damaged air supply lines or components. After repairs are complete, retest for SPN 5542 FMI 18. No: Go to step 4.

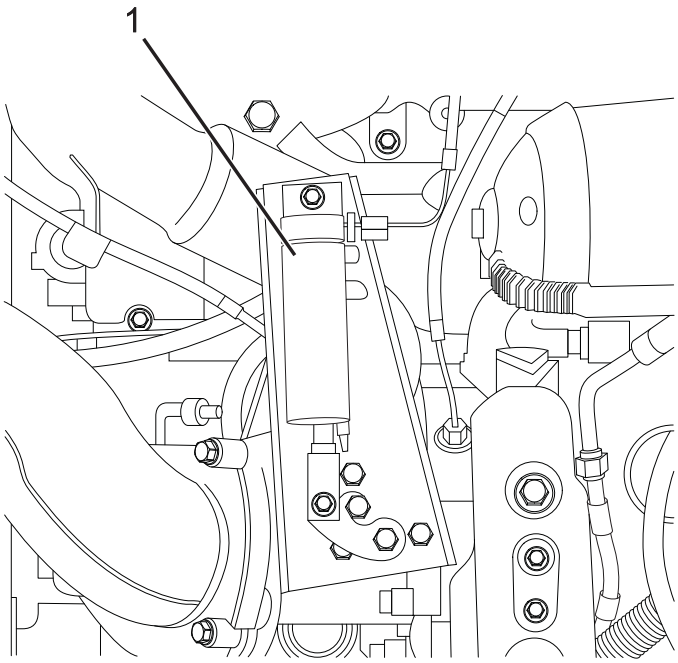

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Figure 366 EBPV location

1. Exhaust Back Pressure Valve (EBPV)

Step	Action	Decision
4	Check for Stuck or Sticking Exhaust Back Pressure Valve (EBPV). Perform Exhaust Back Pressure Valve Test (page 213). Does EBPV pass the EBPV test?	Yes: Replace Air Control Valve (ACV). After repairs are complete, retest for SPN 5542 FMI 18.
		No: Repair EBPV assembly (according to the Exhaust Back Pressure Valve Test). After repairs are complete, retest for SPN 5542 FMI 18.

NOTE: After performing all diagnostic steps, if SPN 5542 FMI 18 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

ECB1 (Engine Compression Brake 1)

SPN	FMI	Condition	Possible Causes	Actions
1072	3	ECB1 Control short to PWR	• ECB1 control circuit short to PWR • Failed ECB1 solenoid	Circuit Checks (page 970)
1072	4	ECB1 Control short to GND	• ECB1 control circuit short to GND • Failed ECB1 solenoid	Circuit Checks (page 970)
1072	5	ECB1 Control open load/circuit	• ECB1 control OPEN circuit • Failed ECB1 solenoid	Circuit Checks (page 970)

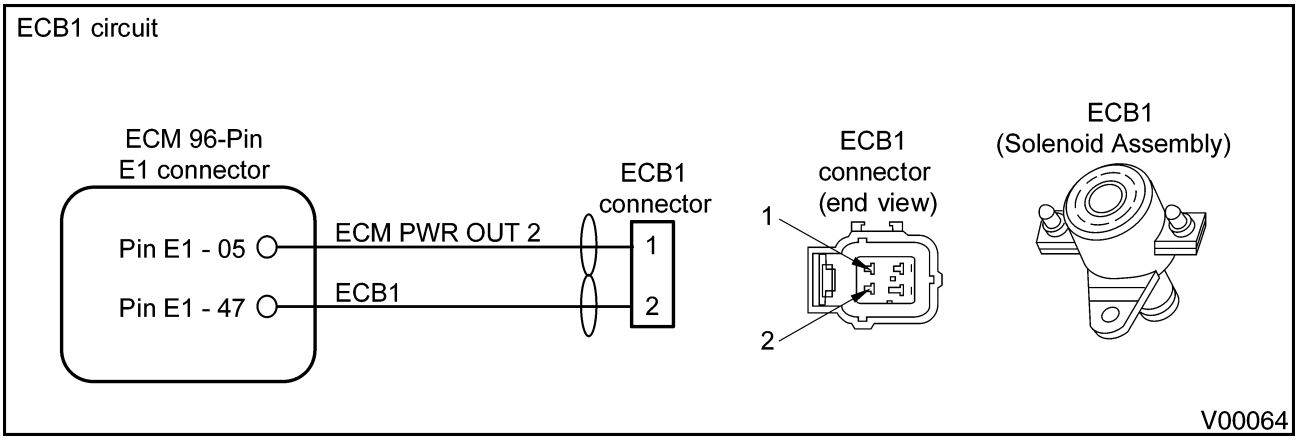

Figure 367 ECB1 circuit diagram

Tools Required

- 180-Pin Breakout Box 00-00956-08
- 2010 MaxxForce 11 & 13 Harness Kit 00-01462-00
- 3-Banana Plug Harness ZTSE4498
- 500 Ohm Resistor Harness ZTSE4497
- Big Bore Terminal Test Probe Kit ZTSE4899
- Breakout Harness ZTSE6004 (ECB)
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

WARNING: To prevent personal injury or death, stay clear of rotating parts (belts and fan) and hot engine surfaces.

Connector Voltage Check – ECB1 Disconnected

Connect Breakout Harness ZTSE6004 to ECB1 engine harness, and leave ECB1 disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	B+	If < B+, check for OPEN circuit. Do Harness Resistance Check.
2 to GND	B+	If < B+, check for OPEN circuit. Do Harness Resistance Check.
If measurements are within specifications, do Operational Voltage Check.		

Operational Voltage Check

NOTE: Ensure battery voltage is at or above 12 V, before running this procedure.

1. Connect Breakout Harness ZTSE6004 between ECB1 and engine harness.
2. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests > KOEO Tests > Actuator Test. Select Engine Compression Brake 1 from the drop-down menu.
3. Command ECB1 to 5%.
4. Use DMM to measure voltage.
5. Command ECB1 to 95%.
6. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
2 to GND	5% = 12 V ± 2.0 V	If < 10 V, check for OPEN circuit.
2 to GND	95% = 2.5 V ± 0.5 V	If > 3 V, check for OPEN circuit or failed ECB1.

Actuator Resistance Check

Turn ignition switch OFF. Connect Breakout Harness ZTSE6004 to ECB1 and leave engine harness disconnected. Use DMM to measure resistance.

Test Point	Specifications	Comment
1 to 2	9 Ω	If not within specification, replace the ECB1.
If measurements are within specifications, go to Harness Resistance Check.		

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM E1 and E2 harness to ECM E1 and E2 connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE6004 to ECB1 engine harness, and leave ECB1 disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
1 to E1-05	< 5 Ω	If > 5 Ω, check for OPEN circuit.
2 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
2 to E1-47	< 5 Ω	If > 5 Ω, check for OPEN circuit.
If voltage and resistance checks are within specifications, check for DTCs. If DTC returns, replace ECB1.		

ECB2 (Engine Compression Brake 2)

SPN	FMI	Condition	Possible Causes	Actions
1073	3	ECB2 Control short to PWR	• ECB2 control circuit short to PWR • Failed ECB2 solenoid	Circuit Checks (page 973)
1073	4	ECB2 Control short to GND	• ECB2 control circuit short to GND • Failed ECB2 solenoid	Circuit Checks (page 973)
1073	5	ECB2 Control open load/circuit	• ECB2 control circuit Open • Failed ECB2 solenoid	Circuit Checks (page 973)

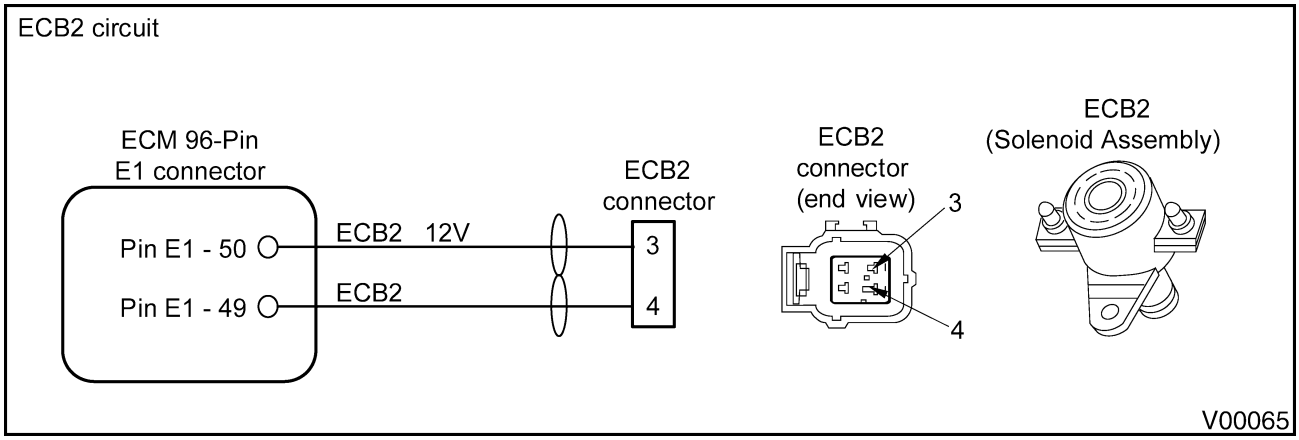

Figure 368 ECB2 circuit diagram

Tools Required

- 180-Pin Breakout Box 00-00956-08
- 2010 MaxxForce 11 & 13 Harness Kit 00-01462-00
- 3-Banana Plug Harness ZTSE4498
- 500 Ohm Resistor Harness ZTSE4497
- Big Bore Terminal Test Probe Kit ZTSE4899
- Breakout Harness ZTSE6004 (ECB)
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

Connector Voltage Check – ECB2 Disconnected

Connect Breakout Harness ZTSE6004 to ECB2 engine harness, and leave ECB2 disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
3 to GND	1 V ± 0.5 V	If < 1 V, check for OPEN circuit. Do Harness Resistance Check.
4 to GND	1 V ± 0.5 V	If < 1 V, check for OPEN circuit. Do Harness Resistance Check.
If measurements are within specifications, do Operational Voltage Check.		

Operational Voltage Check

NOTE: Ensure battery voltage is at or above 12 V, before running this procedure.

1. Connect Breakout Harness ZTSE6004 between ECB2 and engine harness.
2. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests > KOEO Tests > Actuator Test. Select Engine Compression Brake 2 from the drop-down menu.
3. Command ECB2 to 5%.
4. Use DMM to measure voltage.
5. Command ECB2 to 95%.
6. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
4 to GND	5% = 1 V ± 0.5 V	If < 0.5 V, check for OPEN circuit.
4 to GND	95% = 2.5 V ± 0.5 V	If < 2 V, check for OPEN circuit or failed ECB1.

Actuator Resistance Check

Turn ignition switch OFF. Connect Breakout Harness ZTSE6004 to ECB2 and leave engine harness disconnected. Use DMM to measure resistance.

Test Point	Spec	Comment
3 to 4	9 Ω	If not within specification, replace the ECB2.
If measurements are within specifications, go to Harness Resistance Check.		

Harness Resistance Check

Turn ignition switch OFF. Connect 180-Pin Breakout Box with Breakout Harness 00-01468-00 with ECM E1 and E2 harness to ECM E1 connector, and leave ECM disconnected. Connect Breakout Harness ZTSE6004 to ECB2 engine harness and leave ECB2 disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
3 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
3 to E1-50	< 5 Ω	If > 5 Ω, check for OPEN circuit.
4 to GND	> 1k Ω	If < 1k Ω, check for short circuit.

Harness Resistance Check (cont.)

4 to E1-49	< 5 Ω	If > 5 Ω, check for OPEN circuit.

If voltage and resistance checks are within specifications, check for DTCs. If DTC returns, replace the ECB1.

ECL Switch (Engine Coolant Level)

SPN	FMI	Condition	Possible Causes	Actions
111	1	Low Engine Coolant level	• Biased ECT1 sensor or circuit • Low coolant level • Engine cooling system mechanical failure	Step Based Diagnostics (page 976)

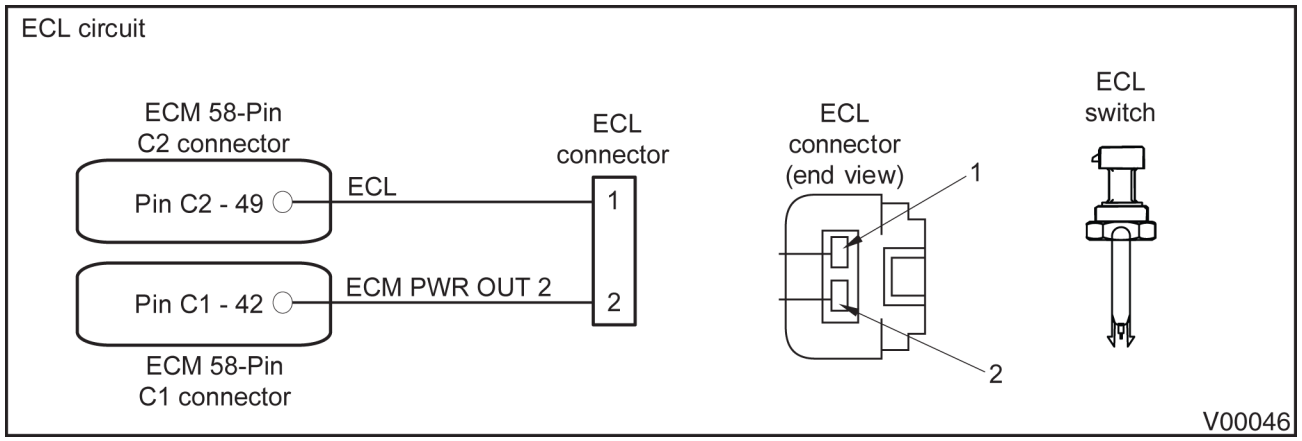

Figure 369 ECL switch circuit diagram

Tools Required

- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

WARNING: To prevent personal injury or death, stay clear of rotating parts (belts and fan) and hot engine surfaces.

Step Based Diagnostics With ServiceMaxx™ Software

Step	Action	Decision
1	Check engine coolant level. Is engine coolant level low, is there evidence of coolant loss or does operator's complaint include engine coolant leaks or consumption?	Yes: Go to Symptom Coolant Loss (page 135). No: Go to step 2

Step	Action	Decision
2	Inspect connector for damaged, corroded or loose pins. Are the connector pins damaged, corroded or loose?	Yes: Repair damaged, corroded or loose pins. After repairs are complete, retest for original problem. No: Go to step 3.

Step	Action	Decision
3	Using Electronic Service Tool (EST) with ServiceMaxx™, Check DTC list for fault code status. Is SPN 111 FMI 1 active?	Yes: Go to step 5. No: Go to step 4.

Step	Action	Decision
4	Wiggle the Engine Coolant Level (ECL) Sensor harness. Did SPN 111 FMI 1 go active?	Yes: Repair or replace ECL Sensor harness. After repairs are complete, retest for original problem. No: Use EST to clear fault codes. Retest for original problem.

Step	Action	Decision
5	Unplug the Engine Coolant Level (ECL) Sensor. Wait one minute and cycle the key. Did SPN 111 FMI 1 become previously active?	Yes: Replace the Engine Coolant Level (ECL)Sensor. No: Repair the open circuit in the Engine Coolant Level (ECL) Sensor harness.

NOTE: After performing all diagnostic steps, if SPN 111 FMI 1 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

ECM Power (Engine Control Module)

SPN	FMI	Condition	Possible Causes	Actions
158	15	ECM Switched voltage too HIGH	• Jump start using more than system voltage • Batteries wired incorrectly	Pin-Point Diagnostics (page 978)
158	17	ECM Switched voltage too LOW	• Low discharged batteries • Charging system failure • High resistance in ECM powering circuits	Pin-Point Diagnostics (page 978)

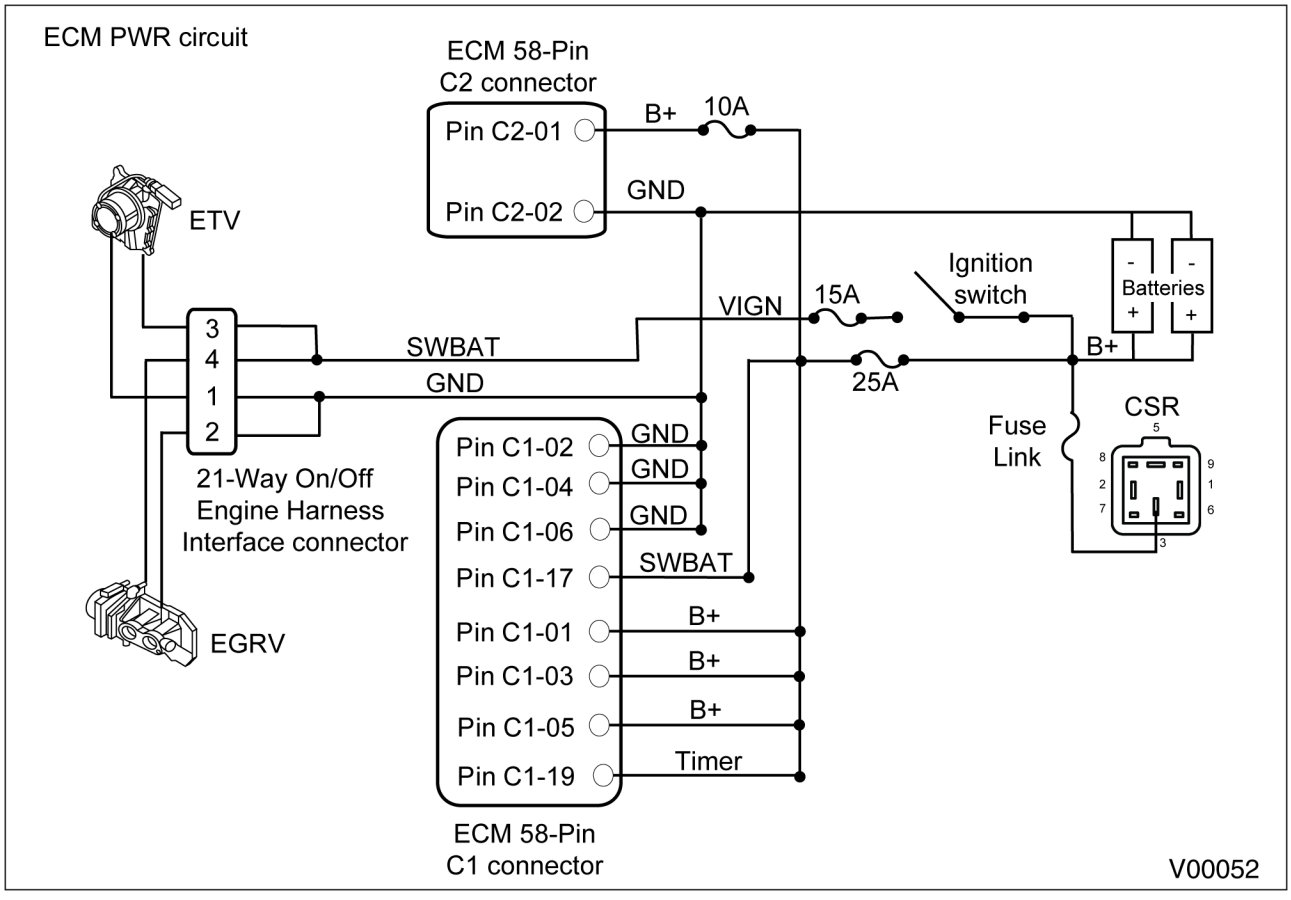

Figure 370 ECM PWR (Input Power) circuit diagram

Tools Required

- 180-Pin Breakout Box 00-00956-08
- 2010 MaxxForce 11 & 13 Harness Kit 00-01462-00
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

SPN 158 FMI 15- ECM Switched voltage too HIGH

Pin-point ECM System Fault

1. Turn engine OFF and measure battery voltage.
   - If battery voltage is above 16 V, batteries are wired incorrectly. Repair circuitry.
2. Start engine and measure battery voltage.
   - If battery voltage is above 16 V, repair charging system.

SPN 158 FMI 17- ECM Switched voltage too LOW

Pin-point ECM System Fault

1. Start engine and measure battery voltage.
   - If battery voltage is below 10 V, repair charging system.
   - If voltage is above 12 V, continue to next step.
2. Using ServiceMaxx™ software, check Switched Battery voltage.
   - If battery voltage is below 10 V, continue pinpoint diagnostics.

Voltage Checks at ECM

Connect 180-Pin Breakout Box with ECM C1 and C2 harness to ECM C1 and C2 vehicle harness connectors, and leave ECM disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
C1-01 to GND	B+	If < B+, check for OPEN in B+ circuit.
C1-03 to GND	B+	If < B+, check for OPEN in B+ circuit.
C1-05 to GND	B+	If < B+, check for OPEN in B+ circuit.
C2-01 to GND	B+	If < B+, check for OPEN in B+ circuit.
C1-19 to GND	B+	If < B+, check for OPEN in Timer circuit.
C1-17 to GND	B+	If < B+, check for OPEN in SWBAT circuit.
C1-02 to B+	B+	If < B+, check for OPEN in ground circuit.
C1-04 to B+	B+	If < B+, check for OPEN in ground circuit.
C1-06 to B+	B+	If < B+, check for OPEN in ground circuit.
C2-02 to B+	B+	If < B+, check for OPEN in ground circuit.

ECM Power Output (Engine Control Module)

SPN	FMI	Condition	Possible Causes	Action
3597	4	ECM Power Output 1 below normal ECM Pins: C1-31, C1-33, C1-54, C2-51, E1-01 and E1-51	• ECM Power Output 1 circuit short to GND	Circuit Checks(page 980)
3598	4	ECM Power Output 2 below normal ECM Pins: C1-42, C2-06, E1-05, E1-28, E1-29 and E1-54	• ECM Power Output 2 circuit short to GND	Circuit Checks(page 981)
3599	4	ECM Power Output 3 below normal ECM Pins: C1-30, C2-03, E1-24, E1-26, and E1-27	• ECM Power Output 3 circuit short to GND	Circuit Checks(page 981)

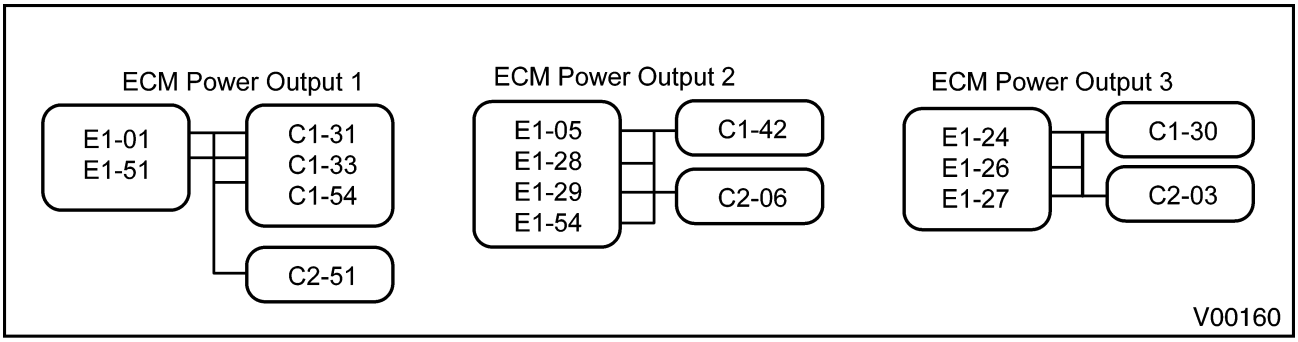

Figure 371 ECM PWR (Output Power) circuit diagram

Tools Required

- 180-Pin Breakout Box 00-00956-08
- 2010 MaxxForce 11 & 13 Harness Kit 00-01462-00
- 3-Banana Plug Harness ZTSE4498
- 500 Ohm Resistor Harness ZTSE4497
- Big Bore Terminal Test Probe Kit ZTSE4899
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

SPN 3597 FMI 4 – ECM Power Output 1

Voltage Check

Connect 180-Pin Breakout Box with ECM C1 and C2 harness to ECM C1 and C2 vehicle harness connectors, and leave ECM disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
C1-31 to GND	B+	If < B+, check for short to GND or internally shorted component. Do Harness Resistance Check.
C1-33 to GND	B+	If < B+, check for short to GND or internally shorted component. Do Harness Resistance Check.
C1-54 to GND	B+	If < B+, check for short to GND or internally shorted component. Do Harness Resistance Check.
C2-51 to GND	B+	If < B+, check for short to GND or internally shorted component. Do Harness Resistance Check.

Connect 180-Pin Breakout Box with ECM E1 and E2 harness to ECM E1 and E2 engine harness connectors, and leave ECM disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
E1-01 to GND	B+	If < B+, check for short to GND or internally shorted component. Do Harness Resistance Check.
E1-51 to GND	B+	If < B+, check for short to GND or internally shorted component. Do Harness Resistance Check.

Harness Resistance Check

NOTE: If circuit fault is intermittent, wiggle harness while measuring resistance.

Turn ignition OFF. Connect 180-Pin Breakout Box with ECM C1 and C2 harness to ECM C1 and C2 vehicle harness connectors, and leave ECM disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
C1-31 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
C1-33 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
C1-54 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
C2-51 to GND	> 1k Ω	If < 1k Ω, check for short circuit.

NOTE: If circuit fault is intermittent, wiggle harness while measuring resistance.

Turn ignition OFF. Connect 180-Pin Breakout Box with ECM E1 and E2 harness to ECM E1 and E2 engine harness connectors, and leave ECM disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
E1-01 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
E1-51 to GND	> 1k Ω	If < 1k Ω, check for short circuit.

SPN 3598 FMI 4 – ECM Power Output 2

Voltage Check

Connect 180-Pin Breakout Box with ECM C1 and C2 harness to ECM C1 and C2 vehicle harness connectors, and leave ECM disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
C1-42 to GND	B+	If < B+, check for short to GND or internally shorted component. Do Harness Resistance Check.
C2-06 to GND	B+	If < B+, check for short to GND or internally shorted component. Do Harness Resistance Check.

Connect 180-Pin Breakout Box with ECM E1 and E2 harness to ECM E1 and E2 engine harness connectors, and leave ECM disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
E1-05 to GND	B+	If < B+, check for short to GND or internally shorted component. Do Harness Resistance Check.
E1-28 to GND	B+	If < B+, check for short to GND or internally shorted component. Do Harness Resistance Check.
E1-29 to GND	B+	If < B+, check for short to GND or internally shorted component. Do Harness Resistance Check.
E1-54 to GND	B+	If < B+, check for short to GND or internally shorted component. Do Harness Resistance Check.

Harness Resistance Check

NOTE: If circuit fault is intermittent, wiggle harness while measuring resistance.

Turn ignition OFF. Connect 180-Pin Breakout Box with ECM C1 and C2 harness to ECM C1 and C2 vehicle harness connectors, and leave ECM disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
C1-42 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
C2-06 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
E1-05 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
E1-28 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
E1-29 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
E1-54 to GND	> 1k Ω	If < 1k Ω, check for short circuit.

NOTE: If circuit fault is intermittent, wiggle harness while measuring resistance.

Turn ignition OFF. Connect 180-Pin Breakout Box with ECM E1 and E2 harness to ECM E1 and E2 engine harness connectors, and leave ECM disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
E1-05 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
E1-28 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
E1-29 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
E1-54 to GND	> 1k Ω	If < 1k Ω, check for short circuit.

SPN 3599 FMI 4 – ECM Power Output 3

Voltage Check

Connect 180-Pin Breakout Box with ECM C1 and C2 harness to ECM C1 and C2 vehicle harness connectors, and leave ECM disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
C1-30 to GND	B+	If < B+, check for short to GND or internally shorted component. Do Harness Resistance Check.
C2-03 to GND	B+	If < B+, check for short to GND or internally shorted component. Do Harness Resistance Check.

Connect 180-Pin Breakout Box with ECM E1 and E2 harness to ECM E1 and E2 engine harness connectors, and leave ECM disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
E1-24 to GND	B+	If < B+, check for short to GND or internally shorted component. Do Harness Resistance Check.
E1-26 to GND	B+	If < B+, check for short to GND or internally shorted component. Do Harness Resistance Check.
E1-27 to GND	B+	If < B+, check for short to GND or internally shorted component. Do Harness Resistance Check.

Harness Resistance Check

NOTE: If circuit fault is intermittent, wiggle harness while measuring resistance.

Turn ignition OFF. Connect 180-Pin Breakout Box with ECM C1 and C2 harness to ECM C1 and C2 vehicle harness connectors, and leave ECM disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
C1-30 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
C2-03 to GND	> 1k Ω	If < 1k Ω, check for short circuit.

NOTE: If circuit fault is intermittent, wiggle harness while measuring resistance.

Turn ignition OFF. Connect 180-Pin Breakout Box with ECM E1 and E2 harness to ECM E1 and E2 engine harness connectors, and leave ECM disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
E1-24 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
E1-26 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
E1-27 to GND	> 1k Ω	If < 1k Ω, check for short circuit.

ECM (Engine Control Module)Self-Diagnostics

SPN	FMI	Condition	Possible Causes	Actions
108	3	BARO signal Out of Range HIGH	Internal ECM failure, replace ECM and perform Crank Position (CKP) relearn procedure (page 987).	Pin-Point Diagnostics (page 985)
108	4	BARO signal Out of Range LOW	Internal ECM failure, replace ECM and perform CKP relearn procedure (page 987)	Pin-Point Diagnostics (page 985)
628	12	ECM Memory Error	Internal ECM failure, replace ECM and perform CKP relearn procedure (page 987)	Pin-Point Diagnostics (page 985)
629	2	ECM Error –Level 2 Monitoring	Internal ECM failure, replace ECM and perform CKP relearn procedure (page 987)	Pin-Point Diagnostics (page 985)
629	8	Engine Off timer fault	Internal ECM failure, replace ECM and perform CKP relearn procedure (page 987)	Pin-Point Diagnostics (page 985)
629	12	ECM Internal chip Error	Internal ECM failure, replace ECM and perform CKP relearn procedure (page 987)	Pin-Point Diagnostics (page 985)
629	14	ECM Internal component overtemperature	Internal ECM failure, replace ECM and perform CKP relearn procedure (page 987)	Pin-Point Diagnostics (page 985)
1110	31	ECM Internal component	Internal ECM failure, replace ECM and perform CKP relearn procedure (page 987)	Pin-Point Diagnostics (page 986)

NOTE: Ensure battery voltage is at or above 12 V, before running the following procedures.

Tools Required

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

SPN 108 FMI 3- BARO signal Out of Range HIGH

Checks whether the signal from the Barometric Pressure (BARO) sensor is above the maximum threshold.

Pin-point ECM Self-Diagnostic Fault

1. Clear DTC, cycle ignition switch.
2. If DTC is still active, replace ECM and perform CKP relearn procedure (page 987).

SPN 108 FMI 4 - BARO signal Out of Range LOW

Checks whether the signal from the BARO sensor is below the minimum threshold.

Pin-point ECM Self-Diagnostic Fault

1. Clear DTC, cycle ignition switch.
2. If DTC is still active, replace ECM and perform CKP relearn procedure (page 987).

SPN 628 FMI 12- ECM Memory Error

Pin-point ECM Self-Diagnostic Fault

1. Clear DTC, cycle ignition switch.
2. If DTC is still active, replace ECM and perform CKP relearn procedure (page 987).

SPN 629 FMI 2- ECM Error- Level 2 Monitoring

Pin-point ECM Self-Diagnostic Fault

1. Clear DTC, cycle ignition switch.
2. If DTC is still active, replace ECM and perform CKP relearn procedure (page 987).

SPN 629 FMI 8 - Engine Off timer fault

Pin-point ECM Self-Diagnostic Fault

1. Clear DTC, cycle ignition switch.
2. If DTC is still active, replace ECM and perform CKP relearn procedure (page 987).

SPN 629 FMI 12- ECM Internal chip Error

Pin-point ECM Self-Diagnostic Fault

1. Clear DTC, cycle ignition switch.
2. If DTC is still active, replace ECM and perform CKP relearn procedure (page 987).

SPN 629 FMI 14- ECM Internal component

Pin-point ECM Self-Diagnostic Fault

1. Clear DTC, cycle ignition switch.
2. If DTC is still active, replace ECM and perform CKP relearn procedure (page 987).

SPN 1110 FMI 31 – ECM Detects Fueling Without Demand

1. Clear DTC, cycle ignition switch.
2. If DTC is still active, replace ECM and perform CKP relearn procedure (page 987).

Crank Sensor Relearn Procedure

Tools Required

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

Function

To perform Crankshaft Position (CKP) sensor relearn after replacing the ECM, CMP, or CKP sensor.

1. Turn ignition switch to ON, engine OFF.
2. Connect EST to vehicle's Diagnostic Connector.
3. Start ServiceMaxx™ software.
4. From sessions drop-down menu select Programming.
5. Search for parameter Crankshaft Position Learning Reset Request (ID 95232).
6. Click in Value field and select Yes from drop-down menu.
7. Click on Program Engine button.
8. After programming is complete, the value will switch back to No.

ECS (Engine Coolant System)

SPN	FMI	Condition	Possible Causes	Actions
110	17	Engine Coolant System below OBD monitoring temperature	• Low coolant level • Failed Engine Coolant Temperature 1 (ECT1) sensor • Failed engine cooling fan (stuck on) • Failed thermostat	Step-Based Diagnostics (page 989)
110	18	Engine Coolant System below closed loop minimum Temperature	• Low coolant level • Failed Engine Coolant Temperature 1 (ECT1) sensor • Failed engine cooling fan (stuck on) • Failed thermostat	Step-Based Diagnostics (page 991)
1659	20	ECT1 below expected: Check Thermostat	• Failed thermostat	Pin-Point Diagnostics (page 993)
4752	4	EGR Cooler Efficiency: EGR Outlet Temp above expected	• Low coolant level • EGR cooler failure	Pin-Point Diagnostics (page 993)

Overview

Tools Required

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

SPN 110 FMI 17- Engine Coolant System below OBD monitoring temperature

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Minimum Onboard Diagnostics (OBD) coolant temperature not reached.	Engine Coolant Temperature 1 (ECT1) < 158°F (70°C)	Expected Engine Coolant Temperature > 158°F (70°C) Limp home mode inactive DPF regeneration inactive Power Take Off (PTO) inactive Barometric (BARO) pressure > 11 psi (75 kPa) Engine running > 30 seconds Ambient Air Temp (AAT) > -40°F (-40°C)	60 seconds

Fault Overview

Fault code sets when the signal from Engine Coolant Temperature 1 (ECT1) is not increasing as expected.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 110 FMI 3 and 4 (ECT1)

Fault Facts

In cold climates, operating the vehicle for extended periods of time at idle, or Without a winter front, may cause this fault to set.

Drive Cycle to Determine Fault Status

Drive Cycle 13 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Low coolant level
- Failed Engine Coolant Temperature 1 (ECT1) sensor
- Failed engine cooling fan (stuck on)
- Failed thermostat (stuck Open)

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 110 FMI 3,4 (ECT1). Is EST DTC list free of SPN 110 FMI 3,4?	Yes: Go to step 2. No: Repair SPN 110 FMI 3,4. After repairs are complete, retest for SPN 110 FMI 17.

Step	Action	Decision
2	Inspect coolant level. Check the coolant for correct level and condition. Is coolant filled to correct level?	Yes: Go to step 3. No: Perform Coolant Loss (page 135) test. After repairs are complete, retest for SPN 110 FMI 17.

Step	Action	Decision
3	Check for stuck on engine cooling fan. Using EST with ServiceMaxx™, go to Tests > KOER Tests > Engine Fan Test. Determine fans ability to maintain desired speeds. Is the fan operating properly?	Yes: Go to step 4. No: Repair or replace radiator fan assembly. After repairs are complete, retest for SPN 110 FMI 17.

Step	Action	Decision
4	Check for a failed ECT1 sensor. Using EST, perform the Coolant Control Valve Test. Go to Tests > KOER Tests > Coolant Control Valve Test. Set the Coolant Mixer Valve to On (95%) and run the engine at high idle. Are ECT1 and ECT2 within 10°F (6°C) of each other?	Yes: Replace Thermostats. After repairs are complete, retest for SPN 110 FMI 17. No: Replace Engine Coolant Temperature 1 (ECT1) sensor. After repairs are complete, retest for SPN 110 FMI 17.

NOTE: After performing all diagnostic steps, if SPN 110 FMI 17 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 110 FMI 18- Engine Coolant System below closed loop minimum temperature

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Minimum closed-loop coolant temperature not reached.	ECT1 < 50°F (10°C)	Calculated Engine Coolant Temperature > 50°F (10°C) Limp home mode inactive DPF regeneration inactive Power Take Off (PTO) inactive Barometric (BARO) pressure > 11 psi (75 kPa) Engine running > 30 seconds Ambient Air Temp (AAT) > -40° F (-40°C)	60 seconds

Fault Overview

Fault code sets when the signal from Engine Coolant Temperature 1 (ECT1) does not allow for closed-loop operation.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 110 FMI 3 and 4 (ECT1)

Fault Facts

In cold climates, operating the vehicle for extended periods of time at idle, or Without a winter front, may cause this fault to set.

Drive Cycle to Determine Fault Status

Drive Cycle 13 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Low coolant level
- Failed Engine Coolant Temperature 1 (ECT1) sensor
- Failed engine cooling fan (stuck on)
- Failed thermostat (stuck Open)

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 110 FMI 3,4 (ECT1). Is EST DTC list free of SPN 110 FMI 3,4?	Yes: Go to step 2. No: Repair SPN 110 FMI 3,4. After repairs are complete, retest for SPN 110 FMI 18.

Step	Action	Decision
2	Inspect coolant level. Check the coolant for correct level. Is coolant filled to correct level?	Yes: Go to step 3. No: Perform Coolant Loss (page 135) test. After repairs are complete, retest for SPN 110 FMI 18.

Step	Action	Decision
3	Check for a stuck on engine cooling fan. Using EST with ServiceMaxx™ go to Tests > KOER Tests > Engine Fan Test. Determine fans ability to maintain desired speeds. Is the fan operating properly?	Yes: Go to step 4. No: Repair or replace fan assembly. After repairs are complete, retest for SPN 110 FMI 18.

Step	Action	Decision
4	Check for a failed ECT1 sensor. Using EST, perform the Coolant Control Valve Test. Go to Tests > KOER Tests > Coolant Control Valve Test. Set the Coolant Mixer Valve to On (95%) and run the engine at high idle. Are ECT1 and ECT2 within 10°F (6°C) of each other?	Yes: Replace Thermostats. After repairs are complete, retest for SPN 110 FMI 18. No: Replace Engine Coolant Temperature 1 (ECT1) sensor. After repairs are complete, retest for SPN 110 FMI 18.

NOTE: After performing all diagnostic steps, if SPN 110 FMI 18 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

Cold Soak Sensor Compare Check With ServiceMaxx™ Software

NOTE: Temperature values need to be measured after 8 hours of cold soak.

1. Turn ignition switch ON, engine OFF.
2. Using ServiceMaxx™ software, open the Default session.
3. Compare Engine Coolant Temperature 1 (ECT1) to Engine Coolant Temperature 2 (ECT2). Sensor temperatures should be within 10°F (6°C) of each other.
   - If ECT1 is 10°F (6°C) or more above or below ECT2, check for poor circuitry going to the ECT1 sensor.
4. Verify engine fan is not stuck ON. Using EST with ServiceMaxx™ software, run Tests > KOER Test > Engine Fan Test.
5. Remove thermostats using procedure in the *Engine Service Manual*.
   - If the thermostat assemblies are stuck open, damaged, cracked, or not operating properly, replace them.
   - If engine fan or thermostat are not the cause, verify if code was set due to extended idle time in very cold ambient temperatures while running a large cabin heater.

ECT1 Sensor (Engine Coolant Temperature 1)

SPN	FMI	Condition	Possible Causes	Actions
110	2	ECT1 signal erratic, intermittent, or incorrect	• Aftermarket block heater installed • Failed Engine Coolant Temperature 1 (ECT1) sensor • High resistance in ECT1 circuit • High resistance in SIG GND circuit	Step-Based Diagnostics (page 996)
110	3	ECT1 signal Out of Range HIGH	• ECT1 signal OPEN or short to PWR • SIG GND circuit OPEN • Failed Engine Coolant Temperature 1 (ECT1) sensor	Pin-Point Diagnostics (page 999)
110	4	ECT1 signal Out of Range LOW	• ECT1 signal circuit short to GND • Failed Engine Coolant Temperature 1 (ECT1) sensor	Pin-Point Diagnostics (page 999)

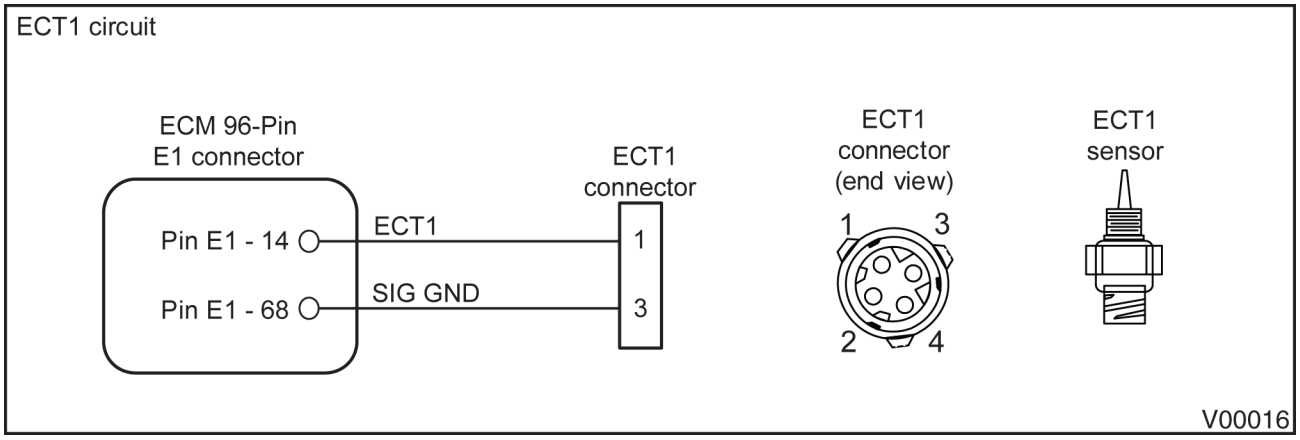

Figure 372 ECT1 sensor circuit diagram

NOTE: See latest version of N13 with SCR Engine and Aftertreatment Wiring Schematic Form 0000002203 for additional circuit information.

Overview

The ECT1 sensor is a thermistor that is supplied 5 V VREF at pin-1 from ECM pin E1-14. The sensor is grounded at pin-3 from ECM pin E1-68. As the coolant temperature increases the resistance of the thermistor decreases, causing the signal voltage to decrease.

Tools Required

- 180-Pin Breakout Box 00-00956-08
- 2010 MaxxForce 11 & 13 Harness Kit 00-01462-00
- 3-Banana Plug Harness ZTSE4498
- 500 Ohm Resistor Harness ZTSE4497
- Big Bore Terminal Test Probe Kit ZTSE4899
- Breakout Harness ZTSE4827
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

SPN 110 FMI 2 - ECT1 signal erratic, intermittent, or incorrect

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Engine Coolant Temperature 1 (ECT1) does not agree with other sensors.	ECT1 temperature difference from Intake Manifold Temperature (IMT) > 72°F (40°C)	Key-On Engine is cold soaked Difference between Engine Coolant Temperature 2 (ECT2), Ambient Air Temperature (AAT), and Exhaust Gas Temperature 1 (EGT1) at Key-On < 27°F (15°C)	0.1 seconds

Fault Overview

Fault code sets when Engine Coolant Temperature 1 (ECT1) differs from Intake Manifold Temperature (IMT) > 72°F (40°C) after a cold soak.

Malfunction Indicator Lamp (MIL) Reaction

This fault does not illuminate the MIL when active.

Associated Faults

SPN 110 FMI 0, 3, 4, 11, 15, 16, 17, 18 (ECT1)

Fault Facts

Diagnostic runs at initial Key-On after a minimum of an 8 hour cold soak.

Drive Cycle to Determine Fault Status

Drive Cycle 10 in 2013 HD-OBD Diagnostic Reference Manual.

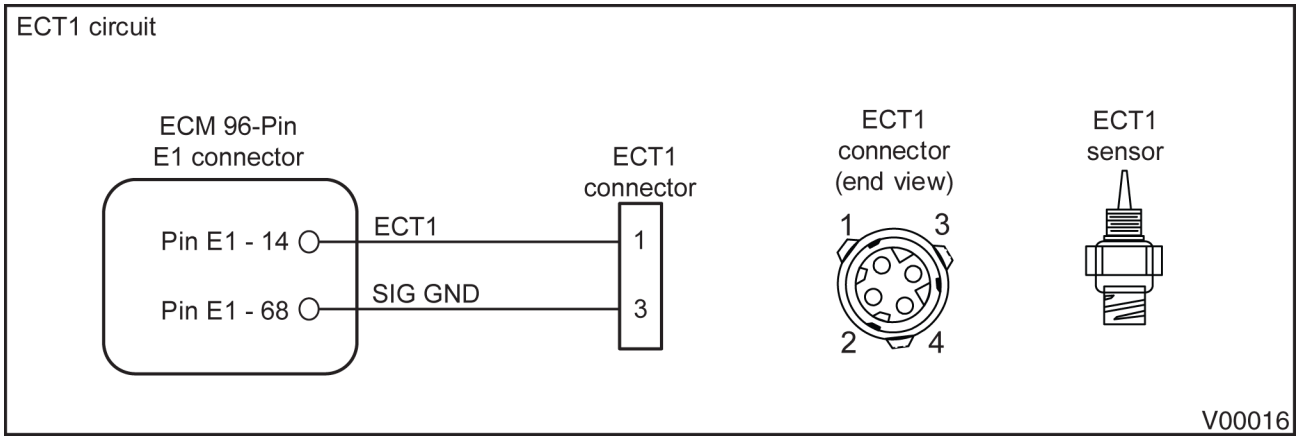

Figure 373 ECT1 sensor circuit diagram

Possible Causes

- Aftermarket block heater installed

- Failed ECT1 sensor
- High resistance in ECT1 circuit
- High resistance in SIG GND circuit

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 110 FMI 0, 3, 4, 11, 15, 16, 17 (ECT1). Is EST DTC list free of SPN 110 FMI 0, 3, 4, 11, 15, 16, 17?	Yes: Go to step 2. No: Repair SPN 110 FMI 0, 3, 4, 11, 15, 16, 17. After repairs are complete, retest for SPN 110 FMI 2.

Step	Action	Decision
2	Check ECT1 circuit for high resistance. Connect Breakout Harness ZTSE4827 to ECT1 harness and leave ECT1 disconnected. Connect 180-pin Breakout Box with ECM Breakout Harness 00-01468-00 to ECM E1 harness, and leave ECM disconnected. Key OFF, use a DMM to measure resistance from Breakout Harness ZTSE4827 pin-1 and 180-pin Breakout Box pin E1-14. Is resistance less than 5 ohms?	Yes: Go to step 3. No: Repair high resistance between ECT1 connector pin-1 and ECM connector pin E1-14. After repairs are complete, retest for SPN 110 FMI 2.

Step	Action	Decision
3	Check SIG GND circuit for high resistance. Connect Breakout Harness ZTSE4827 to ECT1 harness and leave ECT1 disconnected. Connect 180-pin Breakout Box with ECM Breakout Harness 00-01468-00 to ECM E1 harness, and leave ECM disconnected. Key OFF, use a DMM to measure resistance from Breakout Harness ZTSE4827 pin-3 and 180-pin Breakout Box pin E1-68. Is resistance less than 5 ohms?	Yes: Go to step 4. No: Repair high resistance between ECT1 connector pin-3 and ECM connector pin E1-68. After repairs are complete, retest for SPN 110 FMI 2.

NOTE: An aftermarket block heater could set this fault.

Step	Action	Decision
4	Check for a failed ECT1 sensor. If installed, disconnect aftermarket block heater. After performing drive cycle 10, using EST with ServiceMaxx™ software, open the Continuous Monitor session. Compare ECT1 with Intake Manifold Temperature (IMT). Is the ECT1 difference greater than 10°F (6°C) of IMT value?	Yes: Replace ECT1 sensor. After repairs are complete, retest for SPN 110 FMI 2. No: Aftermarket block heater causing fault code to set.

NOTE: After performing all diagnostic steps, if SPN 110 FMI 2 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

Pinpoint Diagnostics With ServiceMaxx™ Software

WARNING: To prevent personal injury or death, stay clear of rotating parts (belts and fan) and hot engine surfaces.

1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, run the Continuous Monitor test.
2. Monitor sensor voltage and verify an active DTC for this sensor.
   - If DTC is previously active, monitor signal while wiggling harness of suspect sensor. If circuit is interrupted, signal will spike and DTC will go active or pending.
   - If DTC is active, continue to Sensor Circuit Check.

NOTE: Inspect connectors for damaged pins, corrosion, or loose pins. Repair if necessary.

Sensor Circuit Check With ServiceMaxx™ Software

Connect Breakout Harness ZTSE4827 to ECT1 vehicle harness, and leave ECT1 sensor disconnected. Connect 180-Pin Breakout Box with ECM E1 and E2 harness between ECM E1 and E2 connectors and ECM. Turn ignition ON. Use a DMM to measure voltage.

Test Point	Specification	Comment– < Less than, > Greater than
Measure pin E1-71 to GND	4.5 V to 5 V	If < 4.5 V, check ECT1 signal circuit for short to GND.
Measure pin E1-71 to GND Short ECT1 pin-1 to GND	0 V	If > 0.25 V, check ECT1 signal circuit for OPEN. Do Harness Resistance Check (page 1000).
Measure pin E1-71 to GND Short ECT1 pin-1 to pin-3	0 V	If > 0.25 V, check SIG GND circuit for OPEN. Do Harness Resistance Check (page 1000).
Measure pin E1-71 to GND Short 500 Ω resistor between ECT1 pin-1 and pin-3	< 1.0 V	If > 1.0 V, check ECT1 signal circuit for short to PWR.
If checks are within specification, connect sensor and clear DTCs. If active code remains, replace ECT1 sensor.		

Connector Voltage Check Without ServiceMaxx™ Software

Connect Breakout Harness ZTSE4827 to ECT1 engine harness, and leave ECT1 sensor disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	4.5 V to 5 V	If < 4.5 V, check for short to GND.
3 to B+	B+	If < B+, check for short to PWR.

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM E1 and E2 harness to ECM E1 and E2 engine harness connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE4827 to ECT1 engine harness and leave ECT1 sensor disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
1 to E1-14	< 5 Ω	If > 5 Ω, check for OPEN circuit.
3 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
3 to E1-68	< 5 Ω	If > 5 Ω, check for OPEN circuit.

ECT2 Sensor (Engine Coolant Temperature 2)

SPN	FMI	Condition	Possible Causes	Actions
4076	2	ECT2 signal erratic, intermittent, or incorrect	• Aftermarket block heater installed • Failed ECT2 sensor • High resistance in ECT2 circuit • High resistance in SIG GND circuit	Step-Based Diagnostics (page 1003)
4076	3	ECT2 signal Out of Range HIGH	• ECT2 signal circuit OPEN or short to PWR • Failed ECT2 sensor	Pin-Point Diagnostics (page 1005)
4076	4	ECT2 signal Out of Range LOW	• ECT2 signal circuit short to GND • Failed ECT2 sensor	Pin-Point Diagnostics (page 1005)
4076	17	ECT2 signal stuck low, not warming up	• Failed Coolant Flow Valve (CFV) or circuit • Failed Coolant Mixer Valve (CMV) or circuit	Pin-Point Diagnostics (page 1005)

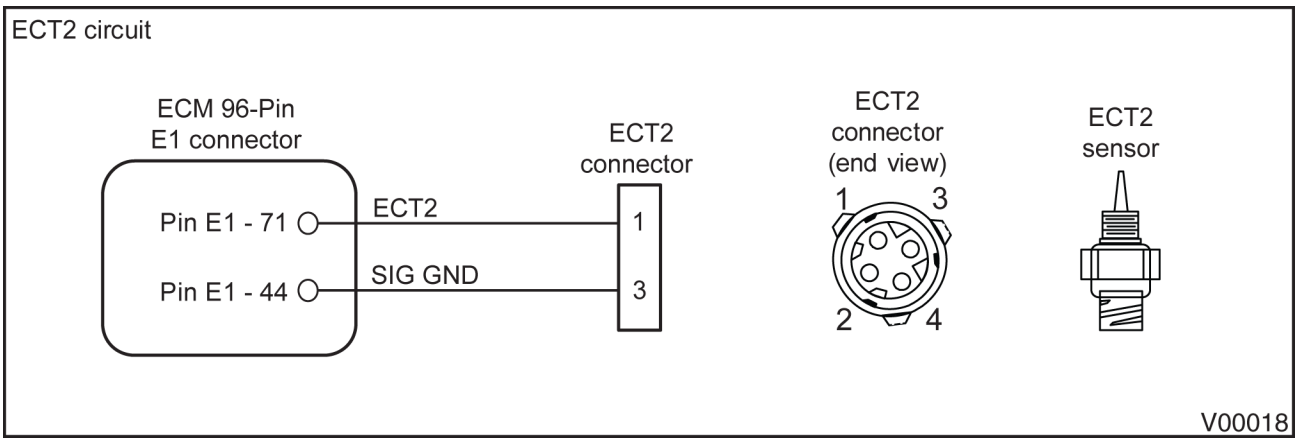

Figure 374 ECT2 sensor circuit diagram

NOTE: See latest version of N13 with SCR Engine and Aftertreatment Wiring Schematic Form 0000002203 for additional circuit information.

Overview

The ECT2 sensor is a thermistor that is supplied 5 V VREF at pin-1 from ECM pin E1-71. The sensor is grounded at pin-3 from ECM pin E1-44. As the coolant temperature increases the resistance of the thermistor decreases, causing the signal voltage to decrease.

Tools Required

- 180-Pin Breakout Box 00-00956-08
- 2010 MaxxForce 11 & 13 Harness Kit 00-01462-00
- Breakout Harness ZTSE4827
- 500 Ohm Resistor Harness ZTSE4497
- Big Bore Terminal Test Probe Kit ZTSE4899
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

SPN 4076 FMI 2 ECT2 signal erratic, intermittent, or incorrect

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Engine Coolant Temperature 2 (ECT2) does not agree with other sensors.	ECT2 difference from Inlet Air Temp (IAT) > 10°F (6°C)	Key-On Engine is cold soaked Difference between Engine Coolant Temperature 1 (ECT1), Ambient Air Temperature (AAT), and Exhaust Gas Temperature 1 (EGT1) at Key on < 27°F (15°C)	Immediate

Fault Overview

Fault code sets when Engine Coolant Temperature 2 (ECT2) differs from Inlet Air Temp (IAT) > 10°F (6°C) after a cold soak.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Fault Facts

Diagnostic runs at initial Key-On after a minimum of an 8 hour cold soak.

Drive Cycle to Determine Fault Status

Drive Cycle 10 then 4 in 2013 HD-OBD Diagnostic Reference Manual.

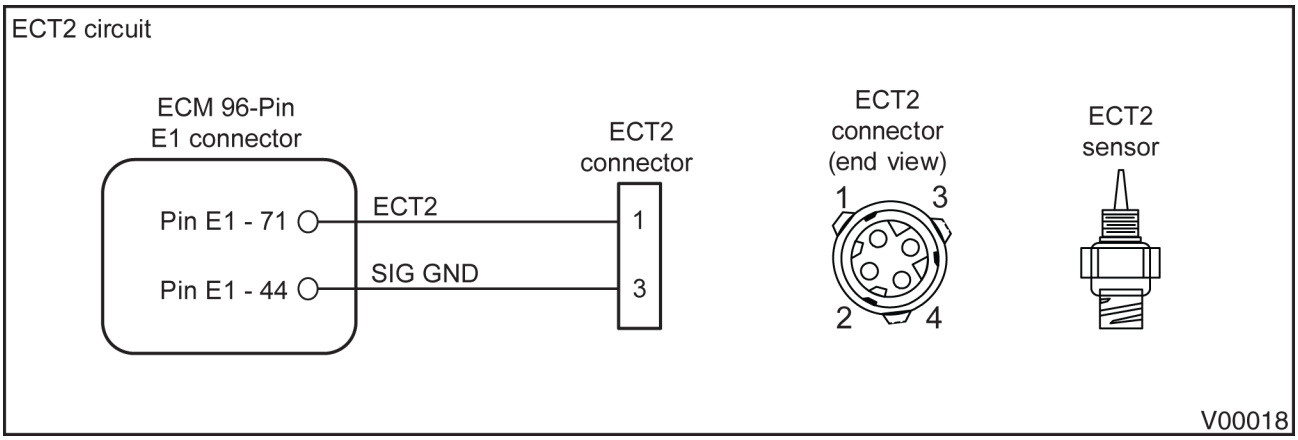

Figure 375 ECT2 sensor circuit diagram

Possible Causes

- Aftermarket block heater installed
- Failed ECT2 sensor
- High resistance in ECT2 circuit
- High resistance in SIG GND circuit

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 105 FMI 3, 4 and SPN 4076 FMI 0, 3, 4, 15, 17(ECT2). Is EST DTC list free of SPN 105 FMI 3, 4 and SPN 4076 FMI 0, 3, 4, 15, 17?	Yes: Go to step 2. No: Repair SPN 105 FMI 3, 4 and SPN 4076 FMI 0, 3, 4, 15, 17. After repairs are complete, retest for SPN 4076 FMI 2.

Step	Action	Decision
2	Check ECT2 circuit for high resistance. Connect Breakout Harness ZTSE4827 to ECT2 harness and leave ECT2 disconnected. Connect 180-pin Breakout Box with ECM Breakout Harness 00-01468-00 to ECM E1 harness, and leave ECM disconnected. Key OFF, use a DMM to measure resistance from Breakout Harness ZTSE4827 pin-1 and 180-pin Breakout Box pin E1-71. Is resistance less than 5 ohms?	Yes: Go to step 3. No: Repair high resistance between ECT2 connector pin-1 and ECM connector pin E1-71. After repairs are complete, retest for SPN 4076 FMI 2.

Step	Action	Decision
3	Check SIG GND circuit for high resistance. Connect Breakout Harness ZTSE4827 to ECT2 harness and leave ECT2 disconnected. Connect 180-pin Breakout Box with ECM Breakout Harness 00-01468-00 to ECM E1 harness , and leave ECM disconnected. Key OFF, use a DMM to measure resistance from Breakout Harness ZTSE4827 pin-3 and 180-pin Breakout Box pin E1-44. Is resistance less than 5 ohms?	Yes: Go to step 4. No: Repair high resistance between ECT2 connector pin-3 and ECM connector pin E1-44. After repairs are complete, retest for SPN 4076 FMI 2.

NOTE: An aftermarket block heater could set this fault.

Step	Action	Decision
4	Check for a failed ECT2 sensor. If installed, disconnect aftermarket block heater. After performing drive cycle 10, using ServiceMaxx™ software, open the Continuous Monitor session. Compare ECT2 with Inlet Air Temp (IAT). Is the ECT2 difference greater than 10°F (6°C) of IAT value?	Yes: Replace ECT2 sensor. After repairs are complete, retest for SPN 4076 FMI 2. No: Aftermarket block heater causing fault code to set.

NOTE: After performing all diagnostic steps, if SPN 4076 FMI 2 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

Pinpoint Diagnostics With ServiceMaxx™ Software

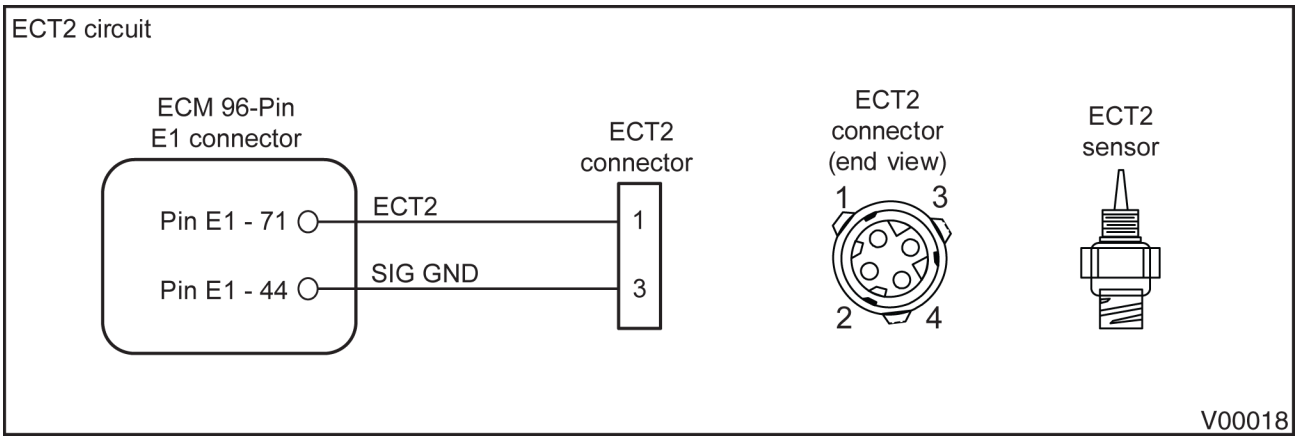

Figure 376 ECT2 sensor circuit diagram

WARNING: To prevent personal injury or death, stay clear of rotating parts (belts and fan) and hot engine surfaces.

1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, run the Continuous Monitor test.
2. Monitor sensor voltage and verify an active DTC for this sensor.
   - If DTC is previously active, monitor signal while wiggling harness of suspect sensor. If circuit is interrupted, signal will spike and DTC will go active or pending.
   - If DTC is active, continue to Cold Soak Sensor Compare Check.

NOTE: Inspect connectors for damaged pins, corrosion, or loose pins. Repair if necessary.

SPN 4076 FMI 16 – ECT2 signal does not agree with other sensors (Cold soak)

Cold Soak Sensor Compare Check With ServiceMaxx™ Software

NOTE: Temperature values need to be measured after 8 hours of cold soak.

1. Turn ignition switch ON, engine OFF.
2. Using ServiceMaxx™ software, open the Default session.
3. Compare ECT2, Engine Coolant Temperature 1 (ECT1), and Engine Oil Temperature (EOT). Sensor temperatures should be within 5 °C (10 °F) of each other.
   - If ECT2 is 5 °C (10 °F) above or below the ECT1 or EOT, check for poor circuitry going to the ECT2 sensor.
   - If circuits are within specification, replace ECT2 sensor.

Sensor Circuit Check With ServiceMaxx™ Software

Connect Breakout Harness ZTSE4827 to ECT2 connector and leave sensor disconnected. Connect 180-pin Breakout Box with ECM E1 and E2 harness between ECM E1 and E2 connectors and ECM. Turn ignition ON. Use a DMM to measure voltage.

Test Point	Specification	Comment– < Less than, > Greater than
Measure pin E1-14 to GND	4.5 V to 5 V	If <4.5 V, check ECT2 signal circuit for short to GND.
Measure pin E1-14 to GND Short ECT2 pin-1 to GND	0 V	If > 0.25 V, check ECT2 signal circuit for OPEN. Do Harness Resistance Check (page 1006).
Measure pin E1-14 to GND Short ECT2 pin-1 to pin-3	0 V	If > 0.25 V, check SIG GND circuit for OPEN. Do Harness Resistance Check (page 1006).
Measure pin E1-14 to GND Short 500 Ω resistor between ECT2 pin-1 and pin-3	< 1.0 V	If > 1.0 V, check ECT2 signal circuit for short to PWR.
If checks are within specification, connect sensor and clear DTCs. If active code remains, replace ECT2 sensor.		

Connector Voltage Check Without ServiceMaxx™ Software

Connect Breakout Harness ZTSE4827 to ECT2 engine harness, and leave ECT2 sensor disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	4.5 V to 5 V	If < 4.5 V, check for short to GND.
3 to B+	B+	If < B+, check for short to PWR.

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM E1 and E2 harness to ECM E1 and E2 engine harness connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE4827 to ECT2 engine harness, and leave ECT2 sensor disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
1 to E1-71	< 5 Ω	If > 5 Ω, check for OPEN circuit.
3 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
3 to E1-44	< 5 Ω	If > 5 Ω, check for OPEN circuit.

EFC (Engine Fan Control)– Two Speed and Variable

SPN	FMI	Condition	Possible Causes	Actions
647	3	EFC short to PWR	• EFC circuit short to PWR	Circuit Checks (page 1009)
647	4	EFC short to GND	• EFC circuit short to GND	Circuit Checks (page 1009)
647	5	EFC open load/circuit	• EFC circuit OPEN • EFC failure	Circuit Checks (page 1009)

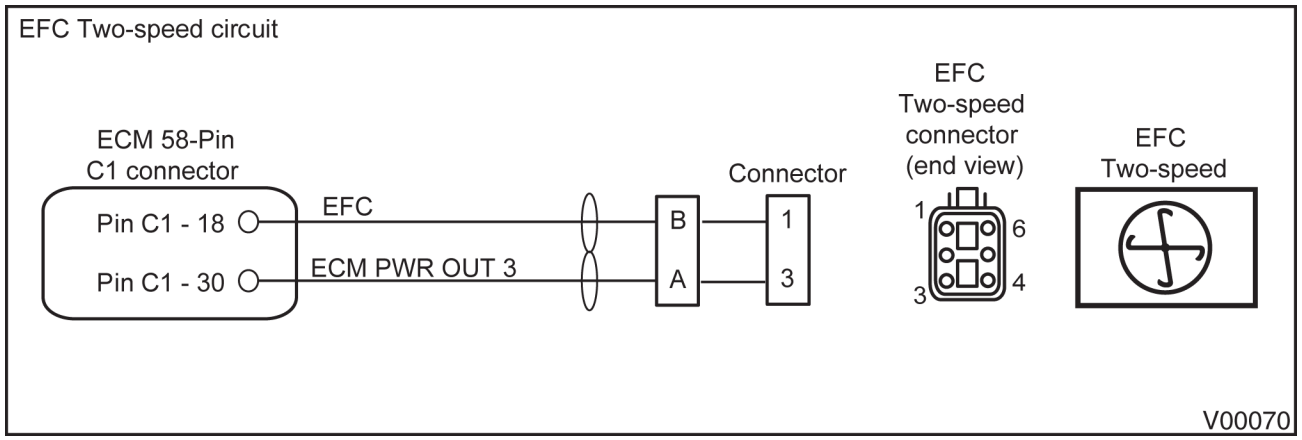

Figure 377 Two-Speed EFC circuit diagram

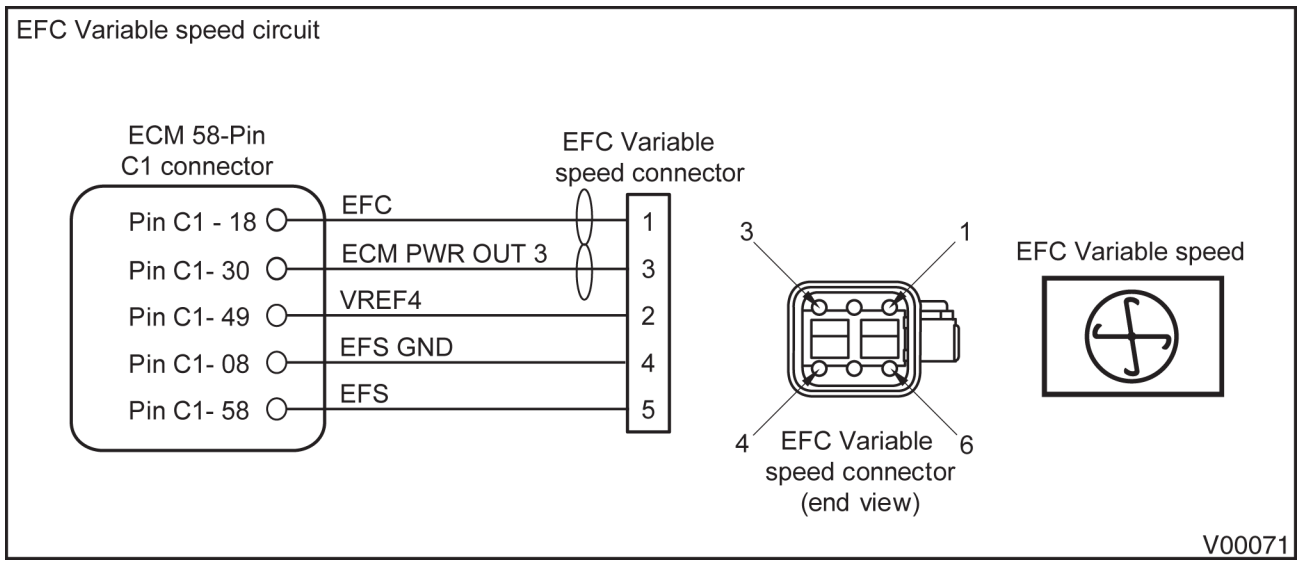

Figure 378 Variable EFC circuit diagram

Tools Required

- 180-Pin Breakout Box 00-00956-08
- 2010 MaxxForce 11 & 13 Harness Kit 00-01462-00
- 3-Banana Plug Harness ZTSE4498
- 500 Ohm Resistor Harness ZTSE4497
- Big Bore Terminal Test Probe Kit ZTSE4899
- Breakout Harness ZTSE4844 (EFAN)
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

Function Two-Speed EFC

The purpose of the engine fan is to force a higher airflow through the radiator when the A/C is on or the ECT goes above a set temperature.

The single-speed EFC is an air-actuated belt-driven on-off design. When engaged the fan runs at input sheave speed, and when disengaged the fan speed is close to zero.

The two-speed EFC is an air actuated belt-driven two-speed drive. When engaged the fan runs at input sheave speed, and when the air clutch releases, the fan runs at a nominal speed driven by a magnetic eddy current system that produces 300-400 rpm at idle and 700-900 rpm at when the engine rpm is 1900. This provides improved cooling and delays the fan coming on in high ambient temperatures or at high loads.

The difference between the single speed and two-speed EFCs is internal to the fan hub; both fans have identical external circuitry.

Function Variable EFC

The purpose of the variable electronic engine fan is to force a higher airflow through the radiator when the A/C is on or when the ECT goes above a set temperature.

The variable EFC is a direct-driven electronically controlled viscous fan drive. The fan has a number of operating regions.

- From 300 to 1100 engine rpm it is an on-off drive. Off is under 300 rpm, on is 99% of input speed.
- From 1100 to 1750 engine rpm it is a variable speed drive with an effective range of 800 rpm to 99% of input speed.
- From 1750 to 2150 engine rpm it is on-off again.
- From 2150 to 2450 engine rpm it is either off or 2625 rpm.
- Above 2450 engine rpm it is off.

EFC – Two Speed Sensor Circuit Operation

The default state of the EFC is ON. B+ is needed to turn the fan OFF.

ECM Pin C1-18 controls the EFC to shut off by supplying PWR to the EFC deactivating it.

EFC – Variable Sensor Circuit Operation

The default state of the EFC is ON. B+ is needed to turn the fan OFF.

ECM Pin C1-18 controls the EFC to shut off by supplying B+ to the EFC, deactivating it.

ECM Pin C1-58 controls EFC speed by supplying a Pulse Width Modulated (PWM) signal to the EFC.

Voltage Check at Single or Two-Speed EFC Connector - Actuator Test

NOTE: Ensure battery voltage is at or above 12 V, before running this procedure.

1. Connect Breakout Harness ZTSE4844 to single or two-speed EFC 2-pin connector, and leave EFC disconnected.
2. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests > KOEO Tests > Actuator Test. Select Engine Fan Control from the drop-down menu.
3. Command Engine Fan Control to 5%.
4. Use DMM to measure voltage.
5. Command Engine Fan Control to 95%.
6. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
A to GND	B+	If < B+, check for open in ECM PWR OUT 3.
B to GND	0 V to 0.25 V	If > 0.25 V, check for short to PWR.
Actuator Test - at 5% state		
B to GND	0 V to 0.25 V	If > 0.25 V, check for short to PWR.
Actuator Test - at 95% state		
B to GND	B+	If < B+, check EFC circuit for OPEN or short to GND. Do Harness Resistance Check.

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM C1 and C2 harness to ECM C1 and C2 vehicle harness connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE4484 to EFC vehicle harness, and leave EFC disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
C1-30 to A	< 5 Ω	If > 5 Ω, check for OPEN circuit between ECM pin C1-30 and EFC pin A.
C1-18 to B	< 5 Ω	If > 5 Ω, check for OPEN circuit between ECM pin C1-18 and EFC pin B.

If voltage and resistance measurements are within specification but DTC is still active, or EFC does not work, replace the EFC.

EGRT Sensor (Exhaust Gas Recirculation Temperature)

SPN	FMI	Condition	Possible Causes	Actions
412	1	EGRT signal stuck low, not warming up	• Biased EGRT sensor or circuit	Pin-Point Diagnostics (page 1012)
412	2	EGRT signal does not agree with other sensors	• Biased EGRT sensor or circuit	Pin-Point Diagnostics (page 1012)
412	3	EGRT signal Out of Range HIGH	• EGRT signal circuit OPEN or shorted to PWR • SIG GND circuit OPEN • Failed EGRT sensor	Pin-Point Diagnostics (page 1012)
412	4	EGRT signal Out of Range LOW	• EGRT signal circuit short to GND • Failed EGRT sensor or circuit	Pin-Point Diagnostics (page 1012)

EGRT circuit

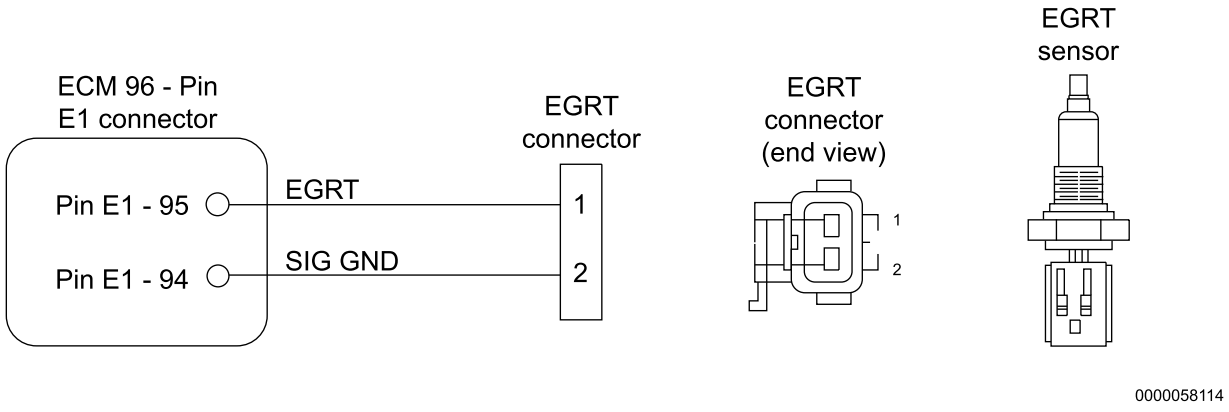

Figure 379 EGRT sensor circuit diagram

Tools Required

- 180-Pin Breakout Box 00-00956-08
- 2010 MaxxForce 11 & 13 Harness Kit 00-01462-00
- 3-Banana Plug Harness ZTSE4498
- 500 Ohm Resistor Harness ZTSE4497
- Big Bore Terminal Test Probe Kit ZTSE4899
- Breakout Harness ZTSE4760A (EGRT)
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software

- Interface cable (RP1210B compliant supporting J1939 and J1708)

Pinpoint Diagnostics With ServiceMaxx™ Software

WARNING: To prevent personal injury or death, stay clear of rotating parts (belts and fan) and hot engine surfaces.

1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, run the Continuous Monitor test.
2. Monitor sensor voltage and verify an active DTC for this sensor.
   - If DTC is previously active, monitor signal while wiggling harness of suspect sensor. If circuit is interrupted, signal will spike and DTC will go active or pending.
   - If DTC is active, continue to Cold Soak Sensor Compare Check.

NOTE: Inspect connectors for damaged pins, corrosion, or loose pins. Repair if necessary.

SPN 412 FMI 2 – EGRT signal does not agree with other sensors

Cold Soak Sensor Compare Check With ServiceMaxx™ Software

NOTE: Temperature values need to be measured after 8 hours of cold soak.

1. Turn ignition switch ON, engine OFF.
2. Using ServiceMaxx™ software, open the Default session.
3. Compare EGRT, Engine Coolant Temperature 1 (ECT1), and Engine Coolant Temperature 2 (ECT2). Sensor temperatures should be within 5 °C (10 °F) of each other.
   - If EGRT is 5 °C (10 °F) above or below the ECT1 and ECT2, check for poor circuitry going to the EGRT sensor.
   - If circuits are within specification, replace EGRT sensor.

Sensor Circuit Check With ServiceMaxx™ Software

Connect Breakout Harness ZTSE4760A to EGRT engine harness, and leave EGRT sensor disconnected. Turn ignition ON.

Test Point	Specification	Comment– < Less than, > Greater than
EST – Monitor EGRTv	4.5 – 5 V	If <4.5 V, check EGRT signal circuit for short to GND.
EST – Monitor EGRTv Short pin 1 to GND	0 V	If > 0.25 V, check EGRT signal circuit for OPEN. Do Harness Resistance Check.
EST – Monitor EGRTv Short pin 1 to 2	0 V	If > 0.25 V, check SIG GND circuit for OPEN. Do Harness Resistance Check.
EST – Monitor EGRTv Short 500 Ω resistor across pins 1 and 2	< 1.0 V	If > 1.0 V, check EGRT signal circuit for short to PWR.
If checks are within specification, connect sensor and clear DTCs. If active code remains, replace EGRT sensor.		

Connector Voltage Check Without ServiceMaxx™ Software

Connect Breakout Harness ZTSE4760A to EGRT engine harness, and leave EGRT sensor disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	5 V	If < 4.5 V, check EGRT signal circuit for short to GND.
2 to B+	B+	If < B+, check SIG GND for OPEN circuit.

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM E1 and E2 harness to ECM E1 and E2 vehicle harness connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE4760A to EGRT engine harness, and leave EGRT sensor disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
1 to E1-95	< 5 Ω	If > 5 Ω, check for OPEN circuit.
2 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
2 to E1-94	< 5 Ω	If > 5 Ω, check for OPEN circuit.

EGR (Exhaust Gas Recirculation) Valve

SPN	FMI	Condition	Possible Causes	Actions
27	0	EGRP fault: over temperature	• EGR overheated • Low coolant flow through EGR • Hot soaking after hard run and shut down • Low coolant level • Failed Coolant Flow Valve (CFV)	Pin-Point Diagnostics (page 1018)
27	3	EGRP signal Out of Range HIGH	• EGRP circuit short to PWR	Pin-Point Diagnostics (page 1020)
27	4	EGRP signal Out of Range LOW	• EGRP Open circuit • EGRP circuit short to GND	Pin-Point Diagnostics (page 1020)
27	7	EGRP does not agree with commanded position	• Sticking or failed EGR valve • EGRP circuit fault • EGRC circuit fault	Pin-Point Diagnostics (page 1020)
27	10	EGRP sensor feedback deviation during Cold Start Emissions Reduction (CSER)	• Sticking or failed EGR valve • EGRP circuit fault • EGRC circuit fault	Step-Based Diagnostics (page 1019)
2791	3	EGRC short to PWR	• EGRC circuit short to PWR	Pin-Point Diagnostics (page 1020)

2791	5	EGRC open load/circuit	• EGRC circuit OPEN • Failed EGR valve • Sensor or connector terminals: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing.	Pin-Point Diagnostics (page 1020)
2791	8	EGR valve not receiving ECM PWM signal	• Broken return spring in EGR valve • Sensor or connector terminals: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing.	Pin-Point Diagnostics (page 1020)

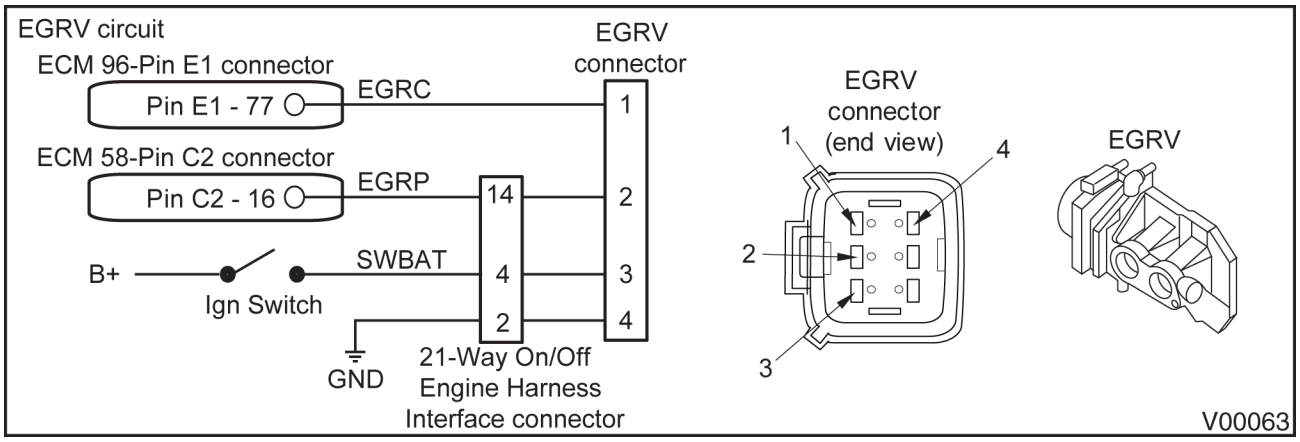

Figure 380 EGR Valve circuit diagram

Overview

The Exhaust Gas Recirculation (EGR) valve is used to control exhaust flow through the EGR cooler. The EGR valve contains a PWM controlled valve and Exhaust Gas Recirculation Position (EGRP) sensor. The Engine Control Module (ECM) sends a signal to the EGR valve to move to the desired position. The EGRP, located inside the EGR valve, monitors and provides an EGRV position signal to the ECM.

Tools Required

- 180-Pin Breakout Box 00-00956-08
- 2010 MaxxForce 11 & 13 Harness Kit 00-01462-00
- 3-Banana Plug Harness ZTSE4498
- 500 Ohm Resistor Harness ZTSE4497
- Big Bore Terminal Test Probe Kit ZTSE4899
- Breakout Harness ZTSE6016 (EGR Valve)
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

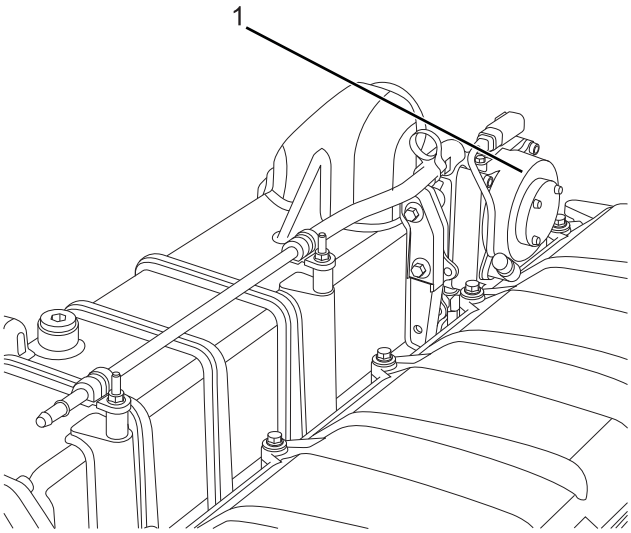

Figure 381 EGR Valve Location (Right Rear Engine)

1. Exhaust Gas Recirculation (EGR) valve

SPN 27 FMI 0 - EGRP fault: over temperature

1. Check coolant level. Low coolant level will cause coolant flow problems through the EGR cooler and valve.
2. Use ServiceMaxx™ software to run KOER Coolant Control Valve Test. Verify Coolant Flow Valve (CFV) and Coolant Mixer Valve (CMV) are working and interstage cooler is sending cooled coolant to the EGR valve.
3. Interview the driver. Ask the driver if they shut the engine down right after a hard run. Instruct them to let the engine idle for 5 minutes before shutting down. This will give the coolant a chance to cool the EGR valve.

SPN 27 FMI 10 - EGRP sensor feedback deviation during CSER

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Exhaust Gas Recirculation (EGR) Valve position sensor does not a agree with ECM commanded position	EGR valve position > 10% from commanded position	Key ON	10 seconds

Fault Overview

Fault code sets when feedback from the Exhaust Gas Recirculation Position (EGRP) does not agree with the Engine Control Module (ECM) commanded position during Cold Start Emission Reduction (CSER).

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 27 FMI 7.

Drive Cycle to Determine Fault Status

Drive Cycle 18 then 4 in 2013 HD-OBD Diagnostic Reference Manual.

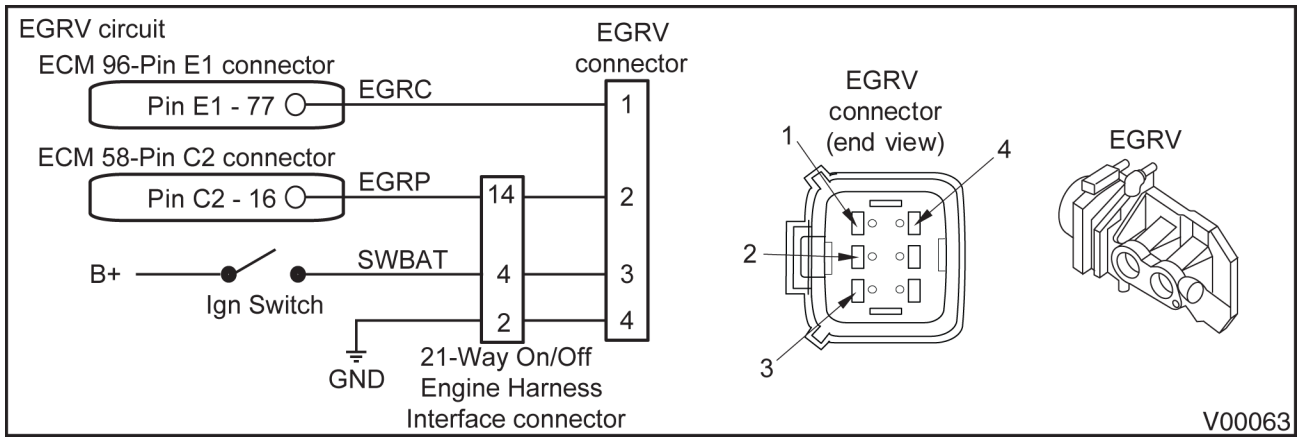

Figure 382 EGR Valve circuit diagram

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 27 FMI 3, SPN 27 FMI 4, and SPN 2791. Is SPN 27 FMI 10 the only fault code active?	Yes: Do Operational Voltage Check (page 1021). After repairs are complete, retest for SPN 27 FMI 10.
		No: Repair other fault code(s). After repairs are complete, retest for SPN 27 FMI 10.

NOTE: After doing all diagnostic steps, if SPN 27 FMI 10 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

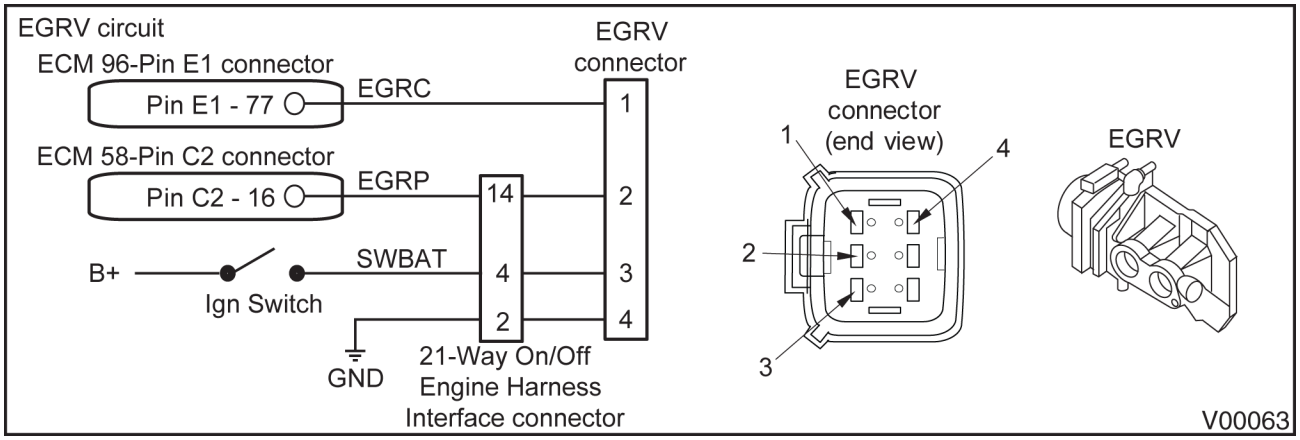

Figure 383 EGR Valve circuit diagram

Pinpoint Diagnostics With ServiceMaxx™ Software

WARNING: To prevent personal injury or death, stay clear of rotating parts (belts and fan) and hot engine surfaces.

1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, load the 2010 Actuator session.
2. Select EGR Position from the Actuator drop-down menu on the right side.
3. Command actuator movement by clicking on the Start Test button. Monitor EGR Position (EGRP) and EGR Valve CTL (EGRC).
   - If EGRP does not closely match EGRC, check EGR valve for mechanical problem.
   - If EGR valve does not move, continue to Connector Voltage Check.

Connector Voltage Check — EGR Valve Disconnected

Connect Breakout Harness ZTSE6016 to EGR valve engine harness, and leave EGR valve disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
4 to battery positive	B+	If < B+, check for OPEN in GND circuit. Do Harness Resistance Check (page 1022).
3 to GND	B+	If < B+, check for OPEN in SWBAT circuit or blown fuse.
2 to GND	5.0 V ± 1.0 V	If > 6 V, check for short to PWR. If < 4 V, check for OPEN or short to GND. Do Harness Resistance Check (page 1022).
1 to GND	0 V to 1 V	If > 1 V, check for short to PWR.
If measurements are within specifications, do Operational Voltage Check.		

Operational Voltage Check

NOTE: Ensure battery voltage is at or above 12 V, before running this procedure.

1. Connect Breakout Harness ZTSE6016 between EGR valve and engine harness.
2. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests > KOEO Tests > Actuator Test. Select EGR Position from the drop-down menu.
3. Command EGRP to 5%.
4. Use DMM to measure voltage.
5. Command EGRP to 95%.
6. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
2 to GND	5% = 3.0 V ± 1.0 V	If > 4.0 V, check for OPEN or short to PWR. If < 2.0 V, check for short circuit or failed EGR valve.
2 to GND	95% = 0.8 V ± 0.5 V	If > 1.3 V, check for OPEN or short to PWR.
1 to GND	5% = 7.5 V ± 1.0 V	If > 8.5 V, check for short to PWR. If < 6.5 V, check for short circuit.
1 to GND	95% = 0.5 V ± 0.5 V	If > 1.0 V, check for OPEN circuit or failed EGR valve.

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM E1 and E2 harness to ECM E1 and E2 engine harness connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE6016 to EGR engine harness, and leave EGR valve disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
1 to E1-77	< 5 Ω	If > 5 Ω, check for OPEN circuit.
2 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
2 to C2-16	< 5 Ω	If >5 Ω, check for OPEN circuit.
4 to GND	< 5 Ω	If > 5 Ω, check for OPEN circuit.

If voltage and resistance checks are within specifications, check for DTCs. If the DTC returns, replace the EGR valve.

EGR (Exhaust Gas Recirculation) System Monitor

SPN	FMI	Condition	Possible Causes	Actions
3058	10	Engine did not go into Closed loop EGR control when expected	• Biased O_2 sensor or circuit • O_2 heater or circuit • Biased BARO sensor or circuit • EGR valve or circuit failure • Intake Throttle Valve (ITV) or circuit failure	Step-Based Diagnostics (page 1024)

Fault Overview

Without the O_2 sensor operating at the expected temperature, the vehicle will not operate the EGRV in a closed loop system. Open loop operation occurs when the engine operates the EGRV based on calculations rather than on feedback from the O_2 sensor. Operating the EGRV before the engine reaches operating temperature and establishes closed loop operation could cause performance issues.

Tools Required

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

SPN 3058 FMI 10 - Engine Did Not Go Into Closed Loop EGR Control When Expected

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Monitor the time it takes for EGR to enter closed loop control	Time to warm-up > calculated time based on (Engine Coolant Temperature 1 (ECT1) sensor at engine start) x (barometric pressure)	Cold Ambient Protection (CAP) inactive Key ON Engine Compression brake inactive Engine in required speed / load operating conditions	0.05 Seconds

Fault Overview

Fault code sets when O_2 sensor is unable to reach required operating temperature or EGR valve failed to react to enter open loop operation. Open loop operation occurs when the engine operates the EGRV based on calculations rather than on feedback from the O_2. Operating the EGRV before the engine reaches operating temperature and establishes closed loop operation could cause performance issues.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN's 27, 51, 108, 724, 2791, 3223, 3464, 4765, 5542, and 5543.

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for other fault codes. Is SPN 3058 FMI 10 the only fault code active?	Yes: Go to step 2.
		No: Repair other fault code(s). After repairs are complete, retest for SPN 3058 FMI 10.

Step	Action	Decision
2	Inspect air intake system, exhaust system, and air filter for restrictions, air leaks, or physical damage. Also, inspect the fuel system from fuel tank to AFTFI valve for leaks or physical damage. Is air intake system, exhaust system, fuel system and air filter free of restrictions, leaks, and physical damage?	Yes: Go to step 3.
		No: Repair restrictions, air leaks , fuel leaks or physical damage. After repairs are complete, retest for SPN 3058 FMI 10.

Step	Action	Decision
3	Using EST with ServiceMaxx™ software, run Continuous Monitor session and monitor Diesel Oxidation Catalyst Inlet Temperature (DOCIT) sensor (wiggle test may be necessary if code is inactive or pending). Is DOCIT sensor within specifications?	Yes: Go to step 4. No: Do Hot Run Aftertreatment Sensor Compare Check Test (page 96). After repairs are complete, retest for SPN 3058 FMI 10.

Step	Action	Decision
4	Using EST with ServiceMaxx™ software, run Continuous Monitor session and monitor Oxygen (O2S) sensor (wiggle test may be necessary if code is inactive or pending). Is O2S sensor within specifications?	Yes: Go to step 5. No: Do O2S Biased Sensor or Circuit Check (page 1332) and retest for SPN 3058 FMI 10.

Step	Action	Decision
5	Using EST with ServiceMaxx™ software, run Continuous Monitor session and monitor Barometric Pressure (BARO) sensor. See Key-On Engine-Off (KOEO) Barometric Pressure (page 1535) for sensor value (wiggle test may be necessary if code is inactive or pending). Is the BARO sensor within specifications?	Yes: Go to step 6. No: Do ECM Self-Diagnostics (page 984) and retest for SPN 3058 FMI 10.

Step	Action	Decision
6	Using EST with ServiceMaxx™ software, see Exhaust Gas Recirculation (EGR) Valve Pinpoint Diagnostics (page 1020) for EGR Valve Actuator command test. Is EGR Valve within specifications?	Yes: Go to step 7. No: Correct EGR Valve issues and retest for SPN 3058 FMI 10.

Step	Action	Decision
7	Using EST with ServiceMaxx™ software, see Engine Throttle Valve (ETV) Pinpoint Diagnostics (page 1039) for ETV Valve Actuator command test. Is ETV Valve within specifications?	Yes: Go to step 8. No: Correct ETV issues and retest for SPN 3058 FMI 10.

Step	Action	Decision
8	Using EST with ServiceMaxx™ software, do Exhaust Back Pressure Valve (EBPV) test (page 213) for EBPV Actuator test. Is EBPV within specifications?	Yes: Verify each step was completed correctly and the proper decision was made. Notify supervisor for further action. No: Correct EBPV issues and retest for SPN 3058 FMI 10.

NOTE: After performing all diagnostic steps, if SPN 3058 FMI 10 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

EOL Sensor (Engine Oil Level)

SPN	FMI	Condition	Possible Causes	Actions
98	3	EOL signal Out of Range HIGH	• EOL signal circuit OPEN or short to PWR • SIG GND circuit OPEN • Failed EOL sensor	Pin-Point Diagnostics (page 1029)
98	4	EOL signal Out of Range LOW	• EOL signal circuit short to GND • Failed EOL sensor	Pin-Point Diagnostics (page 1029)
1135	3	EOT2 signal Out of Range HIGH	• EOT2 signal circuit OPEN or short to PWR • SIG GND circuit OPEN • Failed EOL sensor	Pin-Point Diagnostics (page 1029)
1135	4	EOT2 signal Out-of-Range LOW	• EOL signal circuit short to GND • Failed EOL sensor	Pin-Point Diagnostics (page 1029)

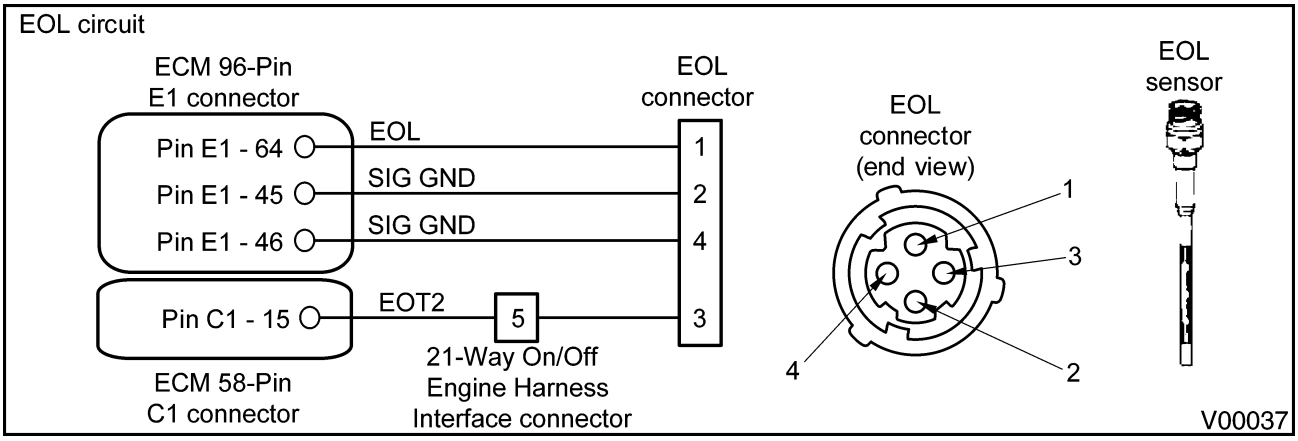

Figure 384 EOL sensor circuit diagram

Tools Required

- 180-Pin Breakout Box 00-00956-08
- 2010 MaxxForce 11 & 13 Harness Kit 00-01462-00
- 3-Banana Plug Harness ZTSE4498
- 500 Ohm Resistor Harness ZTSE4497
- Big Bore Terminal Test Probe Kit ZTSE4899
- Breakout Harness ZTSE4827 (EOL)
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

Pinpoint Diagnostics With ServiceMaxx™ Software

WARNING: To prevent personal injury or death, stay clear of rotating parts (belts and fan) and hot engine surfaces.

1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, run the Continuous Monitor session.
2. Monitor sensor voltage. Verify an active DTC for the sensor.
   - If DTC is inactive, monitor the signal while wiggling the connector and all wires at suspected location. If the circuit is interrupted, the signal will spike and the DTC will go active.
   - If DTC is active, continue to Sensor Circuit Check.

NOTE: Inspect connectors for damaged pins, corrosion, loose pins. Repair if necessary.

Sensor Circuit Check With ServiceMaxx™ Software

Connect Breakout Harness ZTSE4827 to EOL vehicle harness, and leave EOL sensor disconnected. Turn ignition ON..

Test Point	Specification	Comment– < Less than, > Greater than
EST – Monitor EOLv	4.5 V – 5 V	If < 4.5 V, check EOL circuit for short to GND.
EST – Monitor EOT2v	4.5 V – 5 V	If < 4.5 V, check EOT2 circuit for short to GND.
EST – Monitor EOLv Short pin 1 to GND	0 V	If > 0.5 V, check EOL circuit for OPEN. Do Harness Resistance Check.
EST – Monitor EOLv Short pin 1 to 4	0 V	If > 0.5 V, check SIG GND circuit for OPEN. Do Harness Resistance Check.
EST – Monitor EOT2v Short pin 3 to GND	0 V	If > 0.5 V, check EOT2 circuit for OPEN. Do Harness Resistance Check.
EST – Monitor EOT2v Short pin 2 to 3	0 V	If > 0.5 V, check SIG GND circuit for OPEN. Do Harness Resistance Check.

If checks are within specification, connect sensor and clear DTCs. If active code remains, replace EOL sensor.

Connector Voltage Check Without ServiceMaxx™ Software

Connect Breakout Harness ZTSE4827 to EOL vehicle harness, and leave EOL sensor disconnected. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	5 V ± 5 V	If > 5.5 V, check EOL for short to PWR. If < 4.5 V, check EOL for OPEN or short to GND. Do Harness Resistance Check.
3 to GND	5 V	If > 5.5 V, check EOT2 for short to PWR. If < 4.5 V, check EOT2 for OPEN or short to GND. Do Harness Resistance Check.
2 to B+	B+	If < B+, check SIG GND for OPEN circuit.
4 to B+	B+	If < B+, check SIG GND for OPEN circuit.

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM E1 and E2 harness to ECM E1 and E2 vehicle harness connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE4827 to EOL vehicle harness, and leave EOL sensor disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	> 1k Ω	If < 1k Ω, check for short GND in EOL circuit.
1 to E1-64	< 5 Ω	If > 5 Ω, check for OPEN in EOL circuit.
2 to E1-45	< 5 Ω	If > 5 Ω, check for OPEN in SIG GND circuit.
3 to GND	>1k Ω	If < 1k Ω, check for short to GND in EOT2 circuit.
3 to C1-15	< 5 Ω	If > 5 Ω, check for OPEN in EOT2 circuit.
4 to E1-46	< 5 Ω	If > 5 Ω, check for OPEN in SIG GND circuit.

EOP Sensor (Engine Oil Pressure)

SPN	FMI	Condition	Possible Causes	Actions
100	3	EOP signal Out of Range HIGH	• EOP signal circuit OPEN or short to PWR • SIG GND circuit OPEN • Failed EOP sensor	Pin-Point Diagnostics (page 1032)
100	4	EOP signal Out of Range LOW	• EOP signal circuit short to GND • VREF5 circuit OPEN • Failed EOP sensor	Pin-Point Diagnostics (page 1032)

EOP circuit

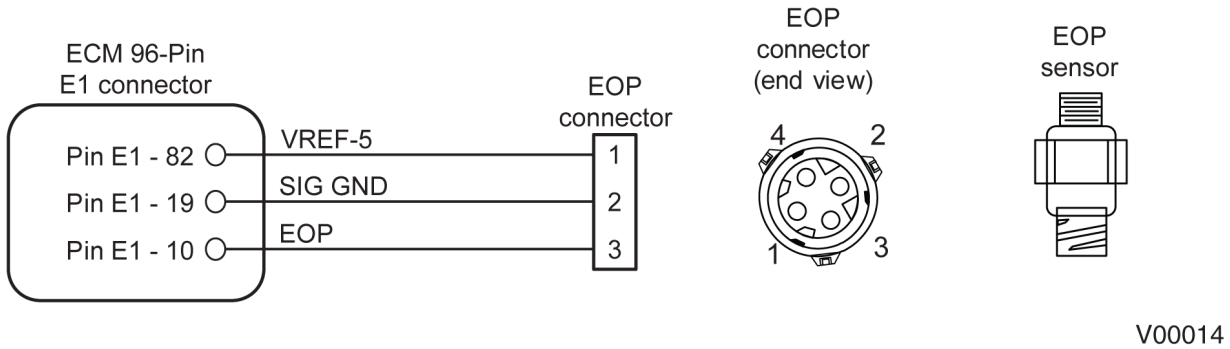

Figure 385 EOP sensor circuit diagram

Tools Required

- 180-Pin Breakout Box 00-00956-08
- 2010 MaxxForce 11 & 13 Harness Kit 00-01462-00
- 3-Banana Plug Harness ZTSE4498
- 500 Ohm Resistor Harness ZTSE4497
- Big Bore Terminal Test Probe Kit ZTSE4899
- Breakout Harness ZTSE4882 (EOP)
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

Pinpoint Diagnostics With ServiceMaxx™ Software

WARNING: To prevent personal injury or death, stay clear of rotating parts (belts and fan) and hot engine surfaces.

1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, run the Continuous Monitor test.
2. Monitor sensor voltage and verify an active DTC for this sensor.
   - If DTC is previously active, monitor signal while wiggling harness of suspect sensor. If circuit is interrupted, signal will spike and DTC will go active or pending.
   - If DTC is active, continue to Sensor Circuit Check.

NOTE: Inspect connectors for damaged pins, corrosion, or loose pins. Repair if necessary.

Sensor Circuit Check

Connect Breakout Harness ZTSE4882 to EOP engine harness, and leave EOP sensor disconnected. Turn ignition ON.

Test Point	Specification	Comment – < Less than, > Greater than
EST – Monitor EOPv	5.0 V ± 0.5 V	If < 4.5 V, check EOP signal circuit for short to GND
DMM – Measure volts 1 to GND	5.0 V ± 0.5 V	If > 5.5 V, check VREF5 circuit for short to PWR. If < 4.5 V, check VREF5 circuit for OPEN or short to GND. Do Harness Resistance Check (page 1033).
DMM – Measure voltage 1 to 2	5 V ± 0.5 V	If < 4.5 V, check SIG GND circuit for OPEN. Do Harness Resistance Check (page 1033).
EST – Monitor EOPv Short across Breakout Harness ZTSE4882 pins 2 and 3	0 V	If > 0.5 V, check EOP signal circuit for OPEN. Do Harness Resistance Check (page 1033).
If checks are within specification, connect sensor and clear DTCs. If active DTC remains, replace EOP sensor.		

Connector Voltage Check

Connect Breakout Harness ZTSE4882 to EOP engine harness, and leave EOP sensor disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	5 V ± 0.5 V	If > 5.5 V, check VREF5 circuit for short to PWR. If < 4.5 V, check VREF5 circuit for OPEN or short to GND. Do Harness Resistance Check (page 1033).
2 to GND	0 V	If > 0.25V, check SIG GND circuit for short to PWR.
3 to GND	5 V ± 0.5 V	If < 4.5 V, check EOP signal circuit for short to GND.

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM E1 and E2 harness to ECM E1 and E2 vehicle harness connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE4882 to EOP engine harness, and leave EOP sensor disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	> 1k Ω	If < 1k Ω, check for short to GND.
1 to E1-82	< 5 Ω	If > 5 Ω, check for OPEN circuit.
2 to GND	> 1k Ω	If < 1k Ω, check for short to GND.
2 to E1-19	< 5 Ω	If > 5 Ω, check for OPEN circuit.
3 to GND	> 1k Ω	If < 1k Ω, check for short to GND.
3 to E1-10	< 5 Ω	If > 5 Ω, check for OPEN circuit.

EOT Sensor (Engine Oil Temperature)

SPN	FMI	Condition	Possible Causes	Action
175	3	EOT signal Out of Range High	• EOT signal circuit OPEN or short to PWR • SIG GND circuit OPEN • Failed EOT sensor	Pin-Point Diagnostics (page 1035)
175	4	EOT signal Out of Range LOW	• EOT signal circuit short to GND • Failed EOT sensor	Pin-Point Diagnostics (page 1035)

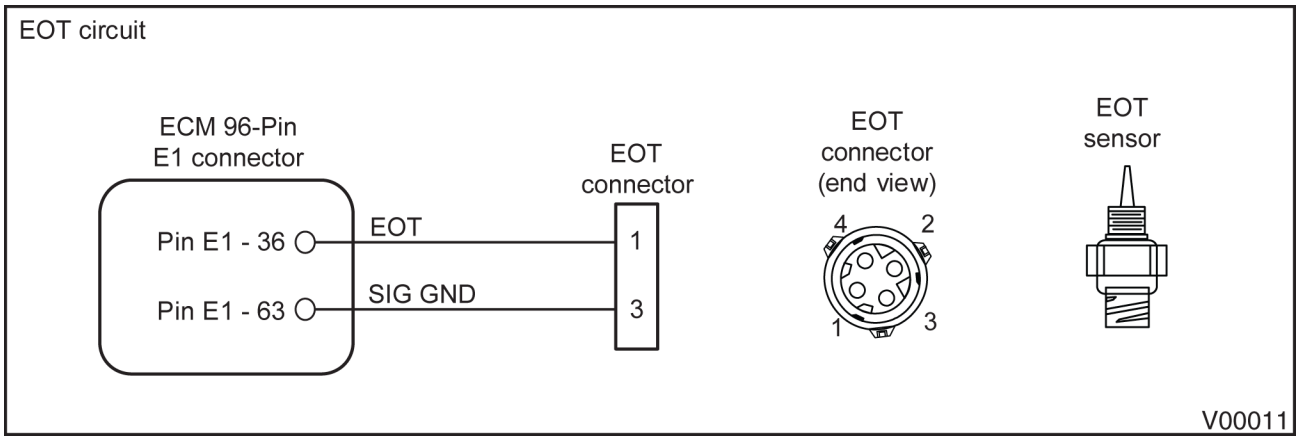

Figure 386 EOT sensor circuit diagram

Tools Required

- 180-Pin Breakout Box 00-00956-08
- 2010 MaxxForce 11 & 13 Harness Kit 00-01462-00
- 3-Banana Plug Harness ZTSE4498
- 500 Ohm Resistor Harness ZTSE4497
- Big Bore Terminal Test Probe Kit ZTSE4899
- Breakout Harness ZTSE4827 (EOT)
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

Pinpoint Diagnostics With ServiceMaxx™ Software

WARNING: To prevent personal injury or death, stay clear of rotating parts (belts and fan) and hot engine surfaces.

1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, run the Continuous Monitor test.
2. Monitor sensor voltage and verify an active DTC for this sensor.
   - If DTC is previously active, monitor signal while wiggling harness of suspect sensor. If circuit is interrupted, signal will spike and DTC will go active or pending.
   - If DTC is active, continue to Sensor Circuit Check.

NOTE: Inspect connectors for damaged pins, corrosion, or loose pins. Repair if necessary.

Sensor Circuit Check With ServiceMaxx™ Software

Connect Breakout Harness ZTSE4827 to EOT engine harness, and leave EOT sensor disconnected. Turn ignition ON.

Test Point	Specification	Comment– < Less than, > Greater than
EST – Monitor EOTv	4.5 V to 5 V	If < 4.5 V, check EOT signal circuit for short to GND.
EST – Monitor EOTv Short pin 1 to GND	0 V	If > 0.25 V, check EOT signal circuit for OPEN. Do Harness Resistance Check (page 1036).
EST – Monitor EOTv Short pin 1 to 3	0 V	If > 0.25 V, check SIG GND circuit for OPEN. Do Harness Resistance Check (page 1036).
EST – Monitor EOTv Short 500 Ω resistor across pins 1 and 3	< 1.0 V	If > 1.0 V, check EOT signal circuit for short to PWR.
If checks are within specification, connect sensor and clear DTCs. If active code remains, replace EOT sensor.		

Pinpoint Diagnostics Without ServiceMaxx™ Software

Connect Breakout Harness ZTSE4827 to EOT engine harness, and leave EOT sensor disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	4.5 V to 5 V	If < 4.5 V, check for short to GND.
3 to B+	B+	If < B+, check for short to PWR.

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM E1 and E2 harness to ECM E1 and E2 vehicle harness connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE4827 to EOT engine harness, and leave EOT sensor disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
1 to E1-36	< 5 Ω	If > 5 Ω, check for OPEN circuit.
3 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
3 to E1-63	< 5 Ω	If > 5 Ω, check for OPEN circuit.

ETV (Engine Throttle Valve)

SPN	FMI	Condition	Possible Causes	Actions
51	0	ETP fault: over temperature	• ETV internal failure	Pin-Point Diagnostics (page 1039)
51	3	ETP signal Out of Range HIGH	• ETP circuit short to PWR	Pin-Point Diagnostics (page 1039)
51	4	ETP signal Out of Range LOW	• ETP Open Circuit • ETP circuit short to GND	Pin-Point Diagnostics (page 1039)
51	7	ETP does not agree with commanded position	• Sticking or failed ETV • ETP circuit fault • ETC circuit fault	Pin-Point Diagnostics (page 1039)
51	10	ETP sensor feedback deviation during Cold Start Emissions Reduction (CSER)	• Sticking or failed ETV • ETP circuit fault • ETC circuit fault	Step-Based Diagnostics (page 1042)
3464	3	ETC short to PWR	• ETC circuit short to PWR • Failed ETV	Pin-Point Diagnostics (page 1039)
3464	5	ETC open load/circuit	• ETC circuit OPEN • Failed ETV	Pin-Point Diagnostics (page 1039)
3464	8	ETC not receiving command from ECM	• ETC circuit fault	Pin-Point Diagnostics (page 1039)

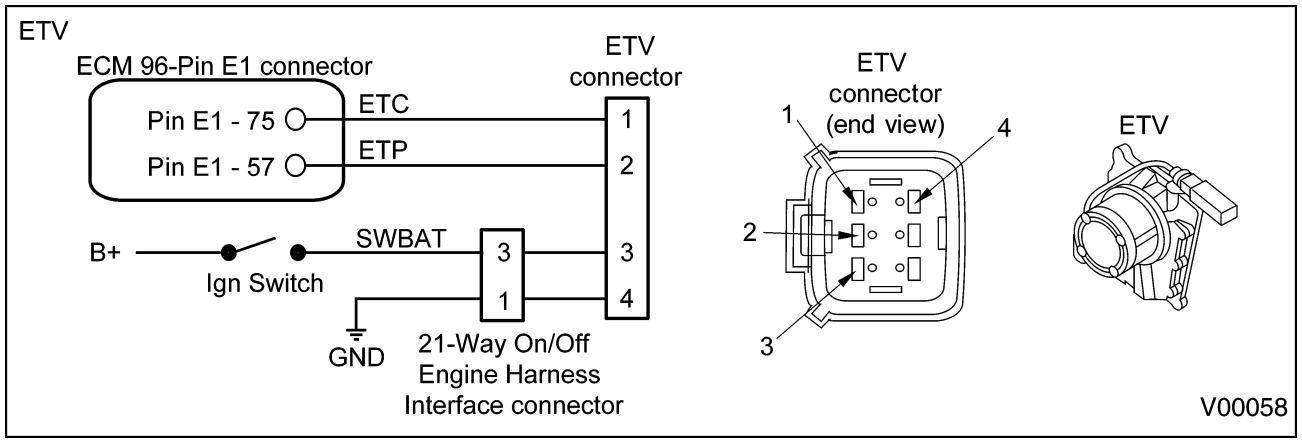

Figure 387 ETV valve circuit diagram

Overview

The Engine Throttle Valve (ETV) controls the flow of fresh air (boosted and cooled), and Exhaust Gas Recirculation (EGR) gases through the intake manifold. The ETV contains a variable-position actuator that moves an internal butterfly valve. The Engine Control Module (ECM) sends a signal to the ETV to move to the desired position through the Engine Throttle Control (ETC) circuit. The Engine Throttle Position (ETP) sensor, located inside the ETV, monitors ETV position and provides a signal to the ECM.

Tools Required

- 180-Pin Breakout Box 00-00956-08
- 2010 MaxxForce 11 & 13 Harness Kit 00-01462-00
- 3-Banana Plug Harness ZTSE4498
- 500 Ohm Resistor Harness ZTSE4497
- Big Bore Terminal Test Probe Kit ZTSE4899
- Breakout Harness ZTSE6016 (ETV)
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

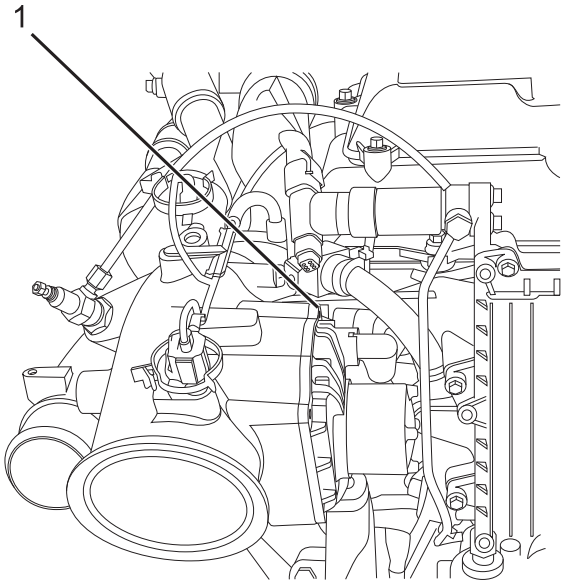

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Figure 388 ETV Location

1. Engine Throttle Valve (ETV)

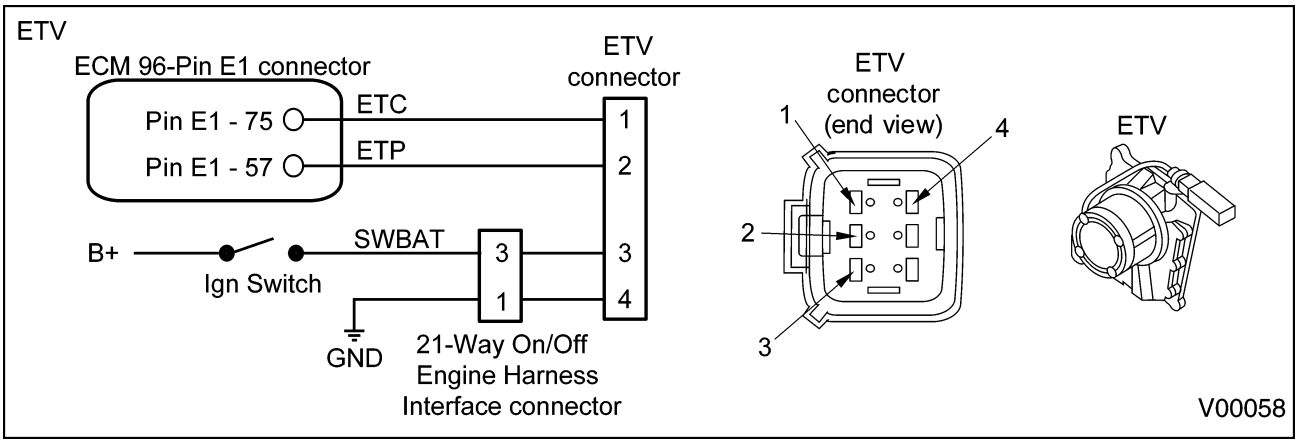


Figure 389 ETV valve circuit diagram

Pinpoint Diagnostics With ServiceMaxx™ Software

WARNING: To prevent personal injury or death, stay clear of rotating parts (belts and fan) and hot engine surfaces.

1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests > KOEO Tests > Actuator Test.
2. Select ETV Position from the Actuator drop-down menu on the right side.
3. Command actuator movement by clicking on the Start Test button. Monitor Engine Throttle Position (ETP) and Engine Throttle CTL (ETC).
   - If ETP does not closely match ETC, check ETV for mechanical problem.
   - If ETV does not move, continue to Connector Voltage Check.

Connector Voltage Check — ETV Disconnected

Connect Breakout Harness ZTSE6016 to ETV engine harness, and leave ETV disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
4 to battery positive	B+	If < B+, check for OPEN in GND circuit. Do Harness Resistance Check (page 1041).
3 to GND	B+	If < B+, check for OPEN in SWBAT circuit or blown fuse.
2 to GND	12 V ± 2.0 V	If < 10 V, check for OPEN or short to GND. Do Harness Resistance Check (page 1041).
1 to GND	0 V to 1 V	If > 1 V, check for short to power.
If measurements are within specifications, do Operational Voltage Check.		

Operational Voltage Check

NOTE: Ensure battery voltage is at or above 12 V, before running this procedure.

1. Connect Breakout Harness ZTSE6016 between ETV and engine harness.
2. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests > KOEO Tests > Actuator Test. Select ETV Position from the drop-down menu.
3. Command ETVP to 5%.
4. Use DMM to measure voltage.
5. Command ETVP to 95%.
6. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
2 to GND	5% = 3.0 V ± 1.0 V	If > 4.0 V, check for OPEN or short to PWR.
		If < 2.0 V, check for short circuit or failed ETV.
2 to GND	95% = 0.8 V ± 0.5 V	If > 1.3 V, check for OPEN or short to PWR.
1 to GND	5% = 7.5 V ± 1.0 V	If > 8.5 V, check for short to PWR.
		If < 6.5 V, check for short circuit.
1 to GND	95% = 0.5 V ± 0.5 V	If > 1.0 V, check for OPEN circuit or failed ETV.

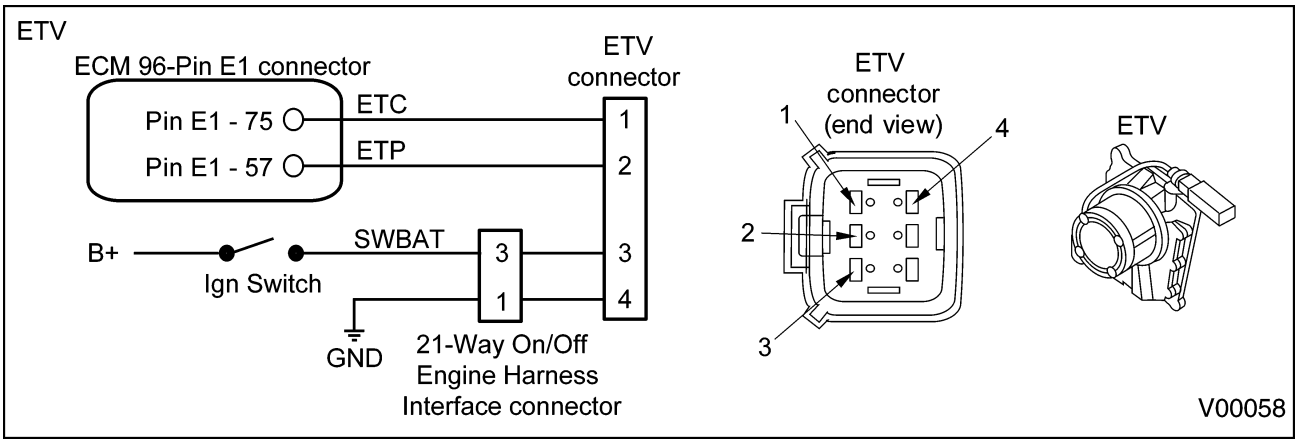


Figure 390 ETV valve circuit diagram

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM E1 and E2 harness to ECM E1 and E2 engine harness connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE6016 to ETV engine harness, and leave APP sensor disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
1 to E1-75	< 5 Ω	If > 5 Ω, check for OPEN circuit.
2 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
2 to E1-57	< 5 Ω	If > 5 Ω, check for OPEN circuit.
4 to GND	< 5 Ω	If > 5 Ω, check for OPEN circuit.
If voltage and resistance checks are within specifications, check for DTCs. If the DTC returns, replace the ETV.		

SPN 51 FMI 10 - ETP sensor feedback deviation during CSER

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Engine Throttle Position (ETP) sensor does not a agree with ECM commanded position	Engine Throttle Valve (ETV) position > 10% from commanded position	Key ON	8 seconds

Fault Overview

Fault code sets when feedback from the Engine Throttle Position (ETP) sensor does not agree with the Engine Control Module (ECM) commanded position during Cold Start Emission Reduction (CSER).

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 51 FMI 7.

Drive Cycle to Determine Fault Status

Drive Cycle 18 then 4 in 2013 HD-OBD Diagnostic Reference Manual.

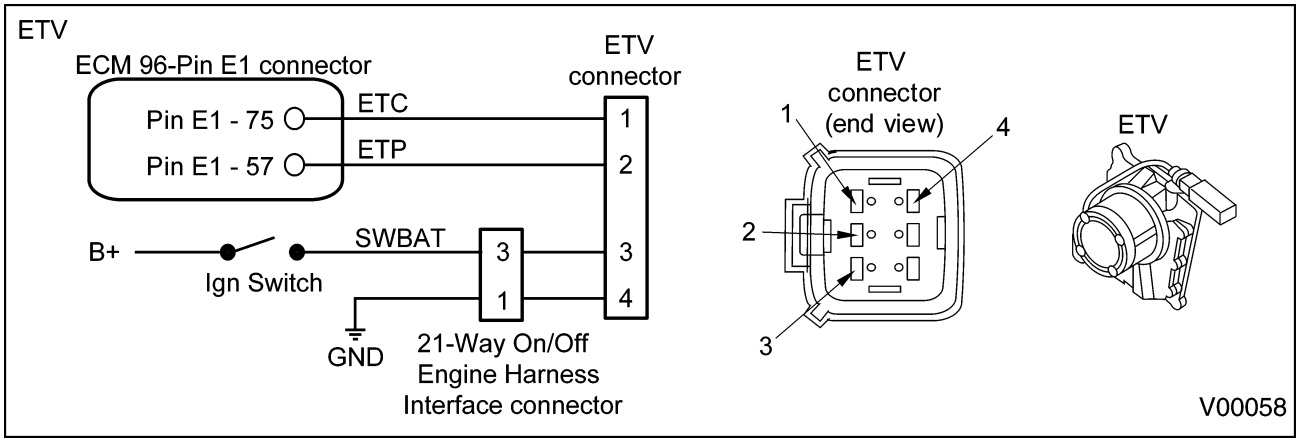


Figure 391 ETV valve circuit diagram

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 51 FMI 3, SPN 51 FMI 4, SPN 3464 FMI 3, and SPN 3464 FMI 5. Is SPN 51 FMI 10 the only fault code active?	Yes: Do Operational Voltage Check (page 1040). After repairs are complete, retest for SPN 51 FMI 10.
		No: Repair other fault code(s). After repairs are complete, retest for SPN 51 FMI 10.

NOTE: After doing all diagnostic steps, if SPN 51 FMI 10 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

EWPS (Engine Warning Protection System)

SPN	FMI	Condition	Possible Causes	Actions
100	1	Engine Oil System below critical pressure	• Biased EOP sensor or circuit • Engine oil system mechanical failure	EWPS Programmable Parameters (page 1050)
100	11	Engine oil pressure below dealer programmed engine RPM value	• Lubrication system suction side leak (pickup tube) • Engine oil system mechanical failure • Biased EOP sensor or circuit	EWPS Programmable Parameters (page 1050)
100	17	Low Oil Pressure vehicle event fault	• Oil pressure regulator stuck open • Biased EOP sensor or circuit • Engine oil system mechanical failure	EWPS Programmable Parameters (page 1050)
100	18	Engine Oil System below Warning Pressure	• Biased EOP sensor or circuit • Engine oil system mechanical failure	EWPS Programmable Parameters (page 1050)
110	0	Engine Coolant System above Critical Temperature	• Incorrect value in Programmable Parameter (PP) 77022 • Blockage between radiator and Charge Air Cooler (CAC) or Low Temperature Radiator (LTR) • Cooling system overheating • Degraded coolant	Step-Based Diagnostics (page 1051)

110	11	Event Logger, Coolant Temp Hot, Extreme	• Incorrect value in Programmable Parameter (PP) 8332 • Blockage between radiator and Charge Air Cooler (CAC) or Low Temperature Radiator (LTR) • Cooling system overheating • Degraded coolant	Step-Based Diagnostics (page 1053)
110	15	Engine Coolant System above Warning Temperature	• Incorrect value in Programmable Parameter (PP) 77012 • Failed thermostat • Low Temperature Radiator (LTR) restricted • Blockage between Charge Air Cooler (CAC) and radiator • Degraded coolant • Failed waterpump • Failed Coolant Control Valve (CCV)	Step-Based Diagnostics (page 1055)
110	16	Engine Coolant System above OBD maximum temperature	• Low coolant level • Check for leaks or boiling out	EWPS Programmable Parameters (page 1050)
175	0	Engine Coolant System above critical temperature	• Biased EOT sensor or circuit • Failed Engine oil cooler	EWPS Programmable Parameters (page 1050)
175	11	Engine Oil System above critical temperature	• Biased EOT sensor or circuit • Failed engine oil cooler	EWPS Programmable Parameters (page 1050)
175	15	Engine Coolant System above warning temperature	• Biased EOT sensor or circuit	EWPS Programmable Parameters (page 1050)

188	0	Engine unable to achieve desired idle speed (too high)	• Engine over-fueling • External fuel source • Lube oil leak to intake • Fuel leak to intake • Contaminated fuel	Step-Based Diagnostics (page 1057)
188	1	Engine unable to achieve desired idle speed (too low)	• Low Fuel Rail Pressure (FRP) • Low Fuel Delivery Pressure (FDP) • Low cylinder compression • Clutch or Power Take Off (PTO) engagement without command • Injector or injector circuit fault	Step-Based Diagnostics (page 1059)
188	15	Engine speed during CSER unable to achieve desired idle speed (too high)	• Engine over-fueling • External fuel source • Lube oil leak to intake • Fuel leak to intake • Contaminated fuel	Step-Based Diagnostics (page 1062)
188	16	Engine unable to achieve desired speed: secondary fuel detected	• External fuel source • Lube oil leak to intake • Fuel leak to intake • Contaminated fuel	Step-Based Diagnostics (page 1064)
188	17	Engine speed during CSER unable to achieve desired idle speed (too low)	• Low Fuel Rail Pressure (FRP) • Low Fuel Delivery Pressure (FDP) • Low cylinder compression • Clutch or Power Take Off (PTO) engagement without throttle	Step-Based Diagnostics (page 1066)

190	0	Engine overspeed most severe level	• Failed turbocharger • Failed fuel injector • External fuel source • Lube oil leak to intake • Fuel leak to intake • Contaminated fuel	Step-Based Diagnostics (page 1068)
190	11	Engine overspeed vehicle event fault	• Transmission in too low of a gear at high vehicle speed	EWPS Programmable Parameters (page 1050)
190	15	Engine overspeed detected	• Transmission in too low of a gear at high vehicle speed	EWPS Programmable Parameters (page 1050)
190	16	Engine above 2250 rpm	• Transmission in too low of a gear at high vehicle speed	EWPS Programmable Parameters (page 1050)
731	16	Knock detected: Cylinder Acceleration Above Normal	• Alternate fuel source (Oil) • VSS issue or circuit • Fuel injector leaking	Step-Based Diagnostics (page 1070)
731	18	Knock Detected: Unexpected Fueling without Demand	• Alternate fuel source (Oil) • VSS issue or circuit • Fuel injector leaking	Step-Based Diagnostics (page 1072)
2588	0	Vehicle overspeed 1, event log, extreme	• Vehicle speed has exceeded the value in PP 77232	Step-Based Diagnostics (page 1074)
2588	15	Vehicle overspeed 1, event log, non extreme	• Vehicle speed has exceeded the value in PP 77232	Step-Based Diagnostics (page 1075)
2589	0	Vehicle overspeed 2, event log, extreme	• Vehicle speed has exceeded the value in PP 77242	Step-Based Diagnostics (page 1076)
2589	15	Vehicle overspeed 2, event log, non extreme	• Vehicle speed has exceeded the value in PP 77242	Step-Based Diagnostics (page 1077)

4076	0	ECT2 above Critical (EWPS programmable limit)	• Biased ECT2 sensor or circuit • Low coolant level • Engine cooling system mechanical failure	EWPS Programmable Parameters (page 1050)
4076	15	ECT2 above Warning (EWPS programmable limit)	• Biased ECT2 sensor or circuit • Low coolant level • Engine cooling system mechanical failure	EWPS Programmable Parameters (page 1050)
5395	0	Engine unable to achieve desired idle torque (too high)	• Failed fuel injector • Aftermarket PTO system not installed correctly • Aftermarket PTO system not programmed correctly	Step-Based Diagnostics (page 1078)
5395	1	Engine unable to achieve desired idle torque (too low)	• Engine mechanical failure • Failed cylinder • External fuel source • Lube oil leak to intake • Fuel leak to intake • Contaminated fuel	Step-Based Diagnostics (page 1080)

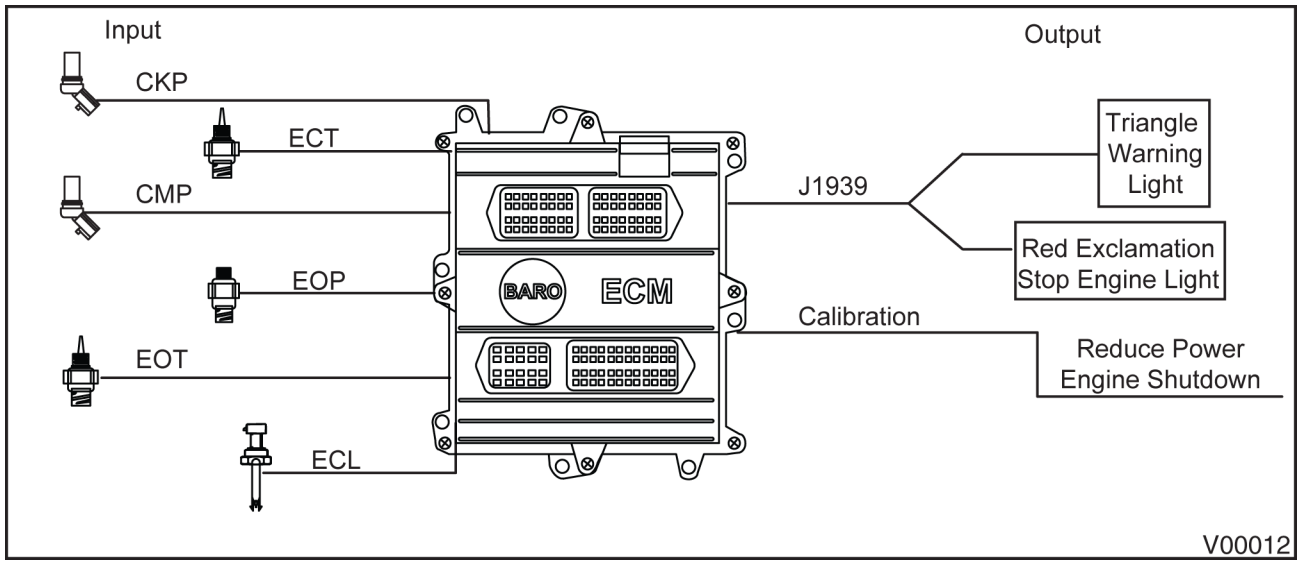


Figure 392 Functional diagram for the EWPS

Function

The EWPS warns the operator of conditions that can damage the engine.

The Standard Warning System is the base system in which all engines are equipped. If one of these faults are detected, the ECM illuminates the red engine lamp and sets a corresponding DTC.

The following optional features to this base system provide added warning or protection.

Standard Warning – No engine shutdown available.

- ECT - Engine overheat warning
- EOP - Low engine oil pressure warning

3-way Warning – No engine shutdown available.

- ECT - Engine overheat warning
- EOP - Low engine oil pressure warning
- ECL - Low engine coolant level warning

3-way Protection – Engine shutdown is available if critical condition is detected.

- ECT, EOP, ECL - Same as 3-way Warning
- ECT - Engine overheat critical protection
- EOP - Low engine oil pressure critical protection
- ECL - Low engine coolant level critical protection

Warning (Amber Triangle Light) – Temperature above specific threshold sounds a buzzer, illuminates the red OIL / WATER (OWL) lamp, and sets a DTC.

Critical (Exclamation Mark Stop Lamp) – Temperature above specific threshold shuts down the engine and sets a DTC.

Event log (if equipped) – This feature logs occurrences of the event according to the engine hours and odometer readings.

EWPS Programmable Parameters

- 1 = 3-way Warning
- 2 = 3-way Protection
- 3 = Standard Warning

ECT Warning Temperature – Specifies temperature threshold where the Triangle Warning light and warning buzzer are turned on.

ECT Critical Temperature – Specifies temperature threshold where an engine shutdown is commanded (Exclamation Engine Stop lamp).

EOP Engine Speed Region Boundary 1 (600 RPM) – Specifies at what RPM a specified oil pressure (EOP Critical Pressure for Region 1) should be detected.

EOP Engine Speed Region Boundary 2 (800 RPM) – Specifies at what RPM a specified oil pressure (EOP Critical Pressure for Region 2) should be detected.

EOP Engine Speed Region Boundary 3 (1000 RPM) – Specifies at what RPM a specified oil pressure (EOP Critical Pressure for Region 3) should be detected.

EOP Warning Pressure for Region 1 (10 psi / 69 kPa) – Specifies the minimum oil pressure with engine speed greater than EOP Engine Speed Region Boundary 1. Failure to meet set point turns on the OIL / WATER lamp and warning buzzer.

EOP Warning pressure for Region 2 (16 psi / 110 kPa) – Specifies the minimum oil pressure with engine speed greater than EOP Engine Speed Region Boundary 1 but less than EOP Engine Speed Region Boundary 2. Failure to meet set point turns on the OIL / WATER lamp and warning buzzer.

EOP Warning Pressure for Region 3 (20 psi / 138 kPa) – Specifies the minimum oil pressure with engine speed greater than EOP Engine Speed Region Boundary 2, but less than EOP Engine Speed Region Boundary 3. Failure to meet set point turns on the OIL / WATER lamp and warning buzzer.

EOP Critical Pressure for Region 1 (7.5 psi / 52 kPa) – Specifies the minimum oil pressure with engine speed greater than EOP Engine Speed Region Boundary 1. Failure to meet set point commands an engine shut down.

EOP Critical Pressure for Region 2 (12 psi / 83 kPa) – Specifies the minimum oil pressure with engine speed greater than EOP Engine Speed Region Boundary 1, but less than EOP Engine Speed Region Boundary 2. Failure to meet set point commands an engine shutdown.

EOP Critical Pressure for Region 3. (15 psi / 103 kPa) – Specifies the minimum oil pressure with engine speed greater than EOP Engine Speed Region Boundary 2 but less than EOP Engine Speed Region Boundary 3. Failure to meet set point commands an engine shutdown.

Tools Required

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

SPN 110 FMI 0 - Engine Coolant System above Critical Temperature

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Engine Coolant Temperature 1 (ECT1) above critical temperature	ECT1 > value programmed into Programmable Parameter (PP) 77022	Key-On Engine-Running	Immediate

Fault Overview

Fault code sets when the Electronic Control Module (ECM) detects that Engine Coolant Temperature 1 (ECT1) is above Programmable Parameter (PP) 77022.

Malfunction Indicator Lamp (MIL) Reaction

Engine shutdown is commanded and Red Stop Lamp (RSL) active.

Associated Faults

SPN 110 FMI 2, 3, 4 (ECT1)

Fault Facts

Air pockets in the cooling system can interfere with coolant flow or prevent the thermostats from opening when needed, resulting in this fault.

Drive Cycle to Determine Fault Status

Drive cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Incorrect value in Programmable Parameter (PP) 77022
- Blockage between radiator and Charge Air Cooler (CAC) or Low Temperature Radiator (LTR)
- Cooling system overheating
- Degraded coolant

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 110 FMI 2, 3, 4 (ECT1). Is EST DTC list free of SPN 110 FMI 2, 3, 4?	Yes: Go to step 2. No: Repair SPN 110 FMI 2, 3, 4 (ECT1). After repairs are complete, retest SPN 110 FMI 0.

Step	Action	Decision
2	Check for blockage between radiator and Charge-Air Cooler (CAC) or Low Temperature Radiator (LTR). Inspect the between the radiator and CAC / LTR for blockage. Is there any blockage between the radiator and CAC or LTR?	Yes: Clean blockage between the CAC and LTR. After repairs are complete, retest for SPN 110 FMI 11. No: Go to step 3.

Step	Action	Decision
3	Check Programmable Parameter (PP) 77022. Using EST with ServiceMaxx™ software, go to Sessions > Programming > Engine Warn Protection System. Check value, verify with customer desired temperature limit and compare to normal operating temperature. Is PP 77022 programmed correctly?	Yes: Go to step 4. No: Program PP 77022 to correct value. After repairs are complete, retest for SPN 110 FMI 0.

Step	Action	Decision
4	Check for degraded coolant. Using Coolant And Battery Refractometer ZTSE4796, determine condition of coolant. Is coolant filled to spec, clean, and Not degraded?	Yes: Go to step 5. No: Perform coolant flush and fill coolant to spec. After repairs are complete, retest for SPN 110 FMI 0.

Step	Action	Decision
5	Determine coolant over temperature condition. Perform Coolant Over-Temperature tests (page 150). Is cooling system free from physical damage and Not leaking?	Yes: Retest for SPN 110 FMI 0. No: Repair engine cooling system. After repairs are complete, retest for SPN 110 FMI 0.

NOTE: After doing all diagnostic steps, if SPN 110 FMI 0 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 110 FMI 11 - Event Logger, Coolant Temp Hot, Extreme

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Engine coolant at Engine Coolant Temperature 1 (ECT1) is above critical temperature	ECT1 > value programmed into Programmable Parameter (PP) 8332	Key-On Engine-Running	Immediate

Fault Overview

Fault code sets when the Electronic Control Module (ECM) detects that engine coolant at Engine Coolant Temperature 1 (ECT1) is above Programmable Parameter (PP) 8332.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 110 FMI 2, 3, 4 (ECT1)

Fault Facts

Air pockets in the cooling system can interfere with coolant flow or prevent the thermostats from opening when needed, resulting in this fault.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

- Incorrect value in Programmable Parameter (PP) 8332
- Blockage between radiator and Charge Air Cooler (CAC) or Low Temperature Radiator (LTR)
- Cooling system overheating
- Degraded coolant

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 110 FMI 2, 3, 4 (ECT1). Is EST DTC list free of SPN 110 FMI 2, 3, 4?	Yes: Go to step 2. No: Repair SPN 110 FMI 2, 3, 4. After repairs are complete, retest SPN 110 FMI 11.

Step	Action	Decision
2	Check for blockage between radiator and Charge-Air Cooler (CAC) or Low Temperature Radiator (LTR). Inspect the between the radiator and CAC / LTR for blockage. Is there any blockage between the radiator and CAC or LTR?	Yes: Clean blockage between the CAC and LTR. After repairs are complete, retest for SPN 110 FMI 11. No: Go to step 3.

Step	Action	Decision
3	Check Programmable Parameter (PP) 8332. Using EST with ServiceMaxx™ software, go to Sessions > Programming > Engine Warn Protection System. Check value, verify with customer desired temperature limit and compare to normal operating temperature. Is PP 8332 programmed correctly?	Yes: Go to step 4. No: Program PP 8332 to correct value. After repairs are complete, retest for SPN 110 FMI 11.

Step	Action	Decision
4	Check for degraded and low coolant. Using Coolant And Battery Refractometer ZTSE4796, determine condition of coolant. Is coolant filled to spec, clean, and Not degraded?	Yes: Go to step 5. No: Perform coolant flush and fill coolant to spec. After repairs are complete, retest for SPN 110 FMI 11.

Step	Action	Decision
5	Determine coolant over temperature condition. Perform Coolant Over-Temperature (page 150). Is cooling system free from physical damage and Not leaking?	Yes: Retest for SPN 110 FMI 11. No: Repair engine cooling system. After repairs are complete, retest for SPN 110 FMI 11.

NOTE: After doing all diagnostic steps, if SPN 110 FMI 11 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 110 FMI 15 - Engine Coolant System above Warning Temperature

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Engine coolant at Engine Coolant Temperature 1 (ECT1) is above Warning temperature.	ECT1 > value programmed into Programmable Parameter (PP) 77012	Key-On Engine-Running (KOER)	Immediate

Fault Overview

Fault code sets when the Electronic Control Module (ECM) detects that engine coolant at Engine Coolant Temperature 1 (ECT1) is above Programmable Parameter (PP) 77012.

Malfunction Indicator Lamp (MIL) Reaction

Warning Lamp set and Warning buzzer turned ON.

Associated Faults

SPN 110 FMI 2, 3, 4 (ECT1)

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Incorrect value in Programmable Parameter (PP) 77012
- Failed Thermostat
- Low Temperature Radiator (LTR) Plugged
- Blockage between Charge Air Cooler (CAC) and Radiator
- Degraded Coolant
- Failed Waterpump
- Failed CCV

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 110 FMI 2, 3, 4 (ECT1). Is EST DTC list free of SPN 110 FMI 2, 3, 4?	Yes: Go to step 2. No: Repair SPN 110 FMI 2, 3, 4. After repairs are complete, retest SPN 110 FMI 15.

Step	Action	Decision
2	Check for blockage stuck between Charge-Air Cooler (CAC) and Low Temperature Radiator (LTR). Inspect the between the CAC and LTR for blockage. Is there a blockage between the CAC and LTR?	Yes: Go to step 3. No: Clean blockage between the CAC and LTR. After repairs are complete, retest for SPN 110 FMI 15.

Step	Action	Decision
3	Check Programmable Parameter (PP) 77012. Using EST with ServiceMaxx™ software, go to Sessions > Programming > Engine Warn Protection System. Check value, verify with customer desired temperature limit and compare to normal operating temperature. Is PP 77012 programmed correctly?	Yes: Go to step 4. No: Program PP 77012 to correct value. After repairs are complete, retest for SPN 110 FMI 15.

Step	Action	Decision
4	Check for degraded and low coolant. Using Coolant And Battery Refractometer ZTSE4796, determine condition of coolant. Is coolant filled to spec, clean, and Not degraded?	Yes: Go to step 5. No: Perform coolant flush and fill coolant to spec. After repairs are complete, retest for SPN 110 FMI 15.

Step	Action	Decision
5	Determine coolant over temperature condition. Perform Coolant Over- Temperature (page 150). Is cooling system free from physical damage and Not leaking?	Yes: Go to step 6. No: Repair engine cooling system. After repairs are complete, retest for SPN 110 FMI 15.

Step	Action	Decision
6	Check for Failed Coolant Control Valve (CCV). Perform CCV Test (page 156). Is the CCV working correctly?	Yes: Retest for SPN 110 FMI 15. No: Replace Coolant Control Valve assembly. (CCV) . After repairs are complete, retest for SPN 110 FMI 15.

NOTE: After doing all diagnostic steps, if SPN 110 FMI 15 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 188 FMI 0 - Engine speed unable to achieve desired idle speed (too high)

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Engine idle speed too high	Engine speed > 106.7% of desired idle speed	Key ON Engine Coolant Temperature 1 (ECT1) between 16°F (-9°C) and 248°F (120°C) Vehicle speed < 0.62 mph PTO not engaged Accelerator pedal position 0%	10 seconds

Fault Overview

Fault sets when vehicle is stationary and engine speed is greater than what is requested by the Engine Control Module (ECM).

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 110 FMI 2 (ECT1); SPN 5395 FMI 0 (EWPS)

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Cause

- Engine over-fueling
- External fuel source
- Lube oil leak to intake
- Fuel leak to intake
- Contaminated fuel

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 110 FMI 2 (ECT1); SPN 5395 FMI 0 (EWPS). Is EST DTC list free of SPN 110 FMI 2; SPN 5395 FMI 0?	Yes: Go to step 2. No: Repair SPN 110 FMI 2; SPN 5395 FMI 0. After repairs are complete, retest for SPN 188 FMI 0.

Step	Action	Decision
2	Inspect for airborne combustibles (such as propane saturated air, ether) near engine. Inspect air filter and intake system for stains, concentrations of contaminants, odors / smells from external fuel sources, and modifications. Is the engine intake system intact and free from any external fuel sources?	Yes: Go to step 3. No: Repair source of combustibles. After repairs are complete, retest for SPN 188 FMI 0.

Step	Action	Decision
3	Inspect for a lube oil leak to intake. Perform Lube Oil to Intake leak test (page 162). Is lube oil leaking to intake?	Yes: Go to step 4. No: Repair lube oil leak to intake. After repairs are complete, retest for SPN 188 FMI 0.

Step	Action	Decision
4	Inspect for a fuel leak to intake. Perform Fuel to Intake leak test (page 174). Is fuel leaking to intake?	Yes: Go to step 5. No: Repair fuel leak to intake. After repairs are complete, retest for SPN 188 FMI 0.

Step	Action	Decision
5	Inspect for contaminated fuel (alternate fuels other than Diesel fuel). Perform Fuel Quality Check (page 193). Is diesel fuel in good condition and Not contaminated?	Yes: Go to step 6. No: Drain fuel tank, and fill with clean and / or known good diesel fuel. After repairs are complete, retest for SPN 188 FMI 0.

Step	Action	Decision
6	Determine if engine has a fuel injector problem. Perform Multiple Cylinder Cutout Test (page 241). Did one or more cylinders have significant speed difference(s) than the others?	Yes: Replace fuel injector on suspected cylinder. After repairs are complete retest for SPN 188 FMI 0. No: Retest for SPN 188 FMI 0.

NOTE: After doing all diagnostic steps, if SPN 188 FMI 0 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 188 FMI 1 - Engine speed unable to achieve desired idle speed (too low)

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Engine idle speed too low	Engine speed < 93.3% of desired idle speed	Key ON Engine Coolant Temperature 1 (ECT1) between 16°F (-9°C) and 248°F (120°C) Vehicle speed < 0.62 mph PTO not engaged Accelerator pedal position 0%	10 seconds

Fault Overview

Fault sets when vehicle is stationary and engine speed is less than what is requested by the Engine Control Module (ECM).

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 651, 652, 653, 654, 655, 656 (INJ); SPN 5395 FMI 1 (EWPS)

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Low Fuel Rail Pressure (FRP)
- Low Fuel Delivery Pressure (FDP)
- Low cylinder compression
- Clutch or Power Take Off (PTO) engagement without command
- Injector or injector circuit fault

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 651, 652, 653, 654, 655, 656 (INJ); SPN 5395 FMI 1 (EWPS). Is EST DTC list free of SPN 651, 652, 653, 654, 655, 656; SPN 5395 FMI 0?	Yes: Go to step 2. No: Repair SPN 651, 652, 653, 654, 655, 656; SPN 5395 FMI 1. After repairs are complete, retest for SPN 188 FMI 1.

Step	Action	Decision
2	Verify Fuel Delivery Pressure (FDP) is within specification. Using Electronic Service Tool (EST) with ServiceMaxx™ software, Key-On Engine-Running (KOER) monitor FDP sensor. Is FDP between 60 and 120 psi?	Yes: Go to step 3. No: Perform Fuel Delivery Pressure Test (page 218). After repairs are complete, retest for SPN 188 FMI 1.

Step	Action	Decision
3	Determine if Fuel Rail Pressure (FRP) is within specification. Using EST with ServiceMaxx software, KOER monitor FRP sensor. Is FRP greater than 10,500 psi?	Yes: Go to step 4. No: Perform High-pressure Pump Inlet Test (High-pressure Pump Inlet Pressure Test, page 228). After repairs are complete, retest for SPN 188 FMI 1.

Step	Action	Decision
4	Determine if the engine has a mechanical cylinder balance problem (compression loss). Perform Crankcase Pressure Test (page 236). Does engine have excessive crankcase pressure?	Yes: Repair base engine compression imbalance. After repairs are complete, retest for SPN 188 FMI 1. No: Go to step 5.

Step	Action	Decision
5	Determine if engine has a fuel injector problem. Perform Multiple Cylinder Cutout Test (page 241). Did one or more cylinders have significant speed difference(s) than the others?	Yes: Go to step 6. No: Go to step 7.

Step	Action	Decision
6	Inspect for failed valve train components. Remove upper valve cover (see Engine Service Manual). Inspect for bent valves, fallen bridges, and valves out of adjustment. Is valve train free of failed valve train components?	Yes: Replace injector suspected by Multiple Cylinder Cutout Test. After repairs are complete, retest for SPN 188 FMI 1. No: Repair failed valve train components. After repairs are complete retest for SPN 188 FMI 1.

Step	Action	Decision
7	Check for Power Take Off (PTO) engagement without command. KOER, monitor PTO output shaft rotation. Is PTO output shaft rotating without throttle?	Yes: Repair PTO unit. After repairs are complete, retest for SPN 188 FMI 1.
		No: Retest for SPN 188 FMI 1.

NOTE: After doing all diagnostic steps, if SPN 188 FMI 1 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 188 FMI 15 - Engine speed during CSER unable to achieve desired idle speed (too high)

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Engine speed during SCR warm-up unable to achieve desired idle speed (too high)	Engine speed 5 percent above set point speed	Engine Coolant Temperature >15.8°F (-9°C) and < 248°F (120°C) Key ON Vehicle speed < 0.62 mph Engine speed > 300 rpm	0.05 seconds

Fault Overview

Fault sets only when a vehicle is stationary and engine speed is 5 percent or more than requested by the Engine Control Module (ECM) during a Cold Start Emissions Reduction (CSER).

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Cause

- Engine over-fueling
- External fuel source
- Lube oil leak to intake
- Fuel leak to intake
- Contaminated fuel

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 188 FMI 0 (EWPS). Is EST DTC list free of SPN 188 FMI 0?	Yes: Go to step 2. No: Repair SPN 188 FMI 0. After repairs are complete, retest for SPN 188 FMI 15.

Step	Action	Decision
2	Inspect for airborne combustibles (such as propane saturated air, ether) near engine. Inspect air filter and intake system for stains, concentrations of contaminants, odors / smells from external fuel sources, and modifications. Is the engine intake system intact and free from any external fuel sources?	Yes: Go to step 3. No: Repair source of combustibles. After repairs are complete, retest for SPN 188 FMI 15.

Step	Action	Decision
3	Inspect for a lube oil leak to intake. Perform Lube Oil to Intake leak test (page 162). Is lube oil leaking to intake?	Yes: Go to step 4. No: Repair lube oil leak to intake. After repairs are complete, retest for SPN 188 FMI 15.

Step	Action	Decision
4	Inspect for a fuel leak to intake. Perform Fuel to Intake leak test (page 174). Is fuel leaking to intake?	Yes: Go to step 5. No: Repair fuel leak to intake. After repairs are complete, retest for SPN 188 FMI 15.

Step	Action	Decision
5	Inspect for contaminated fuel (alternate fuels other than Diesel fuel). Perform Fuel Quality Check (page 193). Is diesel fuel in good condition and Not contaminated?	Yes: Go to step 6. No: Drain fuel tank, and fill with clean and / or known good diesel fuel. After repairs are complete, retest for SPN 188 FMI 15.

Step	Action	Decision
6	Determine if engine has a fuel injector problem. Perform Multiple Cylinder Cutout Test (page 241). Did one or more cylinders have significant speed difference(s) than the others?	Yes: Replace fuel injector on suspected cylinder. After repairs are complete retest for SPN 188 FMI 15. No: Retest for SPN 188 FMI 15.

NOTE: After doing all diagnostic steps, if SPN 188 FMI 15 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 188 FMI 16 - Engine unable to achieve desired speed: secondary fuel detected

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Engine unexpectedly accelerated due to an alternative fuel source.	Engine Speed greater than 2600 RPM	Key-On Engine-Running (KOER) Vehicle stationary	

Fault Overview

Fault code sets when Electronic Control Module (ECM) detects vehicle is stationary and engine speed is higher than 2600 rpm.

Malfunction Indicator Lamp (MIL) Reaction

Red Stop Lamp (RSL) active

Associated Faults

SPN 731 FMI 16 and 18 (EWPS)

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- External fuel source
- Lube oil leak to intake
- Fuel leak to intake
- Contaminated fuel

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 731 FMI 16 and 18 (EWPS). Is EST DTC list free of SPN 731 FMI 16 and 18?	Yes: Go to step 2. No: Repair SPN 731 FMI 16 and 18. After repairs are complete, retest for SPN 188 FMI 16.

Step	Action	Decision
2	Inspect for airborne combustibles (such as propane saturated air, ether) near engine. Inspect air filter and intake system for stains, concentrations of contaminants, odors / smells from external fuel sources, and modifications. Is the engine intake system intact and free from any external fuel sources?	Yes: Go to step 3. No: Repair source of combustibles. After repairs are complete, retest for SPN 188 FMI 16.

Step	Action	Decision
3	Inspect for a lube oil leak to intake. Perform Lube Oil to Intake leak test (page 162). Is lube oil leaking to intake?	Yes: Go to step 4. No: Repair lube oil leak to intake. After repairs are complete, retest for SPN 188 FMI 16.

Step	Action	Decision
4	Inspect for a fuel leak to intake. Perform Fuel to Intake leak test (page 174). Is fuel leaking to intake?	Yes: Go to step 5. No: Repair fuel leak to intake. After repairs are complete, retest for SPN 188 FMI 16.

Step	Action	Decision
5	Inspect for contaminated fuel (alternate fuels other than Diesel fuel). Perform Fuel Quality Check (page 193). Is diesel fuel in good condition and Not contaminated?	Yes: Retest for SPN 188 FMI 16. No: Drain fuel tank, and fill with clean and / or known good diesel fuel. After repairs are complete, retest for SPN 188 FMI 16.

NOTE: After doing all diagnostic steps, if SPN 188 FMI 16 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 188 FMI 17 - Engine speed during CSER unable to achieve desired idle speed (too low)

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Engine speed during SCR warm-up unable to achieve desired idle speed (too low).	Engine speed 5 percent below set point speed	Engine Coolant Temp >15.8°F (-9.04°C) and < 248°F (120°C) Time after Key On > 0 seconds Vehicle speed < 0.62 mph Engine speed > 300 rpm	0.05 seconds

Fault Overview

Fault sets only when a vehicle is stationary and engine speed is 5 percent or less than requested by the Engine Control Module (ECM) during a Cold Start Emissions Reduction (CSER).

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 188 FMI 1 (EWPS). Is EST DTC list free of SPN 188 FMI 1?	Yes: Go to step 2. No: Repair SPN 188 FMI 1. After repairs are complete, retest for SPN 188 FMI 17.

Step	Action	Decision
2	Determine if the engine has a mechanical cylinder balance problem (compression loss). Perform Crankcase Pressure Test (page 236). Does engine have excessive crankcase pressure?	Yes: Repair base engine compression imbalance. After repairs are complete, retest for SPN 188 FMI 17. No: Go to step 3.

Step	Action	Decision
3	Determine if engine has a fuel injector problem. Perform Multiple Cylinder Cutout Test (page 241). Did one or more cylinders have significant speed difference(s) than the others?	Yes: Go to step 4. No: Go to step 5.

Step	Action	Decision
4	Inspect for failed valve train components. Remove upper valve cover (see Engine Service Manual). Inspect for bent valves, fallen bridges, and valves out of adjustment. Is valve train free of failed valve train components?	Yes: Replace injector suspected by Multiple Cylinder Cutout Test. After repairs are complete, retest for SPN 188 FMI 17.
		No: Repair failed valve train components. After repairs are complete retest for SPN 188 FMI 17.

Step	Action	Decision
5	Determine if Fuel Delivery Pressure (FDP) is within specification. Using Electronic Service Tool (EST) with ServiceMaxx™ software, Key-On Engine-Running (KOER) monitor FDP sensor. FDP should be at a steady pressure of 85 psi or more. Is FDP from 60 - 120 psi?	Yes: Go to step 6.
		No: Do Fuel Delivery Pressure Test (page 218). After repairs are complete, retest for SPN 188 FMI 17.

Step	Action	Decision
6	Determine if Fuel Rail Pressure (FRP) is within specification. Using EST with ServiceMaxx software, KOER monitor FRP sensor. Is FRP greater than 10,500 psi?	Yes: Go to step 7.
		No: Do High-pressure Pump Inlet Pressure Test (page 228).

Step	Action	Decision
7	Check for Power Take Off (PTO) engagement without throttle. KOER, monitor PTO output shaft rotation. Is PTO output shaft rotating without throttle?	Yes: Repair dragging clutch (see appropriate Clutch Service Manual). After repairs are complete, retest for SPN 188 FMI 17.
		No: Replace PTO unit. After repairs are complete, retest for SPN 188 FMI 17.

NOTE: After doing all diagnostic steps, if SPN 188 FMI 17 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 190 - FMI 0 - Engine Overspeed Most Severe level

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Engine speed reaches most severe level with Accelerator Pedal Position (APP) and Vehicle Speed Sensor (VSS) at 0% or 0.	Engine speed exceeds 2600 rpm with no fuel being requested	Vehicle speed < 0.1 mph APP < 0.1% RAPP < 0.1% Engine speed > 2600 rpm	1 event

Fault Overview

Fault sets only when a vehicle is stationary and engine speed reaches 2600 rpm with no fuel being requested by the Engine Control Module (ECM). Once conditions are met, the ECM will initiate a protection strategy. The Engine Throttle Valve (ETV) and Exhaust Gas Recirculation (EGR) valve will be closed and fuel injectors disabled. The Fuel Pressure Control Valve (FPCV) will open to relieve fuel rail pressure in case of injector tip damage. A full engine analysis needs to be completed to assess damage from excessive engine speed before the engine can be started.

Malfunction Indicator Lamp (MIL) Reaction

The Malfunction Indicator Lamp and Red Stop Lamp (RSL) will illuminate when this fault is detected.

CAUTION: To prevent engine damage, do not attempt to start engine until a full engine analysis and all diagnostic steps have been completed.

NOTE:

Before beginning diagnosis:

- Take pictures of all damage / failure evidence
- Do not replace any parts until a full inspection has been completed.
- Failed turbocharger
- Failed fuel injector
- External fuel source
- Lube oil leak to intake
- Fuel leak to intake
- Contaminated fuel

Step	Action	Decision
1	Inspect for airborne combustibles (ex. propane saturated air, ether, etc.) near engine. Inspect air filter and intake system for stains, concentrations of contaminants, odors / smells from external fuel sources, and modifications. Is the engine intake system intact and free from any external fuel sources?	Yes: Go to step 2. No: Repair source of combustibles. After repairs are complete, retest for SPN 190 FMI 0.

Step	Action	Decision
2	Inspect for a lube oil leak to intake. Perform Lube Oil to Intake leak test (page 162). Is lube oil leaking to intake?	Yes: Go to step 3. No: Repair lube oil leak to intake. After repairs are complete, retest for SPN 190 FMI 0.

Step	Action	Decision
3	Inspect for a fuel leak to intake. Perform Fuel to Intake leak test (page 174). Is fuel leaking to intake?	Yes: Go to step 4. No: Repair fuel leak to intake. After repairs are complete, retest for SPN 190 FMI 0.

Step	Action	Decision
4	Inspect for contaminated fuel (alternate fuels other than Diesel fuel). Perform Fuel Quality Check (page 193). Is diesel fuel in good condition and Not contaminated?	Yes: Retest for SPN 190 FMI 0. No: Drain fuel tank, and fill with clean and / or known good diesel fuel. After repairs are complete, retest for SPN 190 FMI 0.

NOTE: After doing all diagnostic steps, if SPN 190 FMI 0 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 731 FMI 16 - Knock detected: Cylinder Acceleration Above Normal

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Engine Control Module (ECM) compares time between pulses of the Crankshaft Position (CKP) sensor after fuel injection to determine whether the engine has accelerated or decelerated.	Difference between desired crankshaft speed and actual crankshaft speed exceeds a predetermined threshold	Vehicle stationary Engine speed > 500 RPM Accelerator pedal position (APP) signal < 0.1% Clutch Not pressed Coolant temperature is between 15°F (-9°C) and 248°F (120°C) Inactive: SPN 110 (ECT1); SPN 191 (TOSS); SPN 560 (J1939); 1659 (ECS); 4076 (ECT2)	

Fault Overview

Fault code sets when an increase in engine speed is detected without a request for an increase in engine speed.

Malfunction Indicator Lamp (MIL) Reaction

Red Stop Lamp (RSL) illuminated.

Associated Faults

SPN 110 (ECT1), SPN 190 FMI 0 (EWPS), SPN 191 (TOSS), SPN 560 (J1939), SPN 637 (CKP); SPN 1659 (ECS), 4076 (ECT2)

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Alternate fuel source (Oil)
- Vehicle Speed Sensor (VSS) or circuit fault

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 110 (ECT1); SPN 190 (EWPS); SPN 191 (TOSS); SPN 560 (J1939); SPN 637 (CKP); SPN 1659 (ECS); 4076 (ECT2). Is EST DTC list free of SPN 110; SPN 190 FMI 0; SPN 191; SPN 560; SPN 637; SPN 1659; SPN 4076?	Yes: Go to step 2. No: Repair SPN 110; SPN 190 FMI 0; SPN 191; SPN 560; SPN 637; SPN 1659; SPN 4076. After repairs are complete, retest for SPN 731 FMI 16.

Step	Action	Decision
2	Inspect for a lube oil leak to intake. Perform Lube Oil to Intake leak test (page 162). Is lube oil leaking to intake?	Yes: Repair lube oil leak to intake. After repairs are complete, retest for SPN 731 FMI 16.
		No: Troubleshoot VSS (page 1428). After repairs are complete, retest for SPN 731 FMI 16.

NOTE: After doing all diagnostic steps, if SPN 731 FMI 16 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 731 FMI 18 - Knock Detected: Unexpected Fueling without Demand

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Engine Control Module (ECM) compares time between pulses of the Crankshaft Position (CKP) sensor after fuel injection to determine whether the engine has accelerated or decelerated.	Difference between desired crankshaft speed and actual crankshaft speed exceeds a predetermined threshold	Vehicle stationary Engine speed between 500 rpm and 1600 rpm AND No rapid rpm acceleration Accelerator Pedal Position (APP) stable signal Clutch not released for manual transmission Gear change not detected for automatic transmission Coolant temperature is between 15°F (-9°C) and 248°F (120°C) Inactive: SPN 91 (APP); SPN 110 (ECT1); SPN 191 (TOSS); SPN 560 (J1939); SPN 636 (CMP); SPN 637 (CKP); SPN 1659 (ECS); SPN 2623 (APP); SPN 4076 (ECT2)	

Fault Overview

Fault code sets when an increase in engine speed is detected without a change in fuel command.

Malfunction Indicator Lamp (MIL) Reaction

Red Stop Lamp (RSL) illuminated.

Associated Faults

SPN 91 (APP), SPN 110 (ECT1), SPN 190 FMI 0 (EWPS), SPN 191 (TOSS), SPN 560 (J1939), SPN 636 (CMP), SPN 637 (CKP), SPN 1659 (ECS), SPN 2623 (APP), SPN 4076 (ECT2)

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Alternate fuel source (Oil)
- Vehicle Speed Sensor (VSS) or circuit fault
- Fuel injector leaking
- Flywheel fault

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 91 (APP); SPN 110 (ECT1); SPN 190 (EWPS); SPN 191 (TOSS); SPN 560 (J1939); SPN 636 (CMP); SPN 637 (CKP); SPN 1659 (ECS); SPN 2623 (APP); SPN 4076 (ECT2). Is EST DTC list free of SPN 91; SPN 110; SPN 190 FMI 0; SPN 191; SPN 560; SPN 636; SPN 637; SPN 1659; SPN 2623 (APP); SPN 4076?	Yes: Go to step 2. No: Repair SPN 91; SPN 110; SPN 190 FMI 0; SPN 191; SPN 560; SPN 636; SPN 637; SPN 1659; SPN 2623; SPN 4076. After repairs are complete, retest for SPN 731 FMI 18.

Step	Action	Decision
2	Inspect for a lube oil leak to intake. Perform Lube Oil to Intake leak test (page 162). Is lube oil leaking to intake?	Yes: Repair lube oil leak to intake. After repairs are complete, retest for SPN 731 FMI 18. No: Troubleshoot VSS (page 1428). After repairs are complete, retest for SPN 731 FMI 18.

NOTE: After doing all diagnostic steps, if SPN 731 FMI 18 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 2588 FMI 0 - Vehicle overspeed 1, event log, extreme

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Vehicle over-speed level 1: This occurs when vehicle speed is above value in Programmable Parameter (PP) 77232.	Vehicle speed is greater than the value of PP 77232	Key-On Engine-Running (KOER)	

Fault Overview

Fault code sets when the Engine Control Module (ECM) detects vehicle speed exceeds the value set in Programmable Parameter (PP) 77232.

Malfunction Indicator Lamp (MIL) Reaction

9 - Special error class for VETS faults

Associated Faults

SPN 191 (VSS).

Fault Facts

This fault indicates vehicle speed has exceeded the value programmed in PP 77232. Depending on the value, fault may or may not indicate a vehicle problem.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Vehicle speed has exceeded the value set in PP 77232

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 191 (VSS). Is EST DTC list free of SPN 191?	Yes: Verify PP 77232 is set to appropriate speed value. No: Repair SPN 191. After repairs are complete, retest for SPN 2588 FMI 0.

NOTE: After doing all diagnostic steps, if SPN 2588 FMI 0 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 2588 FMI 15 - Vehicle overspeed 1, event log, non extreme

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Vehicle over-speed level 1: This occurs when vehicle speed is above value in Programmable Parameter (PP) 77232.	Vehicle speed is greater than the value of PP 77232	Key-On Engine-Running (KOER)	

Fault Overview

Fault code sets when the Engine Control Module (ECM) detects vehicle speed exceeds the value set in Programmable Parameter (PP) 77232.

Malfunction Indicator Lamp (MIL) Reaction

9 - Special error class for VETS faults

Associated Faults

SPN 191 (VSS).

Fault Facts

This fault indicates vehicle speed has exceeded the value programmed in PP 77232. Depending on the value, fault may or may not indicate a vehicle problem.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Vehicle speed has exceeded the value set in PP 77232

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 191 (VSS). Is EST DTC list free of SPN 191?	Yes: Yes: Verify PP 77232 is set to appropriate speed value.
		No: Repair SPN 191. After repairs are complete, retest for SPN 2588 FMI 15.

NOTE: After doing all diagnostic steps, if SPN 2588 FMI 15 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 2589 FMI 0 - Vehicle overspeed 2, event log, extreme

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Vehicle over-speed level 2: This occurs when vehicle speed is above value in Programmable Parameter (PP) 77242.	Vehicle speed is greater than the value of PP 77242	Key-On Engine-Running (KOER)	

Fault Overview

Fault code sets when the Engine Control Module (ECM) detects vehicle speed exceeds the value set in Programmable Parameter (PP) 77242.

Malfunction Indicator Lamp (MIL) Reaction

9 - Special error class for VETS faults

Associated Faults

SPN 191 (VSS).

Fault Facts

This fault indicates vehicle speed has exceeded the value programmed in PP 77242. Depending on the value, fault may or may not indicate a vehicle problem.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Vehicle speed has exceeded the value set in PP 77242

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 191 (VSS). Is EST DTC list free of SPN 191?	Yes: Verify PP 77242 is set to appropriate speed value. No: Repair SPN 191. After repairs are complete, retest for SPN 2589 FMI 0.

NOTE: After doing all diagnostic steps, if SPN 2589 FMI 0 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 2589 FMI 15 - Vehicle overspeed 2, event log, non extreme

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Vehicle over-speed level 2: This occurs when vehicle speed is above value in Programmable Parameter (PP) 77242.	Vehicle speed is greater than the value of PP 77242	Key-On Engine-Running (KOER)	

Fault Overview

Fault code sets when the Engine Control Module (ECM) detects vehicle speed exceeds the value set in Programmable Parameter (PP) 77242.

Malfunction Indicator Lamp (MIL) Reaction

9 - Special error class for VETS faults

Associated Faults

SPN 191 (VSS).

Fault Facts

This fault indicates vehicle speed has exceeded the value programmed in PP 77242. Depending on the value, fault may or may not indicate a vehicle problem.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Vehicle speed has exceeded the value set in PP 77242

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 191 (VSS). Is EST DTC list free of SPN 191?	Yes: Verify PP 77242 is set to appropriate speed value. No: Repair SPN 191. After repairs are complete, retest for SPN 2589 FMI 15.

NOTE: After doing all diagnostic steps, if SPN 2589 FMI 15 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 5395 FMI 0 - Engine Unable to Achieve Desired Idle Torque (Too High)

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Engine idle fuel quantity too high, engine unable to achieve desired idle torque.	Engine speed and fuel quantity greater than expected.	Vehicle speed <0.62 mph Key ON Engine coolant temperature < 239°F (115°C) Engine coolant temperature > 16°F (–9°C) Engine speed > 560 rpm	10 Seconds

Fault Overview

Fault code sets when the Engine Control Module (ECM) detects fuel quantity is and engine speed is greater than expected.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 188 FMI 1 (EWPS).

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Failed fuel injector
- Aftermarket PTO system not installed correctly
- Aftermarket PTO system not programmed correctly

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 188 FMI 1 (EWPS). Is EST DTC list free of SPN 188 FMI 1?	Yes: Go to step 2. No: Repair SPN 188 FMI 1. After repairs are complete, retest for SPN 5395 FMI 0.

Step	Action	Decision
2	Determine if the engine has a mechanical cylinder balance problem (compression loss). Perform Crankcase Pressure Test (page 236). Does engine have excessive crankcase pressure?	Yes: Repair base engine compression imbalance. After repairs are complete, retest for SPN 5395 FMI 0. No: Go to step 3

Step	Action	Decision
3	Determine if engine has a fuel injector problem. Perform Multiple Cylinder Cutout Test (page 241). Did one or more cylinders have significant speed difference(s) than the others?	Yes: Go to step 4. No: Go to step 5.

Step	Action	Decision
4	Inspect for failed valve train components. Remove upper valve cover (see Engine Service Manual). Inspect for bent valves, fallen bridges, and valves out of adjustment. Is valve train free of failed valve train components?	Yes: Replace injector suspected by Multiple Cylinder Cutout Test. After repairs are complete, retest for SPN 5395 FMI 0. No: Repair failed valve train components. After repairs are complete retest for SPN 5395 FMI 0.

Step	Action	Decision
5	Inspect for installation of aftermarket PTO system. Was an aftermarket PTO system installed and programmed correctly?	Yes: Do Harness Resistance Check (page 1340). After repairs are complete, retest for SPN 5395 FMI 0. No: After inspection is complete, notify supervisor with results for further action.

NOTE: After doing all diagnostic steps, if SPN 5395 FMI 0 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 5395 FMI 1 - Engine Unable to Achieve Desired Idle Torque (Too Low)

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Engine idle fuel quantity too low, engine unable to achieve desired idle torque.	engine speed and fuel quantity less than expected.	Vehicle speed <0.62 mph Key ON Engine coolant temperature < 239°F (115°C) Engine coolant temperature > 16°F (–9°C) Engine speed > 560 rpm	10 Seconds

Fault Overview

Fault code sets when the Engine Control Module (ECM) detects an un-commanded load being placed on the engine at idle or detects fuel quantity is less than expected.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 188 FMI 0 (EWPS).

Drive Cycle to Determine Fault Status

Drive Cycle 22 in 2013 HD-OBD Diagnostic Reference Manual.

- Engine mechanical failure
- Failed cylinder
- External fuel source
- Lube oil leak to intake
- Fuel leak to intake
- Contaminated fuel

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 188 FMI 0 (EWPS). Is EST DTC list free of SPN 188 FMI 0?	Yes: Go to step 2. No: Repair SPN 188 FMI 0. After repairs are complete, retest for SPN 5395 FMI 1.

Step	Action	Decision
2	Determine if the engine has a mechanical cylinder balance problem (compression loss). Perform Crankcase Pressure Test (page 236). Does engine have excessive crankcase pressure?	Yes: Repair base engine compression imbalance. After repairs are complete, retest for SPN 5395 FMI 1.
		No: Go to step 3

Step	Action	Decision
3	Determine if engine has a fuel injector problem. Perform Multiple Cylinder Cutout Test (page 241). Did one or more cylinders have significant speed difference(s) than the others?	Yes: Go to step 4.
		No: Go to step 5.

Step	Action	Decision
4	Inspect for failed valve train components. Remove upper valve cover (see Engine Service Manual). Inspect for bent valves, fallen bridges, and valves out of adjustment. Is valve train free of failed valve train components?	Yes: Replace injector suspected by Multiple Cylinder Cutout Test. After repairs are complete, retest for SPN 5395 FMI 1.
		No: Repair failed valve train components. After repairs are complete retest for SPN 5395 FMI 1.

Step	Action	Decision
5	Inspect for airborne combustibles (ex. propane saturated air, ether, etc.) near engine. Inspect air filter and intake system for stains, concentrations of contaminants, odors / smells from external fuel sources, and modifications. Is the engine intake system intact and free from any external fuel sources?	Yes: Go to step 6.
		No: Repair source of combustibles. After repairs are complete, retest for SPN 5395 FMI 1.

Step	Action	Decision
6	Inspect for a lube oil leak to intake. Perform Lube Oil to Intake leak test (page 162). Is lube oil leaking to intake?	Yes: Go to step 7.
		No: Repair lube oil leak to intake. After repairs are complete, retest for SPN 5395 FMI 1.

Step	Action	Decision
7	Inspect for a fuel leak to intake. Perform Fuel to Intake leak test (page 174). Is fuel leaking to intake?	Yes: Go to step 8.
		No: Repair fuel leak to intake. After repairs are complete, retest for SPN 5395 FMI 1.

Step	Action	Decision
8	Inspect for contaminated fuel (alternate fuels other than Diesel fuel). Perform Fuel Quality Check (page 193). Is diesel fuel in good condition and Not contaminated?	Yes: Retest for SPN 5395 FMI 1.
		No: Drain fuel tank, and fill with clean and / or known good diesel fuel. After repairs are complete, retest for SPN 5395 FMI 1.

NOTE: After doing all diagnostic steps, if SPN 5395 FMI 1 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

FDP Sensor (Fuel Delivery Pressure)

SPN	FMI	Condition	Possible Causes	Actions
94	0	Fuel pressure above maximum	• VREF5 circuit Open or high resistance • SIG GND circuit Open or high resistance • FDP circuit Open or high resistance • Restricted secondary (engine) fuel filter • Restriction in return line to fuel tank • Failed Fuel Delivery Pressure (FDP) sensor	Step-Based Diagnostics (page 1086)
94	3	FDP signal Out of Range HIGH	• FDP signal circuit OPEN or short to PWR • SIG GND circuit OPEN • VREF5 circuit OPEN • Failed FDP sensor	Pin-Point Diagnostics (page 1089)
94	4	FDP signal Out of Range LOW	• FDP signal circuit short to GND • Failed FDP sensor	Pin-Point Diagnostics (page 1089)

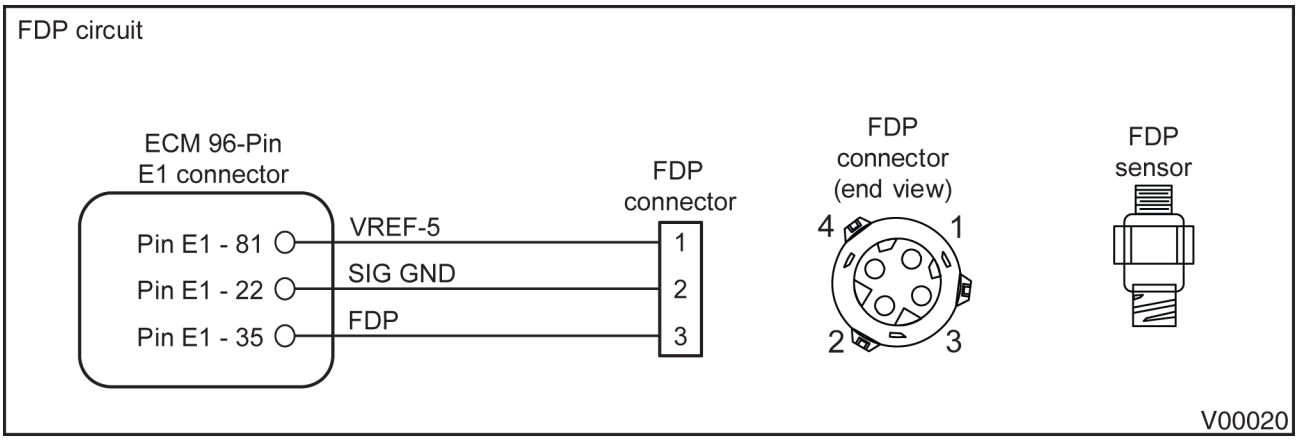


Figure 393 FDP sensor circuit diagram

NOTE: See latest version of Navistar N13 Engine and Aftertreatment Wiring Schematic Form 0000002203 for additional circuit information.

Overview

The Fuel Delivery Pressure (FDP) sensor measures the fuel delivery pressure exiting the secondary (engine) fuel filter assembly. This data is sent to the ECM to monitor the low pressure fuel pumps performance and condition.

Tools Required

- 180-Pin Breakout Box 00-00956-08
- 3-Banana Plug Harness ZTSE4498
- 500 Ohm Resistor Harness ZTSE4497
- Big Bore Terminal Test Probe Kit ZTSE4899
- Breakout Harness ZTSE4881 (FDP)
- Digital Multimeter (DMM)
- Fuel Inlet Restriction / Aeration Tool ZTSE4886
- Fuel Pressure Gauge ZTSE4681
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

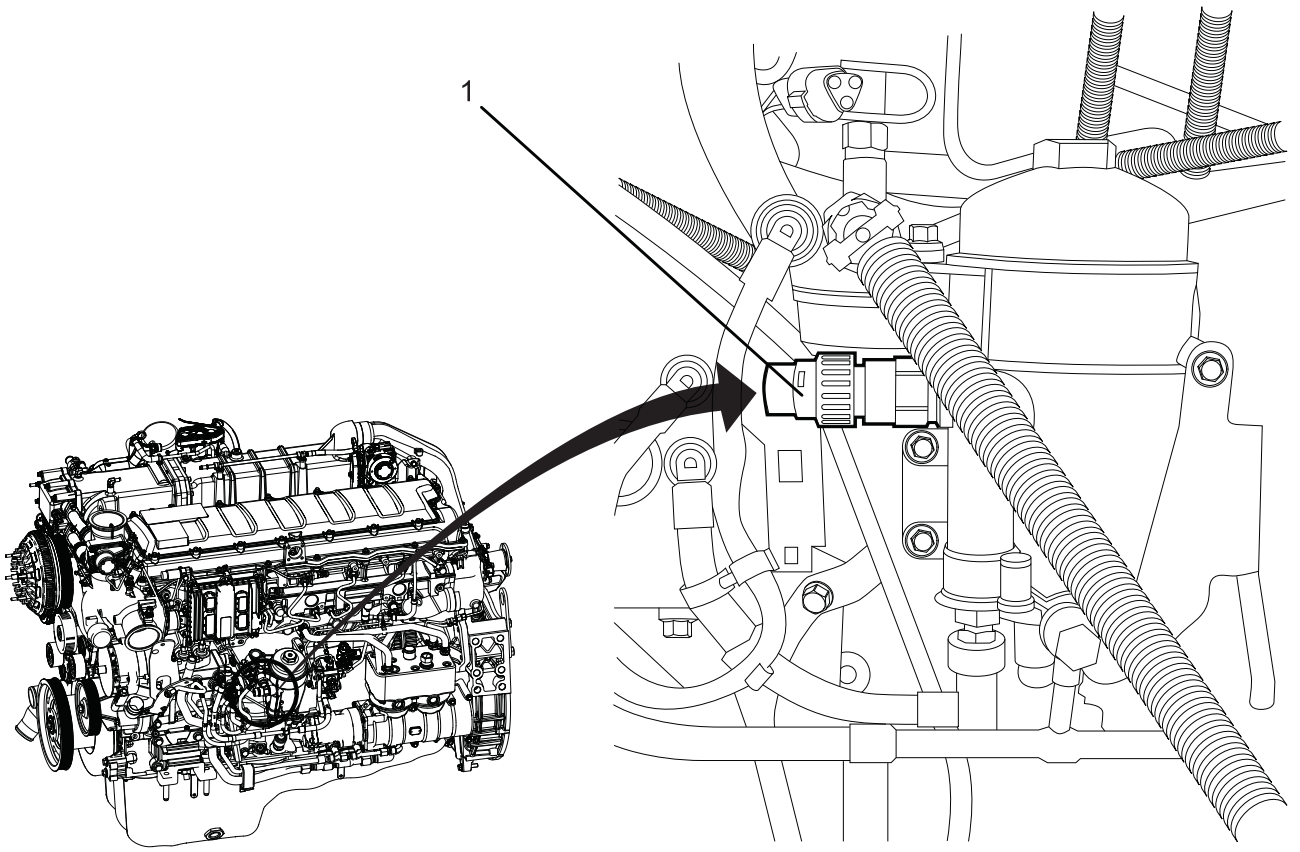


Figure 394 FDP Sensor Location

1. Fuel Delivery Pressure (FDP) sensor

SPN 94 FMI 0 - Fuel Delivery Pressure above Critical

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Signal from Fuel Delivery Pressure (FDP) sensor above expected (in-range, but not rational).	Fuel delivery pressure > 145 psi (1000 kPa) or (130 psi [900 kPa] at idle)	Key-On Engine-Running (KOER)	2 seconds

Fault Overview

Fault code sets when Electronic Control Module (ECM) detects that Fuel Delivery Pressure (FDP) is over 130 psi (900 kPa) at idle, or over 145 psi (1000 kPa) when engine speed is above idle.

Malfunction Indicator Lamp (MIL) Reaction

When fault is active, MIL will not illuminate.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

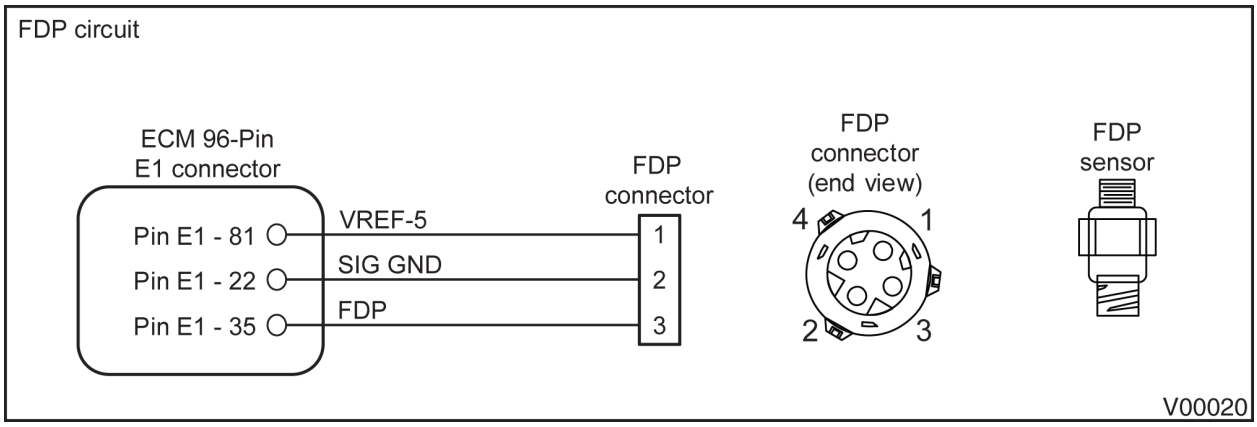


Figure 395 FDP Sensor Circuit Diagram

Possible Causes

- VREF5 circuit Open or high resistance
- SIG GND circuit Open or high resistance
- FDP circuit Open or high resistance
- Restricted secondary (engine) fuel filter
- Restriction in return line to fuel tank
- Failed Fuel Delivery Pressure (FDP) sensor

Step	Action	Decision
1	Inspect connections at Fuel Delivery Pressure (FDP) sensor. Key OFF, disconnect FDP sensor. Check FDP sensor and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the FDP sensor connector, harness, and terminals clean and undamaged?	Yes: Go to step 2. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 94 FMI 0.

Step	Action	Decision
2	Check for a failed FDP sensor. Connect Fuel Inlet Restriction / Aeration Tool ZTSE4886 between low side pressure line and the inlet to the secondary (engine) mounted fuel filter. Connect Fuel Pressure Gauge ZTSE4681 to Fuel Inlet Restriction / Aeration Tool ZTSE4886. Run engine at idle and high idle, compare gauge with the ServiceMaxx value. (Note: ServiceMaxx reads 15 psi below gauge pressure). Do idle and high idle fuel pressure values stay within 2 psi each other?	Yes: Go to step 3. No: Go to step 5.

Step	Action	Decision
3	Check for a restricted secondary (engine) fuel filter. Perform the High-pressure Pump Inlet Pressure Test (page 228). Is fuel pressure constantly between 85 to 120 psi at low and high idle?	Yes: Go to step 4. No: Replace secondary fuel filter. After repairs are complete, retest for SPN 94 FMI 0.

Step	Action	Decision
4	Check for restriction in return line to fuel tank. Perform the HP Pump Fuel Return Pressure Test (page 233). Is fuel pressure < 13 psi?	Yes: Replace the FDP sensor. After repairs are complete, retest for SPN 94 FMI 0. No: Repair restriction in return line to fuel tank. After repairs are complete, retest for SPN 94 FMI 0.

Step	Action	Decision
5	Check for Open or high resistance in VREF5 circuit. Connect 180-pin Breakout Box with Breakout Harness 00-01468-00 to vehicle harness and leave Engine Control Module (ECM) disconnected. Connect Breakout Harness ZTSE4881 to vehicle harness and leave FDP sensor disconnected. Key OFF, use a DMM to measure resistance from Breakout Harness pin-1 to 180-pin Breakout Box pin E1-81. Is resistance less than 5 ohms?	Yes: Go to step 6. No: Repair Open or high resistance between FDP connector pin-1 and ECM pin E1-81. After repairs are complete, retest for SPN 94 FMI 0.

Step	Action	Decision
6	Check for Open or high resistance in SIG GND circuit. Connect 180-pin Breakout Box with Breakout Harness 00-01468-00 to vehicle harness and leave ECM disconnected. Connect Breakout Harness ZTSE4881 to vehicle harness and leave FDP sensor disconnected. Key OFF, use a DMM to measure resistance from Breakout Harness ZTSE4881 pin-2 to 180-pin Breakout Box pin E1-22. Is resistance less than 5 ohms?	Yes: Go to step 7. No: Repair Open or high resistance between FDP connector pin-2 and ECM pin E1-22. After repairs are complete, retest for SPN 94 FMI 0.

Step	Action	Decision
7	Check for Open or high resistance in FDP circuit. Connect 180-pin Breakout Box with Breakout Harness 00-01468-00 to vehicle harness and leave ECM disconnected. Connect Breakout Harness ZTSE4881 to vehicle harness and leave FDP sensor disconnected. Key OFF, use a DMM to measure resistance from Breakout Harness pin-3 to 180-pin Breakout Box pin E1-35. Is resistance less than 5 ohms?	No: Replace the FDP sensor. After repairs are complete, retest for SPN 94 FMI 0. No: Repair Open or high resistance between FDP connector pin-3 and ECM pin E1-35. After repairs are complete, retest for SPN 94 FMI 0.

NOTE: After performing all diagnostic steps, if SPN 94 FMI 0 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

Pinpoint Diagnostics With ServiceMaxx™ Software

WARNING: To prevent personal injury or death, stay clear of rotating parts (belts and fan) and hot engine surfaces.

1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, run the Continuous Monitor test.
2. Monitor sensor voltage and verify an active DTC for this sensor.
   - If DTC is previously active, monitor signal while wiggling harness of suspect sensor. If circuit is interrupted, signal will spike and DTC will go active or pending.
   - If DTC is active, continue to Biased Sensor or Circuit Check.

NOTE: Inspect connectors for damaged pins, corrosion, or loose pins. Repair if necessary.

Sensor Circuit Check With ServiceMaxx™ Software

Connect Breakout Harness ZTSE4881 to FDP engine harness, and leave FDP sensor disconnected. Turn ignition ON.

Test Point	Specification	Comment – < Less than, > Greater than
EST – Monitor FDPv	5.0 V ± 0.5 V	If > 4.5 V, check FDP signal circuit for short to GND
DMM — Measure voltage 1 to GND	5.0 V ± 0.5 V	If > 5.5 V, check VREF5 for short to PWR. If < 4.5 V, check VREF5 for OPEN or short to GND. Do Harness Resistance Check (page 1090).
DMM — Measure voltage 1 and 2	5 V ± 0.5 V	If < 4.5 V, check SIG GND for OPEN. Do Harness Resistance Check (page 1090).
EST – Monitor FDPv Short across Breakout Harness ZTSE4881 pins 2 to 3	5 V ± 0.5 V	If > 0.5 V, check FDP signal circuit for OPEN. Do Harness Resistance Check (page 1090).
If checks are within specification, connect sensor and clear DTCs. If active code remains, replace FDP sensor.		

Connector Voltage Check Without ServiceMaxx™ Software

Connect Breakout Harness ZTSE4881 to FDP engine harness, and leave FDP sensor disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	5 V ± 0.5 V	If > 5.5 V, check VREF5 for short to PWR. If < 4.5 V, check VREF5 for OPEN or short to GND. Do Harness Resistance Check (page 1090).
2 to GND	0 V	If > 0.25 V, check SIG GND circuit for short to PWR.
3 to GND	5.0 V	If <, 4.5 V, check FDP signal circuit for short to GND.

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM E1 and E2 harness to ECM E1 and E2 engine harness connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE4881 to FDP engine harness, and leave FDP sensor disconnected. Use DMM to measure resistance.

Test Point	Specifications	Comment – < Less than, > Greater than
1 to GND	> 1k Ω	If < 1k Ω, check for short to GND.
1 to E1-81	< 5 Ω	If > 5 Ω, check for OPEN circuit.
2 to GND	> 1k Ω	If < 1k Ω, check for short to GND.

Harness Resistance Check (cont.)

2 to E1-22	< 5 Ω	If > 5 Ω, check for OPEN circuit.
3 to GND	> 1k Ω	If < 1k Ω, check for short to GND.
3 to E1-35	< 5 Ω	If > 5 Ω, check for OPEN circuit.

FPCV (Fuel Pressure Control Valve)

SPN	FMI	Condition	Possible Causes	Actions
633	3	FPCV short to PWR	• FPCV circuit short to PWR • Failed FPCV valve	Pin-Point Diagnostics (page 1093)
633	4	FPCV short to GND	• FPCV circuit short to GND • Failed FPCV valve	Pin-Point Diagnostics (page 1093)
633	5	FPCV open load/circuit	• FPCV circuit OPEN • Failed FPCV	Pin-Point Diagnostics (page 1093)

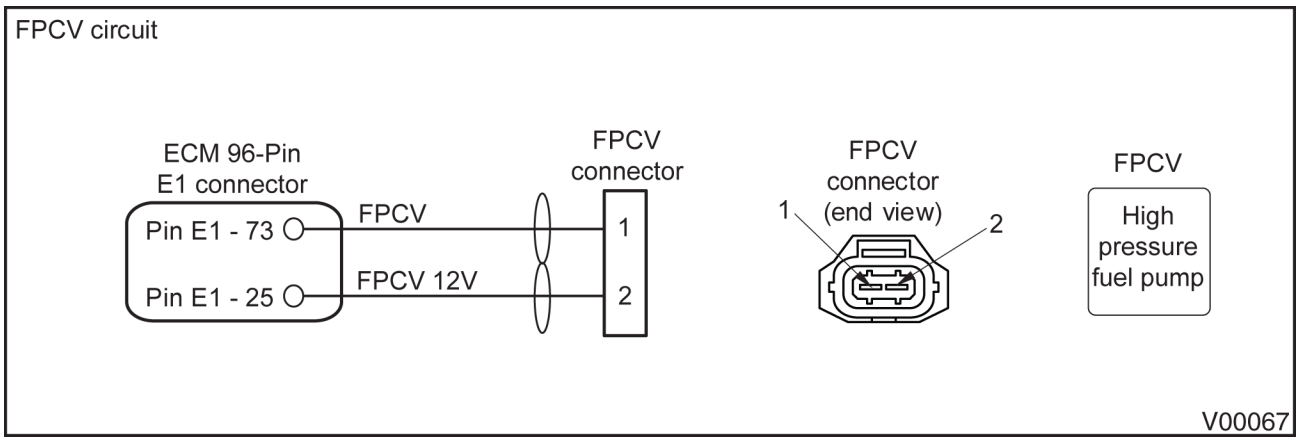


Figure 396 FPCV circuit diagram

Tools Required

- 180-Pin Breakout Box 00-00956-08
- 2010 MaxxForce 11 & 13 Harness Kit 00-01462-00
- 3-Banana Plug Harness ZTSE4498
- 500 Ohm Resistor Harness ZTSE4497
- Big Bore Terminal Test Probe Kit ZTSE4899
- Breakout Harness ZTSE4828 (FPCV)
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

Pinpoint Diagnostics With ServiceMaxx™ Software

WARNING: To prevent personal injury or death, stay clear of rotating parts (belts and fan) and hot engine surfaces.

1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, select Tests > KOER Tests > High Pressure Pump Test.
2. Run High Pressure Pump Test.
   - If High Pressure Pump Test fails, check FPCV valve for mechanical problem.
   - If FPCV valve does not move, continue with pinpoint diagnostics.

Connector Voltage Check – FPCV Disconnected

Connect Breakout Harness ZTSE4828 to FPCV engine harness, and leave FPCV sensor disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
2 to GND	B+	If < B+, OPEN circuit. Do Harness Resistance Check
1 to GND	0.8 V	If >1.3 V, Check for OPEN circuit. Do Harness Resistance Checks
If measurements are within specifications, do Operational Voltage Check.		

Operational Voltage Check

NOTE: Ensure battery voltage is at or above 12 V, before running this procedure.

1. Connect Breakout Harness ZTSE4828 between FPCV and engine harness.
2. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests > KOEO Tests > Actuator Test. Select Fuel Pressure Control Valve from the drop-down menu.
3. Command FPCV to 5%.
4. Use DMM to measure voltage.
5. Command FPCV to 95%.
6. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	5% = 8.5 V ± 1.0 V	If < 7.5 V, check for OPEN circuit. Do Harness Resistance Check.
1 to GND	95% = 1.5 V ± 0.5 V	If > 2.0 V, check for OPEN circuit or failed actuator.

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM E1 and E2 harness to ECM E1 and E2 engine harness connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE4828 to FPCV engine harness, and leave FPCV sensor disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	> 1k Ω	If < 1k Ω, check for short to GND.
1 to E1-73	< 5 Ω	If > 5 Ω, check for OPEN circuit.
2 to GND	> 1k Ω	If < 1k Ω, check for OPEN circuit.
2 to E1-25	< 5 Ω	If > 5 Ω, check for OPEN circuit.

If voltage and resistance checks are within specifications, the FPCV is working correctly. See High Pressure Fuel System (page 227) in “Engine Symptoms Diagnostics."

FRP Sensor (Fuel Rail Pressure)

SPN	FMI	Condition	Possible Causes	Actions
157	3	FRP signal Out of Range HIGH	• FRP signal circuit short to PWR • SIG GND circuit high resistance or Open • Failed FRP sensor	Circuit Checks (page 1097)
157	4	FRP signal Out of Range LOW	• FRP signal circuit short to GND • FRP signal circuit high resistance or Open • Failed FRP sensor • VREF6 circuit high resistance or Open	Circuit Checks (page 1097)
157	20	FRP signal Drifted HIGH	• FRP signal circuit short to PWR • SIG GND circuit high resistance or Open • Failed FRP sensor	Step-based Diagnostics (page 1100)
157	21	FRP signal Drifted LOW	• FRP signal circuit short to GND • FRP signal circuit high resistance or Open • Failed FRP sensor • VREF6 circuit high resistance or Open	Step-based Diagnostics (page 1102)

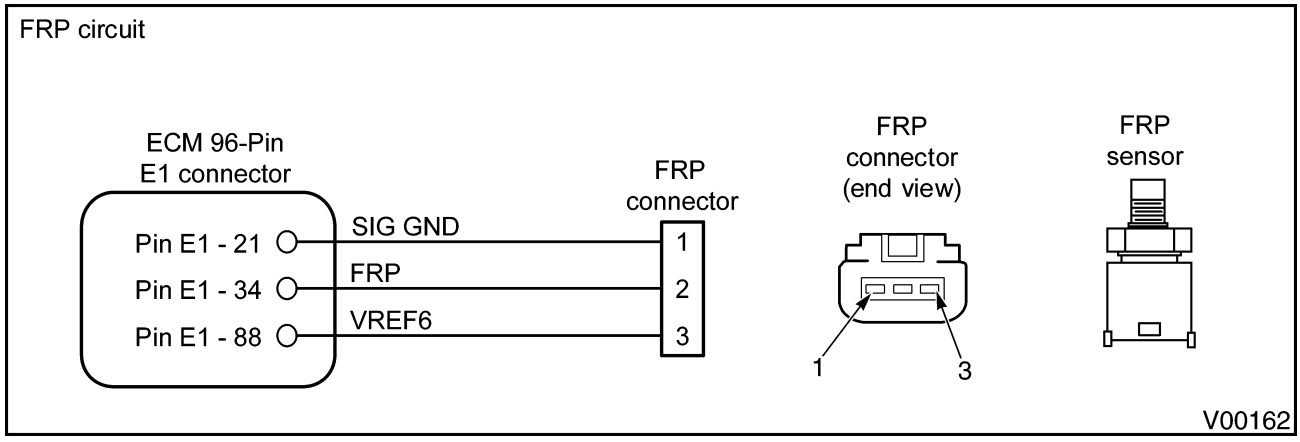


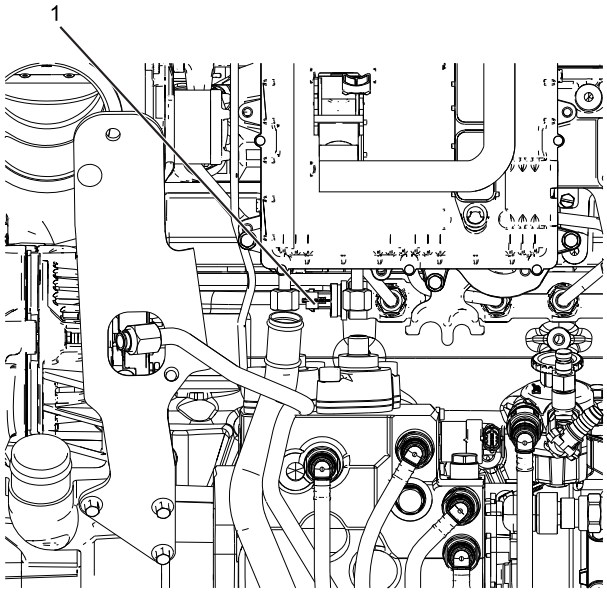
Figure 397 FRP sensor circuit diagram

Overview

The FRP sensor is a variable-capacitance sensor that measures fuel rail pressure at the high-pressure common fuel rail. As pressure increases, sensor capacitance changes causing the voltage sent to Engine Control Module (ECM) to change. The ECM adjusts the Fuel Pressure Control Valve (FPCV) duty cycle to match engine requirements for starting, engine load, speed, and temperature.

Tools Required

- 180-Pin Breakout Box 00-00956-08
- 2010 MaxxForce 11 & 13 Harness Kit 00-01462-00
- 3-Banana Plug Harness ZTSE4498
- 500 Ohm Resistor Harness ZTSE4497
- Big Bore Terminal Test Probe Kit ZTSE4899
- Breakout Harness ZTSE4829 (FRP)
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)



0000041032

Figure 398 FRP Sensor Location

1. Fuel Rail Pressure (FRP) sensor

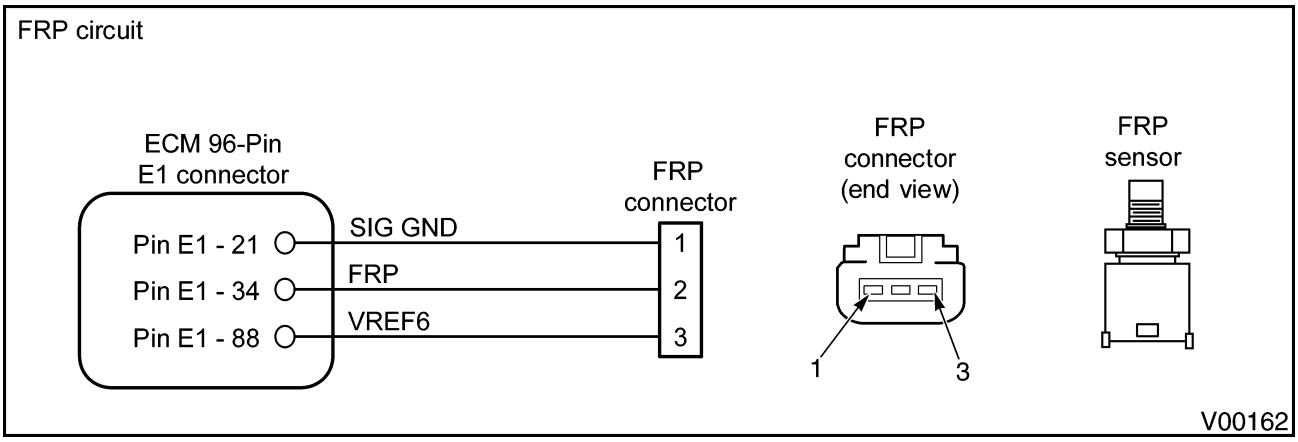


Figure 399 FRP sensor circuit diagram

Pinpoint Diagnostics With ServiceMaxx™ Software

WARNING: To prevent personal injury or death, stay clear of rotating parts (belts and fan) and hot engine surfaces.

1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, run the Continuous Monitor test.
2. Monitor sensor voltage and verify an active DTC for this sensor.
   - If DTC is previously active, monitor signal while wiggling harness of suspect sensor. If circuit is interrupted, signal will spike.
   - If DTC is active or pending, continue to Sensor Circuit Check.

NOTE: Inspect connectors for damaged pins, corrosion, or loose pins. Repair if necessary.

Sensor Circuit Check With ServiceMaxx™ Software

Connect Breakout Harness ZTSE4829 to FRP engine harness, and leave FRP sensor disconnected. Turn ignition ON.

Test Point	Specification	Comment – < Less than, > Greater than
EST – Monitor FRPv	5.0 V ± 0.5 V	If < 4.5 V, check FRP signal circuit for short to GND.
DMM — Measure volts 3 to GND	5.0 V ± 0.5 V	If > 5.5 V, check VREF6 for short to PWR. If < 4.5 V, check VREF6 for OPEN or short to GND. Do Harness Resistance Check (page 1099).
DMM — Measure voltage 1 to 3	5 V ± 0.5 V	If < 4.5 V, check SIG GND for OPEN. Do Harness Resistance Check (page 1099).
EST – Monitor FRPv Short across Breakout Harness ZTSE4829 pins 2 to 3	4.5 V to 5.5 V	If < 4.5 V, check FRP signal circuit for OPEN. Do Harness Resistance Check (page 1099).
If checks are within specification, connect sensor and clear DTCs. If active code remains, replace FRP sensor.		

Connector Voltage Check Without ServiceMaxx™ Software

Connect Breakout Harness ZTSE4829 to FRP engine harness, and leave FRP sensor disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
3 to GND	5.0 V ± 0.5 V	If > 5.5 V, check VREF6 for short to PWR. If < 4.5 V, check VREF6 for OPEN or short to GND. Do Harness Resistance Check (page 1099).
1 to GND	0 V	If > 0.25 V, check SIG GND circuit for short to PWR.
2 to GND	0 V	If < 4.5 V, check FRP signal circuit for short to GND

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM E1 and E2 harness to ECM E1 and E2 engine harness connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE4829 to FRP engine harness, and leave FRP sensor disconnected. Use DMM to measure resistance.

Test Point	Specifications	Comment – < Less than, > Greater than
1 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
1 to E1-21	< 5 Ω	If > 5 Ω, check for OPEN circuit.
2 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
2 to E1-34	< 5 Ω	If > 5 Ω, check for OPEN circuit.
3 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
3 to E1-88	< 5 Ω	If > 5 Ω, check for OPEN circuit.

SPN 157 - FMI 20 FRP signal Drifted HIGH

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Fuel Rail Pressure rationality offset high (during after run)	Fuel Rail Pressure (FRP) signal greater than 0.609 volts	Engine coolant temp. > 138°F (60°C) Key ON ECM in After Run (“house keeping”) Injector blank shot cycle complete	3 Events

Fault Overview

After shutdown, with enable conditions met, the Engine Control Module (ECM) operates after run cycle (for 30 to 45 seconds) to do needed "house keeping" operations. The after run cycle is the process the ECM goes through to save memory and shutdown.

Malfunction Indicator Lamp (MIL) Reaction

When fault is active, MIL will not illuminate.

Associated Faults

If SPN 3514 FMI 14 is active, correct and then retest for SPN 157 FMI 20.

Drive Cycle

See 2013 HD-OBD Diagnostic Reference Manual.

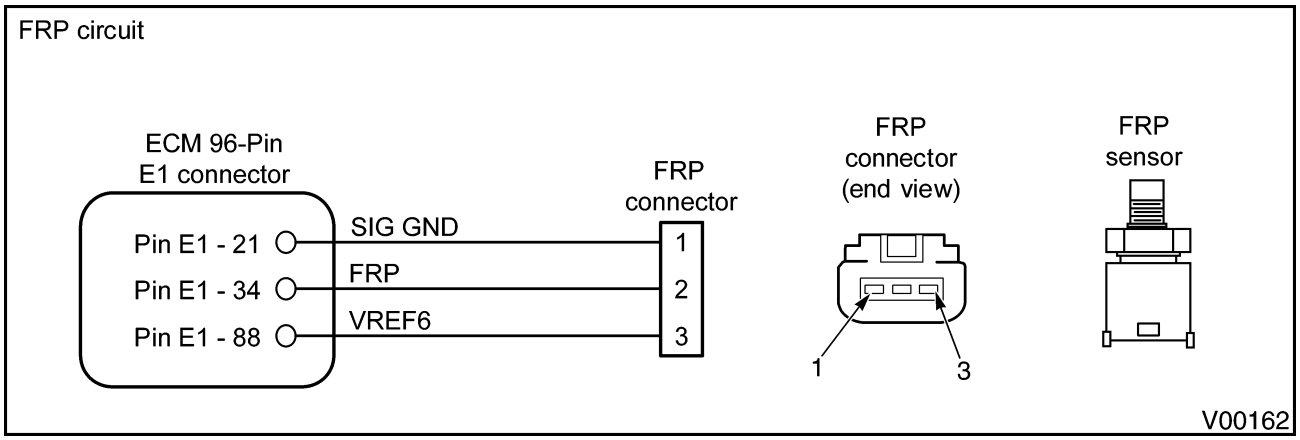


Figure 400 FRP sensor circuit diagram

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for other fault codes. Is SPN 157 FMI 20 the only fault code active?	Yes: Go to step 2. No: Repair other fault code(s). After repairs are complete, retest for SPN 157 FMI 20.

Step	Action	Decision
2	Inspect connections at FRP sensor. Key OFF, disconnect FRP sensor. Check FRP sensor and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the FRP sensor connector, harness, and terminals clean and undamaged?	Yes: Go to step 3. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 157 FMI 20.

Step	Action	Decision
3	Check FRP circuit for short to power. Using EST with ServiceMaxx™, run Continuous Monitor session. Key-On Engine-Off, FRP sensor connected. Does ServiceMaxx™ software show FRP sensor voltage less than 5.0 volts?	Yes: Go to step 4. No: Repair short to power from FRP sensor connector pin 2 to ECM 96–pin connector E1-34. After repairs are complete, retest for SPN 157 FMI 20.

Step	Action	Decision
4	Check SIG GND circuit for high resistance. With FRP sensor disconnected, connect Breakout Harness 4829. Measure resistance between FRP sensor connector pin 1 and a known good ground. Is resistance less than 5 ohms?	Yes: Replace FRP sensor. See Engine Service Manual. No: Repair high resistance between FRP sensor connector pin 1 and ECM 96–pin connector E1-21. After repairs are complete, retest for SPN 157 FMI 20.

NOTE: After doing all diagnostic steps, if SPN 157 FMI 20 remains verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 157 - FMI 21 FRP signal Drifted LOW

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Fuel Rail Pressure rationality offset low (during after run)	Fuel Rail Pressure (FRP) signal less than 0.424 volts	Engine coolant temp. > 138°F (60°C) Key ON ECM in After Run (“house keeping”) Injector blank shot cycle complete	3 Events

Fault Overview

After shutdown, with enable conditions met, the Engine Control Module (ECM) operates after run cycle (for 30 to 45 seconds) to do needed "house keeping" operations. The after run cycle is the process the ECM goes through to save memory and shutdown.

Malfunction Indicator Lamp (MIL) Reaction

When fault is active, MIL will not illuminate.

Associated Faults

If SPN 3514 FMI 14 is active, correct and then retest for SPN 157 FMI 21.

Drive Cycle

See 2013 HD-OBD Diagnostic Reference Manual.

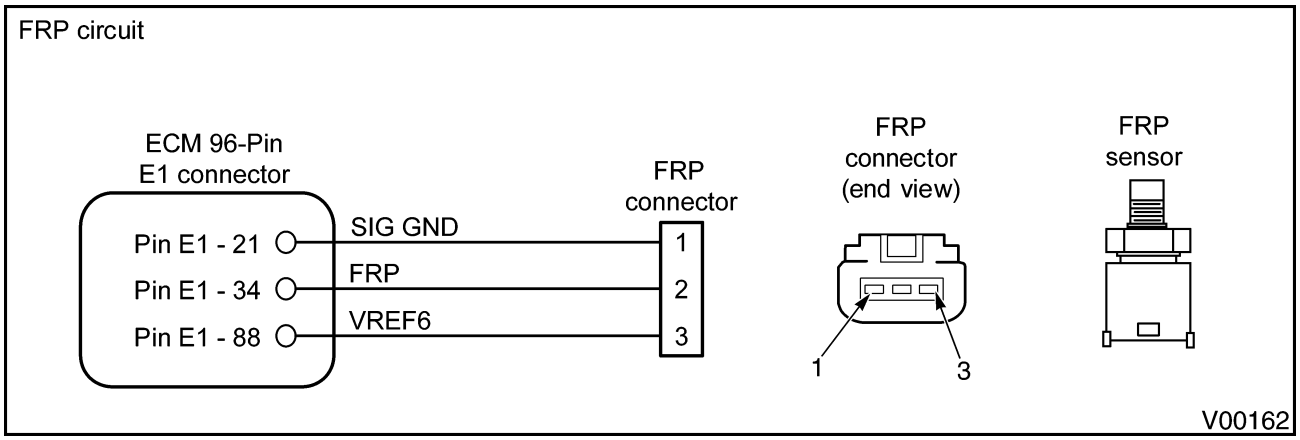


Figure 401 FRP sensor circuit diagram

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for other fault codes. Is SPN 157 FMI 21 the only fault code active?	Yes: Go to step 2. No: Repair other fault code(s). After repairs are complete, retest for SPN 157 FMI 21.

Step	Action	Decision
2	Inspect connections at FRP sensor. Key OFF, disconnect FRP sensor. Check FRP sensor and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the FRP sensor connector, harness, and terminals clean and undamaged?	Yes: Go to step 3. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 157 FMI 21.

Step	Action	Decision
3	Check FRP circuit for short to ground. Connect Breakout Harness 4829 to FRP sensor connector and leave FRP sensor disconnected. Use a DMM to measure resistance between Breakout harness 4829 test point 2 and a known, good ground. Is resistance greater than 1000 ohms?	Yes: Go to step 4. No: Repair short to ground between FRP connector pin 2 and ECM 96–pin connector E1-34. After repairs are complete, retest for SPN 157 FMI 21.

Step	Action	Decision
4	Check VREF6 circuit for Open or high resistance. Key-On Engine-Off (KOEO), with Breakout Harness 4829 connected to FRP sensor connector, use a DMM to measure voltage between FRP sensor connector pin 3 and a known good ground. Is voltage 4.5 volts or greater?	Yes: Go to step 5. No: Repair high resistance between FRP sensor connector pin 3 and ECM 96–pin connector E1-88. After repairs are complete, retest for SPN 157 FMI 21.

Step	Action	Decision
5	Check FRP circuit for high resistance or Open. Using EST with ServiceMaxx™ software, run Continuous Monitor session. KOEO, with Breakout Harness 4829 connected, short FRP sensor connector pin 3 to pin 2. Does ServiceMaxx™ software show FRP sensor voltage 4.5 volts or more?	Yes: Replace FRP sensor. See Engine Service Manual. No: Repair high resistance between FRP sensor connector pin 2 and ECM 96–pin connector E1-34. After repairs are complete, retest for SPN 157 FMI 21.

NOTE: After doing all diagnostic steps, if SPN 157 FMI 21 remains verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

FRP (Fuel Rail Pressure) System

SPN	FMI	Condition	Possible Causes	Actions
157	0	FRP relief valve opening fault	• Outdated ECM calibration	Calibration out-of-date (page 1108)
157	14	FRP Relief Valve failure	• Outdated ECM calibration	Calibration out-of-date (page 1108)
3055	0	FRP exceeded maximum	• Restricted high-pressure pump fuel return line • Failed Fuel Pressure Control Valve (FPCV) (sticking)	Step-Based Diagnostics (page 1109)
3055	1	Low Fuel Pressure at start	• Fuel Rail Pressure (FRP) sensor or circuit fault • Low fuel level • Low-pressure fuel system leaks • Restricted engine mounted secondary fuel filter • Aerated fuel delivery • Restricted low pressure fuel system • Internal leak in high-pressure fuel system • Leaking fuel pressure relief valve • Leaking KUEV valve • Stuck or sticking FPCV • Failed low-pressure fuel pump • Failed high-pressure fuel pump	Step-Based Diagnostics (page 1111)

3055	15	FRP below minimum with maximum command	• Low fuel level • Fuel pressure fuel system leaks • Restricted engine mounted secondary fuel filter • Aerated fuel delivery • Restricted fuel supply • Internal leak in high-pressure fuel system • Leaking fuel pressure relief valve • Leaking KUEV valve • Stuck or sticking FPCV • Failed low-pressure fuel pump • Failed high-pressure fuel pump	Step-Based Diagnostics (page 1115)
3055	17	FRP above maximum with minimum command	• Restricted high-pressure pump fuel return line • Fuel Pressure Control Valve (FPCV) or circuit fault	Step-Based Diagnostics (page 1119)

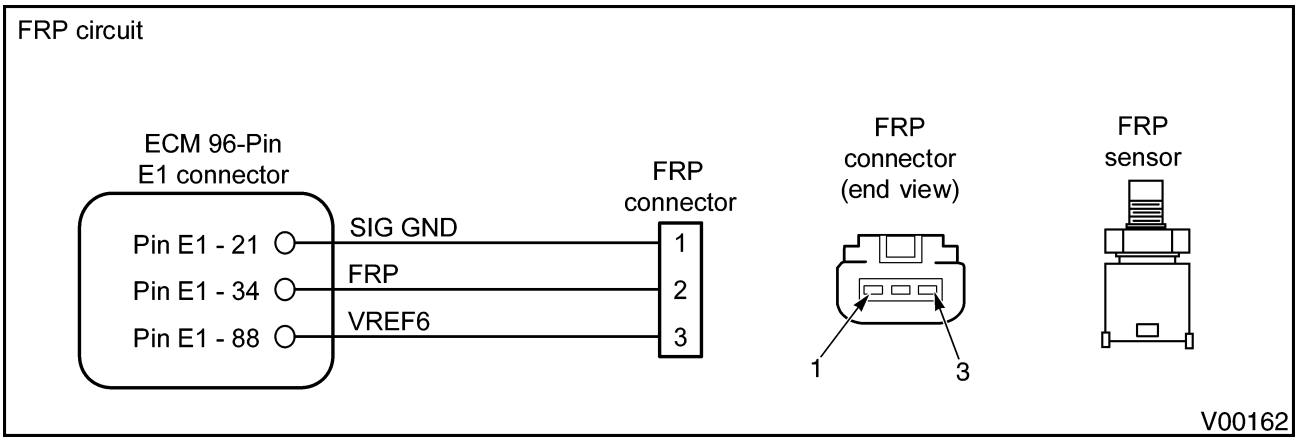


Figure 402 FRP Sensor Circuit Diagram

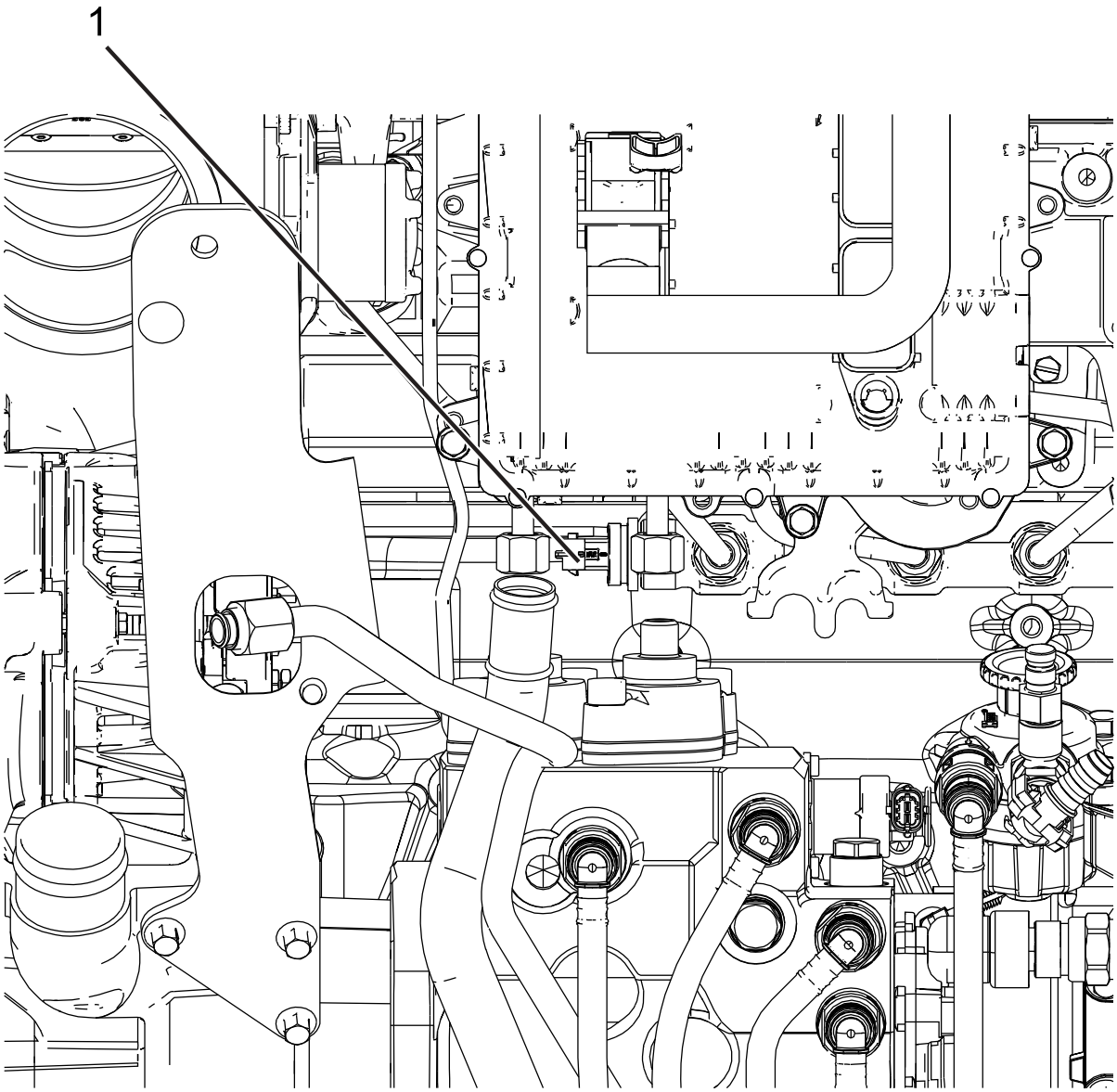
NOTE: See latest version of Navistar N13 Engine and Aftertreatment Wiring Schematic Form 0000002203 for additional circuit information.

Overview

The Fuel Rail Pressure (FRP) sensor is a variable-capacitance sensor that measures pressure at the high-pressure common fuel rail. As pressure increases, sensor capacitance changes causing voltage to Engine Control Module (ECM) to change. The ECM adjusts the Fuel Pressure Control Valve (FPCV) duty cycle to control fuel pressure for starting and for changing engine load, speed, and temperature.

Tools Required

- Breakout Harness ZTSE4828 (FPCV)
- 2010 MaxxForce 11 & 13 Harness Kit 00-01462-00
- Fuel Inlet Restriction / Aeration Tool ZTSE4886
- Fuel Pressure Gauge ZTSE4681
- Fuel Line Coupler ZTSE4906
- Compucheck fitting ZTSE4526
- Clean Fuel Source Tool 15-637-01
- Pressure Test Kit ZTSE4409
- High Pressure Return Line Tester ZTSE4887
- High Pressure Rail Plug ZTSE6098
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)



0000041032

Figure 403 FRP Sensor Location

1. Fuel Rail Pressure (FRP) sensor

Pinpoint Diagnostics With ServiceMaxx™ Software

WARNING: To prevent personal injury or death, stay clear of rotating parts (belts and fan) and hot engine surfaces.

SPN 157 FMI 0 - FRP relief valve opening fault

Re-flash Engine Control Module (ECM) software.

SPN 157 FMI 14 - FRP Relief Valve failure

Re-flash ECM software.

SPN 3055 FMI 0 - FRP Exceeded Maximum

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Fuel Rail Pressure (FRP) above maximum pressure.	FRP greater than 34,000 psi (235,000 kpa)	Key ON Closed loop FRP control	0.25 seconds

Fault Overview

Fault code sets when signal from the Fuel Rail Pressure (FRP) sensor indicates FRP exceeds 34,000 psi (235,000 kPa).

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 94 FMI 0 (FDP); SPN 157 FMI 3, 4, 20, and 21 (FRP); and SPN 633 FMI 3, 4, and 5 (FPCV)

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Restricted high-pressure pump fuel return line
- Failed Fuel Pressure Control Valve (FPCV) (sticking)

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 94 FMI 0 (FDP); SPN 157 FMI 3, 4, 20, and 21 (FRP); and SPN 633 FMI 3, 4, and 5 (FPCV). Is the EST DTC list free of SPN 94 FMI 0; SPN 157 FMI 3, 4, 20, and 21 and SPN 633 FMI 3, 4, and 5?	Yes: Go to step 2. No: Repair SPN 94 FMI 0; SPN 157 FMI 3, 4, 20, and 21; and SPN 633 FMI 3, 4, and 5. After repairs are complete, retest for SPN 3055 FMI 0.

Step	Action	Decision
2	Check for restricted fuel return line. Perform HP Pump Fuel Return Pressure Test (page 233). Is pressure < 13 psi?	Yes: Go to step 3. No: Repair restriction in fuel return line between high-pressure fuel pump and fuel tank. After repairs are complete, retest for SPN 3055 FMI 0.

Step	Action	Decision
3	Check for a failed Fuel Pressure Control Valve (FPCV). Key OFF, connect Breakout Harness ZTSE4828 to FPCV and leave vehicle harness disconnected. Using a DMM, measure resistance between ZTSE4828 pin-1 and pin-2. Is resistance between 2.6 and 3.2 ohms?	Yes: Go to step 4. No: Replace FPCV. After repairs are complete, retest for SPN 3055 FMI 0.

Step	Action	Decision
4	Check for a sticking FPCV. Run engine at idle. Using EST, monitor the difference between the desired and actual fuel rail pressure for 5 minutes. Does pressure difference remain < 1160 psi (80 Bar) throughout the test?	Yes: Retest for SPN 3055 FMI 0. No: Replace FPCV. After repairs are complete, retest for SPN 3055 FMI 0.

NOTE: After performing all diagnostic steps, if SPN 3055 FMI 0 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3055 FMI 1 - Low Fuel Pressure at Start

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Fuel Rail Pressure (FRP) below minimum pressure.	FRP less than 1,450 psi (10,000 kpa)	Engine Speed > 70 rpm Ambient Pressure > 12 psi (83 kPa) Ambient Temp > 19°F (-7°C) Battery Voltage (before crank) > 11 Volts	0.5 seconds

Fault Overview

Fault code sets when the Engine Control Module (ECM) detects Fuel Rail Pressure (FRP) does not build within a predetermined time while the engine is cranking.

Malfunction Indicator Lamp (MIL) Reaction

MIL may illuminate when this fault is detected during one drive cycle.

Associated Faults

SPN 94 FMI 0 (FDP); SPN 157 FMI 3, 4, 20, and 21 (FRP); and SPN 633 FMI 3, 4, and 5 (FPCV)

Fault Facts

The KUEV valve is a flow control valve that allows return fuel to lubricate the internal components of the high-pressure fuel pump when the engine is running. The KUEV valve can be serviced separately from the high-pressure fuel pump.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Fuel Rail Pressure (FRP) sensor or circuit fault
- Low fuel level
- Low-pressure fuel system leaks
- Restricted engine mounted secondary fuel filter
- Aerated fuel delivery
- Restricted low pressure fuel system
- Internal leak in high-pressure fuel system
- Leaking fuel pressure relief valve
- Leaking KUEV valve
- Stuck or sticking FPCV
- Failed low-pressure fuel pump
- Failed high-pressure fuel pump

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 94 FMI 0 (FDP); SPN 157 FMI 3, 4, 20, and 21 (FRP); and SPN 633 FMI 3, 4, and 5 (FPCV). Is EST DTC list free of SPN 94 FMI 0; SPN 157 FMI 3, 4, 20, and 21; and SPN 633 FMI 3, 4, and 5?	Yes: Go to step 2. No: Repair SPN 94 FMI 0; SPN 157 FMI 3, 4, 20, and 21; and SPN 633 FMI 3, 4, and 5. After repairs are complete, retest for SPN 3055 FMI 1.

Step	Action	Decision
2	Check fuel level. Read fuel level using the vehicle instrument panel gauge and perform a visual inspection of fluid level in the fuel tank. Is fuel tank fluid level above 1/2 tank?	Yes: Go to step 3. No: Add fuel and prime engine. After repairs are complete, retest for SPN 3055 FMI 1.

Step	Action	Decision
3	Check fuel tank, fuel lines, and fuel filter assembles for: cracks and pitting; and loose, leaking, or damaged connections. Are the fuel tank, fuel lines, and fuel filter assembles in good condition and Not leaking?	Yes: Go to step 4. No: Add fuel or repair leaks, and prime engine. After repairs are complete, retest for SPN 3055 FMI 1.

Step	Action	Decision
4	Check that the engine cranks at a minimum of 130 rpm. Crank engine for maximum of 20 seconds. Does engine crank at a minimum of 130 rpm?	Yes: Go to step 5. No: Repair low cranking speed. After repairs are complete, retest for SPN 3055 FMI 1.

Step	Action	Decision
5	Verify the engine starts. Crank engine for maximum of 20 seconds. If engine does not start, wait 2 minutes and try again. Does engine start and maintain idle?	Yes: Go to SPN 3055 FMI 15 (page 1115). No: Go to step 6.

Step	Action	Decision
6	Check for a failed FRP sensor or circuit. Disconnect the FRP sensor electrical connector and attempt to start engine. Crank engine for maximum of 20 seconds. Does the engine start?	Yes: Diagnose FRP Sensor (page 1095). After repairs are complete, retest for SPN 3055 FMI 1. No: Reconnect sensor and go to step 7.

Step	Action	Decision
7	Check for low FDP. Perform Fuel Delivery Pressure (FDP) Test (page 218). Does FDP measure > 30 psi (15 psi in ServiceMaxx™)?	Yes: Go to step 11. No: Go to step 8.

Step	Action	Decision
8	Check for leaks or restrictions in the fuel supply to the low-pressure fuel pump. Perform Fuel Dead head Test (page 225). Is fuel dead head pressure greater than 65 psi?	Yes: Go to step 11. No: Go to step 9.

Step	Action	Decision
9	Check for aeration in low-pressure fuel system. Perform Fuel Aeration Test (page 221). Is low-pressure fuel system free from aeration?	Yes: Go to step 10. No: Repair aeration in low-pressure fuel system. After repairs are complete, retest for SPN 3055 FMI 1.

Step	Action	Decision
10	Check for restriction in low-pressure fuel system. Perform Fuel Restriction Test (page 221). Is low-pressure fuel system free of restrictions?	Yes: Replace low-pressure fuel pump. After repairs are complete, retest for SPN 3055 FMI 1. No: Repair restriction in low-pressure fuel system. After repairs are complete, retest for SPN 3055 FMI 1.

Step	Action	Decision
11	Check for a restricted engine mounted secondary fuel filter. Perform High-pressure Pump Inlet Pressure Test (page 228). Does the fuel pressure gauge read > 30 psi?	Yes: Go to step 12. No: Replace engine mounted secondary fuel filter. After repairs are complete, retest for SPN 3055 FMI 1.

Step	Action	Decision
12	Check for excessive fuel return. Perform Fuel Rail Pressure (FRP) Return Flow Test Part 1 (page 229). Is the fuel volume returned between 20-22 ml?	Yes: Go to step 15. No: Go to step 13.

Step	Action	Decision
13	Check for a failed fuel pressure relief valve. Perform Fuel Rail Pressure (FRP) Return Flow Test Part 2 (page 229). Is the line free of return fuel from fuel rail?	Yes: Go to step 14. No: Replace fuel pressure relief valve. After repairs are complete, retest for SPN 3055 FMI 1.

Step	Action	Decision
14	Check for an internal leak in the high-pressure fuel system. Perform Fuel Rail Pressure (FRP) Leak Isolation (page 231). Is fuel leaking out of High Pressure Return Line Tester ZTSE4887?	Yes: Retest for SPN 3055 FMI 1. If fault is still present notify supervisor for further action. No: Replace the last capped injector, injector tube, and all HP lines removed during this test. After repairs are complete, retest for SPN 3055 FMI 1.

Step	Action	Decision
15	Check for a failed KUEV valve. Perform the HP Pump Return Flow Test (page 227). Is High Pressure Return Line Tester ZTSE4887 free of fuel from the high-pressure pump return port?	Yes: Replace the high-pressure fuel pump. After repairs are complete, go to step 16. No: Replace KUEV valve. After repairs are complete, retest for SPN 3055 FMI 1.

Step	Action	Decision
16	Verify the fuel return line is free from restriction. Run HP Pump Fuel Return Pressure Test (page 233). Is pressure < 13 psi?	Yes: Retest for SPN 3055 FMI 1. If fault is still present notify supervisor for further action. No: Repair restriction in fuel return line between high-pressure fuel pump and fuel tank. After repairs are complete, retest for SPN 3055 FMI 1.

NOTE: After performing all diagnostic steps, if SPN 3055 FMI 1 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3055 FMI 15 - FRP Below Minimum with Maximum Command

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Fuel Rail Pressure (FRP) governor deviation above maximum limit	Rail pressure governor error > 725 psi at 600-750 rpm	Key ON Metering unit flow > function engine speed (41,500-55,000 mm^3/s) Engine mode normal Engine speed > 0 rpm OR FRP > 13,050 psi (90,000 kpa) for more than 20 engine revolutions Metering unit flow < 327,670 mm^3/sec	10 seconds

Fault Overview

Fault code sets when the Engine Control Module (ECM) detects Fuel Rail Pressure (FRP) is below minimum when the maximum is commanded.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 157 FMI 3, 4, 20, 21 (FRP); and SPN 633 FMI 3, 4, and 5 (FPCV)

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Low fuel level
- Fuel pressure fuel system leaks
- Restricted engine mounted secondary fuel filter
- Aerated fuel delivery
- Restricted fuel supply
- Internal leak in high-pressure fuel system
- Leaking fuel pressure relief valve
- Leaking KUEV valve
- Stuck or sticking FPCV
- Failed low-pressure fuel pump
- Failed high-pressure fuel pump

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 157 FMI 3, 4, 20, and 21 (FRP) or SPN 633 FMI 3, 4, and 5 (FPCV). Is the EST DTC list free of SPN 157 FMI 3, 4, 20, and 21, and SPN 633 FMI 3, 4, and 5?	Yes: Go to step 2. No: Repair SPN 157 FMI 3, 4, 20, and 21, and SPN 633 FMI 3, 4, and 5. After repairs are complete, retest for SPN 3055 FMI 15.

Step	Action	Decision
2	Check fuel level. Read fuel level using the vehicle instrument panel gauge and perform a visual inspection of fluid level in the fuel tank. Is fuel tank fluid level above 1/2 tank?	Yes: Go to step 3. No: Add fuel and prime engine. After repairs are complete, retest for SPN 3055 FMI 15.

Step	Action	Decision
3	Check fuel tank, fuel lines, and fuel filter assembles for: cracks and pitting; and loose, leaking, or damaged connections. Are the fuel tank, fuel lines, and fuel filter assembles in good condition and Not leaking?	Yes: Go to step 4. No: Add fuel or repair leaks, and prime engine. After repairs are complete, retest for SPN 3055 FMI 15.

Step	Action	Decision
4	Check that the engine cranks at a minimum of 130 rpm. Crank engine for maximum of 20 seconds. Does engine crank at a minimum of 130 rpm?	Yes: Go to step 5. No: Repair low cranking speed. After repairs are complete, retest for SPN 3055 FMI 15.

Step	Action	Decision
5	Verify the engine starts. Crank engine for maximum of 20 seconds. If engine does not start, wait 2 minutes and try again. Does engine start and maintain idle?	Yes: Go to step 6. No: Go to SPN 3055 FMI 1 (page 1111).

Step	Action	Decision
6	Check for low FDP. Perform Fuel Delivery Pressure (FDP) Test (page 218). Does FDP measure between 85 - 120 psi?	Yes: Go to step 10. No: Go to step 7.

Step	Action	Decision
7	Check for leaks or restrictions in the fuel supply to the low-pressure fuel pump. Perform Fuel Dead head Test (page 225). Is fuel dead head pressure greater than 65 psi?	Yes: Go to step 10. No: Go to step 8.

Step	Action	Decision
8	Check for aeration in low-pressure fuel system. Perform Fuel Aeration Test (page 221). Is low-pressure fuel system free from aeration?	Yes: Go to step 9. No: Repair aeration in low-pressure fuel system. After repairs are complete, retest for SPN 3055 FMI 15.

Step	Action	Decision
9	Check for restriction in low-pressure fuel system. Perform Fuel Restriction Test (page 223). Is low-pressure fuel system free of restrictions?	Yes: Retest for SPN 3055 FMI 15. If fault is still present notify supervisor for further action. No: Repair restriction in low-pressure fuel system. After repairs are complete, retest for SPN 3055 FMI 15.

Step	Action	Decision
10	Check for a restricted engine mounted secondary fuel filter. Perform High-pressure Pump Inlet Pressure Test (page 228). Does the fuel pressure gauge read > 30 psi?	Yes: Go to step 11. No: Replace engine mounted secondary fuel filter. After repairs are complete, retest for SPN 3055 FMI 15.

Step	Action	Decision
11	Check for excessive fuel return. Perform Fuel Rail Pressure (FRP) Return Flow Test Part 1 (page 229). Is the fuel volume returned between 20-22 ml?	Yes: Go to step 14. No: Go to step 12.

Step	Action	Decision
12	Check for a failed fuel pressure relief valve. Perform Fuel Rail Pressure (FRP) Return Flow Test Part 2 (page 229). Is the line free of return fuel from fuel rail?	Yes: Go to step 13. No: Replace fuel pressure relief valve. After repairs are complete, retest for SPN 3055 FMI 15.

Step	Action	Decision
13	Check for an internal leak in the high-pressure fuel system. Perform Fuel Rail Pressure (FRP) Leak Isolation (page 231). Is fuel leaking out of High Pressure Return Line Tester ZTSE4887?	Yes: Retest for SPN 3055 FMI 15. If fault is still present notify supervisor for further action.
		No: Replace the last capped injector, injector tube and all HP lines removed during this test. After repairs are complete, retest for SPN 3055 FMI 15.

Step	Action	Decision
14	Check for a failed KUEV valve. Perform the HP Pump Return Flow Test (page 227). Is High Pressure Return Line Tester ZTSE4887 free of fuel from the high-pressure pump return port while cranking?	Yes: Replace the high-pressure fuel pump. After repairs are complete, go to step 15.
		No: Replace KUEV valve. After repairs are complete, retest for SPN 3055 FMI 15.

Step	Action	Decision
15	Verify the fuel return line is free from restriction. Run HP Pump Fuel Return Pressure Test (page 233). Is pressure < 13 psi?	Yes: Retest for SPN 3055 FMI 15. If fault is still present notify supervisor for further action.
		No: Repair restriction in fuel return line between high-pressure fuel pump and fuel tank. After repairs are complete, retest for SPN 3055 FMI 15.

NOTE: After performing all diagnostic steps, if SPN 3055 FMI 15 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3055 FMI 17 - FRP Above Maximum with Minimum Command

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Fuel Rail Pressure (FRP) governor deviation below minimum limit	FRP governor error less than 725 psi at 600-750 rpm	Key ON ECM Not in limp-home mode Metering unit flow < 327,670 mm^3/sec Engine speed > 0 rpm OR FRP > 13,053 psi (90,000 kpa) for more than 20 engine revolutions Fuel injector quantity command > 5 mg/stroke ECT1 > -40°F (-40°C) Engine Not overrunning	10 seconds

Fault Overview

Fault code sets when the Engine Control Module (ECM) detects Fuel Rail Pressure (FRP) exceeds 13,053 psi (90,000 kPa) when the Fuel Pressure Control Valve (FPCV) is commanded to minimum pressure.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 94 FMI 0 (FDP); SPN 157 FMI 3, 4, 20, 21 (FRP); and SPN 633 FMI 3, 4, and 5 (FPCV)

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Restricted high-pressure pump fuel return line
- FRP sensor or circuit fault
- Fuel Pressure Control Valve (FPCV) or circuit fault

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 94 FMI 0 (FDP); SPN 157 FMI 3, 4, 20; and 21 (FRP) or SPN 633 FMI 3, 4, and 5 (FPCV). Is the EST DTC list free of SPN 94 FMI 0; SPN 157 FMI 3, 4, 20, and 21; and SPN 633 FMI 3, 4, and 5?	Yes: Go to step 2. No: Repair SPN 94 FMI 0; SPN 157 FMI 3, 4, 20, and 21; and SPN 633 FMI 3, 4, and 5. After repairs are complete, retest for SPN 3055 FMI 17.

Step	Action	Decision
2	Check for restricted fuel return line. Perform HP Pump Fuel Return Pressure Test (page 233). Is pressure < 13 psi?	Yes: Go to step 3. No: Repair restriction in fuel return line between high-pressure fuel pump and fuel tank. After repairs are complete, retest for SPN 3055 FMI 17.

Step	Action	Decision
3	Check for a failed FRP sensor or circuit. Disconnect the FRP sensor electrical connector and attempt to start engine. Crank engine for maximum of 20 seconds. Does the engine start and maintain idle?	Yes: Diagnose FRP Sensor (page 1095). After repairs are complete, retest for SPN 3055 FMI 17. No: Reconnect sensor and go to step 4.

Step	Action	Decision
4	Check for a failed Fuel Pressure Control Valve (FPCV). Key OFF, connect Breakout Harness ZTSE4828 to FPCV and leave vehicle harness disconnected. Using a DMM, measure resistance between ZTSE4828 pin-1 and pin-2. Is resistance between 2.6 and 3.2 ohms?	Yes: Go to step 5. No: Replace FPCV. After repairs are complete, retest for SPN 3055 FMI 17.

Step	Action	Decision
5	Check for a sticking FPCV. Run engine at idle. Using EST, monitor the difference between the desired and actual fuel rail pressure for 5 minutes. Does the pressure difference maintain < 1160 psi (80 bar) throughout the test?	Yes: Retest for SPN 3055 FMI 17. No: Replace FPCV. After repairs are complete, retest for SPN 3055 FMI 17.

NOTE: After performing all diagnostic steps, if SPN 3055 FMI 17 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

Fuel Level

SPN	FMI	Condition	Possible Causes	Actions
96	3	Fuel Level signal Out of Range HIGH	• Fuel level sensor signal circuit Open or high resistance • Fuel level sensor GND circuit Open or high resistance • Fuel level sensor signal circuit Short to power • Failed fuel level sensor	Step-Based Diagnostics (page 1122)
96	4	Fuel Level signal Out of Range Low	• Fuel level sensor signal circuit short to GND • Failed fuel level sensor	Step-Based Diagnostics (page 1123)
96	19	Fuel Level not detected on J1939	• Fuel level sensor signal circuit Open or high resistance • Fuel level sensor GND circuit Open or high resistance • Fuel level sensor signal circuit short to PWR • Fuel level sensor signal circuit short to GND • Body Controller offline • Failed fuel level sensor	Step-Based Diagnostics (page 1124)

Overview

The fuel level is broadcast on the J1939 public Controller Area Network (CAN) bus. This signal is sent from the Body Controller (BC) which is where the fuel level signal is received. If the BC is not located on J1939 many other CAN networks may be affected.

Tools Required

- Big Bore Terminal Test Probe Kit ZTSE4899
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

SPN 96 FMI 3- Fuel Level signal Out of Range HIGH (Open or high resistance)

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Fuel level sensor is shorted to high voltage or open / high resistance in fuel level sensor circuit.	Body Controller detects that the fuel level sensor voltage is too high 1 second.	Key ON	1 second

Fault Overview

Fault code sets when the Body Controller detects high signal voltage on the fuel level sensor circuit for more than one second.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Fuel level sensor or circuit fault

Step	Action	Decision
1	Verify that Body Controller (BC) is communicating. Using EST, check that the BC is listed in the Sniffer section. Is the Body Controller listed?	Yes: Diagnose fuel level circuit fault. See appropriate Truck Service Manual. After repairs are complete, retest for SPN 96 FMI 19.
		No: Repair Body Controller fault. After repairs are complete, retest for SPN 96 FMI 19.

NOTE: After performing all diagnostic steps, if SPN 96 FMI 3 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 96 FMI 4 - Fuel Level signal Out of Range LOW

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Fuel level sensor is shorted to low (GND).	Resistance between fuel level sensor and ground < 0.2 ohms	Key ON	1 second

Fault Overview

Fault code sets when the Body Controller detects low signal voltage from the fuel level sensor circuit for more than one second.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Fuel level sensor or circuit fault

Step	Action	Decision
1	Verify that Body Controller (BC) is communicating. Using EST, check that the BC is listed in the Sniffer section. Is the Body Controller listed?	Yes: Diagnose fuel level circuit fault. See appropriate Truck Service Manual. After repairs are complete, retest for SPN 96 FMI 19.
		No: Repair Body Controller fault. After repairs are complete, retest for SPN 96 FMI 19.

NOTE: After performing all diagnostic steps, if SPN 96 FMI 4 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 96 FMI 19 - Fuel Level not detected on J1939

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Fuel level signal message not present on J1939 bus.	Fuel level signal message not present	Key ON	Immediate

Fault Overview

Fault code sets when the Body Controller detects no fuel level signal message.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Body Controller offline
- Fuel level sensor or circuit fault

Step	Action	Decision
1	Verify that Body Controller (BC) is communicating. Using EST, check that the BC is listed in the Sniffer section. Is the Body Controller listed?	Yes: Diagnose fuel level circuit fault. See appropriate Truck Service Manual. After repairs are complete, retest for SPN 96 FMI 19.
		No: Repair Body Controller fault. After repairs are complete, retest for SPN 96 FMI 19.

NOTE: After performing all diagnostic steps, if SPN 96 FMI 19 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

Hard Brake Monitor

SPN	FMI	Condition	Possible Causes	Actions
1810	0	Hard Brake monitor, event log, extreme	• Incorrect programmable parameter value • Hard brake event	Pinpoint Diagnostics (page 1125)
1810	15	Hard Brake monitor, even log non-extreme	• Incorrect programmable parameter value • Hard brake event	Pinpoint Diagnostics (page 1125)

Overview

The hard brake monitor feature determines hard vehicle speed deceleration incidents. An incident occurs when programmable parameter 89052 Hard Brake Decel Rate Threshold is set at too low of a speed change. The incident is then reported to the ECM and stored as a vehicle event.

Tools Required

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

Pinpoint Diagnostics With ServiceMaxx™ Software

SPN 1810 FMI 0 - Hard Brake monitor, event log, extreme

1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, load the Parameters session and adjust parameter ID 89052 Hard Brake Decel Rate Threshold to 5-9 mph/s.
2. Program engine and retest for 1810 FMI 0.

SPN 1810 FMI 15- Hard Brake monitor, event log, non-extreme

1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, load the Parameters session and adjust parameter ID 89052 Hard Brake Decel Rate Threshold to 5-9 mph/s.
2. Program engine and retest for 1810 FMI 15.

HS (Humidity Sensor) / IAT (Inlet Air Temperature Sensor)

SPN	FMI	Condition	Possible Causes	Actions
172	2	IAT signal does not agree with other sensors	• Biased IAT sensor or circuit	Pin-Point Diagnostics (page 1127)
172	3	IAT Out of Range HIGH	• IAT signal circuit OPEN or short to PWR • SIG GND circuit OPEN • Failed IAT sensor	Pin-Point Diagnostics (page 1127)
172	4	IAT Out of Range LOW	• IAT signal circuit short to GND • Failed IAT sensor	Pin-Point Diagnostics (page 1127)
354	3	Relative Humidity signal Out of Range HIGH	• HS signal circuit OPEN or short to PWR • SIG GND circuit OPEN • Failed HS sensor	Pin-Point Diagnostics (page 1127)
354	4	Relative Humidity signal Out of Range LOW	• HS signal circuit short to GND • Failed HS sensor	Pin-Point Diagnostics (page 1127)

HS/IAT circuit

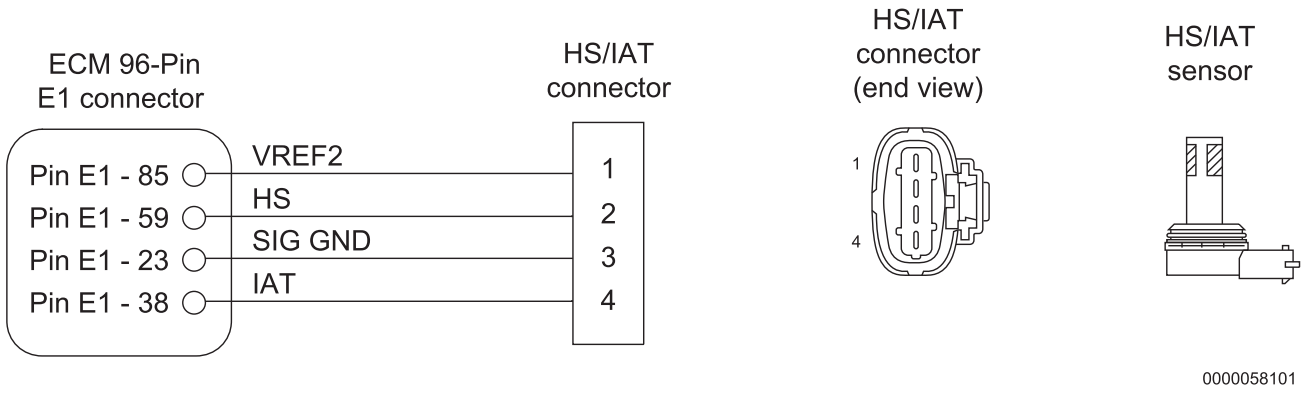


Figure 405 HS/IAT sensor circuit diagram

Tools Required

- 180-Pin Breakout Box 00-00956-08
- 2010 MaxxForce 11 & 13 Harness Kit 00-01462-00
- 3-Banana Plug Harness ZTSE4498
- 500 Ohm Resistor Harness ZTSE4497
- Big Bore Terminal Test Probe Kit ZTSE4899
- Breakout Harness ZTSE4830 (HS/IAT)
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

Pinpoint Diagnostics With ServiceMaxx™ Software

WARNING: To prevent personal injury or death, stay clear of rotating parts (belts and fan) and hot engine surfaces.

1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, run the Continuous Monitor test.
2. Monitor sensor voltage and verify an active DTC for this sensor.
   - If DTC is previously active, monitor signal while wiggling harness of suspect sensor. If circuit is interrupted, signal will spike and DTC will go active or pending.
   - If DTC is active, continue to Cold Soak Sensor Compare Check.

NOTE: Inspect connectors for damaged pins, corrosion, or loose pins. Repair if necessary.

SPN 172 FMI 2 – IAT signal does not agree with other sensors

Cold Soak Sensor Compare Check With ServiceMaxx™ Software

NOTE: Temperature values need to be measured after 8 hours of cold soak.

1. Turn ignition switch ON, engine OFF.
2. Using ServiceMaxx™ software, open the Default session.
3. Compare IAT and Ambient Air Temperature (AAT). Sensor temperatures should be within 5 °C (10 °F) of each other.
   - If IAT is 5 °C (10 °F) above or below AAT, check for poor circuitry going to the IMT sensor.
   - If circuits are within specification, replace HS/IAT sensor.

Sensor Circuit Check With ServiceMaxx™ Software

Connect Breakout Harness ZTSE4830 to HS/IAT engine harness, and leave HS/IAT sensor disconnected. Turn ignition ON.

Test Point	Specification	Comment– < Less than, > Greater than
EST - Monitor HSv	5.0 V ± 0.5 V	If < 4.5 V check HS signal circuit for short to GND.
EST - Monitor IATv	5.0 V ± 0.5 V	If < 4.5 V check IAT signal circuit for short to GND.
EST - Monitor HSv Short pin 2 to GND	0 V	If > 0.25 V, check HS signal circuit for OPEN. Do Harness Resistance Check.
EST - Monitor HSv Short pin 2 to 3	0 V	If > 0.25 V, check SIG GND circuit for OPEN. Do Harness Resistance Check.
EST - Monitor IATv Short pin 4 to GND	0 V	If > 0.25 V, check IAT signal circuit for OPEN. Do Harness Resistance Check.
EST – Monitor HSv Short 500 Ω resistor across pins 2 and 3	< 1.0 V	If > 1.0 V, check HS signal circuit for short to PWR.
EST – Monitor HSv Short 500 Ω resistor across pins 3 and 4	< 1.0 V	If > 1.0 V, check IAT signal circuit for short to PWR.

Connector Voltage Check Without ServiceMaxx™ Software

Connect Breakout Harness ZTSE4830 to HS/IAT engine harness, and leave HS/IAT sensor disconnected. Turn ignition ON.. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	5.0 V ± 0.5 V	If < 4.5 V, check for OPEN in VREF2 circuit.
2 to GND	5.0 V ± 0.5 V	If < 4.5 V, check for OPEN in HS circuit.
3 to B+	B+	If < B+, check for OPEN is SIG GND circuit.
4 to GND	5.0 V ± 0.5 V	If < 4.5 V, check for OPEN in IAT circuit.

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM E1 and E2 harness to ECM E1 and E2 engine harness connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE4830 to HS/IAT engine harness, and leave HS/IAT sensor disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	> 1k Ω	If < 1k Ω, check VREF2 circuit for short to GND.
1 to E1-85	< 5 Ω	If > 5 Ω, check VREF2 circuit for OPEN.
2 to GND	> 1k Ω	If < 1k Ω, check HS circuit for short to GND.
2 to E1-59	< 5 Ω	If > 5 Ω, check HS circuit for OPEN.
3 to GND	> 1k Ω	If < 1k Ω, check SIG GND circuit for short to GND.

Harness Resistance Check (cont.)

3 to E1-23	< 5 Ω	If > 5 Ω, check SIG GND circuit for OPEN.
4 to GND	> 1k Ω	If < 1k Ω, check IAT circuit for short to GND.
4 to E1-38	< 5 Ω	If > 5 Ω, check IAT circuit for OPEN.

IMP (Intake Manifold Pressure)

SPN	FMI	Condition	Possible Causes	Actions
102	2	IMP signal does not agree with BARO	• Biased IMP sensor or circuit	Circuit Checks (page 1133)
102	3	IMP signal Out of Range HIGH	• IMP signal circuit OPEN or short to PWR • SIG GND circuit OPEN • Failed IMP sensor	Circuit Checks (page 1133)
102	4	IMP signal Out of Range LOW	• IMP signal circuit short to GND • VREF2 circuit OPEN • Failed IMP sensor	Circuit Checks (page 1133)
102	10	IMP Boost slow response	• Turbocharger 2 (TC2) wastegate stuck open • Restricted intake air system • Charge Air Cooler (CAC) hose leaking • CAC leak • Failed turbocharger • Exhaust leak • Restricted exhaust • Exhaust Gas Recirculation (EGR) fault	Step Based Diagnostics (page 1135)

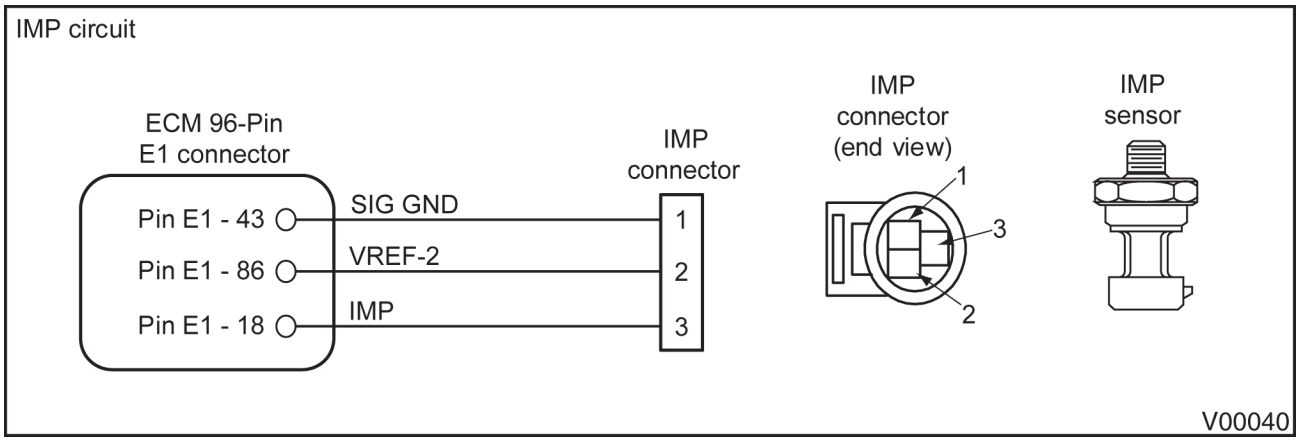


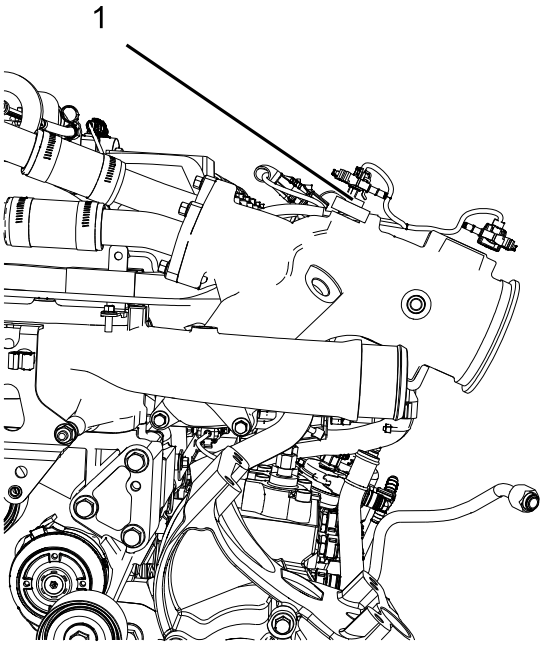
Figure 406 IMP Sensor Circuit Diagram

Overview

The IMP sensor is a variable-capacitance sensor that measures charge-air pressure entering the air intake throttle duct. As pressure increases, ceramic material moves closer to a thin metal disc (internal sensor), causing a change in capacitance that changes the voltage sent to, and interpreted by, the Engine Control Module (ECM). IMP is monitored by the ECM for Exhaust Gas Recirculation (EGR) and turbocharger wastegate control.

Tools Required

- 180-Pin Breakout Box 00-00956-08
- 2010 MaxxForce 11 & 13 Harness Kit 00-01462-00
- 3-Banana Plug Harness ZTSE4498
- 500 Ohm Resistor Harness ZTSE4497
- Big Bore Terminal Test Probe Kit ZTSE4899
- Breakout Harness ZTSE4850 (IMP)
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)



0000038233

Figure 407 IMP Sensor Location

1. Intake Manifold Pressure (IMP) sensor

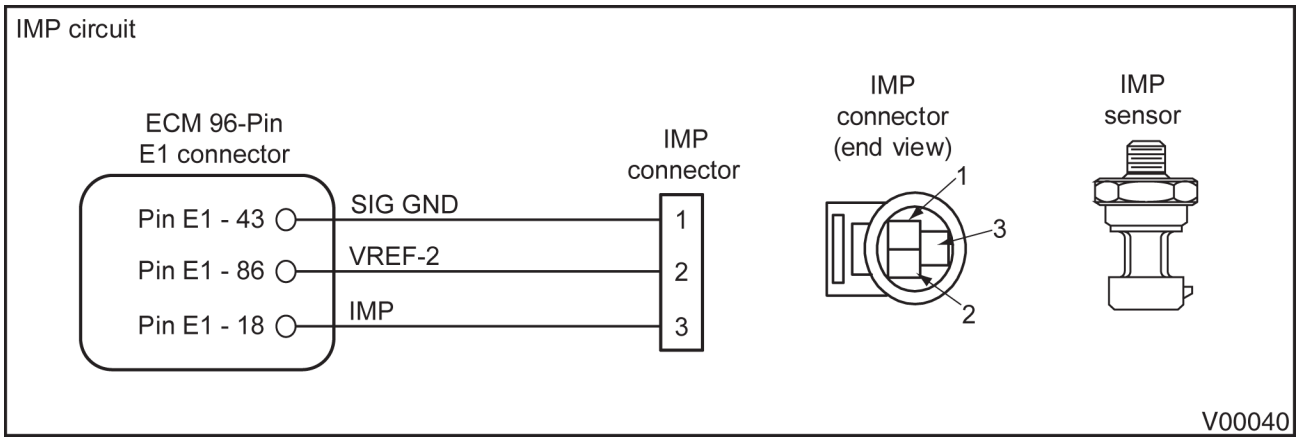


Figure 408 IMP Sensor Circuit Diagram

Pinpoint Diagnostics With ServiceMaxx™ Software

1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, run the Continuous Monitor test.
2. Monitor sensor voltage and verify an active DTC for this sensor.
   - If DTC is previously active, monitor signal while wiggling harness of suspect sensor. If circuit is interrupted, signal will spike and DTC will go active or pending.
   - If DTC is active, continue to Biased Sensor or Circuit Check.

NOTE: Inspect connectors for damaged pins, corrosion, or loose pins. Repair if necessary.

Biased Sensor or Circuit Check

1. Turn ignition switch ON, engine OFF.
2. Using ServiceMaxx™ software, open the Continuous Monitor session.
3. Verify S_IMP volts are within specification. See “APPENDIX A: PERFORMANCE SPECIFICATIONS."
   - If voltage is not within specification, go to Circuit Checks (page 1133). If circuits are within specification, replace IMP sensor.

Sensor Circuit Check With ServiceMaxx™ Software

Connect Breakout Harness ZTSE4850 to IMP engine harness, and leave IMP sensor disconnected. Turn ignition ON.

Test Point	Specification	Comment – < Less than, > Greater than
EST – Monitor IMPv	5.0 V ± 0.5 V	If < 4.5 V, check IMP signal circuit for short to GND. Do Harness Resistance Check (page 1134).
DMM – Measure volts 2 to GND	5.0 V ± 0.5 V	If > 5.5 V, check VREF2 circuit for short to PWR. If < 4.5 V, check VREF2 circuit for OPEN or short to GND. Do Harness Resistance Check (page 1134).
DMM – Measure voltage 1 to 2	5.0 V ± 0.5 V	If < 4.5 V, check SIG GND for OPEN. Do Harness Resistance Check (page 1134).
EST – Monitor IMPv Short across Breakout Harness ZTSE4850 pins 1 and 3	0 V	If > 0.5 V, check IMP signal circuit for OPEN or short to PWR. Do Harness Resistance Check (page 1134).
If checks are within specifications, connect sensor and clear DTCs. If active DTC remains, replace IMP sensor.		

Connector Voltage Check Without ServiceMaxx™ Software

Connect Breakout Harness ZTSE4850 to IMP engine harness, and leave IMP sensor disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
1 to B+	B+	If < B+, check SIG GND circuit for OPEN or short to PWR.
2 to GND	5.0 V ± 0.5 V	If > 5.5 V, check VREF2 for short to PWR. If < 4.5 V, check VREF2 for OPEN or short to GND. Do Harness Resistance Check (page 1134).
3 to GND	5.0 V ± 0.5 V	If < 4.5 V, check IMP signal circuit for short to GND. Do Harness Resistance Check (page 1134).

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM E1 and E2 harness to ECM E1 and E2 engine harness connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE4850 to IMP engine harness, and leave IMP sensor disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
1 to E1-43	< 5 Ω	If > 5 Ω, check for OPEN circuit.
2 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
2 to E1-86	< 5 Ω	If > 5 Ω, check for OPEN circuit.
3 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
3 to E1-18	< 5 Ω	If > 5 Ω, check for OPEN circuit.

SPN 102 - FMI 10 IMP - Boost Slow Response

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Intake Manifold Pressure (IMP) accumulated deviation from boost.	Intake Manifold Pressure (IMP) does not maintain less than 80 psi (550 kPa) difference between actual and desired.	Rate of Change in Engine Speed > 100 rpm/s Key ON Engine Speed > 800 rpm Rate of Change in Injection Quantity > 50 mg Injection Quantity > 0 mg/stroke and < 500 mg/stroke	1 event

Malfunction Indicator Lamp (MIL) Reaction

When fault is active, MIL will not illuminate.

Associated Faults

SPN's 27 (EGR), 51 (ETV), 1189 (TC2WC), 2791 (EGR) and 3464 (ETV).

Drive Cycle

See 2013 HD-OBD Diagnostic Reference Manual.

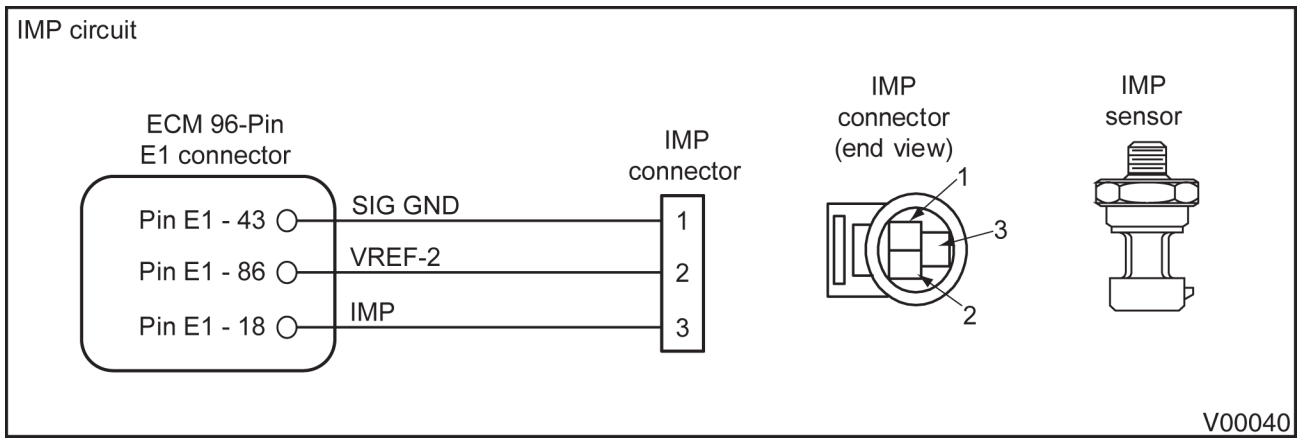


Figure 409 IMP Sensor Circuit Diagram

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 27 (EGR); SPN 51 (ETV); SPN 1189 (TC2WC); SPN 2791 (EGR); SPN 3464 (ETV). Is EST DTC list free of SPN 27; SPN 51; SPN 1189; SPN 2791; SPN 3464?	Yes: Go to step 2. No: Repair SPN 27; SPN 51; SPN 1189; SPN 2791; SPN 3464. After repairs are complete, retest for SPN 102 FMI 10.

Step	Action	Decision
2	Inspect air intake system, exhaust system, and air filter for restrictions, air leaks, or physical damage. Also, inspect the fuel system from fuel tank to AFTFI valve for leaks or physical damage. Is air intake system, exhaust system, fuel system and air filter free of restrictions, leaks, and physical damage?	Yes: Go to step 3. No: Repair restrictions, air leaks , fuel leaks or physical damage. After repairs are complete, retest for SPN 102 FMI 10.

Step	Action	Decision
3	Determine if Intake Manifold Pressure (IMP) sensor or circuit is out of specifications. Using EST with ServiceMaxx™ software, do IMP Biased Sensor or Circuit Check (page 1133). Is IMP sensor within specifications?	Yes: Go to step 4. No: Repair IMP sensor or circuit. After repairs are complete, retest for SPN 102 FMI 10.

Step	Action	Decision
4	Verify IMP changes when Turbocharger 2 Wastegate Control (TC2WC) and Exhaust Gas Recirculation (EGR) valve are commanded On. Key-On Engine-Running (KOER). Run Air Management Test while monitoring IMP sensor signal. Does IMP sensor signal change: • When TC2WC is commanded On? • When EGR valve is commanded On?	IMP signal change only when TC2WC is commanded On: Do EGR Pinpoint Diagnostics (page 1020) and check for EGR issue. After repairs are complete, retest for SPN 102 FMI 10. IMP signal change only with EGR valve commanded On: Do TC2WC voltage and circuit checks (page 1405). After repairs are complete, retest for SPN 102 FMI 10. Neither change IMP signal when commanded On: Go to step 5. Both change IMP signal when commanded On: Go to step 7.

Step	Action	Decision
5	Verify IMP sensor and bore are not restricted due to carbon buildup. Remove and inspect IMP sensor and bore for carbon buildup. Is IMP sensor and bore free of carbon buildup?	Yes: Go to step 6. No: Clean IMP sensor bore of carbon deposits. After repairs are complete, retest for SPN 102 FMI 10. Go to step 6 if cleaning does not resolve fault code.

Step	Action	Decision
6	Determine if Charge Air Cooler is leaking. Do Charge Air Cooler (CAC) pressure test (page 245). Was CAC free of leaks?	Yes: Go to step 7. No: Correct air leak(s). After repairs are complete, retest for SPN 102 FMI 10.

Step	Action	Decision
7	Do a road test (100% throttle when safe to do so) while recording a snap shot of the following signals: • Diesel Particulate Filter Differential Pressure (DPFDP) = 0.5 – 0.8 psi • Turbocharger 1 Turbine Outlet Pressure (TC1TOP) = 2 – 3 psi Are DPFDP and TC1TOP within specification? **NOTE:** DPFDP and TC1TOP specifications only apply with soot load < 40%.	**Both** TC1TOP and DPFDP signals are above specification: Go to step 8. **Only** TC1TOP signal above specification: Remove Diesel Oxidation Catalyst (DOC) for inspection and clean or replace as necessary. After repairs are complete, retest for SPN 102 FMI 10. **Neither** signal above specification: Go to step 9.

Step	Action	Decision
8	Using EST with ServiceMaxx software, start an DPF Filter Regeneration procedure. Is DPF Filter Regeneration procedure running without an Abort Message in ServiceMaxx™?	Yes: Go to step 9. No: Correct Parked Regen Inhibitors (page 348) and restart DPF Filter Regeneration procedure.

Step	Action			Decision
9	While running DPF Filter Regeneration procedure, inspect for exhaust leaks and monitor following signals during test: Are Parked Regen Checks within specification during DPF Filter Regeneration procedure?			If Parked Regen Checks are within specification: Go to step 7.
	Parked Regen Checks	**Specifications**	**Pass / Fail**	
	Engine condition	Smooth, not stumbling		If AFTFP1 is below 110 psi: Do Fuel Delivery Pressure (FDP) Test (page 218). Repair any FDP measurements out of specification. After repairs are complete, retest for SPN 102 FMI 10.
	Engine Coolant Temp (ECT)	Above 122°F (50°C) per ServiceMaxx		
	DOCIT	After 5 – 10 minutes above 500°F (260°C)		If AFTFP1 fuel pressure is below 40-70 psi at AFTFI opening: Clean AFTFI

	DOCOT	After 5 – 10 minutes above 986°F (530°C)		valve, housing, and bore. After cleaning procedure is complete, retest for SPN 102 FMI 10.
	DPFOT	Below 1292°F (700°C)		If Parked Regen Checks other than AFTFP1 is out of specifications: Repair Parked Regen Check (page 350). After repairs complete, retest for SPN 102 FMI 10.
	Aftertreatment Fuel Pressure 1 (AFTFP1)	> 110 psi during test		

Step	Action	Decision
10	After DPF Filter Regeneration procedure is complete, does Diesel Particulate Filter Differential Pressure (DPFDP) signal measure below 0.5 psi at high idle?	Yes: Go to step 11.
		No: Remove DPF and inspect for restrictions. If restricted, have the DPF cleaned using the appropriate DPF cleaning equipment. After repairs are complete, retest for SPN 102 FMI 10.

Step	Action	Decision
11	Inspect turbochargers for correct operation. Inspect for signs of wear on the turbocharger compressor wheel and air inlet. Look for chipping, scuffs, and rough finishes. Was anything determined to be malfunctioning or damaged?	Yes: Repair or replace turbocharger as necessary. After repairs are complete, retest for SPN 102 FMI 10.
		No: After doing all diagnostic steps, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

NOTE: After doing all diagnostic steps, if SPN 102 FMI 10 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

IMT Sensor (Intake Manifold Temperature)

SPN	FMI	Condition	Possible Causes	Actions
105	2	IMT signal does not agree with other sensors	• Biased IMT sensor or circuit	Pin-Point Diagnostics (page 1140)
105	3	IMT signal Out of Range HIGH	• IMT signal OPEN or short to PWR • SIG GND circuit OPEN • Failed IMT sensor	Pin-Point Diagnostics (page 1140)
105	4	IMT signal Out of Range LOW	• IMT signal circuit short to GND • Failed IMT sensor	Pin-Point Diagnostics (page 1140)
105	18	IMT signal not responding as expected	• IMT signal does not rise during engine warm up	Pin-Point Diagnostics (page 1140)

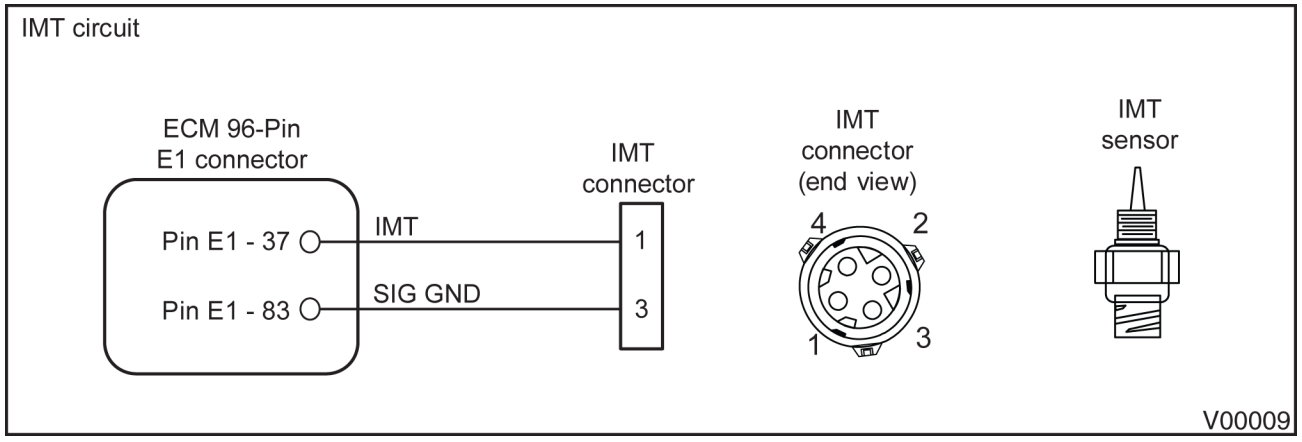


Figure 410 IMT sensor circuit diagram

Tools Required

- 180-Pin Breakout Box 00-00956-08
- 2010 MaxxForce 11 & 13 Harness Kit 00-01462-00
- 3-Banana Plug Harness ZTSE4498
- 500 Ohm Resistor Harness ZTSE4497
- Big Bore Terminal Test Probe Kit ZTSE4899
- Breakout Harness ZTSE4883 (IMT)
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

Pinpoint Diagnostics With ServiceMaxx™ Software

WARNING: To prevent personal injury or death, stay clear of rotating parts (belts and fan) and hot engine surfaces.

1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, run the Continuous Monitor test.
2. Monitor sensor voltage and verify an active DTC for this sensor.
    - If DTC is previously active, monitor signal while wiggling harness of suspect sensor. If circuit is interrupted, signal will spike and DTC will go active or pending.
    - If DTC is active, continue to Cold Soak Sensor Compare Check.

NOTE: Inspect connectors for damaged pins, corrosion, or loose pins. Repair if necessary.

Cold Soak Sensor Compare Check With ServiceMaxx™ Software

SPN 105 FMI 2 – IMT signal does not agree with other sensors

DTC sets after cold soak and IMT signal does not compare with other air temperature sensors.

SPN 105 FMI 18 – IMT signal not responding as expected

DTC sets if IMT signal does not rise 10 °C (50 °F) after a cold soak, when engine is started and run above 1400 rpm for 45 seconds.

NOTE: Temperature values need to be measured after 8 hours of cold soak.

1. Turn ignition switch ON, engine OFF.
2. Using ServiceMaxx™ software, open the Default session.
3. Compare IMT, Ambient Air Temperature (AAT), and Inlet Air Temperature (IAT). Sensor temperatures should be within 5 °C (10 °F) of each other.
   - If IMT is 5 °C (10 °F) above or below AAT, IAT, or IMT, check for poor circuitry going to the IMT sensor.
   - If circuits are within specification, replace IMT sensor.
4. Start engine while monitoring IMT signal.
   - If IMT signal does not raise 10 °C (50 °F), check for poor circuitry going to the sensor.
   - If circuits are within specification, replace sensor.

Sensor Circuit Check With ServiceMaxx™ Software

Connect Breakout Harness ZTSE4883 to IMT engine harness, and leave IMT sensor disconnected. Turn ignition ON.

Test Point	Specification	Comment– < Less than, > Greater than
EST – Monitor IMTv	5.0 V ± 0.5 V	If <4.5 V, check IMT signal circuit for short to GND.
EST – Monitor IMTv Short pin 1 to GND	0 V	If > 0.25 V, check IMT signal circuit for OPEN. Do Harness Resistance Check.
EST – Monitor IMTv Short pin 1 to 3	0 V	If > 0.25 V, check SIG GND circuit for OPEN. Do Harness Resistance Check.
EST – Monitor IMTv Short 500 Ω resistor across pins 1 and 3	< 1.0 V	If > 1.0 V, check IMT signal circuit for short to PWR.
If checks are within specification, connect sensor and clear DTCs. If active code remains, replace IMT sensor.		

Connector Voltage Check Without ServiceMaxx™ Software

Connect Breakout Harness ZTSE4883 to IMT engine harness, and leave IMT sensor disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	4.5 V to 5 V	If < 4.5 V, check for short to GND.
3 to B+	B+	If < B+, check for short to PWR.

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM E1 and E2 harness to ECM E1 and E2 engine harness connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE4883 to IMT engine harness, and leave IMT sensor disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
1 to E1-37	< 5 Ω	If > 5 Ω, check for OPEN circuit.
3 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
3 to E1-83	< 5 Ω	If > 5 Ω, check for OPEN circuit.

INJ (Injector) Circuits

SPN	FMI	Condition	Possible Causes	Actions
651	4	Injector 1 short circuit	• INJ1 H circuit shorted to INJ1 L circuit • INJ1 H circuit short to GND • INJ1 L circuit short to GND • Fuel injector 1 shorted to engine brake housing • Failed fuel injector 1	Step-Based Diagnostics (page 1150)
651	5	Injector 1 open load/circuit	• INJ1 H circuit Open or high resistance • INJ1 L circuit Open or high resistance • Failed fuel injector 1 (Open coil)	Step-Based Diagnostics (page 1154)
652	4	Injector 2 short circuit	• INJ2 H circuit shorted to INJ2 L circuit • INJ2 H circuit short to GND • INJ2 L circuit short to GND • Fuel injector shorted to engine brake housing • Failed fuel injector 2	Step-Based Diagnostics (page 1158)
652	5	Injector 2 open load/circuit	• INJ2 H circuit Open or high resistance • INJ2 L circuit Open or high resistance • Failed fuel injector 2 (Open coil)	Step-Based Diagnostics (page 1162)

653	4	Injector 3 short circuit	• INJ3 H circuit shorted to INJ3 L circuit • INJ3 H circuit short to GND • INJ3 L circuit short to GND • Fuel injector shorted to engine brake housing • Failed fuel injector 3	Step-Based Diagnostics (page 1166)
653	5	Injector 3 open load/circuit	• INJ3 H circuit Open or high resistance • INJ3 L circuit Open or high resistance • Failed fuel injector 3 (Open coil)	Step-Based Diagnostics (page 1170)
654	4	Injector 4 short circuit	• INJ4 H circuit shorted to INJ4 L circuit • INJ4 H circuit short to GND • INJ4 L circuit short to GND • Fuel injector shorted to engine brake housing • Failed fuel injector 4	Step-Based Diagnostics (page 1174)
654	5	Injector 4 open load/circuit	• INJ4 H circuit Open or high resistance • INJ4 L circuit Open or high resistance • Failed fuel injector 4 (Open coil)	Step-Based Diagnostics (page 1178)

655	4	Injector 5 short circuit	• INJ5 H circuit shorted to INJ5 L circuit • INJ5 H circuit short to GND • INJ5 L circuit short to GND • Fuel injector shorted to engine brake housing • Failed fuel injector 5	Step-Based Diagnostics (page 1182)
655	5	Injector 5 open load/circuit	• INJ5 H circuit Open or high resistance • INJ5 L circuit Open or high resistance • Failed fuel injector 5 (Open coil)	Step-Based Diagnostics (page 1186)
656	4	Injector 6 short circuit	• INJ6 H circuit shorted to INJ6 L circuit • INJ6 H circuit short to GND • INJ6 L circuit short to GND • Fuel injector shorted to engine brake housing • Failed fuel injector 6	Step-Based Diagnostics (page 1190)
656	5	Injector 6 open load/circuit	• INJ6 H circuit Open or high resistance • INJ6 L circuit Open or high resistance • Failed fuel injector 6 (Open coil)	Step-Based Diagnostics (page 1194)
2797	11	INJ Control Group 1 short circuit (INJ 1, 3, 5)	• INJ1 H circuit short to PWR • INJ1 H circuit short to GND • INJ1 H short to INJ1 L • INJ1 L circuit short to PWR	Step-Based Diagnostics (page 1198)

- INJ1 L circuit short to GND
- Fuel injector 1 shorted to engine brake housing
- Failed fuel injector 1
- INJ3 H circuit short to PWR
- INJ3 H circuit short to GND
- INJ3 H short to INJ3 L
- INJ3 L circuit short to PWR
- INJ3 L circuit short to GND
- Fuel injector 3 shorted to engine brake housing
- Failed fuel injector 3
- INJ5 H circuit short to PWR
- INJ5 H circuit short to GND
- INJ5 H short to INJ6 L
- INJ5 L circuit short to PWR
- INJ5 L circuit short to GND
- Fuel injector 5 shorted to engine brake housing
- Failed fuel injector 5

2798	11	INJ Control Group 2 short circuit (INJ 2, 4, 6)	• INJ2 H circuit short to PWR • INJ2 H circuit short to GND • INJ2 H short to INJ2 L • INJ2 L circuit short to PWR • INJ2 L circuit short to GND • Fuel injector 2 shorted to engine brake housing • Failed fuel injector 2 • INJ4 H circuit short to PWR • INJ4 H circuit short to GND • INJ4 H short to INJ4 L • INJ4 L circuit short to PWR • INJ4 L circuit short to GND • Fuel injector 4 shorted to engine brake housing • Failed fuel injector 4 • INJ6 H circuit short to PWR • INJ6 H circuit short to GND • INJ6 H short to INJ6 L • INJ6 L circuit short to PWR • INJ6 L circuit short to GND • Fuel injector 6 shorted to engine brake housing • Failed fuel injector 6	Step-Based Diagnostics (page 1208)

Fuel Injector circuits

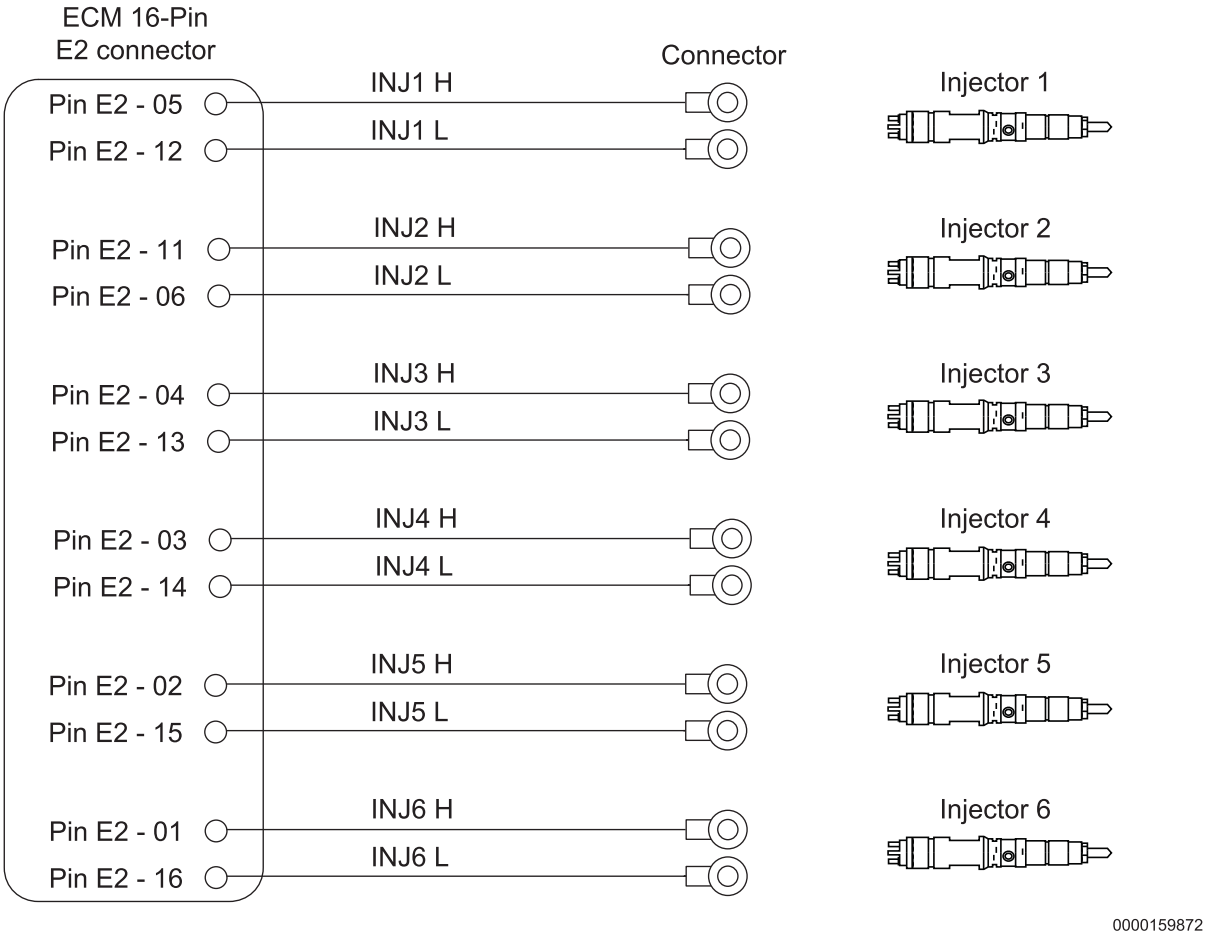


Figure 411 Fuel Injector circuit diagram

NOTE: See latest version of Navistar N13 Engine and Aftertreatment Wiring Schematic Form 0000002203 for additional circuit information.

Overview

When the Engine Control Module (ECM) determines fueling is required to a cylinder, voltage is supplied to the fuel injector. The fuel injector has a magnetic coil, which lifts a needle inside the injector. The needle moving upward uncovers the spray holes directing fuel into the cylinder. When the ECM determines injection should end, voltage to the magnetic coil is removed.

Tools Required

- 180-Pin Breakout Box 00-00956-08
- Breakout Harness 00-01468-00
- 500 Ohm Resistor Harness ZTSE4497
- Big Bore Terminal Test Probe Kit ZTSE4899
- Digital Multimeter (DMM)

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

SPN 651 FMI 4- Injector 1 short circuit

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Short to GND detected in fuel injector 1 circuit	INJ1 circuit resistance to ground < 0.5 ohms	Engine Control Module (ECM) commands injector firing	3 events

Fault Overview

Fault code sets when a short to GND is detected in Fuel Injector 1 circuit.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

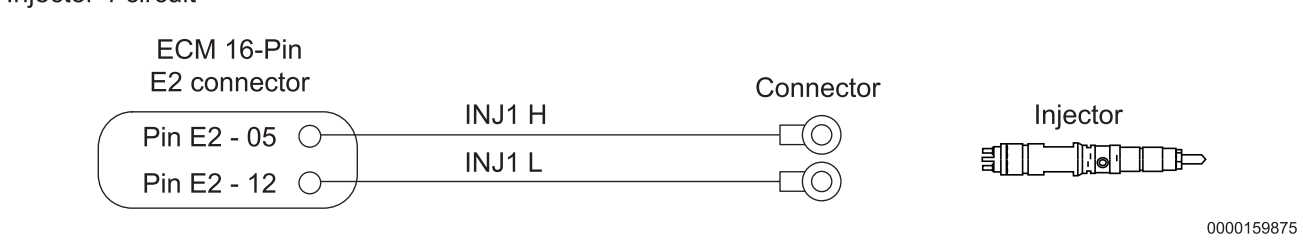


Figure 412 Injector 1 circuit diagram

Possible Causes

- INJ1 H circuit shorted to INJ1 L circuit
- INJ1 H circuit short to GND
- INJ1 L circuit short to GND
- Fuel injector shorted to engine brake housing
- Failed fuel injector 1

WARNING: To prevent personal injury or death, shut engine down before doing voltage checks for injector solenoids. When the engine is running, injector circuits have high voltage and amperage.

CAUTION: To avoid engine damage, turn the ignition switch to OFF before disconnecting connectors. Failure to turn ignition switch to OFF will cause a voltage spike and damage to electrical components.

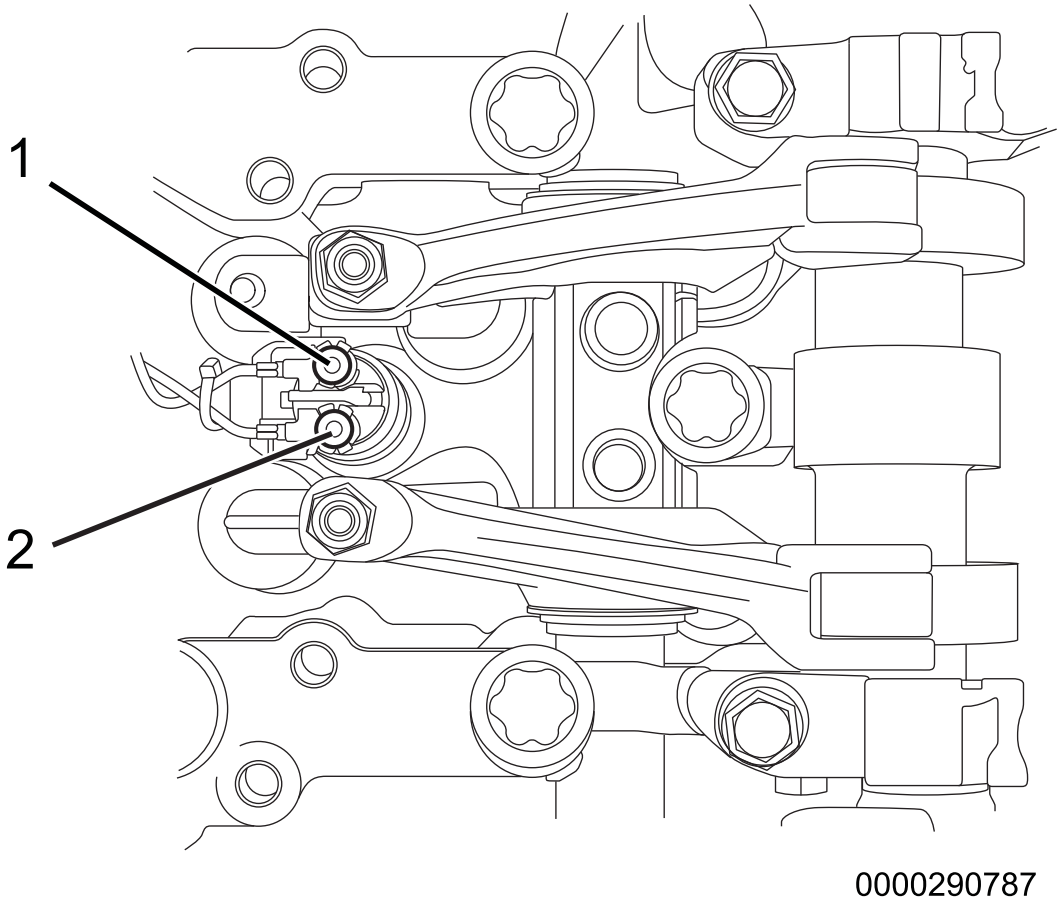


Figure 413 Fuel Injector Wiring Terminal Orientation

1. Fuel injector H wiring terminal
2. Fuel injector L wiring terminal (brown wire color [typical])

Step	Action	Decision
1	Verify proper fuel injector and terminal orientation. Remove upper valve cover and engine brake housing (see Engine Service Manual). Verify fuel injector terminals are installed parallel to avoid a short to ground on the engine brake housings. Are fuel injector 1 terminals oriented correctly and Not contacting the engine brake housing?	Yes: Go to step 2. No: Adjust connections so fuel injector 1 and injector terminals will not contact the engine brake housing. After repairs are complete, retest for SPN 651 FMI 4.

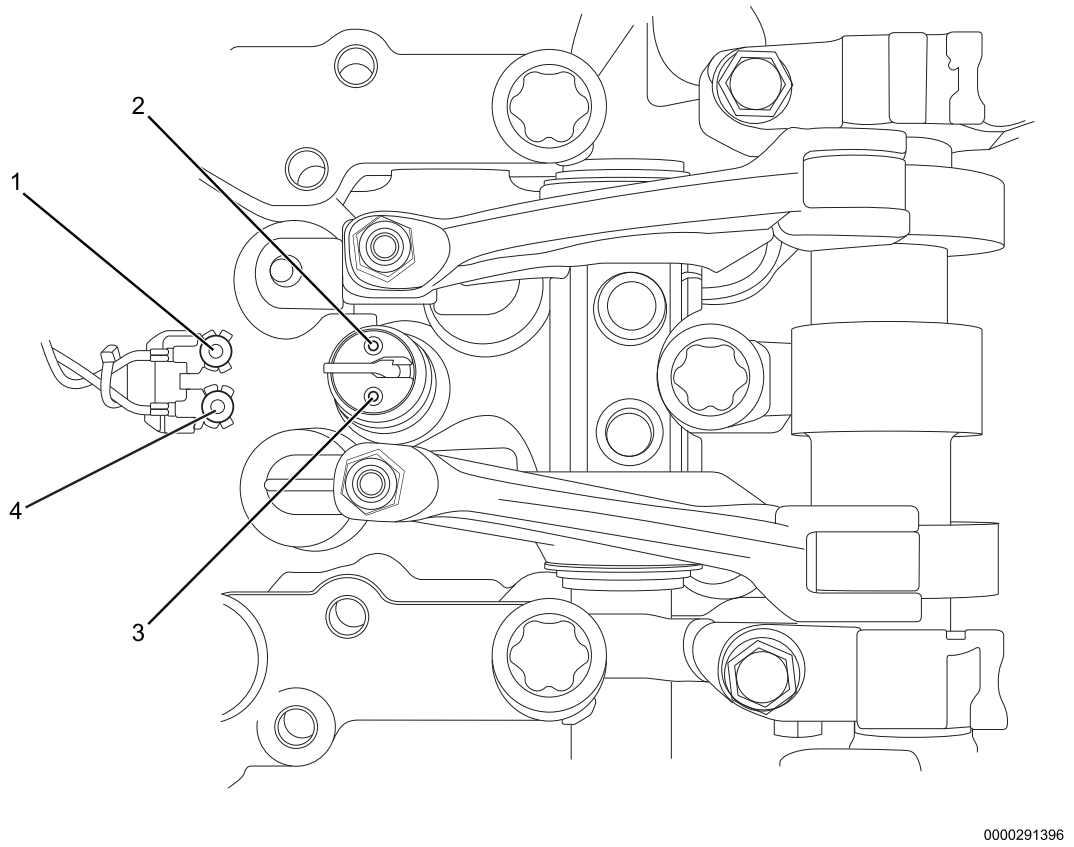


Figure 414 Fuel Injector Wiring Terminal Orientation

1. Fuel injector H wiring terminal
2. Fuel injector H terminal
3. Fuel injector L terminal
4. Fuel injector L wiring terminal (brown wire color [typical])

Step	Action	Decision
2	Check for a shorted fuel injector 1 coil. Key OFF, disconnect the connectors from fuel injector 1. Using a DMM, check resistance across fuel injector 1 terminals. Is resistance between 0.2 to 0.8 Ohms?	Yes: Go to step 3. No: Replace fuel injector 1. After repairs are complete, retest for SPN 651 FMI 4.

Step	Action	Decision
3	Inspect connections at Electronic Control Module (ECM) E2 connector. Key OFF, disconnect ECM E2 connector. Check ECM E2 connector and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the ECM E2 connector, harness, and terminals clean and undamaged?	Yes: Go to step 4. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 651 FMI 4.

Step	Action	Decision
4	Check for fuel injector 1 high side terminal short to ground. Key OFF, with ECM E2 connector disconnected and wiring terminals disconnected from fuel injector 1, use a DMM to test resistance between high side terminal and a known good GND. Is resistances greater than 1000 ohms?	Yes: Go to step 5. No: Replace fuel injector 1. After repairs are complete, retest for SPN 651 FMI 4.

Step	Action	Decision
5	Check for fuel injector 1 low side terminal short to ground. Key OFF, with ECM E2 connector disconnected and wiring terminals disconnected from fuel injector 1, use a DMM to test resistance between low side terminal and a known good GND. Is resistances greater than 1000 ohms?	Yes: Go to step 6. No: Replace fuel injector 1. After repairs are complete, retest for SPN 651 FMI 4.

Step	Action	Decision
6	Check for INJ1 H short to INJ1 L. Key OFF, connect 180-pin Breakout Box with Breakout Harness 00-01468-00 to ECM E2 connector, leave ECM disconnected. Using a DMM with fuel injector 1 disconnected. measure resistance between Breakout Box pins E2-05 and E2-12 (wiggle test may be required). Is resistance greater than 1000 ohms?	Yes: Go to step 7. No: Repair short between INJ1 H circuit and INJ1 L circuit. After repairs are complete, retest for SPN 651 FMI 4.

Step	Action	Decision
7	Check INJ 1 H circuit for short to GND. Key OFF, connect 180-pin breakout box with Breakout Harness 00-01468-00 to ECM E2 connector, leave ECM disconnected. Using a DMM with fuel injector 1 disconnected, measure resistance between Breakout Box pin E2-05 and known good GND (wiggle test may be required). Is resistance greater than 1000 Ohms?	Yes: Repair short to GND between E2-12 and fuel injector 1. After repairs are complete, retest for SPN 651 FMI 4. No: Repair short to GND between E2-05 and fuel injector 1. After repairs are complete, retest for SPN 651 FMI 4.

NOTE: After performing all diagnostic steps, if SPN 651 FMI 4 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 651 FMI 5- Injector 1 Open load / circuit

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Open detected in fuel injector 1 circuit.	INJ1 circuit > 30 ohms	Engine Control Module (ECM) commands injector firing	3 events

Fault Overview

Fault code sets when a short to GND is detected in Fuel Injector 1 circuit.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

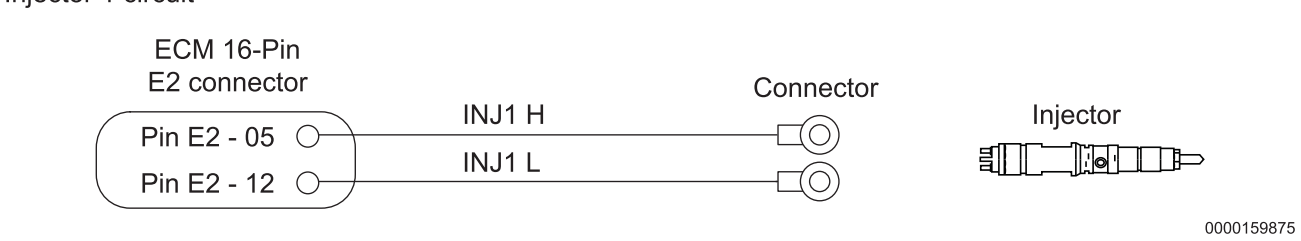


Figure 415 Injector 1 circuit diagram

Possible Causes

- INJ1 H circuit Open or high resistance
- INJ1 L circuit Open or high resistance
- Failed fuel injector 1 (Open coil)

WARNING: To prevent personal injury or death, shut engine down before doing voltage checks for injector solenoids. When the engine is running, injector circuits have high voltage and amperage.

CAUTION: To avoid engine damage, turn the ignition switch to OFF before disconnecting connectors. Failure to turn ignition switch to OFF will cause a voltage spike and damage to electrical components.

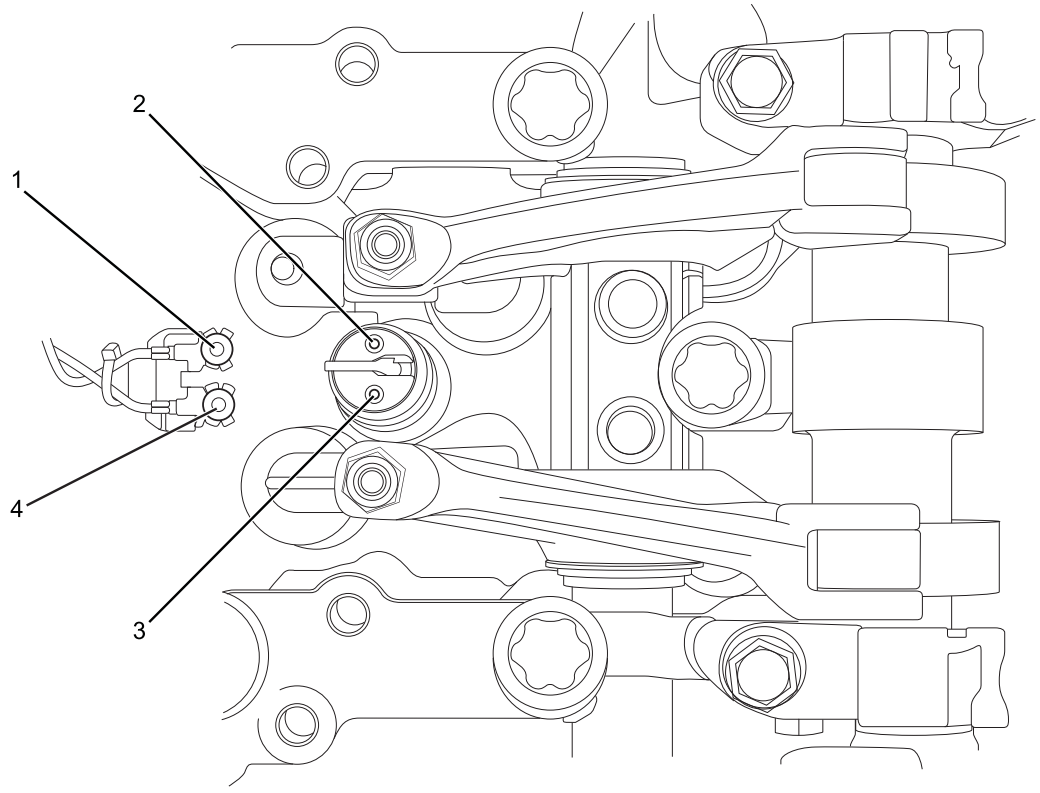


Figure 416 Fuel Injector Wiring Terminal Orientation

1. Fuel injector H wiring terminal
2. Fuel injector H terminal
3. Fuel injector L terminal
4. Fuel injector L wiring terminal (brown wire color [typical])

Step	Action	Decision
1	Inspect connections at fuel injector 1. Remove upper valve cover and engine brake housing (see Engine Service Manual). Check fuel injector 1 connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the fuel injector 1 connector, harness, and terminals clean and undamaged?	Yes: Go to step 2. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 651 FMI 5.

Step	Action	Decision
2	Check for a failed fuel injector 1 (Open coil). Key OFF, disconnect the connectors from fuel injector 1. Using a DMM, measure resistance between fuel injector 1 H and L terminals. Is resistance between 0.2 to 0.8 Ohms?	Yes: Go to step 3. No: Replace fuel injector 1. After repairs are complete, retest for SPN 651 FMI 5.

Step	Action	Decision
3	Inspect connections at ECM E2 connector. Key OFF, disconnect ECM E2 connector. Check ECM E2 connector and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the ECM E2 connector, harness, and terminals clean and undamaged?	Yes: Go to step 4.
		No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 651 FMI 5.

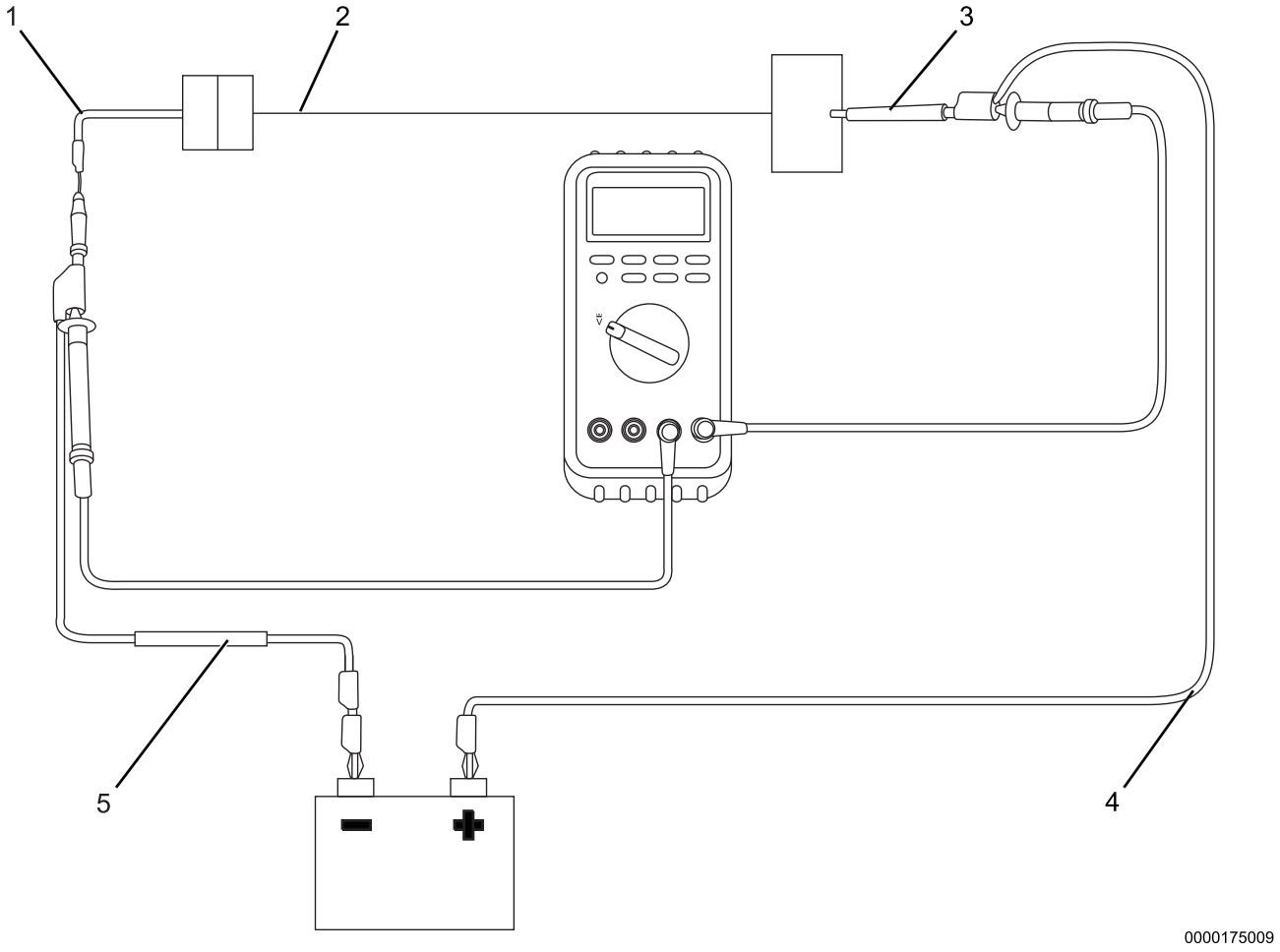


Figure 417 Voltage drop test (typical)

1. Breakout harness
2. Circuit under test
3. Terminal from ZTSE4435C
4. Jumper wire
5. 500 Ohm Resistor Jumper Harness ZTSE4497

Step	Action	Decision
4	Check INJ1 H circuit for Open or high resistance (voltage drop). 1. Key OFF, disconnect fuel injector 1 and ECM E2 connector. 2. Using Engine Terminal Test Kit ZTSE4435C, insert proper terminal into ECM pin E2-05. 3. Connect one end of the 500 Ohm Resistor Jumper Harness ZTSE4497 to terminal in E2-05, and connect the other end of 500 Ohm Resistor Jumper Harness to PWR (use a jumper wire if needed). 4. Connect INJ1 H ring terminal to a known good GND (use a jumper wire if needed) 5. Using a DMM, measure voltage between fuel injector 1 INJ 1 H ring terminal and terminal in ECM pin E2-05. Is voltage less than 0.3V?	Yes: Repair Open or high resistance between fuel injector 1 INJ1 L ring terminal and ECM pin E2-12. After repairs are complete, retest for SPN 651 FMI 5. No: Repair Open or high resistance between fuel injector 1 INJ1 H ring terminal and ECM pin E2-05. After repairs are complete, retest for SPN 651 FMI 5.

NOTE: After performing all diagnostic steps, if SPN 651 FMI 5 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 652 FMI 4- Injector 2 short circuit

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Short to GND detected in fuel injector 2 circuit	INJ2 circuit resistance to ground < 0.5 ohms	ECM commands injector firing	3 events

Fault Overview

Fault code sets when a short to GND is detected in Fuel Injector 2 circuit.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

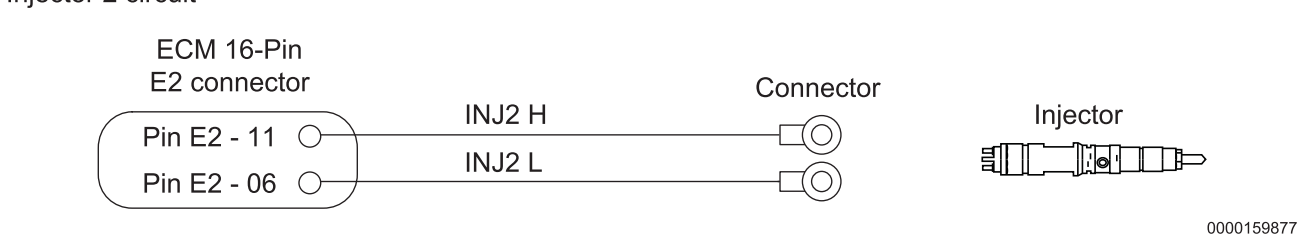


Figure 418 Injector 2 circuit diagram

Possible Causes

- INJ2 H circuit shorted to INJ2 L circuit
- INJ2 H circuit short to GND
- INJ2 L circuit short to GND
- Fuel injector shorted to engine brake housing
- Failed fuel injector 2

WARNING: To prevent personal injury or death, shut engine down before doing voltage checks for injector solenoids. When the engine is running, injector circuits have high voltage and amperage.

CAUTION: To avoid engine damage, turn the ignition switch to OFF before disconnecting connectors. Failure to turn ignition switch to OFF will cause a voltage spike and damage to electrical components.

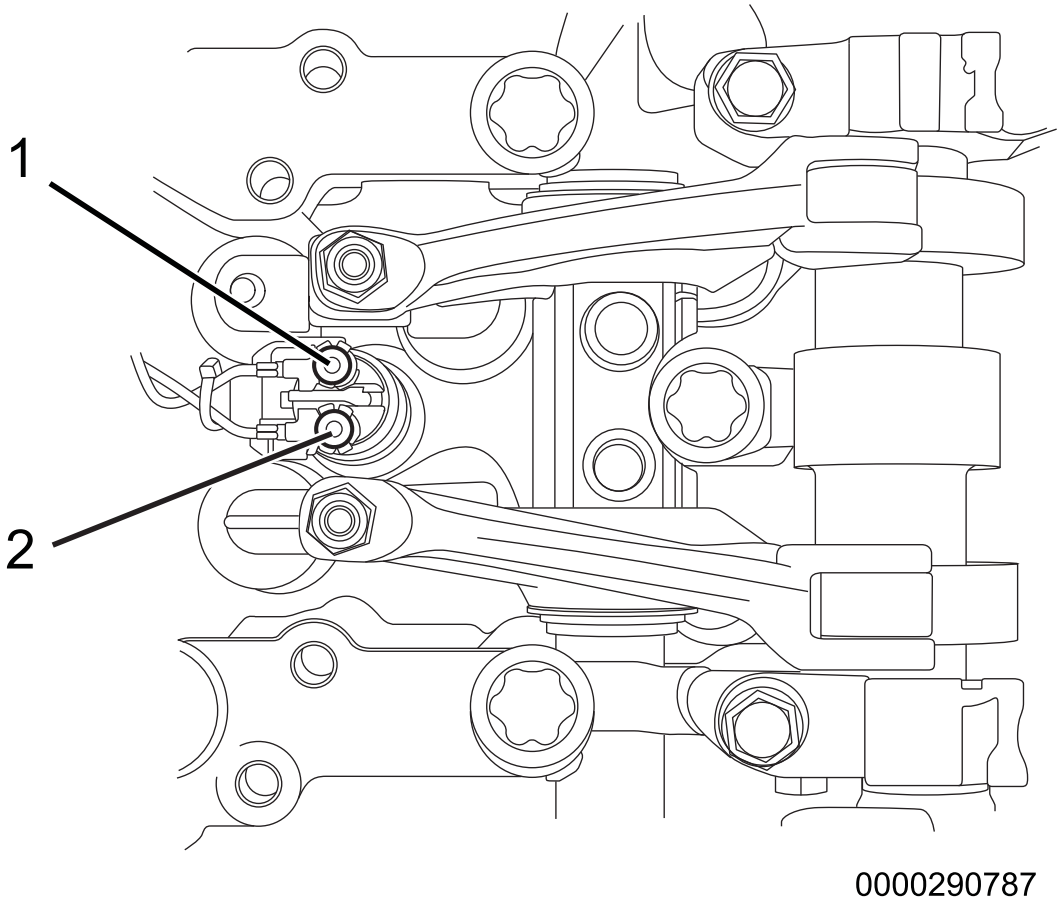


Figure 419 Fuel Injector Wiring Terminal Orientation

1. Fuel injector H wiring terminal
2. Fuel injector L wiring terminal (brown wire color [typical])

Step	Action	Decision
1	Verify proper fuel injector and terminal orientation. Remove upper valve cover and engine brake housing (see Engine Service Manual). Verify fuel injector terminals are installed parallel to avoid a short to ground on the engine brake housings. Are fuel injector 2 terminals oriented correctly and Not contacting the engine brake housing?	Yes: Go to step 2. No: Adjust connections so fuel injector 2 and injector terminals will not contact the engine brake housing. After repairs are complete, retest for SPN 652 FMI 4.

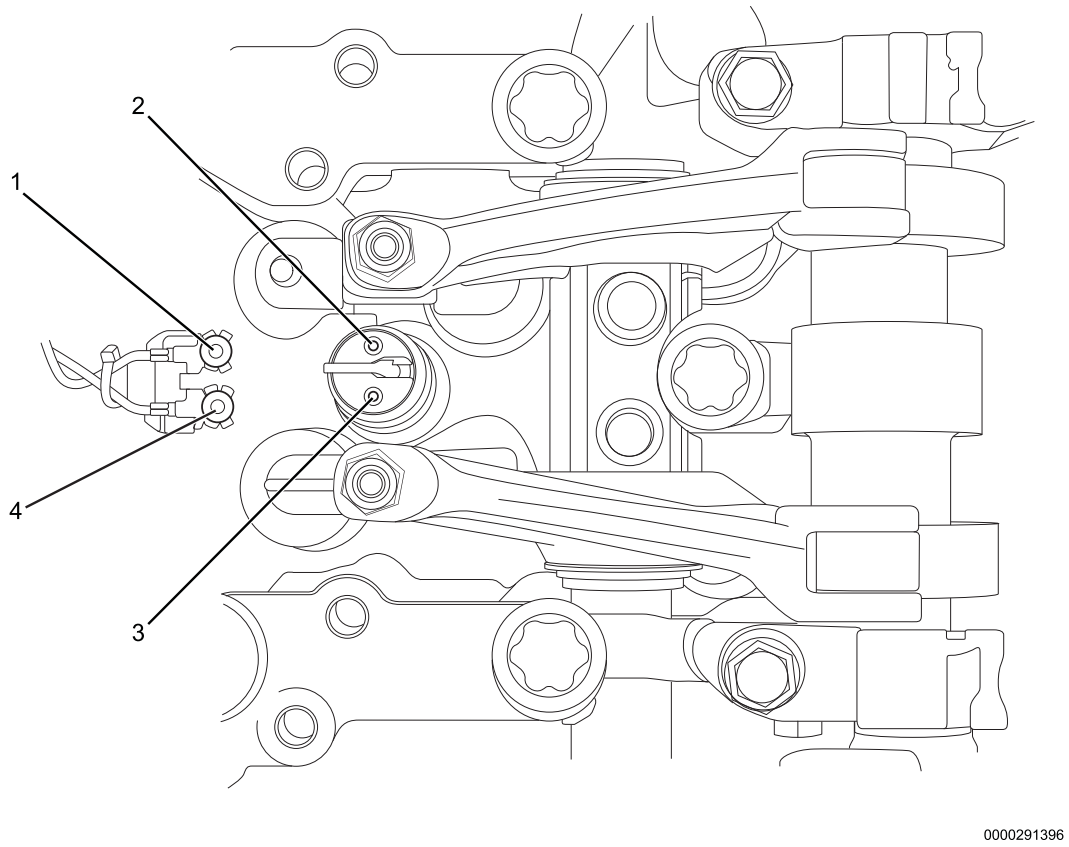


Figure 420 Fuel Injector Wiring Terminal Orientation

1. Fuel injector H wiring terminal
2. Fuel injector H terminal
3. Fuel injector L terminal
4. Fuel injector L wiring terminal (brown wire color [typical])

Step	Action	Decision
2	Check for a shorted fuel injector 2 coil. Key OFF, disconnect the wiring terminals from fuel injector 2. Using a DMM, check resistance across fuel injector 2 terminals. Is resistance between 0.2 to 0.8 Ohms?	Yes: Go to step 3. No: Replace fuel injector 2. After repairs are complete, retest for SPN 652 FMI 4.

Step	Action	Decision
3	Inspect connections at Electronic Control Module (ECM) E2 connector. Key OFF, disconnect ECM E2 connector. Check ECM E2 connector and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the ECM E2 connector, harness, and terminals clean and undamaged?	Yes: Go to step 4. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 652 FMI 4.

Step	Action	Decision
4	Check for fuel injector 2 high side terminal short to ground. Key OFF, with ECM E2 connector disconnected and wiring terminals disconnected from fuel injector 2, use a DMM to test resistance between high side terminal and a known good GND. Is resistances greater than 1000 ohms?	Yes: Go to step 5. No: Replace fuel injector 2. After repairs are complete, retest for SPN 652 FMI 4.

Step	Action	Decision
5	Check for fuel injector 2 low side terminal short to ground. Key OFF, with ECM E2 connector disconnected and wiring terminals disconnected from fuel injector 2, use a DMM to test resistance between low side terminal and a known good GND. Is resistances greater than 1000 ohms?	Yes: Go to step 6. No: Replace fuel injector 2. After repairs are complete, retest for SPN 652 FMI 4.

Step	Action	Decision
6	Check for INJ2 H short to INJ2 L. Key OFF, connect 180-pin Breakout Box with Breakout Harness 00-01468-00 to ECM E2 connector, leave ECM disconnected. Using a DMM with fuel injector 2 disconnected. measure resistance between Breakout Box pins E2-06 and E2-11 (wiggle test may be required). Is resistance greater than 1000 ohms?	Yes: Go to step 7. No: Repair short between INJ2 H circuit and INJ2 L circuit. After repairs are complete, retest for SPN 652 FMI 4.

Step	Action	Decision
7	Check INJ2 H circuit for short to GND. Key OFF, connect 180-pin breakout box with Breakout Harness 00-01468-00 to ECM E2 connector, leave ECM disconnected. Using a DMM with fuel injector 2 disconnected, measure resistance between Breakout Box pin E2-06 and known good GND (wiggle test may be required). Is resistance greater than 1000 Ohms?	Yes: Repair short to GND between E2-11 and fuel injector 2. After repairs are complete, retest for SPN 652 FMI 4. No: Repair short to GND between E2-06 and fuel injector 2. After repairs are complete, retest for SPN 652 FMI 4.

NOTE: After performing all diagnostic steps, if SPN 652 FMI 4 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 652 FMI 5- Injector 2 Open load / circuit

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Open detected in fuel injector 2 circuit.	INJ2 circuit > 30 ohms	ECM commands injector firing	3 events

Fault Overview

Fault code sets when a short to GND is detected in Fuel Injector 2 circuit.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

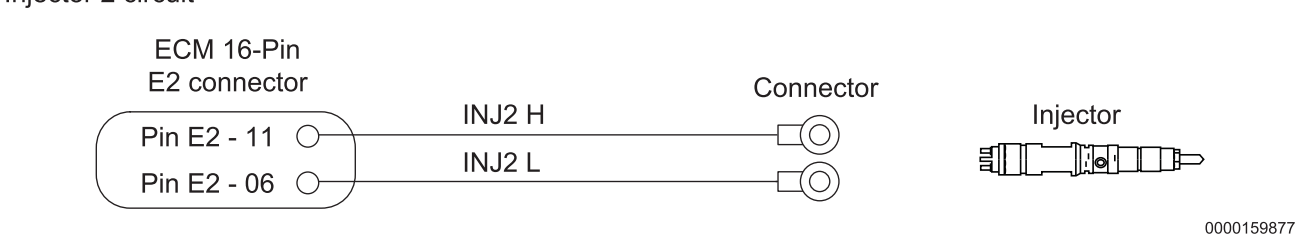


Figure 421 Injector 2 circuit diagram

Possible Causes

- INJ2 H circuit Open or high resistance
- INJ2 L circuit Open or high resistance
- Failed fuel injector

WARNING: To prevent personal injury or death, shut engine down before doing voltage checks for injector solenoids. When the engine is running, injector circuits have high voltage and amperage.

CAUTION: To avoid engine damage, turn the ignition switch to OFF before disconnecting connectors. Failure to turn ignition switch to OFF will cause a voltage spike and damage to electrical components.

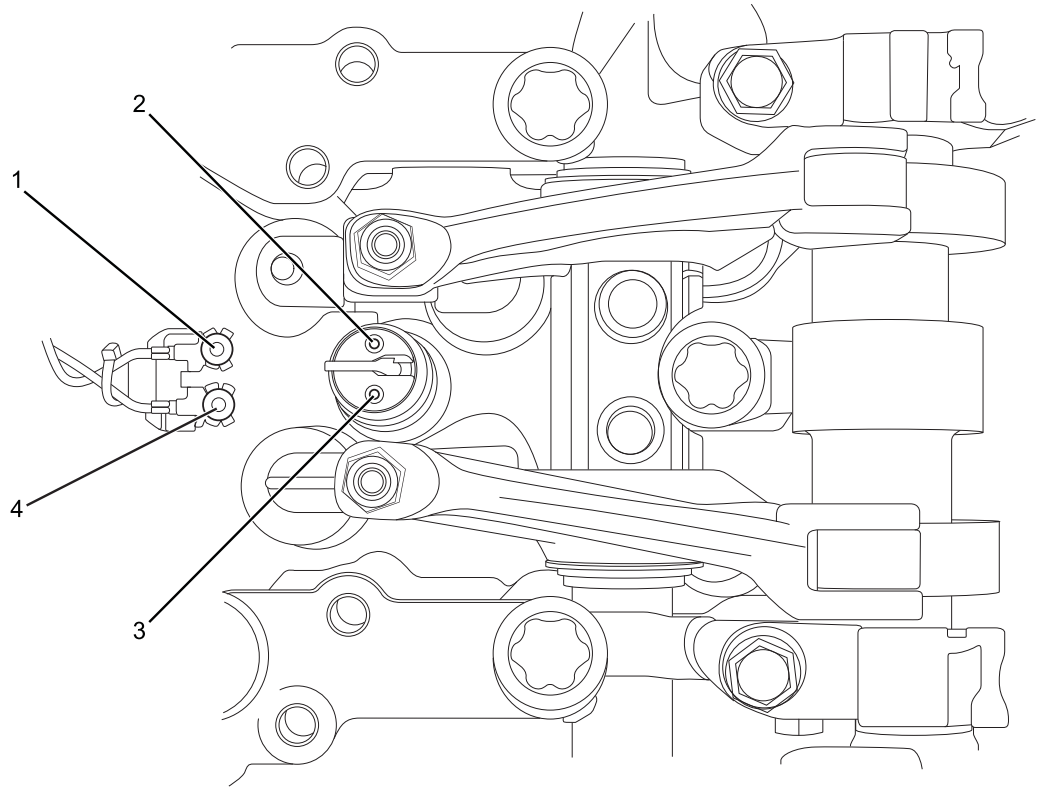


Figure 422 Fuel Injector Wiring Terminal Orientation

1. Fuel injector H wiring terminal
2. Fuel injector H terminal
3. Fuel injector L terminal
4. Fuel injector L wiring terminal (brown wire color [typical])

Step	Action	Decision
1	Inspect connections at fuel injector 2. Remove upper valve cover and engine brake housing (see Engine Service Manual). Check fuel injector 2 connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the fuel injector 2 connector, harness, and terminals clean and undamaged?	Yes: Go to step 2. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 652 FMI 5.

Step	Action	Decision
2	Check for a failed fuel injector 2 (Open coil). Key OFF, disconnect the connectors from fuel injector 2. Measure resistance between fuel injector 2 H and L terminals. Is resistance between 0.2 to 0.8 Ohms?	Yes: Go to step 3. No: Replace fuel injector 2. After repairs are complete, retest for SPN 652 FMI 5.

Step	Action	Decision
3	Inspect connections at ECM E2 connector. Key OFF, disconnect ECM E2 connector. Check ECM E2 connector and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the ECM E2 connector, harness, and terminals clean and undamaged?	Yes: Go to step 4.
		No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 652 FMI 5.

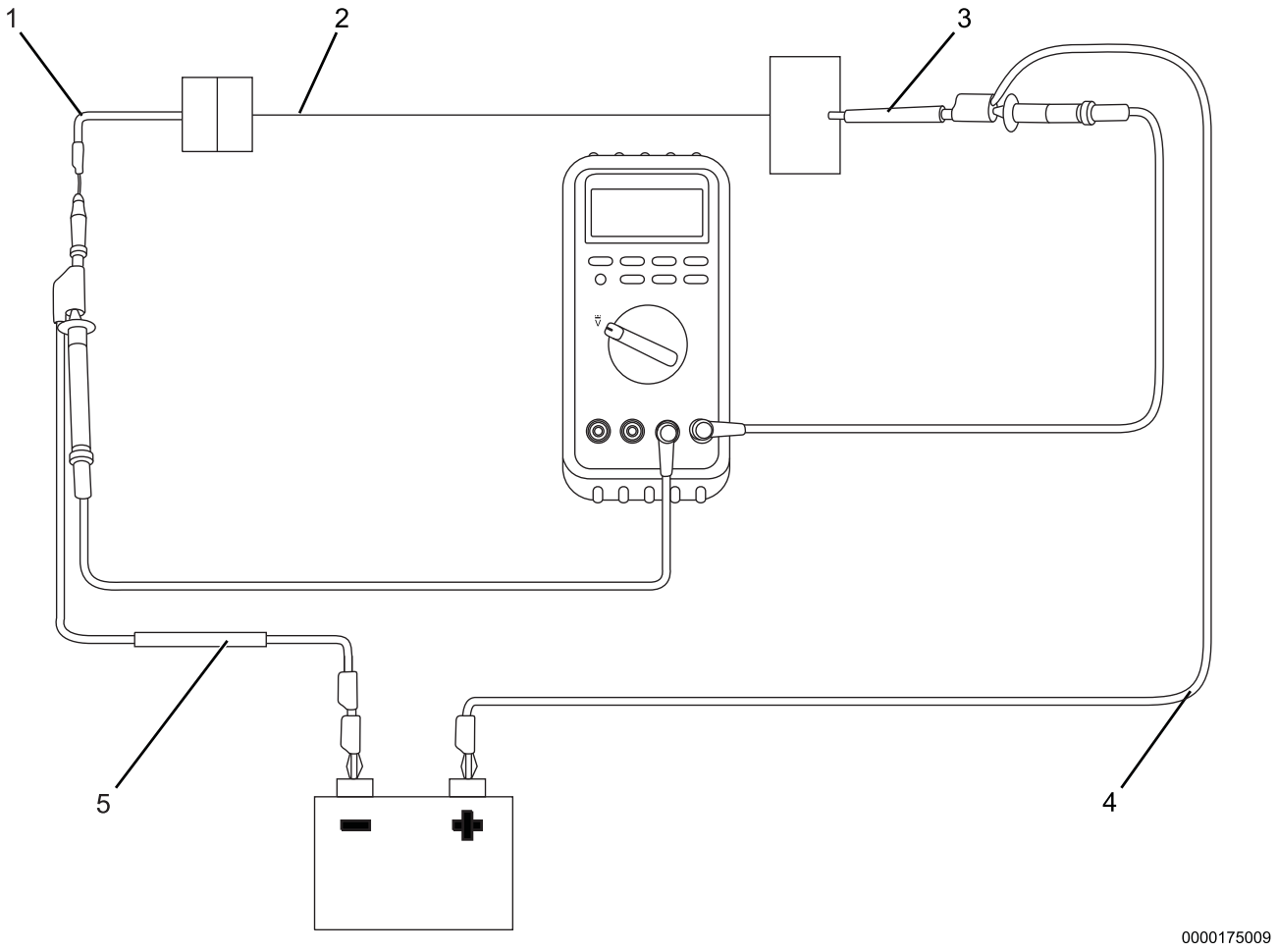


Figure 423 Voltage drop test (typical)

1. Breakout harness
2. Circuit under test
3. Terminal from ZTSE4435C
4. Jumper wire
5. 500 Ohm Resistor Jumper Harness ZTSE4497

Step	Action	Decision
4	Check INJ1 H circuit for Open or high resistance (voltage drop). 1. Key OFF, disconnect fuel injector 2 and ECM E2 connector. 2. Using Engine Terminal Test Kit ZTSE4435C, insert proper terminal into ECM pin E2-06. 3. Connect one end of the 500 Ohm Resistor Jumper Harness ZTSE4497 to terminal in E2-06, and the other end of 500 Ohm Resistor Jumper Harness to PWR (use a jumper wire if needed). 4. Connect INJ2 H ring terminal to a known good GND (use a jumper wire if needed) 5. Using a DMM, measure voltage between fuel injector 2 INJ 2 H ring terminal and terminal in ECM pin E2-06. Is voltage less than 0.3V?	Yes: Repair Open or high resistance between fuel injector 1 INJ2 L ring terminal and ECM pin E2-11. After repairs are complete, retest for SPN 652 FMI 5. No: Repair Open or high resistance between fuel injector 1 INJ2 H ring terminal and ECM pin E2-06. After repairs are complete, retest for SPN 652 FMI 5.

NOTE: After performing all diagnostic steps, if SPN 652 FMI 5 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 653 FMI 4- Injector 3 short circuit

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Short to GND detected in fuel injector 3 circuit	INJ3 circuit resistance to ground < 0.5 ohms	ECM commands injector firing	3 events

Fault Overview

Fault code sets when a short to GND is detected in Fuel Injector 3 circuit.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

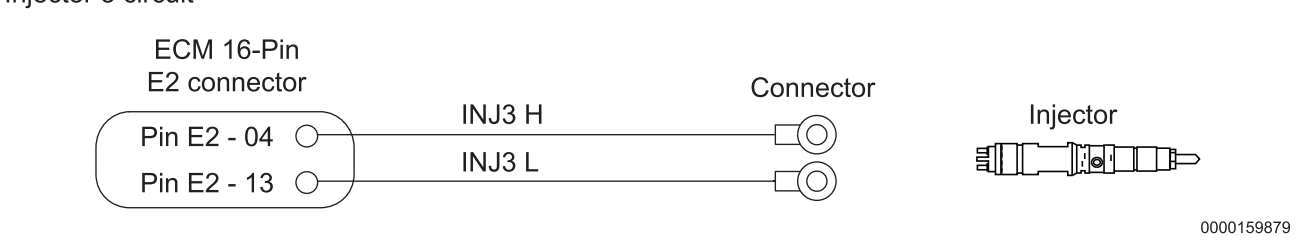


Figure 424 Injector 3 circuit diagram

Possible Causes

- INJ3 H circuit shorted to INJ3 L circuit
- INJ3 H circuit short to GND
- INJ3 L circuit short to GND
- Fuel injector shorted to engine brake housing
- Failed fuel injector

WARNING: To prevent personal injury or death, shut engine down before doing voltage checks for injector solenoids. When the engine is running, injector circuits have high voltage and amperage.

CAUTION: To avoid engine damage, turn the ignition switch to OFF before disconnecting connectors. Failure to turn ignition switch to OFF will cause a voltage spike and damage to electrical components.

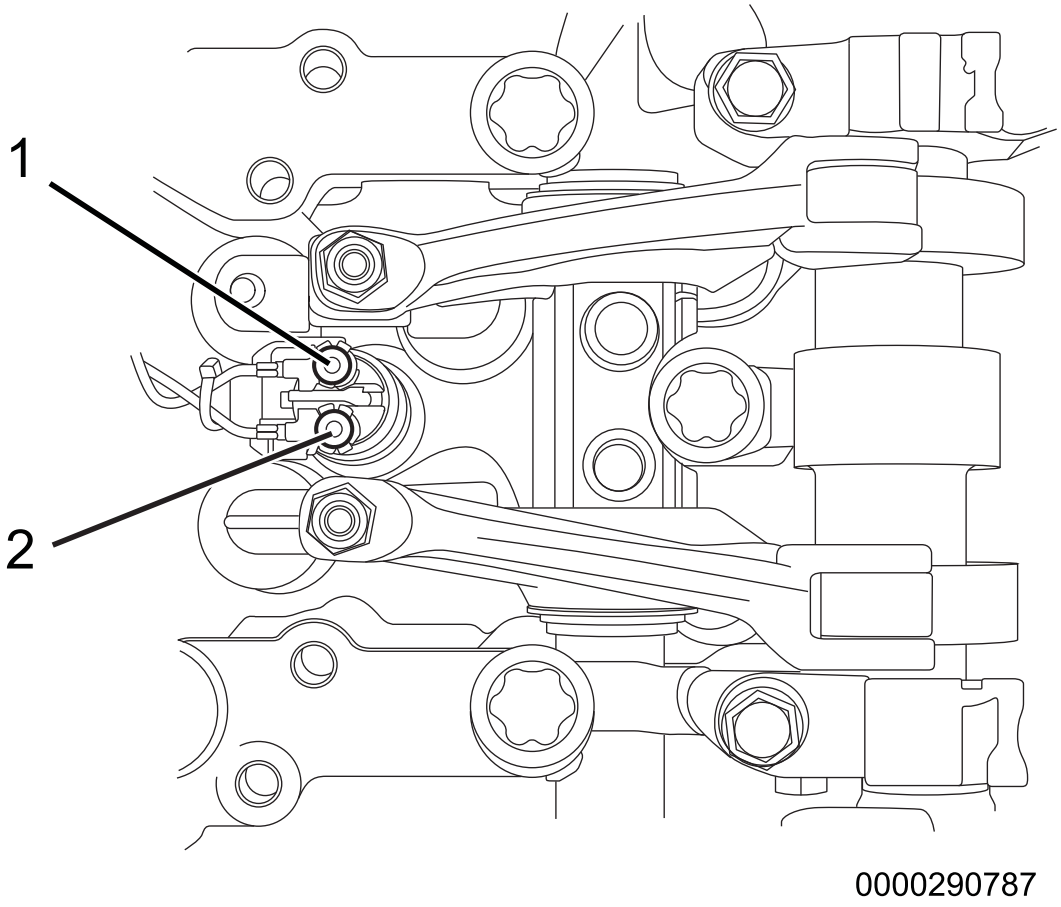


Figure 425 Fuel Injector Wiring Terminal Orientation

1. Fuel injector H wiring terminal
2. Fuel injector L wiring terminal (brown wire color [typical])

Step	Action	Decision
1	Verify proper fuel injector and terminal orientation. Remove upper valve cover and engine brake housing (see Engine Service Manual). Verify fuel injector terminals are installed parallel to avoid a short to ground on the engine brake housings. Are fuel injector 3 terminals oriented correctly and Not contacting the engine brake housing?	Yes: Go to step 2. No: Adjust connections so fuel injector 3 and injector terminals will not contact the engine brake housing. After repairs are complete, retest for SPN 653 FMI 4.

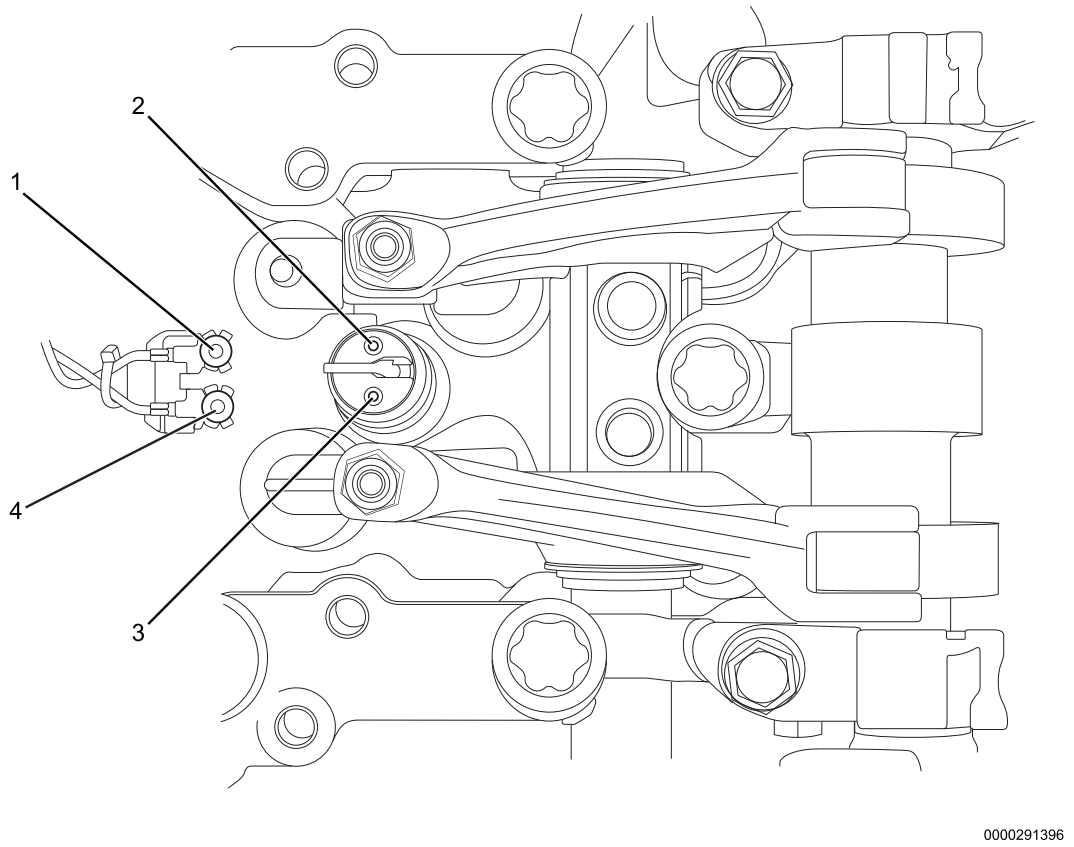


Figure 426 Fuel Injector Wiring Terminal Orientation

1. Fuel injector H wiring terminal
2. Fuel injector H terminal
3. Fuel injector L terminal
4. Fuel injector L wiring terminal (brown wire color [typical])

Step	Action	Decision
2	Check for a shorted fuel injector 3 coil. Key OFF, disconnect the connectors from fuel injector 3. Using a DMM, check resistance across fuel injector 3 terminals. Is resistance between 0.2 to 0.6 Ohms?	Yes: Go to step 3. No: Replace fuel injector 3. After repairs are complete, retest for SPN 653 FMI 4.

Step	Action	Decision
3	Inspect connections at Electronic Control Module (ECM) E2 connector. Key OFF, disconnect ECM E2 connector. Check ECM E2 connector and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the ECM E2 connector, harness, and terminals clean and undamaged?	Yes: Go to step 4. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 653 FMI 4.

Step	Action	Decision
4	Check for fuel injector 3 high side terminal short to ground. Key OFF, with ECM E2 connector disconnected and wiring terminals disconnected from fuel injector 3, use a DMM to test resistance between high side terminal and a known good GND. Is resistances greater than 1000 ohms?	Yes: Go to step 5. No: Replace fuel injector 3. After repairs are complete, retest for SPN 653 FMI 4.

Step	Action	Decision
5	Check for fuel injector 3 low side terminal short to ground. Key OFF, with ECM E2 connector disconnected and wiring terminals disconnected from fuel injector 3, use a DMM to test resistance between low side terminal and a known good GND. Is resistances greater than 1000 ohms?	Yes: Go to step 6. No: Replace fuel injector 3. After repairs are complete, retest for SPN 653 FMI 4.

Step	Action	Decision
6	Check for INJ3 H short to INJ3 L. Key OFF, connect 180-pin Breakout Box with Breakout Harness 00-01468-00 to ECM E2 connector, leave ECM disconnected. Using a DMM with fuel injector 3 disconnected. measure resistance between Breakout Box pins E2-04 and E2-13 (wiggle test may be required). Is resistance greater than 1000 ohms?	Yes: Go to step 7. No: Repair short between INJ3 H circuit and INJ3 L circuit. After repairs are complete, retest for SPN 653 FMI 4.

Step	Action	Decision
7	Check INJ3 H circuit for short to GND. Key OFF, connect 180-pin breakout box with Breakout Harness 00-01468-00 to ECM E2 connector, leave ECM disconnected. Using a DMM with fuel injector 3 disconnected, measure resistance between Breakout Box pin E2-04 and known good GND (wiggle test may be required). Is resistance greater than 1000 Ohms?	Yes: Repair short to GND between E2-13 and fuel injector 3. After repairs are complete, retest for SPN 653 FMI 4. No: Repair short to GND between E2-04 and fuel injector 3. After repairs are complete, retest for SPN 653 FMI 4.

NOTE: After performing all diagnostic steps, if SPN 653 FMI 4 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 653 FMI 5- Injector 3 Open load / circuit

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Open detected in fuel injector 3 circuit.	INJ3 circuit > 30 ohms	ECM commands injector firing	3 events

Fault Overview

Fault code sets when a short to GND is detected in Fuel Injector 3 circuit.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

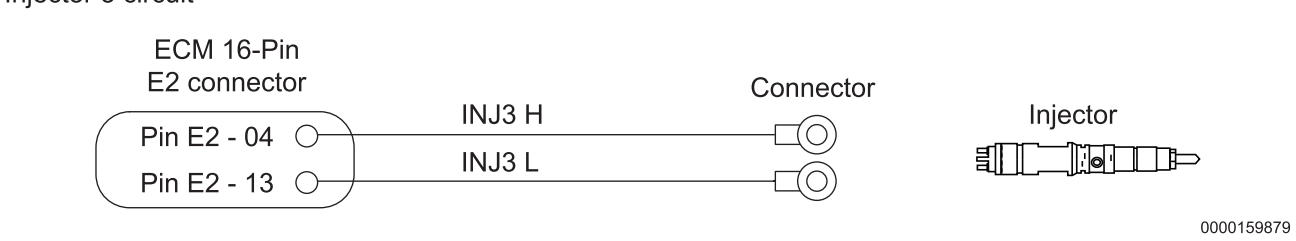


Figure 427 Injector 3 circuit diagram

Possible Causes

- INJ3 H circuit Open or high resistance
- INJ3 L circuit Open or high resistance
- Failed fuel injector

WARNING: To prevent personal injury or death, shut engine down before doing voltage checks for injector solenoids. When the engine is running, injector circuits have high voltage and amperage.

CAUTION: To avoid engine damage, turn the ignition switch to OFF before disconnecting connectors. Failure to turn ignition switch to OFF will cause a voltage spike and damage to electrical components.

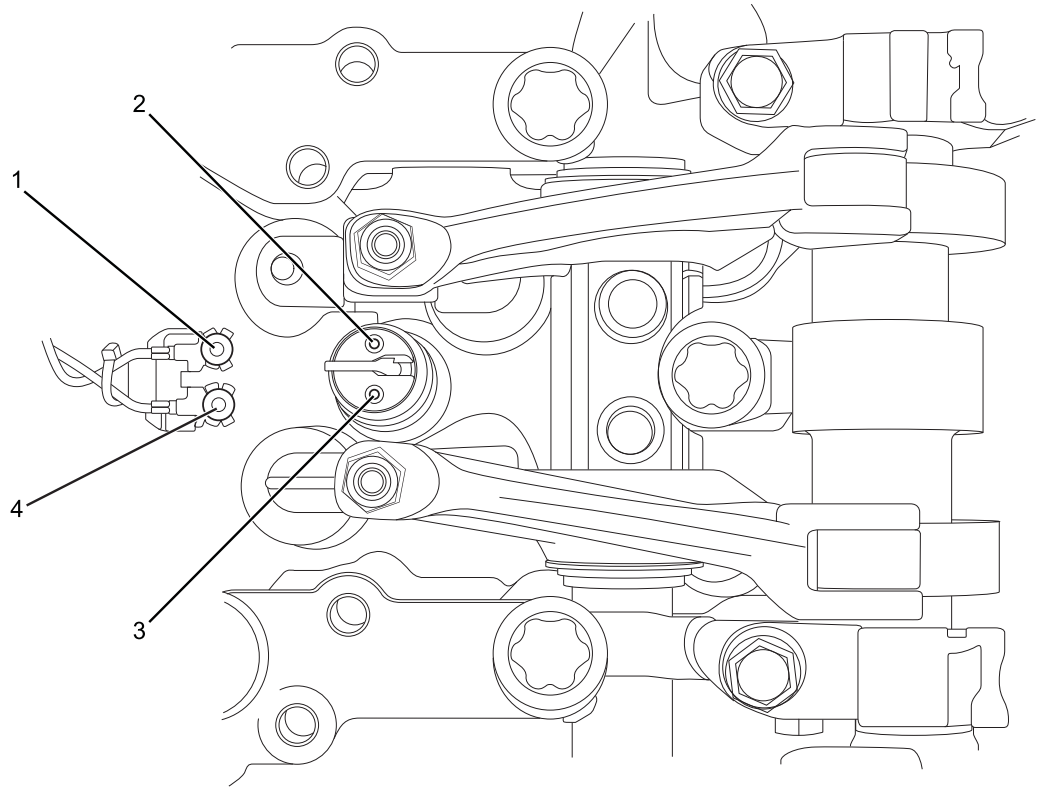


Figure 428 Fuel Injector Wiring Terminal Orientation

1. Fuel injector H wiring terminal
2. Fuel injector H terminal
3. Fuel injector L terminal
4. Fuel injector L wiring terminal (brown wire color [typical])

Step	Action	Decision
1	Inspect connections at fuel injector 3. Remove upper valve cover and engine brake housing (see Engine Service Manual). Check fuel injector 3 connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the fuel injector 3 connector, harness, and terminals clean and undamaged?	Yes: Go to step 2. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 653 FMI 5.

Step	Action	Decision
2	Check for a Open fuel injector 3 coil. Disconnect the connectors from fuel injector 3. Check resistance across fuel injector 3. Is resistance between 0.2 to 0.8 Ohms?	Yes: Go to step 3. No: Replace fuel injector 3. After repairs are complete, retest for SPN 653 FMI 5.

Step	Action	Decision
3	Inspect connections at ECM E2 connector. Key OFF, disconnect ECM E2 connector. Check ECM E2 connector and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the ECM E2 connector, harness, and terminals clean and undamaged?	Yes: Go to step 4.
		No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 653 FMI 5.

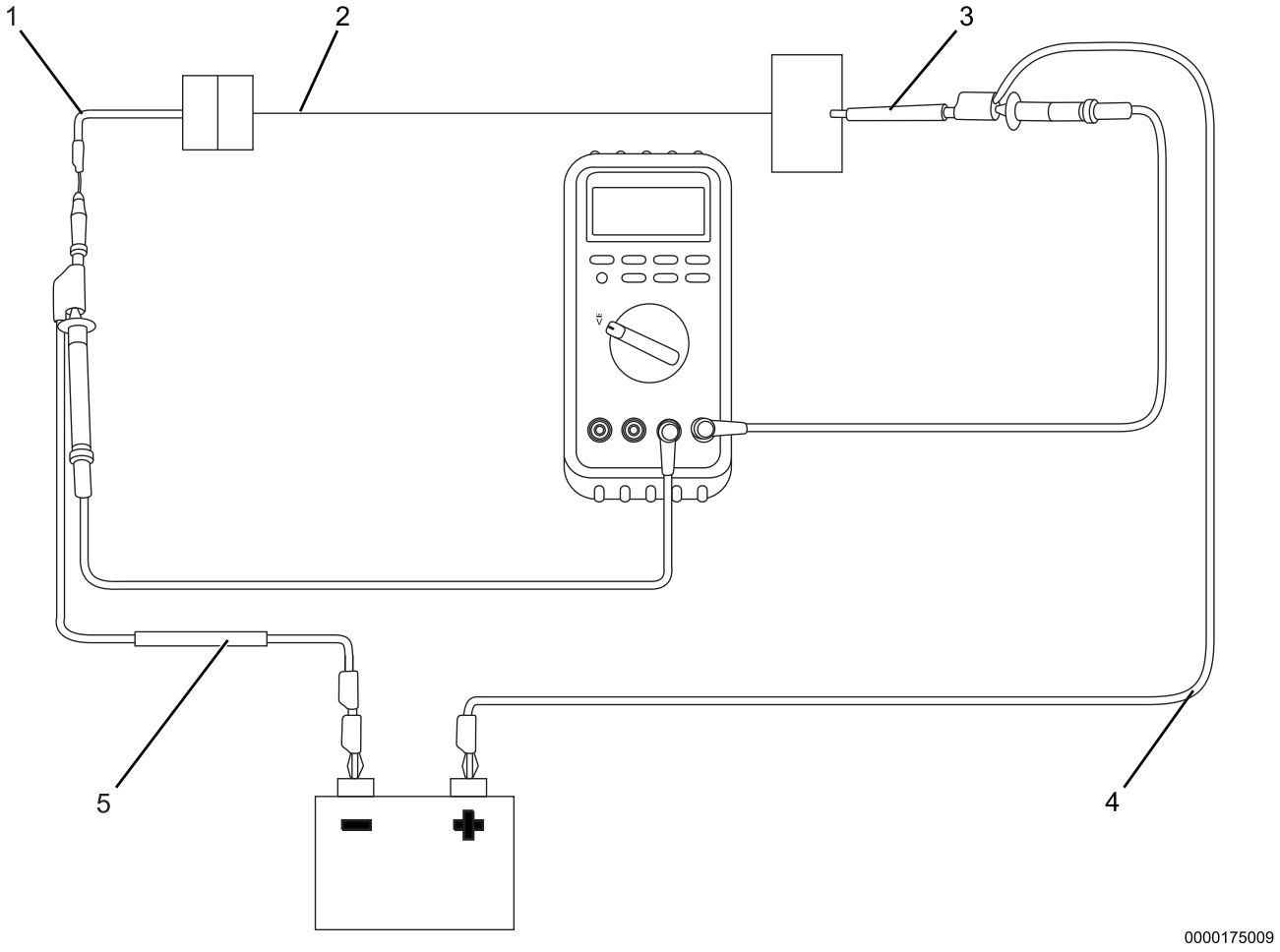


Figure 429 Voltage drop test (typical)

1. Breakout harness
2. Circuit under test
3. Terminal from ZTSE4435C
4. Jumper wire
5. 500 Ohm Resistor Jumper Harness ZTSE4497

Step	Action	Decision
4	Check INJ3 H circuit for Open or high resistance (voltage drop). 1. Key OFF, disconnect fuel injector 3 and ECM E2 connector. 2. Using Engine Terminal Test Kit ZTSE4435C, insert proper terminal into ECM pin E2-04. 3. Connect one end of the 500 Ohm Resistor Jumper Harness ZTSE4497 to terminal in E2-04, and the other end of 500 Ohm Resistor Jumper Harness to PWR (use a jumper wire if needed). 4. Connect INJ3 H ring terminal to a known good GND (use a jumper wire if needed) 5. Using a DMM, measure voltage between fuel injector 3 INJ 3 H ring terminal and terminal in ECM pin E2-04. Is voltage less than 0.3V	Yes: Repair INJ3 L circuit between fuel injector 3 and pin E2-13. After repairs are complete, retest for SPN 653 FMI 5. No: Repair INJ3 H circuit between fuel injector 3 and pin E2-04. After repairs are complete, retest for SPN 653 FMI 5.

NOTE: After performing all diagnostic steps, if SPN 653 FMI 5 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 654 FMI 4- Injector 4 short circuit

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Short to GND detected in fuel injector 4 circuit	INJ3 circuit resistance to ground < 0.5 ohms	ECM commands injector firing	3 events

Fault Overview

Fault code sets when a short to GND is detected in Fuel Injector 4 circuit.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Injector 4 circuit

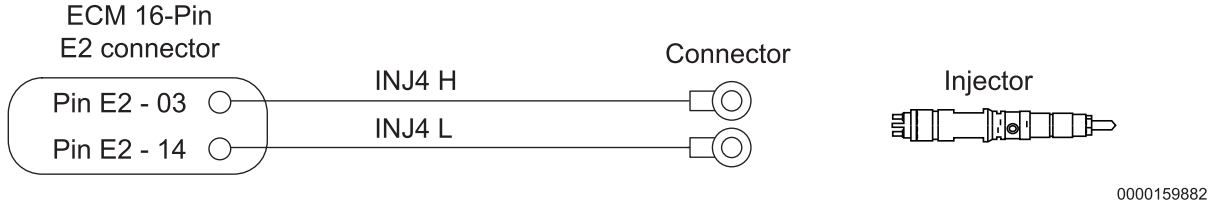


Figure 430 Injector 4 circuit diagram

Possible Causes

- INJ4 H circuit shorted to INJ4 L circuit
- INJ4 H circuit short to GND
- INJ4 L circuit short to GND
- Fuel injector shorted to engine brake housing
- Failed fuel injector

WARNING: To prevent personal injury or death, shut engine down before doing voltage checks for injector solenoids. When the engine is running, injector circuits have high voltage and amperage.

CAUTION: To avoid engine damage, turn the ignition switch to OFF before disconnecting connectors. Failure to turn ignition switch to OFF will cause a voltage spike and damage to electrical components.

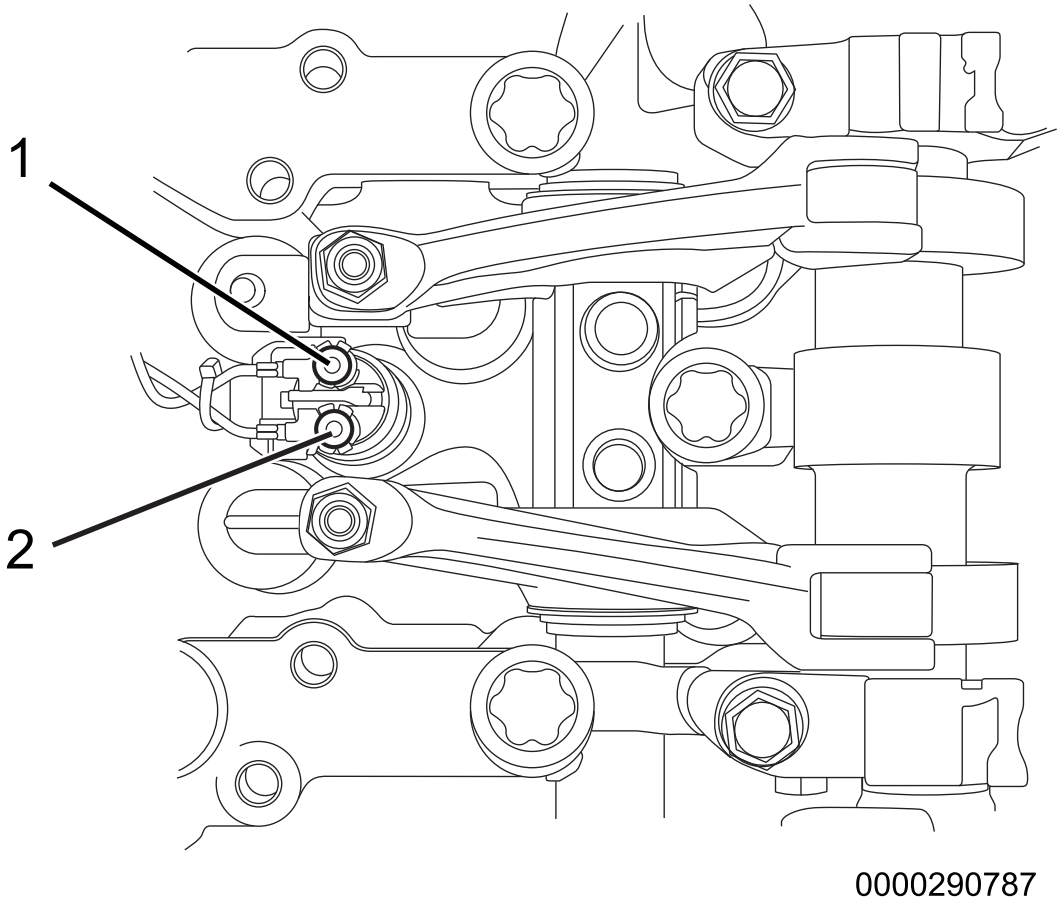


Figure 431 Fuel Injector Wiring Terminal Orientation

1. Fuel injector H wiring terminal
2. Fuel injector L wiring terminal (brown wire color [typical])

Step	Action	Decision
1	Verify proper fuel injector and terminal orientation. Remove upper valve cover and engine brake housing (see Engine Service Manual). Verify fuel injector terminals are installed parallel to avoid a short to ground on the engine brake housings. Are fuel injector 4 terminals oriented correctly and Not contacting the engine brake housing?	Yes: Go to step 2. No: Adjust connections so fuel injector 4 and injector terminals will not contact the engine brake housing. After repairs are complete, retest for SPN 654 FMI 4.

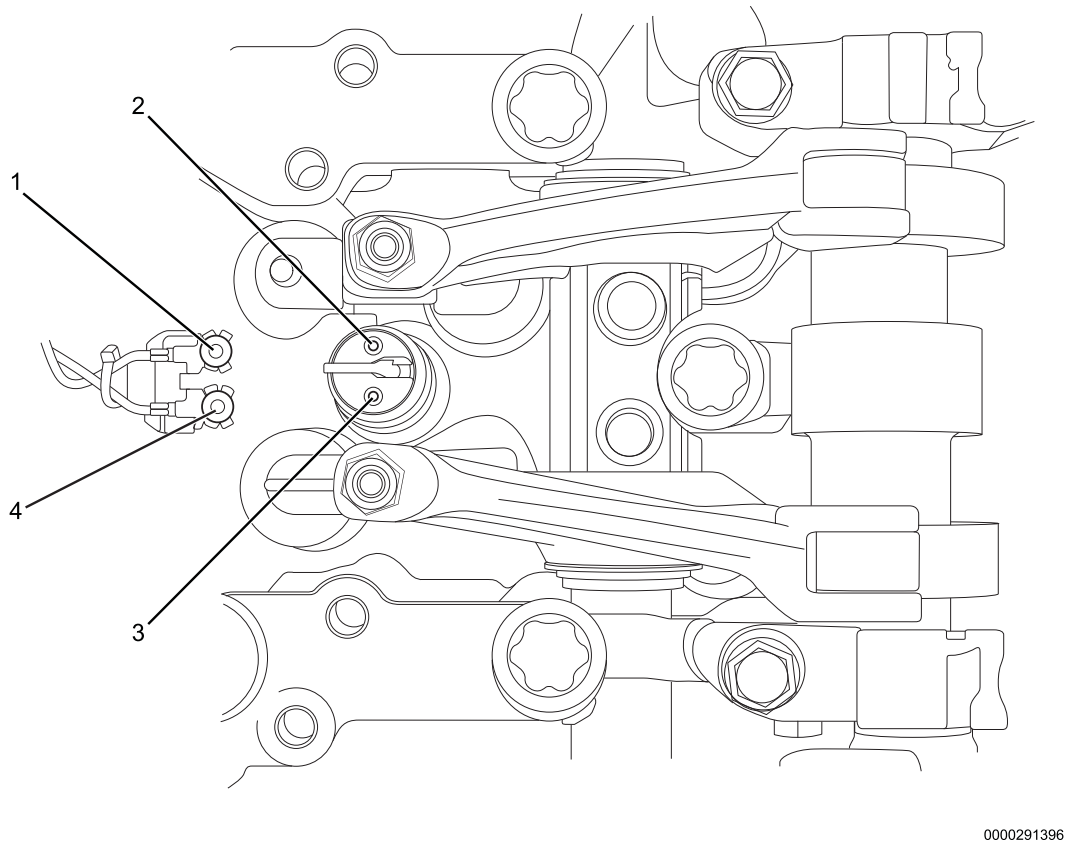


Figure 432 Fuel Injector Wiring Terminal Orientation

1. Fuel injector H wiring terminal
2. Fuel injector H terminal
3. Fuel injector L terminal
4. Fuel injector L wiring terminal (brown wire color [typical])

Step	Action	Decision
2	Check for a shorted fuel injector 4 coil. Key OFF, disconnect the connectors from fuel injector 4. Using a DMM, check resistance across fuel injector 4 terminals. Is resistance between 0.2 to 0.8 Ohms?	Yes: Go to step 3. No: Replace fuel injector 4. After repairs are complete, retest for SPN 654 FMI 4.

Step	Action	Decision
3	Inspect connections at Electronic Control Module (ECM) E2 connector. Key OFF, disconnect ECM E2 connector. Check ECM E2 connector and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the ECM E2 connector, harness, and terminals clean and undamaged?	Yes: Go to step 4. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 654 FMI 4.

Step	Action	Decision
4	Check for fuel injector 4 high side terminal short to ground. Key OFF, with ECM E2 connector disconnected and wiring terminals disconnected from fuel injector 4, use a DMM to test resistance between high side terminal and a known good GND. Is resistances greater than 1000 ohms?	Yes: Go to step 5. No: Replace fuel injector 4. After repairs are complete, retest for SPN 654 FMI 4.

Step	Action	Decision
5	Check for fuel injector 4 low side terminal short to ground. Key OFF, with ECM E2 connector disconnected and wiring terminals disconnected from fuel injector 4, use a DMM to test resistance between low side terminal and a known good GND. Is resistances greater than 1000 ohms?	Yes: Go to step 6. No: Replace fuel injector 4. After repairs are complete, retest for SPN 654 FMI 4.

Step	Action	Decision
6	Check for INJ4 H short to INJ4 L. Key OFF, connect 180-pin Breakout Box with Breakout Harness 00-01468-00 to ECM E2 connector, leave ECM disconnected. Using a DMM with fuel injector 4 disconnected. measure resistance between Breakout Box pins E2-03 and E2-14 (wiggle test may be required). Is resistance greater than 1000 ohms?	Yes: Go to step 7. No: Repair short between INJ4 H circuit and INJ4 L circuit. After repairs are complete, retest for SPN 654 FMI 4.

Step	Action	Decision
7	Check INJ4 H circuit for short to GND. Key OFF, connect 180-pin breakout box with Breakout Harness 00-01468-00 to ECM E2 connector, leave ECM disconnected. Using a DMM with fuel injector 4 disconnected, measure resistance between Breakout Box pin E2-03 and known good GND (wiggle test may be required). Is resistance greater than 1000 Ohms?	Yes: Repair short to GND between E2-14 and fuel injector 4. After repairs are complete, retest for SPN 654 FMI 4. No: Repair short to GND between E2-03 and fuel injector 4. After repairs are complete, retest for SPN 654 FMI 4.

NOTE: After performing all diagnostic steps, if SPN 654 FMI 4 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 654 FMI 5- Injector 4 Open load / circuit

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Open detected in fuel injector 4 circuit.	INJ4 circuit > 30 ohms	ECM commands injector firing	3 events

Fault Overview

Fault code sets when a short to GND is detected in Fuel Injector 4 circuit.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Injector 4 circuit

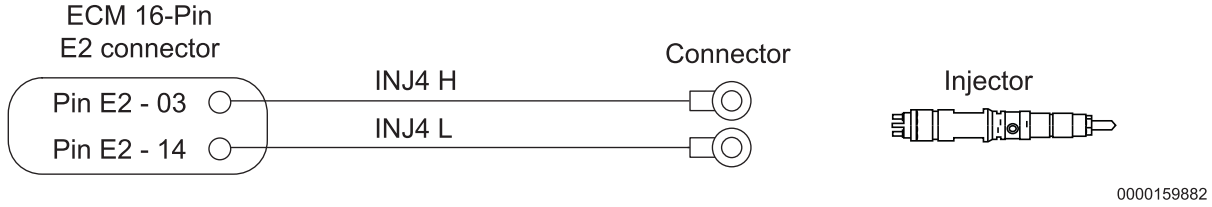


Figure 433 Injector 4 circuit diagram

Possible Causes

- INJ4 H circuit Open or high resistance
- INJ4 L circuit Open or high resistance
- Failed fuel injector

WARNING: To prevent personal injury or death, shut engine down before doing voltage checks for injector solenoids. When the engine is running, injector circuits have high voltage and amperage.

CAUTION: To avoid engine damage, turn the ignition switch to OFF before disconnecting connectors. Failure to turn ignition switch to OFF will cause a voltage spike and damage to electrical components.

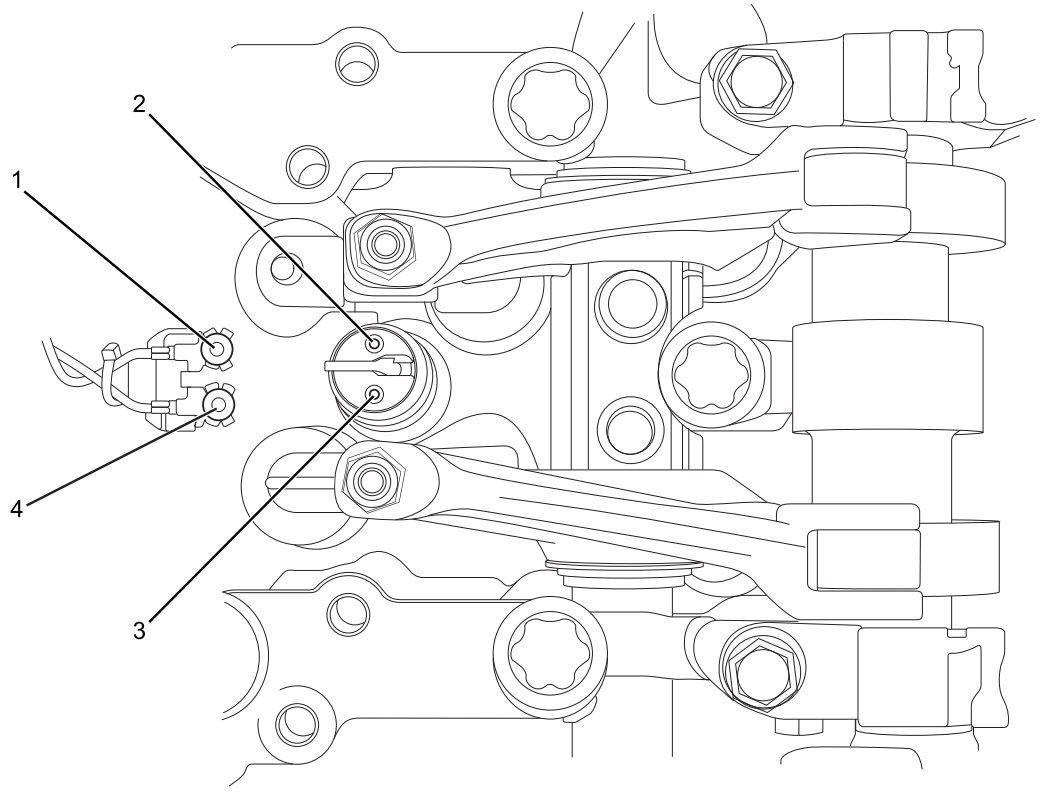


Figure 434 Fuel Injector Wiring Terminal Orientation

1. Fuel injector H wiring terminal
2. Fuel injector H terminal
3. Fuel injector L terminal
4. Fuel injector L wiring terminal (brown wire color [typical])

Step	Action	Decision
1	Inspect connections at fuel injector 4. Remove valve cover and engine brake housing (see Engine Service Manual). Check fuel injector 4 connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the fuel injector 4 connector, harness, and terminals clean and undamaged?	Yes: Go to step 2. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 654 FMI 5.

Step	Action	Decision
2	Check for a Open fuel injector 4 coil. Disconnect the connectors from fuel injector 4. Check resistance across fuel injector 4. Is resistance between 0.2 to 0.8 Ohms?	Yes: Go to step 3. No: Replace fuel injector 4. After repairs are complete, retest for SPN 654 FMI 5.

Step	Action	Decision
3	Inspect connections at ECM E2 connector. Key OFF, disconnect ECM E2 connector. Check ECM E2 connector and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the ECM E2 connector, harness, and terminals clean and undamaged?	Yes: Go to step 4.
		No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 654 FMI 5.

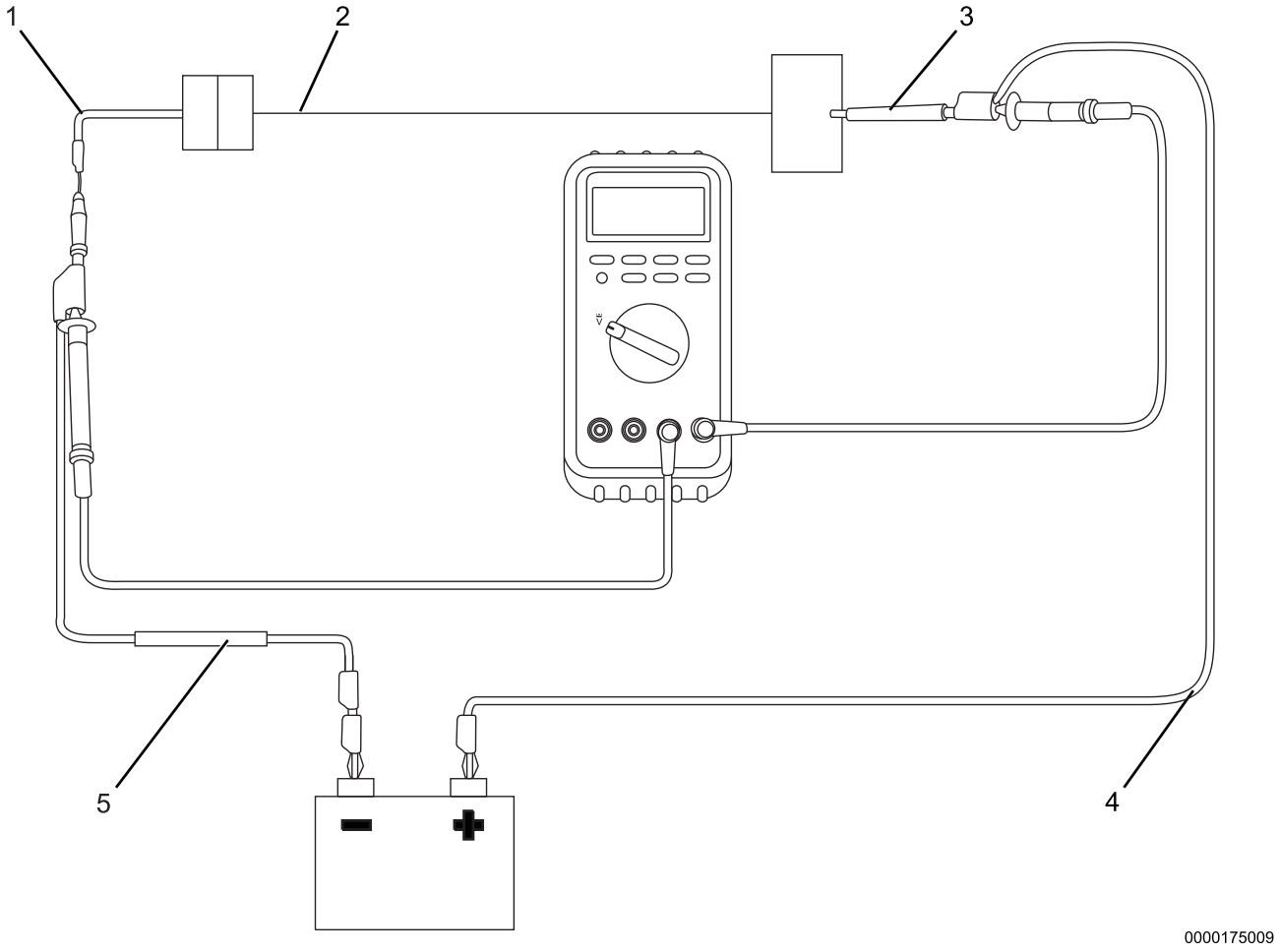


Figure 435 Voltage drop test (typical)

1. Breakout harness
2. Circuit under test
3. Terminal from ZTSE4435C
4. Jumper wire
5. 500 Ohm Resistor Jumper Harness ZTSE4497

Step	Action	Decision
4	Check INJ4 H circuit for Open or high resistance (voltage drop). 1. Key OFF, disconnect fuel injector 4 and ECM E2 connector. 2. Using Engine Terminal Test Kit ZTSE4435C, insert proper terminal into ECM pin E2-03. 3. Connect one end of the 500 Ohm Resistor Jumper Harness ZTSE4497 to terminal in E2-03, and the other end of 500 Ohm Resistor Jumper Harness to PWR (use a jumper wire if needed). 4. Connect INJ4 H ring terminal to a known good GND (use a jumper wire if needed) 5. Using a DMM, measure voltage between fuel injector 4 INJ 4 H ring terminal and terminal in ECM pin E2-03. Is voltage less than 0.3V	Yes: Repair INJ4 L circuit between fuel injector 4 and pin E2-14. After repairs are complete, retest for SPN 654 FMI 5. No: Repair INJ4 H circuit between fuel injector 4 and pin E2-03. After repairs are complete, retest for SPN 654 FMI 5.

NOTE: After performing all diagnostic steps, if SPN 654 FMI 5 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 655 FMI 4- Injector 5 short circuit

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Short to GND detected in fuel injector 5 circuit	INJ5 circuit resistance to ground < 0.5 ohms	ECM commands injector firing	3 events

Fault Overview

Fault code sets when a short to GND is detected in Fuel Injector 5 circuit.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

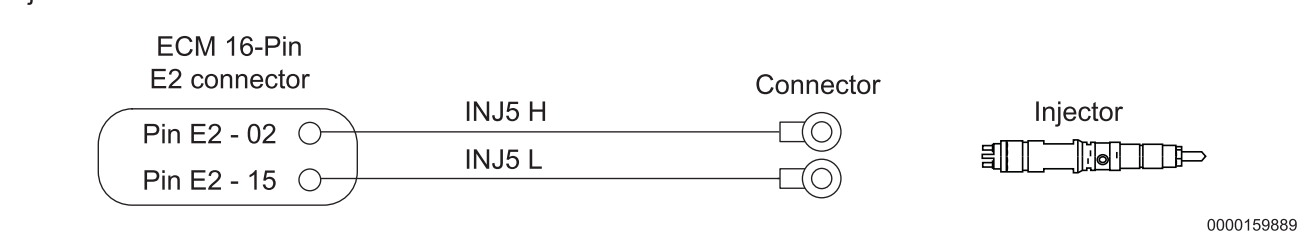


Figure 436 Injector 5 circuit diagram

Possible Causes

- INJ5 H circuit shorted to INJ5 L circuit
- INJ5 H circuit short to GND
- INJ5 L circuit short to GND
- Fuel injector shorted to engine brake housing
- Failed fuel injector

WARNING: To prevent personal injury or death, shut engine down before doing voltage checks for injector solenoids. When the engine is running, injector circuits have high voltage and amperage.

CAUTION: To avoid engine damage, turn the ignition switch to OFF before disconnecting connectors. Failure to turn ignition switch to OFF will cause a voltage spike and damage to electrical components.

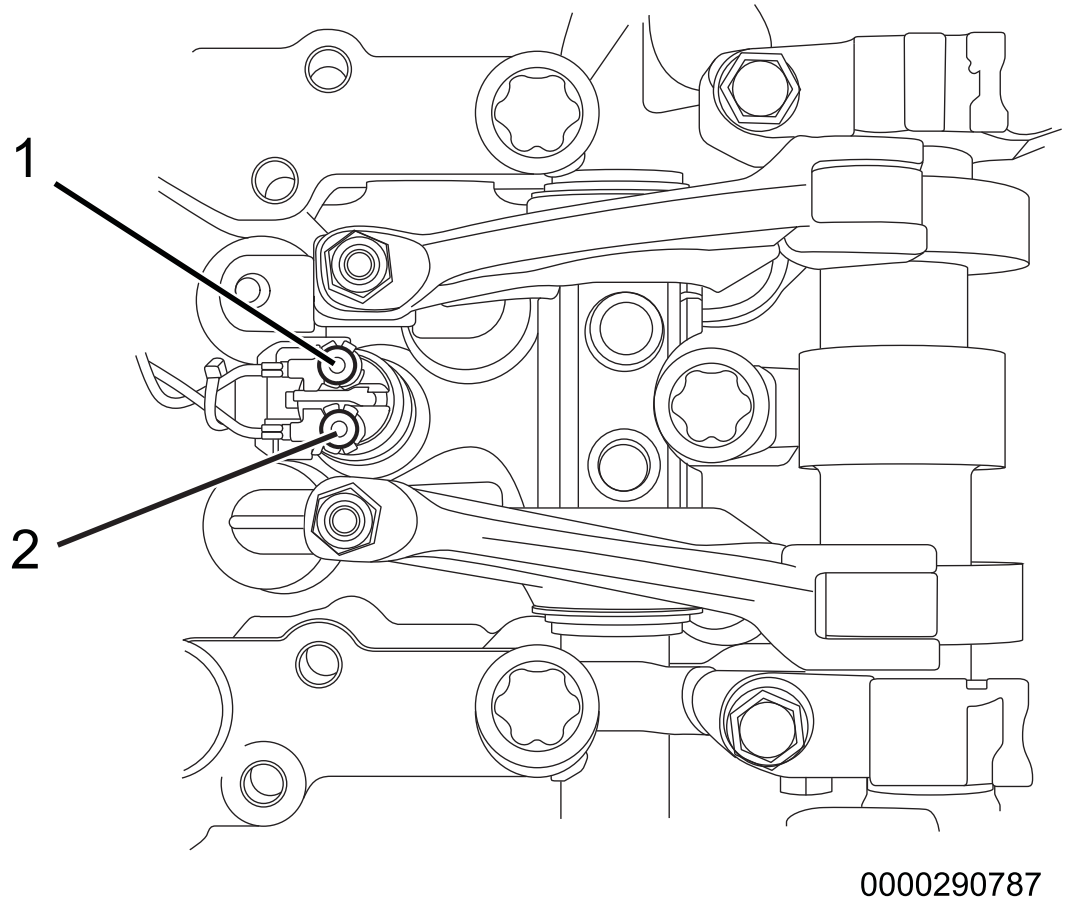


Figure 437 Fuel Injector Wiring Terminal Orientation

1. Fuel injector H wiring terminal
2. Fuel injector L wiring terminal (brown wire color [typical])

Step	Action	Decision
1	Verify proper fuel injector and terminal orientation. Remove upper valve cover and engine brake housing (see Engine Service Manual). Verify fuel injector terminals are installed parallel to avoid a short to ground on the engine brake housings. Are fuel injector 5 terminals oriented correctly and Not contacting the engine brake housing?	Yes: Go to step 2. No: Adjust connections so fuel injector 5 and injector terminals will not contact the engine brake housing. After repairs are complete, retest for SPN 655 FMI 4.

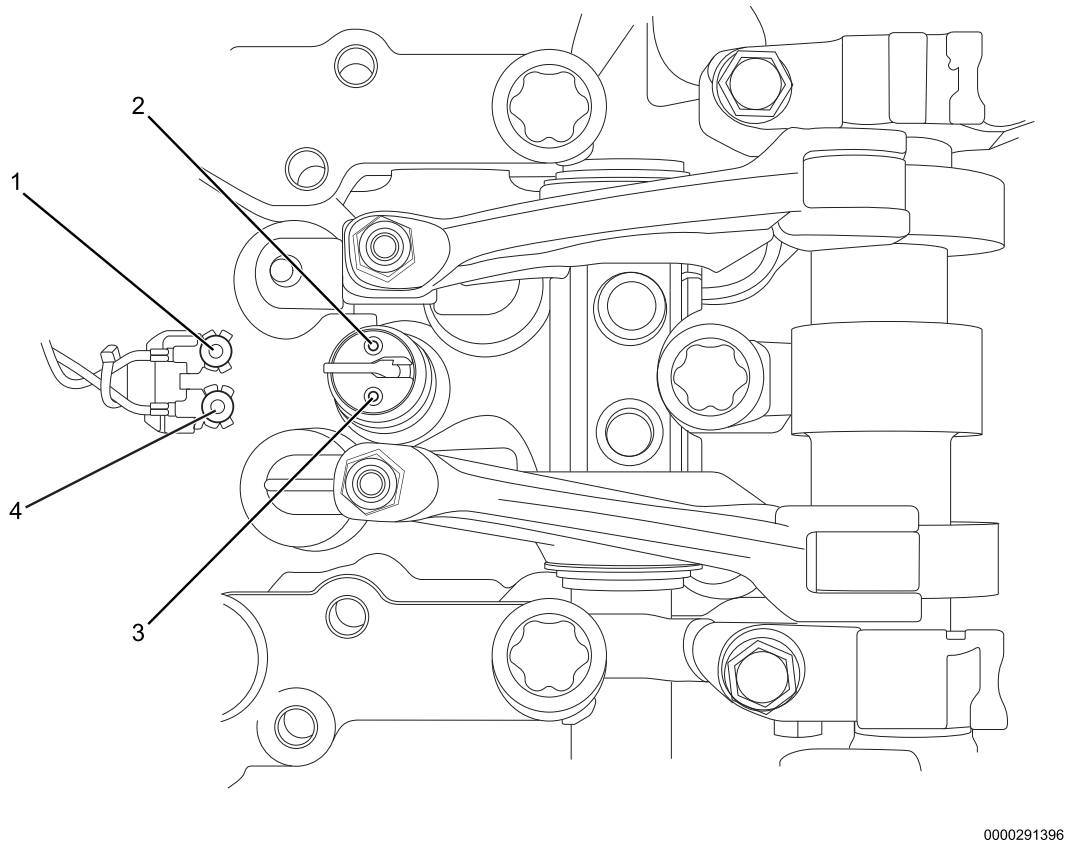


Figure 438 Fuel Injector Wiring Terminal Orientation

1. Fuel injector H wiring terminal
2. Fuel injector H terminal
3. Fuel injector L terminal
4. Fuel injector L wiring terminal (brown wire color [typical])

Step	Action	Decision
2	Check for a shorted fuel injector 5 coil. Key OFF, disconnect the connectors from fuel injector 5. Using a DMM, check resistance across fuel injector 5 terminals. Is resistance between 0.2 to 0.8 Ohms?	Yes: Go to step 3. No: Replace fuel injector 5. After repairs are complete, retest for SPN 655 FMI 4.

Step	Action	Decision
3	Inspect connections at Electronic Control Module (ECM) E2 connector. Key OFF, disconnect ECM E2 connector. Check ECM E2 connector and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the ECM E2 connector, harness, and terminals clean and undamaged?	Yes: Go to step 4. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 655 FMI 4.

Step	Action	Decision
4	Check for fuel injector 5 high side terminal short to ground. Key OFF, with ECM E2 connector disconnected and wiring terminals disconnected from fuel injector 5, use a DMM to test resistance between high side terminal and a known good GND. Is resistance greater than 1000 ohms?	Yes: Go to step 5. No: Replace fuel injector 5. After repairs are complete, retest for SPN 655 FMI 4.

Step	Action	Decision
5	Check for fuel injector 5 low side terminal short to ground. Key OFF, with ECM E2 connector disconnected and wiring terminals disconnected from fuel injector 5, use a DMM to test resistance between low side terminal and a known good GND. Is resistance greater than 1000 ohms?	Yes: Go to step 6. No: Replace fuel injector 5. After repairs are complete, retest for SPN 655 FMI 4.

Step	Action	Decision
6	Check for INJ5 H short to INJ5 L. Key OFF, connect 180-pin Breakout Box with Breakout Harness 00-01468-00 to ECM E2 connector, leave ECM disconnected. Using a DMM with fuel injector 5 disconnected. measure resistance between Breakout Box pins E2-02 and E2-15 (wiggle test may be required). Is resistance greater than 1000 ohms?	Yes: Go to step 7. No: Repair short between INJ5 H circuit and INJ5 L circuit. After repairs are complete, retest for SPN 655 FMI 4.

Step	Action	Decision
7	Check INJ5 H circuit for short to GND. Key OFF, connect 180-pin breakout box with Breakout Harness 00-01468-00 to ECM E2 connector, leave ECM disconnected. Using a DMM with fuel injector 5 disconnected, measure resistance between Breakout Box pin E2-02 and known good GND (wiggle test may be required). Is resistance greater than 1000 Ohms?	Yes: Repair short to GND between E2-15 and fuel injector 5. After repairs are complete, retest for SPN 655 FMI 4. No: Repair short to GND between E2-02 and fuel injector 5. After repairs are complete, retest for SPN 655 FMI 4.

NOTE: After performing all diagnostic steps, if SPN 655 FMI 4 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 655 FMI 5- Injector 5 Open load / circuit

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Open detected in fuel injector 5 circuit.	INJ5 circuit > 30 ohms	ECM commands injector firing	3 events

Fault Overview

Fault code sets when a short to GND is detected in Fuel Injector 5 circuit.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

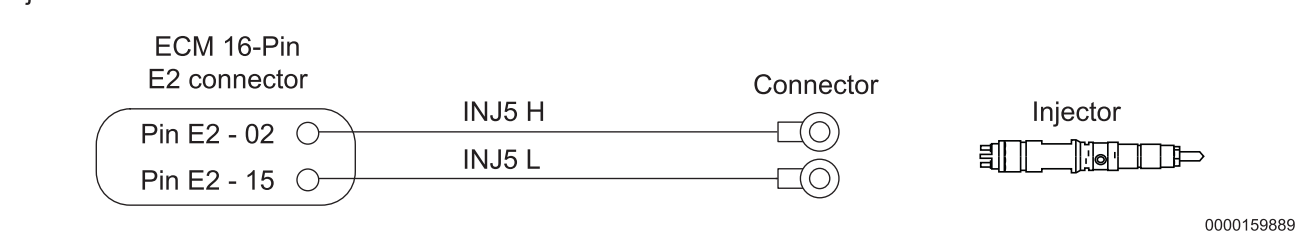


Figure 439 Injector 5 circuit diagram

Possible Causes

- INJ5 H circuit Open or high resistance
- INJ5 L circuit Open or high resistance
- Failed fuel injector

WARNING: To prevent personal injury or death, shut engine down before doing voltage checks for injector solenoids. When the engine is running, injector circuits have high voltage and amperage.

CAUTION: To avoid engine damage, turn the ignition switch to OFF before disconnecting connectors. Failure to turn ignition switch to OFF will cause a voltage spike and damage to electrical components.

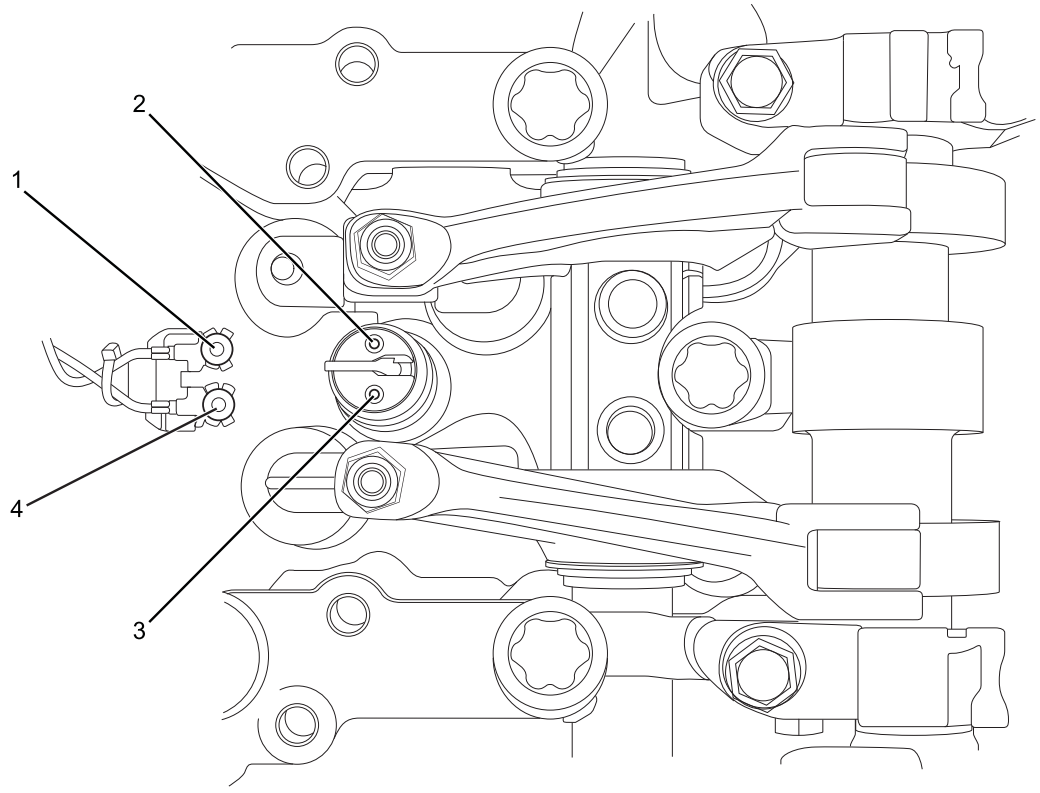


Figure 440 Fuel Injector Wiring Terminal Orientation

1. Fuel injector H wiring terminal
2. Fuel injector H terminal
3. Fuel injector L terminal
4. Fuel injector L wiring terminal (brown wire color [typical])

Step	Action	Decision
1	Inspect connections at fuel injector 5. Remove upper valve cover and engine brake housing (see Engine Service Manual). Check fuel injector 5 connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the fuel injector 5 connector, harness, and terminals clean and undamaged?	Yes: Go to step 2. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 655 FMI 5.

Step	Action	Decision
2	Check for a Open fuel injector 5 coil. Disconnect the connectors from fuel injector 5. Check resistance across fuel injector 5 terminals. Is resistance between 0.2 to 0.8 Ohms?	Yes: Go to step 3. No: Replace fuel injector 5. After repairs are complete, retest for SPN 655 FMI 5.

Step	Action	Decision
3	Inspect connections at ECM E2 connector. Key OFF, disconnect ECM E2 connector. Check ECM E2 connector and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the ECM E2 connector, harness, and terminals clean and undamaged?	Yes: Go to step 4.
		No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 655 FMI 5.

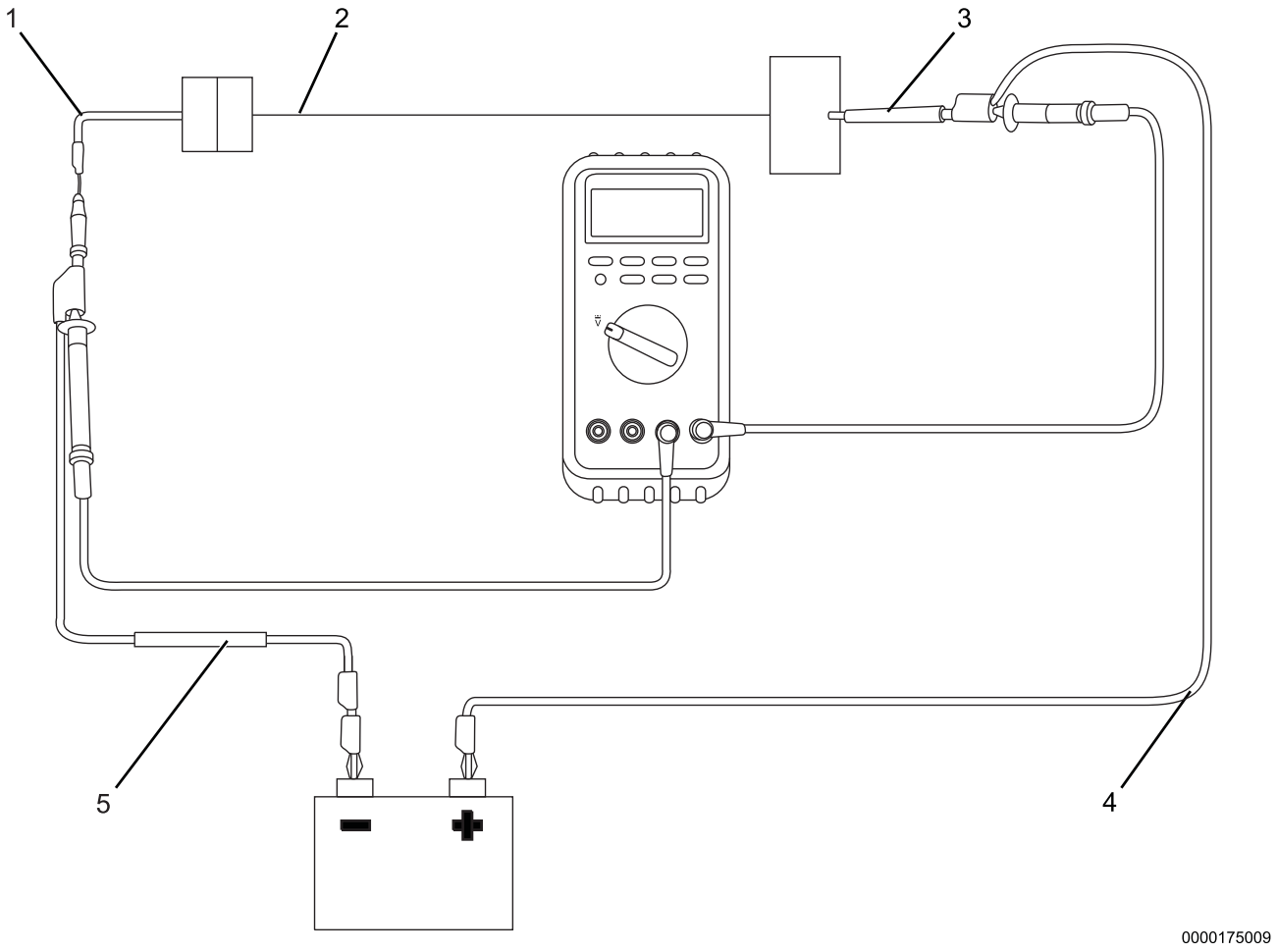


Figure 441 Voltage drop test (typical)

1. Breakout harness
2. Circuit under test
3. Terminal from ZTSE4435C
4. Jumper wire
5. 500 Ohm Resistor Jumper Harness ZTSE4497

Step	Action	Decision
4	Check INJ5 H circuit for Open or high resistance (voltage drop). 1. Key OFF, disconnect fuel injector 5 and ECM E2 connector. 2. Using Engine Terminal Test Kit ZTSE4435C, insert proper terminal into ECM pin E2-02. 3. Connect one end of the 500 Ohm Resistor Jumper Harness ZTSE4497 to terminal in E2-02, and the other end of 500 Ohm Resistor Jumper Harness to PWR (use a jumper wire if needed). 4. Connect INJ5 H ring terminal to a known good GND (use a jumper wire if needed) 5. Using a DMM, measure voltage between fuel injector 5 INJ 5 H ring terminal and terminal in ECM pin E2-02. Is voltage less than 0.3V	Yes: Repair INJ5 L circuit between fuel injector 5 and pin E2-15. After repairs are complete, retest for SPN 655 FMI 5. No: Repair INJ5 H circuit between fuel injector 5 and pin E2-02. After repairs are complete, retest for SPN 655 FMI 5.

NOTE: After performing all diagnostic steps, if SPN 655 FMI 5 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 656 FMI 4- Injector 6 short circuit

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Short to GND detected in fuel injector 6 circuit	INJ6 circuit resistance to ground < 0.5 ohms	ECM commands injector firing	3 events

Fault Overview

Fault code sets when a short to GND is detected in Fuel Injector 6 circuit.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

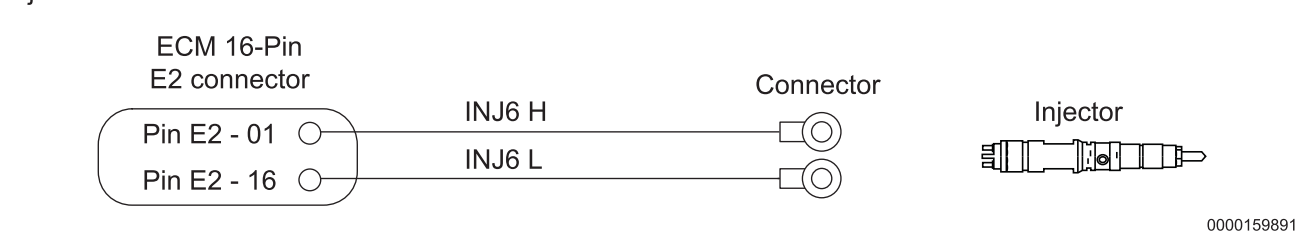


Figure 442 Injector 5 circuit diagram

Possible Causes

- INJ6 H circuit shorted to INJ6 L circuit
- INJ6 H circuit short to GND
- INJ6 L circuit short to GND
- Fuel injector shorted to engine brake housing
- Failed fuel injector

WARNING: To prevent personal injury or death, shut engine down before doing voltage checks for injector solenoids. When the engine is running, injector circuits have high voltage and amperage.

CAUTION: To avoid engine damage, turn the ignition switch to OFF before disconnecting connectors. Failure to turn ignition switch to OFF will cause a voltage spike and damage to electrical components.

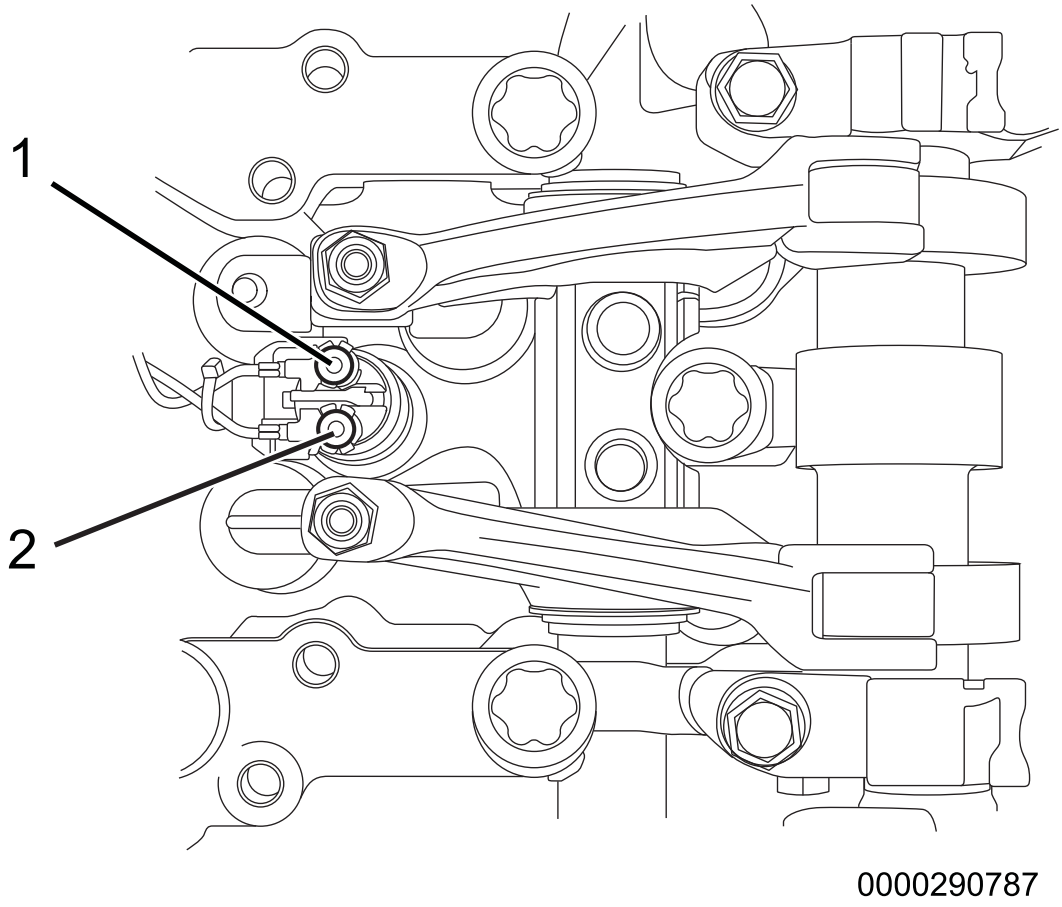


Figure 443 Fuel Injector Wiring Terminal Orientation

1. Fuel injector H wiring terminal
2. Fuel injector L wiring terminal (brown wire color [typical])

Step	Action	Decision
1	Verify proper fuel injector and terminal orientation. Remove upper valve cover and engine brake housing (see Engine Service Manual). Verify fuel injector terminals are installed parallel to avoid a short to ground on the engine brake housings. Are fuel injector 6 terminals oriented correctly and Not contacting the engine brake housing?	Yes: Go to step 2. No: Adjust connections so fuel injector 6 and injector terminals will not contact the engine brake housing. After repairs are complete, retest for SPN 656 FMI 4.

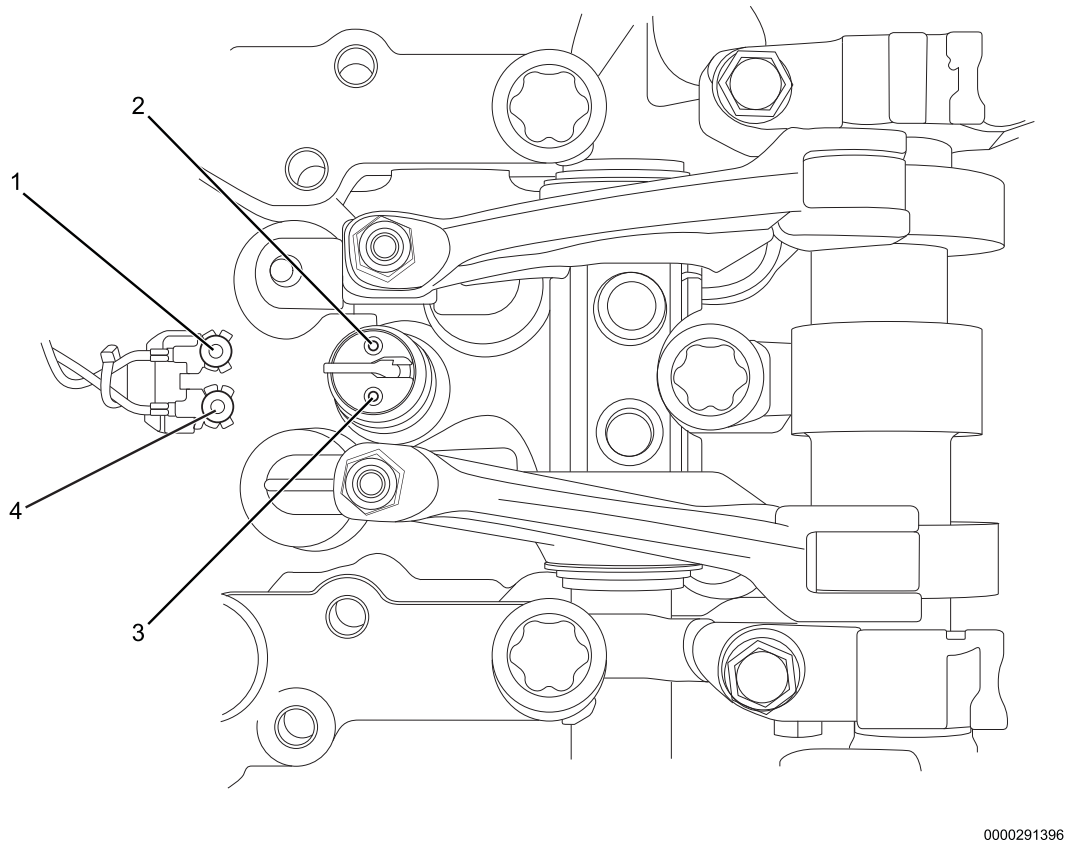


Figure 444 Fuel Injector Wiring Terminal Orientation

1. Fuel injector H wiring terminal
2. Fuel injector H terminal
3. Fuel injector L terminal
4. Fuel injector L wiring terminal (brown wire color [typical])

Step	Action	Decision
2	Check for a shorted fuel injector 6 coil. Key OFF, disconnect the connectors from fuel injector 6. Using a DMM, check resistance across fuel injector 6 terminals. Is resistance between 0.2 to 0.8 Ohms?	Yes: Go to step 3. No: Replace fuel injector 6. After repairs are complete, retest for SPN 656 FMI 4.

Step	Action	Decision
3	Inspect connections at Electronic Control Module (ECM) E2 connector. Key OFF, disconnect ECM E2 connector. Check ECM E2 connector and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the ECM E2 connector, harness, and terminals clean and undamaged?	Yes: Go to step 4. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 656 FMI 4.

Step	Action	Decision
4	Check for fuel injector 6 high side terminal short to ground. Key OFF, with ECM E2 connector disconnected and wiring terminals disconnected from fuel injector 6, use a DMM to test resistance between high side terminal and a known good GND. Is resistance greater than 1000 ohms?	Yes: Go to step 5. No: Replace fuel injector 6. After repairs are complete, retest for SPN 655 FMI 4.

Step	Action	Decision
5	Check for fuel injector 6 low side terminal short to ground. Key OFF, with ECM E2 connector disconnected and wiring terminals disconnected from fuel injector 6, use a DMM to test resistance between low side terminal and a known good GND. Is resistance greater than 1000 ohms?	Yes: Go to step 6. No: Replace fuel injector 6. After repairs are complete, retest for SPN 656 FMI 4.

Step	Action	Decision
6	Check for INJ6 H short to INJ6 L. Key OFF, connect 180-pin Breakout Box with Breakout Harness 00-01468-00 to ECM E2 connector, leave ECM disconnected. Using a DMM with fuel injector 6 disconnected. measure resistance between Breakout Box pins E2-01 and E2-16 (wiggle test may be required). Is resistance greater than 1000 ohms?	Yes: Go to step 7. No: Repair short between INJ6 H circuit and INJ6 L circuit. After repairs are complete, retest for SPN 656 FMI 4.

Step	Action	Decision
7	Check INJ6 H circuit for short to GND. Key OFF, connect 180-pin breakout box with Breakout Harness 00-01468-00 to ECM E2 connector, leave ECM disconnected. Using a DMM with fuel injector 6 disconnected, measure resistance between Breakout Box pin E2-01 and known good GND (wiggle test may be required). Is resistance greater than 1000 Ohms?	Yes: Repair short to GND between E2-16 and fuel injector 6. After repairs are complete, retest for SPN 656 FMI 4. No: Repair short to GND between E2-01 and fuel injector 6. After repairs are complete, retest for SPN 656 FMI 4.

NOTE: After performing all diagnostic steps, if SPN 656 FMI 4 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 656 FMI 5- Injector 6 Open load / circuit

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Open detected in fuel injector 6 circuit.	INJ6 circuit > 30 ohms	ECM commands injector firing	3 events

Fault Overview

Fault code sets when a short to GND is detected in Fuel Injector 6 circuit.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

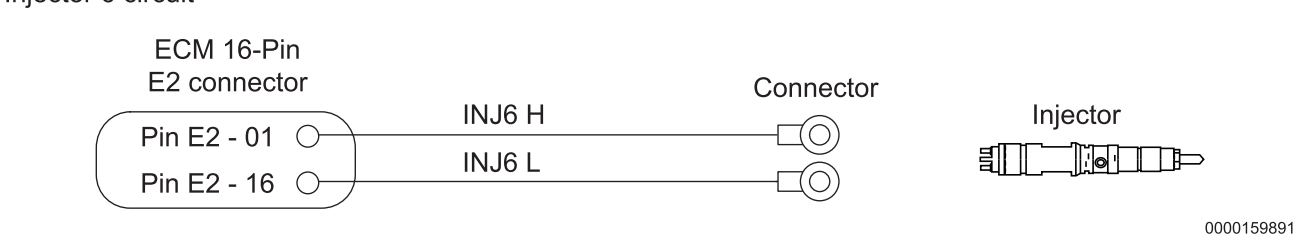


Figure 445 Injector 6 circuit diagram

Possible Causes

- INJ6 H circuit Open or high resistance
- INJ6 L circuit Open or high resistance
- Failed fuel injector

WARNING: To prevent personal injury or death, shut engine down before doing voltage checks for injector solenoids. When the engine is running, injector circuits have high voltage and amperage.

CAUTION: To avoid engine damage, turn the ignition switch to OFF before disconnecting connectors. Failure to turn ignition switch to OFF will cause a voltage spike and damage to electrical components.

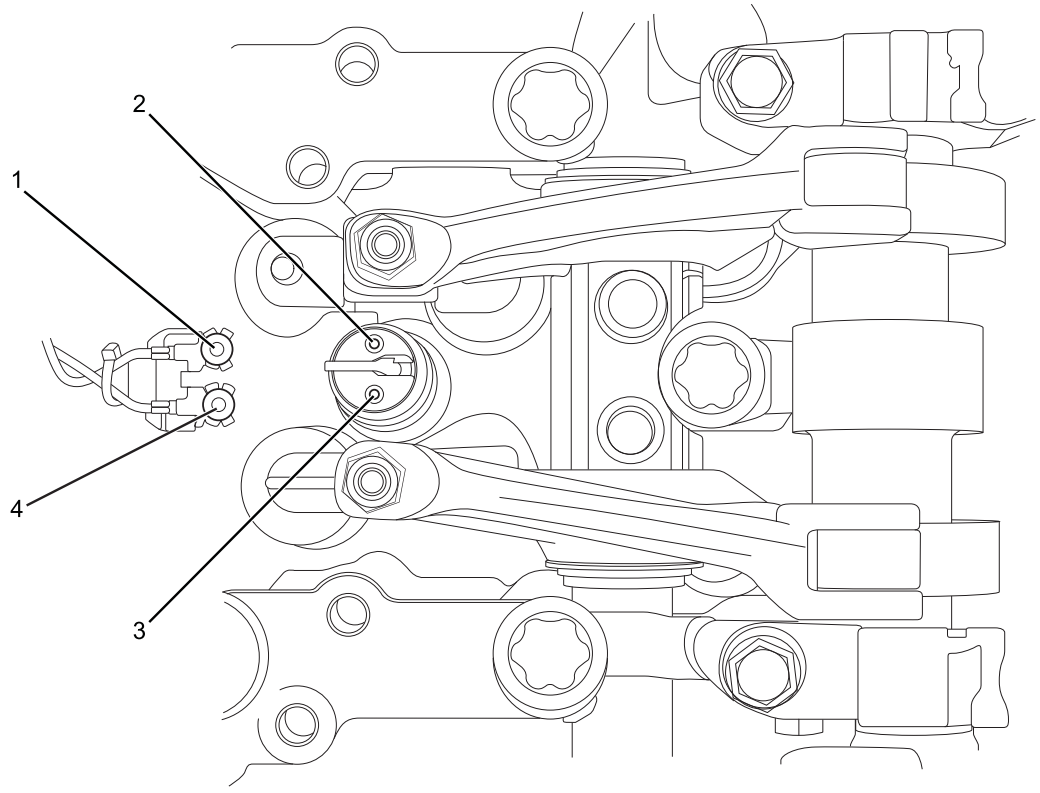


Figure 446 Fuel Injector Wiring Terminal Orientation

1. Fuel injector H wiring terminal
2. Fuel injector H terminal
3. Fuel injector L terminal
4. Fuel injector L wiring terminal (brown wire color [typical])

Step	Action	Decision
1	Inspect connections at fuel injector 6. Remove upper valve cover and engine brake housing (see Engine Service Manual). Check fuel injector 6 connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the fuel injector 6 connector, harness, and terminals clean and undamaged?	Yes: Go to step 2. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 656 FMI 5.

Step	Action	Decision
2	Check for a Open fuel injector 6 coil. Disconnect the connectors from fuel injector 6. Check resistance across fuel injector 6. Is resistance between 0.2 to 0.8 Ohms?	Yes: Go to step 3. No: Replace fuel injector 6. After repairs are complete, retest for SPN 656 FMI 5.

Step	Action	Decision
3	Inspect connections at ECM E2 connector. Key OFF, disconnect ECM E2 connector. Check ECM E2 connector and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the ECM E2 connector, harness, and terminals clean and undamaged?	Yes: Go to step 4.
		No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 656 FMI 5.

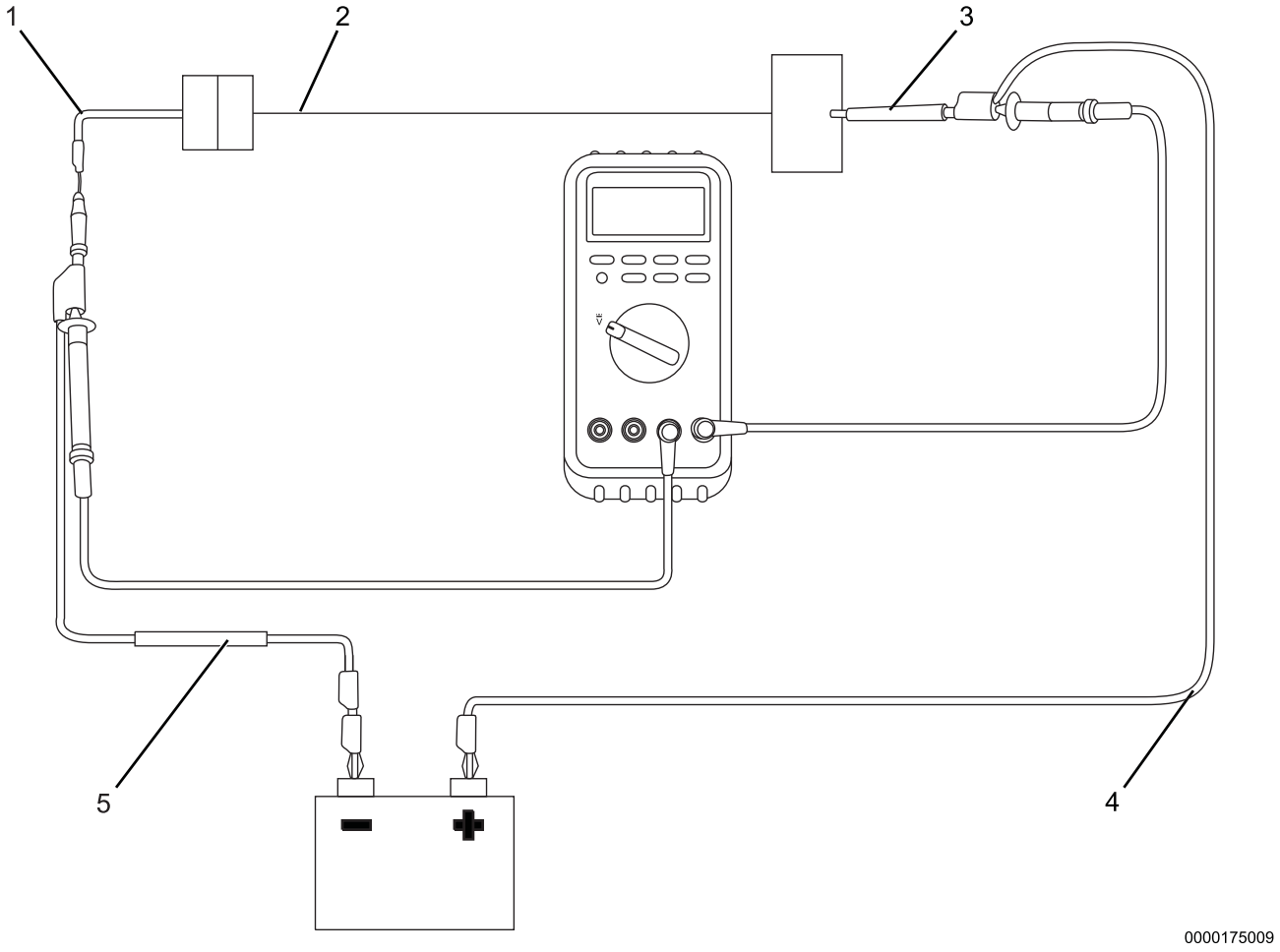


Figure 447 Voltage drop test (typical)

1. Breakout harness
2. Circuit under test
3. Terminal from ZTSE4435C
4. Jumper wire
5. 500 Ohm Resistor Jumper Harness ZTSE4497

Step	Action	Decision
4	Check INJ6 H circuit for Open or high resistance (voltage drop). 1. Key OFF, disconnect fuel injector 6 and ECM E2 connector. 2. Using Engine Terminal Test Kit ZTSE4435C, insert proper terminal into ECM pin E2-01. 3. Connect one end of the 500 Ohm Resistor Jumper Harness ZTSE4497 to terminal in E2-01, and the other end of 500 Ohm Resistor Jumper Harness to PWR (use a jumper wire if needed). 4. Connect INJ6 H ring terminal to a known good GND (use a jumper wire if needed) 5. Using a DMM, measure voltage between fuel injector 6 INJ 6 H ring terminal and terminal in ECM pin E2-01. Is voltage less than 0.3V	Yes: Repair INJ6 L circuit between fuel injector 5 and pin E2-16. After repairs are complete, retest for SPN 656 FMI 5. No: Repair INJ6 H circuit between fuel injector 5 and pin E2-01. After repairs are complete, retest for SPN 656 FMI 5.

NOTE: After performing all diagnostic steps, if SPN 656 FMI 5 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 2797 FMI 11 - Injector Control Group 1 short circuit (INJ 1, 3, 5)

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Short detected in fuel injector 1, 3, or 5 circuits	High side circuit short to PWR impedance < 0.5 Ohms High side circuit short to GND impedance < 1 Ohms Low side circuit short to PWR impedance < 2 Ohms Low side circuit short to GND impedance < 2 Ohms	Engine Speed > 0 rpm Crankshaft angle between 25 deg BTDC and 23 deg ATDC Battery Voltage > 7 Volts	5 firing events

Fault Overview

Fault codes sets when a short circuit is detected in fuel injector 1, 3, or 5.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 651 FMI 4 and 5 (INJ); SPN 653 FMI 4 and 5 (INJ); SPN 655 FMI 4 and 5 (INJ)

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

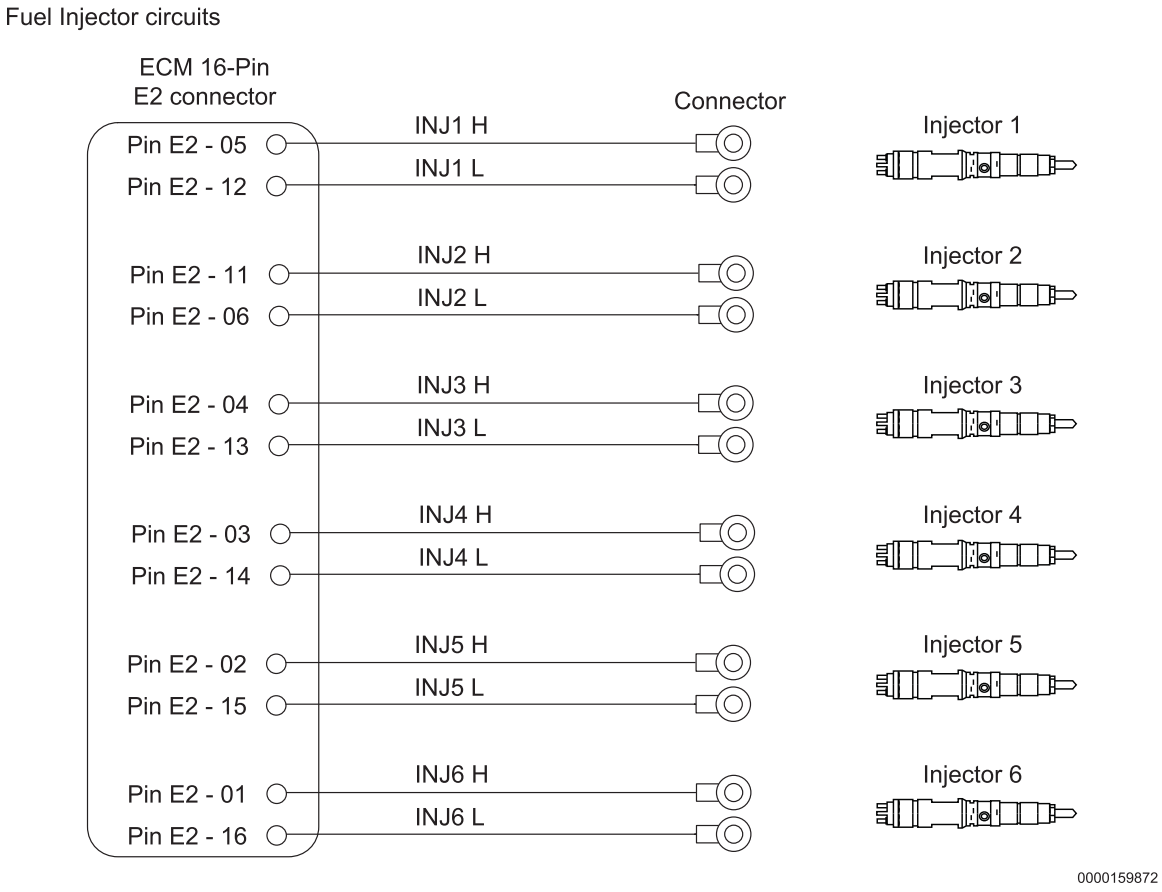


Figure 448 Fuel Injector circuit diagram

Possible Causes

- INJ1 H circuit short to PWR
- INJ1 H circuit short to GND
- INJ1 H short to INJ1 L
- INJ1 L circuit short to PWR
- INJ1 L circuit short to GND
- Fuel injector 1 wiring terminals shorted to engine brake housing
- Failed fuel injector 1
- INJ3 H circuit short to PWR
- INJ3 H circuit short to GND
- INJ3 H short to INJ3 L
- INJ3 L circuit short to PWR
- INJ3 L circuit short to GND
- Fuel injector 3 wiring terminals shorted to engine brake housing

- Failed fuel injector 3
- INJ5 H circuit short to PWR
- INJ5 H circuit short to GND
- INJ5 H short to INJ6 L
- INJ5 L circuit short to PWR
- INJ5 L circuit short to GND
- Fuel injector 5 wiring terminals shorted to engine brake housing
- Failed fuel injector 5

WARNING: To prevent personal injury or death, shut engine down before doing voltage checks for injector solenoids. When the engine is running, injector circuits have high voltage and amperage.

CAUTION: To avoid engine damage, turn the ignition switch to OFF before disconnecting connectors. Failure to turn ignition switch to OFF will cause a voltage spike and damage to electrical components.

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 651 FMI 4 and 5 (INJ); SPN 653 FMI 4 and 5 (INJ); SPN 655 FMI 4 and 5 (INJ). Is EST DTC list free of SPN 651 FMI 4 and 5; SPN 653 FMI 4 and 5; SPN 655 FMI 4 and 5?	Yes: Go to step 2. No: Repair SPN 651 FMI 4 and 5; SPN 653 FMI 4 and 5; SPN 655 FMI 4 and 5. After repairs are complete, retest for SPN 2797 FMI 11.

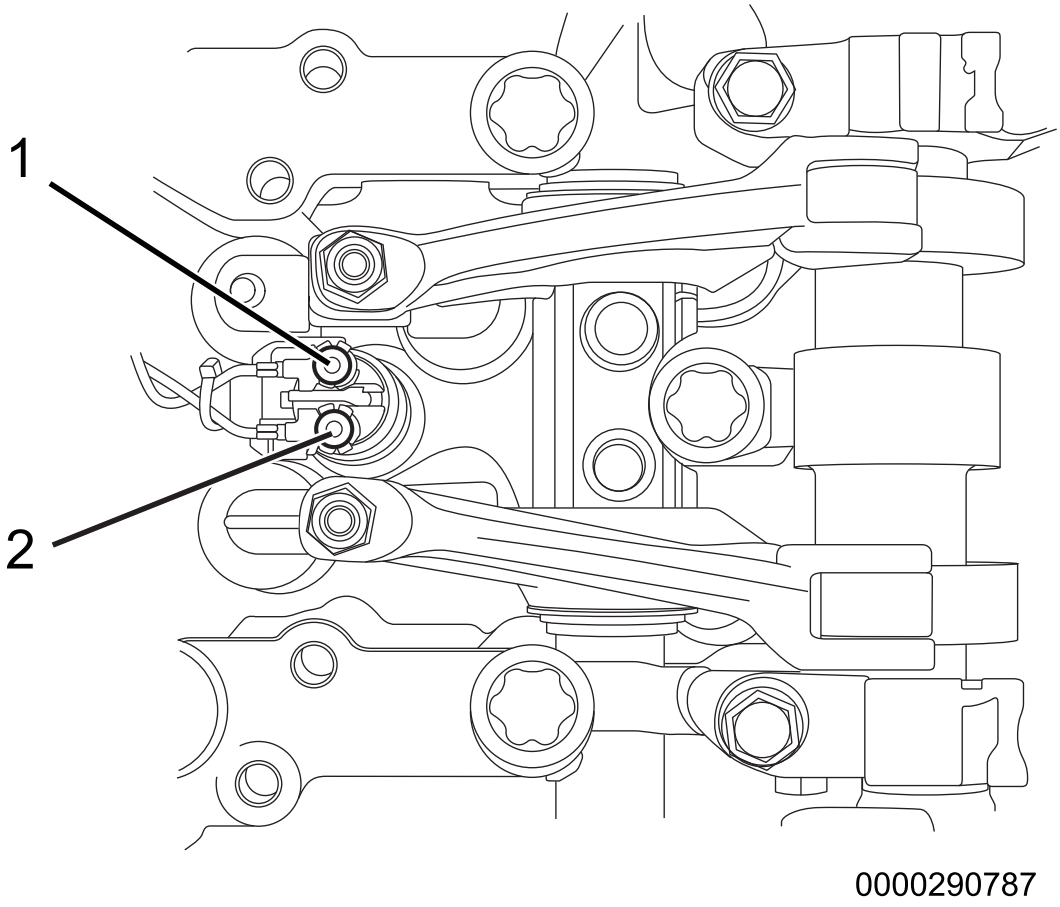


Figure 449 Fuel Injector Wiring Terminal Orientation

1. Fuel injector H wiring terminal
2. Fuel injector L wiring terminal (brown wire color [typical])

Step	Action	Decision
2	Verify proper fuel injector wire terminal orientation. Remove upper valve cover and engine brake housing (see Engine Service Manual). Verify fuel injector terminals are installed parallel so they do not short to ground on the engine brake housings or other components. Are fuel injector wire terminals oriented correctly and Not contacting the engine brake housing?	Yes: Go to step 3. No: Adjust connections so fuel injectors wire terminals will not contact the engine brake housing. After repairs are complete, retest for SPN 2797 FMI 11.

Step	Action	Decision
3	Check for a shorted fuel injector 1 coil. Disconnect wiring terminals from fuel injector 1. Check resistance across fuel injector 1. Is resistance between 0.2 to 0.8 Ohms?	Yes: Go to step 4. No: Replace fuel injector 1. After repairs are complete, retest for SPN 2797 FMI 11.

Step	Action	Decision
4	Check for a shorted fuel injector 3 coil. Disconnect wiring terminals from fuel injector 3. Check resistance across fuel injector 3. Is resistance between 0.2 to 0.8 Ohms?	Yes: Go to step 5. No: Replace fuel injector 3. After repairs are complete, retest for SPN 2797 FMI 11.

Step	Action	Decision
5	Check for a shorted fuel injector 5 coil. Disconnect wiring terminals from fuel injector 5. Check resistance across fuel injector 5. Is resistance between 0.2 to 0.8 Ohms?	Yes: Go to step 6. No: Replace fuel injector 5. After repairs are complete, retest for SPN 2797 FMI 11.

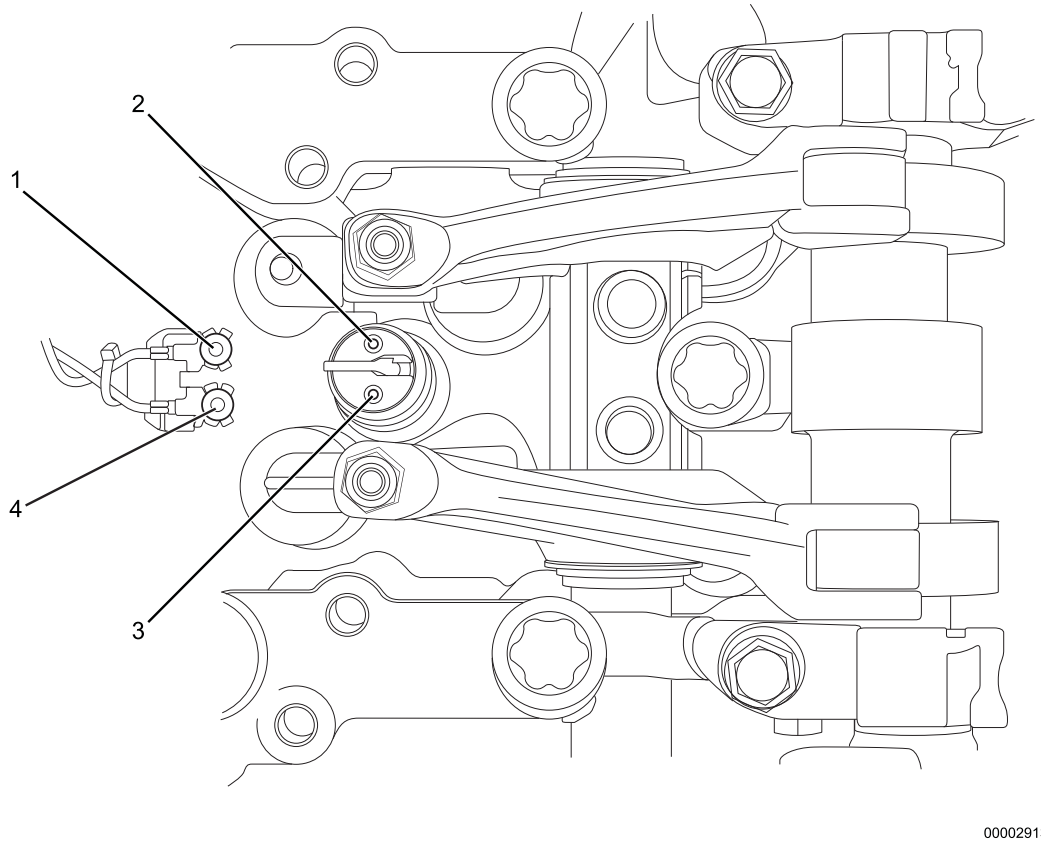


Figure 450 Fuel Injector Wiring Terminal Orientation

1. Fuel injector H wiring terminal
2. Fuel injector H terminal
3. Fuel injector L terminal
4. Fuel injector L wiring terminal (brown wire color [typical])

Step	Action	Decision
6	Check fuel injector 1 H terminal for short to GND. Key OFF with fuel injector 1 disconnected, use a DMM to measure resistance between fuel injector 1 H terminal and GND. Is resistance greater than 1000 ohms?	Yes: Go to step 7. No: Replace fuel injector 1. After repairs are complete, retest for SPN 2797 FMI 11.

Step	Action	Decision
7	Check fuel injector 1 L terminal for short to GND. Key OFF with fuel injector 1 disconnected, use a DMM to measure resistance between fuel injector 1 L terminal and GND. Is resistance greater than 1000 ohms?	Yes: Go to step 8. No: Replace fuel injector 1. After repairs are complete, retest for SPN 2797 FMI 11.

Step	Action	Decision
8	Check fuel injector 3 H terminal for short to GND. Key OFF with fuel injector 3 disconnected, use a DMM to measure resistance between fuel injector 3 H terminal and GND. Is resistance greater than 1000 ohms?	Yes: Go to step 9. No: Replace fuel injector 3. After repairs are complete, retest for SPN 2797 FMI 11.

Step	Action	Decision
9	Check fuel injector 3 L terminal for short to GND. Key OFF with fuel injector 3 disconnected, use a DMM to measure resistance between fuel injector 3 L terminal and GND. Is resistance greater than 1000 ohms?	Yes: Go to step 10. No: Replace fuel injector 3. After repairs are complete, retest for SPN 2797 FMI 11.

Step	Action	Decision
10	Check fuel injector 5 H terminal for short to GND. Key OFF with fuel injector 5 disconnected, use a DMM to measure resistance between fuel injector 5 H terminal and GND. Is resistance greater than 1000 ohms?	Yes: Go to step 11. No: Replace fuel injector 5. After repairs are complete, retest for SPN 2797 FMI 11.

Step	Action	Decision
11	Check fuel injector 5 L terminal for short to GND. Key OFF with fuel injector 5 disconnected, use a DMM to measure resistance between fuel injector 5 L terminal and GND. Is resistance greater than 1000 ohms?	Yes: Go to step 12. No: Replace fuel injector 5. After repairs are complete, retest for SPN 2797 FMI 11.

Step	Action	Decision
12	Inspect connections at ECM E2 connector. Key OFF, disconnect ECM E2 connector. Check ECM E2 connector and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the ECM E2 connector, harness, and terminals clean and undamaged?	Yes: Go to step 13. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 2797 FMI 11.

Step	Action	Decision
13	Check for INJ1 H short to INJ1 L. Key OFF, connect 180-pin Breakout Box with Breakout Harness 00-01468-00 vehicle harness, leave ECM E2 disconnected. Using a DMM, with fuel injector 1 disconnected measure resistance between Breakout Box pins E2-05 and E2-12 (wiggle test may be required). Is resistance greater than 1000 ohms?	Yes: Go to step 14. No: Repair INJ1 H short to INJ1 L. After repairs are complete, retest for SPN 2797 FMI 11.

Step	Action	Decision
14	Check for INJ3 H short to INJ3 L. Key OFF, connect 180-pin Breakout Box with Breakout Harness 00-01468-00 injector harness, leave ECM E2 disconnected. Using a DMM, with fuel injector 3 disconnected measure resistance between Breakout Box pins E2-04 and E2-13 (wiggle test may be required). Is resistance greater than 1000 ohms?	Yes: Go to step 15. No: Repair INJ3 H short to INJ3 L. After repairs are complete, retest for SPN 2797 FMI 11.

Step	Action	Decision
15	Check for INJ5 H short to INJ5 L. Key OFF, connect 180-pin Breakout Box with Breakout Harness 00-01468-00 injector harness, leave ECM E2 disconnected. Using a DMM, with fuel injector 5 disconnected measure resistance between Breakout Box pins E2-02 and E2-15 (wiggle test may be required). Is resistance greater than 1000 ohms?	Yes: Go to step 16. No: Repair INJ5 H short to INJ5 L. After repairs are complete, retest for SPN 2797 FMI 11.

Step	Action	Decision
16.	Check INJ1 H circuit for short to GND. Key OFF, connect 180-pin Breakout Box with Breakout Harness 00-01468-00 to vehicle harness, and leave ECM disconnected. Using a DMM with fuel injector 1 disconnected, measure resistance between Breakout Box pin E2-05 and a known good GND (wiggle test may be required). Is resistance greater than 1000 ohms?	Yes: Go to step 17. No: Repair short to GND between ECM pin E2-05 and fuel injector 1. After repairs are complete, retest for SPN 2797 FMI 11.

Step	Action	Decision
17	Check INJ1 L circuit for short to GND. Key OFF, connect 180-pin Breakout Box with Breakout Harness 00-01468-00 vehicle harness, and leave ECM disconnected. Using a DMM with fuel injector 1 disconnected, measure resistance between Breakout Box pin E2-12 and a known good GND (wiggle test may be required). Is resistance greater than 1000 ohms?	Yes: Go to step 18. No: Repair short to GND between ECM pin E2-12 and fuel injector 1. After repairs are complete, retest for SPN 2797 FMI 11.

Step	Action	Decision
18	Check INJ3 H circuit for short to GND. Key OFF, connect 180-pin Breakout Box with Breakout Harness 00-01468-00 to vehicle harness, and leave ECM disconnected. Using a DMM with fuel injector 3 disconnected, measure resistance between Breakout Box pin E2-04 and a known good GND (wiggle test may be required). Is resistance greater than 1000 ohms?	Yes: Go to step 19. No: Repair short to GND between ECM pin E2-04 and fuel injector 3. After repairs are complete, retest for SPN 2797 FMI 11.

Step	Action	Decision
19	Check INJ3 L circuit for short to GND. Key OFF, connect 180-pin Breakout Box with Breakout Harness 00-01468-00 vehicle harness, and leave ECM disconnected. Using a DMM with fuel injector 3 disconnected, measure resistance between Breakout Box pin E2-13 and a known good GND (wiggle test may be required). Is resistance greater than 1000 ohms?	Yes: Go to step 20. No: Repair short to GND between ECM pin E2-13 and fuel injector 3. After repairs are complete, retest for SPN 2797 FMI 11.

Step	Action	Decision
20	Check INJ5 H circuit for short to GND. Key OFF, connect 180-pin Breakout Box with Breakout Harness 00-01468-00 to vehicle harness, and leave ECM disconnected. Using a DMM with fuel injector 5 disconnected, measure resistance between Breakout Box pin E2-02 and a known good GND (wiggle test may be required). Is resistance greater than 1000 ohms?	Yes: Go to step 21. No: Repair short to GND between ECM pin E2-02 and fuel injector 5. After repairs are complete, retest for SPN 2797 FMI 11.

Step	Action	Decision
21	Check INJ5 L circuit for short to GND. Key OFF, connect 180-pin Breakout Box with Breakout Harness 00-01468-00 vehicle harness, and leave ECM disconnected. Using a DMM with fuel injector 5 disconnected, measure resistance between Breakout Box pin E2-15 and a known good GND (wiggle test may be required). Is resistance greater than 1000 ohms?	Yes: Go to step 22. No: Repair short to GND between ECM pin E2-15 and fuel injector 5. After repairs are complete, retest for SPN 2797 FMI 11.

Step	Action	Decision
22	Check INJ1 H circuit for short to PWR. Key-On Engine-Off (KOEO), connect 180-pin Breakout Box with Breakout Harness 00-01468-00 to vehicle harness, and leave ECM disconnected. Using a DMM with fuel injector 1 disconnected, measure voltage between Breakout Box pin E2-05 and a known good GND (wiggle test may be required). Is voltage less than 0.5 volts?	Yes: Go to step 23. No: Repair short to PWR between ECM pin E2-05 and fuel injector 1. After repairs are complete, retest for SPN 2797 FMI 11.

Step	Action	Decision
23	Check INJ1 L circuit for short to PWR. KOEO, connect 180-pin Breakout Box with Breakout Harness 00-01468-00 to vehicle harness, and leave ECM disconnected. Using a DMM with fuel injector 1 disconnected, measure voltage between Breakout Box pin E2-12 and known good GND (wiggle test may be required). Is voltage less than 0.5 Volts?	Yes: Go to step 24. No: Repair short to PWR between ECM pin E2-12 and fuel injector 1. After repairs are complete, retest for SPN 2797 FMI 11.

Step	Action	Decision
24	Check INJ3 H circuit for short to PWR. KOEO, connect 180-pin Breakout Box with Breakout Harness 00-01468-00 to vehicle harness, and leave ECM disconnected. Using a DMM with fuel injector 3 disconnected, measure voltage between Breakout Box pin E2-04 and known good GND (wiggle test may be required). Is voltage less than 0.5 volts?	Yes: Go to step 25. No: Repair short to PWR between ECM pin E2-04 and fuel injector 3. After repairs are complete, retest for SPN 2797 FMI 11.

Step	Action	Decision
25	Check INJ3 L circuit for short to PWR. KOEO, connect 180-pin Breakout Box with Breakout Harness 00-01468-00 vehicle harness, and leave ECM disconnected. Using a DMM with fuel injector 3 disconnected, measure voltage between Breakout Box pin E2-13 and known good GND (wiggle test may be required). Is voltage less than 0.5 volts?	Yes: Go to step 26. No: Repair short to PWR between ECM pin E2-13 and fuel injector 3. After repairs are complete, retest for SPN 2797 FMI 11.

Step	Action	Decision
26	Check INJ5 H circuit for short to PWR. KOEO, connect 180-pin Breakout Box with Breakout Harness 00-01468-00 to vehicle harness, and leave ECM disconnected. Using a DMM with fuel injector 5 disconnected, measure voltage between Breakout Box pin E2-02 and known good GND (wiggle test may be required). Is voltage less than 0.5 volts?	Yes: Repair short to PWR between ECM pin E2-15 and fuel injector 5. After repairs are complete, retest for SPN 2797 FMI 11. No: Repair short to PWR between ECM pin E2-02 and fuel injector 5. After repairs are complete, retest for SPN 2797 FMI 11.

NOTE: After performing all diagnostic steps, if SPN 2797 FMI 11 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 2798 FMI 11 - Injector Control Group 2 short circuit (INJ 2, 4, 6)

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Short detected in fuel injector 2, 4, or 6 circuits	High side circuit short to PWR impedance < 0.5 Ohms High side circuit short to GND impedance < 1 Ohms Low side circuit short to PWR impedance < 2 Ohms Low side circuit short to GND impedance < 2 Ohms	Engine Speed >0 rpm Crankshaft angle between 25 deg BTDC and 23 deg ATDC Battery Voltage > 7 Volts	5 firing events

Fault Overview

Fault codes sets when a short circuit is detected in fuel injector 2, 4, or 6.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 652 FMI 4 and 5 (INJ); SPN 654 FMI 4 and 5 (INJ); SPN 656 FMI 4 and 5 (INJ)

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

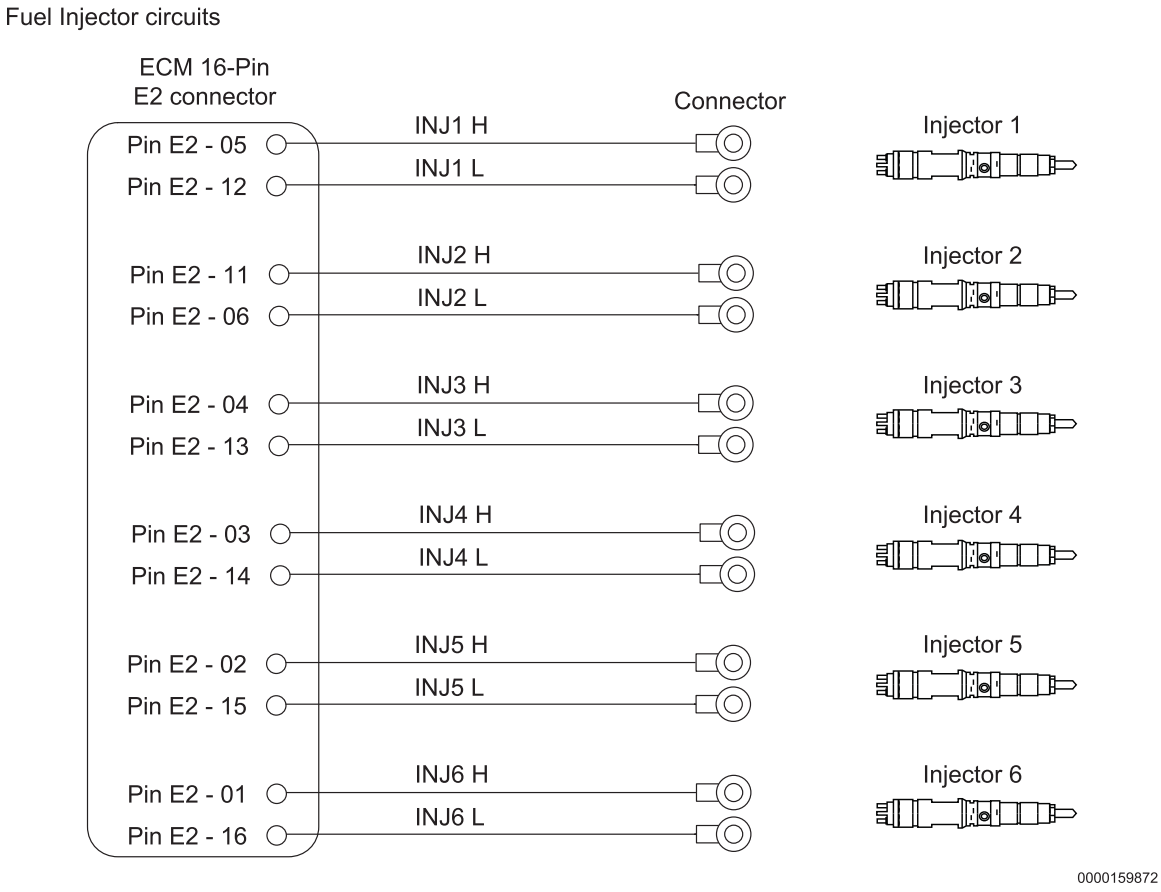


Figure 451 Fuel Injector circuit diagram

Possible Causes

- INJ2 H circuit short to PWR
- INJ2 H circuit short to GND
- INJ2 H short to INJ2 L
- INJ2 L circuit short to PWR
- INJ2 L circuit short to GND
- Fuel injector 2 shorted to engine brake housing
- Failed fuel injector 2
- INJ4 H circuit short to PWR
- INJ4 H circuit short to GND
- INJ4 H short to INJ4 L
- INJ4 L circuit short to PWR
- INJ4 L circuit short to GND
- Fuel injector 4 shorted to engine brake housing

- Failed fuel injector 4
- INJ6 H circuit short to PWR
- INJ6 H circuit short to GND
- INJ6 H short to INJ6 L
- INJ6 L circuit short to PWR
- INJ6 L circuit short to GND
- Fuel injector 6 shorted to engine brake housing
- Failed fuel injector 6

WARNING: To prevent personal injury or death, shut engine down before doing voltage checks for injector solenoids. When the engine is running, injector circuits have high voltage and amperage.

CAUTION: To avoid engine damage, turn the ignition switch to OFF before disconnecting connectors. Failure to turn ignition switch to OFF will cause a voltage spike and damage to electrical components.

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 652 FMI 4 and 5 (INJ); SPN 654 FMI 4 and 5 (INJ); SPN 656 FMI 4 and 5 (INJ). Is EST DTC list free of SPN 652 FMI 4 and 5; SPN 654 FMI 4 and 5; SPN 656 FMI 4 and 5?	Yes: Go to step 2. No: Repair SPN 652 FMI 4 and 5; SPN 654 FMI 4 and 5; SPN 656 FMI 4 and 5. After repairs are complete, retest for SPN 2798 FMI 11.

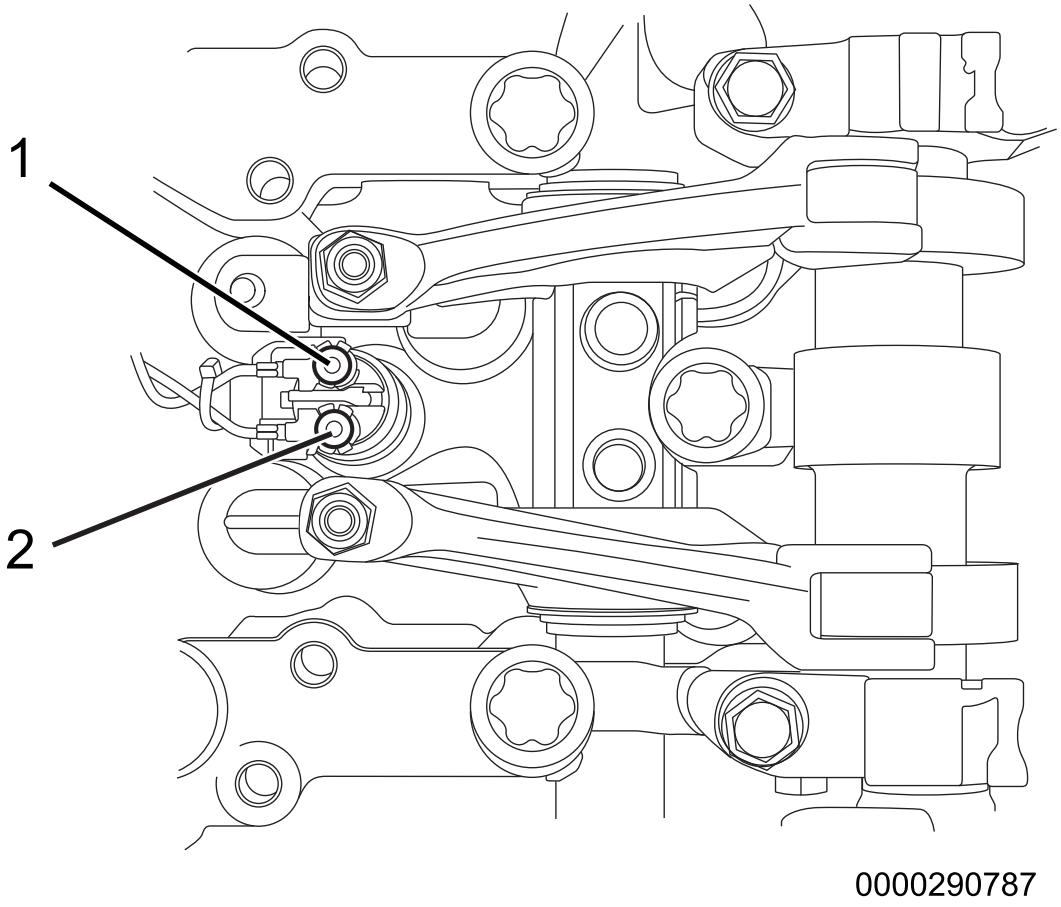


Figure 452 Fuel Injector Wiring Terminal Orientation

1. Fuel injector H wiring terminal
2. Fuel injector L wiring terminal (brown wire color [typical])

Step	Action	Decision
2	Verify proper fuel injector wire terminal orientation. Remove upper valve cover and engine brake housing (see Engine Service Manual). Verify fuel injector terminals are installed parallel so they do not short to ground on the engine brake housings or other components. Are fuel injector wire terminals oriented correctly and Not contacting the engine brake housing?	Yes: Go to step 3. No: Adjust connections so fuel injectors wire terminals will not contact the engine brake housing. After repairs are complete, retest for SPN 2798 FMI 11.

Step	Action	Decision
3	Check for a shorted fuel injector 2 coil. Disconnect wiring terminals from fuel injector 2. Check resistance across fuel injector 2. Is resistance between 0.2 to 0.8 Ohms?	Yes: Go to step 4. No: Replace fuel injector 2. After repairs are complete, retest for SPN 2798 FMI 11.

Step	Action	Decision
4	Check for a shorted fuel injector 4 coil. Disconnect wiring terminals from fuel injector 3. Check resistance across fuel injector 4. Is resistance between 0.2 to 0.8 Ohms?	Yes: Go to step 5. No: Replace fuel injector 4. After repairs are complete, retest for SPN 2798 FMI 11.

Step	Action	Decision
5	Check for a shorted fuel injector 6 coil. Disconnect wiring terminals from fuel injector 5. Check resistance across fuel injector 6. Is resistance between 0.2 to 0.8 Ohms?	Yes: Go to step 6. No: Replace fuel injector 6. After repairs are complete, retest for SPN 2798 FMI 11.

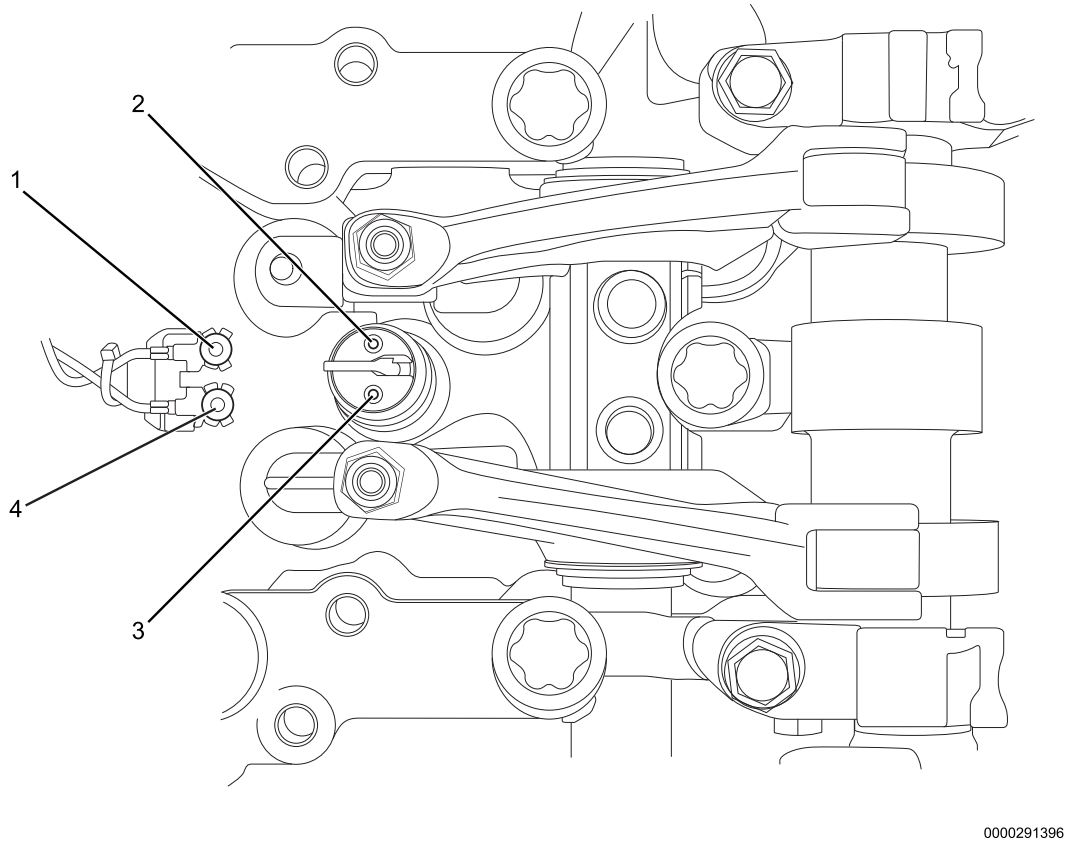


Figure 453 Fuel Injector Wiring Terminal Orientation

1. Fuel injector H wiring terminal
2. Fuel injector H terminal
3. Fuel injector L terminal
4. Fuel injector L wiring terminal (brown wire color [typical])

Step	Action	Decision
6	Check fuel injector 2 H terminal for short to GND. Key OFF with fuel injector 2 disconnected, use a DMM to measure resistance between fuel injector 2 H terminal and GND. Is resistance greater than 1000 ohms?	Yes: Go to step 7. No: Replace fuel injector 2. After repairs are complete, retest for SPN 2798 FMI 11.

Step	Action	Decision
7	Check fuel injector 2 L terminal for short to GND. Key OFF with fuel injector 2 disconnected, use a DMM to measure resistance between fuel injector 2 L terminal and GND. Is resistance greater than 1000 ohms?	Yes: Go to step 8. No: Replace fuel injector 2. After repairs are complete, retest for SPN 2798 FMI 11.

Step	Action	Decision
8	Check fuel injector 4 H terminal for short to GND. Key OFF with fuel injector 4 disconnected, use a DMM to measure resistance between fuel injector 4 H terminal and GND. Is resistance greater than 1000 ohms?	Yes: Go to step 9. No: Replace fuel injector 4. After repairs are complete, retest for SPN 2798 FMI 11.

Step	Action	Decision
9	Check fuel injector 4 L terminal for short to GND. Key OFF with fuel injector 4 disconnected, use a DMM to measure resistance between fuel injector 4 L terminal and GND. Is resistance greater than 1000 ohms?	Yes: Go to step 10. No: Replace fuel injector 4. After repairs are complete, retest for SPN 2798 FMI 11.

Step	Action	Decision
10	Check fuel injector 6 H terminal for short to GND. Key OFF with fuel injector 6 disconnected, use a DMM to measure resistance between fuel injector 6 H terminal and GND. Is resistance greater than 1000 ohms?	Yes: Go to step 11. No: Replace fuel injector 6. After repairs are complete, retest for SPN 2798 FMI 11.

Step	Action	Decision
11	Check fuel injector 6 L terminal for short to GND. Key OFF with fuel injector 6 disconnected, use a DMM to measure resistance between fuel injector 6 L terminal and GND. Is resistance greater than 1000 ohms?	Yes: Go to step 12. No: Replace fuel injector 6. After repairs are complete, retest for SPN 2798 FMI 11.

Step	Action	Decision
12	Inspect connections at ECM E2 connector. Key OFF, disconnect ECM E2 connector. Check ECM E2 connector and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the ECM E2 connector, harness, and terminals clean and undamaged?	Yes: Go to step 13. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 2798 FMI 11.

Step	Action	Decision
13	Check for INJ2 H short to INJ2 L. Key OFF, connect 180-pin Breakout Box with Breakout Harness 00-01468-00 vehicle harness, leave ECM E2 disconnected. Using a DMM, with fuel injector 2 disconnected measure resistance between Breakout Box pins E2-11 and E2-06 (wiggle test may be required). Is resistance greater than 1000 ohms?	Yes: Go to step 14. No: Repair INJ2 H short to INJ2 L. After repairs are complete, retest for SPN 2798 FMI 11.

Step	Action	Decision
14	Check for INJ4 H short to INJ4 L. Key OFF, connect 180-pin Breakout Box with Breakout Harness 00-01468-00 injector harness, leave ECM E2 disconnected. Using a DMM, with fuel injector 4 disconnected measure resistance between Breakout Box pins E2-03 and E2-14 (wiggle test may be required). Is resistance greater than 1000 ohms?	Yes: Go to step 15. No: Repair INJ4 H short to INJ4 L. After repairs are complete, retest for SPN 2798 FMI 11.

Step	Action	Decision
15	Check for INJ6 H short to INJ6 L. Key OFF, connect 180-pin Breakout Box with Breakout Harness 00-01468-00 injector harness, leave ECM E2 disconnected. Using a DMM, with fuel injector 6 disconnected measure resistance between Breakout Box pins E2-01 and E2-16 (wiggle test may be required). Is resistance greater than 1000 ohms?	Yes: Go to step 16. No: Repair INJ6 H short to INJ6 L. After repairs are complete, retest for SPN 2798 FMI 11.

Step	Action	Decision
16.	Check INJ2 H circuit for short to GND. Key OFF, connect 180-pin Breakout Box with Breakout Harness 00-01468-00 to vehicle harness, and leave ECM disconnected. Using a DMM with fuel injector 2 disconnected, measure resistance between Breakout Box pin E2-11 and a known good GND (wiggle test may be required). Is resistance greater than 1000 ohms?	Yes: Go to step 17. No: Repair short to GND between ECM pin E2-11 and fuel injector 2. After repairs are complete, retest for SPN 2798 FMI 11.

Step	Action	Decision
17	Check INJ2 L circuit for short to GND. Key OFF, connect 180-pin Breakout Box with Breakout Harness 00-01468-00 vehicle harness, and leave ECM disconnected. Using a DMM with fuel injector 2 disconnected, measure resistance between Breakout Box pin E2-06 and a known good GND (wiggle test may be required). Is resistance greater than 1000 ohms?	Yes: Go to step 18. No: Repair short to GND between ECM pin E2-06 and fuel injector 2. After repairs are complete, retest for SPN 2798 FMI 11.

Step	Action	Decision
18	Check INJ4 H circuit for short to GND. Key OFF, connect 180-pin Breakout Box with Breakout Harness 00-01468-00 to vehicle harness, and leave ECM disconnected. Using a DMM with fuel injector 4 disconnected, measure resistance between Breakout Box pin E2-03 and a known good GND (wiggle test may be required). Is resistance greater than 1000 ohms?	Yes: Go to step 19. No: Repair short to GND between ECM pin E2-03 and fuel injector 4. After repairs are complete, retest for SPN 2798 FMI 11.

Step	Action	Decision
19	Check INJ4 L circuit for short to GND. Key OFF, connect 180-pin Breakout Box with Breakout Harness 00-01468-00 vehicle harness, and leave ECM disconnected. Using a DMM with fuel injector 4 disconnected, measure resistance between Breakout Box pin E2-14 and a known good GND (wiggle test may be required). Is resistance greater than 1000 ohms?	Yes: Go to step 20. No: Repair short to GND between ECM pin E2-14 and fuel injector 4. After repairs are complete, retest for SPN 2798 FMI 11.

Step	Action	Decision
20	Check INJ6 H circuit for short to GND. Key OFF, connect 180-pin Breakout Box with Breakout Harness 00-01468-00 to vehicle harness, and leave ECM disconnected. Using a DMM with fuel injector 6 disconnected, measure resistance between Breakout Box pin E2-01 and a known good GND (wiggle test may be required). Is resistance greater than 1000 ohms?	Yes: Go to step 21. No: Repair short to GND between ECM pin E2-01 and fuel injector 6. After repairs are complete, retest for SPN 2798 FMI 11.

Step	Action	Decision
21	Check INJ6 L circuit for short to GND. Key OFF, connect 180-pin Breakout Box with Breakout Harness 00-01468-00 vehicle harness, and leave ECM disconnected. Using a DMM with fuel injector 6 disconnected, measure resistance between Breakout Box pin E2-16 and a known good GND (wiggle test may be required). Is resistance greater than 1000 ohms?	Yes: Go to step 22. No: Repair short to GND between ECM pin E2-16 and fuel injector 6. After repairs are complete, retest for SPN 2798 FMI 11.

Step	Action	Decision
22	Check INJ2 H circuit for short to PWR. Key-On Engine-Off (KOEO), connect 180-pin Breakout Box with Breakout Harness 00-01468-00 to vehicle harness, and leave ECM disconnected. Using a DMM with fuel injector 2 disconnected, measure voltage between Breakout Box pin E2-11 and a known good GND (wiggle test may be required). Is voltage less than 0.5 volts?	Yes: Go to step 23. No: Repair short to PWR between ECM pin E2-11 and fuel injector 2. After repairs are complete, retest for SPN 2798 FMI 11.

Step	Action	Decision
23	Check INJ2 L circuit for short to PWR. KOEO, connect 180-pin Breakout Box with Breakout Harness 00-01468-00 to vehicle harness, and leave ECM disconnected. Using a DMM with fuel injector 2 disconnected, measure voltage between Breakout Box pin E2-06 and known good GND (wiggle test may be required). Is voltage less than 0.5 Volts?	Yes: Go to step 24. No: Repair short to PWR between ECM pin E2-06 and fuel injector 2. After repairs are complete, retest for SPN 2798 FMI 11.

Step	Action	Decision
24	Check INJ4 H circuit for short to PWR. KOEO, connect 180-pin Breakout Box with Breakout Harness 00-01468-00 to vehicle harness, and leave ECM disconnected. Using a DMM with fuel injector 4 disconnected, measure voltage between Breakout Box pin E2-03 and known good GND (wiggle test may be required). Is voltage less than 0.5 volts?	Yes: Go to step 25. No: Repair short to PWR between ECM pin E2-03 and fuel injector 4. After repairs are complete, retest for SPN 2798 FMI 11.

Step	Action	Decision
25	Check INJ4 L circuit for short to PWR. KOEO, connect 180-pin Breakout Box with Breakout Harness 00-01468-00 vehicle harness, and leave ECM disconnected. Using a DMM with fuel injector 4 disconnected, measure voltage between Breakout Box pin E2-14 and known good GND (wiggle test may be required). Is voltage less than 0.5 volts?	Yes: Go to step 26. No: Repair short to PWR between ECM pin E2-14 and fuel injector 4. After repairs are complete, retest for SPN 2798 FMI 11.

Step	Action	Decision
26	Check INJ6 H circuit for short to PWR. KOEO, connect 180-pin Breakout Box with Breakout Harness 00-01468-00 to vehicle harness, and leave ECM disconnected. Using a DMM with fuel injector 6 disconnected, measure voltage between Breakout Box pin E2-01 and known good GND (wiggle test may be required). Is voltage less than 0.5 volts?	Yes: Repair short to PWR between ECM pin E2-16 and fuel injector 6. After repairs are complete, retest for SPN 2798 FMI 11. No: Repair short to PWR between ECM pin E2-01 and fuel injector 6. After repairs are complete, retest for SPN 2798 FMI 11.

NOTE: After performing all diagnostic steps, if SPN 2798 FMI 11 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

J1939 Data Link Communications

SPN	FMI	Condition	Possible Causes	Actions
560	19	Transmission Driveline Engaged not detected on J1939	• Transmission driveline engaged switch or circuit fault	See *Electrical System Troubleshooting Guide* for troubleshooting the switch
609	19	ACM not detected on J1939	• CAN-AH circuit Open • CAN-AL circuit Open • CAN-AH circuit short to GND • CAN-AL circuit short to GND • CAN-AH short to CAN-AL • CAN-AH circuit short to power • CAN-AL circuit short to power	Step-Based Diagnostics (page 1225)
639	14	J1939 Data Link Error (ECM unable to transmit)	• J1939 Data link circuit fault • Failed ECM	Circuit Checks (page 1223)
639	19	J1939 Data Link Error (ECM unable to transmit or receive)	• J1939 Data link circuit fault • Failed ECM	Circuit Checks (page 1223)
1590	19	Adaptive Cruise Control not detected on J1939	• Incorrect programmable parameter • J1939 Data link circuit fault	Pinpoint Diagnostics (page 1224)
3695	19	DPF Regen Inhibit Switch status not detected on J1939	• Failed or missing DPF regen inhibit switch • Incorrectly programmed Aftertreatment Control Module (ACM)	Step-Based Diagnostics (page 1232)

3696	19	DPF Park Regen Switch status not detected on J1939	• Failed or missing DPF parked regen switch • Incorrectly programmed Aftertreatment Control Module (ACM)	Step-Based Diagnostics (page 1233)
4360	19	SCRIT signal not detected on J1939	• SWBAT circuit short to GND or Open • CAN-AH circuit Open or short to GND • CAN-AL circuit Open or short to GND • CAN-AH circuit short to power • CAN-AL circuit short to power • GND circuit Open or high resistance • CAN-AH short to CAN-AL • Failed SCR temperature sensor module	Step-Based Diagnostics (page 1235)
4363	19	SCROT signal not detected on J1939	• SWBAT circuit short to GND or Open • CAN-AH circuit Open or short to GND • CAN-AL circuit Open or short to GND • CAN-AH circuit short to power • CAN-AL circuit short to power • GND circuit Open or high resistance • CAN-AH short to CAN-AL • Failed SCR temperature sensor module	Step-Based Diagnostics (page 1239)

4377	19	NH_3 signal not detected on J1939	• SWBAT circuit Open, high resistance, or short GND • CAN-AH circuit Open or short to GND • CAN-AL circuit Open or short to GND • CAN-AH circuit short to power • CAN-AL circuit short to power • GND circuit Open or high resistance • CAN-AH short to CAN-AL • Failed NH_3 sensor module	Step-Based Diagnostics (page 1243)
5742	19	DOC / DPF Temperature Sensor Module signal not detected on J1939	• SWBAT circuit short to GND or Open • CAN-AH circuit Open or short to GND • CAN-AL circuit Open or short to GND • CAN-AH circuit short to power • CAN-AL circuit short to power • GND circuit Open or high resistance • CAN-AH short to CAN-AL • Failed DOC / DPF temperature sensor module	Step-Based Diagnostics (page 1248)
5743	19	SCR Temperature Sensor signal not detected on J1939	• SWBAT circuit short to GND or Open • CAN-AH circuit Open or short to GND • CAN-AL circuit Open or short to GND • CAN-AH circuit short to power	Step-Based Diagnostics (page 1252)

- CAN-AL circuit short to power
- GND circuit Open or high resistance
- CAN-AH short to CAN-AL
- Failed SCR temperature sensor module

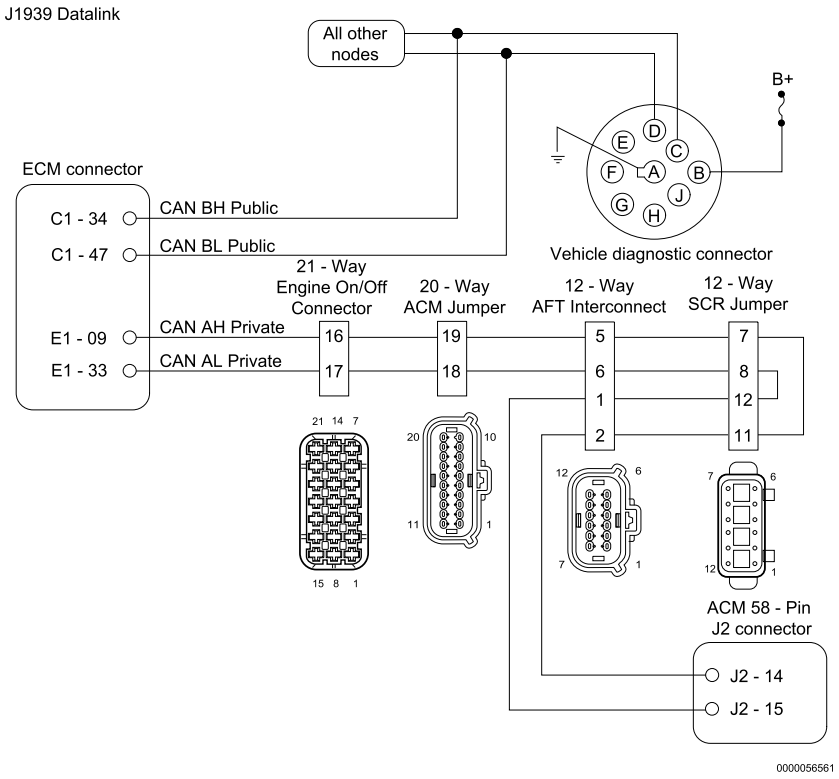


Figure 454 J1939 data link circuit diagram

NOTE: See latest version of Navistar N13 Engine and Aftertreatment Wiring Schematic Form 0000002203 for additional circuit information.

Overview

The Public J1939 circuit provides a communication path between the Engine Control Module (ECM), and other vehicle Controller Area Network (CAN) nodes. The circuit contains two 120 ohm terminating resistors. One resistor will be located inside the cab, and one will be located outside the cab. Wiring for the Public J1939 circuit consists of a shielded twisted pair wire where one wire is CAN-BH, and the other is CAN-BL.

Tools Required

- 180-Pin Breakout Box 00-00956-08

- ACM Breakout Harness 18-100-01
- 2010 MaxxForce 11 & 13 Harness Kit 00-01462-00
- Big Bore Terminal Test Kit ZTSE4899
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with Diamond Logic Builder™ software
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

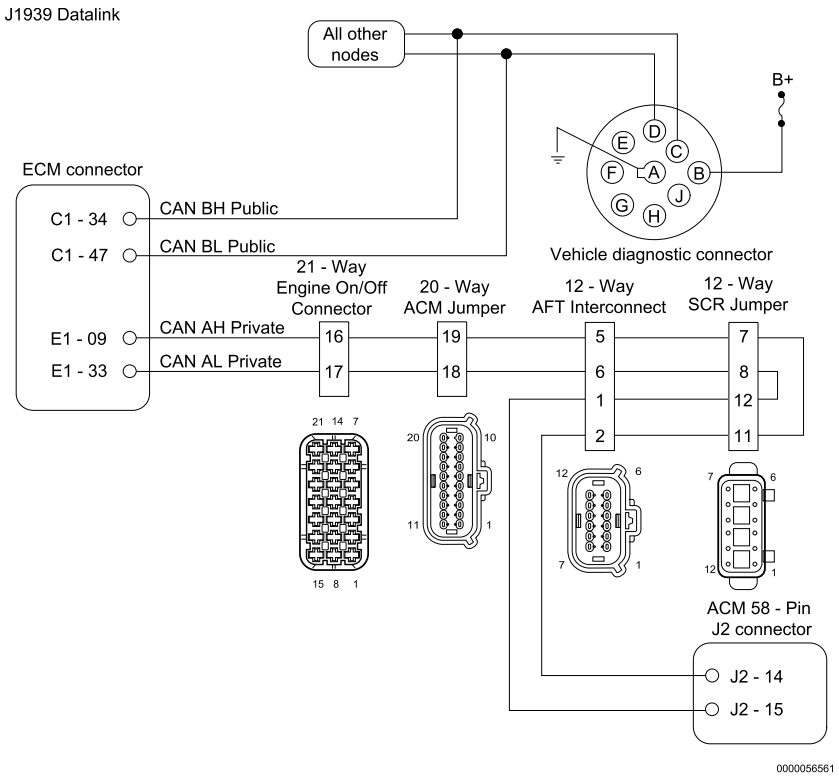


Figure 455 J1939 data link circuit diagram

Vehicle Diagnostic Connector Voltage Check

Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
B to GND	B+	If < B+, check B+ circuit to vehicle diagnostic connector for OPEN or short to GND, or blown fuse.
B to A	B+	If < B+, check GND circuit to vehicle diagnostic connector for OPEN.
C to GND	1 V to 4 V	The sum of C to GND and D to GND should = 4 V to 5 V.
D to GND	1 V to 4 V	The sum of C to GND and D to GND should = 4 V to 5 V.

EST Communication Check

Turn ignition switch to ON. Connect EST to vehicle diagnostic connector. If the EST is unable to communicate with the ECM, disconnect each module connected to the J1939 data link individually, until communication is established.

NOTE:

- If communication to ECM is established, check J1939 circuits to disconnected node for correct wiring. See truck *Electrical System Troubleshooting Guide*.

EST Communication Check (cont.)

- If communication to ECM is not established, go to next test point.

Test Point	Comment
Disconnect Transmission Control Module (TCM)	See above note.
Disconnect Body Controller	See above note.
Disconnect instrument cluster	See above note.
Disconnect other nodes	See above note.

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM C1 and C2 harness to ECM C1 and C2 vehicle harness connectors, and leave ECM disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
C to D	approximately 60 Ω	If not within specification, measure individual CAN terminating resistors.
Terminating Resistor Terminals	approximately 120 Ω	If not within specification, replace faulty terminating resistor(s).
C to C1-34	< 5 Ω	If > 5 Ω, check J1939-H for OPEN in circuit.
C to GND	> 1k Ω	If < 1k Ω, check J1939-H for short to GND.
D to C1-47	< 5 Ω	If > 5 Ω, check J1939-L for OPEN in circuit.
D to GND	> 1k Ω	If < 1k Ω, check J1939-L for short to GND.
A to GND	< 5 Ω	If > 5 Ω, check GND for OPEN in circuit.

Pinpoint Diagnostics With ServiceMaxx™ Software

SPN 1590 FMI 19 - Adaptive Cruise Control not detected on J1939

1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, load the Parameters session and verify the correct Adaptive Cruise Control (ACC) system is selected under parameter ID 76102 Adaptive Cruise Control Enable (disable, Vorad, Wingman, or Wabco).

   Is the correct ACC system selected under parameter ID 76102?

   - Yes: Go to J1939 datalink circuit checks (page 1223).
   - No: Correct parameter ID 76102 and program engine. Retest for SPN 1590 FMI 19.

SPN 609 FMI 19 - ACM not detected on J1939

Fault Overview

Fault code sets when the Engine Control Module (ECM) is unable to communicate with Aftertreatment Control Module (ACM).

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

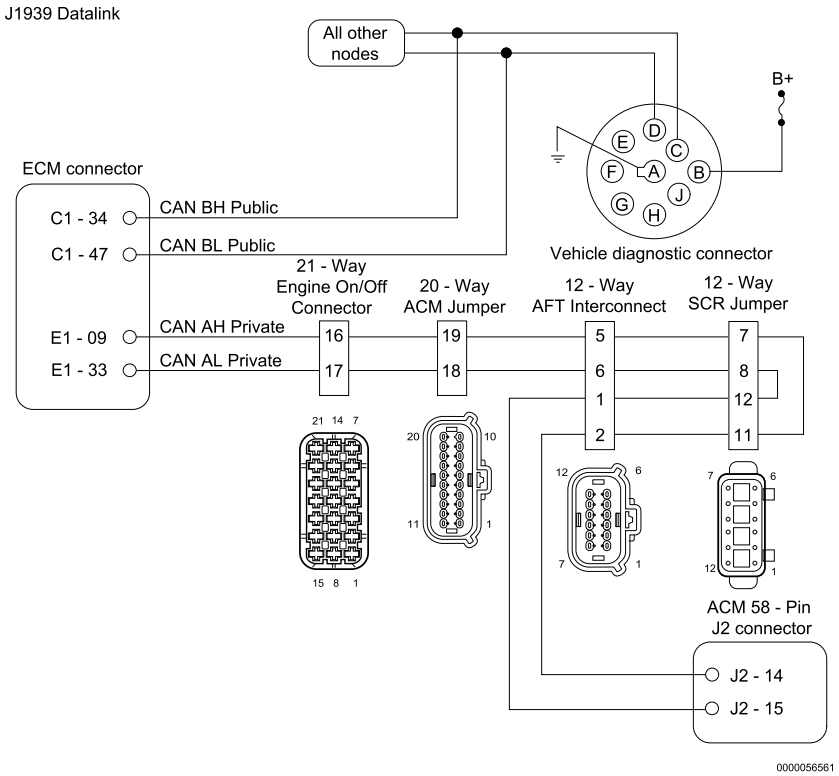


Figure 456 J1939 data link circuit diagram

Possible Causes

- CAN-AH circuit Open
- CAN-AL circuit Open
- CAN-AH circuit short to GND
- CAN-AL circuit short to GND
- CAN-AH short to CAN-AL
- CAN-AH circuit short to power

- CAN-AL circuit short to power

Step	Action	Decision
1	Inspect connections at ACM. Key OFF, disconnect ACM. Check ACM and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the ACM connector, harness, and terminals clean and undamaged?	Yes: Go to step 2. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 609 FMI 19.

Step	Action	Decision
2	Check ACM VBATT circuits. Key OFF, connect ACM Breakout Harness 18-100-01 J2 connector between ACM and aftertreatment harness. Key ON, using a DMM, measure voltage between ACM pin J2-03 and a known good ground, and pin J2-05 and a known good ground. Is voltage at both pins within 0.5 volts of battery voltage?	Yes: Go to step 3. No: Go to step 11

Step	Action	Decision
3	Check ACM GND circuits. Key OFF, connect ACM Breakout Harness 18-100-01 J2 connector between ACM and aftertreatment harness. Key ON, using a DMM, measure voltage between ACM pin J2-04 and B+, and ACM pin J2-06 and B+. Is voltage at both pins within 0.5 volts of battery voltage?	Yes: Go to step 4. No: Go to step 17.

Step	Action	Decision
4	Inspect connections at Engine Control Module (ECM). Key OFF, disconnect ECM. Check ECM and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the ECM connector, harness, and terminals clean and undamaged?	Yes: Go to step 5. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 609 FMI 19.

Step	Action	Decision
5	Check CAN-AH circuit for short to GND. Key OFF, connect ACM Breakout Harness 18-100-01 J2 connector between ACM and aftertreatment harness. Connect Breakout Harness 00-01462-00 E1 connector between ECM and aftertreatment harness. Place ACM overlay on Breakout Box. Connect ACM Breakout harness Z connector and ECM Breakout Harness X connector to Breakout Box. Key ON, use a DMM to measure voltage between pin J2-14 and a known good ground. Is voltage greater than 1 volt?	Yes: Go to step 6. No: short to GND between ACM pin J2-14 and ECM pin E1-09.

Step	Action	Decision
6	Check CAN-AL circuit for short to GND. Key OFF, connect ACM Breakout Harness 18-100-01 J2 connector between ACM and aftertreatment harness. Connect Breakout Harness 00-01462-00 E1 connector between ECM and aftertreatment harness. Place ACM overlay on Breakout Box. Connect ACM Breakout harness Z connector and ECM Breakout Harness X connector to Breakout Box. Key ON, use a DMM to measure voltage at pin J2-15 and a known good ground. Is voltage greater than 1 volt?	Yes: Go to step 7. No: short to GND between ACM pin J2-15 and ECM pin E1-33.

Step	Action	Decision
7	Check CAN-AH circuit for short to power. Key OFF, connect ACM Breakout Harness 18-100-01 J2 connector between ACM and aftertreatment harness. Connect Breakout Harness 00-01462-00 E1 connector between ECM and aftertreatment harness. Place ACM overlay on Breakout Box. Connect ACM Breakout harness Z connector and ECM Breakout Harness X connector to Breakout Box. Key ON, use a DMM to measure voltage at pin J2-14. Is voltage less than 4 volts?	Yes: Go to step 8. No: short to power between ACM pin J2-14 and ECM pin E1-09.

Step	Action	Decision
8	Check CAN-AL circuit for short to power. Key OFF, connect ACM Breakout Harness 18-100-01 J2 connector between ACM and aftertreatment harness. Connect Breakout Harness 00-01462-00 E1 connector between ECM and aftertreatment harness. Place ACM overlay on Breakout Box. Connect ACM Breakout harness Z connector and ECM Breakout Harness X connector to Breakout Box. Kry ON, use a DMM to measure voltage at in J2-15 and a known good ground. Is voltage less than 4 volts?	Yes: Go to step 9. No: short to power between ACM pin J2-15 and ECM pin E1-33.

NOTE: Before performing any resistance checks on the data link circuit, turn ignition switch to the OFF position and disconnect vehicle batteries.

Step	Action	Decision
9	Check CAN-AH circuit for a short to CAN-AL. Leaving breakout box connected to the harnesses, disconnect ACM J2 connector from ACM, and ECM E1 connector from ECM. Key OFF, use a DMM to measure resistance between pin J2-14 and pin J2-15. Is resistance less than 50 ohms?	Yes: Go to step 10. No: Repair short between CAN-AH, and CAN-AL. After repairs are complete, retest for SPN 609 FMI 19.

Step	Action	Decision
10	Check CAN-AH circuit for Open or high resistance. Use a DMM to measure resistance between pin J2-14 and pin J1-07/E1-09. Is resistance less than 5 ohms?	Yes: Open or high resistance between ACM pin J2-15 and ECM pin E1-33. No: Open or high resistance between ACM pin J2-14 and ECM pin E1-09.

Step	Action	Decision
11	Inspect connections at 15-Way Way Underhood PDM connector. Key OFF, disconnect 15-Way Underhood PDM connector. Check 15-Way Underhood PDM connector and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the 15-Way Underhood PDM connector, harness, and terminals clean and undamaged?	Yes: Go to step 12. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 609 FMI 19.

Step	Action	Decision
12	Check voltage to the 15-Way Underhood PDM connector. Key OFF, disconnect 15-Way. Using appropriate terminal from Big Bore Terminal Test Kit ZTSE4899, connect DMM to pin-13 of Underhood PDM and leave harness disconnected. Key ON, measure voltage between pin-13 of Underhood PDM and a known good ground. Is voltage within 0.5 volts of battery voltage?	Yes: Go to step 13. No: Diagnose loss of power from Underhood PDM. See appropriate Truck Service Manual. After repairs are complete, retest for SPN 609 FMI 19.

Step	Action	Decision
13	Inspect connections at 20-Way DEF harness interconnect. Key OFF, disconnect 20-Way. Check 20-Way terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the 20-Way connector, harness, and terminals clean and undamaged?	Yes: Go to step 14. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 609 FMI 19.

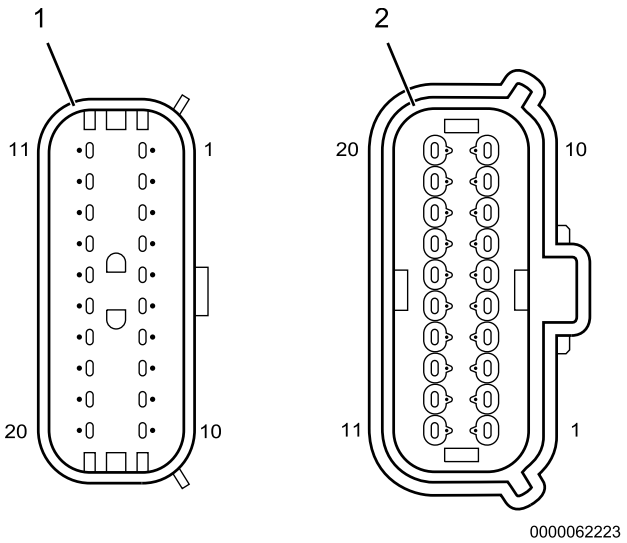


Figure 457 20-Way DEF Harness Connector End View

1. 20-Way DEF harness male side connector
2. 20-Way DEF harness female side connector

Step	Action	Decision
14	Check voltage to the 20-Way DEF Harness Interconnect. Key OFF, reconnect 15-Way Underhood PDM connector. Connect 20-Way DEF Harness Interconnect Breakout Harness 18-050-01 to the female side of the 20-Way, and leave male side disconnected. Key ON, using a DMM, measure voltage between pin-12 and a known good ground. Is voltage within 0.5 volts of battery voltage?	Yes: Go to step 15. No: Repair Open or high resistance in VBATT circuit between 20-Way pin-12 and ACM connector pin J2-03. After repairs are complete, retest for SPN 609 FMI 19.

Step	Action	Decision
15	Check voltage to the 20-Way DEF Harness Interconnect. Key OFF, connect 20-Way DEF Harness Interconnect Breakout Harness 18-050-01 to the female side of the 20-Way, and leave male side disconnected. Key ON, using a DMM, measure voltage between pin-13 and a known good ground. Is voltage within 0.5 volts of battery voltage?	Yes: Go to step 16. No: Repair Open or high resistance in VBATT circuit between 20-Way pin-13 and ACM connector pin J2-05. After repairs are complete, retest for SPN 609 FMI 19.

Step	Action	Decision
16	Check VBATT circuits between 20-Way DEF Harness Interconnect and ACM. Key OFF, connect ACM Breakout Harness 18-100-01 J2 connector between ACM and aftertreatment harness. Key ON, using a DMM, measure voltage between ACM pin J2-05 and a known good ground. Is voltage within 0.5 volts of battery voltage?	Yes: Repair Open or high resistance in VBATT circuit between 20-Way pin-12 and ACM connector pin J2-03. After repairs are complete, retest for SPN 609 FMI 19.
		No: Repair Open or high resistance in VBATT circuit between 20-Way pin-13 and ACM connector pin J2-05. After repairs are complete, retest for SPN 609 FMI 19.

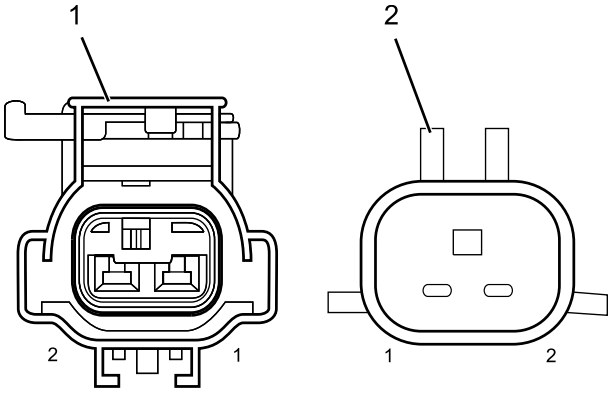


Figure 458 DEF Harness PWR and GND connector view

1. Female connector
2. Male connector

Step	Action	Decision
17	Inspect connections at DEF harness PWR & GND connector. Key OFF, disconnect DEF harness PWR & GND connector. Check DEF harness PWR & GND connector for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DEF harness PWR & GND connector, harness, and terminals clean and undamaged?	Yes: Go to step 18.
		No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 609 FMI 19.

Step	Action	Decision
18	Check ground at the DEF harness PWR & GND connector. Key OFF, connect Breakout Harness ZTSE4760A to the male side of the 20-Way, and leave female side disconnected. Using a DMM, measure voltage between Breakout Harness ZTSE4760A pin-2 and B+. Is voltage within 0.5 volts of battery voltage?	Yes: Go to step 19. No: Diagnose loss of ground to DEF harness PWR & GND connector. See appropriate Truck Service Manual. After repairs are complete, retest for SPN 609 FMI 19.

Step	Action	Decision
19	Check GND circuits between DEF harness PWR & GND connector and ACM. Key OFF, connect ACM Breakout Harness 18-100-01 J2 connector between ACM and aftertreatment harness. Using a DMM, measure voltage between ACM pin J2-04 and B+. Is voltage within 0.5 volts of battery voltage?	Yes: Repair Open or high resistance in GND circuit between DEF harness PWR & GND connector pin-2 and ACM connector pin J2-06. After repairs are complete, retest for SPN 609 FMI 19. No: Repair Open or high resistance in GND circuit between DEF harness PWR & GND connector pin-2 and ACM connector pin J2-04. After repairs are complete, retest for SPN 609 FMI 19.

NOTE: After doing all diagnostic steps, if SPN 609 FMI 19 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3695 FMI 19 - DPF Regen Inhibit Switch status not detected on J1939

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Particulate Filter (DPF) regen inhibit switch status not detected.	DPF regen inhibit switch status not detected on J1939.	Key ON	0 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) does not receive a message for the status of the Diesel Particulate Filter (DPF) regen inhibit switch over the J1939 bus.

Malfunction Indicator Lamp (MIL) Reaction

This fault does not illuminate the MIL.

Drive Cycle to Determine Fault Status

Drive cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Failed or missing DPF regen inhibit switch
- Incorrectly programmed Aftertreatment Control Module (ACM)

Step	Action	Decision
1	Verify truck is equipped with a Diesel Particulate Filter (DPF) regen inhibit switch. Is the vehicle equipped with a DPF regen inhibit switch?	Yes: Repair DPF regen inhibit switch fault (See appropriate Truck Electrical Circuit Diagrams). After repairs are complete, retest for SPN 3695 FMI 19.
		No: Verify the Aftertreatment Control Module (ACM) is not programmed for a DPF regen inhibit switch. After repairs are complete, retest for SPN 3695 FMI 19.

NOTE: After performing all diagnostic steps, if SPN 3695 FMI 19 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3696 FMI 19 - DPF Parked Regen Switch status not detected on J1939

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
DPF parked regen switch status not detected.	DPF parked regen switch status not detected on J1939.	Key ON	0 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) does not receive a message for the status of the DPF Parked Regen Switch over the J1939 bus.

Malfunction Indicator Lamp (MIL) Reaction

This fault does not illuminate the MIL.

Drive Cycle to Determine Fault Status

Drive cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Failed or missing DPF parked regen switch
- Incorrectly programmed Aftertreatment Control Module (ACM)

Step	Action	Decision
1	Verify truck is equipped with a Diesel Particulate Filter (DPF) parked regen switch. Is the vehicle equipped with a DPF parked regen switch?	Yes: Repair DPF parked regen switch fault (See appropriate Truck Electrical Circuit Diagrams). After repairs are complete, retest for SPN 3696 FMI 19.
		No: Verify that the Aftertreatment Control Module (ACM) is not programmed for a DPF parked regen switch. After repairs are complete, retest for SPN 3696 FMI 19.

NOTE: After performing all diagnostic steps, if SPN 3696 FMI 19 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 4360 FMI 19 - SCRIT not detected on J1939

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Selective Catalyst Reduction Inlet Temperature (SCRIT) signal not detected on J1939 Controller Area Network (CAN).	Aftertreatment Control Module (ACM) loses J1939 data link communications with SCRIT sensor.	Key ON	2 events

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) loses J1939 CAN data link communications with the SCR inlet temperature sensor. Engine torque will be reduced if fault is active for a limited period of time. Engine torque will be severely reduced and vehicle speed will be limited after extended engine operation with this fault code active.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

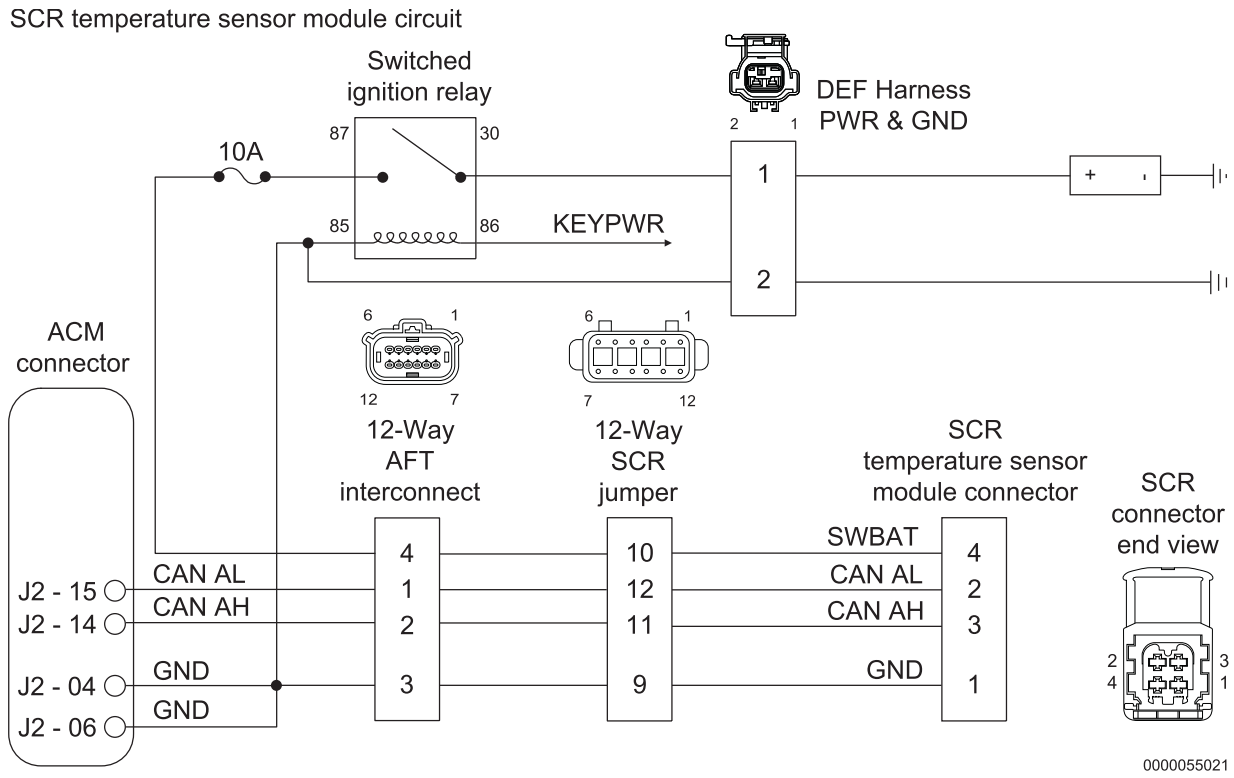


Figure 459 SCR Temperature Sensor Module Circuit Diagram

Possible Cause

- SWBAT circuit short to GND or Open
- CAN-AH circuit Open or short to GND
- CAN-AL circuit Open or short to GND
- CAN-AH circuit short to power
- CAN-AL circuit short to power
- GND circuit Open or high resistance
- CAN-AH short to CAN-AL
- Failed SCR temperature sensor module

Step	Action	Decision
1	Inspect connections at SCR temperature sensor module. Key OFF, disconnect temperature sensor module. Check SCR temperature sensor module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the SCR temperature sensor module connector, harness, and terminals clean and undamaged?	Yes: Go to step 2. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 4360 FMI 19.

Step	Action	Decision
2	Check voltage to the SCR temperature sensor module. Key-On Engine-Off (KOEO), with Breakout Harness 18-648-01 connected between temperature sensor module and vehicle harness, use a DMM to measure voltage between temperature sensor module pin-1 and pin-4. Is voltage within 0.5 volts of battery voltage?	Yes: Go to step 4. No: Go to step 3.

Step	Action	Decision
3	Check SWBAT circuit for Open or short to ground. KOEO, with Breakout Harness 18-648-01 connected between SCR temperature sensor module and vehicle harness, use a DMM to measure voltage between temperature sensor module pin-4 and a known good ground. Is voltage at pin-4 within 0.5 volts of battery voltage?	Yes: Repair Open or high resistance between SCR temperature sensor module pin-1 and ground. After repairs are complete, retest for SPN 4360 FMI 19. No: Repair Open or short to ground between SCR temperature sensor module connector pin-4 and switched ignition relay pin-87. After repairs are complete, retest for SPN 4360 FMI 19.

Step	Action	Decision
4	Check CAN-AH circuit for Open or short to GND. KOEO, with Breakout Harness 18-648-01 connected between SCR temperature sensor module and vehicle harness, use a DMM to measure voltage between temperature sensor module pin-3 and a known good ground. Is voltage greater than 1 volt?	Yes: Go to step 5. No: Repair Open or short to ground between SCR temperature sensor module connector pin-3 and ACM connector J2-14. After repairs are complete, retest for SPN 4360 FMI 19.

Step	Action	Decision
5	Check CAN-AH circuit for short to power. KOEO, with Breakout Harness 18-648-01 connected between SCR temperature sensor module and vehicle harness, use a DMM to measure voltage between temperature sensor module pin-3 and a known good ground. Is voltage less than 4 volts?	Yes: Go to step 6. No: Repair short to power between SCR temperature sensor module connector pin-3 and ACM connector J2-14. After repairs are complete, retest for SPN 4360 FMI 19.

Step	Action	Decision
6	Check CAN-AL circuit for Open or short to GND. KOEO, with Breakout Harness 18-648-01 connected between SCR temperature sensor module and vehicle harness, use a DMM to measure voltage between temperature sensor module pin-2 and a known good ground. Is voltage greater than 1 volt?	Yes: Go to step 7. No: Repair Open or short to ground between SCR temperature sensor module connector pin-2 and ACM connector J2-15. After repairs are complete, retest for SPN 4360 FMI 19.

Step	Action	Decision
7	Check CAN-AL circuit for short to power. KOEO, with Breakout Harness 18-648-01 connected between SCR temperature sensor module and vehicle harness, use a DMM to measure voltage between temperature sensor module pin-2 and a known good ground. Is voltage less than 4 volts?	Yes: Go to step 8. No: Repair short to power between SCR temperature sensor module connector pin-2 and ACM connector J2-15. After repairs are complete, retest for SPN 4360 FMI 19.

Step	Action	Decision
8	Check CAN-AL circuit for short to CAN-AH. Key OFF, with Breakout Harness 18-648-01 connected between SCR temperature sensor module and vehicle harness, use a DMM to measure resistance between temperature sensor module pin-2 and pin-3. Is resistance greater than 50 ohms?	Yes: Replace SCR temperature sensor module. After repairs are complete, retest for SPN 4360 FMI 19. No: Repair short between SCR temperature sensor module connector pin-2 and pin-3. After repairs are complete, retest for SPN 4360 FMI 19.

NOTE: After performing all diagnostic steps, if SPN 4360 FMI 19 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 4363 FMI 19 - SCROT not detected on J1939

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Selective Catalyst Reduction Outlet Temperature (SCROT) signal not detected on J1939 Controller Area Network (CAN).	Aftertreatment Control Module (ACM) loses J1939 data link communications with SCROT sensor.	Key ON	2 events

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) loses J1939 CAN data link communications with the SCR outlet temperature sensor module. Engine torque will be reduced if fault is active for a limited period of time. Engine torque will be severely reduced and vehicle speed will be limited after extended engine operation with this fault code active.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

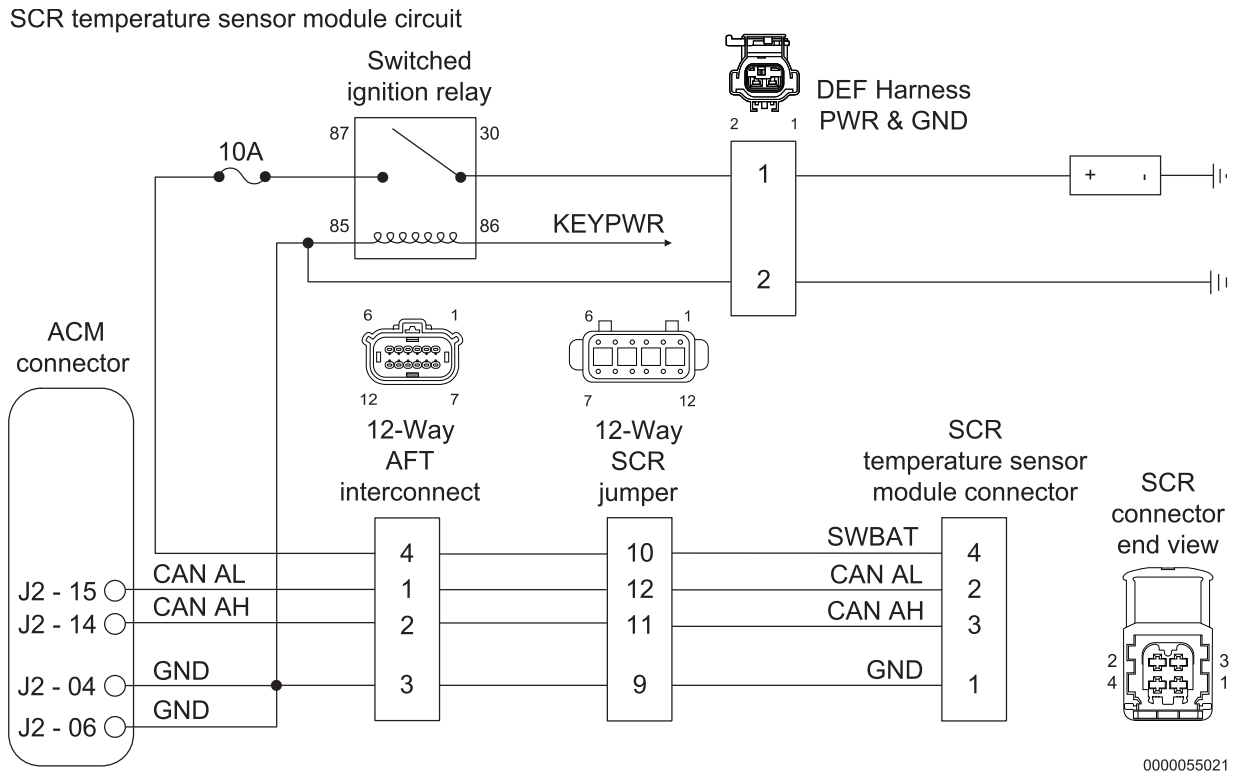


Figure 460 SCR Temperature Sensor Module Circuit Diagram

Possible Cause

- SWBAT circuit short to GND or Open
- CAN-AH circuit Open or short to GND
- CAN-AL circuit Open or short to GND
- CAN-AH circuit short to power
- CAN-AL circuit short to power
- GND circuit Open or high resistance
- CAN-AH short to CAN-AL
- Failed SCR temperature sensor module

Step	Action	Decision
1	Inspect connections at SCR temperature sensor module. Key OFF, disconnect SCR temperature sensor module. Check SCR temperature sensor module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the SCR temperature sensor module connector, harness, and terminals clean and undamaged?	Yes: Go to step 2. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 4363 FMI 19.

Step	Action	Decision
2	Check voltage to the SCR temperature sensor module. Key-On Engine-Off (KOEO), with Breakout Harness 18-648-01 connected between temperature sensor module and vehicle harness, use a DMM to measure voltage between temperature sensor module pin-1 and pin-4. Is voltage within 0.5 volts of battery voltage?	Yes: Go to step 4. No: Go to step 3.

Step	Action	Decision
3	Check SWBAT circuit for Open or short to ground. KOEO, with Breakout Harness 18-648-01 connected between SCR temperature sensor module and vehicle harness, use a DMM to measure voltage between temperature sensor module pin-4 and a known good ground. Is voltage at pin-4 within 0.5 volts of battery voltage?	Yes: Repair Open or high resistance between SCR temperature sensor module pin-1 and ground. After repairs are complete, retest for SPN 4363 FMI 19. No: Repair Open or short to ground between SCR temperature sensor module connector pin-4 and switched ignition relay pin-87. After repairs are complete, retest for SPN 4363 FMI 19.

Step	Action	Decision
4	Check CAN-AH circuit for Open or short to GND. KOEO, with Breakout Harness 18-648-01 connected between SCR temperature sensor module and vehicle harness, use a DMM to measure voltage between temperature sensor module pin-3 and a known good ground. Is voltage greater than 1 volt?	Yes: Go to step 5. No: No: Repair Open or short to ground between SCR temperature sensor module connector pin-3 and ACM connector J2-14. After repairs are complete, retest for SPN 4363 FMI 19.

Step	Action	Decision
5	Check CAN-AH circuit for short to power. KOEO, with Breakout Harness 18-648-01 connected between SCR temperature sensor module and vehicle harness, use a DMM to measure voltage between temperature sensor module pin-3 and a known good ground. Is voltage less than 4 volts?	Yes: Go to step 6. No: Repair short to power between SCR temperature sensor module connector pin-3 and ACM connector J2-14. After repairs are complete, retest for SPN 4363 FMI 19.

Step	Action	Decision
6	Check CAN-AL circuit for Open or short to GND. KOEO, with Breakout Harness 18-648-01 connected between SCR temperature sensor module and vehicle harness, use a DMM to measure voltage between temperature sensor module pin-2 and a known good ground. Is voltage greater than 1 volt?	Yes: Go to step 7. No: Repair Open or short to ground between SCR temperature sensor module connector pin-2 and ACM connector J2-15. After repairs are complete, retest for SPN 4363 FMI 19.

Step	Action	Decision
7	Check CAN-AL circuit for short to power. KOEO, with Breakout Harness 18-648-01 connected between SCR temperature sensor module and vehicle harness, use a DMM to measure voltage between temperature sensor module pin-2 and a known good ground. Is voltage less than 4 volts?	Yes: Go to step 8. No: Repair short to power between SCR temperature sensor module connector pin-2 and ACM connector J2-15. After repairs are complete, retest for SPN 4363 FMI 19.

Step	Action	Decision
8	Check CAN-AL circuit for short to CAN-AH. Key OFF, with Breakout Harness 18-648-01 connected between SCR temperature sensor module and vehicle harness, use a DMM to measure resistance between temperature sensor module pin-2 and pin-3. Is resistance greater than 50 ohms?	Yes: Replace SCR temperature sensor module. After repairs are complete, retest for SPN SPN 4363 FMI 19. No: Repair short between SCR temperature sensor module connector pin-2 and pin-3. After repairs are complete, retest for SPN 4363 FMI 19.

NOTE: After performing all diagnostic steps, if SPN 4363 FMI 19 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 4377 FMI 19- NH_3 signal not detected on J1939

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Ammonia NH_3 sensor module not detected on J1939 Controller Area Network (CAN).	Aftertreatment Control Module (ACM) loses J1939 data link communications with NH_3 sensor module.	Key ON	2 events

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) loses J1939 data link communications with the NH_3 sensor module.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

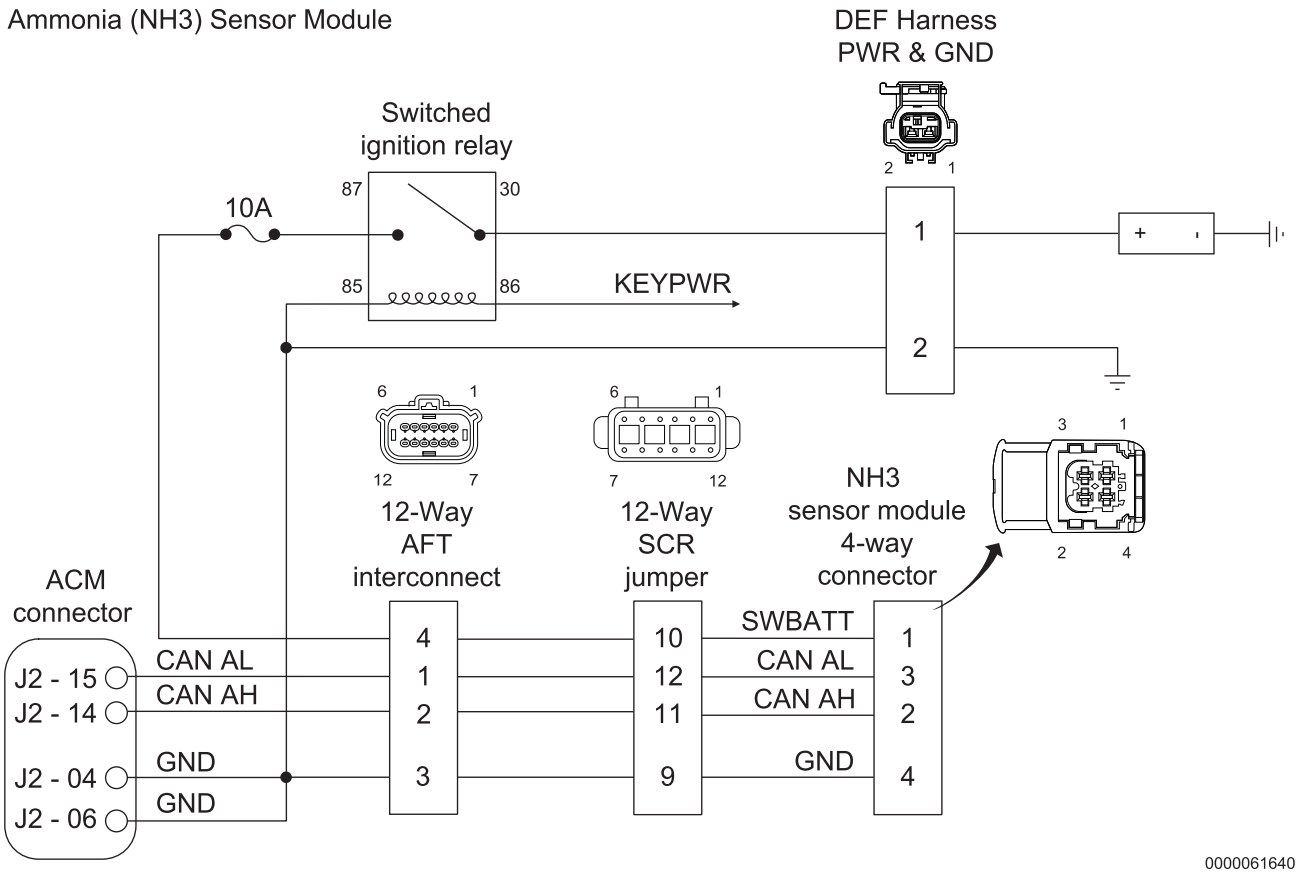
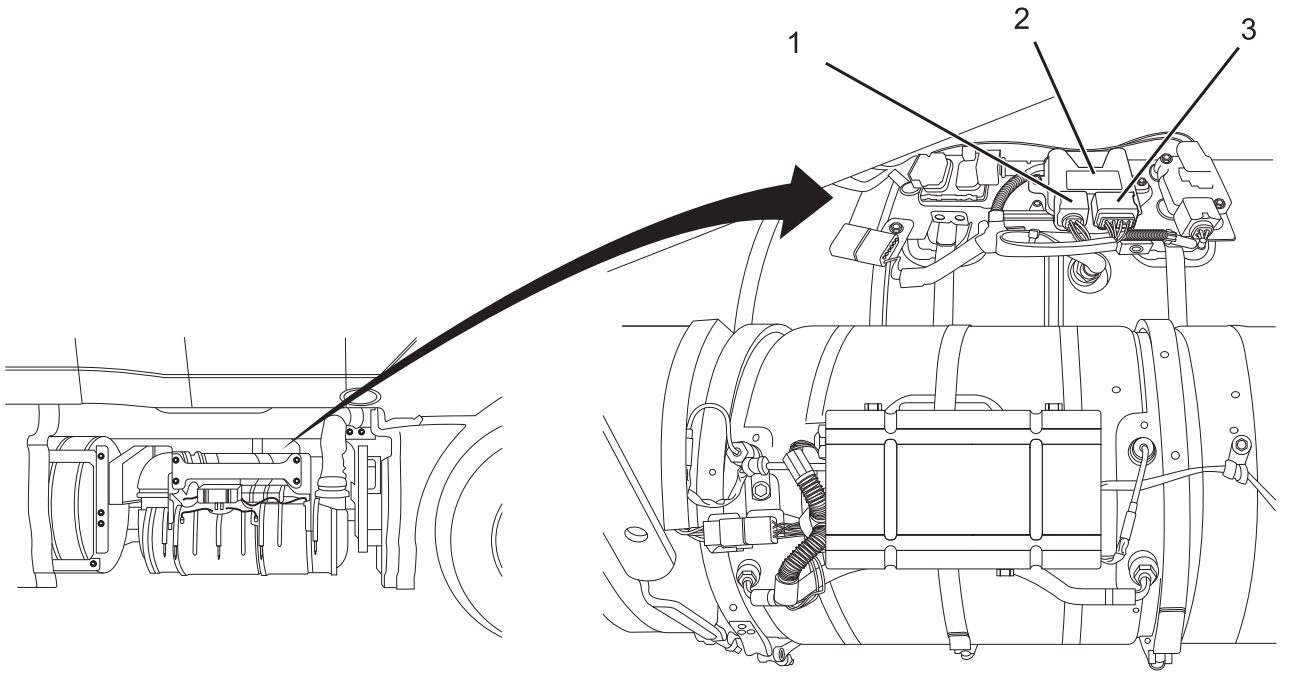


Figure 461 Ammonia (NH_3) Sensor Module Circuit Diagram

Possible Causes

- SWBAT circuit Open, high resistance, or short GND
- CAN-AH circuit Open or short to GND
- CAN-AL circuit Open or short to GND
- CAN-AH circuit short to power
- CAN-AL circuit short to power
- GND circuit Open or high resistance
- CAN-AH short to CAN-AL
- Failed NH_3 sensor module



0000055800

Figure 462 NH_3 Sensor Module Location.

1. Ammonia (NH_3) sensor module 4-way connector
2. NH_3 sensor module
3. NH_3 sensor 8-way connector

Step	Action	Decision
1	Inspect connections at Ammonia (NH_3) sensor module 4-way connector. Key OFF, disconnect NH_3 sensor module. Check NH_3 sensor module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the NH_3 sensor module 4-way connector, harness, and terminals clean and undamaged?	Yes: Go to step 2. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 4377 FMI 19.

Step	Action	Decision
2	Check voltage to the NH_3 sensor module 4-way. Key-On Engine-Off, with Breakout Harness 18-801-01 connected between NH_3 sensor module and vehicle harness, use a DMM to measure voltage between NH_3 sensor module pin-1 and pin-4. Is voltage within 0.5 volts of battery voltage?	Yes: Go to step 4. No: Go to step 3.

Step	Action	Decision
3	Check SWBAT circuit for Open, high resistance, or short to ground. Key-On Engine-Off (KOEO), with Breakout Harness 18-801-01 connected between NH_3 sensor module 4-way and vehicle harness, use a DMM to measure voltage between sensor module pin-1 and a known good ground. Is voltage at pin-1 within 0.5 volts of battery voltage?	Yes: Repair Open or high resistance between NH_3 sensor module pin-4 and ground. After repairs are complete, retest for SPN 4377 FMI 19.
		No: Repair Open, high resistance, or short to ground between NH_3 sensor module connector pin-1 and switched ignition relay pin-87. After repairs are complete, retest for SPN 4377 FMI 19.

Step	Action	Decision
4	Check CAN-AH circuit for Open or short to GND. KOEO, with Breakout Harness 18-801-01 connected between NH_3 sensor module 4-way and vehicle harness, use a DMM to measure voltage between NH_3 sensor module pin-2 and a known good ground. Is voltage greater than 1 volt?	Yes: Go to step 5.
		No: Repair Open or short to ground between NH_3 sensor module connector pin-2 and ACM connector J2-14. After repairs are complete, retest for SPN 4377 FMI 19.

Step	Action	Decision
5	Check CAN-AH circuit for short to power. KOEO, with Breakout Harness 18-801-01 connected between NH_3 sensor module 4-way and vehicle harness, use a DMM to measure voltage between NH_3 sensor module pin-2 and a known good ground. Is voltage less than 4 volts?	Yes: Go to step 6.
		No: Repair short to power between NH_3 sensor module connector pin-2 and ACM connector J2-14. After repairs are complete, retest for SPN 4377 FMI 19.

Step	Action	Decision
6	Check CAN-AL circuit for Open or short to GND. KOEO, with Breakout Harness 18-801-01 connected between NH_3 sensor module 4-way and vehicle harness, use a DMM to measure voltage between NH_3 sensor module pin-3 and a known good ground. Is voltage greater than 1 volt?	Yes: Go to step 7.
		No: Repair Open or short to ground between NH_3 sensor module connector pin-3 and ACM connector J2-15. After repairs are complete, retest for SPN 4377 FMI 19.

Step	Action	Decision
7	Check CAN-AL circuit for short to power. KOEO, with Breakout Harness 18-801-01 connected between NH_3 sensor module 4-way and vehicle harness, use a DMM to measure voltage between NH_3 sensor module pin-3 and a known good ground. Is voltage less than 4 volts?	Yes: Go to step 8. No: Repair short to power between NH_3 sensor module connector pin-3 and ACM connector J2-15. After repairs are complete, retest for SPN 4377 FMI 19.

Step	Action	Decision
8	Check CAN-AL circuit for short to CAN-AH. Key OFF, with Breakout Harness 18-801-01 connected between NH_3 sensor module 4-way and vehicle harness, use a DMM to measure resistance between NH_3 sensor module pin-2 and pin-3. Is resistance between pin-2 and pin-3 within 5 ohms of 60 ohms?	Yes: Replace NH_3 sensor module. After repairs are complete, retest for SPN 4377 FMI 19. No: Repair short between CAN-AL and CAN-AH circuits. After repairs are complete, retest for SPN 4377 FMI 19.

NOTE: If resistance is greater than 60 ohms and there is more than one J1939 data link communication bus failure fault code present, suspect a failed terminating resistor.

NOTE: After performing all diagnostic steps, if SPN 4377 FMI 19 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 5742 FMI 19 - DOC / DPF Temperature Sensor Module signal not detected on J1939

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
DPF temperature sensor module not detected on J1939 Controller Area Network (CAN).	Aftertreatment Control Module (ACM) loses J1939 data link communications with DOC / DPF temperature sensor module.	Key ON	2 events

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) loses J1939 data link communications with the Diesel Oxidation Catalyst (DOC) / Diesel Particulate Filter (DPF) temperature sensor module.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

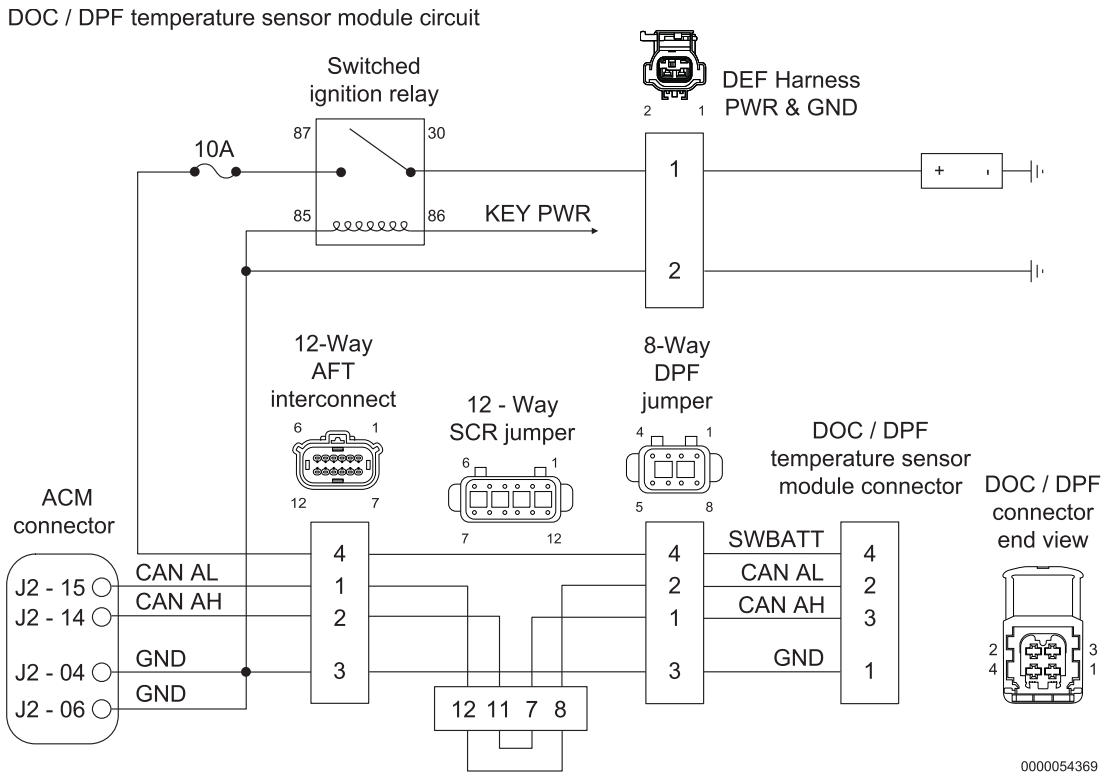


Figure 463 DOC / DPF Temperature Sensor Module Circuit Diagram

Possible Cause

- SWBAT circuit short to GND or Open
- CAN-AH circuit Open or short to GND
- CAN-AL circuit Open or short to GND
- CAN-AH circuit short to power
- CAN-AL circuit short to power
- GND circuit Open or high resistance
- CAN-AH short to CAN-AL
- Failed DOC / DPF temperature sensor module

NOTE: If more than one of the following sensor modules fail (or set a fault), suspect a common power circuit, ground circuit, or switched ignition relay problem. The following components share power and ground circuits: DOC / DPF temperature sensor module, SCR temperature sensor module, NH_3 sensor module, NOx OUT sensor module, NOx IN sensor module, and DEFTLT sensor module.

NOTE: Verify batteries are fully charged and connections are clean.

Step	Action	Decision
1	Inspect connections at DOC / DPF temperature sensor module. Key OFF, disconnect temperature sensor module. Check DOC / DPF temperature sensor module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DOC / DPF temperature sensor module connector, harness, and terminals clean and undamaged?	Yes: Go to step 2. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 5742 FMI 19.

Step	Action	Decision
2	Check voltage to the DOC / DPF temperature sensor module. Key-On Engine-Off (KOEO), with Breakout Harness 18-649-01 connected between temperature sensor module and vehicle harness, use a DMM to measure voltage between temperature sensor module pin-1 and pin-4. Is voltage within 0.5 volts of battery voltage?	Yes: Go to step 4. No: Go to step 3.

Step	Action	Decision
3	Check SWBAT circuit for Open or short to ground. KOEO, with Breakout Harness 18-649-01 connected between DOC / DPF temperature sensor module and vehicle harness, use a DMM to measure voltage between temperature sensor module pin-4 and a known good ground. Is voltage at pin-4 within 0.5 volts of battery voltage?	Yes: Repair Open or high resistance between DOC / DPF temperature sensor module pin-1 and ground. After repairs are complete, retest for SPN 5742 FMI 19. No: Repair Open or short to ground between DOC / DPF temperature sensor module connector pin-4 and switched ignition relay pin-87. After repairs are complete, retest for SPN 5742 FMI 19.

Step	Action	Decision
4	Check CAN-AH circuit for Open or short to GND. KOEO, with Breakout Harness 18-649-01 connected between DOC / DPF temperature sensor module and vehicle harness, use a DMM to measure voltage between temperature sensor module pin-3 and a known good ground. Is voltage greater than 1 volt?	Yes: Go to step 5. No: Repair Open or short to ground between DOC / DPF temperature sensor module connector pin-3 and ACM connector J2-14. After repairs are complete, retest for SPN 5742 FMI 19.

Step	Action	Decision
5	Check CAN-AH circuit for short to power. KOEO, with Breakout Harness 18-649-01 connected between DOC / DPF temperature sensor module and vehicle harness, use a DMM to measure voltage between temperature sensor module pin-3 and a known good ground. Is voltage less than 4 volts?	Yes: Go to step 6. No: Repair short to power between DOC / DPF temperature sensor module connector pin-3 and ACM connector J2-14. After repairs are complete, retest for SPN 5742 FMI 19.

Step	Action	Decision
6	Check CAN-AL circuit for Open or short to GND. KOEO, with Breakout Harness 18-649-01 connected between DOC / DPF temperature sensor module and vehicle harness, use a DMM to measure voltage between temperature sensor module pin-2 and a known good ground. Is voltage greater than 1 volt?	Yes: Go to step 7. No: Repair Open or short to ground between DOC / DPF temperature sensor module connector pin-2 and ACM connector J2-15. After repairs are complete, retest for SPN 5742 FMI 19.

Step	Action	Decision
7	Check CAN-AL circuit for short to power. KOEO, with Breakout Harness 18-649-01 connected between DOC / DPF temperature sensor module and vehicle harness, use a DMM to measure voltage between temperature sensor module pin-2 and a known good ground. Is voltage less than 4 volts?	Yes: Go to step 8. No: Repair short to power between DOC / DPF temperature sensor module connector pin-2 and ACM connector J2-15. After repairs are complete, retest for SPN 5742 FMI 19.

Step	Action	Decision
8	Check CAN-AL circuit for short to CAN-AH. Key OFF, with Breakout Harness 18-649-01 connected between DOC / DPF temperature sensor module and vehicle harness, use a DMM to measure resistance between temperature sensor module pin-2 and pin-3. Is resistance greater than 50 ohms?	Yes: Replace DOC / DPF temperature sensor module. After repairs are complete, retest for SPN 5742 FMI 19. No: Repair short between DOC / DPF temperature sensor module connector pin-2 and pin-3. After repairs are complete, retest for SPN 5742 FMI 19.

NOTE: After performing all diagnostic steps, if SPN 5742 FMI 19 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 5743 FMI 19 - SCR Temperature Sensor Module signal not detected on J1939

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Selective Catalyst Reduction (SCR) temperature sensor module not detected on J1939 Controller Area Network (CAN).	Aftertreatment Control Module (ACM) loses J1939 data link communications with SCR temperature sensor module.	Key ON	2 events

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) loses J1939 data link communications with the SCR temperature sensor module.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

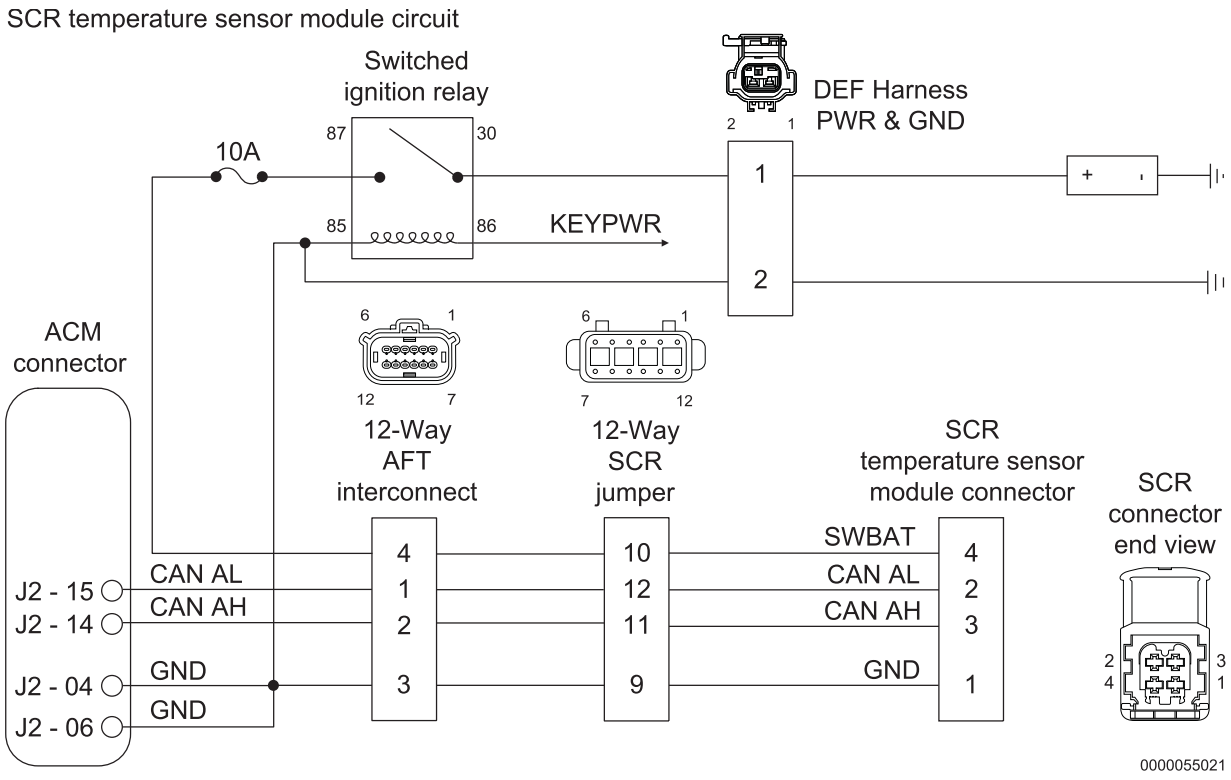


Figure 464 SCR Temperature Sensor Module Circuit Diagram

Possible Cause

- SWBAT circuit short to GND or Open
- CAN-AH circuit Open or short to GND
- CAN-AL circuit Open or short to GND
- CAN-AH circuit short to power
- CAN-AL circuit short to power
- GND circuit Open or high resistance
- CAN-AH short to CAN-AL
- Failed SCR temperature sensor module

NOTE: If more than one of the following sensor modules fail (or set a fault), suspect a common power circuit, ground circuit, or switched ignition relay problem. The following components share power and ground circuits: DOC / DPF temperature sensor module, SCR temperature sensor module, NH_3 sensor module, NOx OUT sensor module, NOx IN sensor module, and DEFTLT sensor module.

NOTE: Verify batteries are fully charged and connections are clean.

Step	Action	Decision
1	Inspect connections at SCR temperature sensor module. Key OFF, disconnect temperature sensor module. Check SCR temperature sensor module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the SCR temperature sensor module connector, harness, and terminals clean and undamaged?	Yes: Go to step 2. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 5743 FMI 19.

Step	Action	Decision
2	Check voltage to the SCR temperature sensor module. Key-On Engine-Off (KOEO), with Breakout Harness 18-648-01 connected between temperature sensor module and vehicle harness, use a DMM to measure voltage between temperature sensor module pin-1 and pin-4. Is voltage within 0.5 volts of battery voltage?	Yes: Go to step 4. No: Go to step 3.

Step	Action	Decision
3	Check SWBAT circuit for Open or short to ground. KOEO, with Breakout Harness 18-648-01 connected between SCR temperature sensor module and vehicle harness, use a DMM to measure voltage between temperature sensor module pin-4 and a known good ground. Is voltage at pin-4 within 0.5 volts of battery voltage?	Yes: Repair Open or high resistance between SCR temperature sensor module pin-1 and ground. After repairs are complete, retest for SPN 5743 FMI 19. No: Repair Open or short to ground between SCR temperature sensor module connector pin-4 and switched ignition relay pin-87. After repairs are complete, retest for SPN 5743 FMI 19.

Step	Action	Decision
4	Check CAN-AH circuit for Open or short to GND. KOEO, with Breakout Harness 18-648-01 connected between SCR temperature sensor module and vehicle harness, use a DMM to measure voltage between temperature sensor module pin-3 and a known good ground. Is voltage greater than 1 volt?	Yes: Go to step 5. No: Repair Open or short to ground between SCR temperature sensor module connector pin-3 and ACM connector J2-14. After repairs are complete, retest for SPN 5743 FMI 19.

Step	Action	Decision
5	Check CAN-AH circuit for short to power. KOEO, with Breakout Harness 18-648-01 connected between SCR temperature sensor module and vehicle harness, use a DMM to measure voltage between temperature sensor module pin-3 and a known good ground. Is voltage less than 4 volts?	Yes: Go to step 6. No: Repair short to power between SCR temperature sensor module connector pin-3 and ACM connector J2-14. After repairs are complete, retest for SPN 5743 FMI 19.

Step	Action	Decision
6	Check CAN-AL circuit for Open or short to GND. KOEO, with Breakout Harness 18-648-01 connected between SCR temperature sensor module and vehicle harness, use a DMM to measure voltage between temperature sensor module pin-2 and a known good ground. Is voltage greater than 1 volt?	Yes: Go to step 7. No: Repair Open or short to ground between SCR temperature sensor module connector pin-2 and ACM connector J2-15. After repairs are complete, retest for SPN 5743 FMI 19.

Step	Action	Decision
7	Check CAN-AL circuit for short to power. KOEO, with Breakout Harness 18-648-01 connected between SCR temperature sensor module and vehicle harness, use a DMM to measure voltage between temperature sensor module pin-2 and a known good ground. Is voltage less than 4 volts?	Yes: Go to step 8. No: Repair short to power between SCR temperature sensor module connector pin-2 and ACM connector J2-15. After repairs are complete, retest for SPN 5743 FMI 19.

Step	Action	Decision
8	Check CAN-AL circuit for short to CAN-AH. Key OFF, with Breakout Harness 18-648-01 connected between SCR temperature sensor module and vehicle harness, use a DMM to measure resistance between temperature sensor module pin-2 and pin-3. Is resistance greater than 50 ohms?	Yes: Replace SCR temperature sensor module. After repairs are complete, retest for SPN 5743 FMI 19. No: Repair short between SCR temperature sensor module connector pin-2 and pin-3. After repairs are complete, retest for SPN 5743 FMI 19.

NOTE: After performing all diagnostic steps, if SPN 5743 FMI 19 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

MIL (Malfunction Indicator Lamp)

SPN	FMI	Condition	Possible Causes	Actions
1213	3	MIL circuit short to PWR	• MIL circuit short to PWR	Circuit Checks (page 1257)
1213	4	MIL circuit short to GND	• MIL circuit shorted to GND • Failed MIL	Circuit Checks (page 1257)
1213	5	MIL open load/circuit	• MIL circuit OPEN • Failed MIL	Circuit Checks (page 1257)

Overview

The Malfunction Indicator Lamp (MIL) illuminates when the Heavy-Duty On-Board Diagnostics (HD-OBD) system detects a malfunction related to the emissions control system. The illuminated MIL indicates the vehicle needs to be serviced at the first convenient opportunity. Lamp may remain active after repair until system operation confirms repair.

Tools Required

- 180-Pin Breakout Box 00-00956-08
- 2010 MaxxForce 11 & 13 Harness Kit 00-01462-00
- Digital Multimeter (DMM)

MIL Connector Voltage Check Without ServiceMaxx™ Software

Turn ignition OFF. Connect 180-Pin Breakout Box with ECM C1 and C2 harness between ECM C1 and C2 connectors and ECM. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
MIL circuit not activated	0.1 V to 0.3 V	If no voltage is present, check for OPEN or short to GND.
C1-57 to GND		If > 0.3 V, check for short to PWR.
MIL circuit activated	B+	If no voltage is present, check for OPEN or short to GND.
C1-57 to GND		

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM C1 and C2 harness to ECM C1 and C2 vehicle harness connectors, and leave ECM disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
C1-57 to 1-H	< 5 Ω	If > 5 Ω, check for OPEN circuit.
C1-24 to 2-C	< 5 Ω	If > 5 Ω, check for OPEN circuit.

NOx (Nitrogen Oxides) IN Sensor Module

SPN	FMI	Condition	Possible Causes	Actions
3216	2	NOx IN signal erratic, intermittent or incorrect	• Failed Nitrogen Oxides (NOx) IN sensor module • SWBAT circuit intermittent short to GND or Open • Power Distribution Module (PDM) loose fuse or relay • Low battery voltage • GND circuit Open or high resistance	Step-Based Diagnostics (page 1264)
3216	4	NOx IN signal Out of Range LOW	• Failed NOx IN sensor module	Step-Based Diagnostics (page 1268)
3216	10	NOx IN signal abnormal rate of change	• Failed NOx IN sensor module	Step-Based Diagnostics (page 1270)
3216	13	NOx IN Out of Calibration	• Incorrect NOx IN sensor module installed	Step-Based Diagnostics (page 1272)
3216	19	NOx IN not detected on J1939	• SWBAT circuit short to GND or Open • CAN-AH circuit Open or short to GND • CAN-AL circuit Open or short to GND • CAN-AH circuit short to power • CAN-AL circuit short to power • GND circuit Open or high resistance • CAN-AH short to CAN-AL • Failed Nitrogen Oxides (NOx) IN sensor module	Step-Based Diagnostics (page 1274)

3216	20	NOx IN signal drifted HIGH	•	Failed NOx IN sensor module	Step-Based Diagnostics (page 1278)
3216	21	NOx IN signal drifted LOW	•	Failed NOx IN sensor module	Step-Based Diagnostics (page 1281)
3218	2	NOx IN power supply signal erratic, intermittent or incorrect	•	Failed NOx IN sensor module	Step-Based Diagnostics (page 1284)
			•	Low battery voltage	
			•	SWBAT circuit intermittent short to GND or Open	
			•	GND circuit Open or high resistance	
			•	Power Distribution Module (PDM) loose fuse or relay	
			•	Incorrect NOx IN sensor module installed	
5024	10	NOx IN Sensor Heater abnormal rate of change	•	Failed NOx IN sensor module	Step-Based Diagnostics(page 1288)
			•	GND circuit Open or high resistance	
			•	SWBAT circuit Open or high resistance	

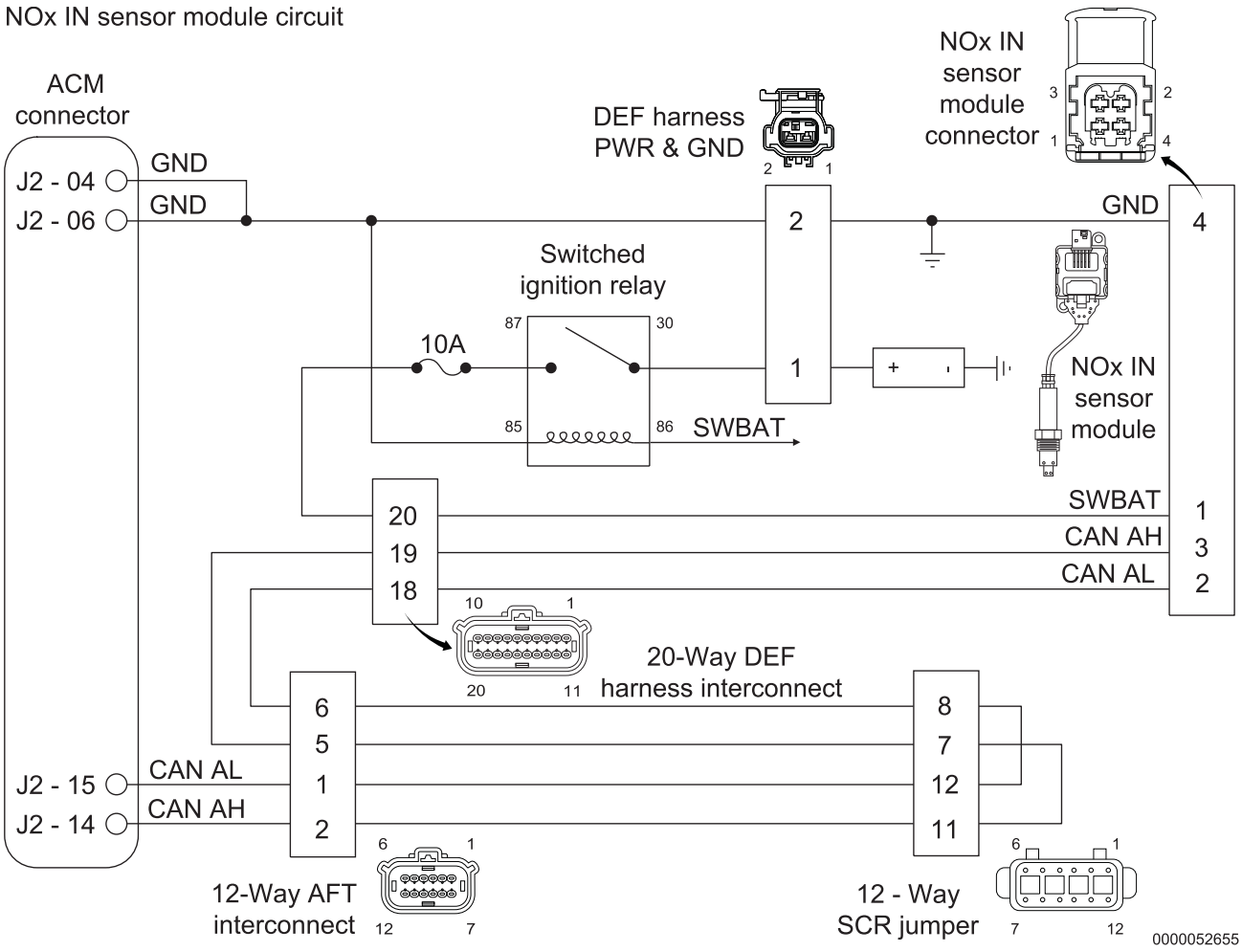


Figure 466 NOx IN Sensor Module Circuit Diagram

NOTE: See latest version of N13 with SCR Engine and Aftertreatment Wiring Schematic Form 0000002203 for additional circuit information.

Overview

The Nitrogen Oxides (NOx) IN sensor module is a smart device used to measure the NOx emissions at the intake of the aftertreatment system. The NOx IN sensor module performs internal diagnostics and reports malfunctions back to the ACM using the J1939 data link. The NOx IN sensor is permanently attached to the NOx control module. They are serviced as a single component and can not be replaced individually.

Tools Required

- 180-Pin Breakout Box 00-00956-08
- ACM Breakout Harness 18-100-01
- Breakout Harness 18-648-01
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software

- Interface cable (RP1210B compliant supporting J1939 and J1708)

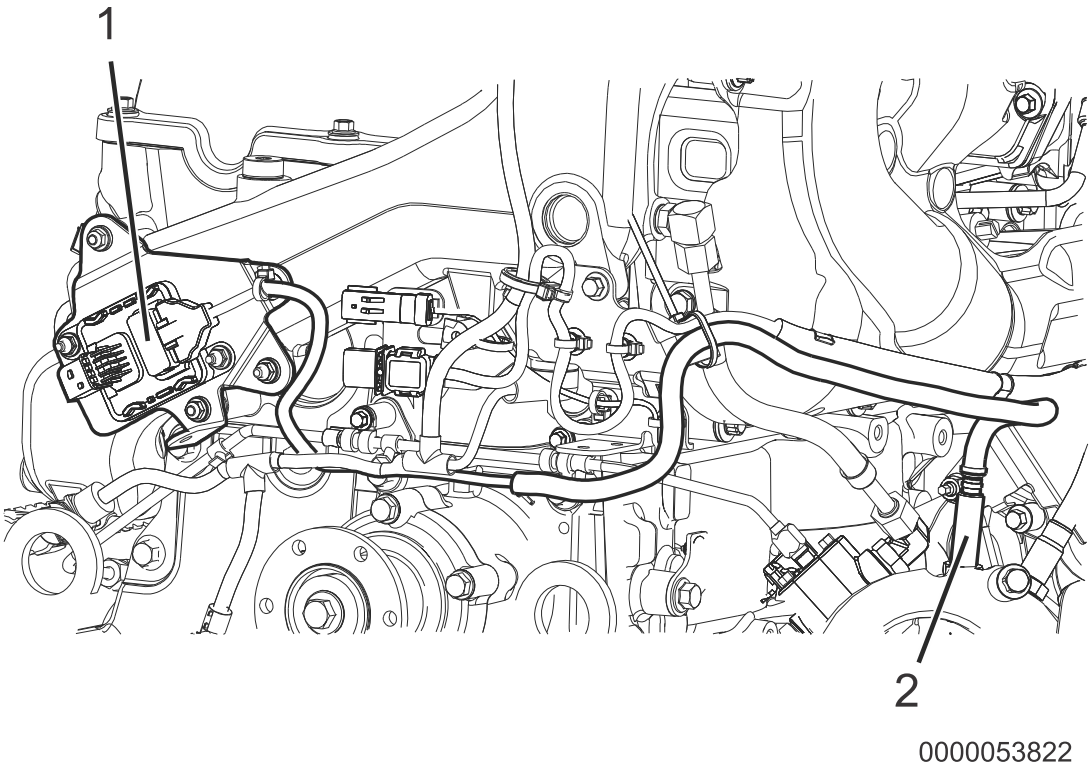


Figure 467 NOx IN Sensor Module Location (Engine Rear View, Typical)

1. Nitrogen Oxides (NOx) IN module
2. NOx IN sensor

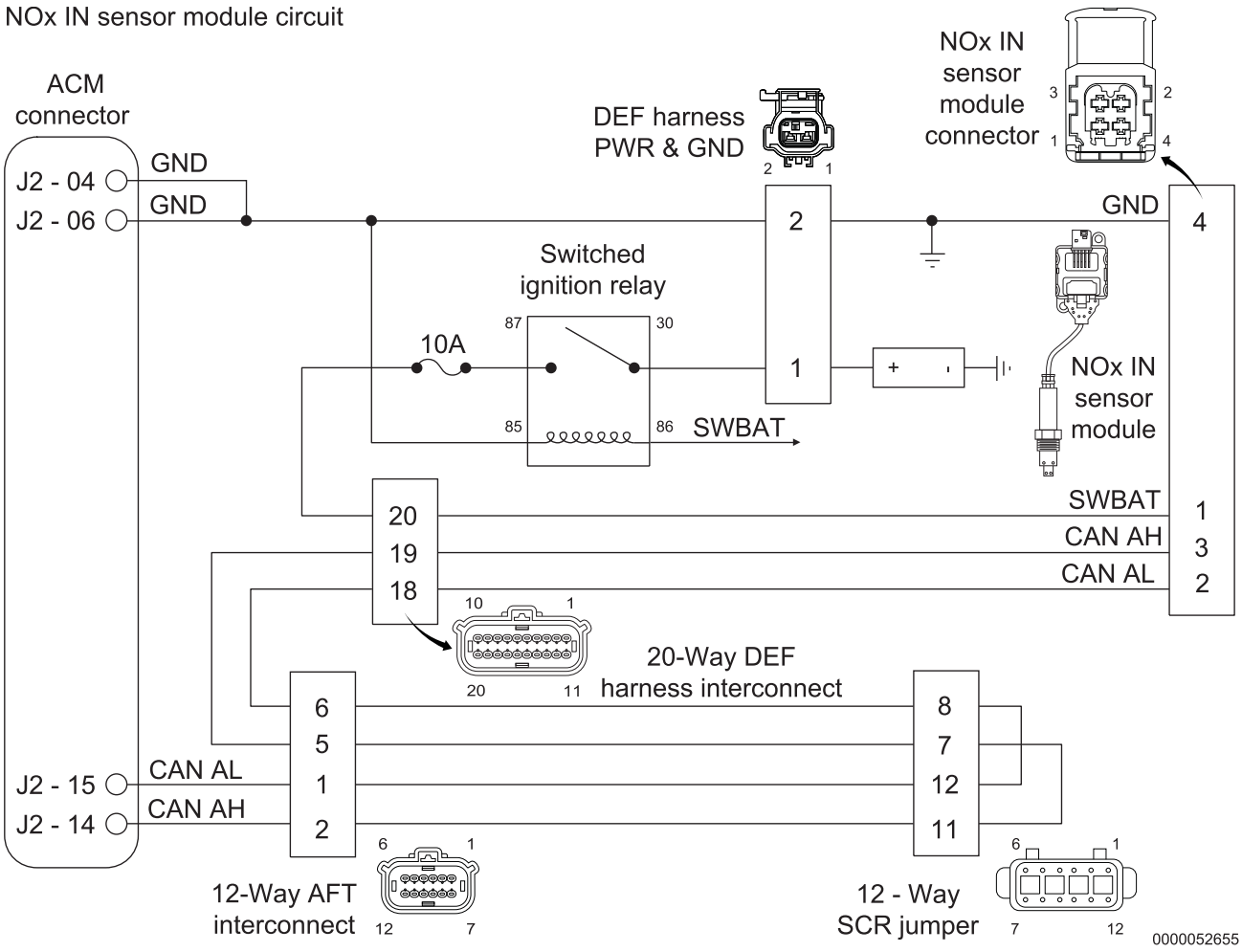


Figure 468 NOx IN Sensor Module Circuit Diagram

Connector Voltage Check Without ServiceMaxx™ Software

Connect Breakout Harness 18-648-01, leave sensor disconnected. Turn ignition switch to ON. Used DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	B+	If < B+, check for OPEN or short to GND.
2 to GND	1 V to 4 V	The sum of 2 to GND and 3 to GND should = 4 V to 5 V.
3 to GND	1 V to 4 V	The sum of 2 to GND and 3 to GND should = 4 V to 5 V.
4 to GND	0 V	If > 0 V, check for short to PWR.
If measurements are within specification, do Harness Resistance Check.		

Harness Resistance Check

Turn ignition switch to OFF. Connect the 180-Pin Breakout Box and SCR (ACM) Breakout Harness 18–100–01 (58–Pin) to ACM. Leave ACM and NOx IN sensor module disconnected.

Test Point	Specification	Comment – < Less than, > Greater than
1 to Switched Ignition Relay pin 87	< 5 Ω	If > 5 Ω, check for OPEN in circuit.
1 to GND	> 1k Ω	If < 1k Ω, check for short to GND.
2 to J2-15	< 5 Ω	If > 5 Ω, check for OPEN in circuit.
2 to GND	> 1k Ω	If < 1k Ω, check for short to GND.
3 to J2-14	< 5 Ω	If > 5 Ω, check for OPEN in circuit.
3 to GND	>1k Ω	If < 1k Ω, check for short to GND.
4 to J2-04	< 5 Ω	If > 5 Ω, check for OPEN in circuit.
4 to J2-06	< 5 Ω	If > 5 Ω, check for OPEN in circuit.

SPN 3216 FMI 2 - NOx IN signal erratic, intermittent or incorrect

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Loss of communication or invalid data from NOx IN sensor module.	Aftertreatment Control module (ACM) loses J1939 data link communications with NOx IN sensor module	Key ON Engine not cranking **NOTE:** Data link-related faults are inhibited for a calibratable amount of time following a Key ON event, a low battery voltage event, an engine cranking event, and a stop / suspend broadcast event. This is to allow reasonable time for data link devices to power up and begin periodic broadcasts before the ECM performs time-out diagnostics.	0.2 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) loses J1939 data link communications with the Nitrogen Oxides (NOx) IN sensor module. Diesel exhaust Fluid (DEF) injection into the aftertreatment system is disabled, and engine torque will be severely reduced.

Malfunction Indicator Lamp (MIL) Reaction

When fault is active, MIL will not illuminate.

Associated Faults

SPN's 3216 FMI 19, 20, and 21.

Drive Cycle to Determine Fault Status

Drive Cycle 20 in 2013 HD-OBD Diagnostic Reference Manual.

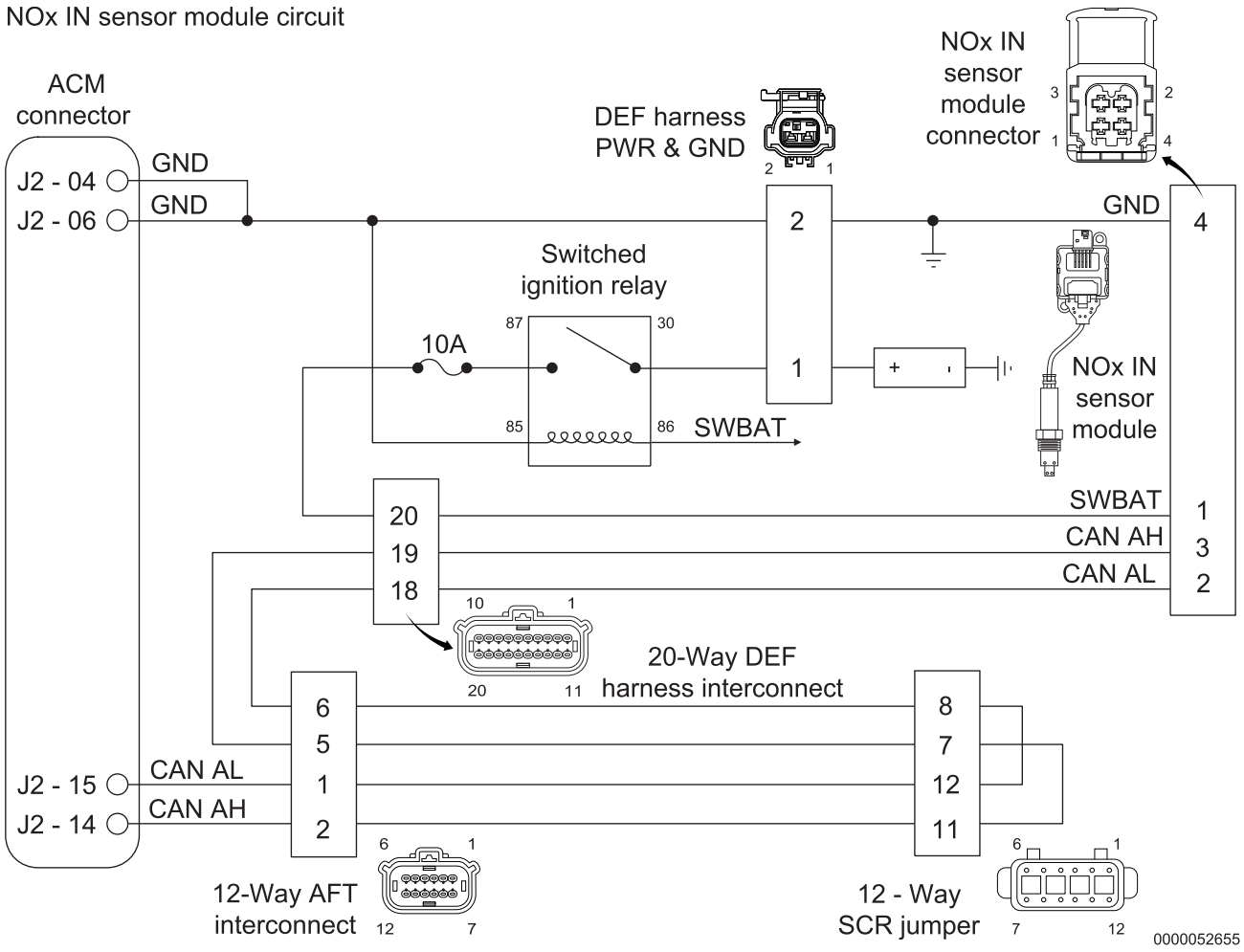


Figure 469 NOx IN Sensor Circuit Diagram

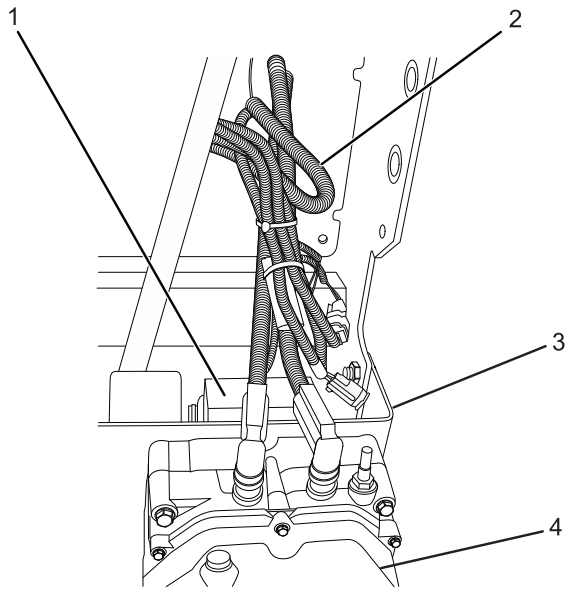


Figure 470 PDM Location (typical)

1. Power Distribution Module (PDM)
2. Diesel Exhaust Fluid (DEF) tank assembly
3. DEF supply module bracket
4. DEF supply module

Step	Action	Decision
1	Check Power Distribution Module (PDM) fuse(s) and relay(s) for blown fuses; loose, missing, or intermittent connections. Are all fuses and relays securely attached and in good condition?	Yes: Go to step 2. No: Secure or replace failed fuse(s) or relay(s) to PDM connector. After repairs are complete, retest for SPN 3216 FMI 2.

Step	Action	Decision
2	Inspect connections at Nitrogen Oxides (NOx) IN sensor module. Key OFF, disconnect NOx IN sensor module. Check NOx IN sensor and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the NOx IN sensor module connector, harness, and terminals clean and undamaged?	Yes: Go to step 3. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3216 FMI 2.

Step	Action	Decision
3	Check for low battery voltage. Inspect battery connections and terminals. Are connections tight and corrosion free, and is battery voltage at least 10 volts?	Yes: Go to step 4.
		No: Clean battery terminals, tighten loose connections, and charge batteries as needed. After repairs are complete, retest for SPN 3216 FMI 2.

Step	Action	Decision
4	Check voltage to the NOx IN sensor module. Key-On Engine-Off (KOEO), with Breakout Harness 18-648-01 connected to NOx IN sensor module, use a DMM to measure voltage between NOx IN sensor module pin-1 and pin-4.	Yes: Replace NOx IN sensor module. After repairs are complete, retest for SPN 3216 FMI 2.
	Is voltage within 0.5 volts of battery voltage?	No: Go to step 5.

Step	Action	Decision
5	Check SWBAT circuit for Open or short to ground. KOEO, with Breakout Harness 18-648-01 connected to NOx IN sensor module , use a DMM to measure voltage between NOx IN sensor module pin-1 and a known good ground. Is voltage at pin-1 within 0.5 volts of battery voltage?	Yes: Repair Open or high resistance between NOx IN sensor module pin 4 and ACM connector pins J2-4 and J2-6. After repairs are complete, retest for SPN 3216 FMI 2.
		No: Repair Open or short to ground between NOx IN sensor module connector pin 1 and ACM connector pins J2-3 and J2-5. After repairs are complete, retest for SPN 3216 FMI 2.

NOTE: After performing all diagnostic steps, if SPN 3216 FMI 2 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3216 FMI 4 - NOx IN signal Out of Range LOW

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
NOx IN sensor module voltage below normal or shorted to low source.	The percentage of time spent in heating mode, as opposed to automatic mode, is > 5 % or the number of transitions from automatic mode to one of the heating states is > than 5 Counts	Inactive: SPN 3216 FMI 19 and SPN 3218 FMI 2. Time after the sensor has reached working temperature and has entered automatic mode > 30 seconds Exhaust gas velocity < 60 m/sec DOC inlet temperature < 1472°F (800°C) Exhaust gas temperature is above a threshold representing the point there is no longer a concern of condensation on the NOx IN sensor module element. NOx IN sensor module battery supply voltage is ≥ 11.4 volts and ≤ 16.5 volts for more than 0.2 seconds.	60 seconds

Fault Overview

Fault code sets when an internal circuit error is detected in the Nitrogen Oxides (NOx) IN sensor module. Diesel Exhaust Fluid (DEF) injection into the aftertreatment system is disabled, and engine torque is severely reduced.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 3216 FMI 19 and SPN 3218 FMI 2.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

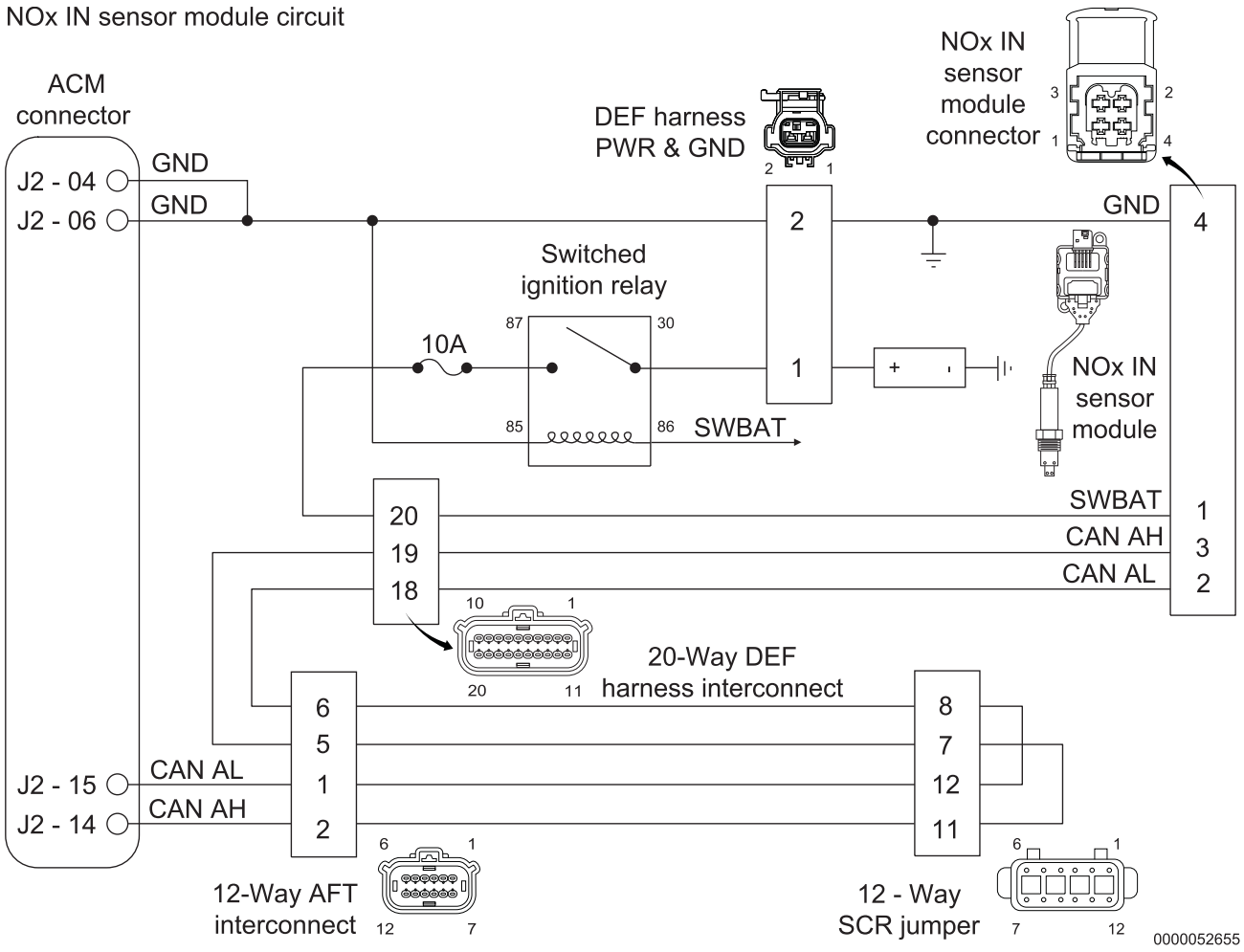


Figure 471 NOx IN Sensor Circuit Diagram

Step	Action	Decision
1	Inspect connections at Nitrogen Oxides (NOx) IN sensor module. Key OFF, disconnect NOx IN sensor module. Check NOx IN sensor module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the NOx IN sensor module connector, harness, and terminals clean and undamaged?	Yes: Replace NOx IN sensor module. After repairs are complete, retest for SPN 3216 FMI 4.
		No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3216 FMI 4.

NOTE: After performing all diagnostic steps, if SPN 3216 FMI 4 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3216 FMI 10 - NOx IN signal abnormal rate of change

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
NOx IN sensor module reading is not valid.	Percent of time > 50 % when NOx IN sensor module reading is not valid (NOx fault).	Inactive: SPN 3216 FMI 4, SPN 3216 FMI 9, and SPN 3218 FMI 2. Exhaust pipe status pressure must be Data Valid Exhaust pressure change rate < 0 kPa/s Exhaust pipe status mass flow rate must be Data Valid Exhaust mass flow change rate < 0 (g/s^2)	300 seconds

Fault Overview

Fault code sets when the Nitrogen Oxides (NOx) IN sensor module reading is invalid.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 3216 FMI 4, 19, and SPN 3218 FMI 2.

Drive Cycle to Determine Fault Status

Drive Cycle 20 in 2013 HD-OBD Diagnostic Reference Manual.

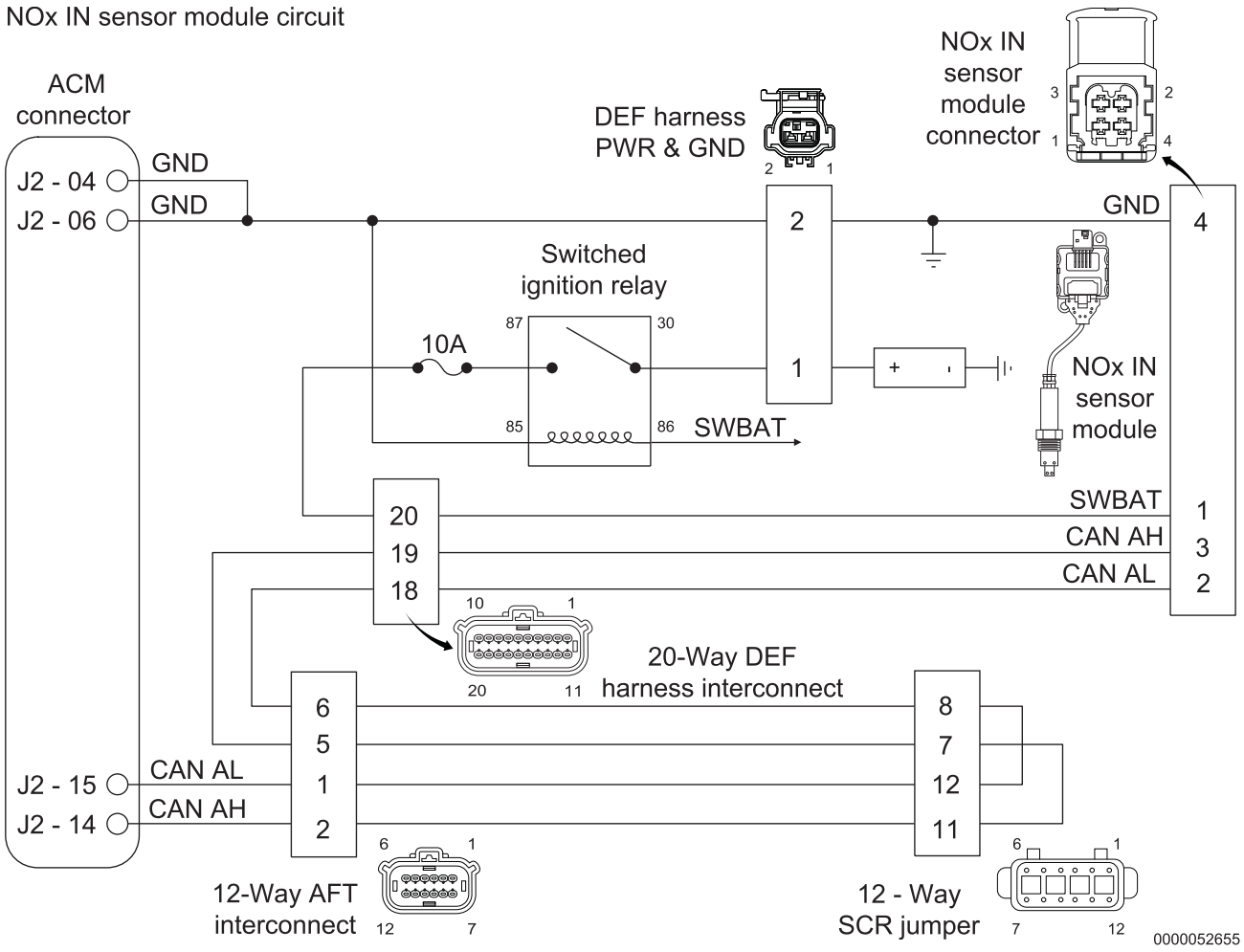


Figure 472 NOx IN Sensor Circuit Diagram

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3216 FMI 4, 19, and SPN 3218 FMI 2. Is SPN 3216 FMI 10 the only fault code active?	Yes: Replace NOx IN sensor module. After repairs are complete, retest for SPN 3216 FMI 10.
		No: Repair other fault code(s). After repairs are complete, retest for SPN 3216 FMI 10.

NOTE: After performing all diagnostic steps, if SPN 3216 FMI 10 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3216 FMI 13 - NOx IN Out of Calibration

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Calibration mismatch between NOx IN sensor module and Aftertreatment Control Module (ACM)	Rated NOx Sensor voltage does not match nominal system voltage of 0 Volts	Key ON	0.2 seconds

Fault Overview

Fault code sets when the Engine Control Module (ECM) detects a mismatch between the engine's electrical system voltage and the Nitrogen Oxides (NOx) IN sensor module voltage rating.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

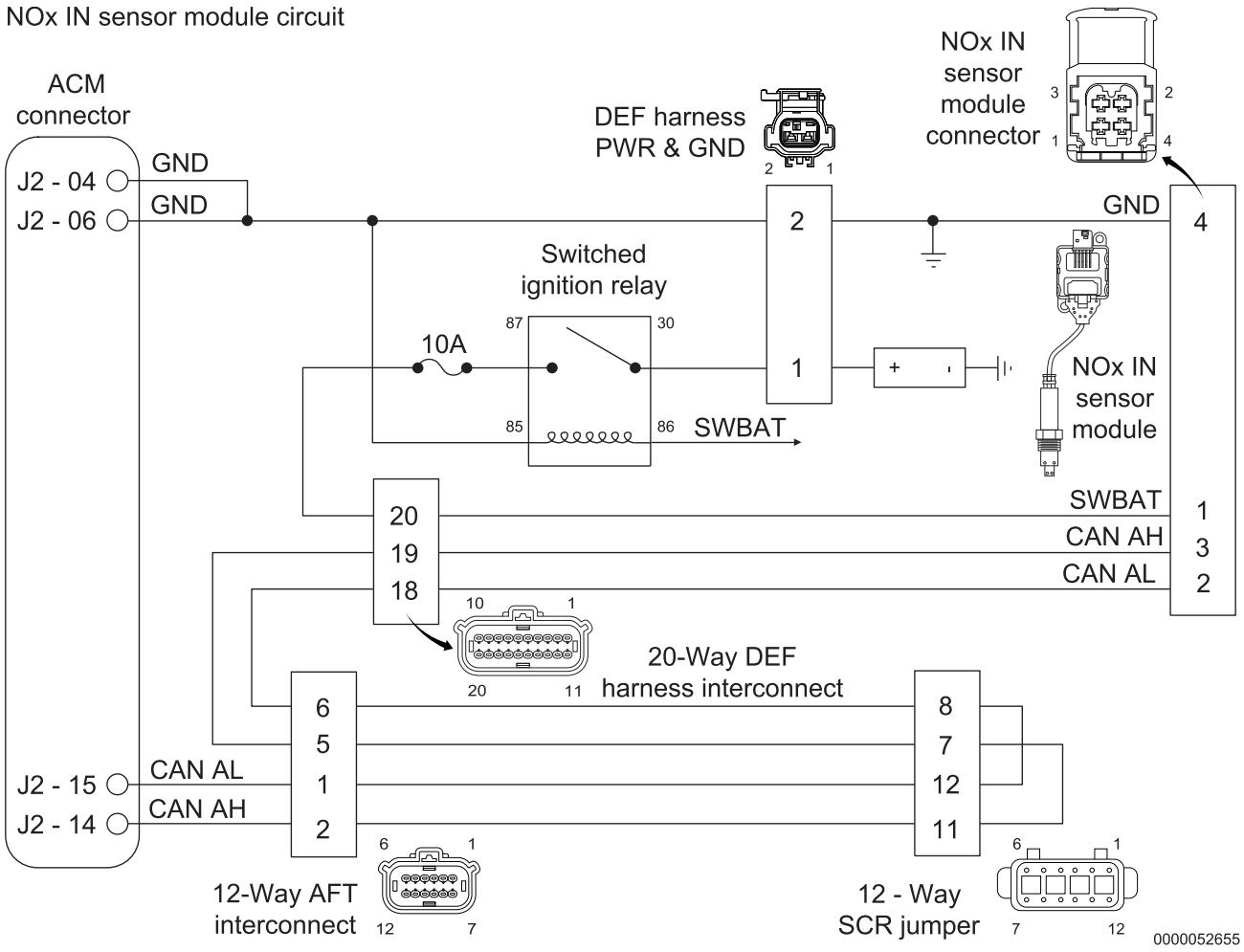


Figure 473 NOx IN Sensor Circuit Diagram

Step	Action	Decision
1	Is SPN 3216 FMI 13 the only fault code active?	Yes: Install correct NOx IN sensor module. After repairs are complete, retest for SPN 3216 FMI 13.

NOTE: After performing all diagnostic steps, if SPN 3216 FMI 13 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3216 FMI 19 - NOx IN not detected on J1939

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Loss of communication or invalid data from NOx IN sensor module.	ACM loses J1939 data link communications with NOx IN sensor module	Key ON Engine not cranking **NOTE:** Data link-related faults are inhibited for a calibratable amount of time following a key-On event, a low battery voltage event, an engine cranking event, and a stop / suspend broadcast event. This is to allow reasonable time for data link devices to power up and begin periodic broadcasts before the ECM performs time-out diagnostics.	0.2 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) loses J1939 data link communications with the Nitrogen Oxides (NOx) IN sensor module. Diesel exhaust Fluid (DEF) injection into the aftertreatment system is disabled, and engine torque will be severely reduced.

Malfunction Indicator Lamp (MIL) Reaction

When fault is active, MIL will not illuminate.

Associated Faults

SPN's 3216 FMI 2, 20, and 21.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

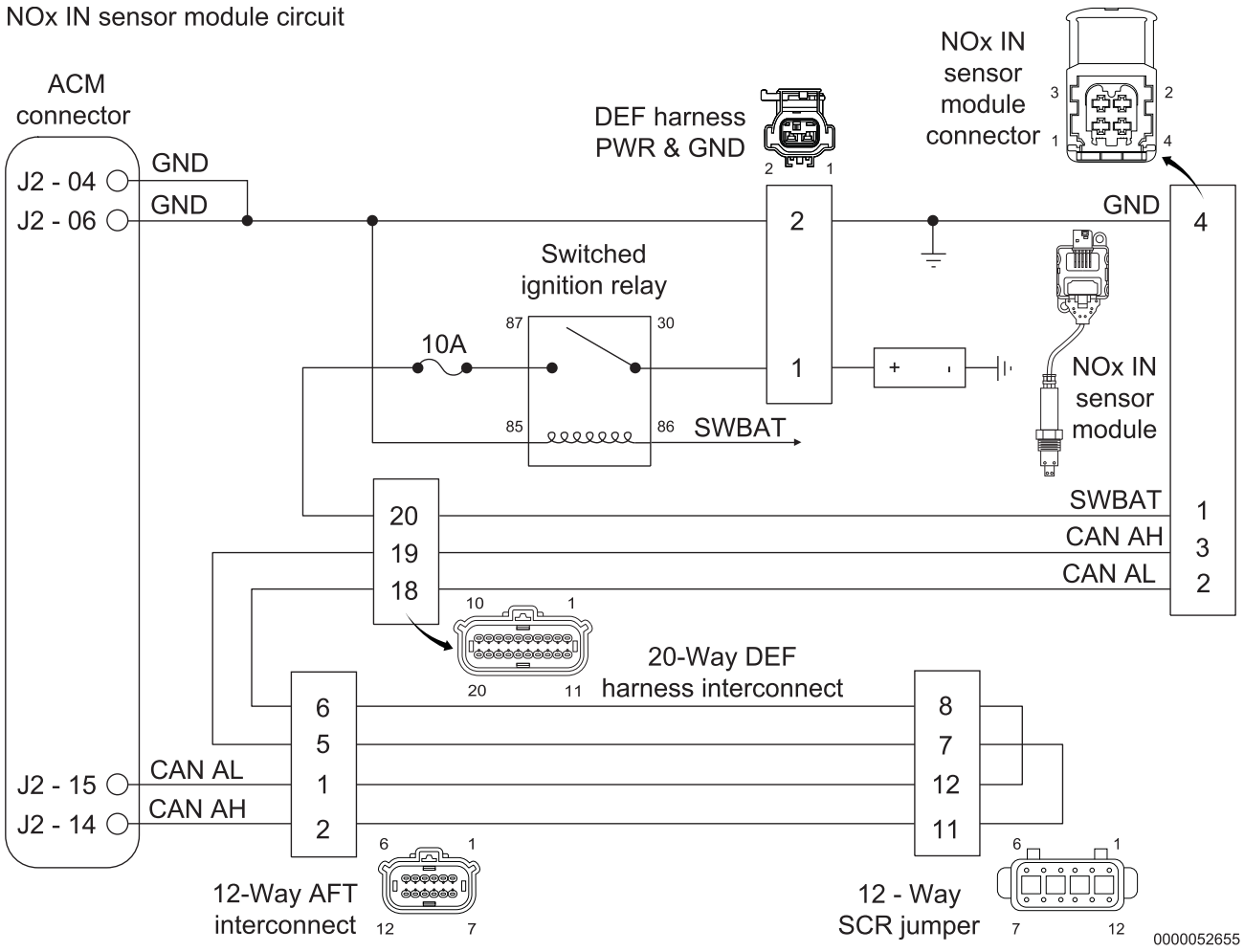


Figure 474 NOx IN Sensor Circuit Diagram

Possible Causes

- SWBAT circuit short to GND or Open
- CAN-AH circuit Open or short to GND
- CAN-AL circuit Open or short to GND
- CAN-AH circuit short to power
- CAN-AL circuit short to power
- GND circuit Open or high resistance
- CAN-AH short to CAN-AL
- Failed Nitrogen Oxides (NOx) IN sensor module

NOTE: If more than one of the following sensor modules fail (or set a fault), suspect a common power circuit, ground circuit, or Switched Ignition Relay problem. The following components share power and ground circuits: DOC / DPF temperature sensor module, SCR temperature sensor module, Ammonia Sensor Module, NOx OUT sensor module, NOx IN sensor module, and DEFTLT sensor module.

NOTE: Verify batteries are fully charged and connections are clean.

Step	Action	Decision
1	Inspect connections at Nitrogen Oxides (NOx) IN sensor module. Key OFF, disconnect NOx IN sensor module. Check NOx IN sensor module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the NOx IN sensor module connector, harness, and terminals clean and undamaged?	Yes: Go to step 2. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3216 FMI 19.

Step	Action	Decision
2	Check voltage to the NOx IN sensor module. Key-On Engine-Off (KOEO), with Breakout Harness 18-648-01 connected between NOx IN sensor module and vehicle harness, use a DMM to measure voltage between NOx IN sensor module pin-1 and pin-4. Is voltage within 0.5 volts of battery voltage?	Yes: Go to step 4. No: Go to step 3.

Step	Action	Decision
3	Check SWBAT circuit for Open or short to ground. KOEO, with Breakout Harness 18-648-01 connected between NOx IN sensor module and vehicle harness, use a DMM to measure voltage between NOx IN sensor module pin-1 and a known good ground. Is voltage at pin-1 within 0.5 volts of battery voltage?	Yes: Repair Open or high resistance between NOx IN sensor module pin-4 and ground. After repairs are complete, retest for SPN 3216 FMI 19. No: Repair Open or short to ground between NOx IN sensor module connector pin-1 and switched ignition relay pin-87. After repairs are complete, retest for SPN 3216 FMI 19.

Step	Action	Decision
4	Check CAN-AH circuit for Open or short to GND. KOEO, with Breakout Harness 18-648-01 connected between NOx IN sensor module and vehicle harness, use a DMM to measure voltage between NOx IN sensor module pin-3 and a known good ground. Is voltage greater than 1 volt?	Yes: Go to step 5. No: Repair Open or short to ground between NOx IN sensor module connector pin-3 and ACM connector J2-14. After repairs are complete, retest for SPN 3216 FMI 19.

Step	Action	Decision
5	Check CAN-AH circuit for short to power. KOEO, with Breakout Harness 18-648-01 connected between NOx IN sensor module and vehicle harness, use a DMM to measure voltage between temperature sensor module pin-3 and a known good ground. Is voltage less than 4 volts?	Yes: Go to step 6. No: Repair short to power between NOx IN sensor module connector pin-3 and ACM connector J2-14. After repairs are complete, retest for SPN 3216 FMI 19.

Step	Action	Decision
6	Check CAN-AL circuit for Open or short to GND. KOEO, with Breakout Harness 18-648-01 connected between NOx IN sensor module and vehicle harness, use a DMM to measure voltage between temperature sensor module pin-2 and a known good ground. Is voltage greater than 1 volt?	Yes: Go to step 7. No: Repair Open or short to ground between NOx IN sensor module connector pin-2 and ACM connector J2-15. After repairs are complete, retest for SPN 3216 FMI 19.

Step	Action	Decision
7	Check CAN-AL circuit for short to power. KOEO, with Breakout Harness 18-648-01 connected between NOx IN sensor module and vehicle harness, use a DMM to measure voltage between temperature sensor module pin-2 and a known good ground. Is voltage less than 4 volts?	Yes: Go to step 8. No: Repair short to power between NOx IN sensor module connector pin-2 and ACM connector J2-15. After repairs are complete, retest for SPN 3216 FMI 19.

Step	Action	Decision
8	Check CAN-AL circuit for short to CAN-AH. Key OFF, with Breakout Harness 18-648-01 connected between NOx IN sensor module and vehicle harness, use a DMM to measure resistance between temperature sensor module pin-2 and pin-3. Is resistance greater than 50 ohms?	Yes: Replace NOx IN sensor module. After repairs are complete, retest for SPN 3216 FMI 19. No: Repair short between NOx IN sensor module connector pin-2 and pin-3. After repairs are complete, retest for SPN 3216 FMI 19.

NOTE: After performing all diagnostic steps, if SPN 3216 FMI 19 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3216 FMI 20 - NOx IN signal drifted HIGH

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Aftertreatment Control Module (ACM) determines Nitrogen Oxides (NOx) IN sensor module signal drifted HIGH.	When idle conditions are detected, compare NOx (ppm) from NOx sensor to NOx model (> 2500 ppm and < 3500 ppm).	Engine speed < 3000 rpm Key ON Battery voltage > 10.7 volts Battery voltage < 15 volts Ambient Temp > -40°F (-40°C) and < 302°F (150°C) Ambient Pressure > 0 psi (0 kPa) and < 87 psi (600 kPa) Engine Coolant Temperature > -40°F (-40°C) and < 302°F (150°C)	20 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) determines the signal from the Nitrogen Oxides (NOx) sensor is high compared to it's modeled value for conditions. Diesel Exhaust Fluid (DEF) injection into the aftertreatment system is disabled, and engine torque will be severely reduced. Vehicle speed will be limited if code is active for an extended period of time.

Malfunction Indicator Lamp (MIL) Reaction

When fault is active, MIL will not illuminate.

Associated Faults

SPN 3216 FMI 4, 19, and SPN 3218 FMI 2.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

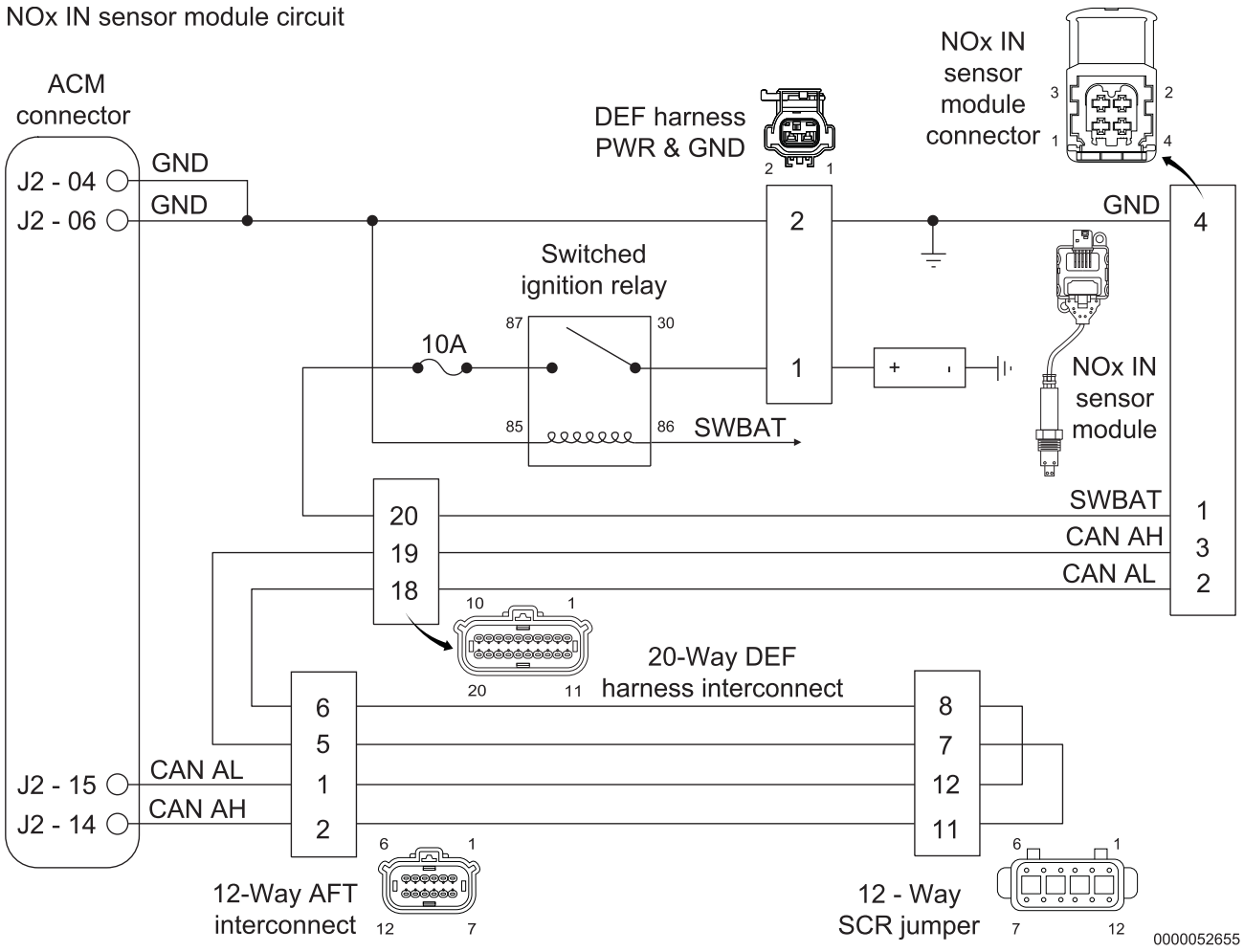


Figure 475 NOx IN Sensor Circuit Diagram

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3216 FMI 4, 19, and SPN 3218 FMI 2. Is SPN 3216 FMI 20 the only fault code active?	Yes: Go to step 2. No: Repair other fault code(s). After repairs are complete, retest for SPN 3216 FMI 20.

Step	Action	Decision
2	Inspect connections at Nitrogen Oxides (NOx) IN sensor module . Key OFF, disconnect NOx IN sensor module. Check NOx IN sensor module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the NOx IN sensor module connector, harness, and terminals clean and undamaged?	Yes: Replace NOx IN sensor module. After repairs are complete, retest for SPN 3216 FMI 20. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3216 FMI 20.

NOTE: After performing all diagnostic steps, if SPN 3216 FMI 20 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3216 FMI 21 - NOx IN signal drifted LOW

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Aftertreatment Control Module (ACM) determines Nitrogen Oxides (NOx) IN sensor module signal drifted LOW.	When steady-state conditions are detected, compare NOx (ppm) from NOx sensor to NOx model (> -500 ppm and < -50 ppm).	Key ON Engine speed < 3000 rpm Ambient Temp between -40°F (-40°C) and 302°F (150°C) Ambient Pressure between 0 psi (0 kPa) and 87 psi (600 kPa) Engine Coolant Temperature between -40°F (-40°C) and 302°F (150°C)	20 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) determines the signal from the Nitrogen Oxides (NOx) sensor is low compared to it's modeled value for conditions. Diesel Exhaust Fluid (DEF) injection into the aftertreatment system is disabled, and engine torque will be severely reduced. Vehicle speed will be limited if code is active for an extended period of time.

Malfunction Indicator Lamp (MIL) Reaction

When fault is active, MIL will not illuminate.

Associated Faults

SPN 3216 FMI 4, 19, and SPN 3218 FMI 2.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

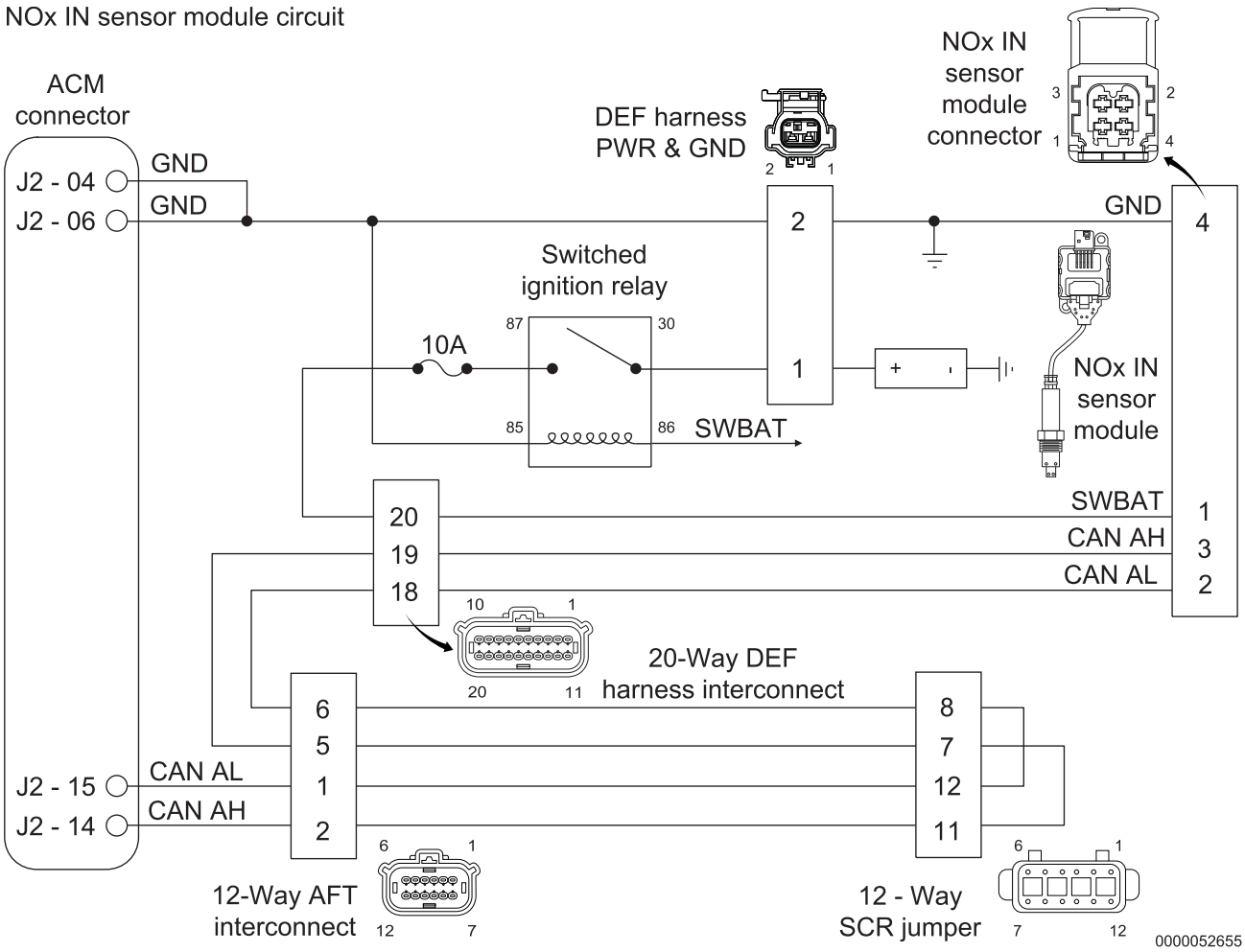


Figure 476 NOx IN Sensor Circuit Diagram

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3216 FMI 4, 19, and SPN 3218 FMI 2. Is SPN 3216 FMI 21 the only fault code active?	Yes: Go to step 2. No: Repair other fault code(s). After repairs are complete, retest for SPN 3216 FMI 21.

Step	Action	Decision
2	Inspect connections at Nitrogen Oxides (NOx) IN sensor module. Key OFF, disconnect NOx IN sensor module. Check NOx IN sensor module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the NOx IN sensor module connector, harness, and terminals clean and undamaged?	Yes: Replace NOx IN sensor module. After repairs are complete, retest for SPN 3216 FMI 21. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3216 FMI 21.

NOTE: After performing all diagnostic steps, if SPN 3216 FMI 21 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3218 FMI 2 - NOx IN power supply signal erratic, intermittent or incorrect

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
The NOx IN sensor module circuitry has detected that its battery supply voltage is outside the desired range.	NOx IN sensor module supply voltage > 16.5 V for 10 seconds NOx IN sensor module supply voltage < 11.4 V for 10 seconds	160 seconds after Exhaust gas temperature is above a threshold representing the point there is no condensation on the NOx IN sensor module element. 100 seconds after the NOx sensor has reached it's operating temperature. SPN 3216 FMI 9 inactive	10 seconds

Fault Overview

Fault code sets when the Engine Control Module (ECM) detects the power supply to the Nitrogen Oxides (NO IN) sensor is above or below a calibratable threshold.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 20 in 2013 HD-OBD Diagnostic Reference Manual.

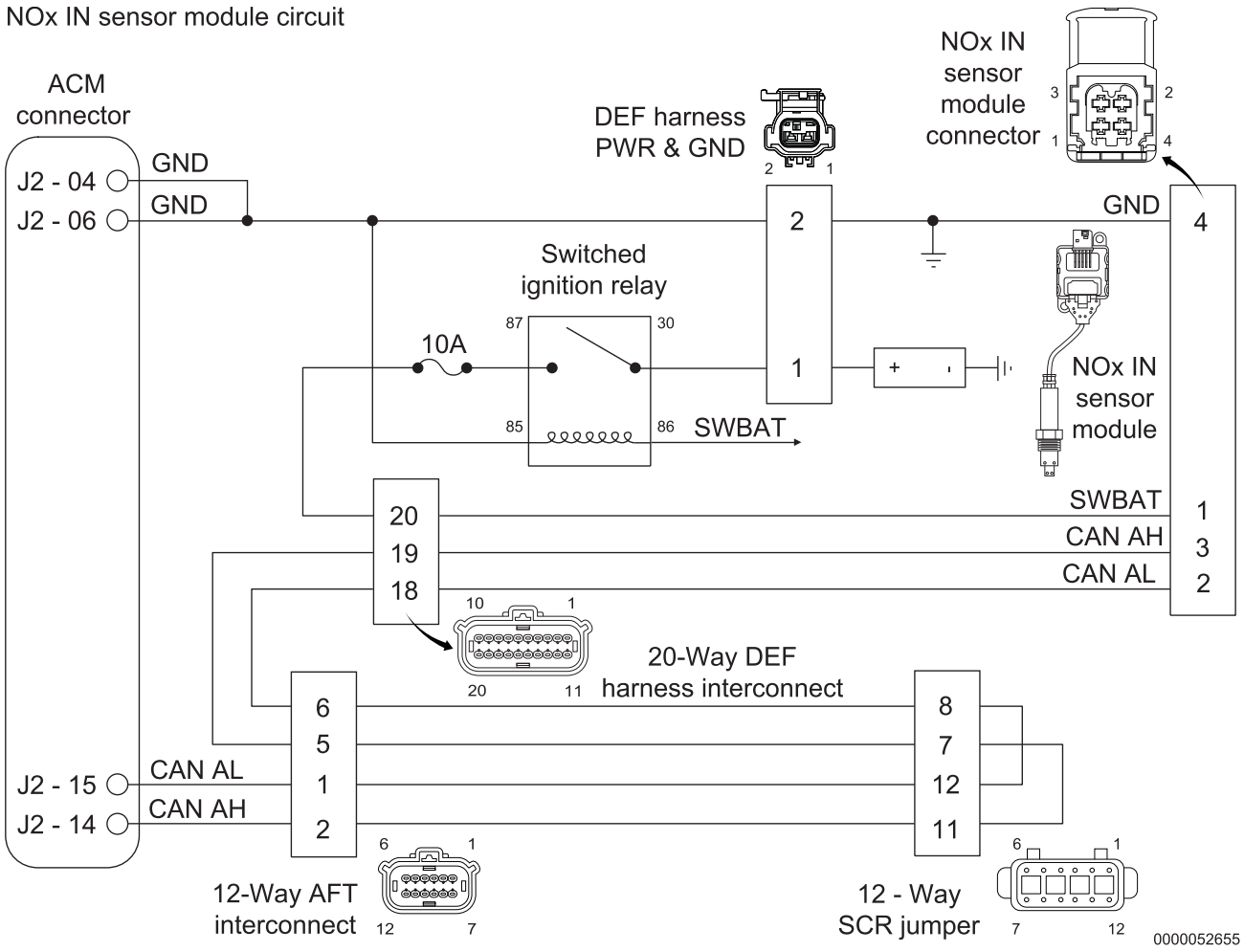


Figure 477 NOx IN Sensor Circuit Diagram

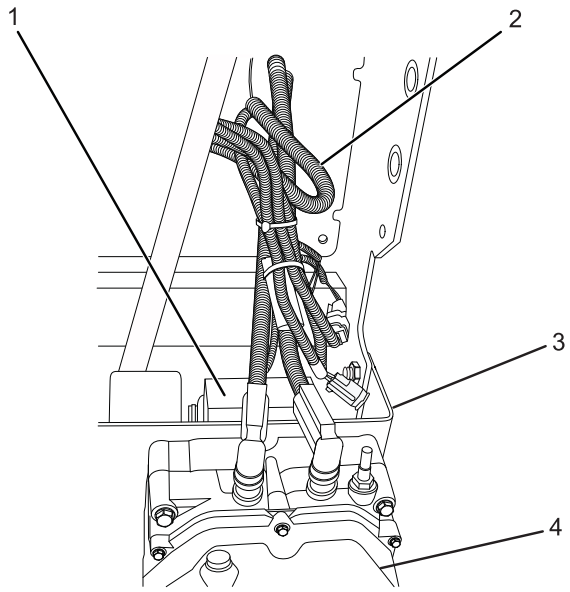


Figure 478 PDM Location (typical)

1. Power Distribution Module (PDM)
2. Diesel Exhaust Fluid (DEF) tank assembly
3. DEF supply module bracket
4. DEF supply module

Step	Action	Decision
1	Check Power Distribution Module (PDM) fuse(s) and relay(s) for blown fuses; loose, missing, or intermittent connections. Are all fuses and relays securely attached and in good condition?	Yes: Go to step 2.
		No: Secure or replace failed fuse(s) or relay(s) to PDM connector. After repairs are complete, retest for SPN 3218 FMI 2.

Step	Action	Decision
2	Inspect connections at Nitrogen Oxides (NOx) IN sensor module. Key OFF, disconnect NOx module. Check NOx IN sensor module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the NOx IN sensor module connector, harness, and terminals clean and undamaged?	Yes: Go to step 3.
		No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3218 FMI 2.

Step	Action	Decision
3	Check for low battery voltage. Inspect battery connections and terminals. Are connections tight and corrosion free, and is battery voltage at least 10 volts?	Yes: Go to step 4.
		No: Clean battery terminals, tighten loose connections, and charge batteries as needed. After repairs are complete, retest for SPN 3218 FMI 2.

Step	Action	Decision
4	Check voltage to the NOx IN sensor module. Key-On Engine-Off (KOEO), with Breakout Harness 18-648-01 connected to NOx IN sensor module, use a DMM to measure voltage between NOx IN sensor module pin–1 and pin–4. Is voltage within 0.5 volts of battery voltage?	Yes: Go to step 6.
		No: Go to step 5.

Step	Action	Decision
5	Check SWBAT circuit for Open or short to ground. KOEO, with Breakout Harness 18-648-01 connected to NOx IN sensor module, use a DMM to measure voltage between NOx IN sensor module pin–1 and a known good ground. Is voltage at pin–1 within 0.5 volts of battery voltage?	Yes: Repair Open or high resistance between NOx IN sensor module pin 4 and ACM connector J2 pins 4 and 6. After repairs are complete, retest for SPN 3218 FMI 2.
		No: Repair Open or short to ground between NOx IN sensor module connector pin 1 and ACM connector J2 pins 3 and 5. After repairs are complete, retest for SPN 3218 FMI 2.

Step	Action	Decision
6	Check for incorrect NOx IN sensor module installed. Is the correct NOx IN sensor module installed?	Yes: Replace NOx IN sensor module. After repairs are complete, retest for SPN 3218 FMI 2.
		No: Install correct NOx IN sensor module. After repairs are complete, retest for SPN 3218 FMI 2.

NOTE: After performing all diagnostic steps, if SPN 3218 FMI 2 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 5024 FMI 10- NOx IN sensor heater abnormal rate of change

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
The NOx IN sensor heater is unable to maintain its operating temperature.	NOx IN sensor heater temperature does not match Aftertreatment Control Module (ACM) predetermined values.	Diesel Oxidation Catalyst Inlet Temperature (DOCIT) > 302°F (150°C) for 5 seconds	0 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Nitrogen Oxides (NOx) IN sensor heater was unable to maintain its normal operating temperature.

Malfunction Indicator Lamp (MIL) Reaction

When fault is active, MIL will not illuminate.

Associated Faults

SPN 3216 FMI 4 and 9 (NOx IN), SPN 3218 FMI 2 (NOx IN), and SPN 4765 FMI 2, 3, and 4 (DOCIT).

Drive Cycle to Determine Fault Status

Drive Cycle 1 then 2 in 2013 HD-OBD Diagnostic Reference Manual.

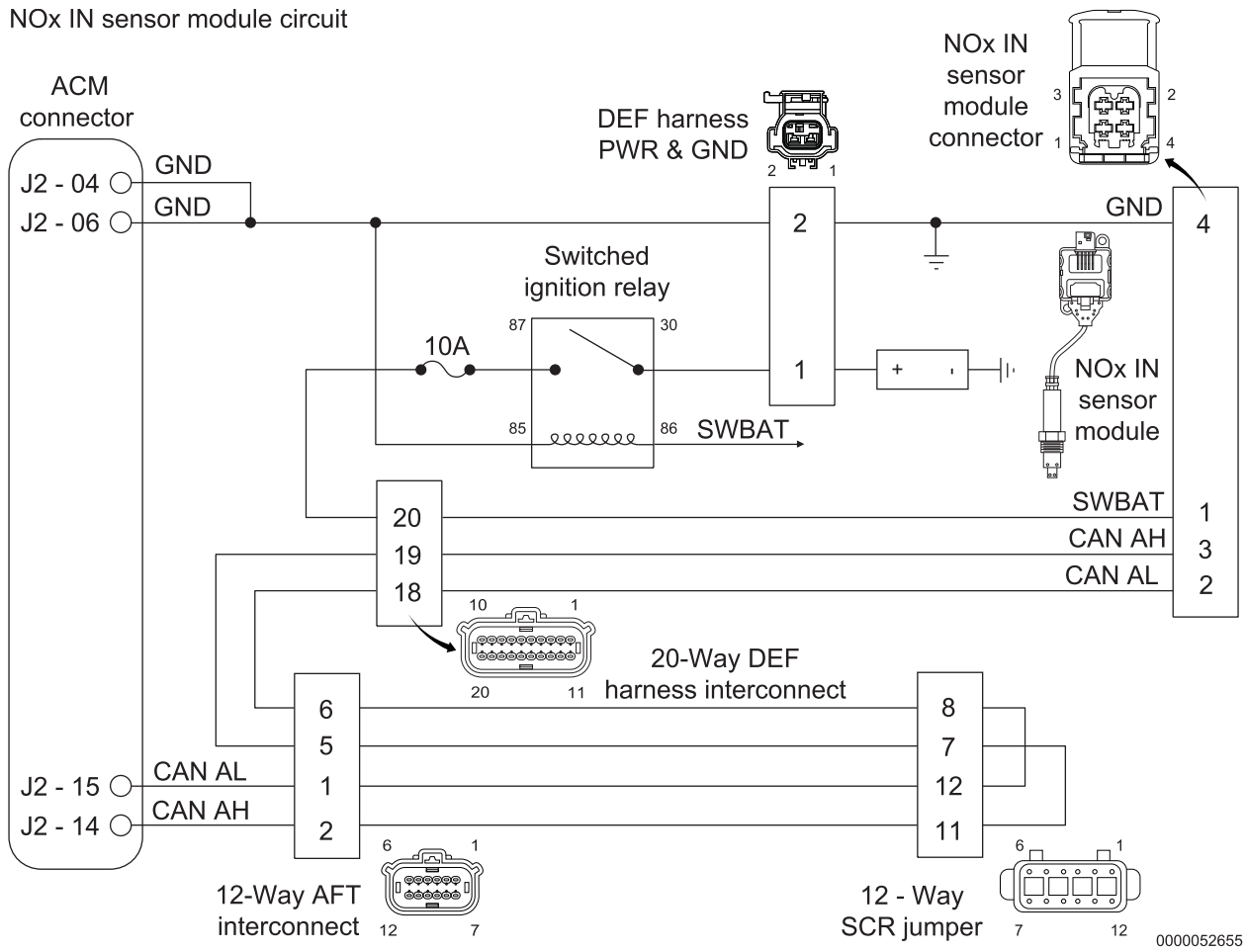


Figure 479 NOx IN Sensor Circuit Diagram

Possible Causes

- Failed NOx IN sensor module
- GND circuit Open or high resistance
- SWBAT circuit Open or high resistance

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3216 FMI 4 and 9 (NOx IN); SPN 3218 FMI 2 (NOx IN); SPN 4765 FMI 2, 3, and 4 (DOCIT). Is EST DTC list free of SPN 3216 FMI 4 and 9; SPN 3218 FMI 2; and SPN 4765 FMI 2, 3, and 4?	Yes: Go to step 2. No: Repair SPN 3216 FMI 4 and 9; SPN 3218 FMI 2; and SPN 4765 FMI 2, 3, and 4. After repairs are complete, retest for SPN 5024 FMI 10.

Step	Action	Decision
2	Inspect connections at Nitrogen Oxides (NOx) IN sensor. Key OFF, disconnect NOx IN sensor. Check NOx IN sensor and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the NOx IN sensor connector, harness, and terminals clean and undamaged?	Yes: Go to step 3. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 5024 FMI 10.

NOTE: If more than one of the following sensor modules fail (or set a fault), suspect a common power circuit, ground circuit, or switched ignition relay problem. The following components share power and ground circuits with the NOx IN sensor module:

- DOC / DPF temperature sensor module
- NOx OUT sensor module
- Ammonia (NH_3) sensor module
- NOx IN sensor module
- DEFTLT sensor module

NOTE: Verify batteries are fully charged and connections are clean.

Step	Action	Decision
3	Check voltage to the NOx IN sensor module. Key-On Engine-Off (KOEO), with Breakout Harness 18-648-01 connected to NOx IN sensor module, use a DMM to measure voltage between Breakout Harness 18-648-01 pin-1 and pin-4. Is voltage less than 0.5 volts of battery voltage?	Yes: Go to step 4. No: Replace NOx IN sensor module. After repairs are complete, retest for SPN 5024 FMI 10.

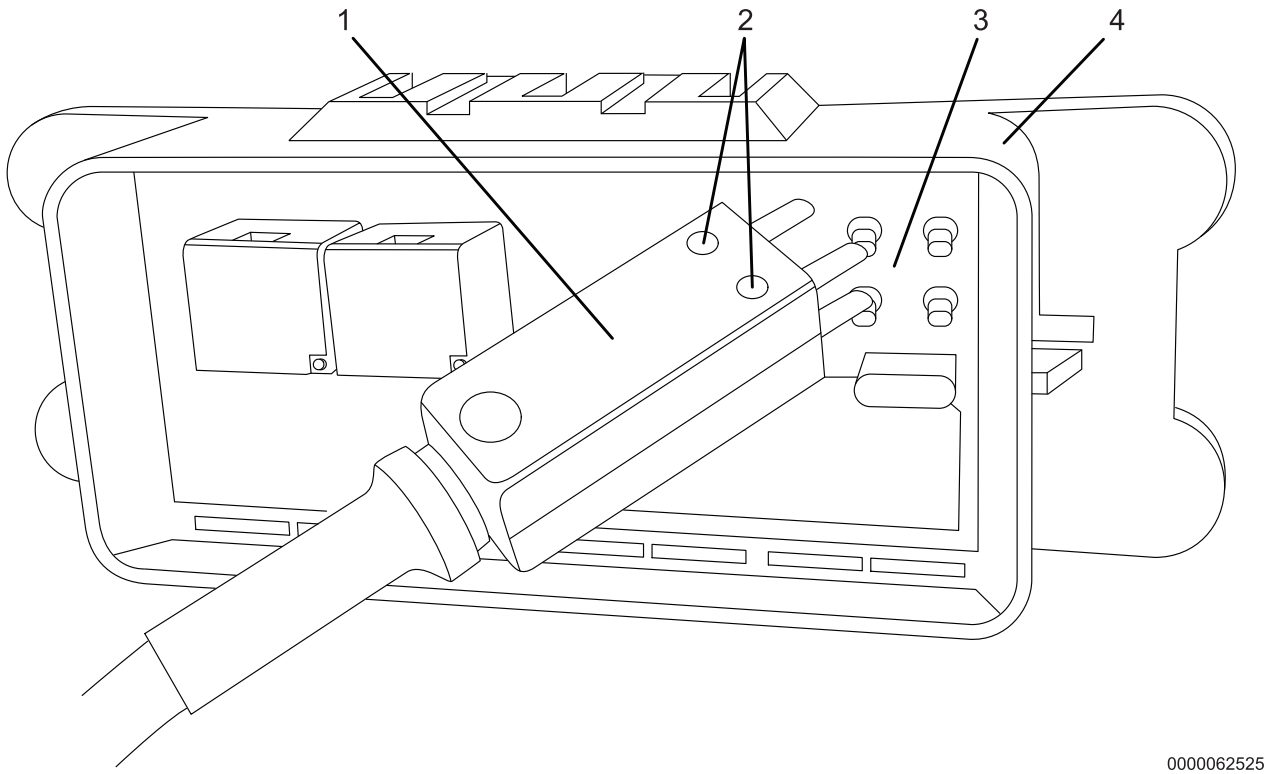


Figure 480 Installation of Breakout Harness ZTSE4908 (typical)

1. Breakout Harness ZTSE4908
2. Relay socket

CAUTION: For correct diagnosis, Breakout Harness ZTSE4908 MUST be installed with the dimples toward the top of the PDM, as shown. Reversed installation WILL result in incorrect measurements.

Step	Action	Decision
4	Check SWBAT circuit for Open or high resistance. Connect Breakout Harness 18-648-01 to NOx IN sensor module and leave disconnected. Connect Breakout Harness ZTSE4908 to switched ignition relay and leave disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness 18-648-01 pin-1 and Breakout Harness ZTSE4908 pin-87. Is resistance less than 5 ohms?	Yes: Repair Open or high resistance between NOx IN sensor module pin-4 and ground. After repairs are complete, retest for SPN 5024 FMI 10. No: Repair Open or high resistance between NOx IN sensor module pin-1 and switched ignition relay pin-87. After repairs are complete, retest for SPN 5024 FMI 10.

NOTE: After performing all diagnostic steps, if SPN 5024 FMI 10 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

NOx (Nitrogen Oxides) OUT Sensor Module

SPN	FMI	Condition	Possible Causes	Actions
3226	2	NOx OUT signal erratic, intermittent or incorrect	• Failed Nitrogen Oxides (NOx) OUT sensor module • SWBAT circuit intermittent short to GND or Open • Power Distribution Module (PDM) loose fuse or relay • GND circuit Open or high resistance	Step-Based Diagnostics (page 1297)
3226	4	NOx OUT signal Out of Range LOW	• Failed NOx OUT sensor module	Step-Based Diagnostics (page 1301)
3226	10	NOx OUT signal abnormal rate of change	• Failed NOx OUT sensor module	Step-Based Diagnostics (page 1303)
3226	13	NOx OUT Out of Calibration	• Incorrect NOx OUT sensor module installed	Step-Based Diagnostics (page 1305)
3226	19	NOx OUT not detected on J1939	• SWBAT circuit short to GND or Open • CAN-AH circuit Open or short to GND • CAN-AL circuit Open or short to GND • CAN-AH circuit short to power • CAN-AL circuit short to power • GND circuit Open or high resistance • CAN-AH short to CAN-AL • Failed Nitrogen Oxides (NOx) OUT sensor module	Step-Based Diagnostics (page 1307)

3226	20	NOx OUT signal drifted HIGH	• Failed NOx OUT sensor module • Diesel Exhaust Fluid (DEF) crystallization or deposits • Improperly installed NOx OUT sensor	Step-Based Diagnostics (page 1311)
3226	21	NOx OUT signal drifted LOW	• Failed NOx OUT sensor module • Improperly installed NOx OUT sensor	Step-Based Diagnostics (page 1314)
3228	2	NOx OUT power supply signal erratic, intermittent or incorrect	• Failed NOx OUT sensor module • SWBAT circuit intermittent short to GND or Open • GND circuit Open or high resistance • Power Distribution Module (PDM) loose fuse or relay • Low battery voltage • Incorrect NOx OUT sensor module installed	Step-Based Diagnostics (page 1316)
5031	10	NOx OUT Sensor Heater not reading correctly	• Failed NOx OUT sensor module • GND circuit Open or high resistance • SWBAT circuit Open or high resistance	Step-Based Diagnostics(page 1319)

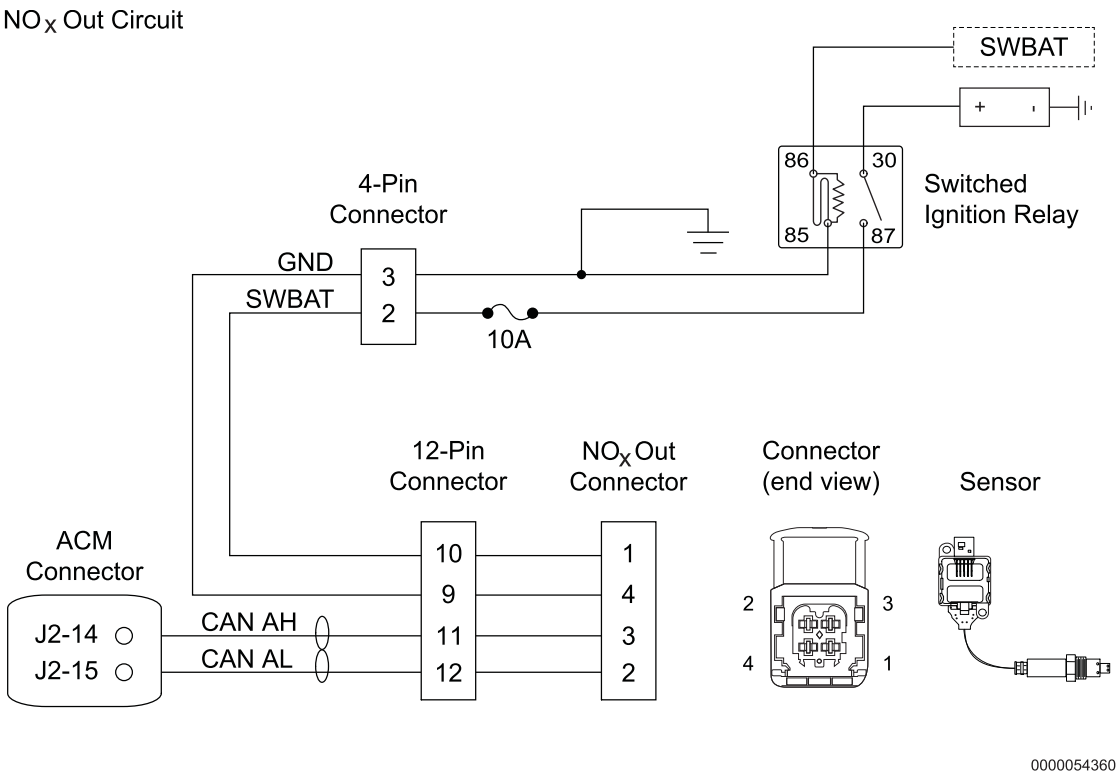


Figure 481 NOx OUT Sensor Circuit Diagram

Overview

The Nitrogen Oxides (NOx) OUT sensor module is a smart device used to measure the NOx emissions at the outlet of the Selective Catalyst Reduction (SCR) Catalyst. The NOx OUT sensor module performs internal diagnostics and reports malfunctions back to the Aftertreatment Control Module (ACM) using the J1939 data link. The NOx OUT sensor is permanently attached to the NOx control module. They are serviced as a single component and can not be replaced individually.

Tools Required

- 180-Pin Breakout Box 00-00956-08
- SCR (ACM) Breakout Harness 18-100-01 (58-Pin)
- Breakout Harness 18-649-01
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

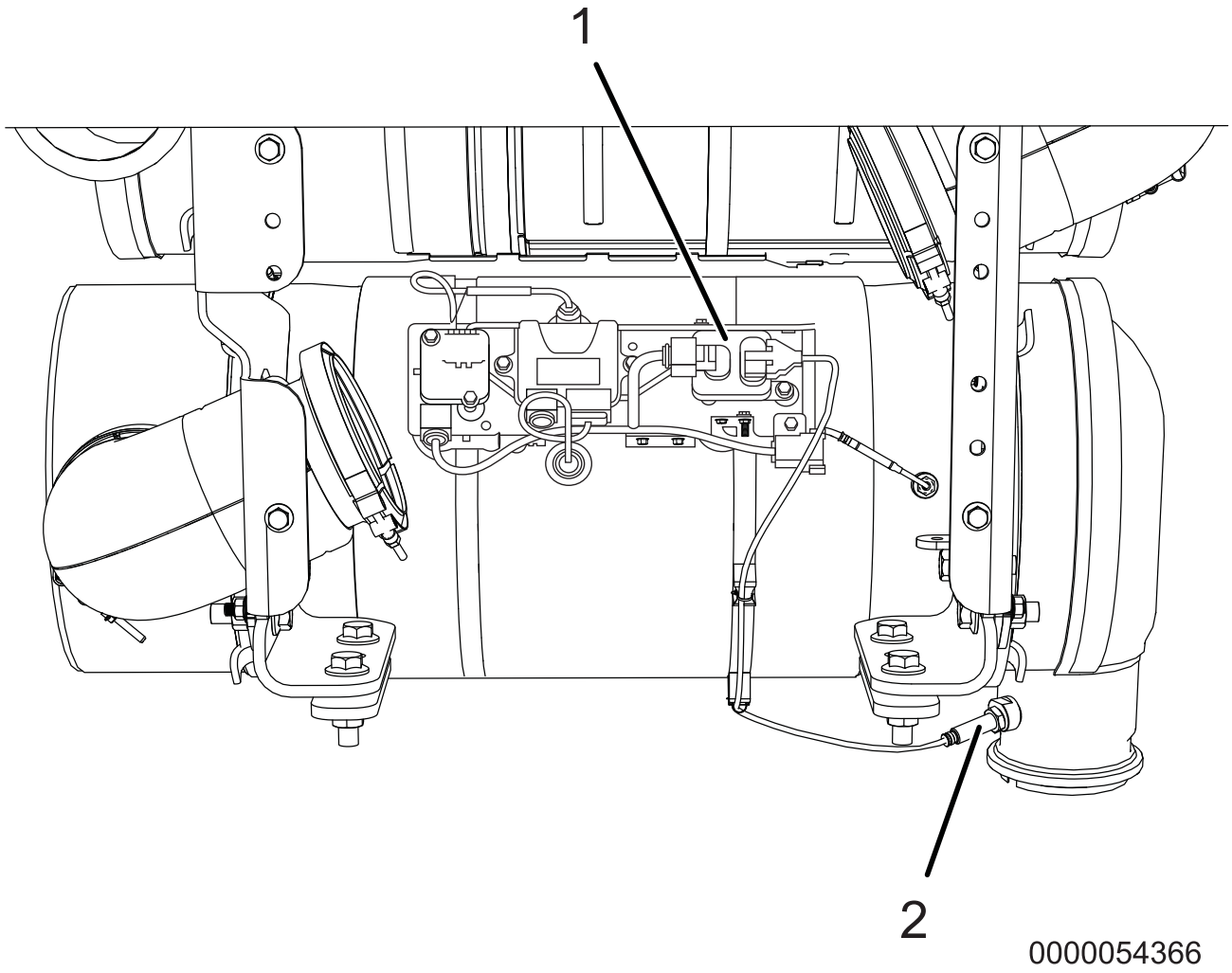


Figure 482 NOx OUT Sensor Module Location

1. Nitrogen Oxides (NOx) OUT Sensor Module
2. NOx OUT Sensor

Connector Voltage Check Without ServiceMaxx™ Software

Connect Breakout Harness 18-649-01, leave NOx OUT sensor module disconnected. Turn ignition switch to ON. Use a DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	B+	If < B+, check for OPEN or short to GND.
2 to GND	1 V to 4 V	The sum of 2 to GND and 3 to GND should = 4 V to 5 V.
3 to GND	1 V to 4 V	The sum of 2 to GND and 3 to GND should = 4 V to 5 V.
4 to GND	0 V	If > 0 V, check for short to PWR.
If measurements are within specification, do Harness Resistance Check.		

Harness Resistance Check

Turn ignition switch to OFF. Connect the 180-Pin Breakout Box and SCR (ACM) Breakout Harness 18–100–01 (58–Pin) to ACM. Leave ACM and NOx OUT sensor module disconnected.

Test Point	Specification	Comment – < Less than, > Greater than
1 to Switched Ignition Relay pin 87	< 5 Ω	If > 5 Ω, check for OPEN in circuit.
1 to GND	> 1k Ω	If < 1k Ω, check for short to GND.
2 to J2-15	< 5 Ω	If > 5 Ω, check for OPEN in circuit.
2 to GND	> 1k Ω	If < 1k Ω, check for short to GND.
3 to J2-14	< 5 Ω	If > 5 Ω, check for OPEN in circuit.
3 to GND	>1k Ω	If < 1k Ω, check for short to GND.
4 to J2-04	< 5 Ω	If > 5 Ω, check for OPEN in circuit.
4 to J2-06	< 5 Ω	If > 5 Ω, check for OPEN in circuit.

SPN 3226 FMI 2 - NOx OUT signal erratic, intermittent or incorrect

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Aftertreatment Control Module (ACM) has detected that the Nitrogen Oxides (NOx) OUT sensor module output is in range, but not varying as expected.	The difference between the maximum and minimum NOx OUT sensor module output < 10 ppm during 3 valid monitoring events	SCR-inlet NOx flow rate> 0.2 g/sec Rate of change of SCR-inlet NOx flow rate > 0.1 g/sec Exhaust mass flow rate > 150 g/sec NOx OUT sensor module reading is valid, no active faults detected by the sensor, the sensor's battery supply voltage is within the desired range, and dew point temperature has been met for a sufficient time to allow the sensor to light off. None of the Abort Conditions are satisfied Inactive: SPN 3226 FMI 4, 10, and 13; SPN 3228 FMI 2; SPN 3242 FMI 2, 3, and 4; SPN 4765 FMI 2, 3, and 4; SPN 5031 FMI 10; SPN 5742 FMI 3, 4, 11, and 12.	0 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects that the Nitrogen Oxides (NOx) OUT sensor module is not reading zero, or is not changing with engine conditions.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN’s 3226 FMI 4 (NOx OUT), SPN 3228 FMI 2 (NOx OUT), and SPN 5031 FMI 10 (NOx OUT).

Drive Cycle to Determine Fault Status

Drive Cycle 21 in 2013 HD-OBD Diagnostic Reference Manual.

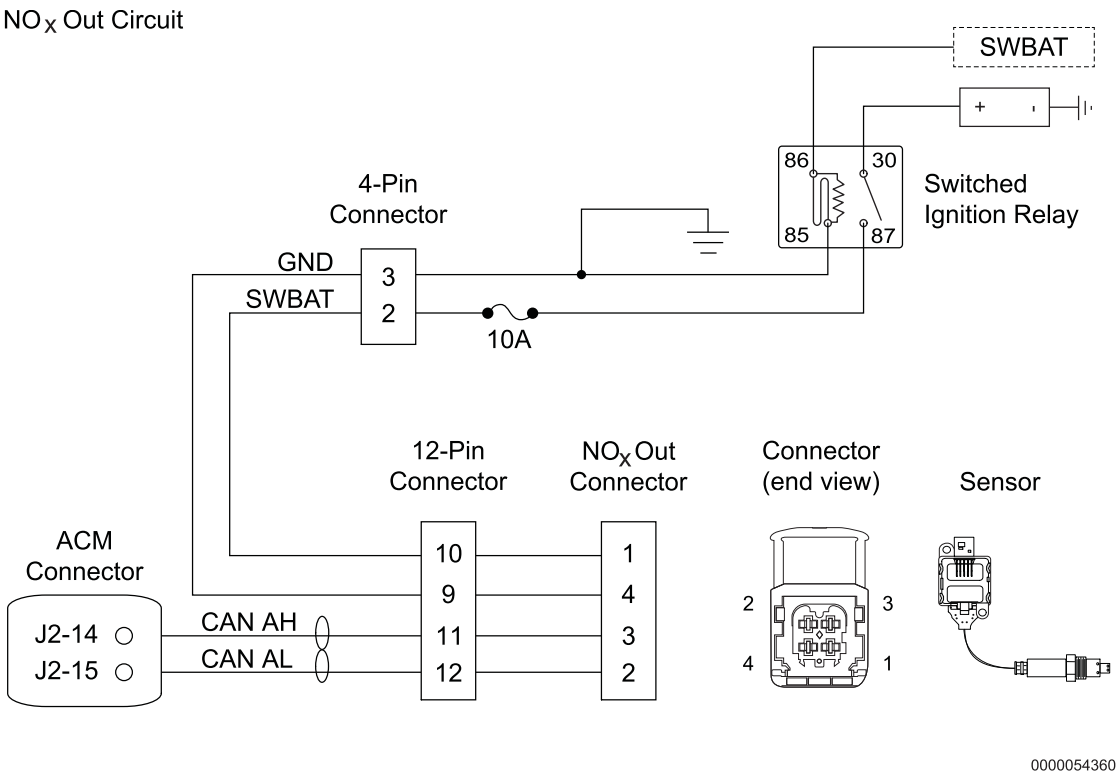


Figure 483 NOx OUT Sensor Circuit Diagram

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3226 FMI 4 (NOx OUT), SPN 3228 FMI 2 (NOx OUT), and SPN 5031 FMI 10 (NOx OUT).	Yes: Go to step 2.
		No: Repair SPN 3226 FMI 4, SPN 3228 FMI 2, and SPN 5031 FMI 10. After repairs are

	Is EST DTC list free of SPN 3226 FMI 4, SPN 3228 FMI 2, and SPN 5031 FMI 10?	complete, retest for SPN 3226 FMI 2.

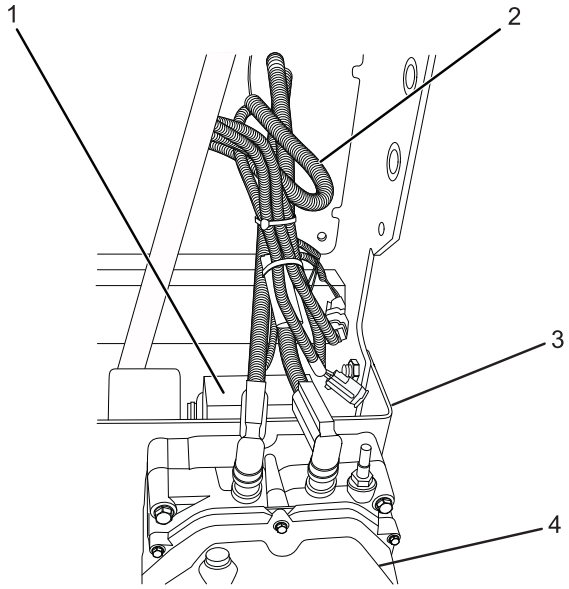


Figure 484 PDM Location (typical)

1. Power Distribution Module (PDM)
2. Diesel Exhaust Fluid (DEF) tank assembly
3. DEF supply module bracket
4. DEF supply module

Step	Action	Decision
2	Check Power Distribution Module (PDM) fuse(s) and relay(s) for blown fuses; loose, missing, or intermittent connections. Are all fuses and relays securely attached and in good condition?	Yes: Go to step 3.
		No: Secure or replace failed fuse(s) or relay(s) to PDM connector. After repairs are complete, retest for SPN 3226 FMI 2.

NOTE: Verify batteries are fully charged and connections are clean.

Step	Action	Decision
3	Inspect connections at Nitrogen Oxides (NOx) OUT sensor module. Key OFF, disconnect NOx OUT sensor module. Check NOx OUT sensor and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the NOx OUT sensor module connector, harness, and terminals clean and undamaged?	Yes: Go to step 4.
		No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3226 FMI 2.

Step	Action	Decision
4	Check voltage to the NOx OUT sensor module. Key-On Engine-Off (KOEO), with Breakout Harness 18-649-01 connected to NOx OUT sensor module, use a DMM to measure voltage between NOx OUT sensor module pin-1 and pin-4. Is voltage within 0.5 volts of battery voltage?	Yes: Replace NOx OUT sensor module. After repairs are complete, retest for SPN 3226 FMI 2. No: Go to step 5.

Step	Action	Decision
5	Check SWBAT circuit for Open or short to ground. KOEO, with Breakout Harness 18-649-01 connected to NOx OUT sensor module , use a DMM to measure voltage between NOx OUT sensor module pin-1 and a known good ground. Is voltage at pin-1 within 0.5 volts of battery voltage?	Yes: Repair Open or high resistance between NOx OUT sensor module pin-4 and ACM connector J2-04 and J2-06. After repairs are complete, retest for SPN 3226 FMI 2. No: Repair Open or short to ground between NOx OUT sensor module connector pin-1 and ACM connector J2-03 and J2-05. After repairs are complete, retest for SPN 3226 FMI 2.

NOTE: After doing all diagnostic steps, if SPN 3226 FMI 2 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3226 FMI 4- NOx OUT signal Out of Range LOW

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
NOx OUT sensor module voltage below normal or shorted to low source.	Failed NOx OUT sensor module	Processing of fail messages from the sensor enabled 160 seconds after dew point reached. Dew point is defined as: Exhaust gas temperature is above a threshold representing the point at which there is no longer a concern of condensation on the NOx OUT sensor element.	10 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects an internal circuit error in the Nitrogen Oxides (NOx) OUT sensor module. Engine torque will be reduced if the engine is operated for a limited period of time with the fault code active. Engine torque will be severely reduced and vehicle speed will be limited after extended engine operation with the fault code active.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 3228 FMI 2 (NOx OUT).

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

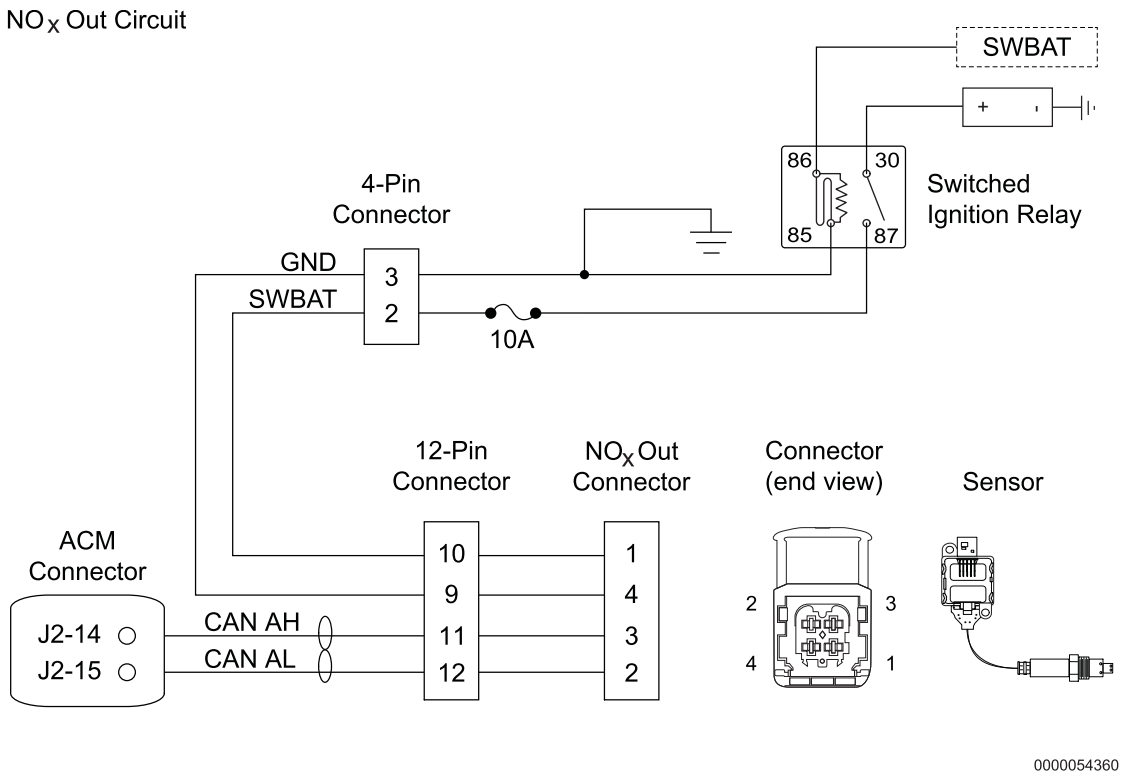


Figure 485 NOx OUT Sensor Circuit Diagram

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3228 FMI 2 (NOx OUT). Is EST DTC list free of SPN 3228 FMI 2?	Yes: Go to step 2. No: Repair SPN 3228 FMI 2. After repairs are complete, retest for SPN 3226 FMI 4.

Step	Action	Decision
2	Inspect connections at Nitrogen Oxides (NOx) OUT sensor module. Key OFF, disconnect NOx OUT sensor module. Check NOx OUT sensor module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the NOx OUT sensor module connector, harness, and terminals clean and undamaged?	Yes: Replace NOx OUT sensor module. After repairs are complete, retest for SPN 3226 FMI 4. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3226 FMI 4.

NOTE: After doing all diagnostic steps, if SPN 3226 FMI 4 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3226 FMI 10 - NOx OUT signal abnormal rate of change

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
NOx OUT sensor reading is not valid.	Percent of time > 50 % when NOx OUT sensor module reading is valid since the internal control loops within the sensor have stabilized	Inactive: SPN 3226 FMI 4, SPN 3226 FMI 9, and SPN 3228 FMI 3. Engine total fueling > 0.01 and rate of active / intrusive injection of fuel in exhaust < 0.2 g/sec for 30 seconds. Internal NOx sensor temperature > 1472°F (800°C) The changing range of exhaust O_2 concentration within a 12 second moving window ≤ 9.96 The changing range of exhaust O_2 concentration within a 6 second moving window ≤ 5.43 Exhaust gas temperature is above a threshold representing the point at which there is no longer a concern of condensation on the NOx sensor element and sensor supply power ≥ 6 V for 150 seconds	300 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects that the Nitrogen Oxides (NOx) OUT sensor module signal is invalid.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 3228 FMI 2 (NOx OUT).

Drive Cycle to Determine Fault Status

Drive Cycle 20 in 2013 HD-OBD Diagnostic Reference Manual.

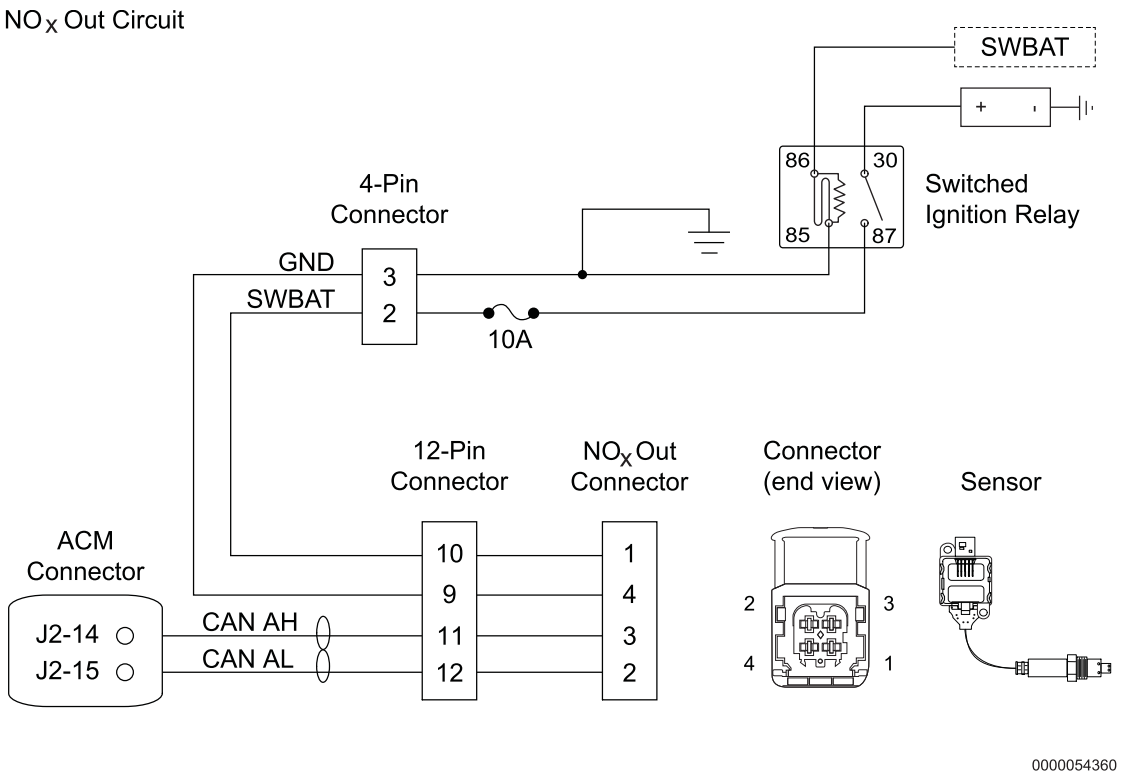


Figure 486 NOx OUT Sensor Circuit Diagram

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3226 FMI 4 and (NOx OUT) SPN 3228 FMI 2 (NOx OUT). Is EST DTC list free of SPN 3226 FMI 4 (NOx OUT) and SPN 3228 FMI 2?	Yes: Replace NOx OUT sensor module. After repairs are complete, retest for SPN 3226 FMI 10.
		No: Repair SPN 3226 FMI 4 and SPN 3228 FMI 2. After repairs are complete, retest for SPN 3226 FMI 10.

NOTE: After doing all diagnostic steps, if SPN 3226 FMI 10 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3226 FMI 13 - NOx OUT Out of Calibration

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Calibration mismatch between the NOx OUT sensor module and the Aftertreatment Control Module (ACM).	Rated NOx OUT sensor module voltage does not match nominal system voltage	Key ON	0 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects that the Nitrogen Oxides (NOx) OUT sensor module voltage rating does not match the engine's electrical system voltage.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

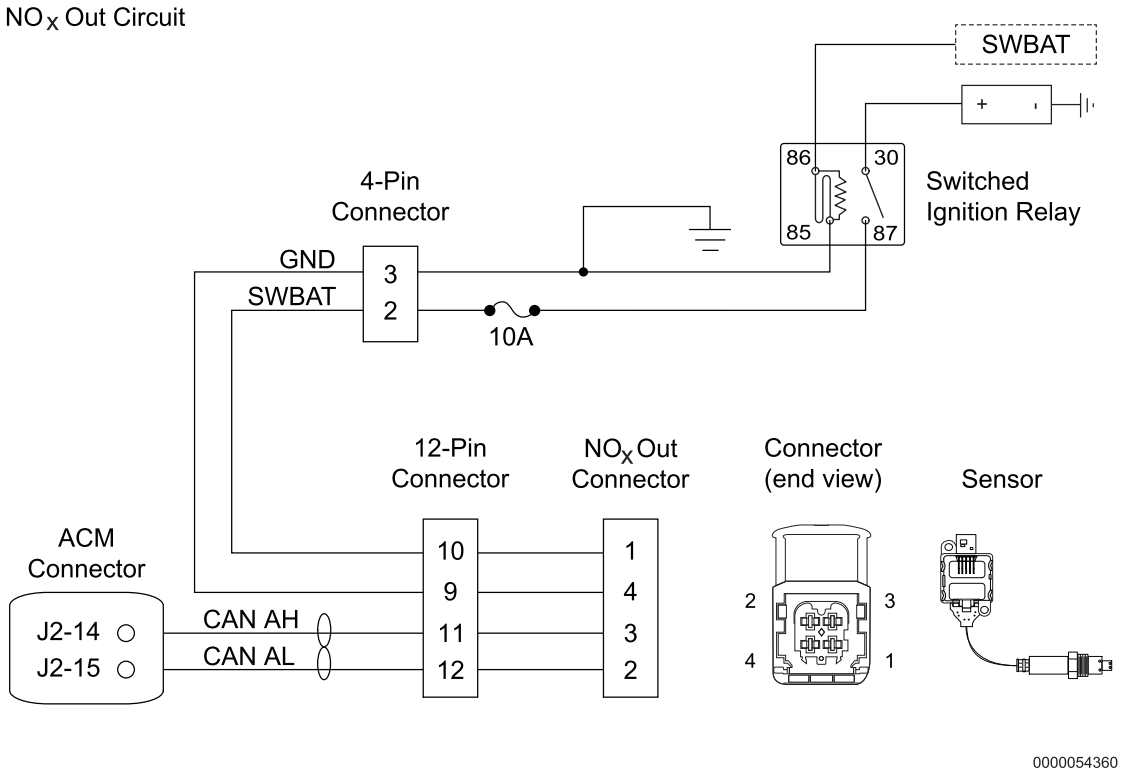


Figure 487 NOx OUT Sensor Circuit Diagram

Step	Action	Decision
1	Verify correct NOx OUT sensor module is installed. Is the correct NOx OUT sensor module installed?	Yes: Replace NOx OUT sensor module. After repairs are complete, retest for SPN 3226 FMI 13.
		No: Install correct NOx OUT sensor module. After repairs are complete, retest for SPN 3226 FMI 13.

NOTE: After doing all diagnostic steps, if SPN 3226 FMI 13 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3226 FMI 19 - NOx OUT Out not detected on J1939

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Loss of communication or invalid data from NOx OUT sensor module.	ACM loses J1939 data link communications with NOx OUT sensor module	Key ON Engine not cranking **NOTE:** Data link-related faults are inhibited for a calibratable amount of time following a Key-On event, a low battery voltage event, an engine cranking event, and a stop / suspend broadcast event. This is to allow reasonable time for data link devices to power up and begin periodic broadcasts before the ECM performs time-out diagnostics.	0 seconds

Fault Overview

Fault code sets when the Engine Control Module (ECM) loses J1939 data link communications with the Nitrogen Oxides (NOx) OUT sensor module. Diesel exhaust Fluid (DEF) injection into the aftertreatment system is disabled, and engine torque will be severely reduced.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

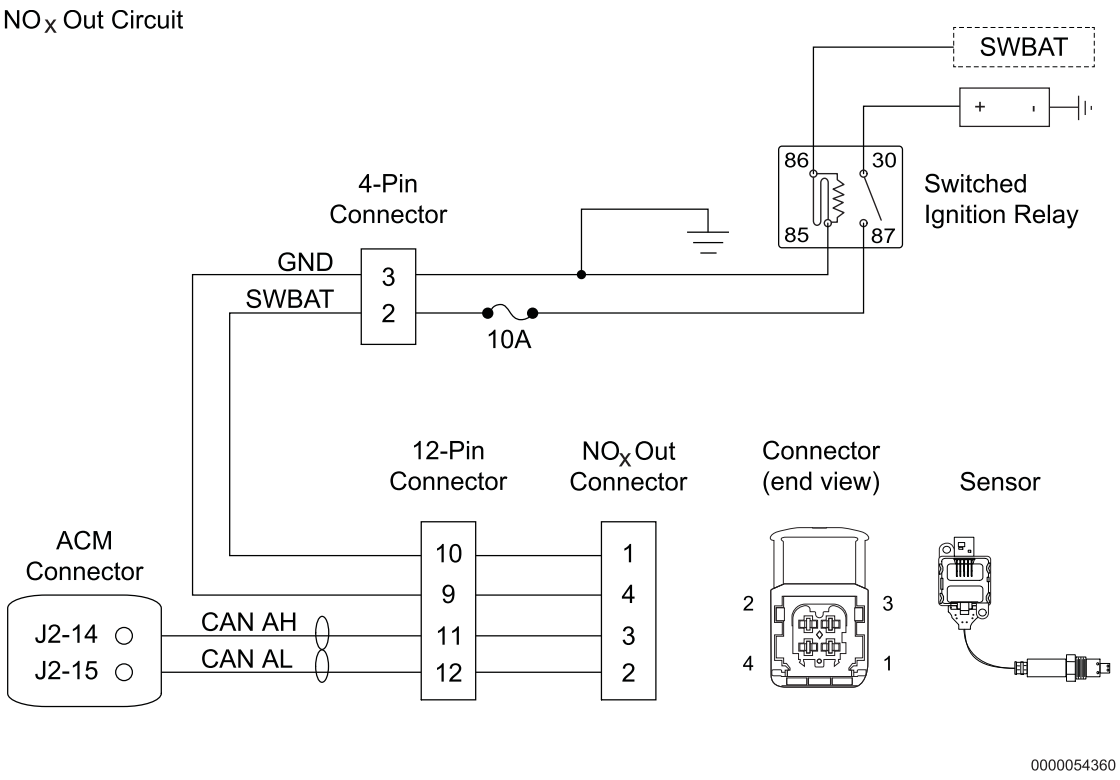


Figure 488 NOx OUT Sensor Circuit Diagram

Possible Causes

- SWBAT circuit short to GND or Open
- CAN-AH circuit Open or short to GND
- CAN-AL circuit Open or short to GND
- CAN-AH circuit short to power
- CAN-AL circuit short to power
- GND circuit Open or high resistance
- CAN-AH short to CAN-AL
- Failed Nitrogen Oxides (NOx) OUT sensor module

NOTE: If more than one of the following sensor modules fail (or set a fault), suspect a common power circuit, ground circuit, or Switched Ignition Relay problem. The following components share power and ground circuits: DOC / DPF temperature sensor module, SCR temperature sensor module, Ammonia Sensor Module, NOx OUT sensor module, NOx IN sensor module, and DEFTLT sensor module.

NOTE: Verify batteries are fully charged and connections are clean.

Step	Action	Decision
1	Inspect connections at Nitrogen Oxides (NOx) OUT sensor module. Key OFF, disconnect NOx OUT sensor module. Check NOx IN sensor module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the NOx OUT sensor module connector, harness, and terminals clean and undamaged?	Yes: Go to step 2. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3226 FMI 19.

Step	Action	Decision
2	Check voltage to the NOx OUT sensor module. Key-On Engine-Off (KOEO), with Breakout Harness 18-648-01 connected between NOx OUT sensor module and vehicle harness, use a DMM to measure voltage between NOx OUT sensor module pin-1 and pin-4. Is voltage within 0.5 volts of battery voltage?	Yes: Go to step 4. No: Go to step 3.

Step	Action	Decision
3	Check SWBAT circuit for Open or short to ground. KOEO, with Breakout Harness 18-648-01 connected between NOx OUT sensor module and vehicle harness, use a DMM to measure voltage between NOx OUT sensor module pin-1 and a known good ground. Is voltage at pin-1 within 0.5 volts of battery voltage?	Yes: Repair Open or high resistance between NOx OUT sensor module pin-4 and ground. After repairs are complete, retest for SPN 3226 FMI 19. No: Repair Open or short to ground between NOx OUT sensor module connector pin-1 and switched ignition relay pin-87. After repairs are complete, retest for SPN 3226 FMI 19.

Step	Action	Decision
4	Check CAN-AH circuit for Open or short to GND. KOEO, with Breakout Harness 18-648-01 connected between NOx OUT sensor module and vehicle harness, use a DMM to measure voltage between NOx OUT sensor module pin-3 and a known good ground. Is voltage greater than 1 volt?	Yes: Go to step 5. No: Repair Open or short to ground between NOx OUT sensor module connector pin-3 and ACM connector J2-14. After repairs are complete, retest for SPN 3226 FMI 19.

Step	Action	Decision
5	Check CAN-AH circuit for short to power. KOEO, with Breakout Harness 18-648-01 connected between NOx OUT sensor module and vehicle harness, use a DMM to measure voltage between temperature sensor module pin-3 and a known good ground. Is voltage less than 4 volts?	Yes: Go to step 6. No: Repair short to power between NOx OUT sensor module connector pin-3 and ACM connector J2-14. After repairs are complete, retest for SPN 3226 FMI 19.

Step	Action	Decision
6	Check CAN-AL circuit for Open or short to GND. KOEO, with Breakout Harness 18-648-01 connected between NOx OUT sensor module and vehicle harness, use a DMM to measure voltage between temperature sensor module pin-2 and a known good ground. Is voltage greater than 1 volt?	Yes: Go to step 7. No: Repair Open or short to ground between NOx OUT sensor module connector pin-2 and ACM connector J2-15. After repairs are complete, retest for SPN 3226 FMI 19.

Step	Action	Decision
7	Check CAN-AL circuit for short to power. KOEO, with Breakout Harness 18-648-01 connected between NOx OUT sensor module and vehicle harness, use a DMM to measure voltage between temperature sensor module pin-2 and a known good ground. Is voltage less than 4 volts?	Yes: Go to step 8. No: Repair short to power between NOx OUT sensor module connector pin-2 and ACM connector J2-15. After repairs are complete, retest for SPN 3226 FMI 19.

Step	Action	Decision
8	Check CAN-AL circuit for short to CAN-AH. Key OFF, with Breakout Harness 18-648-01 connected between NOx OUT sensor module and vehicle harness, use a DMM to measure resistance between temperature sensor module pin-2 and pin-3. Is resistance greater than 50 ohms?	Yes: Replace NOx OUT sensor module. After repairs are complete, retest for SPN 3226 FMI 19. No: Repair short between NOx OUT sensor module connector pin-2 and pin-3. After repairs are complete, retest for SPN 3226 FMI 19.

NOTE: After doing all diagnostic steps, if SPN 3226 FMI 19 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3226 FMI 20 - NOx OUT signal drifted HIGH

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Aftertreatment Control Module (ACM) determines Nitrogen Oxides (NOx) OUT sensor signal drifted HIGH.	Average value of NOx OUT sensor module offset measurement at the decision point > 40 ppm	Engine total fueling ≤ 0.01 mg/stroke NOx OUT sensor module reading is valid since the internal control loops within the sensor have stabilized. Engine is operating in base mode. Exhaust Flow ≥ 100 g/sec Commanded DEF injection rate < 0.1 ml/sec None of the Abort Conditions are satisfied The other Enable Conditions must be true for at least 6 seconds The OBD Arbitrator allows the diagnostic to run. The OBD arbitrator allows the Tail Pipe NOx OUT sensor module gain diagnostics to run.	2.6 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) determines the signal from the Nitrogen Oxides (NOx) OUT sensor module is high during monitoring conditions, or is not changing with engine conditions.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 3226 FMI 4 (NOx OUT), SPN 3228 FMI 2 (NOx OUT), and SPN 5031 FMI 10 (NOx OUT).

Drive Cycle to Determine Fault Status

Drive Cycle 21 in 2013 HD-OBD Diagnostic Reference Manual.

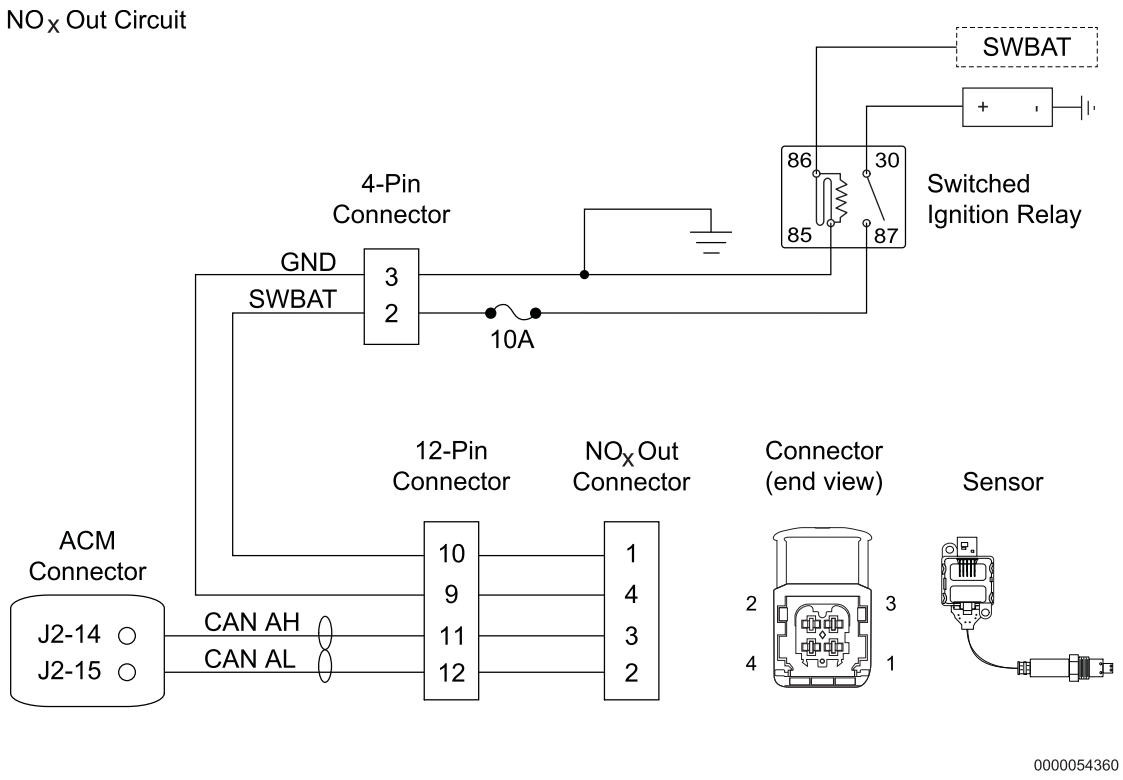


Figure 489 NOx OUT Sensor Circuit Diagram

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3226 FMI 4 (NOx OUT), SPN 3228 FMI 2 (NOx OUT), and SPN 5031 FMI 10 (NOx OUT). Is EST DTC list free of SPN 3226 FMI 4, SPN 3228 FMI 2, and SPN 5031 FMI 10?	Yes: Go to step 2. No: Repair SPN 3226 FMI 4, SPN 3228 FMI 2, and SPN 5031 FMI 10. After repairs are complete, retest for SPN 3226 FMI 20.

Step	Action	Decision
2	Verify proper installation of the Nitrogen Oxides (NOx) OUT sensor module. Check the NOx OUT sensor retaining nut and NOx OUT sensor module retaining cap screws for proper torque. Is the NOx OUT sensor module properly installed?	Yes: Go to step 3. No: Properly install the NOx OUT sensor module. After repairs are complete, retest for SPN 3226 FMI 20.

Step	Action	Decision
3	Check decomposition tube for crystallization. Disconnect decomposition tube from exhaust system (see Exhaust Aftertreatment with DPF and SCR Service Manual) and inspect for Diesel Exhaust Fluid (DEF) crystallization. Is decomposition tube free of DEF crystallization?	Yes: Replace NOx OUT sensor module. After repairs are complete, retest for SPN 3226 FMI 20. No: Remove DEF crystallization from decomposition tube (see Exhaust Aftertreatment with DPF and SCR Service Manual). After repairs are complete, retest for SPN 3226 FMI 20.

NOTE: After doing all diagnostic steps, if SPN 3226 FMI 20 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3226 FMI 21 - NOx OUT signal drifted LOW

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Aftertreatment Control Module (ACM) determines Nitrogen Oxides (NOx) OUT sensor module signal drifted LOW.	Average value of NOx OUT sensor module offset measurement at the decision point < –40 ppm	Engine total fueling ≤ 0.01 mg/stroke NOx OUT sensor module reading is valid since the internal control loops within the sensor have stabilized. Engine is operating in base mode. Exhaust Flow ≥ 100 g/sec Commanded DEF injection rate < 0.1 ml/sec The OBD Arbitrator allows the Tail Pipe NOx OUT sensor module gain diagnostics to run. None of the Abort Conditions are satisfied The other Enable Conditions must be true for at least 6 seconds The OBD Arbitrator allows the diagnostic to run. The OBD arbitrator allows the Tail Pipe NOx OUT sensor module gain diagnostics to run.	2.6 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the reading from the Nitrogen Oxides (NOx) OUT sensor module is low during monitoring conditions, or is not changing with engine conditions.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 3226 FMI 4 (NOx OUT), SPN 3228 FMI 2 (NOx OUT), and SPN 5031 FMI 10 (NOx OUT).

Drive Cycle to Determine Fault Status

Drive Cycle 21 in 2013 HD-OBD Diagnostic Reference Manual.

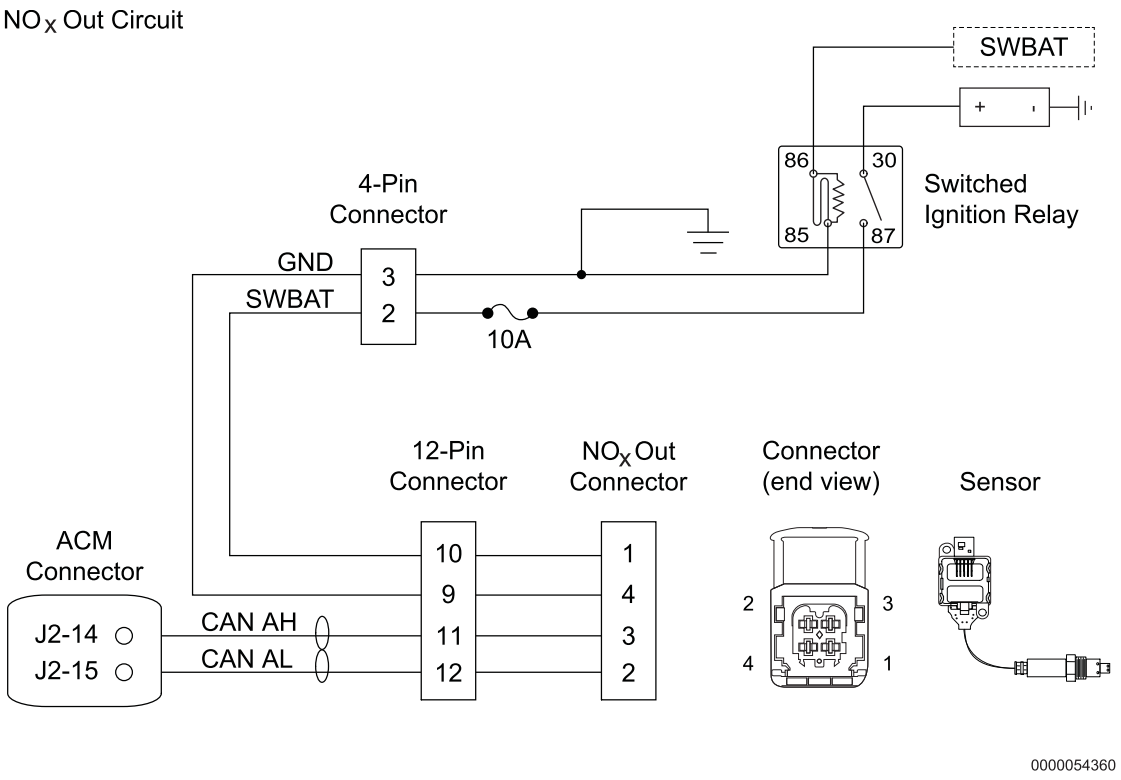


Figure 490 NOx OUT Sensor Circuit Diagram

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3226 FMI 4 (NOx OUT), SPN 3228 FMI 2 (NOx OUT), and SPN 5031 FMI 10 (NOx OUT). Is EST DTC list free of SPN 3226 FMI 4, SPN 3228 FMI 2, and SPN 5031 FMI 10?	Yes: Go to step 2. No: Repair SPN 3226 FMI 4, SPN 3228 FMI 2, and SPN 5031 FMI 10. After repairs are complete, retest for SPN 3226 FMI 21.

Step	Action	Decision
2	Verify proper installation of the Nitrogen Oxides (NOx) OUT sensor module. Check the NOx OUT sensor retaining nut and NOx OUT sensor module retaining cap screws for proper torque. Is the NOx OUT sensor module properly installed?	Yes: Replace NOx OUT sensor module. After repairs are complete, retest for SPN 3226 FMI 21. No: Properly install the NOx OUT sensor module. After repairs are complete, retest for SPN 3226 FMI 21.

NOTE: After doing all diagnostic steps, if SPN 3226 FMI 21 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3228 FMI 2 - NOx OUT power supply signal erratic, intermittent or incorrect

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
NOx OUT sensor module circuitry has detected that its battery supply voltage is outside the desired range.	NOx OUT sensor module supply voltage > 16.5 V for 10 seconds or NOx OUT sensor module supply voltage < 11.4 V for 10 seconds.	160 seconds after exhaust gas temperature is above a threshold representing the point there is no on the NOx sensor element.	10 seconds

Fault Overview

Fault code sets when the Engine Control Module (ECM) detects the power supply to the Nitrogen Oxides (NOx) OUT sensor module is above or below a calibratable threshold.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 168 FMI 16, and 18 (ACM PWR), and SPN 3226 FMI 9 (NOx OUT).

Drive Cycle to Determine Fault Status

Drive Cycle 21 in 2013 HD-OBD Diagnostic Reference Manual.

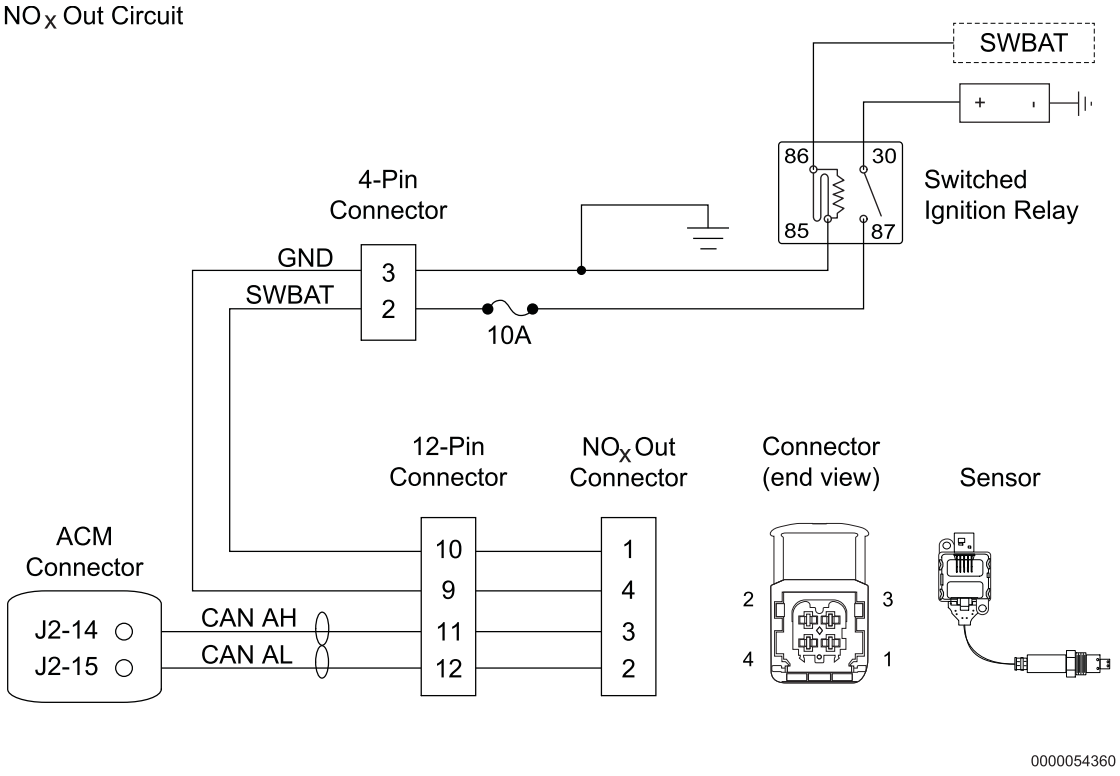


Figure 491 NOx OUT Sensor Circuit Diagram

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 168 FMI 16 and 18 (ACM PWR). Is EST DTC list free of SPN 168 FMI 16 and 18?	Yes: Go to step 2. No: Repair SPN 168 FMI 16 and 18. After repairs are complete, retest for SPN 3228 FMI 2.

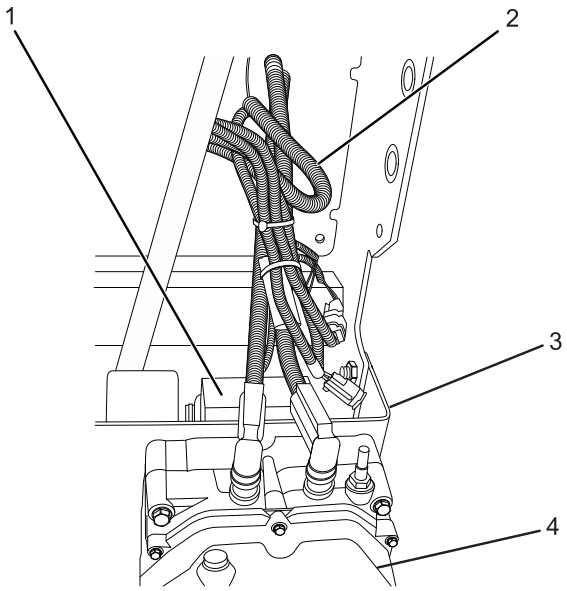


Figure 492 PDM Location (typical)

1. Power Distribution Module (PDM)
2. Diesel Exhaust Fluid (DEF) tank assembly
3. DEF supply module bracket
4. DEF supply module

Step	Action	Decision
2	Check Power Distribution Module (PDM) fuse(s) and relay(s) for blown fuses; loose, missing, or intermittent connections. Are all fuses and relays securely attached and in good condition?	Yes: Go to step 3. No: Secure or replace failed fuse(s) or relay(s) to PDM connector. After repairs are complete, retest for SPN 3228 FMI 2.

NOTE: Verify batteries are fully charged and connections are clean.

Step	Action	Decision
3	Inspect connections at Nitrogen Oxides (NOx) OUT sensor module. Key OFF, disconnect NOx OUT sensor module. Check NOx OUT sensor module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the NOx OUT sensor module connector, harness, and terminals clean and undamaged?	Yes: Go to step 4. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3228 FMI 2.

Step	Action	Decision
4	Check voltage to the NOx OUT sensor module. Key-On Engine-Off (KOEO), with Breakout Harness Breakout Harness 18-649-01 connected to NOx OUT sensor module, use a DMM to measure voltage between NOx OUT sensor module pin-1 and pin-4. Is voltage within 0.5 volts of battery voltage?	Yes: Go to step 6. No: Go to step 5.

Step	Action	Decision
5	Check SWBAT circuit for Open or short to ground. KOEO, with Breakout Harness 18-649-01 connected to NOx OUT sensor module, use a DMM to measure voltage between NOx OUT sensor module pin-1 and a known good ground. Is voltage at pin-1 within 0.5 volts of battery voltage?	Yes: Repair Open or high resistance between NOx OUT sensor module pin-4 and ACM connector J2-04 and J2-06. After repairs are complete, retest for SPN 3228 FMI 2. No: Repair Open or short to ground between NOx OUT sensor module connector pin-1 and ACM connector J2-03 and J2-05. After repairs are complete, retest for SPN 3228 FMI 2.

Step	Action	Decision
6	Check for incorrect NOx OUT sensor module installed. Is the correct NOx OUT sensor module installed?	Yes: Replace NOx OUT sensor module. After repairs are complete, retest for SPN 3228 FMI 2. No: Install correct NOx OUT sensor module. After repairs are complete, retest for SPN 3228 FMI 2.

NOTE: After doing all diagnostic steps, if SPN 3228 FMI 2 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 5031 FMI 10 - NOx OUT sensor heater not reading correctly

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
The NOx OUT sensor heater is unable to maintain normal operating temperature.	NOx OUT sensor heater temperature does not match Aftertreatment Control Module (ACM) predetermined values	DOCIT > 302°F (150°C) for 5 seconds SCROT < 800°C Key-On Engine-Running (KOER) Inactive: SPN 3226 FMI 4 and 13; SPN 3228 FMI 2; SPN 4360 FMI 2; SPN 4363 FMI 2, 3, and 4; SPN 5742 FMI 9; SPN 5743 FMI 3, 4, 9, 11, and 12. Exhaust gas velocity < 60 m/sec Exhaust gas temperature is above a threshold representing the point at which there is no longer a concern of condensation on the NOx OUT sensor element. Time after NOx OUT sensor has reached its working temperature and has entered automatic mode > 30 seconds	0 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Nitrogen Oxides (NOx) OUT sensor heater was unable to maintain its normal operating temperature.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 3226 FMI 4 (NOx OUT), SPN 3228 FMI 2 (NOx OUT), SPN 4360 FMI 2 (SCRIT); and SPN 4363 FMI 2, 3, and 4 (SCROT)

Drive Cycle to Determine Fault Status

Drive Cycle 1 in 2013 HD-OBD Diagnostic Reference Manual.

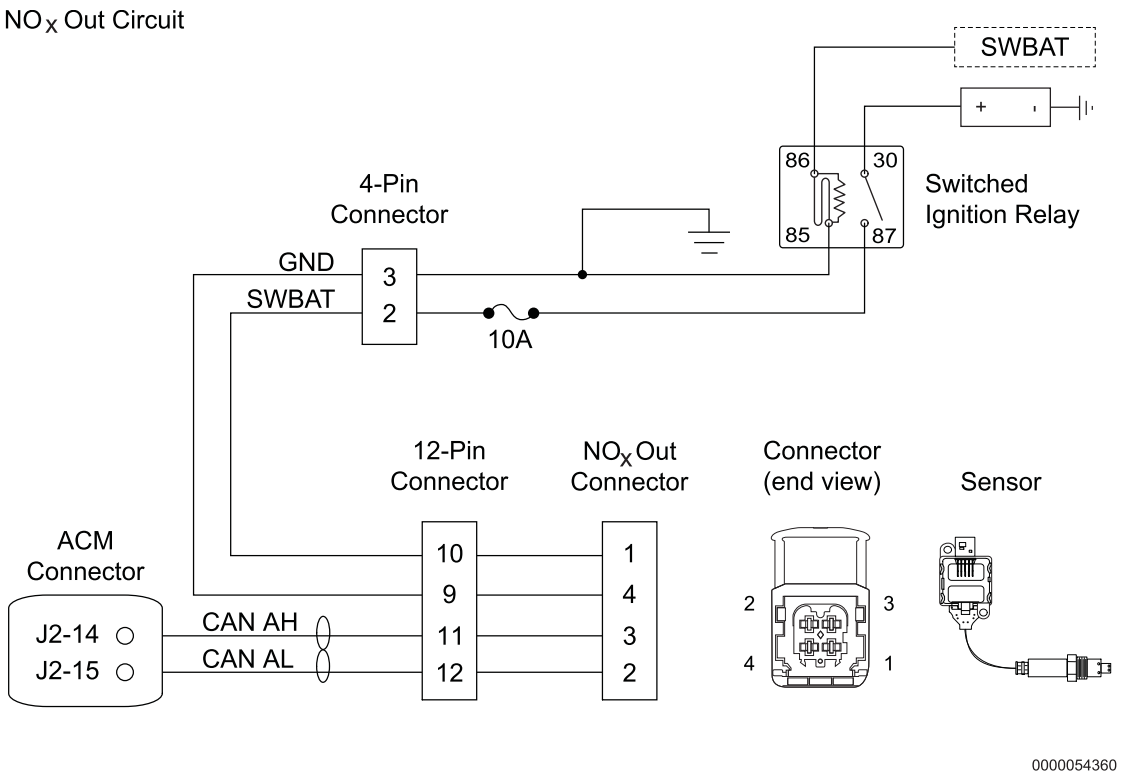


Figure 493 NOx OUT Sensor Circuit Diagram

Possible Causes

- Failed NOx OUT sensor module
- GND circuit Open or high resistance
- SWBAT circuit Open or high resistance

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3226 FMI 4 (NOx OUT); SPN 3228 FMI 2 (NOx OUT); SPN 4360 FMI 2 (SCRIT); and SPN 4363 FMI 2, 3, and 4 (SCROT). Is EST DTC list free of SPN 3226 FMI 4; SPN 3228 FMI 2; SPN 4360 FMI 2; and SPN 4363 FMI 2, 3, and 4?	Yes: Go to step 2. Repair SPN 3226 FMI 4; SPN 3228 FMI 2; SPN 4360 FMI 2; and SPN 4363 FMI 2, 3, and 4. After repairs are complete, retest for SPN 5031 FMI 10.

Step	Action	Decision
2	Inspect connections at Nitrogen Oxides (NOx) OUT sensor. Key OFF, disconnect NOx OUT sensor. Check NOx OUT sensor and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the NOx OUT sensor connector, harness, and terminals clean and undamaged?	Yes: Go to step 3. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 5031 FMI 10.

NOTE: If more than one of the following sensor modules fail (or set a fault), suspect a common power circuit , ground circuit, or switched ignition relay problem. The following components share power and ground circuits with the NOx OUT sensor module:

- DOC / DPF temperature sensor module
- NOx OUT sensor module
- Ammonia (NH_3) sensor module
- SCR temperature sensor module
- DEFTLT sensor

NOTE: Verify batteries are fully charged and connections are clean.

Step	Action	Decision
3	Check power and ground to the NOx OUT sensor module. Key-On Engine-Off (KOEO), with Breakout Harness 18-649-01 connected to NOx OUT sensor module, use a DMM to measure voltage between Breakout Harness 18-649-01 pin-1 and pin-4. Is voltage within 0.5 volts of battery voltage?	Yes: Replace NOx OUT sensor module. After repairs are complete, retest for SPN 5031 FMI 10. No: Go to step 4.

Step	Action	Decision
4	Check SWBAT circuit for Open or high resistance. KOEO, with Breakout Harness 18-649-01 connected to NOx OUT sensor module, use a DMM to measure voltage between Breakout Harness 18-649-01 pin-1 and a known good ground. Is voltage within 0.5 volts of battery voltage?	Yes: Repair Open or high resistance between NOx OUT sensor module pin-4 and ground. After repairs are complete, retest for SPN 5031 FMI 10.
		No: Repair Open or high resistance between NOx OUT sensor module pin-1 and switched ignition relay pin-87. After repairs are complete, retest for SPN 5031 FMI 10.

NOTE: After doing all diagnostic steps, if SPN 5031 FMI 10 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

O_2S (Oxygen Sensor)

SPN	FMI	Condition	Possible Causes	Actions
724	2	O_2S Slow response detecting fueling to non-fueling	• Failed O_2S • Replace sensor and run Oxygen Sensor (O_2S) calibration	Pin-Point Diagnostics (page 1327)
724	3	O_2S circuit Fault: Open or short to PWR	• O_2 circuit short to PWR • Failed O_2S	Pin-Point Diagnostics (page 1327)
724	4	O_2S circuit Fault: Short to GND	• O_2 circuit short to GND • Failed O_2S	Pin-Point Diagnostics (page 1327)
724	5	O_2S circuit fault: Open circuit	• O_2S Open circuit • Failed O_2S	Pin-Point Diagnostics (page 1327)
724	20	O_2S adaptation above maximum limit	• Oxygen sensor contamination • Failed oxygen sensor • Faulty TC1TOP signal	Step-based Diagnostics (page 1329)
724	21	O_2S adaptation below minimum limit	• Biased TC1TOP sensor or circuit • Intermittent TC1TOP circuit fault • Restricted EBPV tube • Failed O_2S or circuit	Circuit Checks (page 1332)
3223	0	O_2S heater temperature above maximum	• O_2 heater circuit short to GND • Failed O_2S	Step-based Diagnostics (page 1333)
3223	1	O_2S heater temperature below minimum	• Charging System fault (Low B+ when O_2 Heater was commanded on) • O_2S or circuit fault	Pin-Point Diagnostics (page 1338)
3223	3	O_2S heater short to PWR	• O_2 heater circuit short to PWR • Failed O_2S	Pin-Point Diagnostics (page 1327)

3223	4	O_2S heater short to GND	• O_2 heater circuit short to GND • Failed O_2S	Pin-Point Diagnostics (page 1327)
3223	5	O_2S heater open load/circuit	• HTR CTL circuit short to GND • ECM PWR OUT 1 circuit Open or high resistance • HTR CTL circuit Open or high resistance • Failed O_2S	Step-Based Diagnostics (page 1335)
3223	17	O_2S heater temperature below minimum at low battery PWR	• Charging system fault (low B+ when O_2 heater was commanded ON)	Pin-Point Diagnostics (page 1338)

O2S Circuit

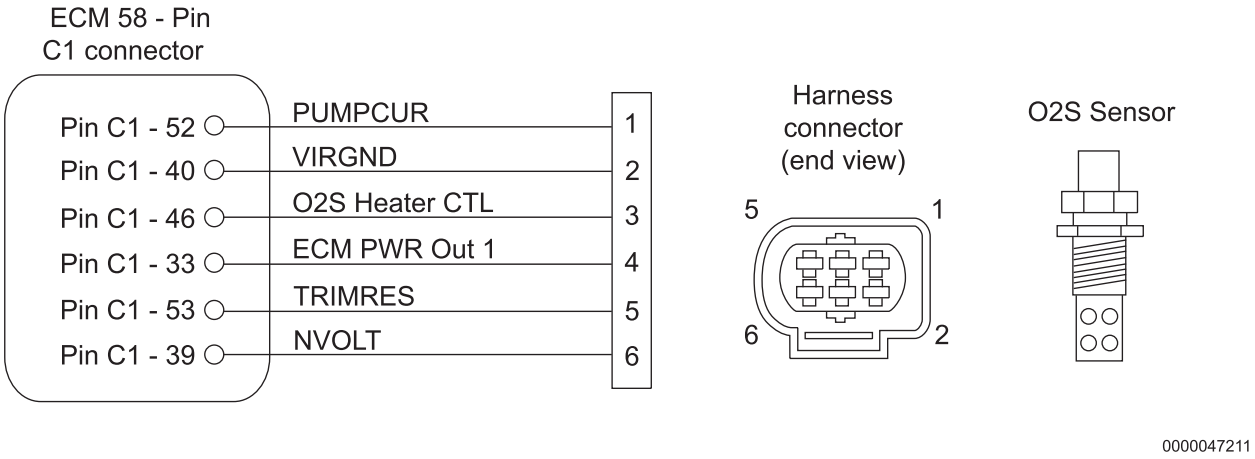


Figure 494 O_2S circuit diagram

Overview

The Oxygen Sensor (O_2S) is a wide band oxygen sensor used to control engine fueling and provide input for Exhaust Gas Recirculation (EGR) valve position. The O_2S is a six wire sensor that provides a variable voltage signal to the Engine Control Module (ECM) to determine the amount of oxygen entering the exhaust system. A heating element is used during initial engine warm-up to bring the sensor up to a normal operating temperature of 1,436°F (780°C). The O_2S heater element is only activated when engine coolant temperature reaches 104°F (40°C), and exhaust gas temperature exceeds 212°F (100°C) for more than 30 seconds.

Tools Required

- 180-Pin Breakout Box 00-00956-08
- 2010 MaxxForce 11 & 13 Harness Kit 00-01462-00
- 3-Banana Plug Harness ZTSE4498
- 500 Ohm Resistor Harness ZTSE4497
- Big Bore Terminal Test Probe Kit ZTSE4899
- Breakout Harness ZTSE4735A (O_2S)
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

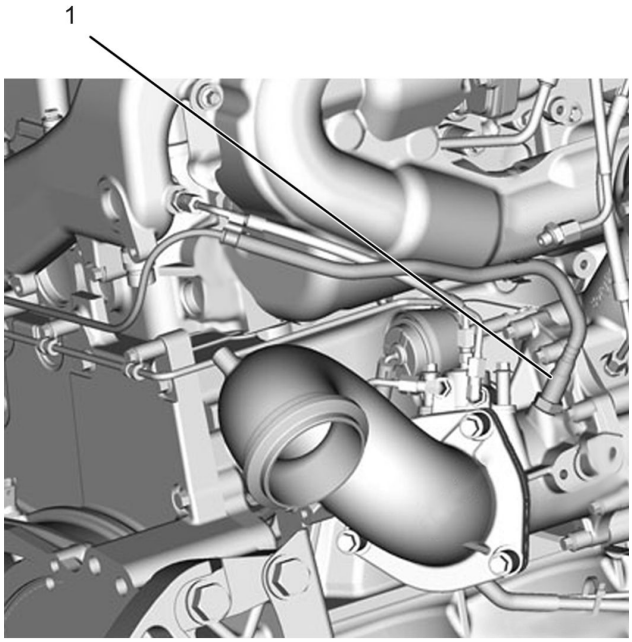


Figure 495 Oxygen Sensor Location

1. Oxygen Sensor (O_2S)

O2S Circuit

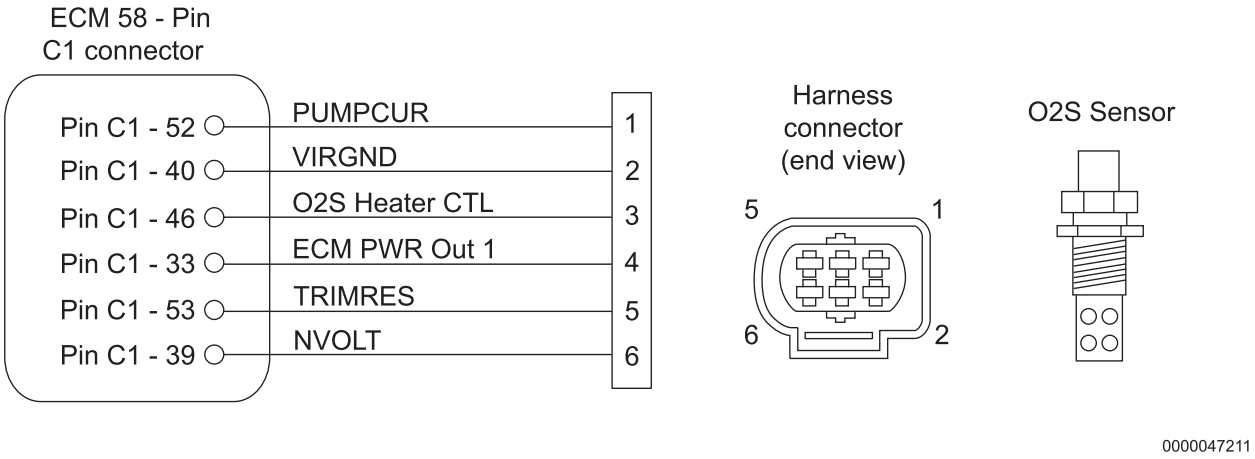


Figure 496 O_2S circuit diagram

WARNING: To prevent personal injury or death, stay clear of rotating parts (belts and fan) and hot engine surfaces.

Pinpoint Diagnostics With ServiceMaxx™ Software

1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, verify DTC is active for this sensor.
   - If code is previously active, wiggle the harness of the suspect sensor. If the circuit is interrupted, the DTC will go active.
   - If code is active, proceed to Connector Voltage Check.

NOTE: Inspect connectors for damaged, corrosion, or loose pins. Repair if necessary.

Connector Voltage Check Without ServiceMaxx™ Software

Connect Breakout Harness ZTSE4735A to O_2S vehicle harness, and leave O_2S sensor disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	2.9 V ± 1 V	If < 1.9 V, check for OPEN or short to GND.
2 to GND	2.6 V ± 1 V	If < 1.6 V, check for OPEN or short to GND.
3 to GND	4.8 V ± 1 V	If < 3.8 V, check for OPEN or short to GND.
4 to GND	12V ± 2 V	If < 10 V, check for OPEN circuit or short to GND.
5 to GND	2.9 V ± 1 V	If < 1.9 V, check for OPEN or short to GND.
6 to GND	3 V ± 1 V	If < 2 V , check for OPEN or short to GND.
If measurements are within specification, do Harness Resistance Check.		

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM C1 and C2 harness to ECM C1 and C2 vehicle harness connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE4735A to O_2S vehicle harness, and leave O_2S sensor disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
1 to C1-52	< 5 Ω	If > 5 Ω, check for OPEN in circuit.
1 to GND	> 1k Ω	If < 1k Ω, check for short to GND.
2 to C1-40	< 5 Ω	If > 5 Ω, check for OPEN in circuit.
2 to GND	> 1k Ω	If < 1k Ω, check for short to GND.
3 to C1-46	< 5 Ω	If > 5 Ω, check for OPEN in circuit.
3 to GND	>1k Ω	If < 1k Ω, check for short to GND.
4 to C1-33	< 5 Ω	If > 5 Ω, check for OPEN in circuit.
4 to GND	>1k Ω	If < 1k Ω, check for short to GND.
5 to C1-53	< 5 Ω	If > 5 Ω, check for OPEN in circuit.
5 to GND	> 1k Ω	If < 1k Ω, check for short to GND.
6 to C1-39	< 5 Ω	If > 5 Ω, check for OPEN in circuit.
6 to GND	> 1k Ω	If < 1k Ω, check for short to GND.
If measurements are in specification, calibrate and install new O_2S.		

SPN 724 FMI 20 – O_2S adaptation above maximum limit

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
The stored adaptation value for the oxygen sensor (O_2S) is above the maximum threshold	Adaptation value > 0.05	Time in overrun (motoring) >0 seconds Exhaust Backpressure Valve (EBPV) not closed Ambient Air Temperature (AAT) < 212°F (100°C) Oxygen sensor temperature >1400°F (760°C) and < 1472°F (800°C) Fresh air flow during overrun > 420 g Not in regeneration mode [Release from dewpoint detection: dew point: ECT1, >10.06 C dew point: DOCIT >100.1 C DOCIT exceeded for >30 seconds] Difference between filtered and unfiltered O2 concentration <0.0018	3 seconds

Fault Overview

Fault code sets when the learned O_2S adaptation value exceeds 0.05.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 3 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Oxygen sensor contamination
- Failed oxygen sensor

Step	Action	Decision
1	Verify ECM has the latest calibration. Check calibration scorecard on Service Portal. Is calibration current?	Yes: Go to step 2. No: Update calibration. After update is complete, go to step 2.

Step	Action	Decision
2	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 724 FMI 3, 4, 5 (O_2S) Is EST DTC list free of SPN 724 FMI 3, 4, 5?	Yes: Go to step 3. No: Repair SPN 724 FMI 3, 4,5. After repairs are complete, retest for SPN 724 FMI 20.

Step	Action	Decision
3	Check O2 sensor adaptation value. Using Electronic Service Tool (EST) with ServiceMaxx™ software, load the parameter session. Find parameter ID 99162 : Lambda sensor adaptation value, and document the value. Is the adaptation value > 0.045?	Yes: Go to step 4. No: Clear fault. After repairs are complete, retest for SPN 724 FMI 20.

Step	Action	Decision
4	Run the Relative Compression Test to add oxygen to the exhaust and then run O2 Sensor Calibration. • Connect a battery charger. • Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests > KOEO Tests> Relative Compression Test. Run the Relative Compression Test (disables the injectors) and crank the engine for 15 seconds. Disregard the results of the Relative Compression Test. • Exit Relative Compression test. Go to Procedures > KOEO Procedures > O2 Sensor Calibration, and run O2 sensor calibration without removing the O2 sensor. Check the value of parameter 99162 : Lambda sensor adaptation value Is the adaptation value > 0.045?	Yes: Replace O2 Sensor. After repairs are complete, go to step 5. No: Clear fault. After repairs are complete, retest for SPN 724 FMI 20.

Step	Action	Decision
5	Run the Relative Compression Test to add oxygen to the exhaust and then run O2 Sensor Calibration. • Connect a battery charger. • Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests > KOEO Tests> Relative Compression Test. Run the Relative Compression Test (disables the injectors) and crank the engine for 15 seconds. Disregard the results of the Relative Compression Test. • Exit Relative Compression test. Go to Procedures > KOEO Procedures > O2 Sensor Calibration, and run O2 sensor calibration without removing the O2 sensor. Check the value of parameter 99162 : Lambda sensor adaptation value Is the adaptation value > 0.045?	Yes: Verify steps were performed in proper sequence and completed correctly. Notify supervisor if fault remains. No: Go to step 6.

Step	Action	Decision
6	Reset relevant ECM parameters in ServiceMaxx. **NOTE:** Not all calibrations have all parameters available. Using EST, load the parameter session. • Set parameters 99520, 99530, and 99540 to 0. • Set parameter 99550 to 780°C. Were parameters programmed successfully?	Yes: Clear fault. After repairs are complete, retest for SPN 724 FMI 20. No: Verify steps were performed in proper sequence and completed correctly. Notify supervisor if fault remains.

NOTE: After performing all diagnostic steps, if SPN 724 FMI 20 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 724 FMI 21 – O_2S adaptation below minimum limit

Biased Sensor or Circuit Check

Perform TC1TOP Sensor Circuit Check (page 1401). Check for restricted exhaust.

1. Check exhaust back pressure valve tube assembly between the Exhaust Back Pressure Valve (EBPV) and Air Control Valve (ACV) for leaks.
   - If leaks are found, repair or replace as necessary. Clear DTC's. If active DTC remains, continue to next step.
   - If no leaks are found, go to next step.
2. Turn ignition switch to ON, engine OFF.
3. Using ServiceMaxx™ software, run the Continuous Monitor Test.
4. Verify S_TC1TOP volts are within specification (lightly wiggle circuits while monitoring TC1TOP signal for spikes). See “APPENDIX A: PERFORMANCE SPECIFICATIONS."
   - If TC1TOP voltage is not within specification, check circuitry for poor continuity. If circuits are acceptable, replace TC1TOP sensor.
   - If TC1TOP voltage is within specification, check for a restricted exhaust system.
   - If TC1TOP voltage is within specification and exhaust is not restricted, verify O_2S circuits are not open or shorted. Calibrate and install new O_2S.

SPN 3223 FMI 0 - O_2S Heater Temperature Above Maximum

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
O_2S temperature too high.	O_2S Temperature ≥ 1472°F (800°C)	Exhaust back pressure valve open < 80% Engine speed > 300 rpm Heater duty cycle > 98% for 6,500 seconds (1.8 hours) Regeneration mode inactive or Oxygen sensor temp > 1202°F (650°C)	30 seconds

Fault Overview

The Oxygen sensor (O_2S) heater element is designed to increase sensor temperature. The O_2S heater is supplied with battery voltage from ECM PWR Out 1 through pin 4 of the O_2S connector. The O_2S heater is active when the Engine Control Module (ECM) supplies ground to the O_2S Heater CTL circuit through ECM connector 1 pin 46. If O_2S temperature is above 1472°F (800°C) this fault will set.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

See 2013 HD-OBD Diagnostic Reference Manual.

O2S Circuit

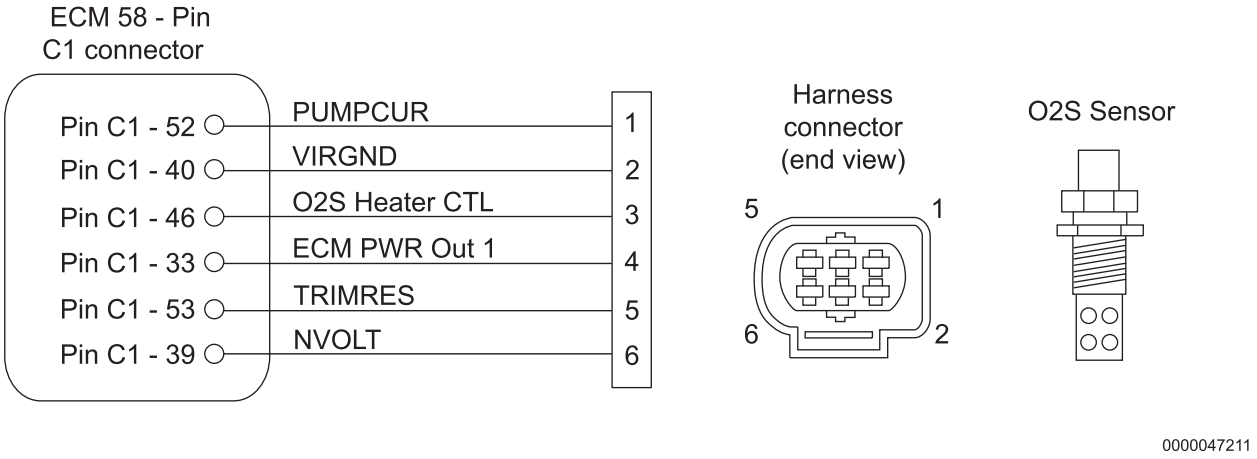


Figure 497 O_2S circuit diagram

Step	Action	Decision
1	Inspect connections at Oxygen Sensor (O_2S). Key OFF, disconnect O_2S connector. Check sensor and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the O_2S connector, harness, and terminals clean and undamaged?	Yes: Go to step 2. No: Repair connector, harness, or terminal. After repairs are complete, retest for SPN 3223 FMI 0.

Step	Action	Decision
2	Check Heater control circuit for short to ground. Connect Breakout Harness ZTSE4735A and leave sensor disconnected. Run engine, using Electronic Service Tool (EST) with ServiceMaxx™ software, monitor O_2S Temp. When O_2S Temp reaches 1,382°F (750°C) or higher (O_2S heater inactive), use a DMM to measure resistance between Breakout Harness ZTSE4735A test point 3, and a known good ground. Is resistance greater than 1,000 ohms?	Yes: Replace Oxygen Sensor. After repairs are complete retest for SPN 3223 FMI 0. No: Repair short to ground between O_2S harness pin 3 and ECM connector 1 pin 46. After repairs are complete, retest for SPN 3223 FMI 0.

NOTE: After doing all diagnostic steps, if SPN 3223 FMI 0 remains verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3223 FMI 5 – O_2S heater open load / circuit

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Open circuit detected in Oxygen Sensor (O_2S) heater.	O_2S heater current >-100 µA and < 100 µA	Key ON	5 seconds

Fault Overview

Fault code sets when Electronic Control Module (ECM) detects an Open circuit in the Oxygen Sensor (O_2S) heater.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 724 FMI 3, 4 (O_2S); SPN 3223 FMI 3, 4 (O_2S); SPN 3597 FMI 4 (ECM PWR).

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

O2S Circuit

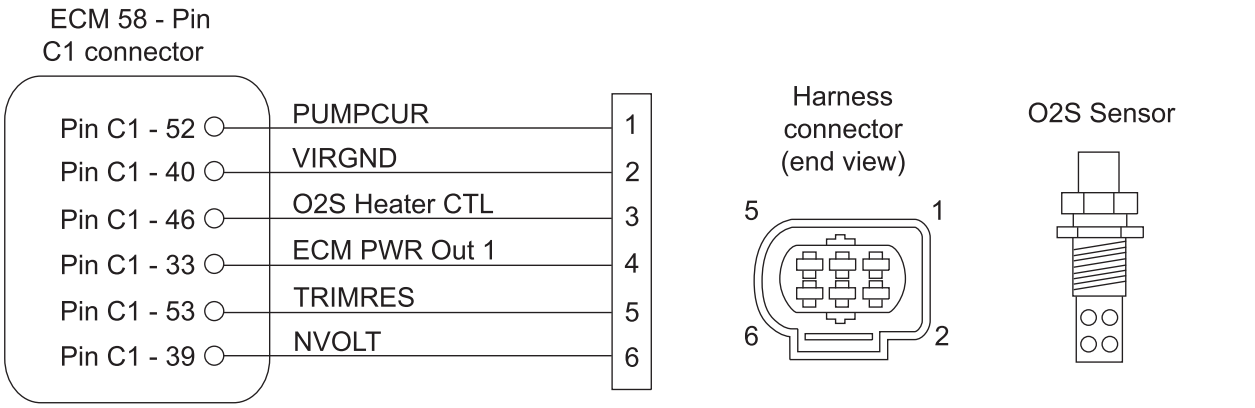


Figure 498 O_2S circuit diagram

Possible Causes

- HTR CTL circuit short to GND
- ECM PWR OUT 1 circuit Open or high resistance
- HTR CTL circuit Open or high resistance
- Failed O_2S

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 724 FMI 3, 4 (O_2S); SPN 3223 FMI 3, 4 (O_2S); SPN 3597 FMI 4 (ECM PWR). Is EST DTC list free of SPN 724 FMI 3, 4; SPN 3223 FMI 3, 4; SPN 3597 FMI 4?	Yes: Go to step 2. No: Repair SPN 724 FMI 3, 4; SPN 3223 FMI 3, 4; SPN 3597 FMI 4. After repairs are complete, retest for SPN 3223 FMI 5.

Step	Action	Decision
2	Inspect connections at Oxygen Sensor (O_2S). Key OFF, disconnect O_2S. Check sensor and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the O_2S connector, harness, and terminals clean and undamaged?	Yes: Go to step 3. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3223 FMI 5.

Step	Action	Decision
3	Inspect connections at ECM C1 connector. Key OFF, disconnect ECM C1 connector. Check connector and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the ECM C1 connector, harness, and terminals clean and undamaged?	Yes: Go to step 4. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3223 FMI 5.

Step	Action	Decision
4	Check for short to GND in the HTR CTL circuit. Connect Breakout Harness ZTSE4735A to O_2S harness, and leave sensor disconnected. Key-On, using a DMM, measure voltage between ZTSE4735A pin-3 and pin-4. Is voltage less than 5 volts?	Yes: Go to step 5 No: Repair short to GND in HTR CTL circuit between O_2S connector pin-3 and ECM pin C1-46. After repairs are complete, retest for SPN 3223 FMI 5.

Step	Action	Decision
5	Check for Open or high resistance in the HTR CTL circuit. Connect 180-pin Breakout Box and ECM C1 & C2 Breakout Harness to vehicle harness, and leave ECM disconnected. Connect Breakout Harness ZTSE4735A to O_2S harness, and leave sensor disconnected. Key-Off, using a DMM, measure resistance between ZTSE4735A pin-3 and ECM pin C1-46. Is resistance less than 5 ohms?	Yes: Go to step 6 No: Repair Open in HTR CTL circuit between O_2S connector pin-3 and ECM pin C1-46. After repairs are complete, retest for SPN 3223 FMI 5.

Step	Action	Decision
6	Check for Open or high resistance in the ECM PWR OUT 1 circuit. Connect 180-pin Breakout Box and ECM C1 & C2 Breakout Harness to vehicle harness, and leave ECM disconnected. Connect Breakout Harness ZTSE4735A to O_2S harness, and leave sensor disconnected. Key-Off, using a DMM, measure resistance between ZTSE4735A pin-4 and ECM pin C1-33. Is resistance less than 5 ohms?	Yes: Replace O_2S. After repairs are complete, retest for SPN 3223 FMI 5.
		No: Repair Open in ECM PWR OUT 1 circuit between O_2S connector pin-4 And ECM pin C1-33. After repairs are complete, retest for SPN 3223 FMI 5.

NOTE: After performing all diagnostic steps, if SPN 3223 FMI 5 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

Pinpoint O_2S System Fault

SPN 3223 FMI 1– O_2S heater temperature below minimum

SPN 3223 FMI 17 – O_2S heater temperature below minimum at low battery PWR

NOTE: SPN 3223 FMI 17 will set if battery voltage is below 10 V when the O_2S heater is commanded ON.

1. Check for other active or previously active DTCs. Repair any electrical fault before continuing with this procedure.
2. Verify batteries and changing system are working within specifications. See "Engine Symptoms Diagnostics."
    - If charging system and battery voltage are working within specification, check for circuit faults to the O_2S. If circuits are within specification, calibrate and install new O_2S.

RAPP (Remote Accelerator Pedal Position)

SPN	FMI	Condition	Possible Causes	Actions
974	3	Remote APP signal Out of Range HIGH	• RPS signal circuit short to PWR • SIG GND circuit OPEN • Failed RAPP system component	Circuit Checks (page 1340)
974	4	Remote APP signal Out of Range LOW	• RPS signal circuit OPEN or short to GND • VREF4 circuit OPEN • Failed RAPP system component	Circuit Checks (page 1340)

Overview

The Remote Accelerator Pedal Position (RAPP) feature allows the operator to set and maintain a constant engine speed from outside the vehicle cab. This feature may also be know as Remote Engine Speed Control (RESC). Control over engine speed is accomplished by using remote mounted switches to turn on the RESC and select the desired engine speed.

Tools Required

- 180-Pin Breakout Box 00-00956-08
- 2010 MaxxForce 11 & 13 Harness Kit 00-01462-00
- 3-Banana Plug Harness ZTSE4498
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

Sensor Circuit Check With ServiceMaxx™ Software

Disconnect Body Builder Connector 2. Turn ignition switch to ON.

Test Point	Specification	Comment – < Less than, > Greater than
EST – Run Continuous Monitor Test and monitor APP1v Short pins 2-A and 2-B	4.5 V to 5 V	If < 4.5 V, check APP1 signal circuit for OPEN. Do Harness Resistance Check (page 1340).
DMM — Measure voltage 2-B to GND	5.0 V ± 0.5 V	If > 5.5 V, check VREF4 for short to PWR. If < 4.5 V, check VREF4 for OPEN or short to GND. Do Harness Resistance Check (page 1340).

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM C1 and C2 harness to ECM C1 and C2 vehicle harness connectors, and leave ECM disconnected. Disconnect Body Builder Connector 2. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
2-A to C1-13	< 5 Ω	If > 5 Ω, check for OPEN in circuit.
2-A to GND	> 1k Ω	If < 1k Ω, check for short to GND.
2-B to C1-37	< 5 Ω	If > 5 Ω, check for OPEN in circuit.
2-B to GND	> 1k Ω	If < 1k Ω, check for short to GND.
2-C to C1-24	< 5 Ω	If > 5 Ω, check for OPEN in circuit.
2-C to GND	>1k Ω	If < 1k Ω, check for short to GND.

SCR Temperature Sensor Module

SPN	FMI	Condition	Possible Causes	Actions
5743	3	SCR Temperature Sensor Module Out of Range HIGH	• Failed SCR temperature sensor module • Incorrect Battery Wiring (in series instead of in parallel) • Charging voltage excessive	Step-Based Diagnostics (page 1344)
5743	4	SCR Temperature Sensor Module Out of Range LOW	• Failed SCR temperature sensor module • GND circuit intermittent Open or high resistance • SWBAT circuit intermittent short to ground or Open	Step-Based Diagnostics (page 1347)
5743	11	SCR Temperature Sensor Module signal erratic, intermittent, or incorrect	• Missing, damaged, or restricted air flow across SCR temperature sensor module • SWBAT circuit intermittent Open or short to GND • GND circuit intermittent Open or short to PWR • Failed SCR temperature sensor module	Step-Based Diagnostics (page 1350)
5743	16	SCR Temperature Sensor Module above Maximum Temperature	• Missing, damaged, or restricted air flow across SCR temperature sensor module • Exhaust leak(s) • Failed SCR temperature sensor module	Step-Based Diagnostics (page 1353)

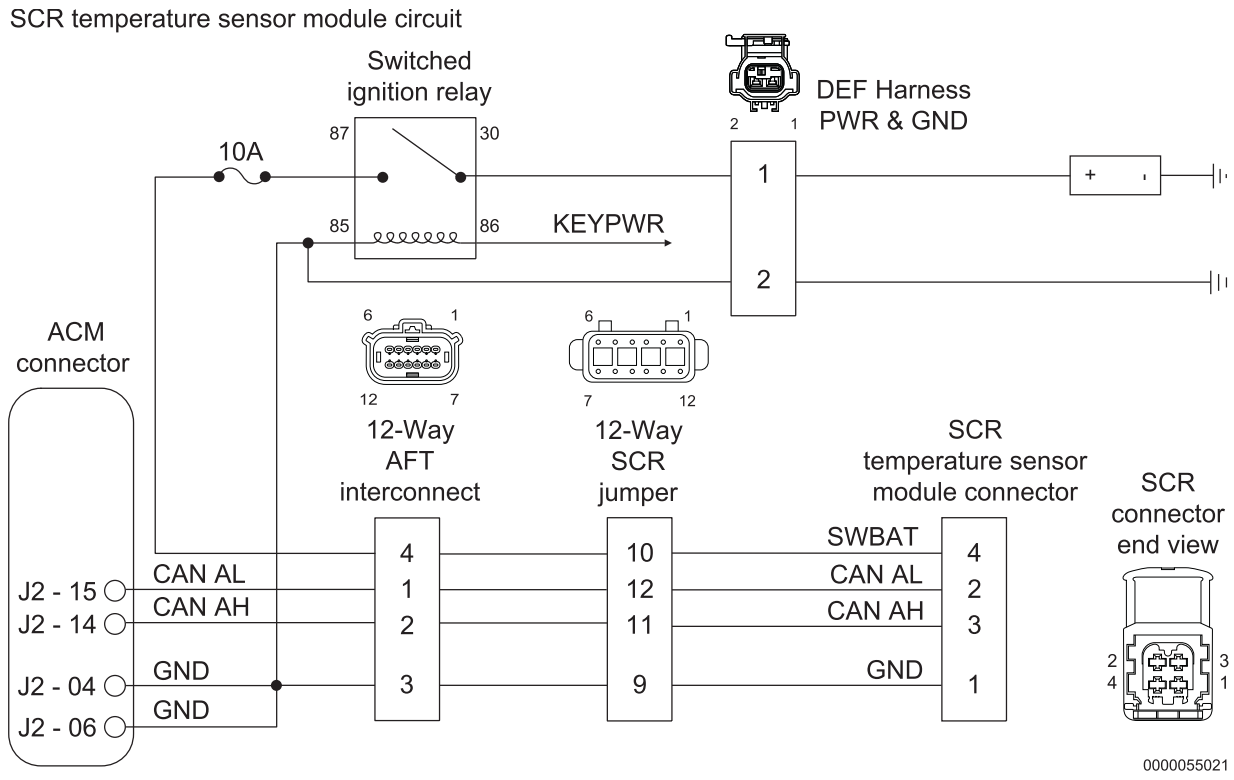


Figure 499 SCR Temperature Sensor Module Circuit Diagram

NOTE: See latest version of Navistar N13 Engine and Aftertreatment Wiring Schematic Form 0000002203 for additional circuit information.

Overview

The Selective Catalyst Reduction (SCR) temperature sensor module monitors signals from the SCR Inlet Temperature (SCRIT), and SCR Outlet Temperature (SCROT) sensors, and communicates to the Aftertreatment Control Module (ACM) over the Controller Area Network (CAN). Engine torque will be reduced if the engine is operated for a limited period of time with this fault code active. Engine torque will be reduced and vehicle speed will be limited after extended engine operation with the fault active.

Tools Required

- 180-Pin Breakout Box 00-00956-08
- Breakout Harness 18-100-01 (58-pin)
- Breakout Harness 18-648-01
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

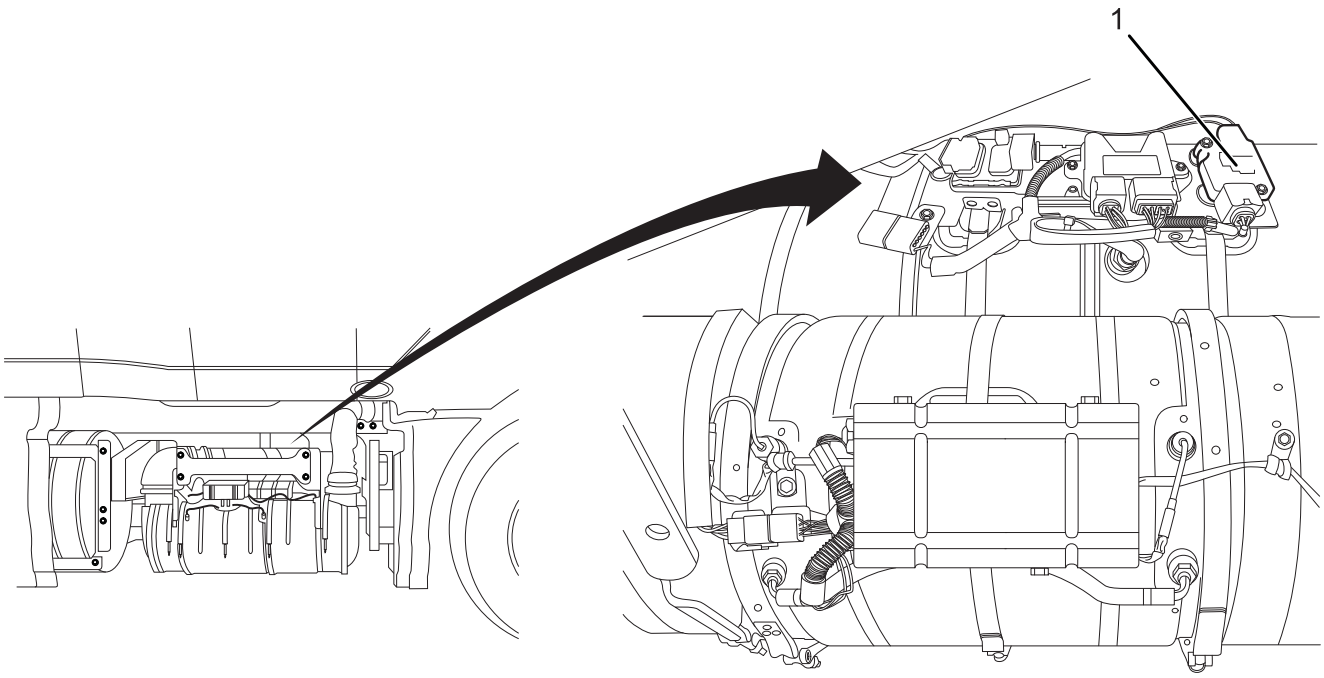


Figure 500 SCR Temperature Sensor Module Location

1. Selective Catalyst Reduction (SCR) temperature sensor module

SPN 5743 FMI 3 - SCR Temperature Sensor Module Out of Range HIGH

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Selective Catalyst Reduction (SCR) temperature sensor module has detected high supply voltage.	SCR temperature sensor module supply voltage > 18 V ± 1 V	Key ON	4.2 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Selective Catalyst Reduction (SCR) temperature sensor module supply voltage is high.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN's 168 FMI 16 (ACM).

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

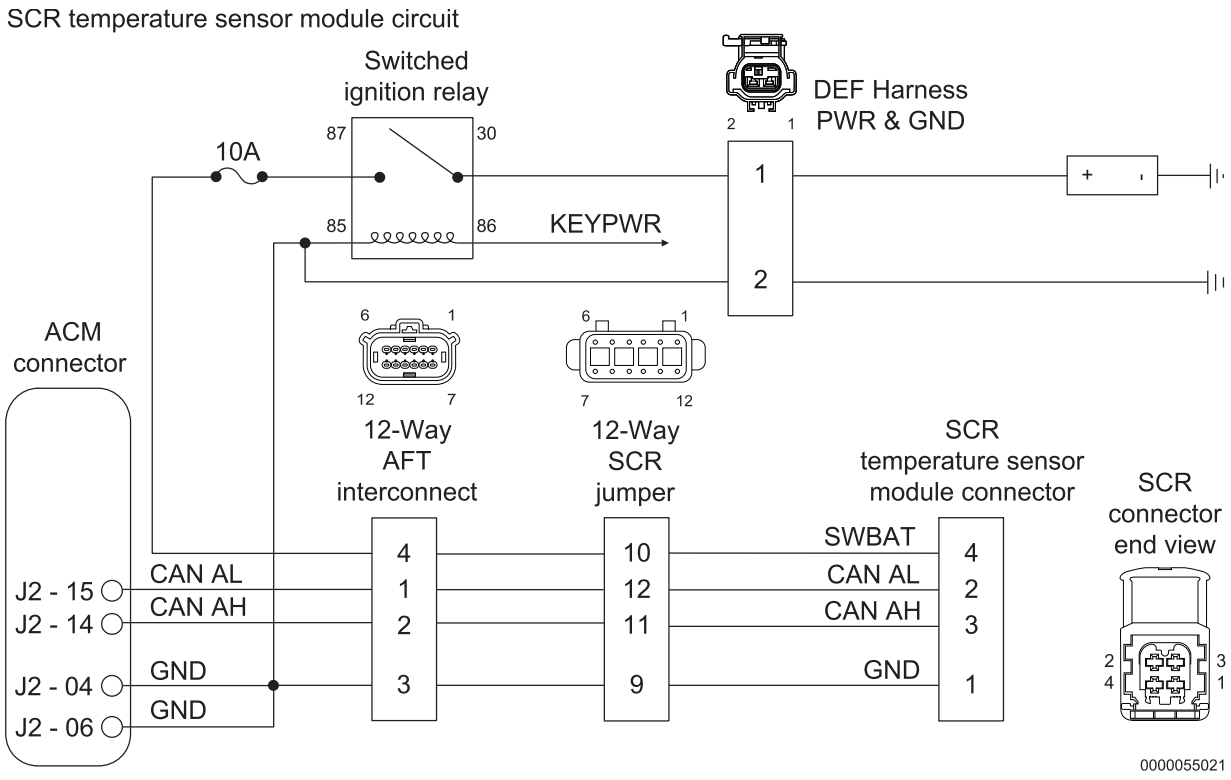


Figure 501 SCR Temperature Sensor Module Circuit Diagram

Possible Causes

- Failed SCR temperature sensor module
- Incorrect battery wiring (series instead of in parallel)
- Charging voltage excessive

Step	Action	Decision
1	Inspect connections at Selective Catalyst Reduction (SCR) temperature sensor module. Key OFF, disconnect SCR temperature sensor module connector. Check SCR temperature sensor module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the SCR temperature sensor module connector, harness, and terminals clean and undamaged?	Yes: Go to step 2. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 5743 FMI 3.

NOTE: Verify charging system is charging at specified voltage.

Step	Action	Decision
2	Check for PWR to the SCR temperature sensor module. Connect 18-648-01 to vehicle harness and leave SCR temperature sensor module disconnected. Key-On Engine-Off (KOEO) use a DMM to measure voltage between breakout harness pin-1 and pin-4. Is voltage between pin-1 and pin-4 within 0.5 volts of battery voltage?	Yes: Replace SCR temperature sensor module. After repairs are complete, retest for SPN 5743 FMI 3 No: Repair incorrect Battery Wiring. After repairs are complete, retest for SPN 5743 FMI 3

NOTE: After performing all diagnostic steps, if SPN 5743 FMI 3 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 5743 FMI 4 - SCR Temperature Sensor Module Out of Range LOW

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Selective Catalyst Reduction (SCR) temperature sensor module has detected low supply voltage.	SCR temperature sensor module supply voltage < 6.3 V ± 0.3 V	Key ON	4.2 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Selective Catalyst Reduction (SCR) temperature sensor module supply voltage is low.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN's 168 FMI 18 (ACM).

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

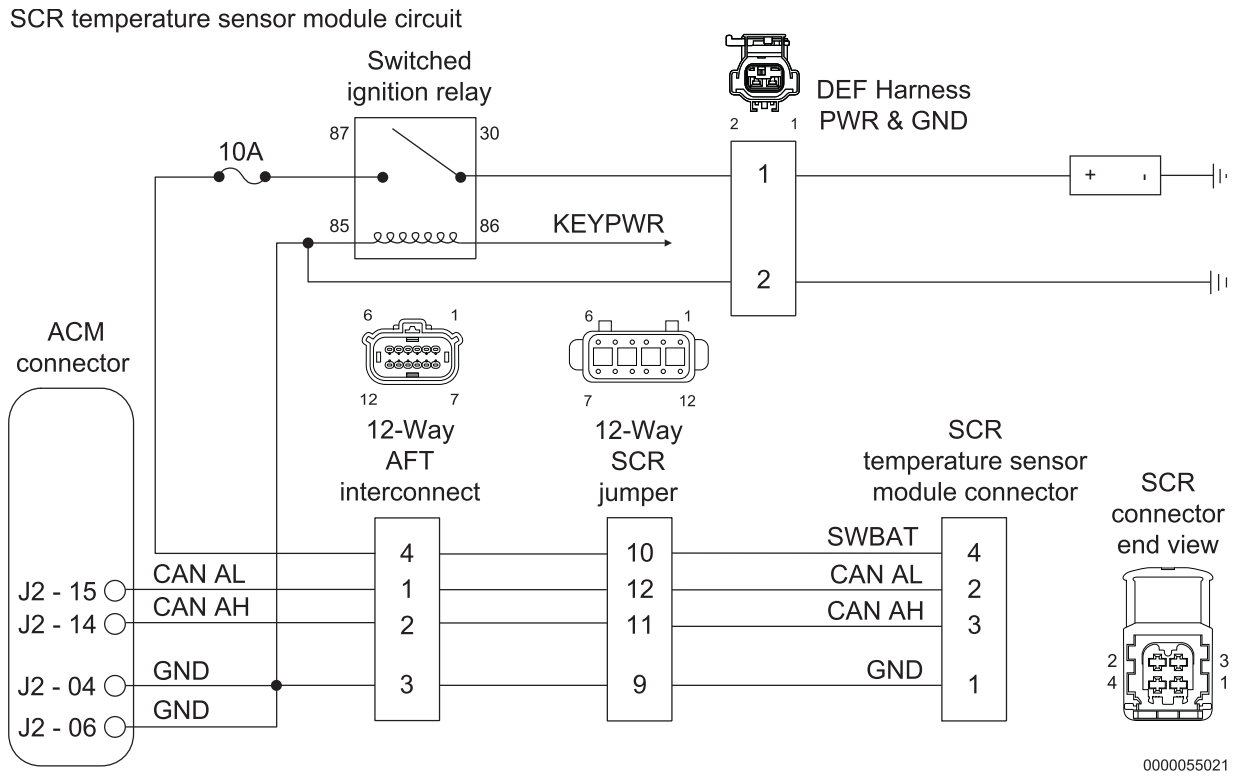


Figure 502 SCR Temperature Sensor Module Circuit Diagram

Possible Causes

- Failed SCR temperature sensor module
- GND circuit intermittent Open or high resistance
- SWBAT circuit intermittent short to GND orr Open

Step	Action	Decision
1	Inspect connections at Selective Catalyst Reduction (SCR) temperature sensor module. Key OFF, disconnect SCR temperature sensor module connector. Check SCR temperature sensor module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the SCR temperature sensor module connector, harness, and terminals clean and undamaged?	Yes: Go to step 2. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 5743 FMI 4.

NOTE: Verify batteries are fully charged and connections are clean.

Step	Action	Decision
2	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 168 FMI 16 and 18. Is EST DTC list free of SPN 168 FMI 16 and 18?	Yes: Go to step 3. No: Repair SPN 168 FMI 16 and 18. After repairs are complete, retest for SPN 5743 FMI 4.

Step	Action	Decision
3	Check SCR temperature sensor module for battery voltage and ground. With SCR temperature sensor module connector disconnected, connect Breakout Harness 18-648-01. Key-On Engine Off (KOEO), use a DMM to measure voltage between SCR temperature sensor module pin-4 and pin-1. Is voltage within 0.5 volts of battery voltage?	Yes: Replace SCR temperature sensor module. After repairs are complete, retest for SPN 5743 FMI 4. No: Go to step 4.

Step	Action	Decision
4	Check SWBAT circuit for Open or short to ground. With SCR temperature sensor module connector disconnected, connect Breakout Harness 18-648-01. KOEO, use a DMM to measure voltage between SCR temperature sensor module pin-4 and a known good ground. Is voltage within 0.5 volts of battery voltage?	Yes: Repair Open or high resistance in GND circuit between SCR temperature sensor module connector pin-1 and ground. After repairs are complete, retest for SPN 5743 FMI 4 No: Repair Open or short to ground in SWBAT circuit between SCR temperature sensor module connector pin-4 and switched ignition relay pin-87. After repairs are complete, retest for SPN 5743 FMI 4.

NOTE: After performing all diagnostic steps, if SPN 5743 FMI 4 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 5743 FMI 11 - SCR Temperature Sensor Module signal erratic, intermittent, or incorrect

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Selective Catalyst Reduction (SCR) temperature sensor module has detected an intermittent power supply voltage drop that results in a reset internal to the module.	Number of SCR temperature sensor module power reset events within a 300 second window is ≥ 5	Key ON Time after Key ON ≥ 5 seconds	5 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the number of SCR temperature sensor module power reset events within a 300 second window is ≥ 5 counts. Active and parked regeneration is disabled. Exhaust Gas Recirculation (EGR) valve operation will be disabled.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN's 168 FMI 16 and 18 (ACM).

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

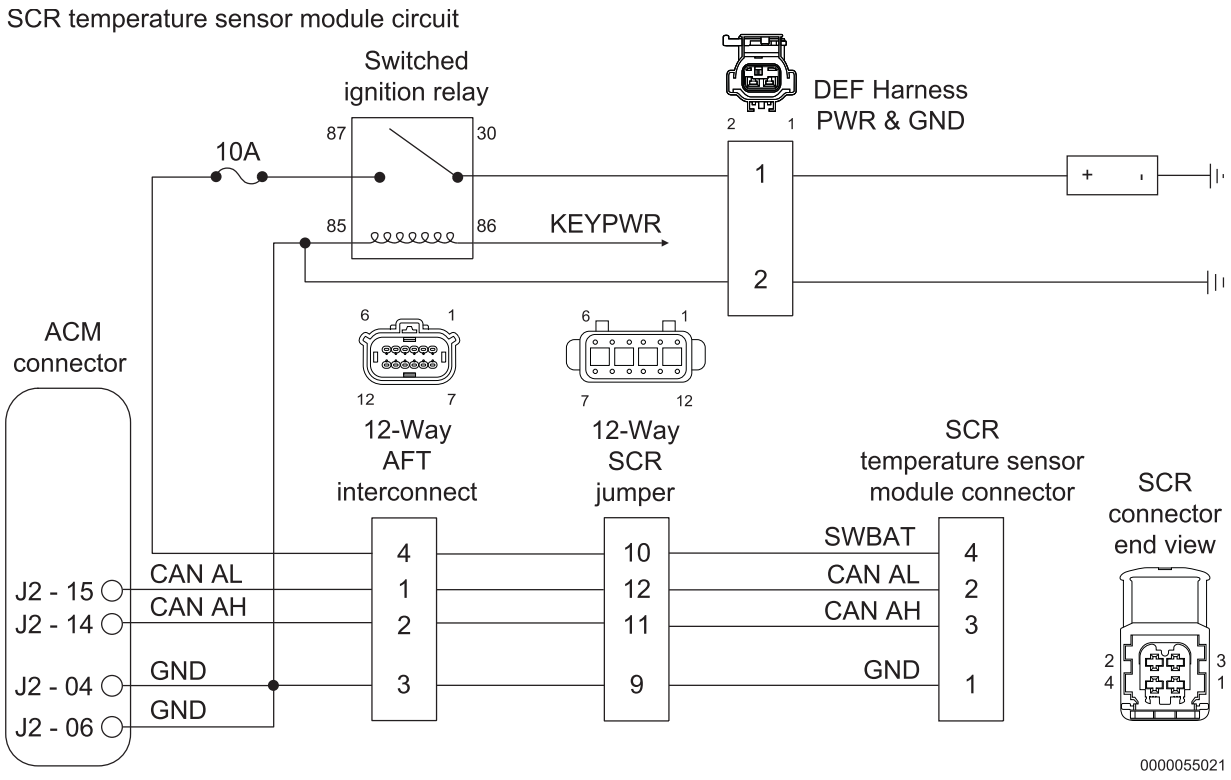


Figure 503 SCR Temperature Sensor Module Circuit Diagram

Possible Causes

- Missing, damaged, or restricted air flow across SCR temperature sensor module
- SWBAT circuit intermittent Open or short to GND
- GND circuit intermittent Open or short to PWR
- Failed SCR temperature sensor module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 168 FMI 16 and 18 (ACM PWR). Is EST DTC list free of SPN 168 FMI 16, and 18?	Yes: Go to step 2. No: Repair SPN 168 FMI 16, and 18. After repairs are complete, retest for SPN 5743 FMI 11.

Step	Action	Decision
2	Inspect for damaged or missing Selective Catalyst Reduction (SCR) temperature sensor module heat shield. Check for air flow restrictions around SCR temperature sensor module (mud, aftermarket shields, flaps, or brackets installed). Is SCR temperature sensor module heat shield free of air restrictions and is not missing or damaged?	Yes: Go to step 3. No: Remove air restriction, or replace or repair SCR temperature sensor module heat shield. After repairs are complete, retest for SPN 5743 FMI 11.

Step	Action	Decision
3	Inspect connections at SCR temperature sensor module. Key OFF, disconnect SCR temperature sensor module. Check SCR temperature sensor module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the SCR temperature sensor module connector, harness, and terminals clean and undamaged?	Yes: Go to step 4. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 5743 FMI 11.

Step	Action	Decision
4	Check SWBAT circuit for intermittent Open or short to ground. With SCR temperature sensor module connector disconnected, connect Breakout Harness 18-648-01. Key-On Engine-Off (KOEO), use a DMM to measure voltage between SCR temperature sensor module pin-4 and a known good ground. (Wiggle test may be required). Is voltage within 0.5 volts of battery voltage?	Yes: Go to step 5. No: Repair intermittent, Open or short to ground in SWBAT circuit between SCR temperature sensor module connector pin-4 and switched ignition relay pin-87. After repairs are complete, retest for SPN 5743 FMI 11.

Step	Action	Decision
5	Check GND circuit for intermittent Open or short to PWR. With SCR temperature sensor module connector disconnected, connect Breakout Harness 18-648 -01. Key-On Engine-Off (KOEO), use a DMM to measure voltage between SCR temperature sensor module pin-1 and pin-4. (Wiggle test may be required). Is voltage within 0.5 volts of battery voltage?	Yes: Replace SCR temperature sensor module. After repairs are complete, retest for SPN 5743 FMI 11. No: Repair intermittent, Open or short to PWR in GND circuit between SCR temperature sensor module connector pin-1 and GND. After repairs are complete, retest for SPN 5743 FMI 11.

NOTE: After performing all diagnostic steps, if SPN 5743 FMI 11 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 5743 FMI 16 - SCR Temperature Sensor Module above Maximum Temperature

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Selective Catalyst Reduction (SCR) temperature sensor module has detected internal temperature too high.	SCR temperature sensor module > 302°F (150°C)	Key-On Engine-Running (KOER)	3.8 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Selective Catalyst Reduction (SCR) temperature sensor module is greater than 302°F (150°C). Active and parked regeneration is disabled. Exhaust Gas Recirculation (EGR) valve operation will be disabled.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Fault Facts

This fault will go inactive after the SCR temperature sensor module temperature drops below the warning limit, and will likely be inactive when the vehicle is in the shop. For this reason, these diagnostics must be used for both active and inactive fault codes.

Inspect for overheated aftertreatment components, cracked exhaust system welds, leaking exhaust system seams, or other damage.

Associated Faults

SPN 4360 FMI 0, 15, 16 (SCRIT); and SPN 4363 FMI 0, 15, 16 (SCROT).

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Missing, damaged, or restricted air flow across SCR temperature sensor module
- Exhaust leak(s)
- Failed SCR temperature sensor module

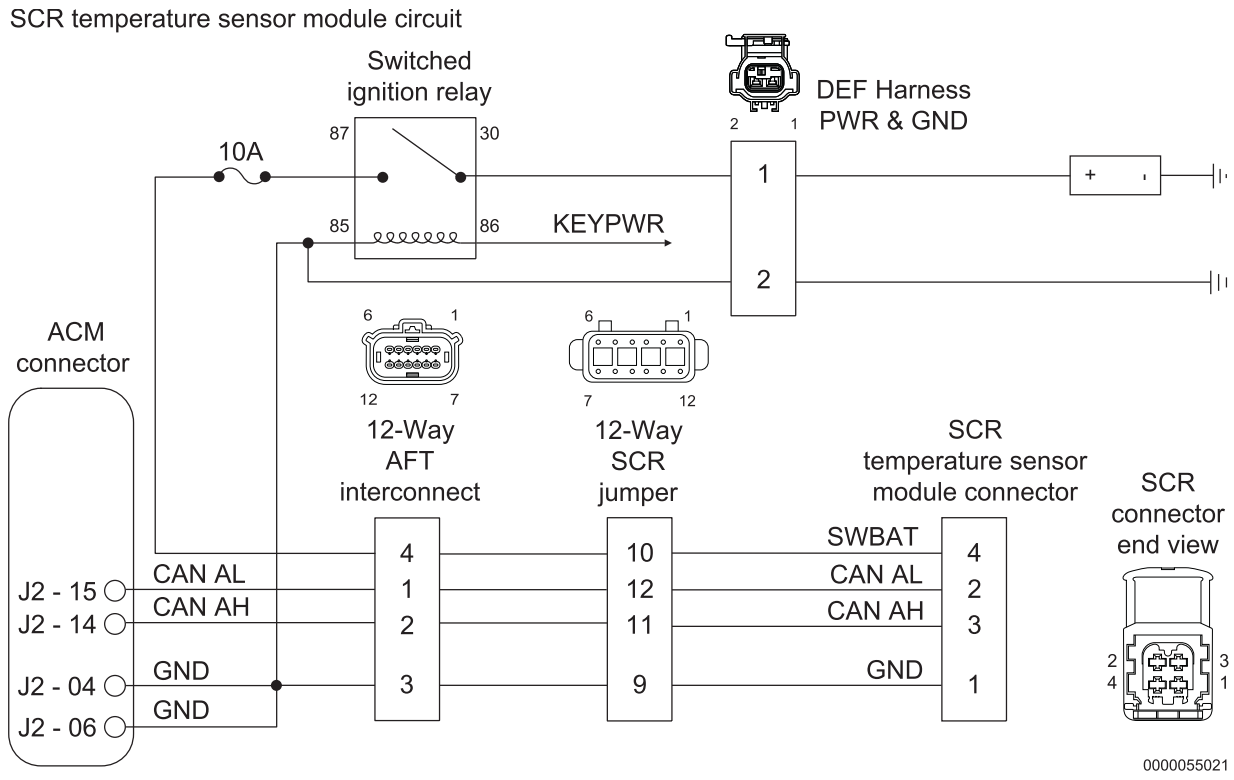


Figure 504 SCR Temperature Sensor Module Circuit Diagram

Possible Causes

- Missing, damaged, or restricted air flow across SCR temperature sensor module
- Exhaust leak(s)
- Failed SCR temperature sensor module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 4360 FMI 0, 15, 16 (SCRIT); and SPN 4363 FMI 0, 15, 16 (SCROT). Is EST DTC list free of SPN 4360 FMI 0, 15, 16; and SPN 4363 FMI 0, 15, 16?	Yes: Go to step 2. No: Repair SPN 4360 FMI 0, 15, 16; and SPN 4363 FMI 0, 15, 16. After repairs are complete, retest for SPN 5743 FMI 16.

Step	Action	Decision
2	Inspect for damaged or missing Selective Catalyst Reduction (SCR) temperature sensor module heat shield. Check for air flow restrictions around SCR temperature sensor module (mud, aftermarket shields, flaps, or brackets installed). Is SCR temperature sensor module heat shield free of air restrictions and is not missing or damaged?	Yes: Go to step 3. No: Remove air restriction, or replace or repair SCR temperature sensor module heat shield. After repairs are complete, retest for SPN 5743 FMI 16.

Step	Action	Decision
3	Inspect exhaust system for leaks and physical damage. Is exhaust system free of leaks and physical damage?	Yes: Replace SCR temperature sensor module. After repairs are complete, retest for SPN 5743 FMI 16.
		No: Repair or replace leaking or damaged exhaust components. Refer to Fault Facts. After repairs are complete, retest for SPN 5743 FMI 16.

NOTE: After performing all diagnostic steps, if SPN 5743 FMI 16 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SCRIT (Selective Catalyst Reduction Inlet Temperature) Sensor

SPN	FMI	Condition	Possible Causes	Actions
4360	0	SCRIT above Critical Temperature	• Contaminated Diesel Exhaust Fluid (DEF) • Leaking fuel injector • Lube oil leak to exhaust • Fuel leak to exhaust • Leaking or stuck Open Aftertreatment Fuel Injector (AFTFI) • Leaking or stuck Open Aftertreatment Fuel Shutoff Valve (AFTFSV) • Failed SCR temperature sensor module	Step-Based Diagnostics (page 1359)
4360	2	SCRIT signal erratic, intermittent, or incorrect	• Failed SCR temperature sensor module	Step-Based Diagnostics (page 1363)
4360	3	SCRIT signal Out of Range HIGH	• Failed SCR temperature sensor module	Step-Based Diagnostics (page 1365)
4360	4	SCRIT signal Out of Range LOW	• Failed SCR temperature sensor module	Step-Based Diagnostics (page 1366)
4360	15	SCRIT above Warning Temperature	• Contaminated Diesel Exhaust Fluid (DEF) • Leaking fuel injector • Lube oil leak to exhaust • Fuel leak to exhaust • Leaking or stuck Open Aftertreatment Fuel Injector (AFTFI) • Leaking or stuck Open Aftertreatment Fuel Shutoff Valve (AFTFSV)	Step-Based Diagnostics (page 1367)

			• Failed SCR temperature sensor module	
4360	16	SCRIT Above Maximum Temperature	• Contaminated Diesel Exhaust Fluid (DEF) • Leaking fuel injector • Lube oil leak to exhaust • Fuel leak to exhaust • Leaking or stuck Open Aftertreatment Fuel Injector (AFTFI) • Leaking or stuck Open Aftertreatment Fuel Shutoff Valve (AFTFSV)) • Failed SCR temperature sensor module	Step-Based Diagnostics (page 1367)

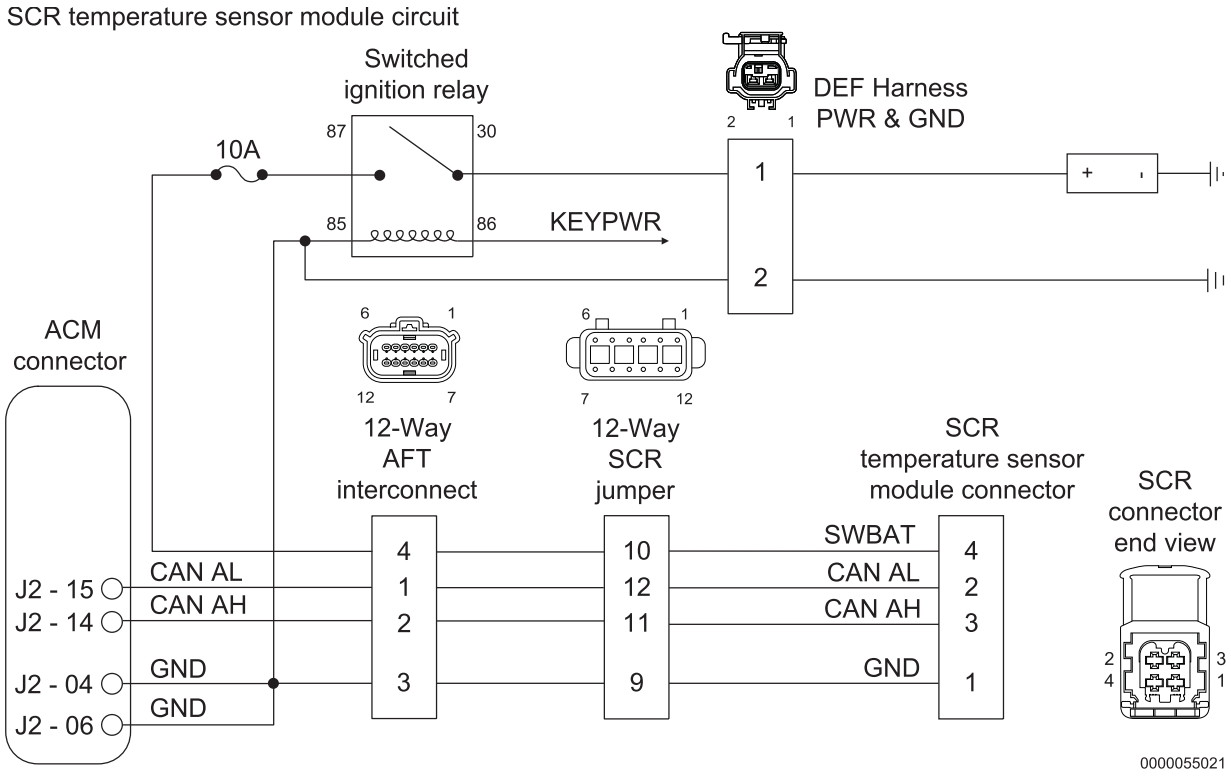


Figure 505 SCR Temperature Sensor Module Circuit Diagram

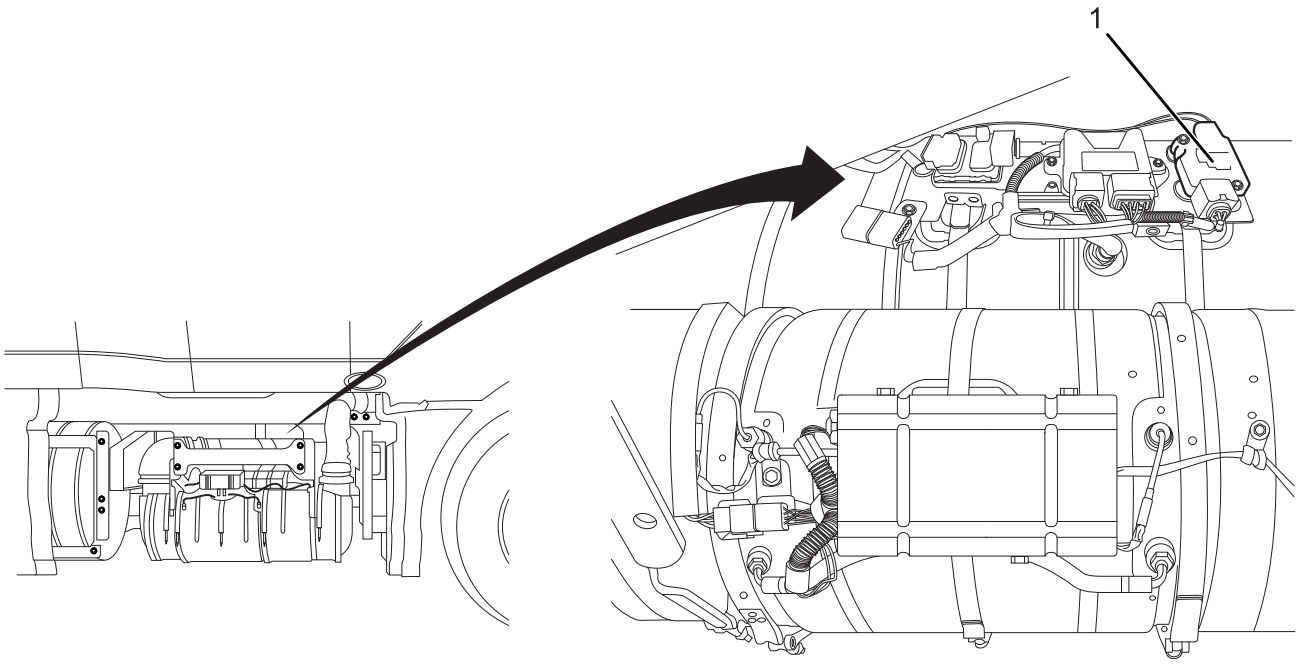
NOTE: See latest version of Navistar N13 Engine and Aftertreatment Wiring Schematic Form 0000002203 for additional circuit information.

Overview

The Selective Catalyst Reduction Inlet Temperature (SCRIT) sensor measures the exhaust temperature at the inlet of the SCR catalyst. The SCR temperature sensor module is a smart device that communicates with the Aftertreatment Control Module (ACM) via the Controller Area Network (CAN). The SCRIT sensor is part of the SCR temperature sensor module, and is not serviceable individually.

Tools Required

- 180-Pin Breakout Box 00-00956-08
- ACM Breakout Harness 18-100-01 (58-pin)
- Breakout Harness 18-648-01
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)



0000055023

Figure 506 SCR Temperature Sensor Module Location

1. Selective Catalyst Reduction (SCR) temperature sensor module

SPN 4360 FMI 0- SCRIT above Critical Temperature

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Selective Catalyst Reduction Inlet Temperature (SCRIT) continuously above a severe, high threshold.	SCRIT > 1472°F (800 °C)	Key-On Engine-Running (KOER) Inactive: SPN 4360 FMI 2, 3, and 4 (SCRIT); and SPN 5743 FMI 3, 4 and 11 (SCR).	20 seconds

Fault Overview

Fault code sets when Aftertreatment Control Module (ACM) detects the Selective Catalyst Reduction Inlet Temperature (SCRIT) sensor reading is greater than 1472°F (800°C) for more than 20 seconds. The Diesel Exhaust Fluid (DEF) injection into the aftertreatment system is disabled and the engine can possibly be shut down.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 1322-1328 FMI 31 (CYL); SPN 3242 FMI 0, 15, and 16 (DPFIT); SPN 3246 FMI 0, 15, and 16 (DPFOT); SPN 4360 FMI 2, 3, and 4 (SCRIT); SPN 4765 FMI 0, 15, and 16 (DOCIT); and SPN 5743 FMI 3, 4, 11, and 16 (SCR).

Fault Fact

If aftertreatment system has had excess fuel, oil, coolant, metal, or other contamination; inspect the entire aftertreatment system for causal damage before re-installing. Inspect for overheated aftertreatment components, cracked exhaust system welds, leaking exhaust system seams, or other damage. This fault will go inactive after the SCRIT drops below the warning limit, and will likely be inactive when the vehicle is in the shop. For this reason, these diagnostics must be used for both active and inactive fault codes.

NOTE: If more than one DOC, DPF and / or SCR temperature sensor over temperature fault code(s) are present, check for unregistered fuel or oil in the exhaust.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Contaminated Diesel Exhaust Fluid (DEF)
- Leaking fuel injector
- Lube oil leak to exhaust
- Fuel leak to exhaust
- Leaking or stuck Open Aftertreatment Fuel Injector (AFTFI)
- Leaking or stuck Open Aftertreatment Fuel Shutoff Valve (AFTFSV)
- Failed SCR temperature sensor module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 1322-1328 FMI 31 (CYL); SPN 3242 FMI 0, 15, and 16 (DPFIT); SPN 3246 FMI 0, 15, and 16 (DPFOT); SPN 4360 FMI 2, 3, and 4 (SCRIT); SPN 4765 FMI 0, 15, and 16 (DOCIT); SPN 5743 FMI 3, 4, 11, and 16 (SCR) fault codes. Is EST DTC list free of SPN 1322-1328 FMI 31; SPN 3242 FMI 0, 15, and 16; SPN 3246 FMI 0, 15, and 16; SPN 4360 FMI 2, 3, and 4; SPN 4765 FMI 0, 15, and 16; SPN 5743 FMI 3, 4, 11, 16?	Yes: Go to step 2. No: Repair SPN 1322-1328 FMI 31; SPN 3242 FMI 0, 15, and 16; SPN 3246 FMI 0, 15, and 16; SPN 4360 FMI 2, 3, and 4; SPN 4765 FMI 0, 15, and 16; SPN 5743 FMI 3, 4, 11, and 16 fault code(s). After repairs are complete, retest for SPN 4360 FMI 0.

Step	Action	Decision
2	Check DEF quality. Obtain a sample of DEF. Visually inspect for contamination, and use special tool DEF Refractometer 5025 to test urea concentration of DEF fluid. Is urea concentration between 30-34 percent and Not contaminated?	Yes: Go to step 3. No: Drain the DEF tank, flush with distilled water, and fill with new and / or known good DEF. After repairs are complete, retest for SPN 4360 FMI 0.

Step	Action	Decision
3	Determine if the engine has a mechanical cylinder balance problem (compression loss). Perform Crankcase Pressure Test (page 236). Does engine have excessive crankcase pressure?	Yes: Repair base engine compression imbalance. After repairs are complete, retest for SPN 4360 FMI 0. No: Go to step 4

Step	Action	Decision
4	Determine if engine has a fuel injector problem. Perform Multiple Cylinder Cutout Test (page 241). Did one or more cylinders have significant speed difference(s) than the others?	Yes: Go to step 5. No: Go to step 6.

Step	Action	Decision
5	Inspect for failed valve train components. Remove upper valve cover (see Engine Service Manual). Inspect for bent valves, fallen bridges, and valves out of adjustment. Is valve train free of failed valve train components?	Yes: Replace injector suspected by Multiple Cylinder Cutout Test. After repairs are complete, retest for SPN 4360 FMI 0. No: Repair failed valve train components. After repairs are complete retest for SPN 4360 FMI 0.

Step	Action	Decision
6	Inspect the turbocharger exhaust outlet for oil or fuel in the aftertreatment system from the engine. Remove the exhaust plumbing from the turbocharger outlet. Was the turbocharger exhaust outlet free of oil or fuel contamination?	Yes: Go to step 7. No: Repair lube oil or fuel leak to exhaust. See Lube Oil to Exhaust (page 163), or See Fuel to Exhaust (page 174). After repairs are complete, retest for SPN 4360 FMI 0.

Step	Action	Decision
7	Check for leaking or stuck open Aftertreatment Fuel Shutoff Valve (AFTFSV). Perform AFT Fuel Shutoff Valve Leak Test (page 121). Is the AFT Fuel Injector (AFTFI) dry and free of fuel?	Yes: Go to step 8. No: Replace AFTFSV. After repairs are complete, retest for SPN 4360 FMI 0.

Step	Action	Decision
8	Check for leaking or stuck open AFTFI. Perform AFT Fuel Injector Leak Test (page 120). Is the AFTFI dry and free of fuel?	Yes: Go to step 9. No: Replace AFTFI. After repairs are complete, retest for SPN 4360 FMI 0.

Step	Action	Decision
9	Check for failed AFT fuel flow. Perform AFT Dosing System Test (page 118). Was 225 to 500 ml of fuel dispensed within 2.5 minutes?	Yes: Go to step 10. No: Replace AFTFI. Refer to Fault Facts. After repairs are complete, retest for SPN 4360 FMI 0.

WARNING: Warning: To prevent personal injury or death, shift transmission to park or neutral, set parking brake, and block wheels before doing diagnostic or service procedures.

Step	Action	Decision
10	Compare SCR Inlet, and SCR outlet temperatures. Perform Hot Run Sensor Comparison Test (page 96). Is the SCR inlet, and SCR outlet temperature sensors with in 77°F (43°C) of each other?	Yes: Go to step 11. No: Replace SCR temperature sensor module. Refer to Fault Facts. After repairs are complete, retest for SPN 4360 FMI 0.

Step	Action	Decision
11	Test for black smoke from the exhaust. Idle the engine and snap the throttle to 100 percent. Perform this test multiple times, if necessary. Is the exhaust free of black smoke?	Yes: Replace SCR catalyst. After repairs are complete, retest for SPN 4360 FMI 0. No: Go to step 12.

Step	Action	Decision
12	Remove the Diesel Oxidation Catalyst (DOC). Inspect the DPF. Check the intake face of the DPF for soot accumulation, face plugging, and damage. Is less than 50 percent of the cells on the intake face completely blocked by soot and undamaged?	Yes: Reinstall DOC and perform a Parked Regeneration. After repairs are complete, retest for SPN 4360 FMI 0. No: Clean or replace DOC. Refer to Fault Facts. After repairs are complete, retest for SPN 4360 FMI 0.

NOTE: After performing all diagnostic steps, if SPN 4360 FMI 0 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 4360 FMI 2- SCRIT signal erratic, intermittent, or incorrect

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Selective Catalytic Reduction Inlet Temperature (SCRIT) is not changing with engine operating conditions (in-range but not rational).	Average temperature difference across the SCR > 162˚F (90˚C) OR average temperature difference across the SCR < -162˚F (-90˚C) SCRIT < 374°F (190°C) OR SCR Outlet Temperature (SCROT) < 392°F (200°C)	Ambient Air Temperature ≥ -68°F (-20°C) Engine coolant temperature > 140°F (60°C) [302°F (150°C) < SCRIT < (600°C) OR 302°F (150°C) < SCROT < 302°F (600°C)] Ambient air pressure (BARO) ≥ 75 kPa (gauge) Engine Speed > 200 RPM for 600 seconds Engine Speed > 800 RPM for 300 seconds Elapsed time since last active regeneration > 1,200 sec 250 g/sec < Exhaust flow < 1,000 g/sec Inactive: SPN 3246 FMI 3 and 4 (DPFOT); SPN 4360 FMI 3, 4 (SCRIT); SPN 4363 FMI 3, 4 (SCROT); SPN 5742 FMI 3, 4, and 11 (DPF); SPN 5743 FMI 3, 4, and 11 (SCR)	300 seconds

Fault Overview

Fault code sets when Aftertreatment Control Module (ACM) has determined the SCR Inlet Temperature (SCRIT) sensor does not match engine operating conditions for more than 5 minutes. Diesel exhaust fluid (DEF) injection into the aftertreatment system is disabled, and engine torque will be reduced if the engine is operated for an extended period of time with this fault active.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 3246 FMI 3 and 4 (DPFOT); SPN 4360 FMI 3 and 4 (SCRIT); SPN 4363 FMI 3 and 4 (SCROT); SPN 5742 FMI 3, 4, and 11 (DPF); and SPN 5743 FMI 3, 4, 11, and 16 (SCR)

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Failed SCR temperature sensor module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code list for SPN 3246 FMI 3 and 4 (DPFOT); SPN 4360 FMI 3 and 4 (SCRIT); SPN 4363 FMI 3 and 4 (SCROT); SPN 5742 FMI 3, 4, and 11 (DPF); and SPN 5743 FMI 3, 4, 11, and 16 (SCR). Is EST DTC list free of SPN 3246 FMI 3 and 4; SPN 4360 FMI 3 and 4; SPN 4363 FMI 3 and 4; SPN 5742 FMI 3, 4, and 11; and SPN 5743 FMI 3, 4, 11, and 16?	Yes: Replace SCR temperature sensor module. After repairs are complete, retest for SPN 4360 FMI 2. No: Repair SPN 3246 FMI 3 and 4; SPN 4360 FMI 3 and 4; SPN 4363 FMI 3 and 4; SPN 5742 FMI 3, 4, and 11; and SPN 5743 FMI 3, 4, 11, and 16 fault code(s). After repairs are complete, retest for SPN 4360 FMI 2.

NOTE: After performing all diagnostic steps, if SPN 4360 FMI 2 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 4360 FMI 3- SCRIT signal Out of Range HIGH

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Selective Catalyst Reduction (SCR) temperature sensor module shorted to battery or Open circuit in SCR Inlet Temperature (SCRIT) sensor circuit.	SCRIT sensor input voltage ≥ 5 volts or SCRIT sensor thermocouple impedance ≥ 10 Ohms	Key ON	16 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Selective Catalyst Reduction Inlet Temperature (SCRIT) sensor circuit is shorted to battery or Open. Active and parked regeneration will be disabled, and engine torque will be reduced if the engine is operated for an extended period of time with this fault active.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 5743 FMI 3, 4, 11, and 16 (SCR)

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Failed SCR temperature sensor module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code list for SPN 5743 FMI 3, 4, 11, and 16 (SCR). Is EST DTC list free of SPN 5743 FMI 3, 4, 11, and 16?	Yes: Replace SCR temperature sensor module. After repairs are complete, retest for SPN 4360 FMI 3.
		No: Repair SPN 5743 FMI 3, 4, 11, and 16 fault code(s). After repairs are complete, retest for SPN 4360 FMI 3.

NOTE: After performing all diagnostic steps, if SPN 4360 FMI 3 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 4360 FMI 4- SCRIT signal Out of Range LOW

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Selective Catalyst Reduction (SCR) temperature sensor module shorted to ground in the SCR Inlet Temperature (SCRIT) sensor circuit.	SCRIT ≤ 1 volts	Key ON	16 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the aftertreatment Selective Catalyst Reduction Inlet Temperature (SCRIT) sensor signal voltage is less than 1 volt. Active and parked regeneration will be disabled and engine torque reduced if the engine is operated for an extended period of time with this fault active.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 5743 FMI 3, 4, 11, and 16 (SCR)

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Failed SCR temperature sensor module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code list for SPN 5743 FMI 3, 4, 11, and 16 (SCR). Is EST DTC list free of SPN 5743 FMI 3, 4, 11, and 16?	Yes: Replace SCR temperature sensor module. After repairs are complete, retest for SPN 4360 FMI 4.
		No: Repair SPN 5743 FMI 3, 4, 11, and 16 fault code(s). After repairs are complete, retest for SPN 4360 FMI 4.

NOTE: After performing all diagnostic steps, if SPN 4360 FMI 4 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 4360 FMI 15- SCRIT Above Warning Temperature

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Selective Catalytic Reduction Inlet Temperature (SCRIT) continuously above a warning temperature.	SCRIT > 1194°F (646°C)	Inactive: SPN 4360 FMI 2, 3, and 4 (SCRIT); SPN 5743 FMI 3, 4 and 11 (SCR).	20 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Selective Catalytic Reduction Inlet Temperature (SCRIT) reading is greater than 1194°F (646°C) for more than 20 seconds. The engine may shut down and diesel exhaust fluid injection into the aftertreatment system is disabled.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 1322-1328 FMI 31 (CYL); SPN 3242 FMI 0, 15, and 16 (DPFIT); SPN 3246 FMI 0, 15, and 16 (DPFOT); SPN 4360 FMI 2, 3, and 4 (SCRIT); SPN 4765 FMI 0, 15, and 16 (DOCIT); SPN 5743 FMI 3, 4, 11, and 16 (SCR).

Fault Fact

If aftertreatment system has had excess fuel, oil, coolant, metal, or other contamination; inspect the entire aftertreatment system for causal damage before re-installing. Inspect for overheated aftertreatment components, cracked exhaust system welds, leaking exhaust system seams, or other damage. This fault will go inactive after the SCRIT drops below the warning limit, and will likely be inactive when the vehicle is in the shop. For this reason, these diagnostics must be used for both active and inactive fault codes.

NOTE: If more than one DOC, DPF and / or SCR temperature sensor over temperature fault code(s) are present, check for unregistered fuel or oil in the exhaust.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Contaminated Diesel Exhaust Fluid
- Leaking fuel injector
- Lube oil leak to exhaust
- Fuel leak to exhaust
- Leaking or stuck Open Aftertreatment Fuel Injector (AFTFI)
- Leaking or stuck Open Aftertreatment Fuel Shutoff Valve (AFTFSV)
- Failed SCR temperature sensor module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 1322-1328 FMI 31 (CYL); SPN 3242 FMI 0, 15, and 16 (DPFIT); SPN 3246 FMI 0, 15, and 16 (DPFOT); SPN 4360 FMI 2, 3, and 4 (SCRIT); SPN 4765 FMI 0, 15, and 16 (DOCIT); SPN 5743 FMI 3, 4, 11, and 16 (SCR) fault codes. Is EST DTC list free of SPN 1322-1328 FMI 31; SPN 3242 FMI 0, 15, and 16; SPN 3246 FMI 0, 15, and 16; SPN 4360 FMI 2, 3, and 4; SPN 4765 FMI 0, 15, and 16; SPN 5743 FMI 3, 4, 11, 16?	Yes: Go to step 2. No: Repair SPN 1322-1328 FMI 31; SPN 3242 FMI 0, 15, and 16; SPN 3246 FMI 0, 15, and 16; SPN 4360 FMI 2, 3, and 4; SPN 4765 FMI 0, 15, and 16; SPN 5743 FMI 3, 4, 11, and 16 fault code(s). After repairs are complete, retest for SPN 4360 FMI 15.

Step	Action	Decision
2	Check DEF quality. Obtain a sample of DEF. Visually inspect for contamination, and use special tool DEF Refractometer 5025 to test urea concentration of DEF fluid. Is urea concentration between 30 - 34 percent and Not contaminated?	Yes: Go to step 3. No: Drain the DEF tank, flush with distilled water, and fill with new and / or known good DEF. After repairs are complete, retest for SPN 4360 FMI 15.

Step	Action	Decision
3	Determine if the engine has a mechanical cylinder balance problem (compression loss). Perform Crankcase Pressure Test (page 236). Does engine have excessive crankcase pressure?	Yes: Repair base engine compression imbalance. After repairs are complete, retest for SPN 4360 FMI 15. No: Go to step 4

Step	Action	Decision
4	Determine if engine has a fuel injector problem. Perform Multiple Cylinder Cutout Test (page 241). Did one or more cylinders have significant speed difference(s) than the others?	Yes: Go to step 5. No: Go to step 6.

Step	Action	Decision
5	Inspect for failed valve train components. Remove upper valve cover (see Engine Service Manual). Inspect for bent valves, fallen bridges, and valves out of adjustment. Is valve train free of failed valve train components?	Yes: Replace injector suspected by Multiple Cylinder Cutout Test. After repairs are complete, retest for SPN 4360 FMI 15. No: Repair failed valve train components. After repairs are complete retest for SPN 4360 FMI 15.

Step	Action	Decision
6	Inspect the turbocharger exhaust outlet for oil or fuel in the aftertreatment system from the engine. Remove the exhaust plumbing from the turbocharger outlet. Was the turbocharger exhaust outlet free of oil or fuel contamination?	Yes: Go to step 7. No: Repair lube oil or fuel leak to exhaust. See Lube Oil to Exhaust (page 163), or See Fuel to Exhaust (page 174). After repairs are complete, retest for SPN 4360 FMI 15.

Step	Action	Decision
7	Check for leaking or stuck open Aftertreatment Fuel Shutoff Valve (AFTFSV). Perform AFT Fuel Shutoff Valve Leak Test (page 121). Is the AFT Fuel Injector (AFTFI) dry and free of fuel?	Yes: Go to step 8. No: Replace AFTFSV. After repairs are complete, retest for SPN 4360 FMI 15.

Step	Action	Decision
8	Check for leaking or stuck open AFTFI. Perform AFT Fuel Injector Leak Test (page 120). Is the AFTFI dry and free of fuel?	Yes: Go to step 9. No: Replace AFTFI. After repairs are complete, retest for SPN 4360 FMI 15.

Step	Action	Decision
9	Check for failed AFT fuel flow. Perform AFT Dosing System Test (page 118). Was 225 to 500 ml of fuel dispensed within 2.5 minutes?	Yes: Go to step 10. No: Replace AFTFI. Refer to Fault Facts. After repairs are complete, retest for SPN 4360 FMI 15.

WARNING: Warning: To prevent personal injury or death, shift transmission to park or neutral, set parking brake, and block wheels before doing diagnostic or service procedures.

Step	Action	Decision
10	Compare SCR Inlet, and SCR outlet temperatures. Perform Hot Run Sensor Comparison Test (page 96). Is the SCR inlet, and SCR outlet temperature sensors with in 77°F (43°C) of each other?	Yes: Go to step 11. No: Replace SCR temperature sensor module. Refer to Fault Facts. After repairs are complete, retest for SPN 4360 FMI 15.

Step	Action	Decision
11	Test for black smoke from the exhaust. Idle the engine and snap the throttle to 100 percent. Perform this test multiple times, if necessary. Is the exhaust free of black smoke?	Yes: Replace SCR catalyst. After repairs are complete, retest for SPN 4360 FMI 15. No: Go to step 12.

Step	Action	Decision
12	Remove the Diesel Oxidation Catalyst (DOC). Inspect the DPF. Check the intake face of the DPF for soot accumulation, face plugging, and damage. Is less than 50 percent of the cells on the intake face completely blocked by soot and undamaged?	Yes: Reinstall DOC and perform a Parked Regeneration. After repairs are complete, retest for SPN 4360 FMI 15. No: Clean or replace DOC. Refer to Fault Facts. After repairs are complete, retest for SPN 4360 FMI 15.

NOTE: After performing all diagnostic steps, if SPN 4360 FMI 15 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 4360 FMI 16- SCRIT Above Maximum Temperature

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
SCR Inlet Temperature (SCRIT) continuously above a maximum temperature.	SCRIT > 1472°F (800°C)	Inactive: SPN 4360 FMI 2, 3, and 4 (SCRIT); SPN 5743 FMI 3, 4 and 11 (SCR).	20 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the SCR Inlet Temperature (SCRIT) reading is greater than 1472°F (800°C) for more than 20 seconds. The engine may shut down and Diesel Exhaust Fluid (DEF) injection into the aftertreatment system is disabled.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 1322-1328 FMI 31 (CYL); SPN 3242 FMI 0, 15, and 16 (DPFIT); SPN 3246 FMI 0, 15, and 16 (DPFOT); SPN 4360 FMI 2, 3, and 4 (SCRIT); SPN 4765 FMI 0, 15, and 16 (DOCIT); SPN 5743 FMI 3, 4, 11, and 16 (SCR).

Fault Fact

If aftertreatment system has had excess fuel, oil, coolant, metal, or other contamination; inspect the entire aftertreatment system for casual damage before re-installing. Inspect for overheated aftertreatment components, cracked exhaust system welds, leaking exhaust system seams, or other damage. This fault will go inactive after the SCRIT drops below the warning limit, and will likely be inactive when the vehicle is in the shop. For this reason, these diagnostics must be used for both active and inactive fault codes.

NOTE: If more than one DOC, DPF and / or SCR temperature sensor over temperature fault code(s) are present, check for unregistered fuel or oil in the exhaust.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Contaminated diesel exhaust fluid
- Leaking fuel injector
- Lube oil leak to exhaust
- Fuel leak to exhaust
- Leaking or stuck Open Aftertreatment Fuel Injector (AFTFI)
- Leaking or stuck Open Aftertreatment Fuel Shutoff Valve (AFTFSV)
- Failed SCR temperature sensor module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 1322-1328 FMI 31 (CYL); SPN 3242 FMI 0, 15, and 16 (DPFIT); SPN 3246 FMI 0, 15, and 16 (DPFOT); SPN 4360 FMI 2, 3, and 4 (SCRIT); SPN 4765 FMI 0, 15, and 16 (DOCIT); SPN 5743 FMI 3, 4, 11, and 16 (SCR) fault codes. Is EST DTC list free of SPN 1322-1328 FMI 31; SPN 3242 FMI 0, 15, and 16; SPN 3246 FMI 0, 15, and 16; SPN 4360 FMI 2, 3, and 4; SPN 4765 FMI 0, 15, and 16; SPN 5743 FMI 3, 4, 11, 16?	Yes: Go to step 2. No: Repair SPN 1322-1328 FMI 31; SPN 3242 FMI 0, 15, and 16; SPN 3246 FMI 0, 15, and 16; SPN 4360 FMI 2, 3, and 4; SPN 4765 FMI 0, 15, and 16; SPN 5743 FMI 3, 4, 11, and 16 fault code(s). After repairs are complete, retest for SPN 4360 FMI 16.

Step	Action	Decision
2	Check DEF quality. Obtain a sample of DEF. Visually inspect for contamination, and use special tool DEF Refractometer 5025 to test urea concentration of DEF fluid. Is urea concentration between 30 - 34 percent and Not contaminated?	Yes: Go to step 3. No: Drain the DEF tank, flush with distilled water, and fill with new and / or known good DEF. After repairs are complete, retest for SPN 4360 FMI 16.

Step	Action	Decision
3	Determine if the engine has a mechanical cylinder balance problem (compression loss). Perform Crankcase Pressure Test (page 236). Does engine have excessive crankcase pressure?	Yes: Repair base engine compression imbalance. After repairs are complete, retest for SPN 4360 FMI 16. No: Go to step 4

Step	Action	Decision
4	Determine if engine has a fuel injector problem. Perform Multiple Cylinder Cutout Test (page 241). Did one or more cylinders have significant speed difference(s) than the others?	Yes: Go to step 5. No: Go to step 6.

Step	Action	Decision
5	Inspect for failed valve train components. Remove upper valve cover (see Engine Service Manual). Inspect for bent valves, fallen bridges, and valves out of adjustment. Is valve train free of failed valve train components?	Yes: Replace injector suspected by Multiple Cylinder Cutout Test. After repairs are complete, retest for SPN 4360 FMI 16. No: Repair failed valve train components. After repairs are complete retest for SPN 4360 FMI 16.

Step	Action	Decision
6	Inspect the turbocharger exhaust outlet for oil or fuel in the aftertreatment system from the engine. Remove the exhaust plumbing from the turbocharger outlet. Was the turbocharger exhaust outlet free of oil or fuel contamination?	Yes: Go to step 7. No: Repair lube oil or fuel leak to exhaust. See Lube Oil to Exhaust (page 163), or See Fuel to Exhaust (page 174). After repairs are complete, retest for SPN 4360 FMI 16.

Step	Action	Decision
7	Check for leaking or stuck open Aftertreatment Fuel Shutoff Valve (AFTFSV). Perform AFT Fuel Shutoff Valve Leak Test (page 121). Is the AFT Fuel Injector (AFTFI) dry and free of fuel?	Yes: Go to step 8. No: Replace AFTFSV. After repairs are complete, retest for SPN 4360 FMI 16.

Step	Action	Decision
8	Check for leaking or stuck open AFTFI. Perform AFT Fuel Injector Leak Test (page 120). Is the AFTFI dry and free of fuel?	Yes: Go to step 9. No: Replace AFTFI. After repairs are complete, retest for SPN 4360 FMI 16.

Step	Action	Decision
9	Check for failed AFT fuel flow. Perform AFT Dosing System Test (page 118). Was 225 to 500 ml of fuel dispensed within 2.5 minutes?	Yes: Go to step 10. No: Replace AFTFI. Refer to Fault Facts. After repairs are complete, retest for SPN 4360 FMI 16.

WARNING: Warning: To prevent personal injury or death, shift transmission to park or neutral, set parking brake, and block wheels before doing diagnostic or service procedures.

Step	Action	Decision
10	Compare SCR Inlet, and SCR outlet temperatures. Perform Hot Run Sensor Comparison Test (page 96). Is the SCR inlet, and SCR outlet temperature sensors with in 77°F (43°C) of each other?	Yes: Go to step 11. No: Replace SCR temperature sensor module. Refer to Fault Facts. After repairs are complete, retest for SPN 4360 FMI 16.

Step	Action	Decision
11	Test for black smoke from the exhaust. Idle the engine and snap the throttle to 100 percent. Perform this test multiple times, if necessary. Is the exhaust free of black smoke?	Yes: Replace SCR catalyst. After repairs are complete, retest for SPN 4360 FMI 16. No: Go to step 12.

Step	Action	Decision
12	Remove the Diesel Oxidation Catalyst (DOC). Inspect the DPF. Check the intake face of the DPF for soot accumulation, face plugging, and damage. Is less than 50 percent of the cells on the intake face completely blocked by soot and undamaged?	Yes: Reinstall DOC and perform a Parked Regeneration. After repairs are complete, retest for SPN 4360 FMI 16. No: Clean or replace DOC. Refer to Fault Facts. After repairs are complete, retest for SPN 4360 FMI 16.

NOTE: After performing all diagnostic steps, if SPN 4360 FMI 16 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SCROT (Selective Catalyst Reduction Outlet Temperature) Sensor

SPN	FMI	Condition	Possible Causes	Actions
4363	0	SCROT above Critical Temperature	• Contaminated Diesel Exhaust Fluid (DEF) • Leaking fuel injector • Lube oil leak to exhaust • Fuel leak to exhaust • Leaking or stuck Open Aftertreatment Fuel Injector (AFTFI) • Leaking or stuck Open Aftertreatment Fuel Shutoff Valve (AFTFSV) • Failed SCR temperature sensor module	Step-Based Diagnostics (page 1379)
4363	2	SCROT signal erratic, intermittent or incorrect	• Failed SCR temperature sensor module	Step-Based Diagnostics (page 1384)
4363	3	SCROT signal Out of Range HIGH	• Failed SCR temperature sensor module	Step-Based Diagnostics (page 1386)
4363	4	SCROT signal Out of Range LOW	• Failed SCR temperature sensor module	Step-Based Diagnostics (page 1387)
4363	15	SCROT above Warning Temperature	• Contaminated Diesel Exhaust Fluid (DEF) • Leaking fuel injector • Lube oil leak to exhaust • Fuel leak to exhaust • Leaking or stuck Open Aftertreatment Fuel Injector (AFTFI) • Leaking or stuck Open Aftertreatment Fuel Shutoff Valve (AFTFSV)	Step-Based Diagnostics (page 1389)

			• Failed SCR temperature sensor module		
4363	16	SCROT above Maximum Temperature	• Contaminated Diesel Exhaust Fluid (DEF) • Leaking fuel injector • Lube oil leak to exhaust • Fuel leak to exhaust • Leaking or stuck Open Aftertreatment Fuel Injector (AFTFI) • Leaking or stuck Open Aftertreatment Fuel Shutoff Valve (AFTFSV) • Failed SCR temperature sensor module	Step-Based Diagnostics (page 1393)	

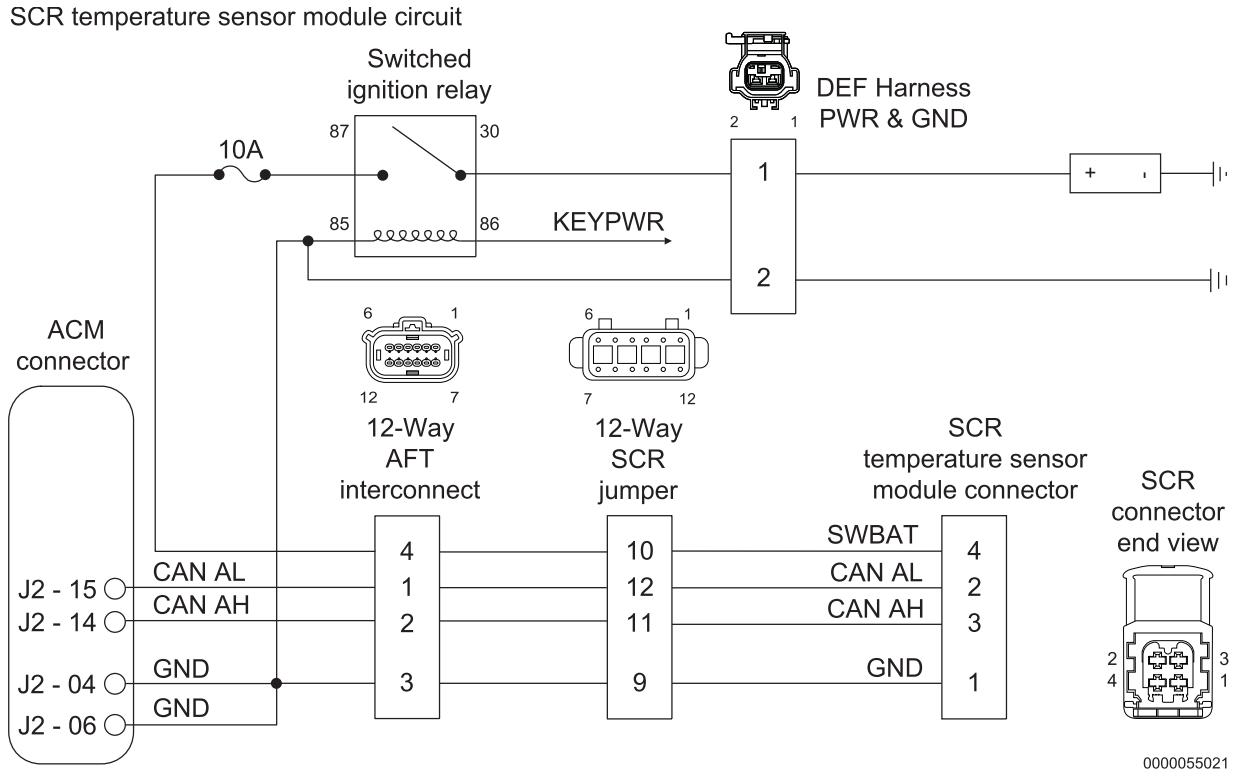


Figure 507 SCR Temperature Sensor Module Circuit Diagram

NOTE: See latest version of Navistar N13 Engine and Aftertreatment Wiring Schematic Form 0000002203 for additional circuit information.

Overview

The Selective Catalyst Reduction Outlet Temperature (SCROT) measures the exhaust temperature at the outlet of the SCR. The SCR temperature sensor module is a smart device that communicates with the Aftertreatment Control Module (ACM) via the Controller Area Network (CAN). The SCROT sensor is part of the SCR temperature sensor module, and is not serviceable individually.

Tools Required

- 180-Pin Breakout Box 00-00956-08
- ACM Breakout Harness 18–100–01 (58–Pin)
- Breakout Harness 18-648-01
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

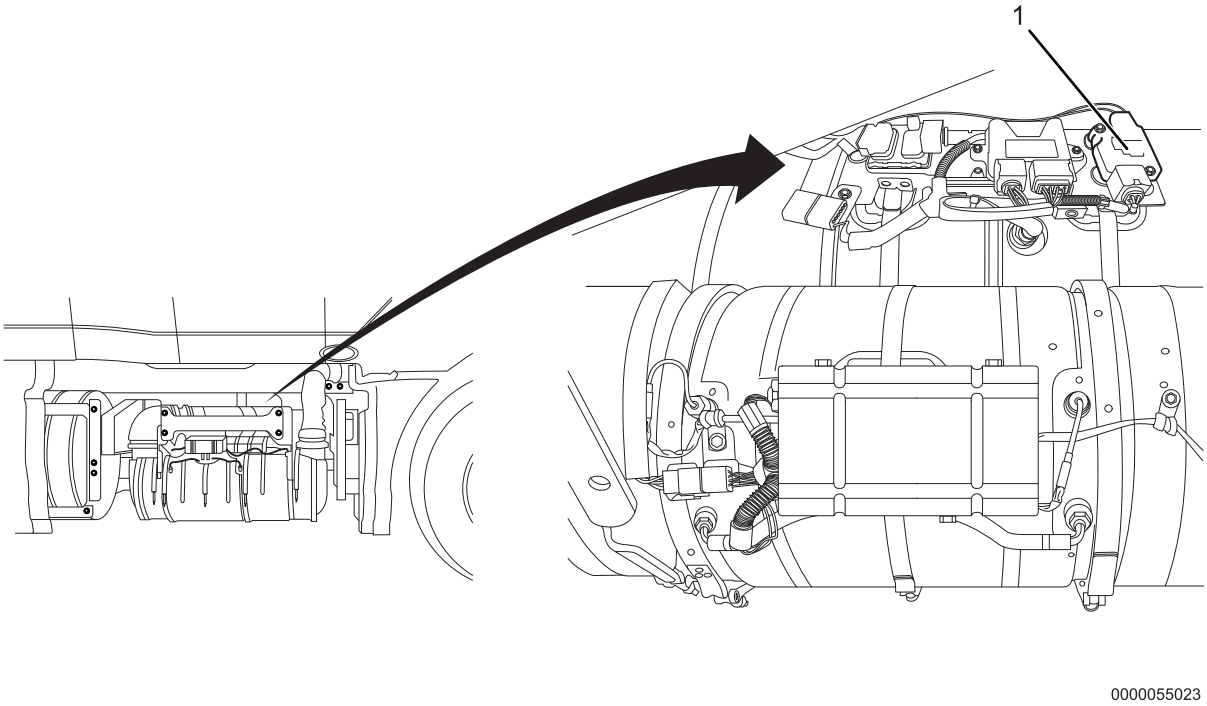


Figure 508 SCR Temperature Sensor Module Location

1. Selective Catalyst Reduction (SCR) temperature sensor module

SPN 4363 FMI 0 SCROT Above Critical Temperature

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Aftertreatment Selective Catalyst Reduction Outlet Temperature (SCROT) continuously above a severe, high threshold.	SCROT > 1472°F (800°C) for more than 20 seconds.	Key-On Engine-Running (KOER). Inactive: SPN 4360 FMI 2, 3, and 4 (SCRIT); SPN 4363 FMI 2, 3, and 4 (SCROT); SPN 5743 FMI 3, 4 and 11 (SCR). SCROT ≥ 392°F (200°C). SCRIT ≥ 392°F (200°C).	180 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the aftertreatment Selective Catalyst Reduction Outlet Temperature (SCROT) sensor reading is greater than 1472°F (800°C) for more than 20 seconds. The Diesel Exhaust Fluid (DEF) injection into the aftertreatment system is disabled and the engine can be shut down.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 1322-1328 FMI 31 (CYL); SPN 3242 FMI 0, 15, and 16 (DPFIT); SPN 3246 FMI 0, 15, and 16 (DPFOT); SPN 4363 FMI 2, 3, and 4 (SCROT); SPN 4765 FMI 0, 15, and 16 (DOCIT); SPN 5743 FMI 3, 4, 11, and 16 (SCR).

Fault Facts

If aftertreatment system has had excess fuel, oil, coolant, metal, or other contamination, inspect the entire aftertreatment system for causal damage before re-installing. Inspect for overheated aftertreatment components, cracked exhaust system welds, leaking exhaust system seams, or other damage. This fault will go inactive after the SCROT drops below the warning limit, and will likely be inactive when the vehicle is in the shop. For this reason, these diagnostics must be used for both active and inactive fault codes.

NOTE: If more than one DOC, DPF and / or SCR temperature sensor over temperature fault codes are present, check for unregistered fuel or oil in the exhaust.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Contaminated Diesel Exhaust Fluid (DEF)
- Leaking fuel injector
- Lube oil leak to exhaust
- Fuel leak to exhaust
- Leaking or stuck Open Aftertreatment Fuel Injector (AFTFI)

- Leaking or stuck Open (AFTFSV) Fuel Shutoff Valve
- Failed SCR temperature sensor module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 1322-1328 FMI 31 (CYL); SPN 3242 FMI 0, 15, and 16 (DPFIT); SPN 3246 FMI 0, 15, and 16 (DPFOT); SPN 4363 FMI 2, 3, and 4 (SCRIT); SPN 4765 FMI 0, 15, and 16 (DOCIT); SPN 5743 FMI 3, 4, 11, and 16 (SCR) fault codes. Is EST DTC list free of SPN 1322-1328 FMI 31; SPN 3242 FMI 0, 15, and 16; SPN 3246 FMI 0, 15, and 16; SPN 4363 FMI 2, 3, and 4; SPN 4765 FMI 0, 15, and 16; SPN 5743 FMI 3, 4, 11, 16?	Yes: Go to step 2. No: Repair SPN 1322-1328 FMI 31; SPN 3242 FMI 0, 15, and 16; SPN 3246 FMI 0, 15, and 16; SPN 4363 FMI 2, 3, and 4; SPN 4765 FMI 0, 15, and 16; SPN 5743 FMI 3, 4, 11, and 16 fault code(s). After repairs are complete, retest for SPN 4363 FMI 0.

Step	Action	Decision
2	Check DEF quality. Obtain a sample of DEF. Visually inspect for contamination, and use special tool DEF Refractometer 5025 to test urea concentration of DEF fluid. Is urea concentration between 30 – 34 percent and Not contaminated?	Yes: Go to step 3. No: Drain the DEF tank, flush with distilled water, and fill with new and / or known good DEF. After repairs are complete, retest for SPN 4363 FMI 0.

Step	Action	Decision
3	Determine if the engine has a mechanical cylinder balance problem (compression loss). Perform Crankcase Pressure Test (page 236). Does engine have excessive crankcase pressure?	Yes: Repair base engine compression imbalance. After repairs are complete, retest for SPN 4363 FMI 0. No: Go to step 4

Step	Action	Decision
4	Determine if engine has a fuel injector problem. Perform Multiple Cylinder Cutout Test (page 241). Did one or more cylinders have significant speed difference(s) than the others?	Yes: Go to step 5. No: Go to step 6.

Step	Action	Decision
5	Inspect for failed valve train components. Remove upper valve cover (see Engine Service Manual). Inspect for bent valves, fallen bridges, and valves out of adjustment. Is valve train free of failed valve train components?	Yes: Replace injector suspected by Multiple Cylinder Cutout Test. After repairs are complete, retest for SPN 4363 FMI 0. No: Repair failed valve train components. After repairs are complete retest for SPN 4363 FMI 0.

Step	Action	Decision
6	Inspect the turbocharger exhaust outlet for oil or fuel to the aftertreatment system. Remove exhaust plumbing from the turbocharger outlet. Was the turbocharger exhaust outlet free of oil and fuel contamination?	Yes: Go to step 7. No: Repair lube oil or fuel leak to exhaust. See Lube Oil to Exhaust (page 163), or See Fuel to Exhaust (page 174). After repairs are complete, retest for SPN 4363 FMI 0.

Step	Action	Decision
7	Check for leaking or stuck open Aftertreatment Fuel Shutoff Valve (AFTFSV). Perform AFT Fuel Shutoff Valve Leak Test (page 121). Is the AFT Fuel Injector (AFTFI) dry and free of fuel?	Yes: Go to step 8. No: Replace AFTFSV. After repairs are complete, retest for SPN 4363 FMI 0.

Step	Action	Decision
8	Check for leaking or stuck open AFTFI. Perform AFT Fuel Injector Leak Test (page 120). Is the AFTFI dry and free of fuel?	Yes: Go to step 9. No: Replace AFTFI. After repairs are complete, retest for SPN 4363 FMI 0.

Step	Action	Decision
9	Check for failed AFT fuel flow. Perform AFT Dosing System Test (page 118). Was 225 to 500 ml of fuel dispensed within 2.5 minutes?	Yes: Go to step 10. No: Replace AFTFI. Refer to Fault Facts. After repairs are complete, retest for SPN 4363 FMI 0.

WARNING: Warning: To prevent personal injury or death, shift transmission to park or neutral, set parking brake, and block wheels before doing diagnostic or service procedures.

Step	Action	Decision
10	Compare SCR Inlet, and SCR outlet temperatures. Perform Hot Run Sensor Comparison Test (page 96). Is the SCR inlet, and SCR outlet temperature sensors with in 77°F (43°C) of each other?	Yes: Go to step 11. No: Replace SCR temperature sensor module. Refer to Fault Facts. After repairs are complete, retest for SPN 4363 FMI 0.

Step	Action	Decision
11	Test for black smoke from the exhaust. Idle the engine, and snap the throttle to 100 percent. Perform this test multiple times, if necessary. Is the exhaust free of black smoke?	Yes: Replace SCR catalyst. After repairs are complete, retest for SPN 4363 FMI 0. No: Go to step 12.

Step	Action	Decision
12	Remove the Diesel Oxidation Catalyst (DOC). Inspect the DPF. Check the intake face of the DPF for soot accumulation, face plugging, and damage. Is less than 50 percent of the cells on the intake face completely blocked by soot and undamaged?	Yes: Reinstall DOC and perform a Parked Regeneration. After repairs are complete, retest for SPN 4363 FMI 0. No: Clean or replace DOC. Refer to Fault Facts. After repairs are complete, retest for SPN 4363 FMI 0.

NOTE: After performing all diagnostic steps, if SPN 4363 FMI 0 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 4363 FMI 2 SCROT signal erratic, intermittent, or incorrect

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Selective Catalytic Reduction Outlet Temperature (SCROT) is not changing with engine operating conditions (in-range but not rational).	Average of the temperature difference across the SCR catalyst > 162˚F (90˚C). OR average of the temperature difference across the SCR catalyst < -162˚F (-90˚C) -162˚F (-90˚C) < average of (DPF outlet temperature - SCR inlet temperature) < 162˚F (90˚C).	Key ON. Engine Speed > 200 RPM. 302˚F (150˚C) < SCR inlet temperature < 1112˚F (600˚C). OR 302˚F (150˚C) < SCR outlet temperature < 1112˚F (600˚C). Elapsed time since last active regeneration > 1200 seconds. Engine Coolant temperature > 140°F (60°C). Inactive: SPN 4360 FMI 3 and 4 (SCRIT); SPN 4363 FMI 3 and 4 (SCROT); and SPN 5743 FMI 3, 4, and 11 (SCR temp sensor module	300 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Selective Catalyst Reduction Outlet Temperature (SCROT) sensor does not match engine operating conditions for more than 5 minutes. A default value for SCROT is used and Diesel Exhaust Fluid (DEF) injection into the aftertreatment system is disabled. Engine torque will be reduced if the engine is operated for an extended period of time with this fault active.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 4360 FMI 3 and 4 (SCRIT); SPN 4363 FMI 3 and 4 (SCROT); and SPN 5743 FMI 3, 4, 11, and 16 (SCR)

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Failed SCR Temperature Sensor Module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code list for SPN 4360 FMI 3 and 4 (SCRIT); SPN 4363 FMI 3 and 4 (SCROT); and SPN 5743 FMI 3, 4, 11 and 16 (SCR).	Yes: Replace SCR temperature sensor module. After repairs are complete, retest for SPN 4363 FMI 2.
	Is EST DTC list free of SPN 4360 FMI 3 and 4; SPN 4363 FMI 3 and 4; and SPN 5743 FMI 3, 4, 11 and 16?	No: Repair SPN 4360 FMI 3 and 4; SPN 4363 FMI 3 and 4; and SPN 5743 FMI 3, 4, 11 and 16 fault code(s). After repairs are complete, retest for SPN 4363 FMI 2.

NOTE: After performing all diagnostic steps, if SPN 4363 FMI 2 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 4363 FMI 3 SCROT signal Out of Range HIGH

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Selective Catalyst Reduction (SCR) temperature sensor module shorted to battery or Open circuit in SCR Outlet Temperature (SCROT) sensor circuit.	SCROT sensor input voltage ≥ 5 volts OR SCROT sensor resistance ≥ 10 Ohms	Key ON.	16 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Selective Catalyst Reduction Outlet Temperature (SCROT) sensor circuit is shorted to battery or Open. Active and parked regeneration will be disabled and engine torque reduced. Engine torque will be severely reduced and vehicle speed will be limited after extended engine operation with this fault code active.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 5743 FMI 3, 4, 11, 16 (SCR).

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Failed SCR temperature sensor module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code list for SPN 5743 FMI 3, 4, 11 and 16 (SCR). Is EST DTC list free of SPN 5743 FMI 3, 4, 11 and 16?	Yes: Replace SCR temperature sensor module. After repairs are complete, retest for SPN 4363 FMI 3.
		No: Repair SPN 5743 FMI 3, 4, 11 and 16 fault code(s). After repairs are complete, retest for SPN 4363 FMI 3.

NOTE: After performing all diagnostic steps, if SPN 4363 FMI 3 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 4363 FMI 4 SCROT signal Out of Range LOW

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Selective Catalyst Reduction (SCR) temperature sensor module shorted to ground in the SCR Outlet Temperature (SCROT) sensor circuit.	SCROT input voltage ≤ 1 volt	Key ON.	16 seconds

Fault Overview

The Aftertreatment Control Module (ACM) has detected an internal circuit error in the Selective Catalyst Reduction (SCR) temperature sensor module, and the SCR Outlet Temperature (SCROT) sensor signal voltage is less than 1 Volt. Active and parked regeneration will be disabled and engine torque reduced if the engine is operated for an extended period of time with this fault active.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 5743 FMI 3, 4, 11, and 16, (SCR)

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Failed SCR temperature sensor module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code list for SPN 5743 FMI 3, 4, 11 and 16 (SCR). Is EST DTC list free of SPN 5743 FMI 3, 4, 11 and 16?	Yes: Replace SCR temperature sensor module. After repairs are complete, retest for SPN 4363 FMI 4.
		No: Repair SPN 5743 FMI 3, 4, 11 and 16 fault code(s). After repairs are complete, retest for SPN 4363 FMI 4.

NOTE: After performing all diagnostic steps, if SPN 4363 FMI 4 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 4363 FMI 15 SCROT Above Warning Temperature

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Selective Catalyst Reduction Outlet Temperature (SCROT) continuously above a warning temperature.	SCROT > 1194°F (646 °C) for more than 20 seconds.	Key-On Engine-Running (KOER). Inactive: SPN 4360 FMI 2, 3, and 4 (SCRIT); SPN 4363 FMI 2, 3, and 4 (SCROT); SPN 5743 FMI 3, 4 and 11 (SCR).	20 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Selective Catalyst Reduction Outlet Temperature (SCROT) sensor reading is greater than 1194°F (646°C) for more than 20 seconds. Diesel Exhaust Fluid (DEF) injection into the aftertreatment system is disabled.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 1322-1328 FMI 31 (CYL); SPN 3242 FMI 0, 15, and 16 (DPFIT); SPN 3246 FMI 0, 15, and 16 (DPFOT); SPN 4363 FMI 2, 3, and 4 (SCROT); SPN 4765 FMI 0, 15, and 16 (DOCIT); SPN 5743 FMI 3, 4, 11, and 16 (SCR).

Fault Facts

If aftertreatment system has had excess fuel, oil, coolant, metal, or other contamination, inspect the entire aftertreatment system for causal damage before re-installing. Inspect for overheated aftertreatment components, cracked exhaust system welds, leaking exhaust system seams, or other damage. This fault will go inactive after the SCROT drops below the warning limit, and will likely be inactive when the vehicle is in the shop. For this reason, these diagnostics must be used for both active and inactive fault codes.

NOTE: If more than one DOC, DPF and / or SCR temperature sensor over temperature fault code(s) are present, check for unregistered fuel or oil in the exhaust.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Contaminated Diesel Exhaust Fluid (DEF)
- Leaking fuel injector
- Lube oil leak to exhaust
- Fuel leak to exhaust
- Leaking or stuck Open Aftertreatment Fuel Injector (AFTFI)
- Leaking or stuck Open (AFTFSV) Fuel Shutoff Valve
- Failed SCR temperature sensor module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 1322-1328 FMI 31 (CYL); SPN 3242 FMI 0, 15, and 16 (DPFIT); SPN 3246 FMI 0, 15, and 16 (DPFOT); SPN 4363 FMI 2, 3, and 4 (SCRIT); SPN 4765 FMI 0, 15, and 16 (DOCIT); SPN 5743 FMI 3, 4, 11, and 16 (SCR) fault codes. Is EST DTC list free of SPN 1322-1328 FMI 31; SPN 3242 FMI 0, 15, and 16; SPN 3246 FMI 0, 15, and 16; SPN 4363 FMI 2, 3, and 4; SPN 4765 FMI 0, 15, and 16; SPN 5743 FMI 3, 4, 11, 16?	Yes: Go to step 2. No: Repair SPN 1322-1328 FMI 31; SPN 3242 FMI 0, 15, and 16; SPN 3246 FMI 0, 15, and 16; SPN 4363 FMI 2, 3, and 4; SPN 4765 FMI 0, 15, and 16; SPN 5743 FMI 3, 4, 11, and 16 fault code(s). After repairs are complete, retest for SPN 4363 FMI 15.

Step	Action	Decision
2	Check DEF quality. Obtain a sample of DEF. Visually inspect for contamination, and use special tool DEF Refractometer 5025 to test urea concentration of DEF fluid. Is urea concentration between 30 - 34 percent and Not contaminated?	Yes: Go to step 3. No: Drain the DEF tank, flush with distilled water, and fill with new and / or known good DEF. After repairs are complete, retest for SPN 4363 FMI 15.

Step	Action	Decision
3	Determine if the engine has a mechanical cylinder balance problem (compression loss). Perform Crankcase Pressure Test (page 236). Does engine have excessive crankcase pressure?	Yes: Repair base engine compression imbalance. After repairs are complete, retest for SPN 4363 FMI 15. No: Go to step 4

Step	Action	Decision
4	Determine if engine has a fuel injector problem. Perform Multiple Cylinder Cutout Test (page 241). Did one or more cylinders have significant speed difference(s) than the others?	Yes: Go to step 5. No: Go to step 6.

Step	Action	Decision
5	Inspect for failed valve train components. Remove upper valve cover (see Engine Service Manual). Inspect for bent valves, fallen bridges, and valves out of adjustment. Is valve train free of failed valve train components?	Yes: Replace injector suspected by Multiple Cylinder Cutout Test. After repairs are complete, retest for SPN 4363 FMI 15. No: Repair failed valve train components. After repairs are complete retest for SPN 4363 FMI 15.

Step	Action	Decision
6	Inspect the turbocharger exhaust outlet for oil or fuel to the aftertreatment system. Remove exhaust plumbing from the turbocharger outlet. Was the turbocharger exhaust outlet free of oil and fuel contamination?	Yes: Go to step 7. No: Repair lube oil or fuel leak to exhaust. See Lube Oil to Exhaust (page 163) or See Fuel to Exhaust (page 174). After repairs are complete, retest for SPN 4363 FMI 15.

Step	Action	Decision
7	Check for leaking or stuck open Aftertreatment Fuel Shutoff Valve (AFTFSV). Perform AFT Fuel Shutoff Valve Leak Test (page 121). Is the AFT Fuel Injector (AFTFI) dry and free of fuel?	Yes: Go to step 8. No: Replace AFTFSV. After repairs are complete, retest for SPN 4363 FMI 15.

Step	Action	Decision
8	Check for leaking or stuck open AFTFI. Perform AFT Fuel Injector Leak Test (page 120). Is the AFTFI dry and free of fuel?	Yes: Go to step 9. No: Replace AFTFI. After repairs are complete, retest for SPN 4363 FMI 15.

Step	Action	Decision
9	Check for failed AFT fuel flow. Perform AFT Dosing System Test (page 118). Was 225 to 500 ml of fuel dispensed within 2.5 minutes?	Yes: Go to step 10. No: Replace AFTFI. Refer to Fault Facts. After repairs are complete, retest for SPN 4363 FMI 15.

WARNING: Warning: To prevent personal injury or death, shift transmission to park or neutral, set parking brake, and block wheels before doing diagnostic or service procedures.

Step	Action	Decision
10	Compare SCR Inlet, and SCR outlet temperatures. Perform Hot Run Sensor Comparison Test (page 96). Is the SCR inlet, and SCR outlet temperature sensors with in 77°F (43°C) of each other?	Yes: Go to step 11. No: Replace SCR temperature sensor module. Refer to Fault Facts. After repairs are complete, retest for SPN 4363 FMI 15.

Step	Action	Decision
11	Test for black smoke from the exhaust. Idle the engine, and snap the throttle to 100 percent. Perform this test multiple times, if necessary. Is the exhaust free of black smoke?	No: Replace SCR catalyst. After repairs are complete, retest for SPN 4363 FMI 15. No: Go to step 12.

Step	Action	Decision
12	Remove the Diesel Oxidation Catalyst (DOC). Inspect the DPF. Check the intake face of the DPF for soot accumulation, face plugging, and damage. Is less than 50 percent of the cells on the intake face completely blocked by soot and undamaged?	Yes: Reinstall DOC and perform a Parked Regeneration. After repairs are complete, retest for SPN 4363 FMI 15. No: Clean or replace DOC. Refer to Fault Facts. After repairs are complete, retest for SPN 4363 FMI 15.

NOTE: After performing all diagnostic steps, if SPN 4363 FMI 15 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 4363 FMI 16 SCROT Above Maximum Temperature

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Selective Catalyst Reduction Outlet Temperature (SCROT) continuously above maximum temperature.	SCROT > 1202°F (650°C) for 60 seconds.	Key-On Engine-Running (KOER). Inactive: SPN 4360 FMI 2, 3, and 4 (SCRIT); SPN 4363 FMI 2, 3, and 4 (SCROT); SPN 5743 FMI 3, 4 and 11 (SCR). Active regeneration not occurring.	60 seconds

Fault Overview

Aftertreatment Control Module (ACM) detects the Selective Catalyst Reduction Outlet Temperature (SCROT) sensor reading is greater than 1202°F (650°C) for more than 60 seconds. The diesel exhaust fluid (DEF) injection into the aftertreatment system is disabled.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 1322-1328 FMI 31 (CYL); SPN 3242 FMI 0, 15, and 16 (DPFIT); SPN 3246 FMI 0, 15, and 16 (DPFOT); SPN 4363 FMI 2, 3, and 4 (SCROT); SPN 4765 FMI 0, 15, and 16 (DOCIT); SPN 5743 FMI 3, 4, 11, and 16 (SCR).

Fault Facts

If aftertreatment system has had excess fuel, oil, coolant, metal, or other contamination, inspect the entire aftertreatment system for causal damage before re-installing. Inspect for overheated aftertreatment components, cracked exhaust system welds, leaking exhaust system seams, or other damage. This fault will go inactive after the SCROT drops below the maximum limit, and will likely be inactive when the vehicle is in the shop. For this reason, these diagnostics must be used for both active and inactive fault codes.

NOTE: If more than one DOC, DPF and / or SCR temperature sensor over temperature fault code(s) are present, check for unregistered fuel or oil in the exhaust.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Contaminated Diesel Exhaust Fluid (DEF)
- Leaking fuel injector
- Lube oil leak to exhaust
- Fuel leak to exhaust
- Leaking or stuck Open Aftertreatment Fuel Injector (AFTFI)
- Leaking or stuck Open (AFTFSV) Fuel Shutoff Valve

- Failed SCR temperature sensor module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 1322-1328 FMI 31 (CYL); SPN 3242 FMI 0, 15, and 16 (DPFIT); SPN 3246 FMI 0, 15, and 16 (DPFOT); SPN 4363 FMI 2, 3, and 4 (SCRIT); SPN 4765 FMI 0, 15, and 16 (DOCIT); SPN 5743 FMI 3, 4, 11, and 16 (SCR) fault codes. Is EST DTC list free of SPN 1322-1328 FMI 31; SPN 3242 FMI 0, 15, and 16; SPN 3246 FMI 0, 15, and 16; SPN 4363 FMI 2, 3, and 4; SPN 4765 FMI 0, 15, and 16; SPN 5743 FMI 3, 4, 11, 16?	Yes: Go to step 2. No: Repair SPN 1322-1328 FMI 31; SPN 3242 FMI 0, 15, and 16; SPN 3246 FMI 0, 15, and 16; SPN 4363 FMI 2, 3, and 4; SPN 4765 FMI 0, 15, and 16; SPN 5743 FMI 3, 4, 11, and 16 fault code(s). After repairs are complete, retest for SPN 4363 FMI 16.

Step	Action	Decision
2	Check DEF quality. Obtain a sample of DEF. Visually inspect for contamination, and use special tool DEF Refractometer 5025 to test urea concentration of DEF fluid. Is urea concentration between 30 - 34 percent and Not contaminated?	Yes: Go to step 3. No: Drain the DEF tank, flush with distilled water, and fill with new and / or known good DEF. After repairs are complete, retest for SPN 4363 FMI 16.

Step	Action	Decision
3	Determine if the engine has a mechanical cylinder balance problem (compression loss). Perform Crankcase Pressure Test (page 236). Does engine have excessive crankcase pressure?	Yes: Repair base engine compression imbalance. After repairs are complete, retest for SPN 4363 FMI 16. No: Go to step 4

Step	Action	Decision
4	Determine if engine has a fuel injector problem. Perform Multiple Cylinder Cutout Test (page 241). Did one or more cylinders have significant speed difference(s) than the others?	Yes: Go to step 5. No: Go to step 6.

Step	Action	Decision
5	Inspect for failed valve train components. Remove upper valve cover (see Engine Service Manual). Inspect for bent valves, fallen bridges, and valves out of adjustment. Is valve train free of failed valve train components?	Yes: Replace injector suspected by Multiple Cylinder Cutout Test. After repairs are complete, retest for SPN 4363 FMI 16. No: Repair failed valve train components. After repairs are complete retest for SPN 4363 FMI 16.

Step	Action	Decision
6	Inspect the turbocharger exhaust outlet for oil or fuel to the aftertreatment system. Remove exhaust plumbing from the turbocharger outlet. Was the turbocharger exhaust outlet free of oil and fuel contamination?	Yes: Go to step 7. No: Repair lube oil or fuel leak to exhaust. See Lube Oil to Exhaust (page 163), or See Fuel to Exhaust (page 174). After repairs are complete, retest for SPN 4363 FMI 16.

Step	Action	Decision
7	Check for leaking or stuck open Aftertreatment Fuel Shutoff Valve (AFTFSV). Perform AFT Fuel Shutoff Valve Leak Test (page 121). Is the AFT Fuel Injector (AFTFI) dry and free of fuel?	Yes: Go to step 8. No: Replace AFTFSV. After repairs are complete, retest for SPN 4363 FMI 16.

Step	Action	Decision
8	Check for leaking or stuck open AFTFI. Perform AFT Fuel Injector Leak Test (page 120). Is the AFTFI dry and free of fuel?	Yes: Go to step 9. No: Replace AFTFI. After repairs are complete, retest for SPN 4363 FMI 16.

Step	Action	Decision
9	Check for failed AFT fuel flow. Perform AFT Dosing System Test (page 118). Was 225 to 500 ml of fuel dispensed within 2.5 minutes?	Yes: Go to step 10. No: Replace AFTFI. Refer to Fault Facts. After repairs are complete, retest for SPN 4363 FMI 16.

WARNING: Warning: To prevent personal injury or death, shift transmission to park or neutral, set parking brake, and block wheels before doing diagnostic or service procedures.

Step	Action	Decision
10	Compare SCR Inlet, and SCR outlet temperatures. Perform Hot Run Sensor Comparison Test (page 96). Is the SCR inlet, and SCR outlet temperature sensors with in 77°F (43°C) of each other?	Yes: Go to step 11. No: Replace SCR temperature sensor module. Refer to Fault Facts. After repairs are complete, retest for SPN 4363 FMI 16.

Step	Action	Decision
11	Test for black smoke from the exhaust. Idle the engine and snap the throttle to 100 percent. Perform this test multiple times, if necessary. Is the exhaust free of black smoke?	Yes: Replace SCR catalyst. After repairs are complete, retest for SPN 4363 FMI 16. No: Go to step 12.

Step	Action	Decision
12	Remove the Diesel Oxidation Catalyst (DOC). Inspect the DPF. Check the intake face of the DPF for soot accumulation, face plugging, and damage. Is less than 50 percent of the cells on the intake face completely blocked by soot and undamaged?	Yes: Reinstall DOC and perform a Parked Regeneration. After repairs are complete, retest for SPN 4363 FMI 16. No: Clean or replace DOC. Refer to Fault Facts. After repairs are complete, retest for SPN 4363 FMI 16.

NOTE: After performing all diagnostic steps, if SPN 4363 FMI 16 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

Service Interval Messages

SPN	FMI	Condition	Possible Causes
1378	31	Change Engine Oil Service Interval	• Change oil and re-set interval counter

Service Interval Messages Operation

The service interval messages are displayed on the instrument cluster message center and include engine oil and fuel filter change reminders.

The change oil reminder can be programmed for kilometers, miles, hours or calculated fuel consumption. These service interval limits may be adjusted at the owner's discretion. The change engine oil message below the odometer illuminates after a preselected parameter is reached.

The fuel filter change message displays when the fuel filter needs replacement due to high filter restriction.

TC1TOP Sensor (Turbocharger 1 Turbine Outlet Pressure)

SPN	FMI	Condition	Possible Causes	Actions
5541	2	TC1TOP signal does not agree with BARO	• Biased TC1TOP sensor or circuit • Intermittent TC1TOP circuit fault • Restricted EBPV tube	Pin-Point Diagnostics (page 1400)
5541	3	TC1TOP signal Out of Range HIGH	• TC1TOP signal circuit OPEN or short to PWR • SIG GND circuit OPEN • Failed TC1TOP sensor	Pin-Point Diagnostics (page 1400)
5541	4	TC1TOP signal Out of Range LOW	• TC1TOP signal circuit short to GND • Failed TC1TOP sensor	Pin-Point Diagnostics (page 1400)

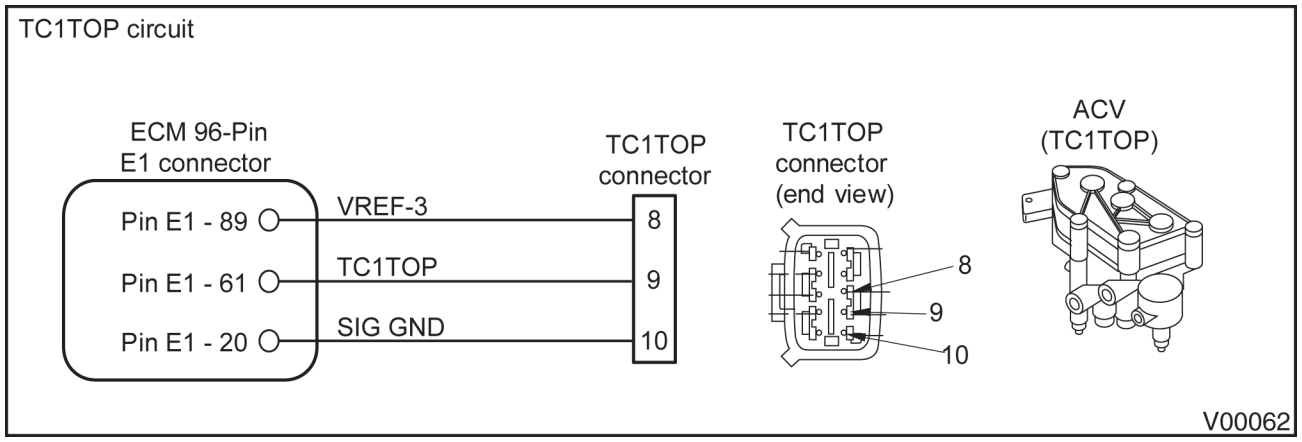


Figure 509 TC1TOP circuit diagram

Tools Required

- 180-Pin Breakout Box 00-00956-08
- 2010 MaxxForce 11 & 13 Harness Kit 00-01462-00
- 3-Banana Plug Harness ZTSE4498
- 500 Ohm Resistor Harness ZTSE4497
- Big Bore Terminal Test Probe Kit ZTSE4899

- Breakout Harness ZTSE6003 (TC1TOP)
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

Note: The TC1TOP, TC2WC, and EBPV circuits share the same connector to the ACV assembly.

Pinpoint Diagnostics With ServiceMaxx™ Software

WARNING: To prevent personal injury or death, stay clear of rotating parts (belts and fan) and hot engine surfaces.

1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, run the Continuous Monitor test.
2. Monitor sensor voltage and verify an active DTC for this sensor.
    - If DTC is previously active, monitor signal while wiggling harness of suspect sensor. If circuit is interrupted, signal will spike and DTC will go active or pending.
    - If DTC is active, continue to Biased Sensor or Circuit Check.

NOTE: Inspect connectors for damaged pins, corrosion, or loose pins. Repair if necessary.

SPN 5541 FMI 2 – TC1TOP signal does not agree with BARO

Biased Sensor or Circuit Check

1. Turn ignition switch ON, engine OFF
2. Using ServiceMaxx™ software, run the Continuous Monitor test.
3. Verify S_TC1TOP volts are within specification (lightly wiggle circuits while monitoring TC1TOP signal for spikes). See “APPENDIX A: PERFORMANCE SPECIFICATIONS."
   - If TC1TOP voltage is not within specification, check circuitry for poor continuity. If circuits are acceptable, replace TC1TOP sensor.
4. Check Exhaust Back Pressure Valve (EBPV) tube between Air Control Valve (ACV) and EBPV for restriction.

Sensor Circuit Check With ServiceMaxx™ Software

Connect Breakout Harness ZTSE6003 to ACV engine harness, and leave ACV sensor disconnected. Turn ignition ON.

Test Point	Specification	Comment – < Less than, > Greater than
EST – Monitor TC1TOPv	4.5 V to 5 V	If < 4.5 V, check TC1TOP signal circuit for short to GND. Do Harness Resistance Check (page 1403).
DMM — Measure voltage 8 to GND	5.0 V ± 0.5 V	If > 5.5 V, check VREF3 for short to PWR. If < 4.5 V, check VREF3 for OPEN or short to GND. Do Harness Resistance Check (page 1403).
DMM — Measure voltage 8 to 10	5 V ± 0.5 V	If < 4.5 V, check SIG GND for OPEN. Do Harness Resistance Check (page 1403).
EST – Monitor TC1TOPv Short across Breakout Harness pins 9 and 10	0 V	If > 0.25 V, check TC1TOP signal for OPEN. Do Harness Resistance Check (page 1403).

If checks are within specification, connect sensor and clear DTCs. Verify sensor voltage is within KOEO specification. See “APPENDIX A: PERFORMANCE SPECIFICATIONS." If sensor voltage is not within specification, replace the sensor.

Connector Voltage Check Without ServiceMaxx™ Software

Connect Breakout Harness ZTSE6003 to ACV engine harness, and leave ACV sensor disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
8 to GND	5.0 V ± 0.5 V	If > 5.5 V, check VREF3 for short to PWR. If < 4.5 V, check VREF3 for OPEN or short to GND. Do Harness Resistance Check (page 1403).

Connector Voltage Check Without ServiceMaxx™ Software (cont.)

10 to GND	0 V	If > 0.25 V, check SIG GND circuit for short to PWR.
9 to GND	4.5 V to 5 V	If < 4.5 V, check TC1TOP signal circuit for short to GND. Do Harness Resistance Check (page 1403).

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM E1 and E2 harness to ECM E1 and E2 engine harness connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE6003 to ACV engine harness, and leave ACV disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
8 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
8 to E1-89	< 5 Ω	If > 5 Ω, check for OPEN circuit.
9 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
9 to E1-61	< 5 Ω	If > 5 Ω, check for OPEN circuit.
10 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
10 to E1–20	< 5 Ω	If > 5 Ω, check for OPEN circuit.

TC2WC (Turbocharger 2 Wastegate Control)

SPN	FMI	Condition	Possible Causes	Actions
1189	3	TC2WC short to PWR	• TC2WC control circuit short to PWR • Failed TC2WC solenoid	Circuit Checks (page 1405)
1189	4	TC2WC short to GND	• TC2WC control circuit short to GND • Failed TC2WC solenoid	Circuit Checks (page 1405)
1189	5	TC2WC open load/circuit	• TC2WC control OPEN circuit • Failed TC2WC solenoid	Circuit Checks (page 1405)

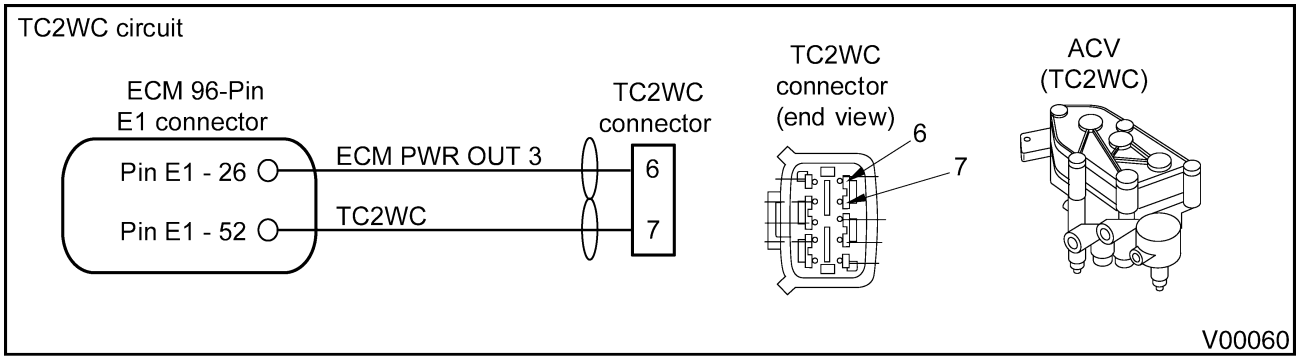


Figure 510 TC2WC circuit diagram

Tools Required

- 180-Pin Breakout Box 00-00956-08
- 2010 MaxxForce 11 & 13 Harness Kit 00-01462-00
- 3-Banana Plug Harness ZTSE4498
- 500 Ohm Resistor Harness ZTSE4497
- Big Bore Terminal Test Probe Kit ZTSE4899
- Breakout Harness ZTSE6003 (TC2WC)
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

Note: The TC2WC, TC1TOP, and EBPV circuits share the same connector to the Air Control Valve (ACV) assembly.

Connector Voltage Check – TC2WC Disconnected

Connect Breakout Harness ZTSE6003 to ACV engine harness, and leave ACV disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
6 to GND	B+	If < B+, check for OPEN circuit. Do Harness Resistance Check.
7 to GND	3.5 V ± 1.0 V	If < 2.5 V, check for OPEN circuit. Do Harness Resistance Check.
If measurements are within specifications, do Operational Voltage Check.		

Operational Voltage Check

NOTE: Ensure air tanks have at least 90 psi (621 kPa) of pressure.

1. Connect Breakout Harness ZTSE6003 between TC2WC and engine harness.
2. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests > KOEO Tests > Actuator Test. Select TC2 Wastegate Control from the drop-down menu.
3. Command TC2 Wastegate Control to 5%.
4. Use DMM to measure voltage.
5. Command TC2 Wastegate Control to 95%.
6. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
7 to GND	5% = 12 V ± 2.0 V	If < 10 V, check for OPEN circuit.
7 to GND	95% = 0.5 V ± 0.5 V	If > 1 V, check for OPEN circuit or failed ACV.

Actuator Resistance Check

Turn ignition switch OFF. Connect Breakout Harness ZTSE6003 to ACV and leave engine harness disconnected. Use DMM to measure resistance.

Test Point	Spec	Comment
6 to 7	4 Ω to 11 Ω	If not within specification, replace the ACV.
If measurements are within specifications, go to Harness Resistance Check.		

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box and Breakout Harness ZTSE6003. Leave ECM and TC2WC disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
6 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
6 to E1-26	< 5 Ω	If > 5 Ω, check for OPEN circuit.
7 to GND	> 1k Ω	If < 1k Ω, check for short circuit.

Harness Resistance Check (cont.)

7 to E1-52	< 5 Ω	If > 5 Ω, check for OPEN circuit.

If voltage and resistance checks are within specifications, check for DTCs. If DTC returns, replace ACV.

TC2CIS (Turbocharger 2 Compressor Inlet Sensor)

SPN	FMI	Condition	Possible Causes	Actions
1173	2	TC2CIT signal does not agree with other sensors	• TC2CIT high resistance • SIG GND high resistance • Failed TC2CIS sensor	Step-Based Diagnostics (page 1410)
1173	3	TC2CIT Out of Range HIGH	• TC2CIT shorted to PWR • TC2CIT Open or high resistance • SIG GND Open or high resistance • Failed TC2CIS sensor	Step-Based Diagnostics (page 1413)
1173	4	TC2CIT Out of Range LOW	• TC2CIT shorted to GND • TC2CIT shorted to SIG GND • Failed TC2CIS sensor	Step-Based Diagnostics (page 1416)
1173	16	TC2CIT signal above desired (Interstage CAC under cooling)	• Failed TC2CIS • Failed Coolant Control Valve (CCV) • Restricted or leaking LPCAC • Inoperative engine cooling fan • Restricted low-temperature radiator • Engine fan or shroud problem	Step-Based Diagnostics (page 1418)
1177	2	TC2CIP signal erratic, intermittent, or incorrect	• TC2CIP high resistance • SIG GND high resistance • Failed TC2CIS sensor	Step-Based Diagnostics (page 1421)

1177	3	TC2CIP signal Out of Range HIGH	• TC2CIP shorted to PWR • TC2CIP Open or high resistance • SIG GND Open or high resistance • Failed TC2CIS sensor	Step-Based Diagnostics (page 1423)
1177	4	TC2CIP signal Out of Range LOW	• TC2CIP shorted to GND • TC2CIP shorted to SIG GND • Failed TC2CIS sensor	Step-Based Diagnostics (page 1426)

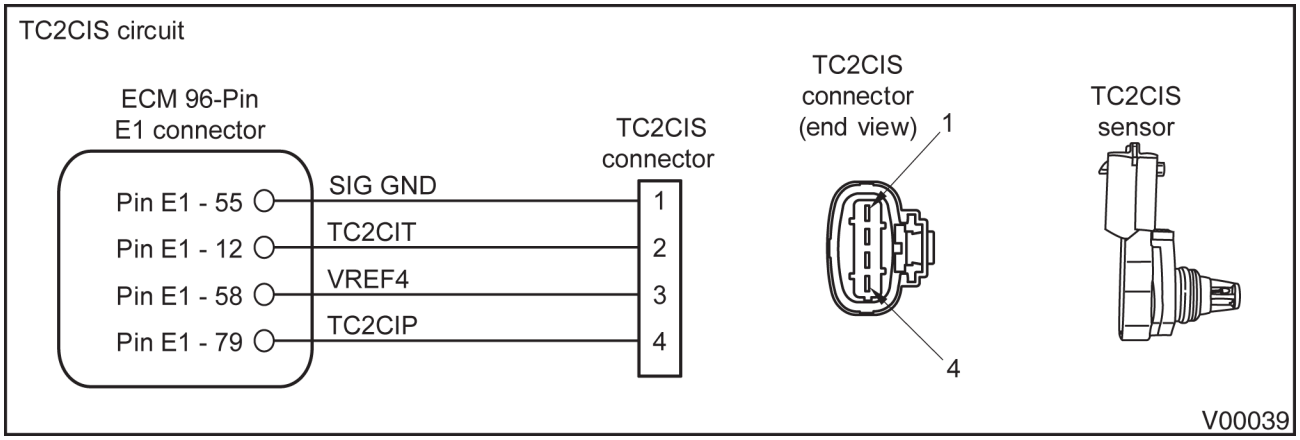


Figure 511 TC2CIS sensor circuit diagram

NOTE: See latest version of N13 with SCR Engine and Aftertreatment Wiring Schematic Form 0000002203 for additional circuit information.

Overview

The Turbocharger 2 Compressor Inlet Sensor (TC2CIS) is a combined temperature and pressure sensor located in the piping between the low-pressure compressor outlet and the high-pressure compressor inlet. This sensor monitors boost pressure for the low-pressure turbo and the temperature of the charge-air entering the high-pressure turbo. The ECM uses these measurements for calculating fuel delivery and controlling the wastegate.

Tools Required

- 180-Pin Breakout Box 00-00956-08
- ECM Breakout Harness 00-01468-00
- Breakout Harness ZTSE4830 (TC2CIS)

- Digital Multimeter (DMM)
- Charge Air Cooler (CAC) Tester ZTSE4341
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

SPN 1173 FMI 2 - TC2CIT signal erratic, intermittent, or incorrect

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Difference between Turbocharger 2 Compressor Inlet temperature (TC2CIT) sensor reading and Intake Manifold Temperature (IMT) and Inlet Air Temperature (IAT) sensor readings greater than expected.	TC2CIT deviation from IMT and IAT greater than expected	Key ON Engine is cold soaked (8 hours)	Immediate

Fault Overview

Fault code sets when Turbocharger 2 Compressor Inlet temperature (TC2CIT) signal difference compared to Inlet Air Temperature (IAT) and Intake Manifold Temperature (IMT) is greater than expected.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 1173 FMI 3 and 4 (TC2CIT), SPN 105 (IMT), SPN 172 (IAT)

Drive Cycle to Determine Fault Status

Drive Cycle 10 then 2 in 2013 HD-OBD Diagnostic Reference Manual.

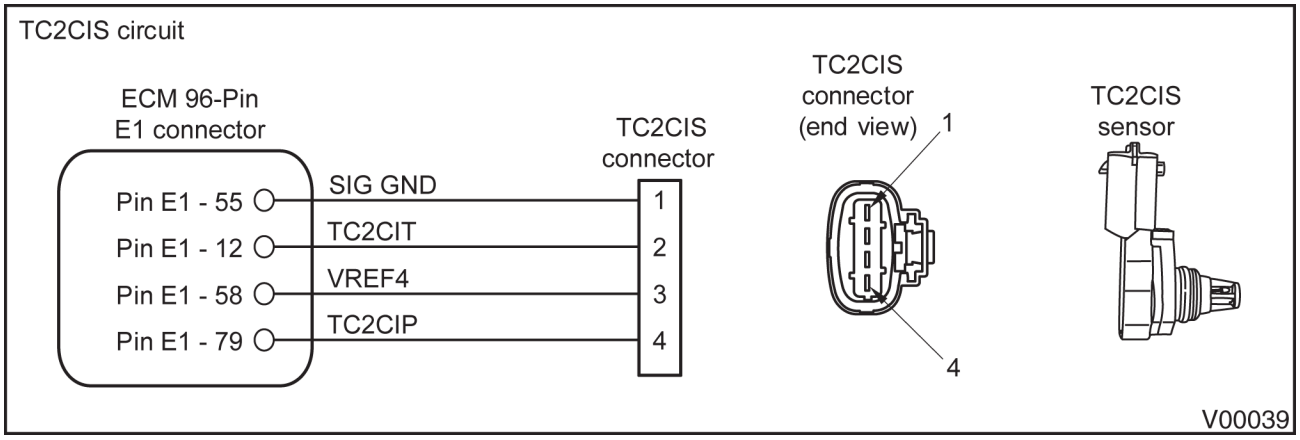


Figure 512 TC2CIS sensor circuit diagram

NOTE: See latest version of Navistar N13 Engine and Aftertreatment Wiring Schematic Form 0000002203 for additional circuit information.

Possible Causes

- TC2CIT high resistance

- SIG GND high resistance
- Failed TC2CIS sensor

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 1173 FMI 3 and 4 (TC2CIT). Is EST DTC list free of SPN 1173 FMI 3 and 4?	Yes: Go to step 2. No: Repair SPN 1173 FMI 3 and 4. After repairs are complete, retest for SPN 1173 FMI 2.

Step	Action	Decision
2	Inspect connections at Turbocharger 2 Compressor Inlet Sensor (TC2CIS). Key OFF, disconnect TC2CIS sensor. Check sensor and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the TC2CIS sensor connector, harness, and terminals clean and undamaged?	Yes: Go to step 3. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 1173 FMI 2.

Step	Action	Decision
3	Inspect connections at ECM E1 connector. Key OFF, disconnect ECM E1 connector. Check ECM and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the ECM E1 connector, harness, and terminals clean and undamaged?	Yes: Go to step 4. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 1173 FMI 2.

Step	Action	Decision
4	Check SIG GND for high resistance. Connect 180-pin Breakout Box and ECM Breakout Harness 00-01468-00 to ECM E1 harness, and leave ECM disconnected. Key-Off with Breakout Harness ZTSE4830 connected to vehicle harness and TC2CIS disconnected, use a DMM to measure resistance between breakout harness pin-1 and breakout box E1 pin-55. Is resistance less than 5 ohms?	Yes: Go to step 5. No: Repair high resistance between TC2CIS pin-1 and ECM connector E1 pin-55. After repairs are complete, retest for SPN 1173 FMI 2.

Step	Action	Decision
5	Check TC2CIT for high resistance. With 180-pin Breakout Box and ECM Breakout Harness 00-01468-00 connected to ECM E1 harness and Breakout Harness ZTSE4830 connected to vehicle harness with leave ECM and TC2CIS disconnected. Key OFF, use a DMM to measure resistance between breakout harness pin-2 and Breakout Box E1 pin-12. Is resistance less than 5 ohms?	Yes: Replace TC2CIS sensor. After repairs are complete, retest for SPN 1173 FMI 2. No: Repair high resistance between TC2CIS pin-2 and ECM connector E1 pin-12. After repairs are complete, retest for SPN 1173 FMI 2.

NOTE: After performing all diagnostic steps, if SPN 1173 FMI 2 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 1173 FMI 3 - TC2CIT signal Out of Range HIGH

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Turbocharger 2 Compressor Inlet Temperature (TC2CIT) signal is above the maximum valid value.	TC2CIT > 4.78 volts	Key ON	2 seconds

Fault Overview

Fault code sets when signal from the Turbocharger 2 Compressor Inlet Sensor (TC2CIS), Turbocharger 2 Compressor Inlet Temperature (TC2CIT) circuit is greater then 4.78 volts.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

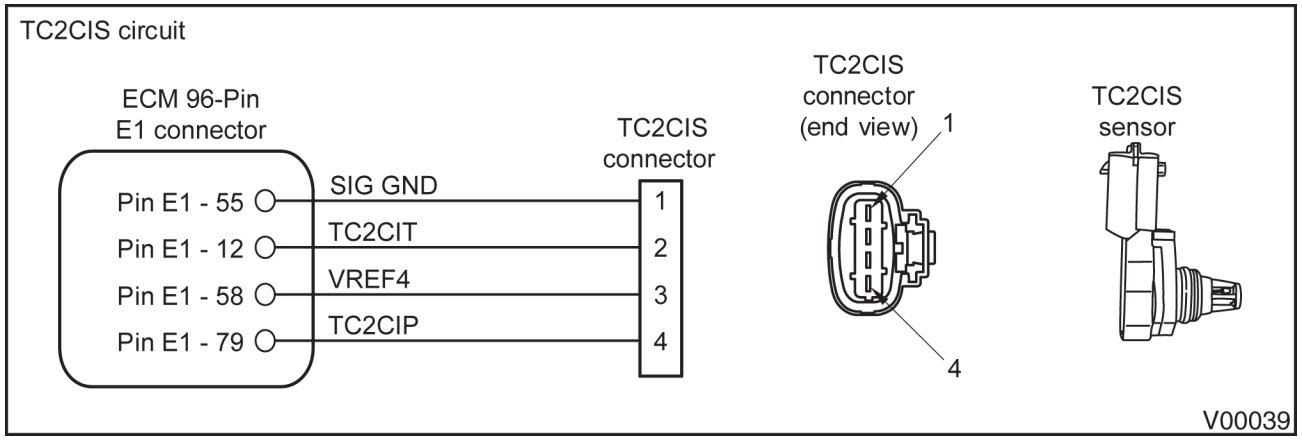


Figure 513 TC2CIS sensor circuit diagram

Possible Causes

- TC2CIT shorted to PWR
- TC2CIT Open or high resistance
- SIG GND Open or high resistance
- Failed TC2CIS sensor

Step	Action	Decision
1	Inspect connections at Turbocharger 2 Compressor Inlet Sensor (TC2CIS) sensor. Key OFF, disconnect TC2CIS sensor. Check sensor and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the TC2CIS sensor connector, harness, and terminals clean and undamaged?	Yes: Go to step 2. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 1173 FMI 3.

Step	Action	Decision
2	Check TC2CIT for a short to PWR. Connect Breakout Harness ZTSE4830 to engine harness, and leave TC2CIS disconnected. Using a DMM, Key-On Engine-Off (KOEO) measure voltage between breakout harness pin-2 and a known good ground. Is voltage less than 5.5 volts?	Yes: Go to step 3. No: Repair short to PWR between TC2CIS pin-2 and ECM pin E1-12. After repairs are complete, retest for SPN 1173 FMI 3.

Step	Action	Decision
3	Inspect connections at ECM E1 connector. Key OFF, disconnect ECM E1 connector. Check ECM and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the ECM E1 connector, harness, and terminals clean and undamaged?	Yes: Go to step 4. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 1173 FMI 3.

Step	Action	Decision
4	Check SIG GND for Open or high resistance. Connect 180-pin Breakout Box and ECM Breakout Harness 00-01468-00 to ECM E1 engine harness, and leave ECM disconnected. Key OFF with Breakout Harness ZTSE4830 connected to vehicle harness and TC2CIS disconnected, use a DMM to measure resistance between Breakout Harness pin-1 and Breakout Box pin E1-55. Is resistance less than 5 ohms?	Yes: Go to step 5. No: Repair Open or high resistance between TC2CIS pin-1 and ECM connector pin E1-55. After repairs are complete, retest for SPN 1173 FMI 3.

Step	Action	Decision
5	Check TC2CIT for Open or high resistance. With 180-pin Breakout Box and ECM Breakout Harness 00-01468-00 connected to ECM E1 engine harness and with Breakout Harness ZTSE4830 connected to vehicle harness and TC2CIS and ECM disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness pin-2 and Breakout Box pin E1-12. Is resistance less than 5 ohms?	Yes: Replace TC2CIS sensor. After repairs are complete, retest for SPN 1173 FMI 3. No: Repair Open or high resistance between TC2CIS pin-2 and ECM connector E1 pin-12. After repairs are complete, retest for SPN 1173 FMI 3.

NOTE: After performing all diagnostic steps, if SPN 1173 FMI 3 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 1173 FMI 4 - TC2CIT signal Out of Range LOW

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Turbocharger 2 Compressor Inlet Temperature (TC2CIT) signal is below minimum.	TC2CIT less than 0.1 volt	Key ON	0.5 seconds

Fault Overview

Fault code sets when signal from the Turbocharger 2 Compressor Inlet Sensor (TC2CIS), Turbocharger 2 Compressor Inlet Temperature (TC2CIT) circuit is less then 0.1 volts.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

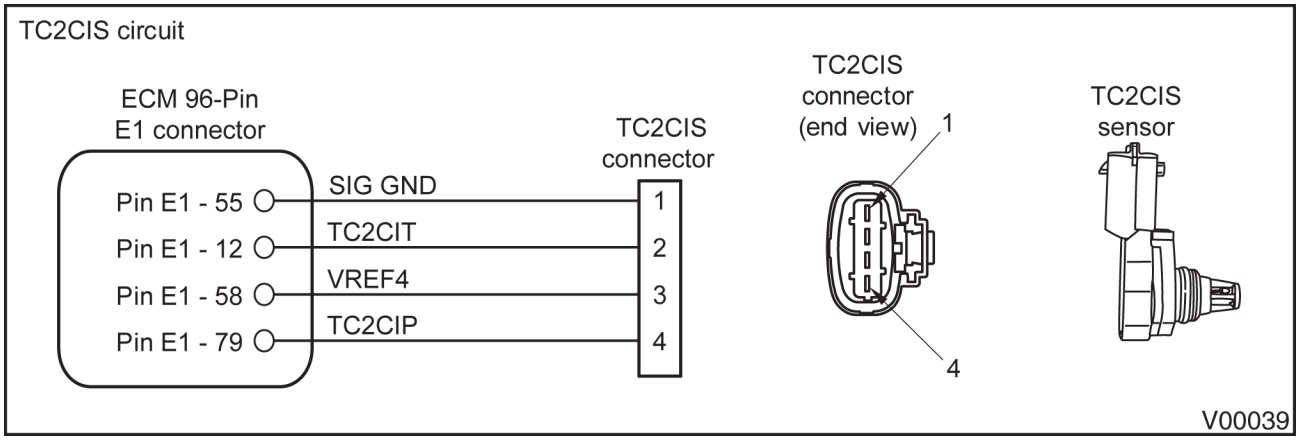


Figure 514 TC2CIS sensor circuit diagram

Possible Causes

- TC2CIT shorted to GND
- TC2CIT shorted to SIG GND
- Failed TC2CIS sensor

Step	Action	Decision
1	Inspect connections at Turbocharger 2 Compressor Inlet Sensor (TC2CIS) sensor. Key OFF, disconnect TC2CIS sensor. Check sensor and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the TC2CIS sensor connector, harness, and terminals clean and undamaged?	Yes: Go to step 2. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 1173 FMI 4.

Step	Action	Decision
2	Check TC2CIT for a short to GND. Connect Breakout Harness ZTSE4830 to engine harness, and leave TC2CIS disconnected. Using a DMM, Key OFF measure resistance between Breakout Harness pin-2 and a known good ground. Is resistance greater than 1000 ohms?	Yes: Go to step 3. No: Repair short to GND between TC2CIS pin-2 and ECM pin E1-12. After repairs are complete, retest for SPN 1173 FMI 4.

Step	Action	Decision
3	Check TC2CIT for a short to SIG GND. Key OFF with Breakout Harness ZTSE4830 connected to engine harness and TC2CIS and ECM disconnecteddisconnected. Use a DMM to measure resistance between Breakout Harness pin-1 and pin-2. Is resistance greater than 1000 ohms?	Yes: Replace TC2CIS sensor. After repairs are complete, retest for SPN 1173 FMI 4. No: Repair short between TC2CIT and SIG GND circuits. After repairs are complete, retest for SPN 1173 FMI 4.

NOTE: After performing all diagnostic steps, if SPN 1173 FMI 4 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 1173 FMI 16 - TC2CIT signal above desired (Interstage CAC under cooling)

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Turbocharger 2 Compressor Inlet Temperature (TC2CIT) signal is greater than expected.	Difference between TC2CIT and engine coolant temperature > a predetermined value, based on engine speed and load.	Engine running Ambient Air Temperature (AAT) between 19°F (-7°C) and 131°F (55°C) Barometric Pressure (BARO) > 10.9 psi (75 kPa) Difference between coolant temperature and expected temperature of the Low Pressure Change Air Cooler (LPCAC) > 68°F (20°C) for 3 seconds or more	3 events

Fault Overview

Fault code sets when Turbocharger 2 Compressor Inlet Temperature (TC2CIT) is above a calculated range, based on operating conditions.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 1173 FMI 3 and 4 (TC2CIT); SPN 5546 (CMV); and SPN 5547 (CFV)

Drive Cycle to Determine Fault Status

Drive Cycle 1 then 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Failed TC2CIS
- Failed Coolant Control Valve (CCV)
- Restricted or leaking LPCAC
- Inoperative engine cooling fan
- Restricted low-temperature radiator
- Engine fan or shroud problem

NOTE: Repair engine cooling system problems and engine overheating before doing this procedure (see "Engine Symptoms Diagnostics").

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 1173 FMI 3 and 4 (TC2CIT); SPN 5546 (CMV); and SPN 5547 (CFV). Is EST DTC list free of SPN 1173 FMI 3, 4; SPN 5546; and SPN 5547?	Yes: Go to step 2. No: Repair SPN 1173 FMI 3, 4; SPN 5546; and SPN 5547. After repairs are complete, retest for SPN 1173 FMI 16.

Step	Action	Decision
2	Inspect for damaged or missing engine cooling fan, fan shroud, and fan hub assembly. Check for air flow restrictions around low temperature radiator. Is engine cooling fan, hub, and shroud, and low temperature radiator free of air restrictions and is not missing or damaged?	Yes: Go to step 3. No: Repair air restriction, or replace engine cooling fan or fan hub assembly. After repairs are complete, retest for SPN 1173 FMI 16.

Step	Action	Decision
3	Check for an inoperative engine cooling fan. Using EST with ServiceMaxx™ software, run Tests > Key-On Engine-Running (KOER) Tests > Engine Fan Tests (page 93) and determine the engine cooling fan's capability to maintain desired speeds. Is the engine cooling fan operating properly?	Yes: Go to step 4. No: Replace fan hub assembly. After repairs are complete, retest for SPN 1173 FMI 16.

Step	Action	Decision
4	Check for a failed TC2CIS sensor. Run engine at high idle for 20 seconds. Using EST with ServiceMaxx™ software, compare TC2CIT temperature values with ECT1 and ECT2. Is TC2CIT within 10°F (6°C) of ECT1 and ECT2?	Yes: Go to step 5. No: Replace TC2CIS sensor. After repairs are complete, retest for SPN 1173 FMI 16.

Step	Action	Decision
5	Check for a failed Coolant Control Valve (CCV). Using EST with ServiceMaxx™ software, run the Tests > Key-On Engine-Running (KOER) Tests > Coolant Control Valve Test (page 98). Follow on screen instructions. Are both Coolant Flow Valve (CFV) and Coolant Mixer Valve (CMV) operating properly?	Yes: Go to step 6. No: Replace CCV. After repairs are complete, retest for SPN 1173 FMI 16.

Step	Action	Decision
6	Check for a restricted or leaking interstage CAC. Install Charge Air Cooler (CAC) Tester ZTSE4341 and test for leakages (see Engine Service Manual). Is the LPCAC free of excessive leaks or other defects?	Yes: Retest for SPN 1173 FMI 16. No: Replace the LPCAC. After repairs are complete, retest for SPN 1173 FMI 16.

NOTE: After performing all diagnostic steps, if SPN 1173 FMI 16 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 1177 FMI 2 - TC2CIP signal erratic, intermittent, or incorrect

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Turbocharger 2 Compressor Inlet Pressure (TC2CIP) signal does not agree with Barometric Pressure (BARO) sensor.	Difference between TC2CIP and BARO > 1.45 psi (12 kpa)	Key-On Engine-Running (KOER)	2 seconds

Fault Overview

Fault code sets when Turbocharger 2 Compressor Inlet Pressure (TC2CIP) signal is not within 12 kpa of the Barometric Pressure (BARO) sensor.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 1177 FMI 3 and 4 (TC2CIT)

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

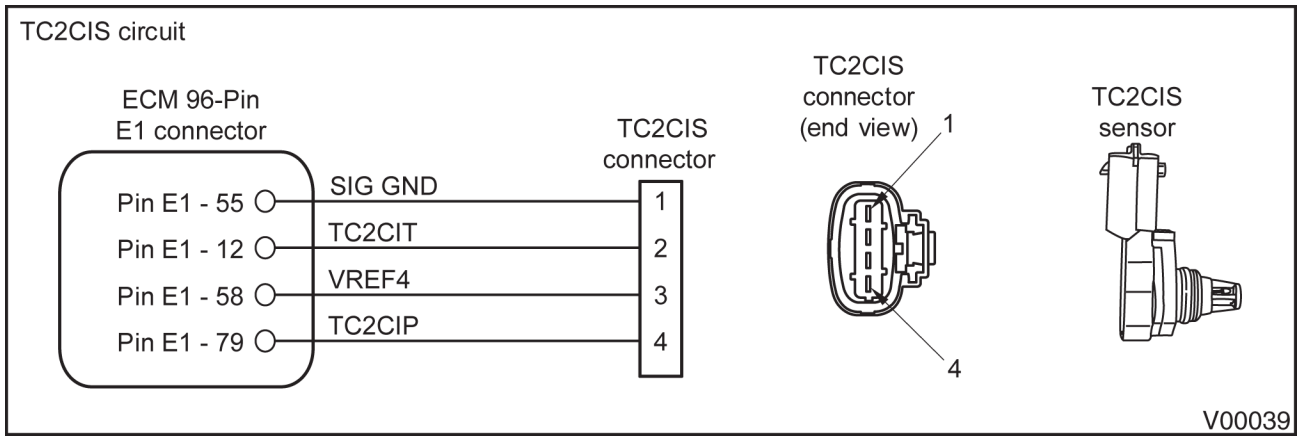


Figure 515 TC2CIS sensor circuit diagram

Possible Causes

- TC2CIP high resistance
- SIG GND high resistance
- Failed TC2CIS sensor

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 1177 FMI 3 and 4 (TC2CIP). Is EST DTC list free of SPN 1177 FMI 3 and 4?	Yes: Go to step 2. No: Repair SPN 1177 FMI 3 and 4. After repairs are complete, retest for SPN 1177 FMI 2.

Step	Action	Decision
2	Inspect connections at Turbocharger 2 Compressor Inlet Sensor (TC2CIS). Key OFF, disconnect TC2CIS sensor. Check sensor and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the TC2CIS sensor connector, harness, and terminals clean and undamaged?	Yes: Go to step 3. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 1177 FMI 2.

Step	Action	Decision
3	Inspect connections at ECM E1 connector. Key OFF, disconnect ECM E1 connector. Check ECM and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the ECM E1 connector, harness, and terminals clean and undamaged?	Yes: Go to step 4. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 1177 FMI 2.

Step	Action	Decision
4	Check SIG GND circuit for high resistance. Connect 180-pin Breakout Box and ECM Breakout Harness 00-01468-00 to ECM E1 harness, and leave ECM disconnected. Connect Breakout Harness ZTSE4830 to engine harness and leave TC2CIS disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness pin-1 and Breakout Box pin E1-55. Is resistance less than 5 ohms?	Yes: Go to step 5. No: Repair high resistance between TC2CIS pin-1 and ECM connector pin E1-55. After repairs are complete, retest for SPN 1177 FMI 2.

Step	Action	Decision
5	Check TC2CIP circuit for high resistance. With 180-pin Breakout Box and ECM Breakout Harness 00-01468-00 to ECM E1 engine harness connected to ECM E1 harness and Breakout Harness ZTSE4830 to engine harness, leave TC2CIS and ECM disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness pin-4 and Breakout Box E1 pin-79. Is resistance less than 5 ohms?	Yes: Replace TC2CIS sensor. After repairs are complete, retest for SPN 1177 FMI 2. No: Repair high resistance between TC2CIS pin-4 and ECM connector pin E1-79. After repairs are complete, retest for SPN 1177 FMI 2.

NOTE: After performing all diagnostic steps, if SPN 1177 FMI 2 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 1177 FMI 3 - TC2CIP signal Out of Range HIGH

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Turbocharger 2 Compressor Inlet Pressure (TC2CIP) signal is greater than expected.	TC2CIP > 4.9 volts	Key ON	0.5 seconds

Fault Overview

Fault code sets when signal from the Turbocharger 2 Compressor Inlet Sensor (TC2CIS), Turbocharger 2 Compressor Inlet Pressure (TC2CIP) circuit is greater then 4.9 volts.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

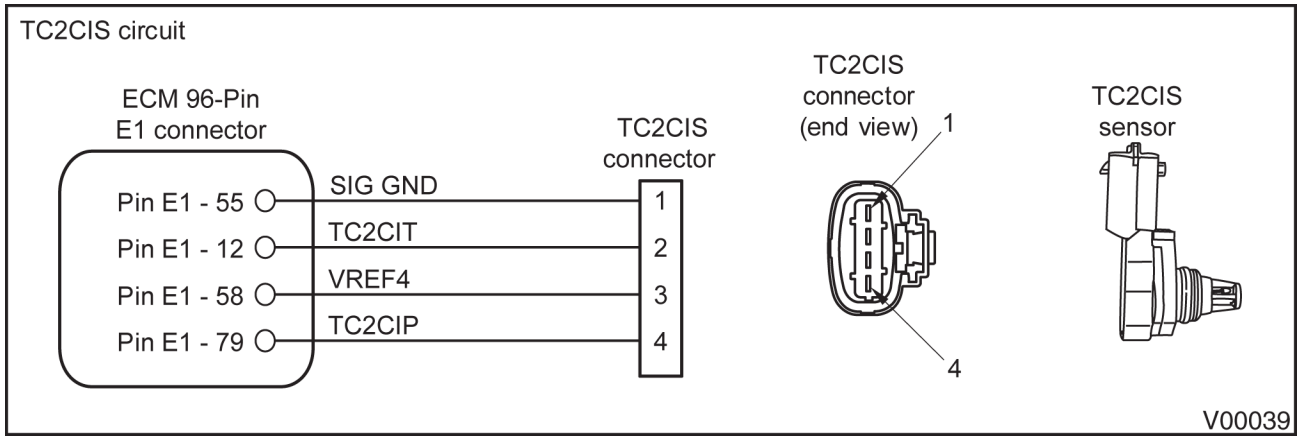


Figure 516 TC2CIS sensor circuit diagram

Possible Causes

- TC2CIP shorted to PWR
- TC2CIP Open or high resistance
- SIG GND Open or high resistance
- Failed TC2CIS sensor

Step	Action	Decision
1	Inspect connections at Turbocharger 2 Compressor Inlet Sensor (TC2CIS) sensor. Key OFF, disconnect TC2CIS sensor. Check sensor and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the TC2CIS sensor connector, harness, and terminals clean and undamaged?	Yes: Go to step 2. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 1177 FMI 3.

Step	Action	Decision
2	Check TC2CIP for a short to PWR. Connect Breakout Harness ZTSE4830 to engine harness, and leave TC2CIS disconnected. Using a DMM, Key-On Engine-Off (KOEO) measure voltage between Breakout Harness pin-4 and a known good ground. Is voltage less than 5.5 volts?	Yes: Go to step 3. No: Repair short to PWR between TC2CIS pin-4 and ECM pin E1-79. After repairs are complete, retest for SPN 1177 FMI 3.

Step	Action	Decision
3	Inspect connections at ECM E1 connector. Key OFF, disconnect ECM E1 connector. Check ECM and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the ECM E1 connector, harness, and terminals clean and undamaged?	Yes: Go to step 4. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 1177 FMI 3.

Step	Action	Decision
4	Check SIG GND for Open or high resistance. Connect 180-pin Breakout Box and ECM Breakout Harness 00-01468-00 to ECM E1 harness, and leave ECM disconnected. Key OFF with Breakout Harness ZTSE4830 connected to vehicle harness and TC2CIS disconnected. Use a DMM to measure resistance between Breakout Harness pin-1 and Breakout Box pin E1-55. Is resistance less than 5 ohms?	Yes: Go to step 5. No: Repair Open or high resistance between TC2CIS pin-1 and ECM connector E1 pin-55. After repairs are complete, retest for SPN 1177 FMI 3.

Step	Action	Decision
5	Check TC2CIP for Open or high resistance. With 180-pin Breakout Box and ECM Breakout Harness 00-01468-00 connected to ECM E1 harness, and leave ECM disconnected. Key OFF with Breakout Harness ZTSE4830 connected to vehicle harness and TC2CIS disconnected. Use a DMM to measure resistance between Breakout Harness pin-4 and Breakout Box pin E1-79. Is resistance less than 5 ohms?	Yes: Replace TC2CIS sensor. After repairs are complete, retest for SPN 1173 FMI 3. No: Repair Open or high resistance between TC2CIS pin-4 and ECM connector E1 pin-79. After repairs are complete, retest for SPN 1177 FMI 3.

NOTE: After performing all diagnostic steps, if SPN 1177 FMI 3 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 1177 FMI 4 - TC2CIP signal Out of Range LOW

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Turbocharger 2 Compressor Inlet Pressure (TC2CIP) signal is less than expected.	TC2CIP < 0.1 volt	Key ON	0.5 seconds

Fault Overview

Fault code sets when signal from the Turbocharger 2 Compressor Inlet Sensor (TC2CIS), Turbocharger 2 Compressor Inlet Pressure (TC2CIP) circuit is less then 0.1 volts.

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

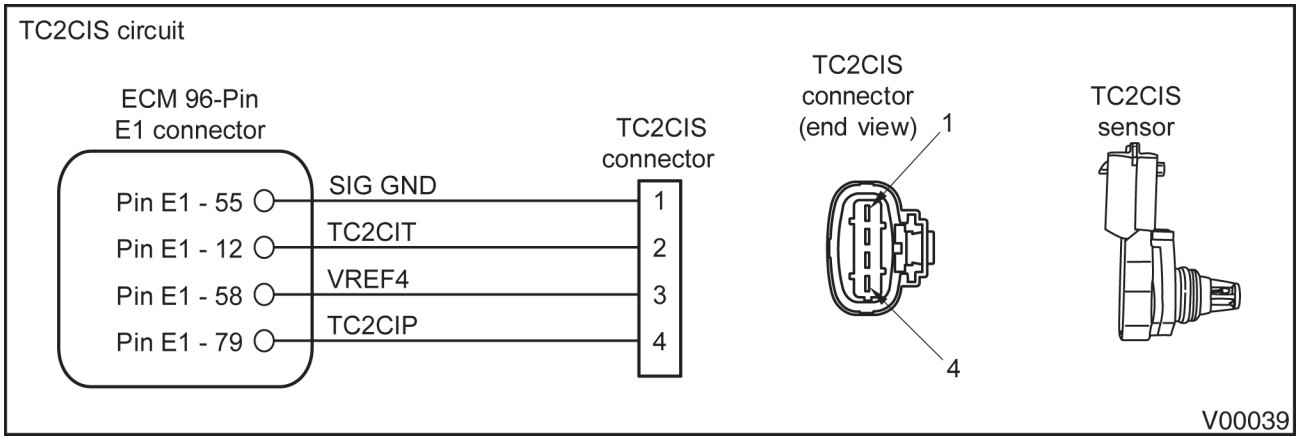


Figure 517 TC2CIS sensor circuit diagram

Possible Causes

- TC2CIP shorted to GND
- TC2CIP shorted to SIG GND
- Failed TC2CIS sensor

Step	Action	Decision
1	Inspect connections at Turbocharger 2 Compressor Inlet Sensor (TC2CIS) sensor. Key OFF, disconnect TC2CIS sensor. Check sensor and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the TC2CIS sensor connector, harness, and terminals clean and undamaged?	Yes: Go to step 2. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 1177 FMI 4.

Step	Action	Decision
2	Check TC2CIP for a short to GND. Connect Breakout Harness ZTSE4830 to engine harness, and leave TC2CIS disconnected. Using a DMM, Key OFF measure voltage between breakout harness pin-4 and a known good ground. Is resistance less than 1000 ohms?	Yes: Go to step 3. No: Repair short to GND between TC2CIS pin-4 and ECM pin E1-79. After repairs are complete, retest for SPN 1177 FMI 4.

Step	Action	Decision
3	Check TC2CIT for a short to SIG GND. With Breakout Harness ZTSE4830 connected to engine harness, and TC2CIS and ECM disconnected, Key OFF use a DMM to measure resistance between Breakout Harness pin-1 and pin-4. Is resistance greater than 1000 ohms?	Yes: Replace TC2CIS sensor. After repairs are complete, retest for SPN 1177 FMI 4. No: Repair short between TC2CIP and SIG GND circuits. After repairs are complete, retest for SPN 1177 FMI 4.

NOTE: After performing all diagnostic steps, if SPN 1177 FMI 4 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

TOSS / VSS (Transmission Output Shaft Speed / Vehicle Speed Sensor) Sensor

SPN	FMI	Condition	Possible Causes	Actions
84	2	Vehicle speed anti-tampering fault	• Incorrect programmable parameter	Pinpoint Diagnostics (page 1431)
191	1	TOSS / VSS not detected while vehicle moving	• VSS sensor circuit OPEN • VSS sensor circuit short PWR • VSS sensor circuit short to GND • VSS sensor failure • Air gap too large between VSS sensor and 16 toothed gear • Damaged 16 toothed gear	Step-based Diagnostics (page 1433)
191	2	TOSS / VSS signal erratic, intermittent, or incorrect	• VSS sensor circuit short PWR • VSS sensor circuit short to GND • VSS sensor failure • Air gap too large between VSS sensor and 16 toothed gear • Damaged 16 toothed gear	Step-based Diagnostics (page 1433)
191	3	TOSS / VSS signal out of range HIGH	• VSS sensor circuit short PWR • VSS sensor failure	Step-based Diagnostics (page 1433)
191	4	TOSS / VSS signal out of range LOW	• VSS sensor circuit OPEN • VSS sensor circuit short to GND • VSS sensor failure	Step-based Diagnostics (page 1433)
191	16	TOSS / VSS reading higher than limit (Hard-wired)	• Vehicle has encountered an over speed condition as described by Programmable Parameter 77542	In Depth Fault Description (page 1436)

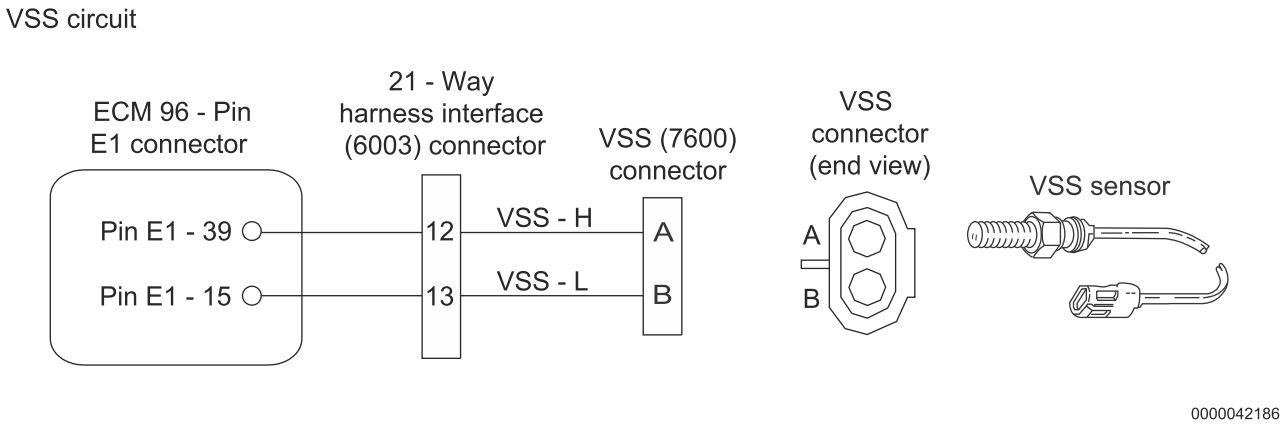


Figure 518 TOSS / VSS Circuit Diagram

Overview

Transmission tailshaft speed is detected by a magnetic pickup mounted on the transmission that senses the rotation of a 16 toothed gear installed on the rear of the transmission. The AC (alternating current) sine wave signal is received by the Engine Control Module (ECM) and is utilized along with tire size and axle ratio, to calculate vehicle speed. Calculated vehicle speed is transmitted to the instrument cluster through the Drive Train Data Link to operate the speedometer within the instrument cluster. Calculated vehicle speed is also utilized in the control strategies that control features such as Cruise Control, PTO operation and Road Speed Limiting.

Tools Required

- 00-00956-08 – 180-pin Breakout Box
- 2010 MaxxForce 11 & 13 Harness Kit 00-01462-00
- Breakout Harness ZTSE4850
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

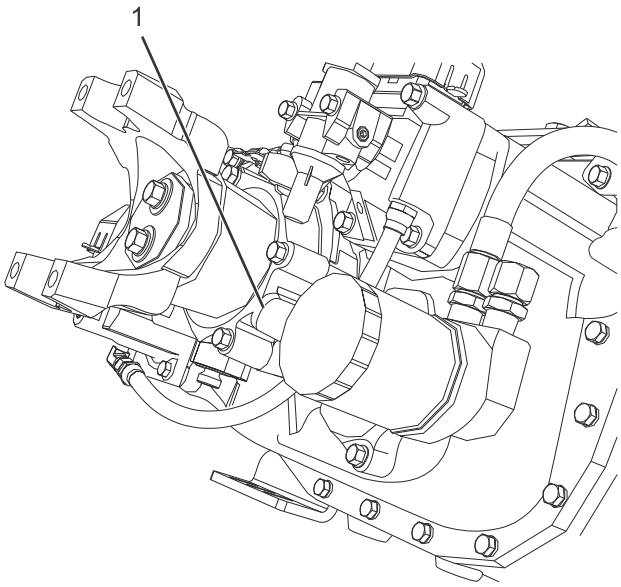


Figure 519 TOSS / VSS Location (Typical)

VSS circuit

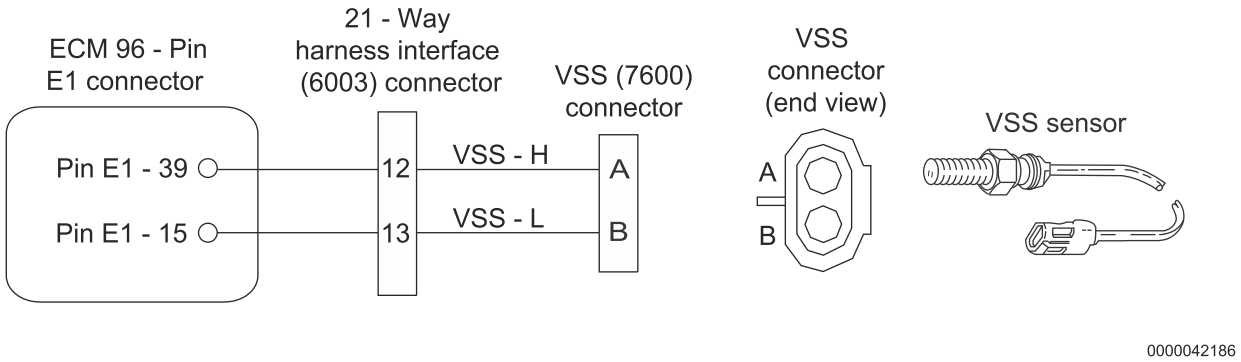


Figure 520 TOSS / VSS Circuit Diagram

Pinpoint Diagnostics With ServiceMaxx™ Software

SPN 84 FMI 2 - Vehicle speed anti-tampering fault

1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, load the Parameters session. Verify the correct value is selected under parameter ID 89003 Vehicle Speed Signal Mode (Hard wire sensor, Public J1939 / CAN OSS, or Public J1939 / Vehicle Speed Sensor).

   Is the correct value selected under parameter ID 89003 Vehicle Speed Signal Mode?

   - Yes: Retest for SPN 84 FMI 2.
   - No: Correct parameter ID 89003 and program engine. Retest for SPN 84 FMI 2.

TOSS / VSS Connector Voltage Check Without ServiceMaxx™ Software

Connect Breakout Harness ZTSE4850 to TOSS/VSS vehicle harness, and leave TOSS/VSS sensor disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
B to GND	2 V to 3 V	If no voltage is present, check for OPEN or short to GND.
A to GND	2 V to 3 V	If no voltage is present, check for OPEN or short to GND.

TOSS / VSS Sensor Continuity Check Without ServiceMaxx™ Software

Turn ignition switch to OFF. Connect Breakout Harness ZTSE4850 to TOSS/VSS sensor harness, and leave vehicle harness disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
B to GND	> 100 Ω	If < 100 Ω, check for short to GND.
A to GND	> 100 Ω	If > 100 Ω check for short to GND.
B to A	600 Ω to 800 Ω	If not within specification, replace VSS sensor.

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM E1 and E2 harness to ECM E1 and E2 vehicle harness connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE4850 to TOSS/VSS vehicle harness, and leave TOSS/VSS sensor disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
E1-15 to B	< 5 Ω	If > 5 Ω, check for OPEN circuit.
E1-39 to A	< 5 Ω	If > 5 Ω, check for OPEN circuit.
E1-15 to GND	> 100 Ω	If < 100 Ω, check for short to GND.
E1-39 to GND	> 100 Ω	If < 100 Ω, check for short to GND.

TOSS / VSS Operational Check Without ServiceMaxx™ Software

Turn ignition switch OFF. Connect 180-Pin Breakout Box with ECM E1 and E2 harness between ECM E1 and E2 connectors and ECM. Turn ignition switch to ON. Use DMM to measure voltage or EST to read signal. Place rear axles on jack stands and block front wheels. Persuade an assistant to rotate drive wheels while performing test.

WARNING: To prevent personal injury or death, read all safety instructions in the "Safety Information" section of this manual.

Test Point	Specification	Comment – < Less than, > Greater than
E1-15 to E1-39	> 2 V AC	If < 2 V AC, check sensor adjustment or replace defective sensor.

SPN 191 FMI 1 TOSS / VSS not detected while vehicle moving

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
No vehicle speed reading when engine load is high	Vehicle speed	Engine speed > 1500 rpm Key ON Engine torque > 74 lb ft (100 N·m) Speed and torque levels met time > 60 seconds Engine not in PTO mode	1 second

SPN 191 FMI 2 TOSS / VSS signal erratic, intermittent, or incorrect

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
VSS signal not detected	Vehicle speed sensor voltage	Key ON	5 second

SPN 191 FMI 3 TOSS / VSS signal out of range HIGH

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
VSS signal out of range HIGH	Vehicle speed sensor voltage	Key ON	0.5 seconds

SPN 191 FMI 4 TOSS / VSS signal out of range LOW

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
VSS signal out of range LOW	Vehicle speed sensor voltage	Key ON	0.5 seconds

SPN 191 FMI 16 TOSS / VSS reading higher then limit

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
TOSS / VSS reading higher then limit (Hard-wired)	Vehicle speed has exceeded programmable limit	Key ON	0.5 seconds

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

See 2013 HD-OBD Diagnostic Reference Manual.

VSS circuit

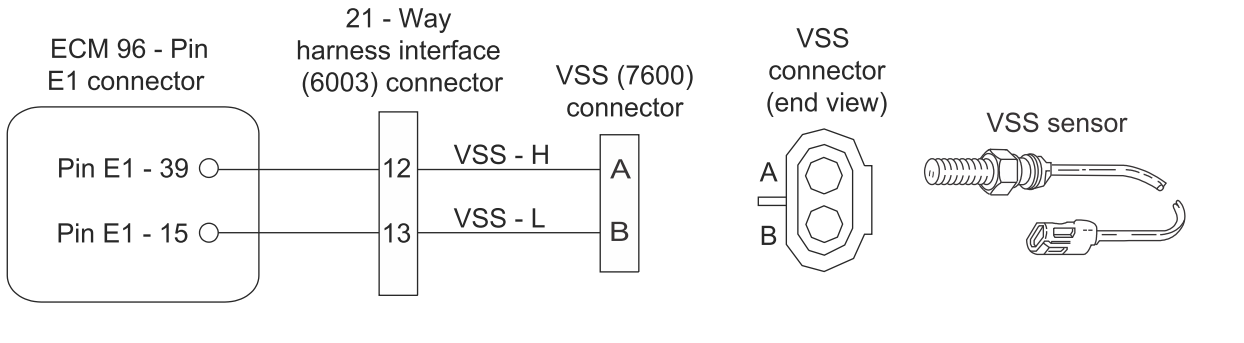


Figure 521 TOSS / VSS Circuit Diagram

Step	Action	Decision
1	Inspect connections at VSS sensor. Key OFF, disconnect VSS sensor connector. Check VSS sensor and connector terminals for: damaged or pinched wires; corroded terminals; loose bent, or broken pins; or broken connector housing. Is the VSS sensor connector, harness, and terminal clean and undamaged.	Yes: Go to step 2. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 191 FMI 1–4.

Step	Action	Decision
2	Disconnect VSS connector (7600). Key-On Engine-Off (KOEO), measure voltage at VSS connector (7600) pins A & B. Do both pins measure 2 to 3 volts?	Yes: Go to step 3. No: Go to step 4.

Step	Action	Decision
3	Do TOSS / VSS Sensor Continuity Check without ServiceMaxx™ Software (page 1431). Is VSS sensor within specification?	Yes: Check VSS sensor air gap or 16 toothed gear and repair as necessary. After repairs are complete, retest for SPN 191 FMI 1–4. No: Replace VSS sensor. After repairs are complete, retest for SPN 191 FMI 1–4.

Step	Action	Decision
4	Disconnect 21-Way Engine Sensor Interface connector (6033). KOEO, measure voltage at engine side 21 Way Engine Sensor Interface connector (6033) pins 12 and 13. Do both pins measure 2 to 3 volts?	Below 2 volts: Repair harness between ECM 96–pin E1 connector and 21 Way Engine Sensor Interface (6033) connector for short to ground or open circuit. After repairs are complete, retest for SPN 191 FMI 1–4.
		Yes: Go to step 5.
		Above 3 volts: Repair harness between ECM 96–pin E1 connector and 21 Way Engine Sensor Interface (6033) connector for short to power. After repairs are complete, retest for SPN 191 FMI 1–4.

Step	Action	Decision
5	KOEO, measure voltage at chassis side 21 Way Engine Sensor Interface connector (6033) pins 12 and 13. Do both pins measure 0 volts?	Yes: Go to step 6.
		No: Repair harness between VSS (7600) connector and 21 Way Engine Sensor Interface (6033) connector for short to power. After repairs are complete, retest for SPN 191 FMI 1–4.

Step	Action	Decision
6	Do TOSS / VSS Operational Check Without ServiceMaxx™ Software (page 1432). Was voltage above 2 volts AC?	Yes: After doing all diagnostic steps, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.
		No: Check VSS sensor air gap or 16 toothed gear and repair as necessary. After repairs are complete, retest for SPN 191 FMI 1–4.

NOTE: After doing all diagnostic steps, if SPN 191 FMI 1–4 remain verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 191 FMI 16

Overview

This fault is not related to the vehicle speed sensor, wiring or tone ring. It is a reaction to the Vehicle Over Speed Indicator Programmable Parameter 77542. If the customer has requested to turn on vehicle over speed notices to driver then the following parameters need to be programmed accordingly. Once these parameters have been programmed and vehicle reaches a vehicle over speed, SPN 191 FMI 16 will be logged in the ECM.

CAUTION: SPN 191 FMI 16 is a result of an over speed being reached and should not be diagnosed as a hardware issue. Failure to comply will result in misdiagnosis and unnecessary repairs.

Parameter ID	Name	Description
77542	Vehicle Over Speed Indicator	• No Vehicle Over Speed Lamp – Vehicle over speed notifications are turned off • Vehicle Over Speed Level 1 Blinking Lamp – Vehicle over speed notifications are enabled for one level (Level 1) • Vehicle Over Speed Level 2 Blinking Lamp – Vehicle over speed notifications are enabled for two levels (Level 1 and Level 2)
77232	Vehicle Over Speed Level 1	This parameter sets the speed at which the first vehicle over speed warning will occur
77242	Vehicle Over Speed Level 2	This parameter sets the speed at which the second vehicle over speed warning will occur

VREF (Voltage Reference)

SPN	FMI	Condition	Possible Causes	Action
3509	14	VREF1 voltage deviation ECM pins: C1-36	• VREF1 circuit short to GND • VREF1 circuit short to PWR • Failed sensor causing short to GND on VREF1 circuit	Pin-Point Tests (page 1439)
3510	14	VREF2 voltage deviation ECM pins: E1-85 and E1-86	• VREF2 circuit short to GND • VREF2 circuit short to PWR • Failed sensor causing short to GND on VREF2 circuit	Pin-Point Tests (page 1440)
3511	14	VREF3 voltage deviation ECM pins: E1-89	• VREF3 circuit short to GND • VREF3 circuit short to PWR • Failed sensor causing short to GND on VREF3 circuit	Pin-Point Tests (page 1440)
3512	14	VREF4 voltage deviation ECM pins: C1-37, C1-49, C2-08, and E1-58	• VREF4 circuit short to GND • VREF4 circuit short to PWR • Failed sensor causing short to GND on VREF4 circuit	Pin-Point Tests (page 1441)

3513	14	VREF5 voltage deviation ECM pins: C1-50, E1-81, and E1-82	• VREF5 circuit short to GND • VREF5 circuit short to PWR • Failed sensor causing short to GND on VREF5 circuit	Pin-Point Tests (page 1442)
3514	14	VREF6 voltage deviation ECM pin: E1-88	• VREF6 circuit short to GND • VREF6 circuit short to PWR • Failed sensor causing short to GND on VREF6 circuit	Pin-Point Tests (page 1443)

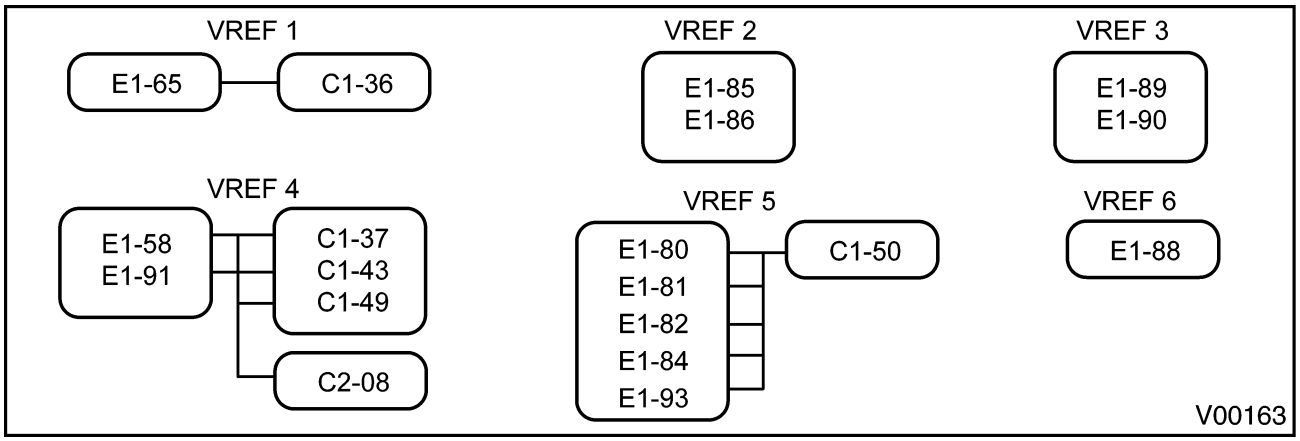


Figure 522 VREF circuit diagram

Tools Required

- 180-Pin Breakout Box 00-00956-08
- 3-Banana Plug Harness ZTSE4498
- 500 Ohm Resistor Harness ZTSE4497
- Big Bore Terminal Test Probe Kit ZTSE4899
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

Voltage Checks for SPN 3509 FMI 14 – VREF1

NOTE: If circuit fault is intermittent, wiggle harness while measuring voltage.

1. Connect 180-Pin Breakout Box between ECM and engine harness. Use DMM to measure voltage.

   Result Comments

   - If voltage is above 5.7 V, check VREF1 for short to PWR.
   - If voltage is below 4.3 V, check VREF1 for short to GND. Go to next step.

2. Disconnect one component at a time on VREF1 circuit.
   - If voltage returns within specification, replace the internally shorted sensor that pulled voltage down.
   - If voltage remains below specification after disconnecting all sensors on VREF1 circuit. Go to Harness Resistance Check (page 1439) and look for VREF1 circuit short to GND.

Test Point	Specification	Comment – < Less than, > Greater than
C1-36 to GND	5 V ± 0.7 V	See Result Comments.

Harness Resistance Check for SPN 3509 FMI 14 – VREF1

NOTE: If circuit fault is intermittent, wiggle harness while measuring resistance.

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM C1 and C2 harness to ECM C1 and C2 vehicle harness connectors, and leave ECM disconnected. Leave VREF1 sensors disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
C1-36 to GND	> 1k Ω	If < 1k Ω, check for short circuit.

Voltage Checks for SPN 3510 FMI 14 – VREF2

NOTE: If circuit fault is intermittent, wiggle harness while measuring voltage.

1. Connect 180-Pin Breakout Box between ECM and engine harness. Use DMM to measure voltage.

   Result Comments

   - If voltage is above 5.7 V, check VREF2 for short to PWR
   - If voltage is below 4.3 V, check VREF2 for short to GND. Go to next step.

2. Disconnect one component at a time on VREF2 circuit.
   - If voltage returns within specification, replace the internally shorted sensor that pulled voltage down.
   - If voltage remains below specification after disconnecting all sensors on VREF2 circuit. Go to Harness Resistance Check (page 1440) and look for VREF2 circuit short to GND.

Test Point	Specification	Comment – < Less than, > Greater than
E1-85 to GND	5 V ± 0.7 V	See Result Comments.
E1-86 to GND	5 V ± 0.7 V	See Result Comments.

Harness Resistance Check for SPN 3510 FMI 14 – VREF2

NOTE: If circuit fault is intermittent, wiggle harness while measuring resistance.

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM C1 and C2 harness to ECM C1 and C2 vehicle harness connectors, and leave ECM disconnected. Leave VREF2 sensors disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
E1-85 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
E1-86 to GND	> 1k Ω	If < 1k Ω, check for short circuit.

Voltage Checks for SPN 3511 FMI 14 – VREF3

NOTE: If circuit fault is intermittent, wiggle harness while measuring voltage.

1. Connect 180-Pin Breakout Box between ECM and engine harness. Use DMM to measure voltage.

   Result Comments

   - If voltage is above 5.7 V, check VREF3 for short to PWR
   - If voltage is below 4.3 V, check VREF3 for short to GND. Go to next step.

2. Disconnect one component at a time on VREF3 circuit.
   - If voltage returns within specification, replace the internally shorted sensor that pulled voltage down.
   - If voltage remains below specification after disconnecting all sensors on VREF3 circuit. Go to Harness Resistance Check (page 1441) and look for VREF3 circuit short to GND.

Test Point	Specification	Comment – < Less than, > Greater than
E1-89 to GND	5 V ± 0.7 V	See Result Comments.

Harness Resistance Check for SPN 3511 FMI 14 – VREF3

NOTE: If circuit fault is intermittent, wiggle harness while measuring resistance.

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM C1 and C2 harness to ECM C1 and C2 vehicle harness connectors, and leave ECM disconnected. Leave VREF3 sensors disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
E1-89 to GND	> 1k Ω	If < 1k Ω, check for short circuit.

Voltage Checks for SPN 3512 FMI 14 – VREF4

NOTE: If circuit fault is intermittent, wiggle harness while measuring voltage.

1. Connect 180-Pin Breakout Box between ECM and engine harness. Use DMM to measure voltage.

   Result Comments

   - If voltage is above 5.7 V, check VREF4 for short to PWR.
   - If voltage is below 4.3 V, check VREF4 for short to GND. Go to next step.

2. Disconnect one component at a time on VREF4 circuit.
   - If voltage returns within specification, replace the internally shorted sensor that pulled voltage down.
   - If voltage remains below specification after disconnecting all sensors on VREF4 circuit. Go to Harness Resistance Check (page 1441) and look for VREF4 circuit short to GND.

Test Point	Specification	Comment – < Less than, > Greater than
C1-37 to GND	5 V ± 0.7 V	See Result Comments.
C1-49 to GND	5 V ± 0.7 V	See Result Comments.
C2-08 to GND	5 V ± 0.7 V	See Result Comments.
E1-58 to GND	5 V ± 0.7 V	See Result Comments.

Harness Resistance Check for SPN 3512 FMI 14 – VREF4

NOTE: If circuit fault is intermittent, wiggle harness while measuring resistance.

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM C1 and C2 harness to ECM C1 and C2 vehicle harness connectors, and leave ECM disconnected. Leave VREF4 sensors disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
C1-37 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
C1-49 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
C2-08 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
E1-58 to GND	> 1k Ω	If < 1k Ω, check for short circuit.

Voltage Checks for SPN 3513 FMI 14 – VREF5

NOTE: If circuit fault is intermittent, wiggle harness while measuring voltage.

1. Connect 180-Pin Breakout Box between ECM and engine harness. Use DMM to measure voltage.

   Result Comments

   - If voltage is above 5.7 V, check VREF5 for short to PWR
   - If voltage is below 4.3 V, check VREF5 for short to GND. Go to next step.

2. Disconnect one component at a time on VREF5 circuit.
   - If voltage returns within specification, replace the internally shorted sensor that pulled voltage down.
   - If voltage remains below specification after disconnecting all sensors on VREF5 circuit. Go to Harness Resistance Check (page 1442) and look for VREF5 circuit short to GND.

Test Point	Specification	Comment – < Less than, > Greater than
C1-50 to GND	5 V ± 0.7 V	See Result Comments.
E1-81 to GND	5 V ± 0.7 V	See Result Comments.
E1-82 to GND	5 V ± 0.7 V	See Result Comments.

Harness Resistance Check for SPN 3513 FMI 14 – VREF5

NOTE: If circuit fault is intermittent, wiggle harness while measuring resistance.

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM C1 and C2 harness to ECM C1 and C2 vehicle harness connectors, and leave ECM disconnected. Leave VREF5 sensors disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
C1-50 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
E1-81 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
E1-82 to GND	> 1k Ω	If < 1k Ω, check for short circuit.

Voltage Checks for SPN 3514 FMI 14 – VREF6

NOTE: If circuit fault is intermittent, wiggle harness while measuring voltage.

1. Connect 180-Pin Breakout Box between ECM and engine harness. Use DMM to measure voltage.

   Result Comments

   - If voltage is above 5.7 V, check VREF6 for short to PWR
   - If voltage is below 4.3 V, check VREF6 for short to GND. Go to next step.

2. Disconnect one component at a time on VREF6 circuit.
   - If voltage returns within specification, replace the internally shorted sensor that pulled voltage down.

Voltage Checks for SPN 3514 FMI 14 – VREF6 (cont.)

- If voltage remains below specification after disconnecting all sensors on VREF6 circuit. Go to Harness Resistance Check (page 1443) and look for VREF6 circuit short to GND.

Test Point	Specification	Comment – < Less than, > Greater than
E1-88 to GND	5 V ± 0.7 V	See Result Comments.

Harness Resistance Check for SPN 3514 FMI 14 – VREF6

NOTE: If circuit fault is intermittent, wiggle harness while measuring resistance.

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM C1 and C2 harness to ECM C1 and C2 vehicle harness connectors, and leave ECM disconnected. Leave VREF6 sensors disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
E1-88 to GND	> 1k Ω	If < 1k Ω, check for short circuit.

WIF Sensor (Water In Fuel)

SPN	FMI	Condition	Possible Causes	Action
4192	3	WIF signal Out of Range HIGH	• WIF circuit short to PWR	Pin-Point Diagnostics (page 1445)
4192	4	WIF signal Out of Range LOW	• WIF circuit short to GND	Pin-Point Diagnostics (page 1445)

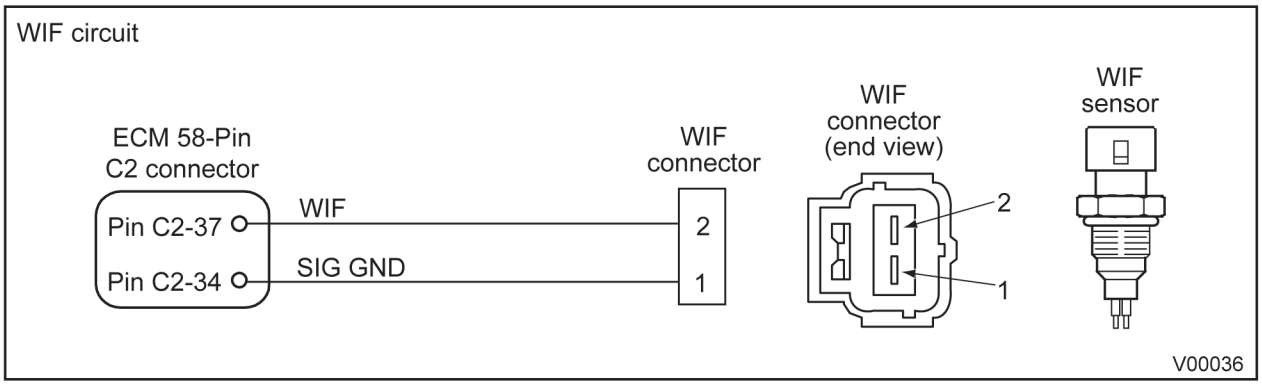


Figure 523 WIF circuit diagram

Tools Required

- 180-Pin Breakout Box 00-00956-08
- 2010 MaxxForce 11 & 13 Harness Kit 00-01462-00
- 3-Banana Plug Harness ZTSE4498
- 500 Ohm Resistor Harness ZTSE4497
- Big Bore Terminal Test Probe Kit ZTSE4899
- Breakout Harness ZTSE6002 (WIF)
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

Pinpoint Diagnostics With ServiceMaxx™ Software

WARNING: To prevent personal injury or death, stay clear of rotating parts (belts and fan) and hot engine surfaces.

1. Drain a fuel sample from the water drain valve on the primary fuel filter housing. See Drain Water from Primary Fuel Filter in the “ENGINE SYMPTOMS DIAGNOSTICS."
   - If water is present, drain all the water out of the system.
   - If no water is present in the fuel sample, continue to next step.
2. Using Electronic Service Tool (EST) with ServiceMaxx™ software, open the Continuous Monitor session.

   NOTE: The WIF signal will read YES if there is water in the fuel filter housing, or if the WIF signal circuit is shorted high.
   - If DTC is inactive, monitor the signal while wiggling the connector and all wires at suspected location. If the circuit is interrupted, the signal will change from No to Yes and the DTC will go active.
   - If DTC is active, go to the next step.
3. Disconnect engine harness from sensor.

   NOTE: Inspect connectors for damaged pins, corrosion, or loose pins. Repair if necessary.
4. Connect Breakout Harness ZTSE6002 to engine harness. Leave sensor disconnected.

Voltage Check

Connect Breakout Harness ZTSE6002 to WIF vehicle harness, and leave WIF sensor disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
1 to B+	B+	If < B+, check SIG GND circuit for OPEN.
2 to GND	4.6 V	If > 5.5 V, check WIF circuit for short to PWR.
		If < 4.0 V, check WIF circuit for short to GND.

Connector Resistance Check to GND

Turn ignition switch OFF. Connect Breakout Harness ZTSE6002 to WIF vehicle harness, and leave WIF sensor disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	< 5 Ω	If > 5 Ω, check SIG GND for OPEN circuit.
2 to GND	> 1k Ω	If < 1k Ω, check WIF circuit for short to GND.

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM C1 and C2 harness to ECM C1 and C2 vehicle harness connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE6002 to WIF vehicle harness, and leave WIF sensor disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
1 to C2-34	< 5 Ω	If > 5 Ω, check for OPEN circuit.
2 to C2-37	< 5 Ω	If > 5 Ω, check for OPEN circuit.

WTSL (Wait to Start Lamp)

SPN	FMI	Condition	Possible Causes	Actions
1081	3	WTSL circuit short to PWR	• Failed WTSL • WTSL circuit shorted to PWR	Step-Based Diagnostics (page 1449)
1081	4	WTSL circuit short to GND	• Failed WTSL • WTSL circuit shorted to GND	Step-Based Diagnostics (page 1451)
1081	5	WTSL open load/circuit	• Failed WTSL • Fuse blown / Open • WTSL circuit Open	Step-Based Diagnostics (page 1453)

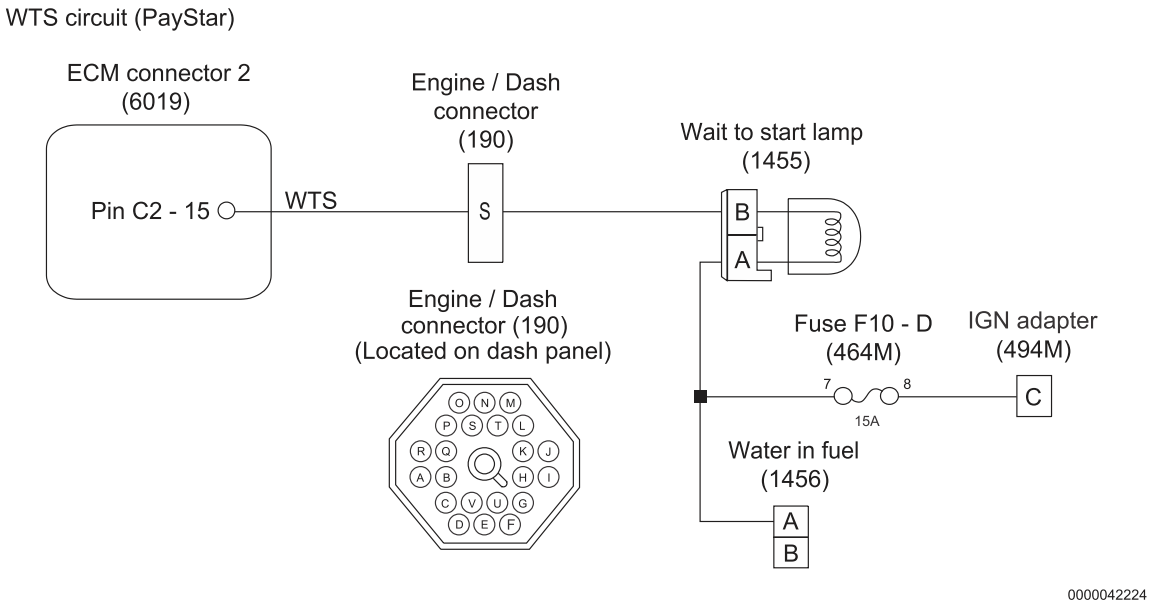


Figure 524 WTSL Circuit Diagram

Overview

The wait-to-start lamp illuminates when the ignition switch is turned ON. For Engine Coolant Temperature (ECT) lower than 50°F (10°C), the Engine Control Module (ECM) activates the Inlet Air Heater Relay (IAHR). The IAHR then energizes the Inlet Air Heater Fuel Igniter (IAHFI) for approximately 35 seconds. Once the IAHFI is heated, the wait-to-start lamp starts to flash and the engine is ready to be started. Once the engine starts, the IAHFI remains energized and the wait-to-start lamp continues to flash for a maximum of four minutes. When the wait-to-start lamp stops flashing, the IAHFI and the IAHS valve are deactivated. If the operator accelerates while the wait-to-start lamp is flashing, the inlet air heater system will shutdown.

Tools Required

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

- Digital Multimeter (DMM)

SPN 1081 - FMI 3 - WTSL circuit short to PWR

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Wait to Start Lamp (WTSL) circuit short to power.	ECM indicates short to battery	Key ON	0.5 seconds

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

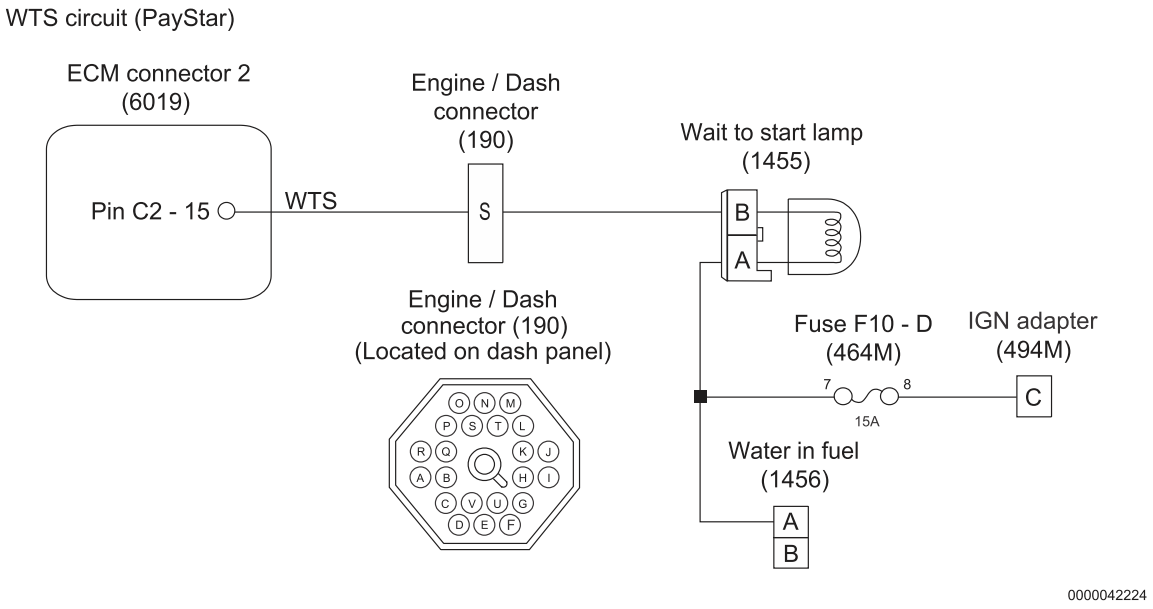


Figure 525 WTSL Circuit Diagram

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for other fault codes. Is SPN 1081 FMI 3 the only fault code active?	Yes: Go to step 2. No: Repair other fault code(s). After repairs are complete, retest for SPN 1081 FMI 3.

Step	Action	Decision
2	Measure for short to power on engine side of WTSL circuit. Disconnect WTSL connector (1455) located in the vehicle instrument panel (see WTSL Circuit Diagram and vehicle Electrical Circuit Diagrams manual for additional details). Key ON, measure voltage at pin B of connector (1455). Is voltage less than 4.2 volts?	Yes: Replace Wait to Start Lamp. After repairs are complete, retest for SPN 1081 FMI 3. No: Repair short to power between WTSL connector (1455) pin B and ECM 58-pin connector C2-15. After repairs are complete, retest for SPN 1081 FMI 3.

NOTE: After doing all diagnostic steps, if SPN 1081 FMI 3 remains verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 1081 - FMI 4 - WTSL circuit short to GND

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Wait to Start Lamp (WTSL) circuit short to ground.	ECM indicates short to ground	Key ON	0.5 seconds

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

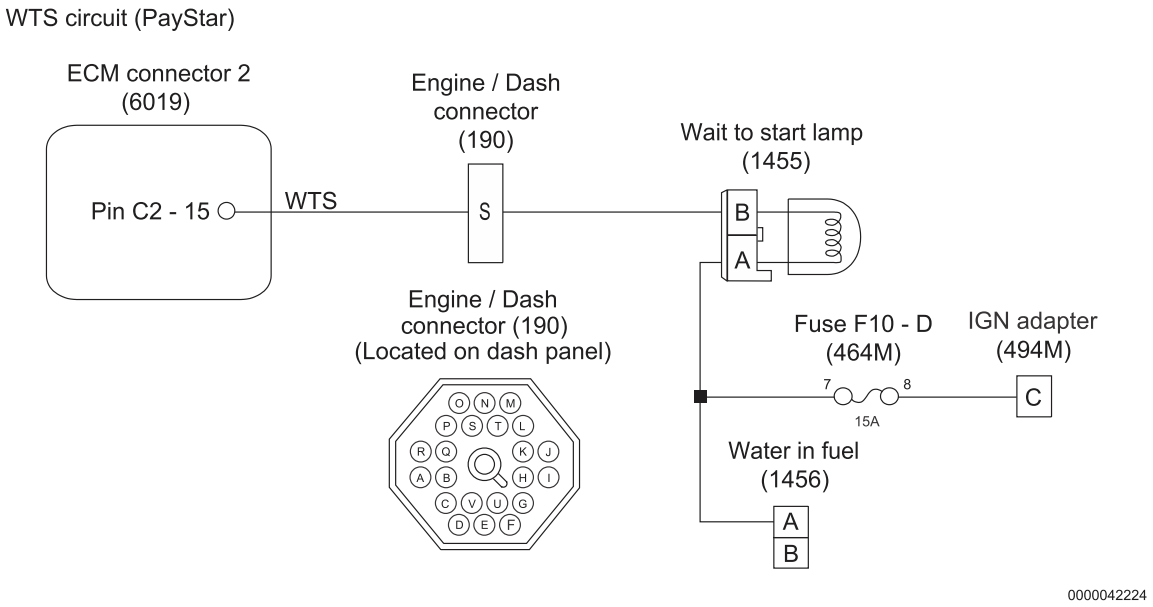


Figure 526 WTSL Circuit Diagram

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for other fault codes. Is SPN 1081 FMI 4 the only fault code active?	Yes: Go to step 2. No: Repair other fault code(s). After repairs are complete, retest for SPN 1081 FMI 4.

Step	Action	Decision
2	Measure engine side of WTSL circuit for short to ground. Disconnect WTSL connector (1455) located in the vehicle instrument panel (see vehicle Electrical Circuit Diagrams for additional details). Key OFF, measure resistance between pin B of connector (1455) and a known good ground. Is resistance greater than 1000 ohms?	Yes: Go to step 3. No: Repair short to ground between WTSL connector (1455) pin B and ECM 58–pin connector C2- 15. After repairs are complete, retest for SPN 1081 FMI 4.

Step	Action	Decision
3	Measure vehicle side of WTSL circuit for short to ground. Key OFF, measure resistance between pin A of connector (1455) and a known good ground. Is resistance greater than 1000 ohms?	Yes: Replace Wait to Start Lamp. After repairs are complete, retest for SPN 1081 FMI 4. No: Repair short to ground between WTSL connector (1455) pin A and vehicle wiring (see WTSL Circuit Diagram and vehicle Electrical Circuit Diagrams for additional details). After repairs are complete, retest for SPN 1081 FMI 4.

NOTE: After doing all diagnostic steps, if SPN 1081 FMI 4 remains verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 1081 - FMI 5- WTSL open load / circuit

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Wait to Start Lamp (WTSL) circuit open.	ECM indicates no load	Key ON	0.5 seconds

Malfunction Indicator Lamp (MIL) Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

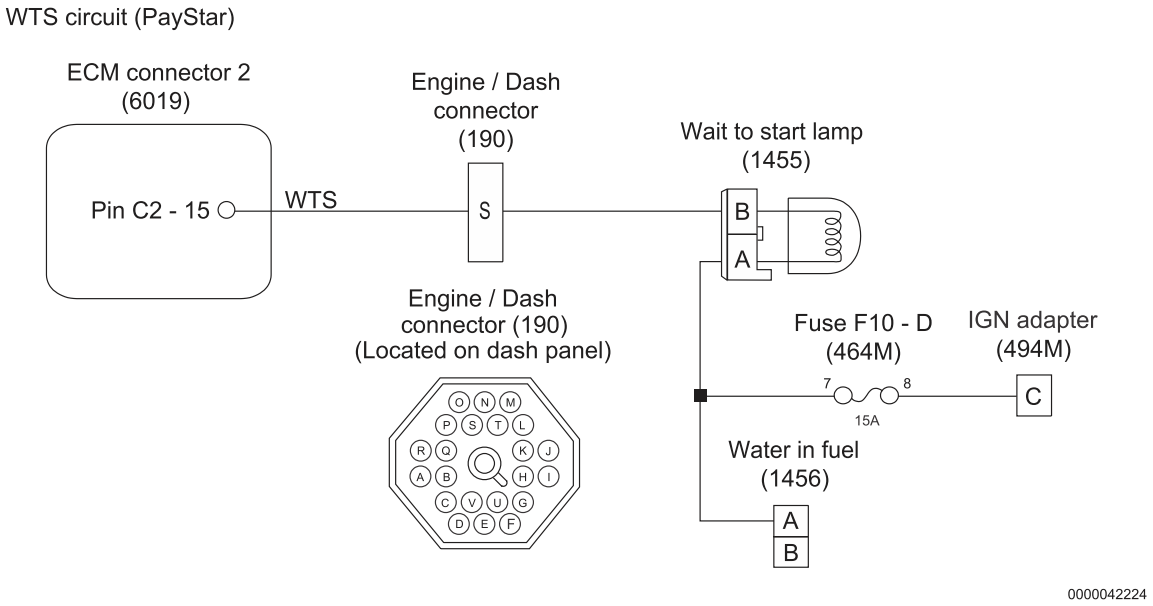


Figure 527 WTSL Circuit Diagram

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for other fault codes. Is SPN 1081 FMI 5 the only fault code active?	Yes: Go to step 2. No: Repair other fault code(s). After repairs are complete, retest for SPN 1081 FMI 5.

Step	Action	Decision
2	Check 15 amp fuse F10-D (464M) (see vehicle Electrical Circuit Diagrams for additional details). Is fuse in good condition and not blown (Open)?	Yes: Go to step 3. No: Replace 15 amp fuse F10-D (464M). After repairs are complete, retest for SPN 1081 FMI 5.

Step	Action	Decision
3	Test vehicle side of circuit for Open. Key OFF, disconnect WTSL connector (1455) located in the vehicle instrument panel (see vehicle Electrical Circuit Diagrams for additional details). Key ON, measure voltage at pin A of connector (1455). Is voltage 12 volts or greater while the WTSL circuit is activated?	Yes: Go to step 4. No: Repair Open or high resistance between WTSL connector pin A and vehicle wiring (see WTSL Circuit Diagram and vehicle Electrical Circuit Diagrams for additional details). After repairs are complete, retest for SPN 1081 FMI 5.

Step	Action	Decision
4	Measure engine side of WTSL circuit for Open. Key OFF, disconnect Engine Control Module (ECM) C2 connector. Measure resistance between ECM connector C2-15 and WTSL connector pin B. Is resistance more than 5 ohms?	Yes: Repair open or high resistance in circuit between ECM connector C2-15 and WTSL connector pin B. After repairs are complete, retest for SPN 1081 FMI 5. No: Replace Wait to Start Lamp. After repairs are complete, retest for SPN 1081 FMI 5.

NOTE: After doing all diagnostic steps, if SPN 1081 FMI 5 remains verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

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Electrical Tools

180-Pin Breakout Box

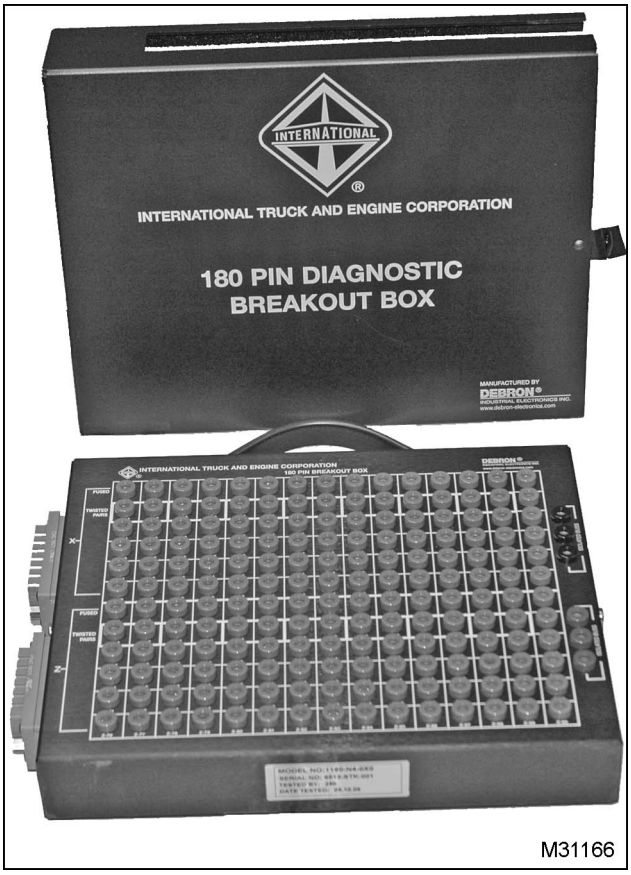


Figure 528 00-00956-08

The 180-Pin Breakout Box allows testing of electronic control system components without disturbing connections or piercing wire insulation to access various signal voltages in the electronic control system.

CAUTION: To prevent damage to the 180-Pin Breakout Box, the 180-Pin Breakout Box is used for measurement only, not to activate or control circuits. High current levels passing through the 180-Pin Breakout Box will burn out the internal circuitry.

This box is universal and can adapt to any control system by means of a unique jumper harness. Each jumper harness is a separate part, complete with a 180-Pin Breakout Box overlay (pin identifier) sheet.

The standard box layout is as follows:

- Two 90-pin connectors which feed 90 banana plug probing points.
- Each 90-pin section of the box is basically a stand-alone box.
- The top row is all fuse protected circuits, the second row is all twisted pair circuits.

2010 MaxxForce 11 & 13 Harness Kit

The 00-01462-00 2010 MaxxForce 11 & 13 Harness Kit with breakout box overlay (pin identifier) sheet is used with the 180-pin Breakout Box. These cables are used to test the circuits going to the engine and chassis connectors on the Engine Control Module (ECM).

3-Banana Plug Harness ZTSE4498

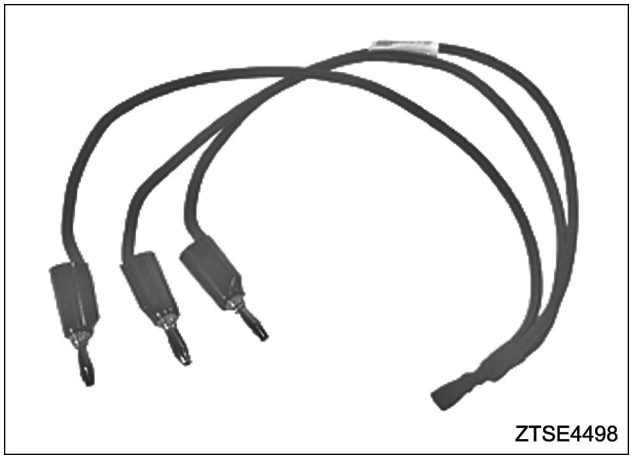


Figure 529 ZTSE4498

The 3-Banana Plug Harness ZTSE4498 is used for sensor-end diagnostics of sensor circuits.

500-Ohm Resistor Harness ZTSE4497

Figure 530 ZTSE4497

The 500-Ohm Resistor Harness ZTSE4497 is used for sensor-end diagnostics of sensor circuits, and for performing loaded circuit tests.

International® Electronic Engine Terminal Test Kit

Figure 531 ZTSE4435C

The International® Electronic Engine Terminal Test Kit is used to access circuits in the connector harness and allows for the use of a DMM without damaging the harness connectors. The probes may also be used as a guide to determine whether the harness connector is retaining correct tension on the mating terminal.

Big Bore Terminal Test Probe Kit

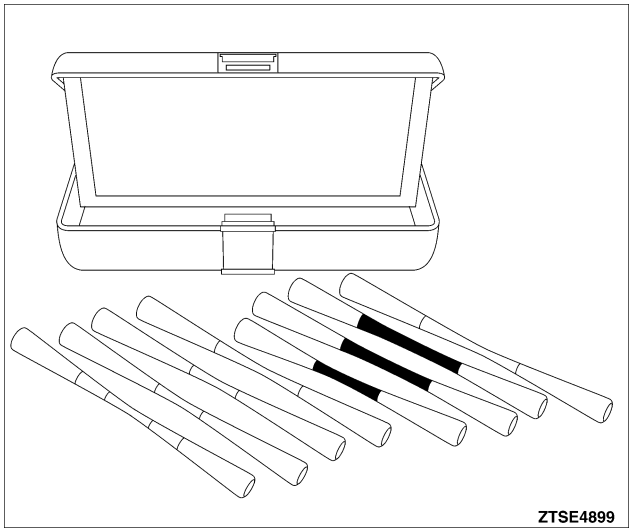


Figure 532 ZTSE4899

The terminal test probe kit is used to access circuit in the connector harness and allows for the use of a DMM without damaging the harness connectors.

Digital Multimeter (DMM) ZTSE4357

Figure 533 ZTSE4357

The DMM ZTSE4357 is used to troubleshoot electrical components, sensors, injector solenoids, relays, and wiring harnesses. The DMM has a high input impedance that allows testing of sensors while the engine is running without loading the circuit being tested. This ensures the signal voltage measurement will not be affected by the voltmeter.

Amp Clamp

Figure 534 ZTSE4575

The Amp Clamp is used to measure amperage draw for the inlet air heater.

EXP-1000 HD by Midtronics

Figure 535 EXP-1000 HD INTL

The EXP-1000 HD by Midtronics is used to measure current draw for the inlet air heater system.

EZ-Tech® Electronic Service Tool (EST)

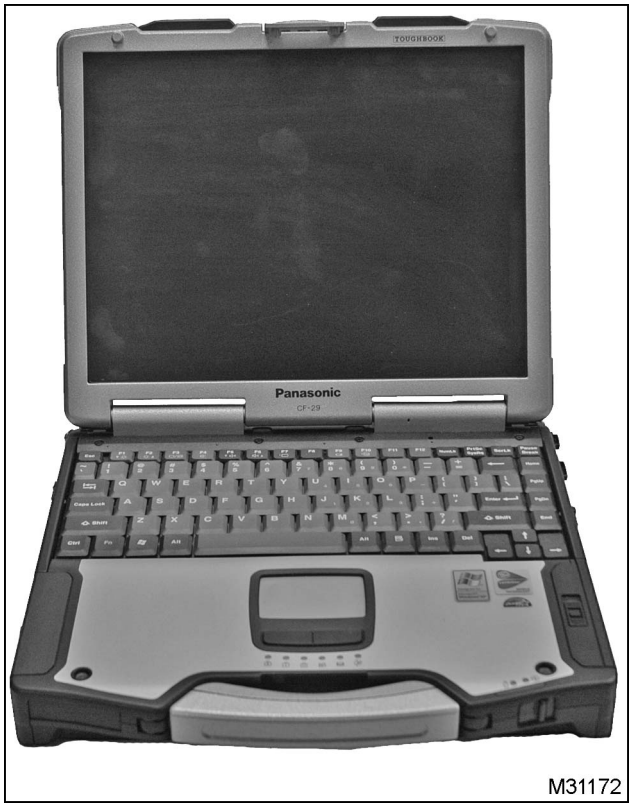


Figure 536 Electronic Service Tool (EST) (typical)

The EST is used to run ServiceMaxx™ software for diagnosing and troubleshooting engine and vehicle problems.

ServiceMaxx™ Software

ServiceMaxx™ software, loaded to an EST or laptop computer, is used to check performance of engine systems, diagnose engine problems, and store troubleshooting history for an engine.

Interface cable (RP1210B compliant supporting J1939 and J1708)

The Interface cable (RP1210B compliant supporting J1939 and J1708) is used to connect the EST to the vehicle. It is available from various suppliers.

Breakout Harness 4485A (APP)

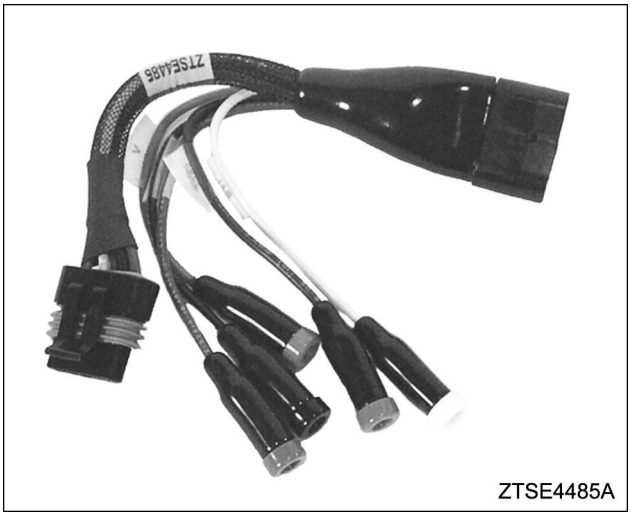


Figure 537 ZTSE4485A

Breakout Harness 4485A is used to measure voltage and resistance on circuits that go to the Accelerator Pedal Position (APP) sensor.

Breakout Harness 4735A (O_2S)

Figure 538 ZTSE4735A

Breakout Harness 4735A is used to measure voltage and resistance on circuits connected to the Oxygen Sensor (O_2S).

Breakout Harness 4760A (AFTFSV, AFTPAV, AFTFI and EGRT)

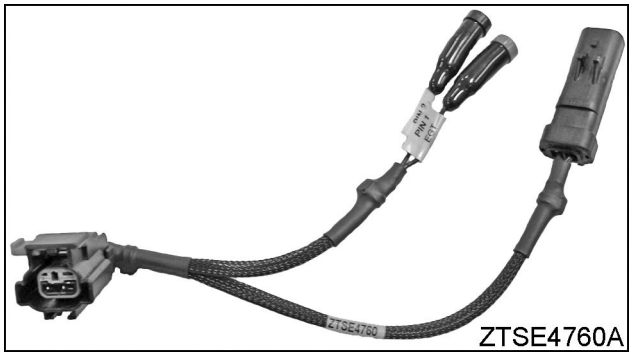


Figure 539 ZTSE4760A

Breakout Harness 4760A is used to measure voltage and resistance on circuits that go to the Aftertreatment Fuel Shutoff Valve (AFTFSV), Aftertreatment Purge Air Valve (AFTPAV), Aftertreatment Fuel Injector (AFTFI), and Exhaust Gas Recirculation Temperature (EGRT) sensors.

Breakout Harness 4827 (DEFTHC, IAHFS, ECT1, ECT2, EOL, and EOT)

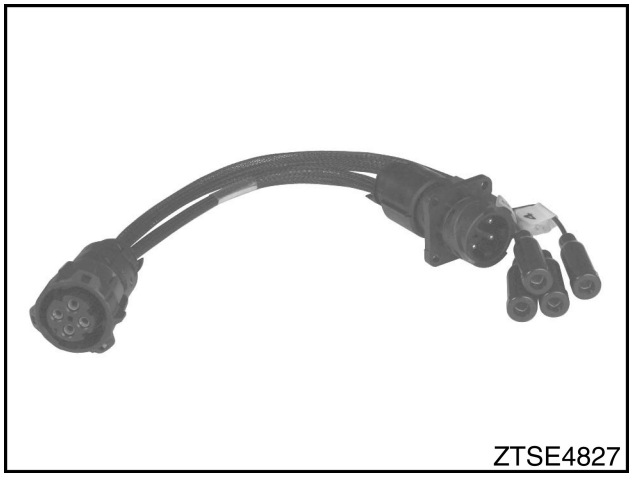


Figure 540 ZTSE4827

Breakout Harness 4827 is used to measure voltage and resistance on circuits connected to the Diesel Exhaust Fluid Tank Heater Valve (DEFTHC), Inlet Air Heater Fuel Solenoid (IAHFS), Engine Coolant Temperature 1 (ECT1), Engine Coolant Temperature 2 (ECT2), Engine Oil Level (EOL), and Engine Oil Temperature (EOT) sensors.

Breakout Harness 4828 (FPCV and DEFDV)

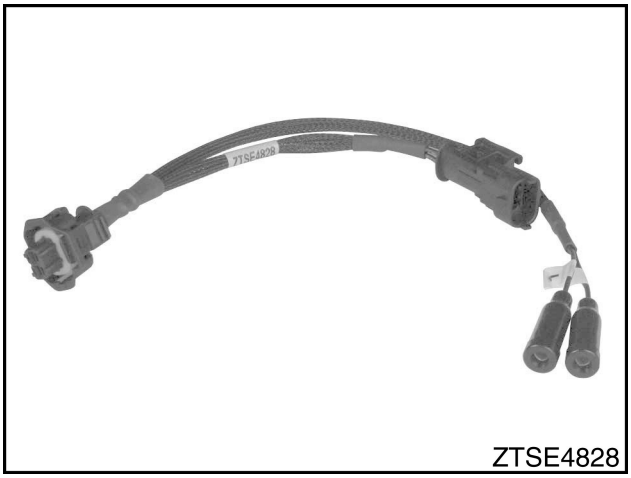


Figure 541 ZTSE4828

Breakout Harness 4828 is used to measure voltage and resistance on circuits connected to the Fuel Pressure Control Valve (FPCV) and Diesel Exhaust Fluid Doser Valve (DEFDV).

Breakout Harness 4829 (FRP)

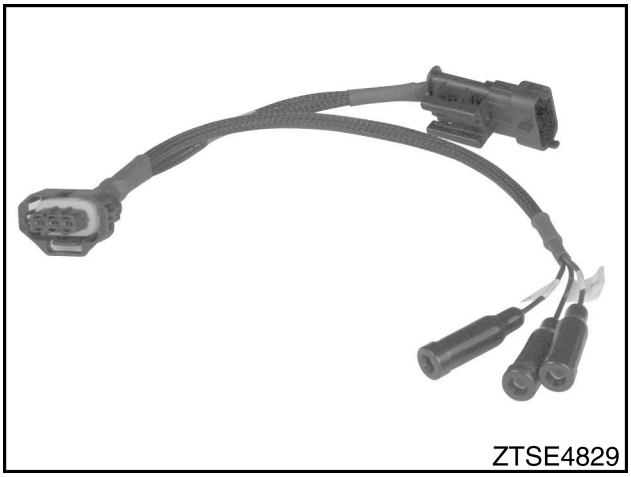


Figure 542 ZTSE4829

Breakout Harness 4829 is used to measure voltage and resistance on circuits connected to the Fuel Rail Pressure (FRP) sensor.

Breakout Harness 4830 (HS/IAT and TC2CIS)

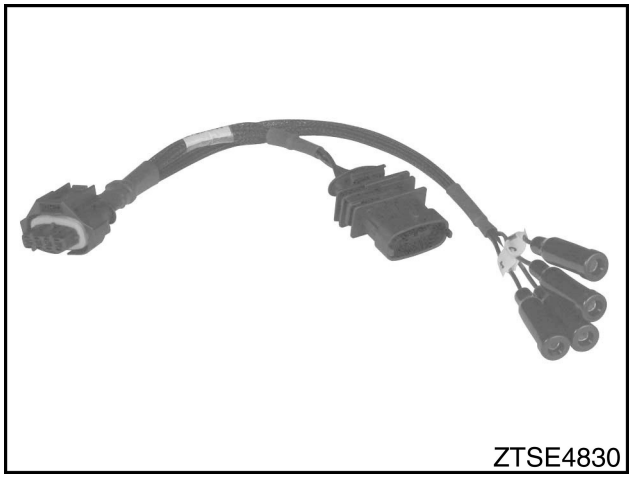


Figure 543 ZTSE4830

Breakout Harness 4830 is used to measure voltage and resistance on circuits connected to the Humidity/Air Inlet Temperature (HS/IAT) sensor and Turbocharger 2 Compressor Inlet Sensor (TC2CIS).

Breakout Harness 4844 (EFAN)

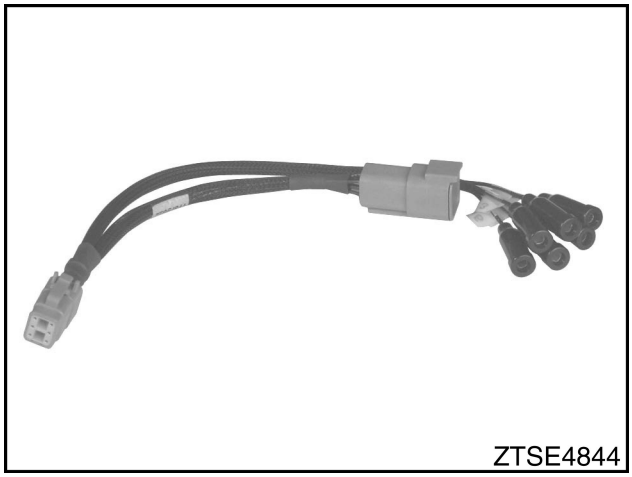


Figure 544 ZTSE4844

Breakout Harness 4844 is used to measure voltage and resistance on circuits connected to the variable Electronic Fan (EFAN) control .

Breakout Harness 4845

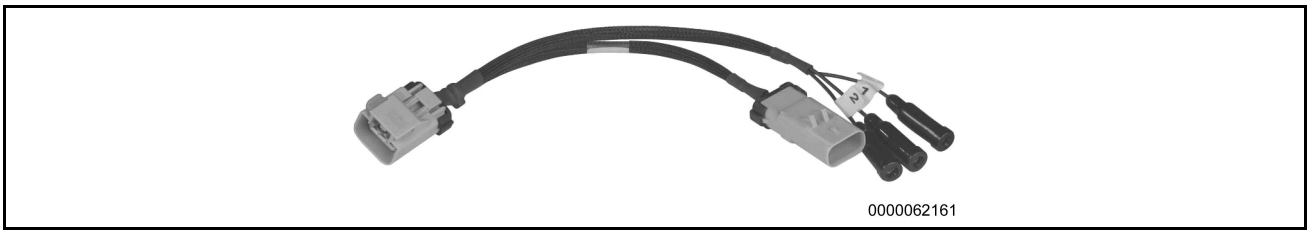


Figure 545 ZTSE4845

Breakout Harness 4845 is used to measure voltage and resistance on circuits connected to the Aftertreatment Fuel Pressure sensor 1 (AFTFP1) sensor.

Breakout Harness 4850 (IMP)

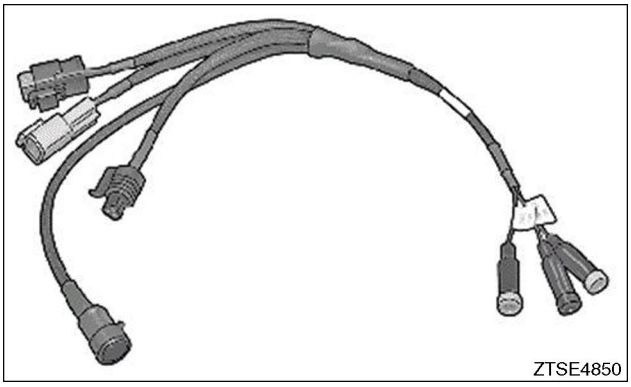


Figure 546 ZTSE4850

Breakout Harness 4850 is used to measure voltage and resistance on circuits connected to the Intake Manifold Pressure (IMP) sensor.

Breakout Harness 4870 (CMV)

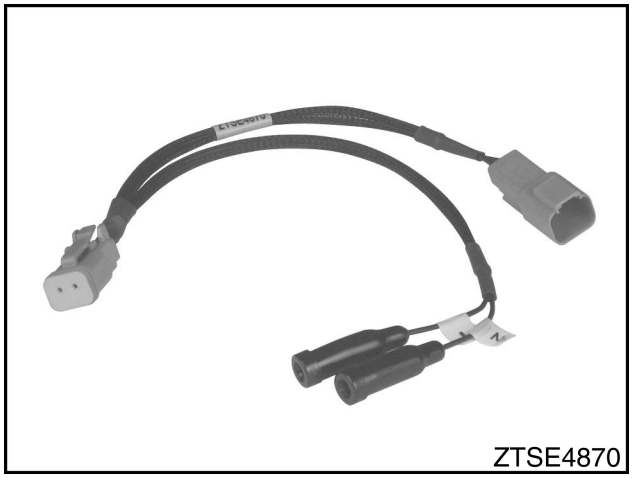


Figure 547 ZTSE4870

Breakout Harness 4870 is used to measure voltage and resistance on circuits connected to the Coolant Mixer Valve (CMV).

Breakout Harness 4871 (AAT and CFV)

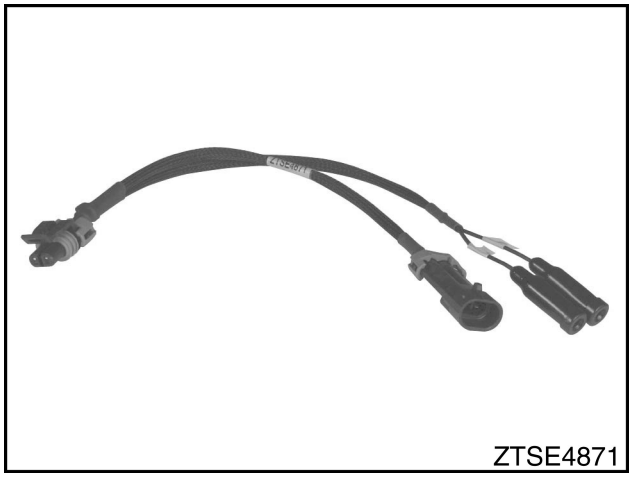


Figure 548 ZTSE4871

Breakout Harness 4871 is used to measure voltage and resistance on circuits connected to the Ambient Air Temperature (AAT) sensor and Coolant Flow Valve (CFV).

Breakout Harness 4881 (FDP)

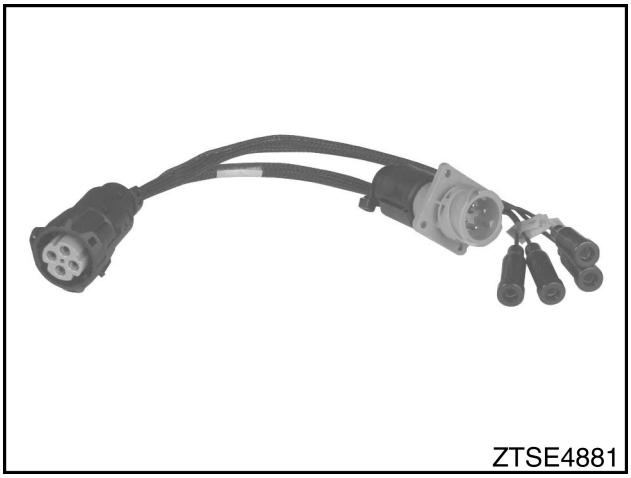


Figure 549 ZTSE4881

Breakout Harness 4881 is used to measure voltage and resistance on circuits connected to the Fuel Delivery Pressure (FDP) sensor.

Breakout Harness 4882 (EOP)

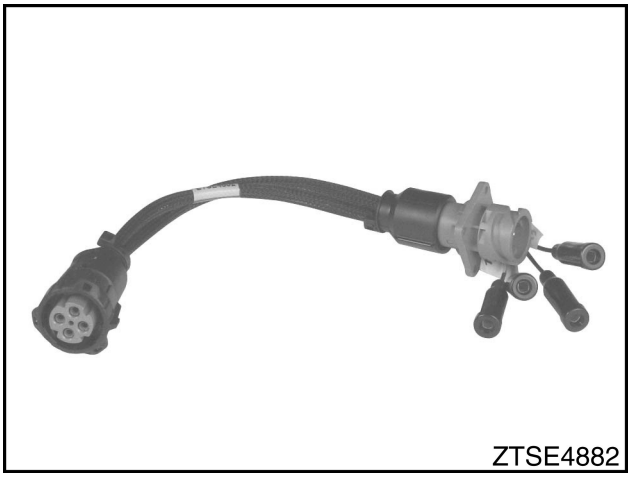


Figure 550 ZTSE4882

Breakout Harness 4882 is used to measure voltage and resistance on circuits connected to the Engine Oil Pressure (EOP) sensor.

Breakout Harness 4883 (IMT)

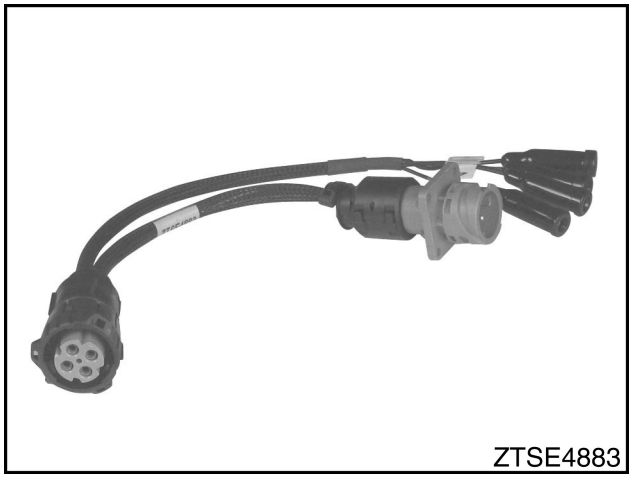


Figure 551 ZTSE4883

Breakout Harness 4883 is used to measure voltage and resistance on circuits connected to the Intake Manifold Temperature (IMT) sensor.

Breakout Harness 4885 (IAHR)

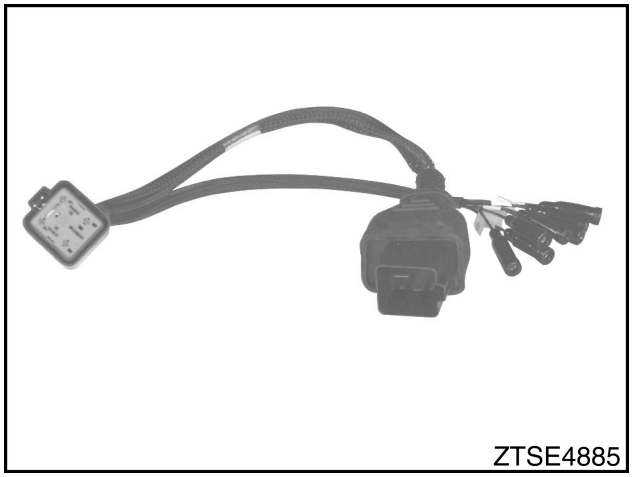


Figure 552 ZTSE4885

Breakout Harness 4885 is used to measure voltage and resistance on circuits connected to the Inlet Air Heater Relay (IAHR).

Breakout Harness 4908

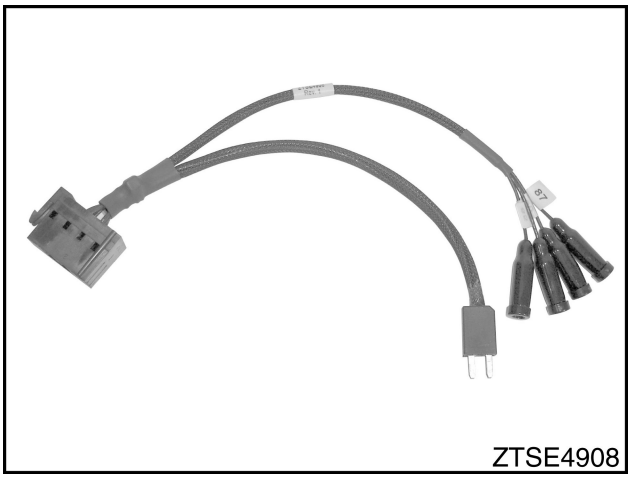


Figure 553 ZTSE4908

Breakout Harness 4908 is used to measure voltage and resistance on various relay circuits.

Breakout Harness 4951 (CCOSS)

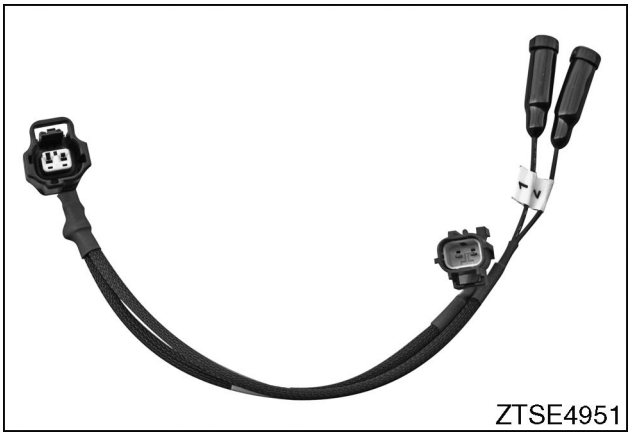


Figure 554 ZTSE4951

Breakout Harness 4951 is used to measure voltage and resistance on circuits connected to the Crankcase Oil Separator Speed (CCOSS) sensor.

Breakout Harness 4993 (CACOT)

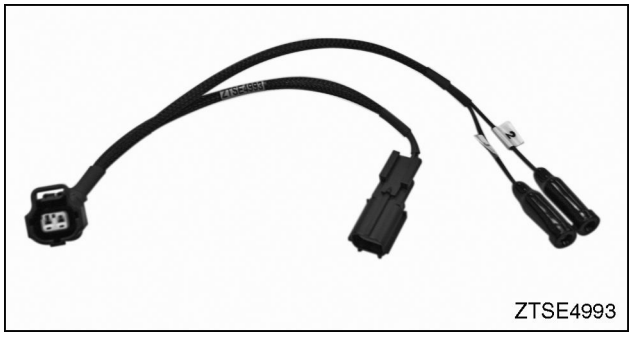


Figure 555 ZTSE4993

Breakout Harness 4993 is used to measure voltage and resistance on circuits that go to the Charge Air Cooler Outlet Temperature (CACOT) sensor.

Breakout Harness 6002 (WIF)

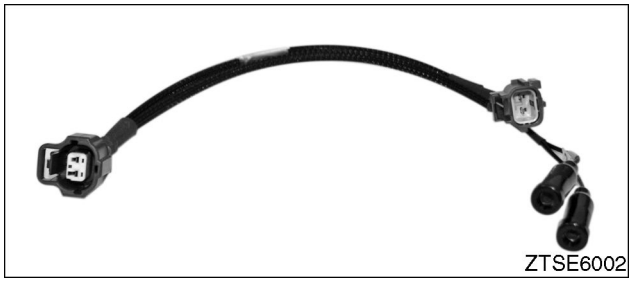


Figure 556 ZTSE6002

Breakout Harness 6002 is used to measure voltage and resistance on circuits that go to the Water In Fuel (WIF) sensor.

Breakout Harness 6003 (EBPV, TC1TOP, and TC2WC)

Figure 557 ZTSE6003

Breakout Harness 6003 is used to measure voltage and resistance on circuits that go to the Exhaust Back Pressure Valve (EBPV), Turbocharger 1 Turbine Outlet Pressure (TC1TOP) sensor, and Turbocharger 2 Wastegate Control (TC2WC).

Breakout Harness 6004 (ECB)

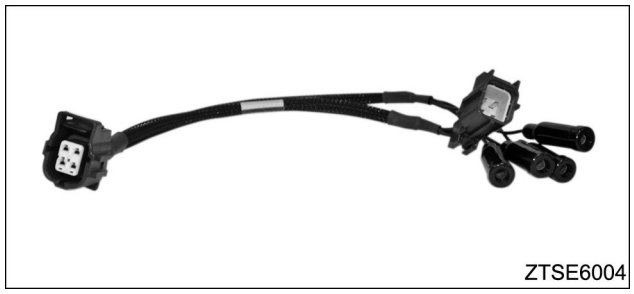


Figure 558 ZTSE6004

Breakout Harness 6004 is used to measure voltage and resistance on circuits that go to the Engine Compression Brake (ECB).

Breakout Harness 6016 (ETV and EGR Valve)

Figure 559 ZTSE6016

Breakout Harness 6016 is used to measure voltage and resistance on circuits that go to the Engine Throttle Valve (ETV) and EGR valve.

Breakout Harness 6021 (CKP and CMP)

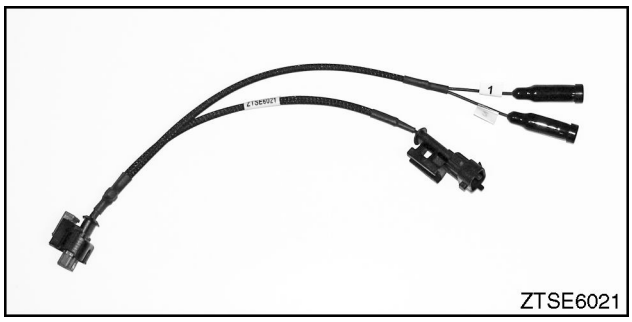


Figure 560 ZTSE6021

Breakout Harness 6021 is used to measure voltage and resistance on circuits that go to the Crankshaft Position (CKP) and Camshaft Position (CMP) sensors.

Breakout Harness 12-574-01 (8-way DPF Jumper)

Figure 561 12-574-01

Breakout Harness 12-574-01 is used to measure voltage and resistance on circuits that pass through the 8-way DPF Jumper.

Breakout Harness 12-575-01 (DPF Differential Pressure / Outlet Pressure Sensor)

Figure 562 12-575-01

Breakout Harness 12-575-01 is used to measure voltage and resistance on circuits that go to the DPF Differential Pressure / Outlet Pressure Sensor.

Breakout Harness 18-045-01 (DEF Suction Line Heater)

Figure 563 18-045-01

Breakout Harness 18-045-01 is used to measure voltage and resistance on circuits that go to the Diesel Exhaust Fluid (DEF) Suction Line Heater.

Breakout Harness 18-046-01 (DEF Return Line Heater)

0000053769

Figure 564 18-046-01

Breakout Harness 18-046-01 is used to measure voltage and resistance on circuits that go to the Diesel Exhaust Fluid (DEF) Return Line Heater.

Breakout Harness 18-047-01 (DEF Pressure Line Heater)

0000053770

Figure 565 18-047-01

Breakout Harness 18-047-01 is used to measure voltage and resistance on circuits that go to the DEF Pressure Line Heater.

Breakout Harness 18-050-01 (20-way DEF Harness Interconnect)

0000053771

Figure 566 18-050-01

Breakout Harness 18-050-01 is used to measure voltage and resistance on circuits that pass through the 20-way DEF Harness Interconnect.

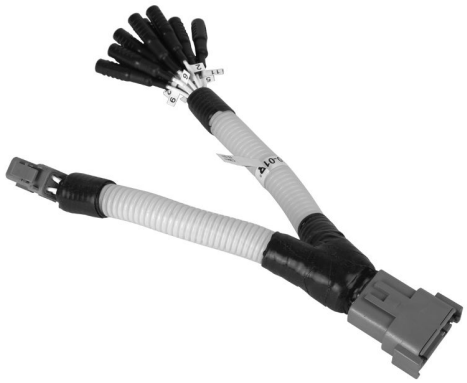
Breakout Harness 18-124-01 (DEF Tank Level and Temperature Sensor)

0000053772

Figure 567 18-124-01

Breakout Harness 18-124-01 is used to measure voltage and resistance on circuits that go to the Diesel Exhaust Fluid (DEF) Tank Level and Temperature Sensor.

Breakout Harness 18-250-01 (12-way SCR Jumper Harness)



0000053773

Figure 568 18-250-01

Breakout Harness 18-250-01 is used to measure voltage and resistance on circuits that pass through the 12-way Selective Catalyst Reduction (SCR) Jumper Harness.

Breakout Harness 18-500-01 (12-way AFT Interconnect)

0000053774

Figure 569 18-500-01

Breakout Harness 18-500-01 is used to measure voltage and resistance on circuits that pass through the 12-way Aftertreatment (AFT) interconnect.

Breakout Harness 18-648-01 (NOx In Sensor Module and SCR Temperature Sensor Module)

0000053775

Figure 570 18-648-01

Breakout Harness 18-648-01 is used to measure voltage and resistance on circuits that go to the Carbon Monoxide (NOx) In sensor module and Selective Catalyst Reduction (SCR) temperature sensor module.

Breakout Harness 18-649-01 (NOx Out and DOC / DPF Temperature Sensor Module)

0000053776

Figure 571 18-649-01

Breakout Harness 18-649-01 is used to measure voltage and resistance on circuits that go to the Carbon Monoxide (NOx) Out and Diesel Oxidation Catalyst / Diesel Particulate Filter (DOC / DPF) temperature sensor module.

Breakout Harness 18-650-01 (Ammonia (NH_3) Sensor)

0000053777

Figure 572 18-650-01

Breakout Harness 18-650-01 is used to measure voltage and resistance on circuits that go to the Ammonia (NH_3) Sensor.

Breakout Harness 18-801-01 (Ammonia (NH_3) Sensor Module)

0000053778

Figure 573 18-801-01

Breakout Harness 18-801-01 is used to measure voltage and resistance on circuits that go to the Ammonia (NH_3) Sensor Module.

Breakout Harness 18-909-01 (DEF Supply Module)

Figure 574 18-909-01

Breakout Harness 18-909-01 is used to measure voltage and resistance on circuits that go to the Diesel Exhaust Fluid (DEF) Supply Module.

Mechanical Tools

Air Cap, Fuel Cap and Plug Kit

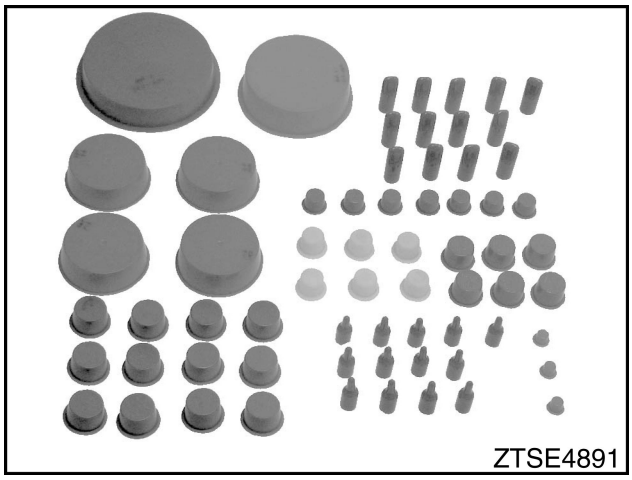


Figure 575 ZTSE4891

The Disposable Air and Fuel Caps are used to cap the fuel system lines and fittings when the fuel system is disconnected for diagnostics. The Disposable Air and Fuel Caps prevent dirt and foreign particles from entering and contaminating the fuel system.

Air Compressor Coolant Line Release Tool

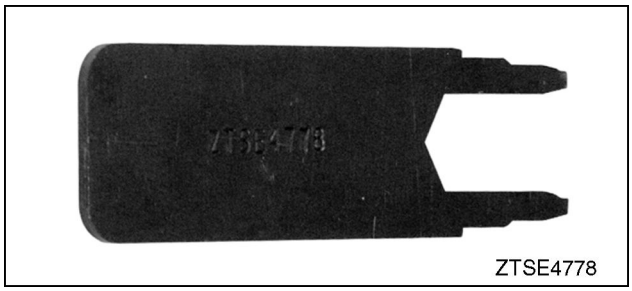


Figure 576 ZTSE4778

Air Compressor Coolant Line Release Tool releases the locking mechanism to allow the removal of the coolant line on the air compressor.

Air Intake Guard

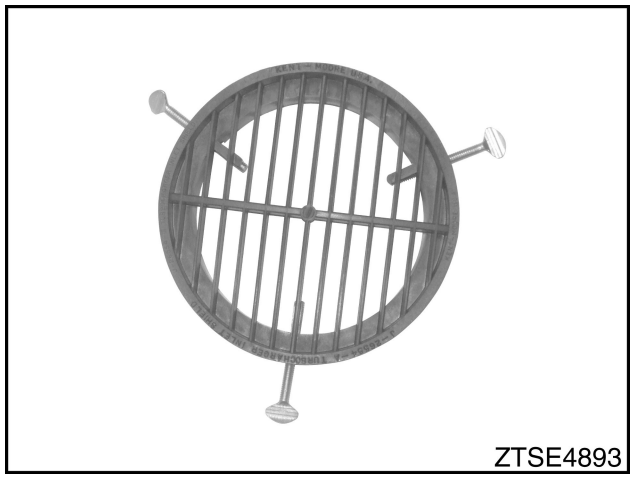


Figure 577 ZTSE4893

The Air Intake Guard is used to protect the turbochargers while performing diagnostics with the air cleaner disconnected.

Blow-by Test Tool

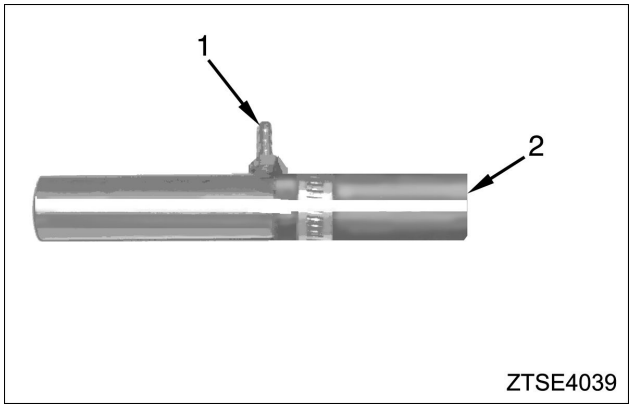


Figure 578 ZTSE4039 (0.406 in. diameter)

1. To magnehelic gauge or manometer
2. To valve cover

The Blow-by Test Tool is used to measure combustion gas flow from the crankcase oil separator and may be used with the digital or Slack Tube® manometer.

Use the pressure readings obtained with this adapter as the main source of engine condition. Use oil consumption trend data if the pressure readings are over the specified limits. Neither changes in oil consumption trends nor crankcase diagnostic pressure trends can establish a specific problem. These changes only indicate that a problem exists.

Clean Fuel Source Tool

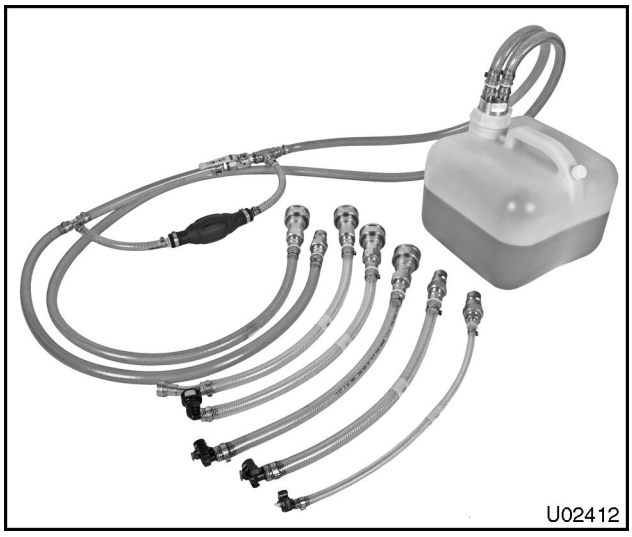


Figure 579 15-637-01

The Clean Fuel Source Tool is used to provide a clean, alternative fuel source to aid in the diagnosis of the fuel system.

Inlet Air Heater Solenoid Test Adapter Kit

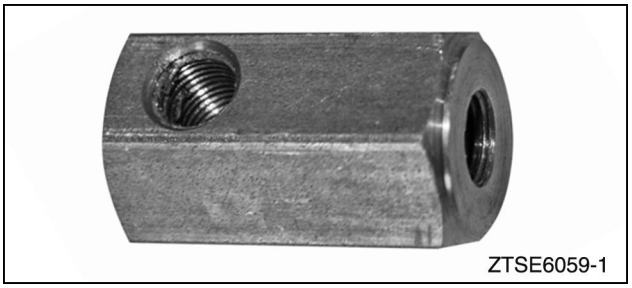


Figure 580 ZTSE6059-1

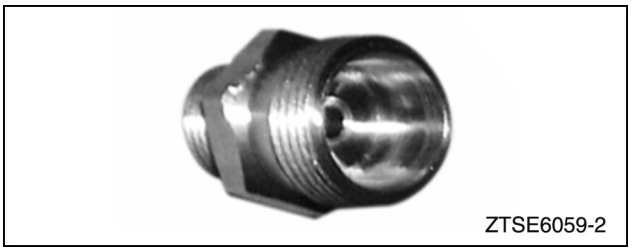


Figure 581 ZTSE6059-2

The Inlet Air Heater Solenoid Test Adapter Kit is used with the Fuel Pressure Gauge to test fuel pressure at the Inlet Air Heater Fuel Igniter (IAHFI) and Inlet Air Heater Fuel Solenoid (IAHFS).

Digital Manometer

Figure 582 Obtain locally

The Digital Manometer is used to measure low vacuum due to intake restriction or low crankcase pressure. A variety of digital manometers are available for purchase locally. The Water Manometer kit (ZTSE2217A) is an alternative to the Digital Manometer.

EGR Cooler Leak Detection Test Kit

Figure 583 KL20060NAV

The EGR Cooler Leak Detection Test Kit is used to pressure test the EGR cooler to check for leaks.

Charge Air Cooler Test Kit

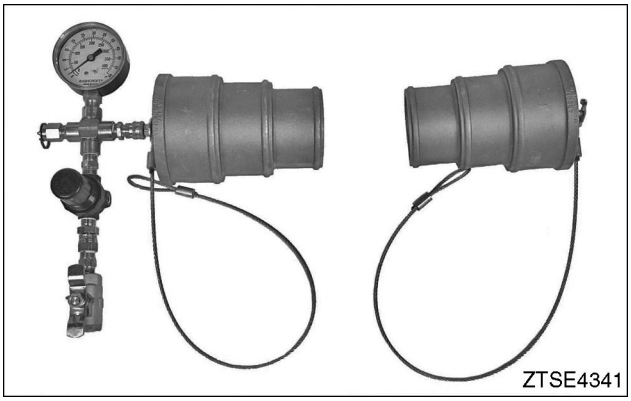


Figure 584 ZTSE4341

The Charge Air Cooler Test Kit is used to pressurize the charge air cooler and piping to check for leaks.

Digital IR Thermometer

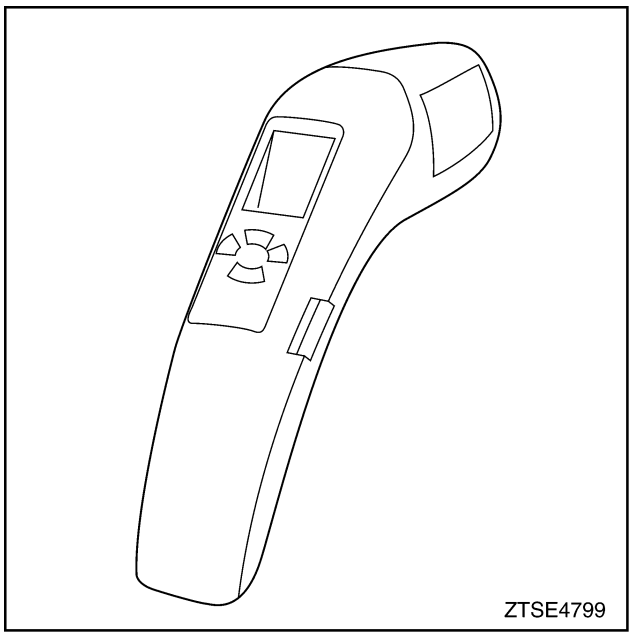


Figure 585 ZTSE4799

The Digital Infrared (IR) Thermometer is used to take temperature readings when Electronic Service Tool (EST) and dash gauge readings need to be verified.

Lash Gauge (0.50mm)

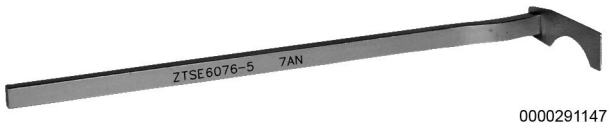


Figure 586 ZTSE6076-5A

This tool is used to measure intake valve lash.

Lash Gauge (0.80mm)

0000290801

Figure 587 ZTSE6076-7A

This tool is used to measure exhaust valve lash.

Fuel Block Off Tool

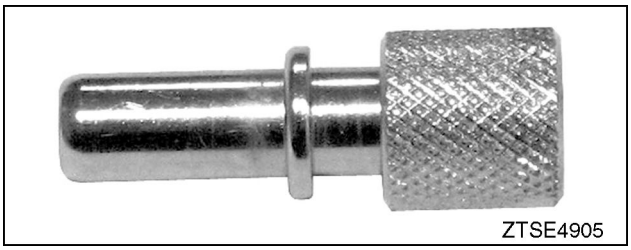


Figure 588 ZTSE4905

The Fuel Block Off Tool is used to block the T-connector fuel line at the high pressure pump in order to measure the low pressure pump output pressure.

Fuel Injector Cups

Figure 589 ZTSE4892

Fuel Injector Cups protects and prevents dirt and debris from damaging the injectors while out of the engine.

Fuel Inlet Restriction and Aeration Tool

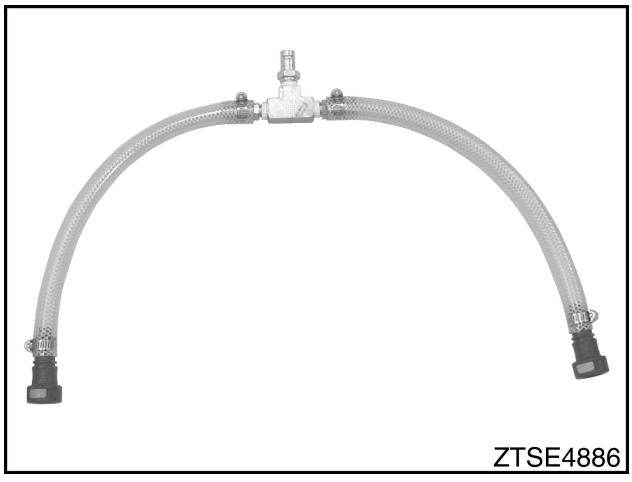


Figure 590 ZTSE4886

The Fuel Inlet Restriction and Aeration Tool is used to check for pressure and aerated fuel in the low fuel pressure system.

Fuel Line Coupler

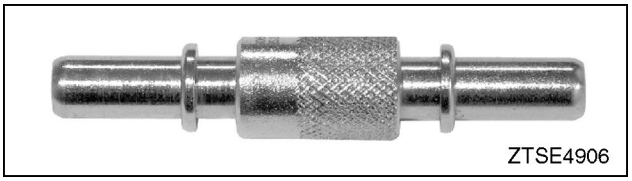


Figure 591 ZTSE4906

The Fuel Line Coupler is used in conjunction with the Fuel Inlet Restriction and Aeration Tool to measure the fuel pressure in the return line.

Fuel Line Disconnect Tool 11.8 mm

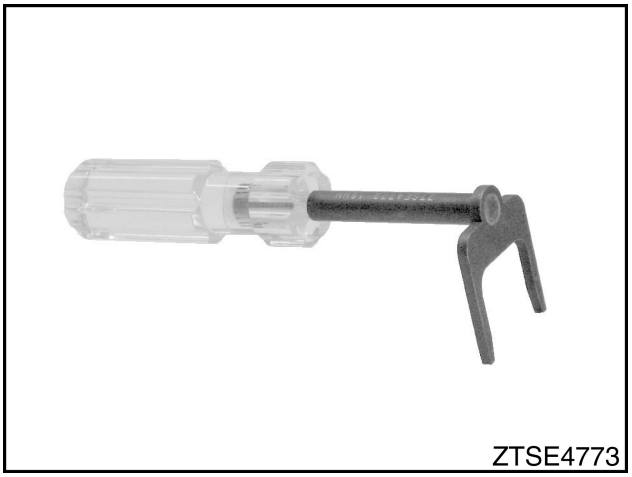


Figure 592 ZTSE4773

The Fuel Line Disconnect Tool 11.8 mm is used to release the locking mechanism on low pressure fuel line connectors.

Fuel Line Disconnect Tool 16 mm

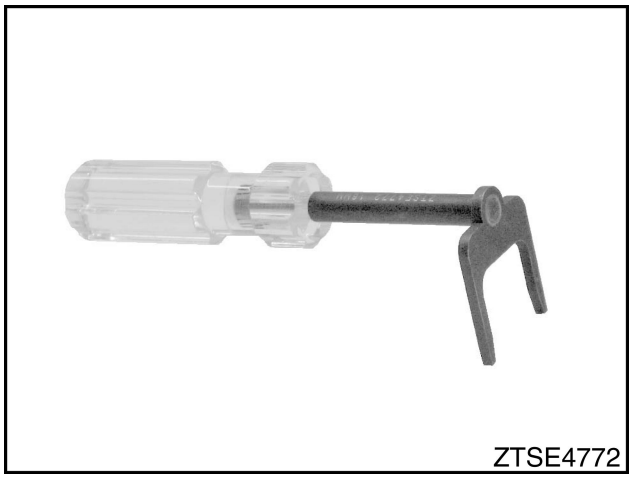


Figure 593 ZTSE4772

The Fuel Line Disconnect Tool 16 mm is used to release the locking mechanism on low pressure fuel line connectors.

Fuel/Oil Pressure Test Coupler

Figure 594 ZTSE4526

The Fuel / Oil Pressure Test Coupler is used with the fuel pressure test fitting for an easy connection to measure fuel pressure.

Fuel Pressure Gauge

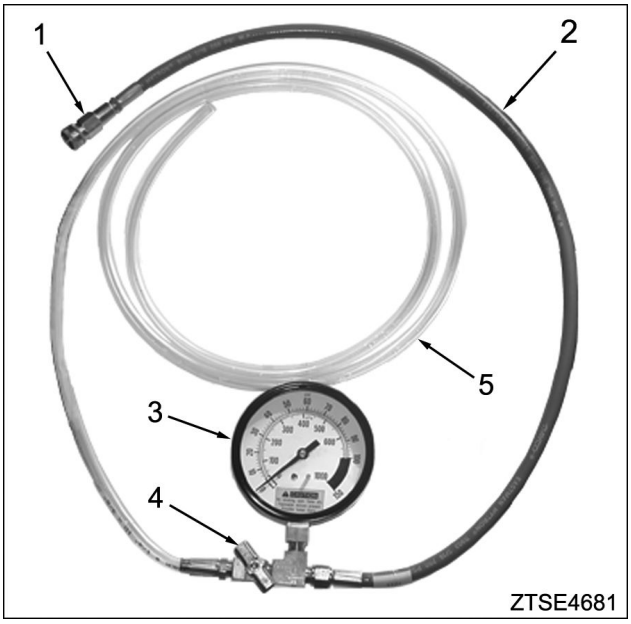


Figure 595 ZTSE4681

1. Quick disconnect check valve
2. Fuel test line
3. Fuel Pressure Gauge
4. Inline shut-off valve
5. Clear test line

The Fuel Pressure Gauge is used to check for fuel pressure and aerated fuel in the low fuel pressure system.

High Pressure Rail Plugs

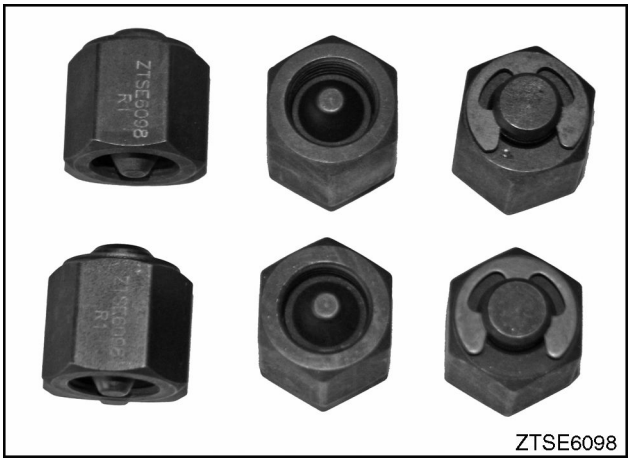


Figure 596 ZTSE6098

The High Pressure Rail Plugs are used to isolate individual injectors by blocking the pressure pipe rail output.

High Pressure Return Line Tester

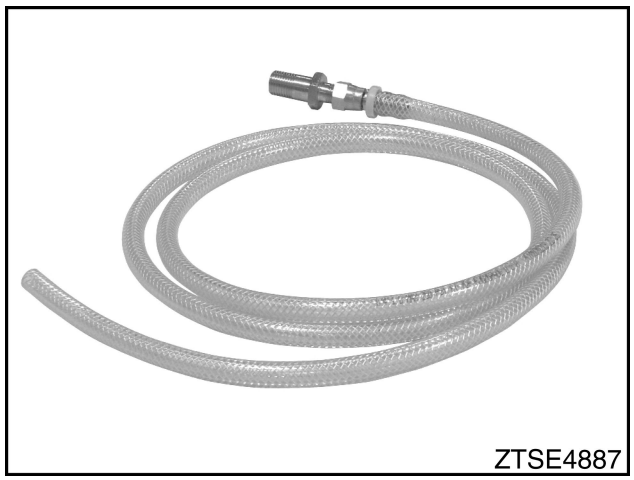


Figure 597 ZTSE4887

The High Pressure Return Line Tester is used to check for fuel returning from the pressure pipe rail or from the cylinder head fuel return port. Tool consists of two adapters, ZTSE4887-1 (17mm) and ZTSE4887-2 (19mm), and hose ZTSE4887-3.

Pressure Test Kit

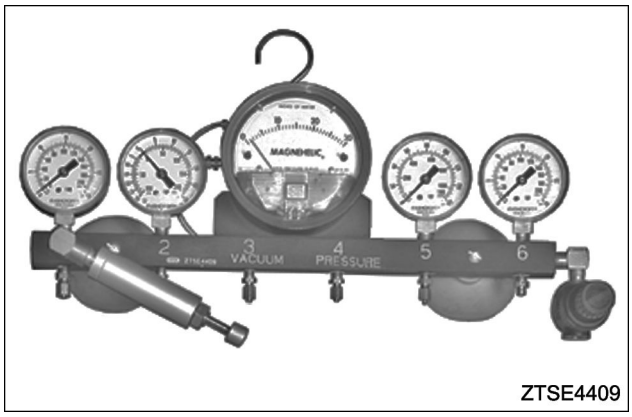


Figure 598 ZTSE4409

The Pressure Test Kit is used to measure intake manifold (boost) pressure, fuel system inlet restriction, fuel pressure, oil pressure, air cleaner intake restriction, and crankcase pressure.

- 0 to 200 kPa (0 to 30 psi) measures intake manifold pressure.
- 0-30 in Hg vacuum /0 to 200 kPa (0 to 30 psi) compound gauge measures fuel system inlet restriction and intake manifold pressure.

  0-30 in H2O 0 to 7.5 kPa (0 to 1 psi) maximum pressure magnehelic gauge measures crankcase pressure and air inlet restriction.
- 60 to 1100 kPa (0 to 160 psi) gauge may be used to check the fuel pressure and oil pressure.

Radiator Pressure Test Kit

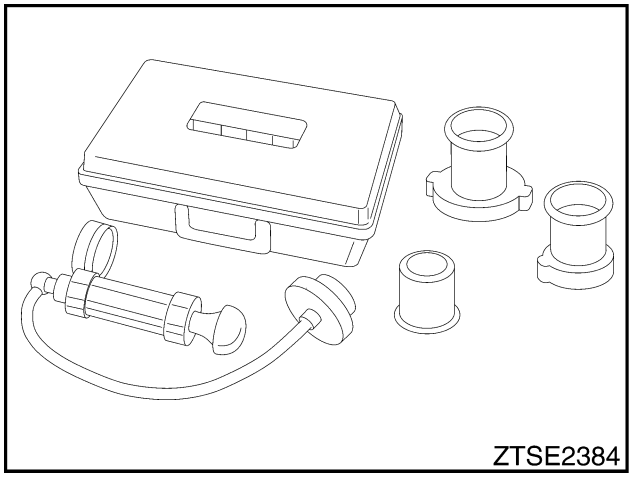


Figure 599 ZTSE2384

The Radiator Pressure Test Kit is used to check pressure caps and cooling systems. The pressure gauge indicates if the pressure cap holds the correct pressure and whether the cooling system has leaks or holds pressure.

Slack Tube® Manometer

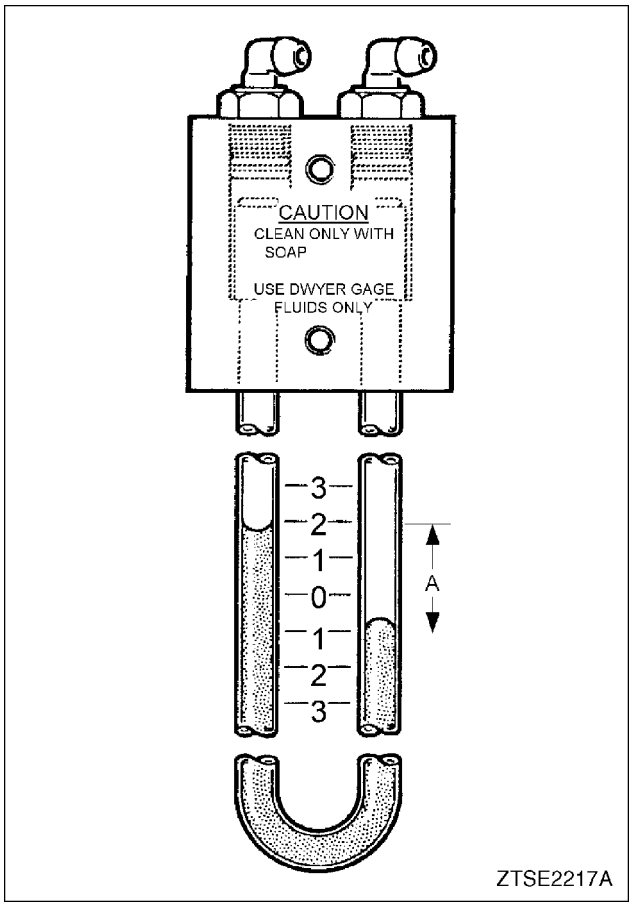


Figure 600 ZTSE2217A

The Slack Tube® Manometer is a U-shaped tube with a scale mounted between the legs of the tube. When the portability of the Pressure Test Kit is not required, this manometer is used to measure low vacuum for intake restriction, low pressure for crankcase, or exhaust back pressure.

Filling

Fill the manometer with water before checking pressure. Use only distilled water. Add some colored water vegetable dye so the scale can be read more easily. With both legs of the manometer open to the atmosphere, fill the tube until the top of the fluid column is near the zero mark on the scale. Shake the tube to eliminate any air bubbles.

Installing, Reading, and Cleaning

1. Support the manometer vertically. Make sure the fluid level is in line with the zero indicator on the graduated scale.
2. Connect one leg of the manometer to the source of the pressure or vacuum. Leave the other leg open to atmospheric pressure.
3. Start the engine and allow it to reach normal operating temperature. Then run the engine to high idle. The manometer can be read after 10 seconds.

4. Record the average position of the fluid level when it is above and below the zero indicator. Add the two figures together. The sum of the two is the total column of fluid (distance A). This represents the crankcase pressure in inches of water (in H_2O).

   At times, both columns of the manometer will not travel the same distance. This is no concern if the leg not connected to the pressure or vacuum source is open to the atmosphere.

5. Compare the manometer reading with engine specifications.

6. When the test is done, clean the tube thoroughly using soap and water. Avoid liquid soaps and solvents.

UV Leak Detection Kit

Figure 601 ZTSE4618

The UV Leak Detection Kit is used with fuel dye to quickly identify leaks. The fuel dye combines with fuel and migrates out at the leak. The ultraviolet lamp illuminates the leaking fuel dye, which appears fluorescent yellow-green in color.

Vacuum Analyzer and Fuel Pump Tester

Figure 602 ZTSE2499

The Vacuum Analyzer and Fuel Pump Tester is used to test the operation of the fuel pump.

Diesel Exhaust Fluid Refractometer

Figure 603 5025

The Diesel Exhaust Fluid (DEF) Refractometer 5025 is used to measure the DEF Urea/Water concentration, which is important for proper SCR system operation.

Aftertreatment Injector Test Kit

Figure 604 12-559-01

The Aftertreatment Injector Test Kit is used when performing tests on the Aftertreatment Fuel Injector (AFTFI).

DEF Doser Valve Spray Test Kit

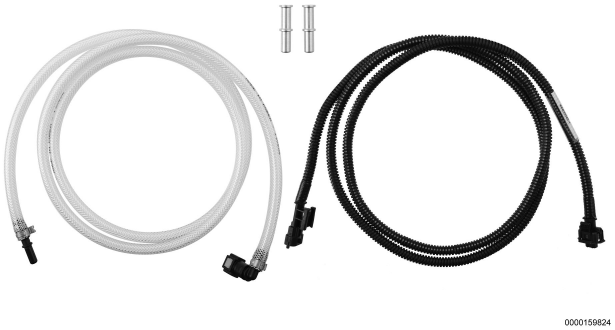


Figure 605 18-559-01

The DEF Doser Valve Spray Test Kit is used when performing tests on the Diesel Exhaust Fluid Doser Valve (DEFDV).

Pressure Gauge Adapter 18-538-01

0000290943

Figure 606 18-538-01

Pressure Gauge Adapter 18-538-01 converts Aftertreatment (AFT) temperature sensor ports to 1/8-in NPT thread so a standard pressure gauge can be used to measure exhaust pressure.

DEF Doser Cleaning Kit

0000291010

Figure 607 18-200-01

18-200-01 DEF Doser Cleaning Kit is used to flush contaminated Diesel Exhaust Fluid (DEF) from the supply module.

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Abbreviations and Acronyms.....1509

Abbreviations and Acronyms

A or amp – Ampere
AAT – Ambient Air Temperature
ABDC – After Bottom Dead Center
ABS – Antilock Brake System
AC – Alternating Current
A/C – Air Conditioner
ACC – Air Conditioner Control
ACCEL – Accelerator
ACD – Air Conditioner Demand
ACM – Aftertreatment Control Module
ACV – Air Control Valve
AFTFI – Aftertreatment Fuel Injector
AFT – Aftertreatment
AFTFP1 – Aftertreatment Fuel Pressure 1
AFTFSV – Aftertreatment Fuel Shutoff Valve
AFTPAV – Aftertreatment Purge Air Valve
Amb – Ambient
amp or A – Ampere
AMS – Air Management System
API – American Petroleum Institute
APP – Accelerator Pedal Position
APP1 – Accelerator Pedal Position 1
APP2 – Accelerator Pedal Position 2
APS – Accelerator Position Sensor
APS/IVS – Accelerator Position Sensor / Idle Validation Switch
ASTM – American Society for Testing and Materials
ATA – American Trucking Association
ATAH – American Trucking Association Link High
ATAL – American Trucking Association Link Low
ATDC – After Top Dead Center
AWG – American Wire Gauge
AWL – Amber Warning Lamp

B+ or VBAT – Battery Voltage
BAP or BARO – Barometric Absolute Pressure
BARO or BAP – Barometric Absolute Pressure
BBDC – Before Bottom Dead Center
BC – Body Controller
BCP – Brake Control Pressure
BCS – Boost Control Solenoid
BDC – Bottom Dead Center
bhp – Brake Horsepower
BNO – Brake Normally Open
BOO – Brake On / Off
BPP – Brake Pedal Position
BPS – Brake Pressure Switch
BSV – Brake Shut-off Valve
BTDC – Before Top Dead Center
BTU – British Thermal Unit

C – Celsius
CAC – Charge Air Cooler
CACOT – Charge Air Cooler Outlet Temperature
CAN – Controller Area Network
CAP – Cold Ambient Protection
CARB – California Air Resources Board
cc – Cubic centimeter
CCA – Cold Cranking Ampere
CCV – Coolant Control Valve
CCOSS – Crankcase Oil Separator Speed
CCPS – Crankcase Pressure Sensor
CCS – Cruise Control Switches
CDR – Crankcase Depression Regulator
cfm – Cubic feet per minute
cfs – Cubic feet per second
CFV – Coolant Flow Valve
CID – Cubic Inch Displacement
CKP – Crankshaft Position
CKPH – Crankshaft Position High
CKPL – Crankshaft Position Low
CKPO – Crankshaft Position Out
cm – Centimeter
CMP – Camshaft Position
CMPH – Camshaft Position High
CMPL – Camshaft Position Low
CMPO – Camshaft Position Out
CMV – Coolant Mixer Valve
CO – Carbon Monoxide
COO – Cruise On / Off switch
CPU – Central Processing Unit
CTC – Coolant Temperature Compensation
Cyl – Cylinder

DB – Decibel
DC – Direct Current
DCA – Diesel Coolant Additive
DDI – Digital Direct Fuel Injection
DDS – Driveline Disengagement Switch
DEF – Diesel Exhaust Fluid
DEFDUH – Diesel Exhaust Fluid Dosing Unit Heater
DEFDV – Diesel Exhaust Fluid Doser Valve
DEFLHR – Diesel Exhaust Fluid Line Heater Relay
DEFLP – Diesel Exhaust Fluid Line Pressure
DEFLT – Diesel Exhaust Fluid Line Temperature
DEFPLH – Diesel Exhaust Fluid Pressure Line Heater
DEFRLH – Diesel Exhaust Fluid Return Line Heater
DEFRV – Diesel Exhaust Fluid Return Valve
DEFSLH – Diesel Exhaust Fluid Suction Line Heater
DEFSP – Diesel Exhaust Fluid Supply Pump
DEFTHC – Diesel Exhaust Fluid Tank Heater Valve
DEFTL – Diesel Exhaust Fluid Tank Level

DEFTLT – Diesel Exhaust Fluid Tank Level and Temperature
DEFTT – Diesel Exhaust Fluid Tank Temperature
DEFUHR – Diesel Exhaust Fluid Unit Heater Relay
DLC – Data Link Connector
DME – Dimethyl Ether
DMM – Digital Multimeter
DOC – Diesel Oxidation Catalyst
DOCIT – Diesel Oxidation Catalyst Inlet Temperature
DOCOT – Diesel Oxidation Catalyst Outlet Temperature
DPF – Diesel Particulate Filter
DPFDP – Diesel Particulate Filter Differential Pressure
DPFOP – Diesel Particulate Filter Outlet Pressure
DPFIT – Diesel Particulate Filter Inlet Temperature
DPFOT – Diesel Particulate Filter Outlet Temperature
DSI – Down Stream Injection
DT – Diesel Turbocharged
DTC – Diagnostic Trouble Code
DTCs – Diagnostic Trouble Codes
DTRM – Diesel Thermo Recirculation Module

EBC – Exhaust Brake Controller
EBP – Exhaust Back Pressure
EBPD – Exhaust Back Pressure Desired
EBPV – Exhaust Back Pressure Valve
ECB – Engine Compression Brake
ECB1 – Engine Compression Brake 1
ECB2 – Engine Compression Brake 2
ECB3 – Engine Compression Brake 3
ECBP – Engine Compression Brake Pressure
ECI – Engine Crank Inhibit
ECL – Engine Coolant Level
ECM – Engine Control Module
ECM GND – Engine Control Module Ground
ECM PWR – Engine Control Module Power
ECS – Engine Coolant System
ECSR – Engine Controlled Shutdown Request
ECT – Engine Coolant Temperature
ECT1 – Engine Coolant Temperature 1
ECT2 – Engine Coolant Temperature 2
EFAN – Engine Fan
EFANS – Engine Fan Speed
EFC – Engine Fan Control
EFP – Engine Fuel Pressure
EFRC – Engine Family Rating Code
EFS – Engine Fan Speed
EFT – Engine Fuel Temperature
EG – Ethylene Glycol
EGC – Electronic Gauge Cluster
EGBP – Exhaust Gas Back Pressure
EGDP – Exhaust Gas Differential Pressure
EGR – Exhaust Gas Recirculation

EGRC – Exhaust Gas Recirculation Control
EGRH – Exhaust Gas Recirculation High control
EGRL – Exhaust Gas Recirculation Low control
EGROT – Exhaust Gas Recirculation Outlet Temperature
EGRP – Exhaust Gas Recirculation Position
EGRT – Exhaust Gas Recirculation Temperature
EGT – Exhaust Gas Temperature
EGT1 – Exhaust Gas Temperature 1
EGT2 – Exhaust Gas Temperature 2
EGT3 – Exhaust Gas Temperature 3
ELS – Exhaust Lambda Sensor
EMI – Electromagnetic Interference
EMP – Exhaust Manifold Pressure
EMT – Exhaust Manifold Temperature
EOL – Engine Oil Level
EOP – Engine Oil Pressure
EOT – Engine Oil Temperature
EOT2 – Engine Oil Temperature 2
EPA – Environmental Protection Agency
EPR – Engine Pressure Regulator
ESC – Electronic System Controller
ESN – Engine Serial Number
EST – Electronic Service Tool
ETC – Engine Throttle Control
ETCH – Engine Throttle Control High
ETCL – Engine Throttle Control Low
ETP – Engine Throttle Position
ETV – Engine Throttle Valve
EVB – Exhaust Valve Brake
EWPS – Engine Warning Protection System

F – Fahrenheit
FCV – Fuel Coolant Valve
FDP – Fuel Delivery Pressure
FEL – Family Emissions Limit
fhp – Friction horsepower
FMI – Failure Mode Indicator
FPC – Fuel Pump Control
FPCV – Fuel Pressure Control Valve
fpm – Feet per minute
FPM – Fuel Pump Monitor
fps – Feet per second
FRP – Fuel Rail Pressure
ft – Feet
FVCV – Fuel Volume Control Valve

GND – Ground (electrical)
gal – Gallon
gal/h – U.S. Gallons per hour
gal/min – U.S. Gallons per minute
GCW – Gross Combined Weight

GCWR – Gross Combined Weight Rating
GVW – Gross Vehicle Weight

H_2O – Water
HC – Hydrocarbons
HCI – Hydrocarbon Injection
HEST – High Exhaust System Temperature
HFCM – Horizontal Fuel Conditioning Module
Hg – Mercury
hp – Horsepower
HPCAC – High-Pressure Charge Air Cooler
HPCR – High-Pressure Common Rail
HPFP – High-Pressure Fuel Pump
hr – Hour
HS – Humidity Sensor
Hyd – Hydraulic

IAH – Inlet Air Heater
IAHC – Inlet Air Heater Control
IAHD – Inlet Air Heater Diagnostic
IAHFI – Inlet Air Heater Fuel Igniter
IAHFS – Inlet Air Heater Fuel Solenoid
IAHR – Inlet Air Heater Relay
IAHS – Inlet Air Heater Solenoid
IAT – Inlet Air Temperature
IC – Integrated Circuit
ICP – Injection Control Pressure
ICPR – Injection Control Pressure Regulator
ICG1 – Injector Control Group 1
ICG2 – Injector Control Group 2
ID – Inside Diameter
IGN – Ignition
ILO – Injector Leak Off
IMP – Intake Manifold Pressure
IMT – Intake Manifold Temperature
in – Inch
inHg – Inch of mercury
inH_2O – Inch of water
INJs – Injectors
IPR – Injection Pressure Regulator
IPR PWR – Injection Pressure Regulator Power
ISC – Interstage Cooler
IST – Idle Shutdown Timer
ITP – Internal Transfer Pump
ITV – Intake Throttle Valve
ITVH – Intake Throttle Valve High control
ITVL – Intake Throttle Valve Low control
ITVP – Intake Throttle Valve Position
IVS – Idle Validation Switch

J1939H – J1939 Data Link High

J1939L – J1939 Data Link Low
JCT – Junction (electrical)

kg – Kilogram
km – Kilometer
km/h – Kilometers per hour
km/l – Kilometers per liter
KOEO – Key-On Engine-Off
KOER – Key-On Engine-Running
kPa – Kilopascal

L – Liter
L/h – Liters per hour
L/m – Liters per minute
L/s – Liters per second
lb – Pound
lbf – Pounds of force
lb/s – Pounds per second
lbf ft – Pounds of force per foot
lb in – Pounds of force per inch
lbm – Pounds of mass
LPCAC – Low-pressure Charge Air Cooler
LSD – Low Sulfur Diesel

m – Meter
m/s – Meters per second
MAF – Mass Air Flow
MAF GND – Mass Air Flow Ground
MAG – Magnetic
MAP – Manifold Absolute Pressure
MAP/IAT – Manifold Absolute Pressure / Inlet Air Temperature
MAT – Manifold Air Temperature
mep – Mean effective pressure
mi – Mile
MIL – Malfunction Indicator Lamp
mm – Millimeter
mpg – Miles per gallon
mph – Miles per hour
MPR – Main Power Relay
MSDS – Material Safety Data Sheet
MSG – Micro Strain Gauge
MSM – Multiplex System Module
MY – Model Year

NC – Normally Closed (electrical)
NETS – Navistar Electronics Technical Support
NH_3 – Ammonia sensor
Nm – Newton meter
NO – Normally Open (electrical)
NO_x – Nitrogen Oxides
NO_x IN – Nitrogen Oxides Inlet sensor

NO_x OUT – Nitrogen Oxides Outlet sensor
O_2S – Oxygen Sensor
O_2SH – Oxygen Sensor Heater
OAT – Organic Acid Technology
OCC – Output Circuit Check
OCP – Overcrank Protection
OD – Outside Diameter
OL – Over Limit
ORH – Out-of-Range High
ORL – Out-of-Range Low
OSHA – Occupational Safety and Health Administration
OWL – Oil/Water Lamp

PID – Parameter Identifier
P/N – Part Number
ppm – Parts per million
PROM – Programmable Read Only Memory
psi – Pounds per square inch
psia – Pounds per square inch absolute
psig – Pounds per square inch gauge
pt – Pint
PTO – Power Takeoff
PWM – Pulse Width Modulate
PWR – Power (voltage)

qt – Quart

RAM – Random Access Memory
RAPP – Remote Accelerator Pedal Position
RAS – Resume / Accelerate Switch (speed control)
REPTO – Rear Engine Power Takeoff
RFI – Radio Frequency Interference
rev – Revolution
rpm – Revolutions per minute
RPRE – Remote Preset
RSE – Radiator Shutter Enable
RVAR – Remote Variable

SAE – Society of Automotive Engineers
SART – Stand Alone Real Time Clock
SCA – Supplemental Cooling Additive
SCCS – Speed Control Command Switches
SCR – Selective Catalyst Reduction
SCRIT – Selective Catalyst Reduction Inlet Temperature
SCROT – Selective Catalyst Reduction Outlet Temperature
SCS – Speed Control Switch
SHD – Shield (electrical)
SID – Subsystem Identifier
SIG GND – Signal Ground
SIG GNDB – Signal Ground Body
SIG GNDC – Signal Ground Chassis

SIG GNDE – Signal Ground Engine
S/N – Serial Number
SPEEDO – Speedometer
SPN – Suspect Parameter Number
SW – Switch (electrical)
SWBAT – Switch Battery
SYNC – Synchronization

TACH – Tachometer output signal
TBD – To Be Determined
TC2CIP – Turbocharger 2 Compressor Inlet Pressure
TC2CIS – Turbocharger 2 Compressor Inlet Sensor
TC2CIT – Turbocharger 2 Compressor Inlet Temperature
TC1TOP – Turbocharger 1 Turbine Outlet Pressure
TC2TOP – Turbocharger 2 Turbine Outlet Pressure
TC2WC – Turbocharger 2 Wastegate Control
TCAPE – Truck Computer Analysis of Performance and Economy
TCM – Transmission Control Module
TDC – Top Dead Center
TDE – Transmission Driving Engaged
TOP – Transmission Oil Pressure
TOSS – Transmission Output Shaft Speed
TOT – Transmission Oil Temperature
TTS – Transmission Tailshaft Speed

ULSD – Ultra-Low Sulfur Diesel
UVC – Under Valve Cover

V – Volt
VBAT or B+ – Battery Voltage
VC – Volume Control
VEPS – Vehicle Electronics Programming System
VGT – Variable Geometry Turbo
VIGN – Ignition Voltage
VIN – Vehicle Identification Number
VOP – Valve Opening Pressure
VRE – Vehicle Retarder Enable
VREF – Reference Voltage
VREFB – Reference Voltage Body
VREFC – Reference Voltage Chassis
VREFE – Reference Voltage Engine
VSO – Vehicle Speed Output
VSO or VSS_CAL – Vehicle Speed Output
VSS – Vehicle Speed Sensor
VSS_CAL or VSO – Vehicle Speed Output
VSSH – Vehicle Speed Sensor High
VSSL – Vehicle Speed Sensor Low

WTSL – Wait to Start Lamp
WEL – Warn Engine Lamp
WIF – Water In Fuel

WIFL – Water In Fuel Lamp
WTEC – World Transmission Electronically Controlled automatic transmissions (Allison)

XCS – Transfercase
XMSN – Transmission

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Terminology.....**1521**

Terminology

Accelerator Pedal Position (APP) sensor – A potentiometer sensor that indicates the position of the throttle pedal.

Accessory work – The work per cycle required to drive engine accessories (normally, only those essential to engine operation).

Actuator – A device that performs work in response to an input signal.

Actuator Control – The ECM controls the actuators by applying a low-level signal (low-side driver) or a high-level signal (high- side driver). When switched On, both drivers complete a ground or power circuit to an actuator.

Aeration – The entrainment of air or combustion gas in coolant, lubricant, or fuel.

Aftercooler (Charge Air Cooler) – A heat exchanger mounted in the charge air path between the turbocharger and engine intake manifold. The aftercooler reduces the charge air temperature by transferring heat from the charge air to a cooling medium (usually air).

Aftertreatment Control Module (ACM) – An electronic processor that monitors and controls the aftertreatment system.

Aftertreatment (AFT) fuel doser module – The AFT fuel doser module controls fuel flow to the AFTFI.

Aftertreatment Fuel Injector (AFTFI) – Injects fuel into the exhaust system to increase temperature of the exhaust gases.

Aftertreatment Purge Air Valve (AFTPAV) – Uses vehicle air to purge the AFT fuel doser module and AFTFI of fuel following active or parked regeneration of the aftertreatment system.

Aftertreatment (AFT) system – A part of the exhaust system that processes engine exhaust to meet emission requirements and traps particulate matter (soot) to prevent it from leaving the tailpipe.

Air Control Valve (ACV) – Contains the HP turbocharger wastegate control port, the Exhaust Back Pressure Valve (EBPV) control port, and the Turbocharger 1 Turbine Outlet Pressure (TC1TOP) port. Although these components are integral to the ACV, each circuit is controlled by the Engine Control Module (ECM). The ACV controls compressed air for each control valve.

Air Inlet Temperature (AIT) sensor – A thermistor sensor that monitors intake air temperature.

Ambient temperature – The environmental air temperature in which a unit is operating. In general, the temperature is measured in the shade (no solar radiation) and represents the air temperature for other engine cooling performance measurement purposes. Air entering the radiator may or may not be the same ambient due to possible heating from other sources or recirculation. (SAE J1004 SEP81)

Ammonia (NH_3) – A chemical found in Diesel Exhaust Fluid (DEF) that combines with Nitrogen Oxides (NOx) in the Selective Catalyst Reduction (SCR) system to form Nitrogen gas and water.

Ampere (amp) – The standard unit for measuring the strength of an electrical current. The flow rate of a charge in a conductor or conducting medium of one coulomb per second. (SAE J1213 NOV82)

Analog – A continuously variable voltage.

Analog to digital converter (A/D) – A device in the ECM that converts an analog signal to a digital signal.

American Trucking Association (ATA) Datalink – A serial datalink specified by the American Trucking Association and the SAE.

Boost pressure – Pressure of charge air leaving the turbocharger.

Inlet manifold pressure greater than atmospheric pressure. Obtained by turbocharging.

Bottom Dead Center (BDC) – The lowest position of the piston during the stroke.

Brake Horsepower (bhp) – The power output from an engine, not the indicated horsepower. The power output of an engine, sometimes-called flywheel horsepower, is less than the indicated horsepower by the amount of friction horsepower consumed in the engine.

Brake Horsepower (bhp) net – Net brake horsepower is measured with all engine components. The power of an engine when configured as a fully equipped engine. (SAE J1349 JUN90)

Calibration – ECM programming strategy to solve engine performance equations and make decisions. Calibration values are stored in ROM and put into the processor during programming to allow the engine to operate within certain parameters.

Camshaft Position (CMP) sensor – A magnetic pickup sensor that provides the ECM with a camshaft speed and position signal.

Carbon Monoxide (CO) – A colorless, odorless, highly poisonous gas that is formed by the incomplete combustion of carbon burning diesel engine. It is present in the exhaust gases of diesel engines.

Catalyst – A substance that produces a chemical reaction without undergoing a chemical change itself.

Catalytic converter – An antipollution device in the exhaust system that contains a catalyst for chemically converting some pollutants in the exhaust gases (carbon monoxide, unburned hydrocarbons, and oxides of nitrogen) into harmless compounds.

Cavitation – A dynamic condition in a fluid system that forms gas-filled bubbles (cavities) in the fluid.

Cetane number – 1. The auto-ignition quality of diesel fuel.

2. A rating applied to diesel fuel similar to octane rating for gasoline.

3. A measure of how readily diesel fuel starts to burn (self-ignites) at high compression temperature.

Diesel fuel with a high cetane number self-ignites shortly after injection into the combustion chamber. Therefore, it has a short ignition delay time. Diesel fuel with a low cetane number resists self-ignition. Therefore, it has a longer ignition delay time.

Charge air – Dense, pressurized, heated air discharged from the turbocharger.

Charge Air Cooler (CAC) – See **Aftercooler**.

Charge Air Outlet Temperature (CACOT) sensor – A thermistor sensor that monitors the temperature of charge air entering the intake air duct.

Closed crankcase – A crankcase ventilation that recycles crankcase gases through a breather, then back to the clean air intake.

Closed loop operation – A system that uses sensors to provide feedback to the ECM. The ECM uses the sensor input to continuously monitor variables and adjust actuators to match engine requirements.

Cloud point – The point when wax crystals occur in fuel, making fuel cloudy or hazy. Usually below -12°C (10°F).

Cold cranking ampere rating (battery rating) – The sustained constant current (in amperes) needed to produce a minimum terminal voltage under a load of 7.2 volts per battery after 30 seconds.

Cold Start Emissions Reduction (CSER) – A type of monitoring strategy used to monitor emission levels during engine warm-up.

Controller Area Network (CAN) – A J1939 high-speed communication link.

Coolant – A fluid used to transport heat from one point to another.

Coolant level switch – A switch sensor used to monitor coolant level.

Coolant Flow Valve (CFV) – The CFV is ECM controlled and redirects coolant through the fuel cooler, based on EFT, when directed.

Coolant Mixer Valve (CMV) – Controls coolant flow through the low-temperature radiator.

Continuous Monitor Test – An ECM function that continuously monitors the inputs and outputs to ensure that readings are within set limits.

Count – Number of events where a specific SPN / FMI setting criteria are meet. Example: 58 counts of 1000 cycles for misfire on cylinder #5.

Crankcase – The housing that encloses the crankshaft, connecting rods, and allied parts.

Crankcase breather – A vent for the crankcase to release excess interior air pressure.

Crankcase Oil Separator Speed (CCOSS) sensor – The CCOSS sensor sends the ECM information about the speed of the crankcase oil separator internal components.

Crankcase pressure – The force of air inside the crankcase against the crankcase housing.

Crankshaft Position (CKP) sensor – A magnetic pickup sensor that determines crankshaft position and speed.

Current – The flow of electrons passing through a conductor. Measured in amperes.

Damper – A device that reduces the amplitude of torsional vibration. (SAE J1479 JAN85)

Deaeration – The removal or purging of gases (air or combustion gas) entrained in coolant or lubricating oil.

Deaeration tank – A separate tank in the coolant system used for one or more of the following functions:

- Deaeration
- Coolant reservoir (fluid expansion and afterboil)
- Coolant retention
- Filling
- Fluid level indication (visible)

Decomposition reactor tube – Converts DEF to ammonia and CO_2 and ensures even evaporation of DEF into the exhaust stream.

Diagnostic Trouble Code (DTC) – 2010 model year vehicles no longer utilize DTC identification by number. DTCs are now identified using the Suspect Parameter Number (SPN) and Failure Mode Indicator (FMI) identifiers only.

Diesel Exhaust Fluid (DEF) – Diesel Exhaust Fluid (DEF) is a nontoxic, nonflammable, colorless liquid that delivers ammonia to the Selective Catalyst Reduction (SCR) system.

Diesel Exhaust Fluid Dosing Unit Heater (DEFDUH) – Maintains proper temperature and prevents freezing of DEF in the DEF supply module.

Diesel Exhaust Fluid Doser Valve (DEFDV) – Injects DEF into the Selective Catalyst Reduction (SCR) system.

Diesel Exhaust Fluid Line Heater Relay (DEFLHR) – Supplies power to the DEF line heaters when commanded ON by the Aftertreatment Control Module (ACM).

Diesel Exhaust Fluid Line Pressure (DEFLP) Sensor – A variable capacitance sensor that measures DEF pressure from the Diesel Exhaust Fluid Supply Pump (DEFSP).

Diesel Exhaust Fluid Pressure Line Heater (DEFPLH) – Maintains proper DEF temperature and prevents freezing of the DEF pressure line.

Diesel Exhaust Fluid Return Line Heater (DEFRLH) – Maintains proper DEF temperature and prevents freezing of the DEF return line.

Diesel Exhaust Fluid Return Valve (DEFRV) – Regulates DEF flow exiting the DEF supply module.

Diesel Exhaust Fluid Suction Line Heater (DEFSLH) – Maintains proper DEF temperature and prevents freezing of the DEF suction line.

Diesel Exhaust Fluid Supply Pump (DEFSP) – Pressurizes outgoing DEF to the Diesel Exhaust Fluid Doser Valve (DEFDV).

Diesel Exhaust Fluid Tank Heater Valve (DEFTHC) – Controls coolant flow to the DEF tank heating coil.

Diesel Exhaust Fluid Tank Level and Temperature (DEFTLT) sensor module – A combinations sensor that monitors DEF tank level and temperature.

Diesel Exhaust Fluid Unit Heater Relay (DEFUHR) – Sends power to the Diesel Exhaust Fluid Dosing Unit Heater (DEFDUH) when commanded ON by the Aftertreatment Control Module (ACM).

Diesel Particulate Filter (DPF) – A diesel particulate filter, sometimes called a DPF, is a device designed to remove diesel particulate matter or soot from the exhaust gas of a diesel engine.

Diesel Oxidation Catalyst (DOC) – A DOC is part of the diesel exhaust Aftertreatment system. DOCs are devices that use a chemical process to break down pollutants in the exhaust stream into less harmful components. More specifically, DOCs utilize rare metals such as palladium and platinum to reduce hydrocarbon based Soluble Organic Fraction (SOF) and carbon monoxide content of diesel exhaust by simple oxidation. The DOC can be used during an active regeneration to create higher exhaust temperatures, thereby reducing soot in the DPF.

Diesel Oxidation Catalyst (DOC) / Diesel Particulate Filter (DPF) temperature sensor module – Monitors signals from the Diesel Oxidation Catalyst Inlet Temperature (DOCIT) sensor, Diesel Particulate Filter Inlet Temperature (DPFIT) sensor, and Diesel Particulate Filter Outlet Temperature (DPFOT) sensor and communicates these signals to the Aftertreatment Control Module (ACM).

Digital Multimeter (DMM) – An electronic meter that uses a digital display to indicate a measured value. Preferred for use on microprocessor systems because it has a very high internal impedance and will not load down the circuit being measured.

Disable – A computer decision that deactivates a system and prevents operation of the system.

Displacement – The stroke of the piston multiplied by the area of the cylinder bore multiplied by the number of cylinders in the engine.

Diesel Particulate Filter (DPF) / outlet pressure sensor – Measures the pressure differential across the Diesel Particulate Filter (DPF) and communicates this back to the Aftertreatment Control Module (ACM).

Driver (high side) – A transistor within an electronic module that controls the power to an actuator circuit.

Driver (low side) – A transistor within an electronic module that controls the ground to an actuator circuit.

Dual Stage Turbocharger – An assembly of two turbochargers (low-pressure and high-pressure) in series to provide a wide range of charge air pressures efficiently.

Duty cycle – A control signal that has a controlled on/off time measurement from 0 to 100%. Normally used to control solenoids.

EGR Cooler – A cooler that allows heat to dissipate from the exhaust gasses before they enter the intake manifold.

Engine Back Pressure Valve (EBPV) – The ECM commands the EBPV to control the Exhaust Brake.

Engine Compression Brake (ECB) valve – The ECB valve controls pressure entering the brake oil gallery from the high-pressure oil rail gallery. This activates the brake actuator pistons and opens the exhaust valves.

Engine Compression Brake 1 (ECB1) solenoid – The ECB1 solenoid controls pressure entering the brake oil gallery from the high-pressure oil rail gallery.

Engine Compression Brake 2 (ECB2) solenoid – The ECB2 solenoid controls pressure entering the brake oil gallery from the high-pressure oil rail gallery.

Engine Compression Brake Pressure (ECBP) sensor – A high-pressure sensor that provides a feedback signal to the ECM indicating brake control pressure.

Engine Control Module (ECM) – An electronic processor that monitors and controls the engine.

Engine Coolant Level (ECL) sensor – A switch sensor that monitors coolant level.

Engine Coolant Temperature 1 (ECT1) sensor – A thermistor sensor that detects engine coolant temperature.

Engine Coolant Temperature 2 (ECT2) sensor – A thermistor sensor that detects engine coolant temperature.

Engine Fuel Temperature (EFT) sensor – A thermistor sensor that measures fuel temperature.

Engine lamp – An instrument panel lamp that comes on when DTCs are set. DTCs can be read as flash codes (red and amber instrument panel lamps).

Engine OFF tests – Tests that are done with the ignition switch ON and the engine OFF.

Engine Oil Pressure (EOP) sensor – A variable capacitance sensor that measures oil pressure.

Engine Oil Temperature (EOT) sensor – A thermistor sensor that measures oil temperature.

Engine rating – Engine rating includes **Rated hp** and **Rated rpm**.

Engine RUNNING tests – Tests done with the engine running.

Engine Throttle Valve (ETV) and Engine Throttle Position Sensor – The ETV valve is used to control airflow during a regeneration process of the aftertreatment system. The ETV valve is also used to ensure a smooth engine shut down by restricting airflow to the engine at shut down.

Engine Warning Protection System (EWPS) – Safeguards the engine from undesirable operating conditions to prevent engine damage and to prolong engine life.

Event – a condition where a fault threshold has set. Example: cylinder misfire event, an instance when the cylinder misfired.

Exhaust Back Pressure (EBP) – The pressure present in the exhaust system during the exhaust period.

Exhaust Back Pressure Valve (EBPV) – A valve that regulates the amount of air pressure applied to the EBPV pneumatic actuator.

Exhaust brake – A brake device using engine exhaust back pressure as a retarding medium.

Exhaust Gas Recirculation (EGR) – A system used to recirculate a portion of the exhaust gases into the power cylinder in order to reduce oxides of nitrogen.

Exhaust Gas Temperature (EGT) – The temperature of exhaust gases.

Exhaust Gas Recirculation Temperature (EGRT) sensor – A thermistor sensor that detects the exhaust gas temperature entering the EGR cooler.

Exhaust Gas Recirculation (EGR) valve – The EGRV controls the flow of exhaust gases to the intake manifold. The EGRV is integrated with an EGR Position (EGRP) sensor.

Exhaust manifold – Exhaust gases flow through the exhaust manifold to the turbocharger exhaust inlet and are directed to the EGR cooler.

Exhaust Manifold Pressure (EMP) sensor – A variable capacitance sensor used to indicate air pressure in the exhaust manifold.

Exhaust Manifold Temperature (EMT) sensor – A thermistor style sensor used to indicate air temperature in the exhaust manifold.

Fault detection/management – An alternate control strategy that reduces adverse effects that can be caused by a system failure. If a sensor fails, the ECM substitutes a good sensor signal or assumed sensor value in its place. A lit amber instrument panel lamp signals that the vehicle needs service.

Failure Mode Indicator (FMI) – Identifies the fault or condition effecting the individual component.

Filter restriction – A blockage, usually from contaminants, that prevents the flow of fluid through a filter.

Flash code – See **Diagnostic Trouble Code (DTC)**.

Fuel Delivery Pressure (FDP) sensor – A variable capacitance sensor that monitors fuel pressure coming from the fuel tank and sends a signal to the ECM.

Fuel inlet restriction – A blockage, usually from contaminants, that prevents the flow of fluid through the fuel inlet line.

Fuel pressure – The force fuel exerts on the fuel system as it is pumped through the fuel system.

Fuel Pressure Control Valve (FPCV) – The FPCV controls the fuel pressure to the fuel rails and is controlled by the ECM. FPCV control depends on fuel pressure and fuel temperature.

Fuel Rail Pressure (FRP) – The amount of pressure in the fuel rail.

Fuel Rail Pressure (FRP) sensor – A variable capacitance sensor that monitors fuel pressure in the fuel rail and sends a signal to the ECM.

Fuel strainer – A pre-filter in the fuel system that keeps larger contaminants from entering the fuel system.

Fuel Volume Control Valve (FVCV) – The FVCV regulates the volume of flow sent to the HPFP. The FVCV allows a sufficient quantity of fuel to be delivered to the HPFP depending on engine load, speed, injector quantity, fuel temperature, and number of injections per cycle.

Fully equipped engine – A fully equipped engine is an engine equipped with only those accessories necessary to perform its intended service. A fully equipped engine does not include components that are used to power auxiliary systems. If these components are integral with the engine or, for any reason are included on the test engine, the power absorbed may be determined and added to the net brake power. (SAE J1995 JUN90)

Fusible link (fuse link) – A fusible link is a special section of low tension cable designed to open the circuit when subjected to an extreme current overload. (SAE J1156 APR86)

Gradeability – The maximum percent grade, which the vehicle can transverse for a specified time at a specified speed. The gradeability limit is the grade upon which the vehicle can just move forward. (SAE J227a)

Gross Combined Weight Rating (GCWR) – Maximum combined weight of towing vehicle (including passengers and cargo) and the trailer. The GCWR indicates the maximum loaded weight that the vehicle is allowed to tow.

Gross brake horsepower – The power of a complete basic engine, with air cleaner, without fan, and alternator, and air compressor not charging.

H-Bridge Circuit – An H-Bridge (bipolar) circuit operates like putting a power source on one side of a motor and connecting the other side of the motor to a ground. This turns the motor. By shifting the leads on the motor, it will turn in the opposite direction.

Hall effect – The development of a transverse electric potential gradient in a current-carrying conductor or semiconductor when a magnetic field is applied.

Hall effect sensor – Transducer that varies its output voltage in response to changes in a magnetic field. Commonly used to time the speed of wheels and shafts.

High-pressure Fuel Pump (HPFP) assembly – The HPFP is a volumetric pump that supplies fuel at high-pressure. The HPFP is mounted in the rear valley on the top of the engine and is driven by the camshaft.

High-pressure Piezo Common Rail (HPCR) – The HPFP pumps fuel through separate tubes to each fuel rail. Each fuel rail has four fuel tubes, one for each injector, that maintain constant pressure from the high-pressure pump to each injector.

High-speed digital inputs – Inputs to the ECM from a sensor that generates varying frequencies (engine speed and vehicle speed sensors).

Horsepower (hp) – Horsepower is the unit of work done in a given period of time, equal to 33,000 pounds multiplied by one foot per minute. 1 hp = 33,000 lb x 1 ft. /1 min.

Humidity Sensor (HS) – A sensor that measures the moisture content of filtered air entering the intake system.

Hydrocarbons – Organic compounds consisting of hydrogen and carbon (fuel and oil).

Injection Pressure Regulator (IPR) valve – A valve that is used to maintain desired injection control pressure.

Injection Control Pressure (ICP) sensor – Provides a feedback signal to the ECM indicating injection control pressure.

Inlet Air Heater (IAH) – Heats incoming air to help reduce cold start emissions.

Inlet Air Heater Fuel Igniter (IAHFI) – The IAHFI heats the intake air by vaporizing and igniting fuel in the air inlet duct.

Inlet Air Heater Fuel Solenoid (IAHFS) – When the engine is cold and cranked, the ECM energizes the IAHFS valve, allowing fuel into the IAHFI, which ignites and warms air drawn into the engine.

Inlet Air Heater Relay (IAHR) – The IAHR provides voltage to the IAHFI, and is controlled by the ECM.

Intake manifold – Engine component that evenly supplies air to each intake port in the cylinder head(s).

Intake Manifold Pressure (IMP) sensor – A variable capacitance sensor used to indicate air pressure in the intake manifold.

Intake Manifold Temperature (IMT) sensor – A thermistor sensor used to indicate air temperature in the intake manifold.

Internal Transfer Pump (ITP) – The ITP is part of the HPFP assembly and driven off the same shaft as the HPFP assembly. The ITP supplies fuel at a slightly higher pressure and flow to the HPFP though the Fuel Volume Control Valve (FVCV). The ITP also provides fuel for cooling and lubrication of the HPFP. Fuel is rerouted as pump return flow through the HPFP cooling and lubrication valve. Pressure is maintained at the inlet of the HPFP piston pump by an ITP regulator.

International NGV Tool Utilized for Next Generation Electronics (INTUNE) – The diagnostics software for chassis related components and systems.

Interstage Cooler (ISC) – Uses cooled coolant to lower the charged air temperature that exits from the turbocharger low-pressure compressor and enters the turbocharger high-pressure compressor.

Low speed digital inputs – Switched sensor inputs that generate an on/off (high/low) signal to the ECM. The input to the ECM from the sensor could be from a high input source switch (usually 5 or 12 volts) or from a grounding switch that grounds the signal from a current limiting resistor in the ECM that creates a low signal (0 volts).

Low temperature radiator thermostat – Coolant flow to the low temperature radiator is regulated by the low temperature radiator thermostat.

Lubricity – Lubricity is the ability of a substance to reduce friction between solid surfaces in relative motion under loaded conditions.

Lug (engine) – A condition when the engine is run at an overly low RPM for the load being applied.

Manifold Absolute Pressure (MAP) – Boost pressure in the manifold that is a result of the turbocharger.

Manifold Absolute Pressure (MAP) sensor – A variable capacitance sensor that measures boost pressure.

Manometer – A double-leg liquid-column gauge, or a single inclined gauge, used to measure the difference between two fluid pressures. Typically, a manometer records in inches of water.

Mass Air Flow – The intake airflow in an engine.

Mass Air Flow (MAF) sensor – The MAF sensor is used for closed loop control of the EGR valve and ITV. The ECM monitors the MAF signal so that the ECM can control the EGR and intake throttle systems.

MasterDiagnostics® (MD) – Diagnostics software for engine related components and systems.

Magnehelic Gauge – A gauge that measures pressure in inches of water.

Magnetic Pickup Sensor – A magnetic pickup sensor generates an alternating frequency that indicates speed. Magnetic pickups have a two-wire connection for signal and ground. This sensor has a permanent magnetic core surrounded by a wire coil. The signal frequency is generated by the rotation of the gear teeth that disturb the magnetic field.

Metering unit valve assembly – The Metering unit valve assembly provides a metered amount of fuel to the Aftertreatment Fuel Injector (AFTFI).

Microprocessor – An integrated circuit in a microcomputer that controls information flow.

Micro Strain Gauge (MSG) Sensor – A MSG sensor measures pressure. Pressure exerts force on a pressure vessel that stretches and compresses to change resistance of strain gauges bonded to the surface of the pressure vessel. Internal sensor electronics convert the changes in resistance to a ratiometric voltage output.

Nitrogen Oxides (NO_x) – Nitrogen oxides form by a reaction between nitrogen and oxygen at high temperatures and pressures in the combustion chamber.

Normally closed – Refers to a switch that remains closed when no control force is acting on it.

Normally open – Refers to a switch that remains open when no control force is acting on it.

NOx IN sensor module – A smart device used to measure the NOx emission at the intake of the aftertreatment system.

NOx OUT sensor module – A smart device used to measure the NOx emissions at the outlet of the SCR catalyst.

Ohm (Ω) – The unit of electrical resistance. One ohm is the value of resistance through which a potential of one volt will maintain a current of one ampere. (SAE J1213 NOV82)

On demand test – A self-test the technician initiates using the EST that is run from a program in the software.

Output Circuit Check (OCC) – An on-demand test done during an Engine OFF self-test to check the continuity of selected actuators.

Oxides of Nitrogen (NOx) – Nitrogen oxides formed by a reaction between nitrogen and oxygen at high temperatures.

Oxygen Sensor (O_2S) – A sensor that monitors oxygen levels in the exhaust.

pH – A measure of the acidity or alkalinity of a solution.

Particulate matter – Particulate matter includes mostly burned particles of fuel and engine oil.

Piezometer – An instrument for measuring fluid pressure.

Power – Power is a measure of the rate at which work (force x distance) is done during a specific time. Compare with Torque.

Power TakeOff (PTO) – Accessory output, usually from the transmission, used to power a hydraulic pump for a special auxiliary feature (garbage packing, lift equipment, etc).

Pulse Width Modulation (PWM) – Succession of digital electrical pulses, rather than an analog signal. Efficient method of providing power between fully on and fully off.

Random Access Memory (RAM) – Computer memory that stores information. Information can be written to and read from RAM. Input information (current engine speed or temperature) can be stored in RAM to be compared to values stored in Read Only Memory (ROM). All memory in RAM is lost when the ignition switch is turned off.

Rated gross horsepower – Engine gross horsepower at rated speed as declared by the manufacturer. (SAE J1995 JUN90)

Rated horsepower – Maximum brake horsepower output of an engine as certified by the engine manufacturer. The power of an engine when configured as a basic engine. (SAE J1995 JUN90)

Rated net horsepower – Engine net horsepower at rated speed as declared by the manufacturer. (SAE J1349 JUN90)

Rated speed – The speed, as determined by the manufacturer, at which the engine is rated. (SAE J1995 JUN90)

Rated torque – Maximum torque produced by an engine as certified by the manufacturer.

Ratiometric Voltage – In a Micro Strain Gauge (MSG) sensor, pressure to be measured exerts force on a pressure vessel that stretches and compresses to change resistance of strain gauges bonded to the surface of the pressure vessel. Internal sensor electronics convert the changes in resistance to a ratiometric voltage output.

Reference voltage (V_{REF}) – A 5 volt reference supplied by the ECM to operate the engine sensors.

Reserve capacity – Time in minutes that a fully charged battery can be discharged to 10.5 volts at 25 amperes.

Regeneration – Oxidation of accumulated soot (carbon-based particulates) in the Diesel Particulate Filter (DPF). The soot is reduced to ash and stored in the PDF.

Return Fuel System – The return fuel system moves unused fuel from the fuel injectors to the fuel cooler. Excess fuel out of the FVCV and the FPCV mix with fuel from the fuel injectors on the way to the fuel cooler.

Selective Catalyst Reduction (SCR) catalyst – Breaks down DEF into ammonia and CO_2 and also converts ammonia and NOx to Nitrogen gas and water.

Selective Catalyst Reduction Inlet Temperature (SCRIT) sensor – Monitors inlet temperature of the SCR catalyst and sends a signal to the SCR temperature sensor module.

Selective Catalyst Reduction Outlet Temperature (SCROT) sensor – Monitors outlet temperature of the SCR catalyst and sends a signal to the SCR temperature sensor module.

Selective Catalyst Reduction (SCR) temperature sensor module – Monitors signals from the Selective Catalyst Reduction Inlet Temperature (SCRIT) sensor and Selective Catalyst Reduction Outlet Temperature (SCROT) sensor, and communicates these signals to the Aftertreatment Control Module (ACM).

ServiceMaxx™ software – Diagnostics software for engine and aftertreatment related components and systems.

Setting criteria – Conditions required by a monitor to set a fault code. Once the setting criteria is met for the required amount of time, the fault code will become either active or pending. Example: SPN 168 FMI 18 sets when battery voltage supplied to the ACM is less than 6.5 volts (setting criteria) for 4 seconds (time required).

Signal Conditioner – The signal conditioner in the internal microprocessor converts analog signals to digital signals, squares up sine wave signals, or amplifies low-intensity signals to a level that the ECM microprocessor can process.

Signal ground – The common ground wire to the ECM for the sensors.

Speed Control Command Switches (SCCS) – A set of switches used for cruise control, Power Take Off (PTO), and remote hand throttle system.

Steady state condition – An engine operating at a constant speed and load and at stabilized temperatures and pressures. (SAE J215 JAN80)

Strategy – A plan or set of operating instructions that the microprocessor follows for a desired goal. Strategy is the computer program itself, including all equations and decision making logic. Strategy is always stored in ROM and cannot be changed during calibration.

Stroke – The movement of the piston from Top Dead Center (TDC) to Bottom Dead Center (BDC).

Substrate – Material that supports the wash coating or catalytic materials.

Suspect Parameter Number (SPN) – A 19-bit number used to identify the item for which diagnostics are being reported. The SPN is used for multiple purposes, some that are specific to diagnostics are as follows;

- Identify the least repairable subsystem that has failed.
- Identify subsystems or assemblies that may not have hard failures but may be exhibiting abnormal operating performance.
- Identify a particular event or condition that will be reported.
- Report a component and non-standard failure mode.

System restriction (air) – The static pressure differential that occurs at a given airflow from air entrance through air exit in a system. Usually measured in inches (millimeters) of water. (SAE J1004 SEP81)

Tachometer output signal – Engine speed signal for remote tachometers.

Thermistor – A semiconductor device. A sensing element that changes resistance as the temperature changes.

Thermistor Sensor – Changes electrical resistance with changes in temperature. Resistance in the thermistor decreases as temperature increases, and increases as temperature decreases. Thermistors work with a resistor that limits current to form a voltage signal matched with a temperature value.

Thrust load – A thrust load pushes or reacts through a bearing in a direction parallel to the shaft.

Time required – The amount of time needed for a monitor to set a fault code when the setting criteria is met. Example: SPN 168 FMI 18 sets when battery voltage supplied to the ACM is less than 6.5 volts (setting criteria) for 4 seconds (time required).

Top Dead Center (TDC) – The uppermost position of the piston during the stroke.

Torque – A force having a twisting or turning effect. For a single force, the cross product of a vector from some reference point to the point of application of the force within the force itself. Also known as moment of force or rotation moment. Torque is a measure of the ability of an engine to do work.

Trip (driving cycle) – Legal definition about what defines a drive cycle or trip to calculate the denominator in the IUMPR (In-Use Monitoring Performance Ratio). For some faults a trip can be a key cycle (including housekeeping time to reset the ECM). Example: out of range circuit checks for sensors. For other faults the trip includes a warm up cycle, driving in certain conditions, etc. Example: thermostat monitor

Trip (MIL illumination and OBD executive) – Amount of trips when the fault must be present to illuminate the MIL, latch the MIL, and store historic fault information. Most faults are two trip faults.

Truck Computer Analysis of Performance and Economy (TCAPE) – A computer program that simulates the performance and fuel economy of trucks.

Turbocharger – A turbine driven compressor mounted on the exhaust manifold. The turbocharger increases the pressure, temperature and density of intake air to charge air.

Turbocharger 1 Turbine Outlet Pressure (TC1TOP) sensor – A variable capacitance sensor that monitors exhaust back-pressure.

Turbocharger 2 Compressor Inlet (TC2CIS) sensor – The TC2CIS sensor includes a thermistor sensor that monitors the temperature of charge air entering the HP turbocharger. This sensor also monitors boost pressure for the LP turbocharger.

Turbocharger Wastegate Control (TCWC) solenoid – Controls the TCWC actuator by regulating the amount of charge air pressure supplied to the TCWC actuator. The TCWC solenoid is controlled by signals from the ECM in response to engine speed, required fuel quantity, boost, exhaust back-pressure, and altitude.

Turbocharger 2 Wastegate Control (TC2WC) solenoid – Controls the TC2WC actuator by regulating the amount of charge air pressure supplied to the wastegate actuator. The TC2WC solenoid is controlled by signals from the ECM in response to engine speed, required fuel quantity, boost, exhaust back-pressure, and altitude. The TC2WC actuator is part of the turbocharger assembly.

Variable capacitance sensor – A variable capacitance sensor measures pressure. The pressure forces a ceramic material closer to a thin metal disc in the sensor, changing the capacitance of the sensor.

Vehicle Electronic System Programming System – The computer system used to program electronically controlled vehicles.

Vehicle Retarder Enable/Engage – Output from the ECM to a vehicle retarder.

Vehicle Speed Sensor (VSS) – Normally a magnetic pickup sensor mounted in the tailshaft housing of the transmission, used to indicate ground speed.

Viscosity – The internal resistance to the flow of any fluid.

Viscous fan – A fan drive that is activated when a thermostat, sensing high air temperature, forces fluid through a special coupling. The fluid activates the fan.

Volt (v) – A unit of electromotive force that will move a current of one ampere through a resistance of one Ohm.

Voltage – Electrical potential expressed in volts.

Voltage drop – Reduction in applied voltage from the current flowing through a circuit or portion of the circuit current multiplied by resistance.

Voltage ignition – Voltage supplied by the ignition switch when the key is ON.

Washcoat – A layer of alumina applied to the substrate in a monolith-type converter.

Water In Fuel (WIF) sensor – A switch sensor that measures the amount of water in the fuel.

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the All Ratings

Key-On Engine-Off

Barometric pressure (500 ft. above sea level)	99.01 kPa (14.36 psi) / 3.91 V
Fuel rail pressure	0 kPa (0 psi) / 0.5 V
Turbocharger 1 turbine outlet pressure	0 kPa (0 psi) / 0.84 V
Fuel delivery pressure	0 kPa (0 psi) / 0.5 V
Intake manifold pressure	0 kPa (0 psi) / 1.06 V
Diesel particulate filter differential pressure	0 kPa (0 psi) / 0.5 V
Exhaust gas recirculation valve position	4.5 to 5.5 %
Engine throttle valve position	4.5 to 5.5 %
Accelerator pedal position sensor (at idle)	0.7 V / 0 %
Accelerator pedal position sensor (depressed to floor)	3.75 V / 99.6 %
Engine oil pressure	0 kPa (0 psi) / 0.5 V

Engine Cranking

Battery voltage (min. based on ECM drop out)	10.5 V
Cranking rpm (min.)	130 rpm
20 seconds maximum crank time per attempt. Wait 2 to 3 minutes before repeating.	
Fuel delivery pressure (min.)	With Gauge: 207 kPa (30 psi) / 1.15 V With EST: 103 kPa (15 psi) / 1.15 V
Fuel rail pressure	20 MPa (3000 psi) / 1 V
Turbocharger 1 turbine outlet pressure	< 34 kPa (< 5 psi) / 0.84 V
Fuel inlet restriction	203 - 305 mmHg (8 - 12 inHg)
High-pressure pump inlet pressure	> 207 kPa (> 30 psi)
Inlet air heater fuel solenoid fuel supply pressure	55 - 82 kPa (8 - 12 psi)
Inlet air heater fuel igniter fuel supply pressure	55 - 82 kPa (8 - 12 psi)
Diesel particulate filter differential pressure	0 kPa (0 psi) / 0.66 V
Exhaust gas recirculation valve	0 %

Low Idle, no load, stabilized engine operating temperature

Fuel delivery pressure (min.)	413 kPa (60 psi) / 1.8 V
Fuel delivery pressure (max.)	827 kPa (120 psi) / 3.2 V
Fuel rail pressure	80,250 kPa (11,639 psi)
Engine speed	600 - 650 rpm
Intake manifold pressure	< 21 kPa (< 3 psi) / 1.026 V
Turbocharger 1 turbine outlet pressure	< 34 kPa (< 5 psi) / 0.84 V
Fuel inlet restriction	330 - 432 mmHg (13 - 17 inHg)
High-pressure pump inlet pressure	482 - 896 kPa (70 - 130 psi)
High-pressure fuel return flow	< 60 ml
Crankcase oil separator speed	7000 to 8500 rpm
Engine coolant temperature 1 (at thermostat opening)	86° C (186° F) / 0.571 V
Engine coolant temperature 1 (max. before DTC is set)	120 °C (248 °F) / 0.64 V
Engine coolant temperature 2 (at thermostat opening)	55 °C (131 °F) / 1.26 V
Engine coolant temperature 2 (max. before DTC is set)	120 °C (248 °F) / 0.64 V
Engine oil pressure (min. with gauge)	68 kPa (10 psi) / 1.5 V
Engine oil temperature	98 °C (208 °F) / 0.405 V
Intake air temperature 2 (boost)	48 °C (118 °F) / 1.06 V
Intake air temperature 2 (boost) (max. before DTC is set)	95 °C (203 °F) / 1.11 V
Intake manifold air temperature	53 °C (127 °F) / 1.329 V
Intake manifold air temperature (max. before DTC is set)	135 °C (275 °F) / 0.47 V
Actuator supply pressure (min.)	620 kPa (90 psi)
Turbocharger wastegate control supply pressure (min.)	358 kPa (52 psi)

High Idle, no load, stabilized engine operating temperature

Air cleaner restriction (max.)	3.7 kPa (15 in H_2O)
Fuel delivery pressure (min.)	413 kPa (60 psi) / 1.8 V
Fuel delivery pressure (max.)	827 kPa (120 psi) / 3.2 V
Fuel rail pressure	165 to 200 MPa (24,000 to 29,000 psi) / 4.01 V
Engine speed	1550 - 2200 rpm
Intake manifold pressure	90 - 110 kPa (13 - 16 psi)
Turbocharger 1 turbine outlet pressure	< 34 kPa (< 5 psi) / 0.84 V
High-pressure pump fuel return pressure	90 kPa (13 psi)
Diesel particulate filter differential pressure (max. before DTC is set)	35 kPa (5 psi) / 1.9 V
Engine oil pressure (min. with gauge)	275 - 482 kPa (40 - 70 psi) / 4.7 V

Full load, rated speed on dynamometer, stabilized engine operating temperature

Air cleaner restriction (max.)	6.2 kPa 25 in H_2O)
Fuel rail pressure	220 MPa (31900 psi) / 4.1 V
Fuel delivery pressure (min.)	413 kPa (60 psi) / 1.3 V
Fuel delivery pressure (max.)	827 kPa (120 psi) / 3.2 V
Engine speed	1550 - 2200 rpm
Intake manifold pressure	> 206 kPa (30 psi) / 2.18 V
Turbocharger 1 turbine outlet pressure	< 34 kPa (< 5 psi) / 0.84 V
Engine oil pressure (min. with gauge)	500 kPa (72 psi) / 3.9 V
Engine oil temperature (max.)	98 °C (208 °F) / 0.41 V
Diesel particulate filter differential pressure (max. before DTC is set)	35 kPa (5 psi) / 1.9 V
Exhaust back pressure (max.)	35 kPa (5 psi)
Water temperature differential across radiator (top and bottom)	9 °C (16 °F)

Component Specifications

Temperature Sensors (Engine Coolant Temperature 1 [ECT1], Engine Coolant Temperature 2 [ECT2], Engine Oil Temperature [EOT], Intake Manifold Air Temperature [IMAT])	
Temperature at -18 °C (0 °F)	4.2 V / 14030 Ω
Temperature at 0 °C (32 °F)	3.6 V / 5876 Ω
Temperature at 21 °C (70 °F)	2.6 V / 2404 Ω
Temperature at 65 °C (150 °F)	0.94 V / 507 Ω
Temperature at 93 °C (200 °F)	0.47 V / 224 Ω
Temperature Sensors (Intake Air Temperature [IAT])	
Temperature at -18 °C (0 °F)	4.21 V / 13866 Ω
Temperature at 0 °C (32 °F)	3.59 V / 5988 Ω
Temperature at 21 °C (70 °F)	2.67 V / 2561 Ω
Temperature at 65 °C (150 °F)	1.05 V / 576 Ω
Temperature Sensors (Diesel Oxidation Catalyst Inlet Temperature [DOCIT], Diesel Oxidation Catalyst Outlet Temperature [DOCOT], Diesel Particulate Filter Outlet Temperature [DPFOT])	
Temperature at 21 °C (70 °F)	4.5 V / 19.4 Ω
Temperature at 65 °C (150 °F)	3.9 V / 7.1 Ω
Temperature at 93 °C (200 °F)	3.4 V / 4.3 Ω
Temperature at 204 °C (400 °F)	1.6 V / 0.96 Ω
Temperature at 482 °C (900 °F)	0.34 V / 0.146 Ω
Other Components	
Camshaft Position (CMP) sensor	860 Ω ± 10% @ 20 °C
Crankshaft Position (CKP) sensor	860 Ω ± 10% @ 20 °C
Coolant Mixer Valve (CMV)	5.45 - 6.00 Ω @ 24 °C
Coolant Flow Valve (CFV)	5.45 - 6.00 Ω @ 24 °C
Inlet Air Heater Fuel Solenoid (IAHFS)	8 Ω ± 1 Ω @ room temperature
Turbocharger Wastegate Control (TC2WC) solenoid	9.5 Ω ± 10%, -5% @ 20 °C

Actuator Output State

Exhaust Gas Recirculation (EGR) valve control	Output state low – 5 % Output state high – 95 %
Exhaust Gas Recirculation Position (EGRP)	Output state low – 5 % Output state high – 95 %
Exhaust Back Pressure (EBP) valve	Output state low – 0 % Output state high – 95%
Engine Throttle Valve (ETV) control	Output state low – 5 % Output state high – 95 %
Engine Throttle Valve (ETV) position	Output state low – 5 % Output state high – 95 %
Turbocharger Wastegate Control (TC2WC) solenoid	Output state low – 5 % Output state high – 95 %
Fuel Pressure Control Valve (FPCV)	Output state low – 5 % Output state high – 95 %
Coolant Flow Valve (CFV)	Output state low – 5 % Output state high – 95 %
Coolant Mixer Valve (CMV)	Output state low – 5 % Output state high – 95 %
Aftertreatment Fuel Doser Control (AFTFD)	Output state low – 5 % Output state high – 95 %
Inlet Air Heater Fuel Igniter (IAHFI)	Output state low – 5 % Output state high – 95 %
Engine Fan Control (EFC)	Output state low – 5 % Output state high – 95 %

Inlet Air Heater System

Inlet air heater fuel igniter current draw	15 A

Crankcase Pressure

High idle no load - crankcase blow by flow	< 8 in H_2O

EBPV Rod Extension

Full travel	42 mm

TC2WC Rod Extension

Full travel	13 mm

Navistar® N13 (12.4 L)

410 hp @ 1700 rpm

International®Navistar® N13 410 hp @ 1700 rpm / 1450 ft•lb @ 1000 rpm	
50 state 2010 Model Year (MY)	
Engine model	GDT410
Engine Family Rating Code (EFRC)	2231 and 1131
Injection timing	Nonadjustable
High idle speed - manual transmission	2200 rpm
High idle speed - automatic transmission	2200 rpm
Low idle speed	600 rpm
Full load on chassis dynamometer or highway, stabilized engine operating temperature	
Intake manifold pressure (gauge)	Peak torque – 196 kPa (29 psi) / 2.17 V
	Rated speed – 295 kPa (43 psi) / 3.30 V

430 hp @ 1700 rpm

International® Navistar® 13 430 hp @ 1700 rpm / 1550 ft•lb @ 1000 rpm	
50 state 2010 Model Year (MY)	
Engine model	GDT430
Engine Family Rating Code (EFRC)	2221 and 1121
Injection timing	Nonadjustable
High idle speed - manual transmission	2200 rpm
High idle speed - automatic transmission	2200 rpm
Low idle speed	600 rpm
Full load on chassis dynamometer or highway, stabilized engine operating temperature	
Intake manifold pressure (gauge)	Peak torque – 213 kPa (31 psi) / 2.36 V
	Rated speed – 298 kPa (43 psi) / 3.33 V

450 hp @ 1700 rpm (Allison Automatic Transmission)

International® Navistar® 13 450 hp @ 1900 rpm / 1250 ft•lb @ 1000 rpm	
50 state 2010 Model Year (MY)	
Engine model	GDT450
Engine Family Rating Code (EFRC)	2221 and 1121
Injection timing	Nonadjustable
High idle speed - automatic transmission	2200 rpm
Low idle speed	600 rpm
Full load on chassis dynamometer or highway, stabilized engine operating temperature	
Intake manifold pressure (gauge)	Peak torque – 124kPa (18 psi) / 1.36 V
	Rated speed – 269 kPa (39 psi) / 3.15 V

450 hp @ 1700 rpm (Manual Transmission)

International® Navistar® 13 450 hp @ 1700 rpm / 1700 ft•lb @ 1000 rpm	
50 state 2010 Model Year (MY)	
Engine model	GDT450
Engine Family Rating Code (EFRC)	2211 and 1111
Injection timing	Nonadjustable
High idle speed - manual transmission	2200 rpm
Low idle speed	600 rpm
Full load on chassis dynamometer or highway, stabilized engine operating temperature	
Intake manifold pressure (gauge)	Peak torque – 214 kPa (31 psi) / 2.73 V
	Rated speed – 285 kPa (41 psi) / 3.33 V

475 hp @ 1700 rpm

International® Navistar® 13 475 hp @ 1700 rpm / 1700 ft•lb @ 1000 rpm	
50 state 2010 Model Year (MY)	
Engine model	GDT475
Engine Family Rating Code (EFRC)	2211 and 1111
Injection timing	Nonadjustable
High idle speed - manual transmission	2200 rpm
High idle speed - automatic transmission	2200 rpm
Low idle speed	600 rpm
Full load on chassis dynamometer or highway, stabilized engine operating temperature	
Intake manifold pressure (gauge)	Peak torque – 214 kPa (31 psi) / 2.73 V
	Rated speed – 285 kPa (41 psi) / 3.33 V

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J1 Connector.....1557
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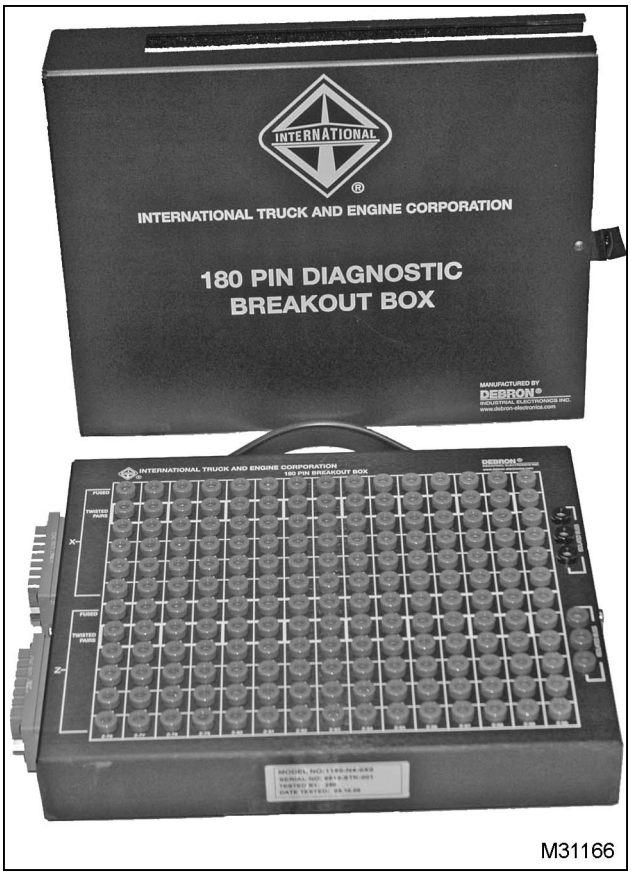
About the Breakout Box

The breakout box allows for testing engine control module and body control module systems without disturbing seals or piercing wire insulation to gain access to various signal voltages in the electronic control system. Different harnesses are provided to attach the breakout box to different control units. Overlays are placed on the breakout box that show which terminals on the breakout box correspond to which pins on the control unit. The breakout box is only used for monitoring voltages or resistance measurements- it can not be used to power a circuit.



Engine Control Module (ECM) Values

C1 Connector

NOTE: Voltage measurements were taken with the ignition Key ON, Engine OFF (KOEO), battery charger connected, and the breakout connected between the Engine Control Module (ECM) and engine harness. See “APPENDIX A: PERFORMANCE SPECIFICATIONS” (page 1535) for actuator output voltages, sensor values, and component specifications in a wide range of conditions.

ECM 58-pin C1 Connector			
ECM Pin	**Abbreviation**	**Circuit Name**	**KOEO**
C1-01, 03, 05	B+	Battery Power	B+
C1-02, 04, 06	GND	Ground	0 V
C1-08	EFS GND	Engine Fan Speed Ground	0 V
C1-11	SIG GND	Signal Ground	0 V
C1-13	RPS	Remote Pedal Sensor	0.08 V
C1-15	EOT2	Engine Oil Temperature 2	5.00 V
C1-17	SWBAT	Switched Battery	B+
C1-18	EFC	Engine Fan Control	0.21 V
C1-19	TIMER	Stand-Alone Real Timer	B+
C1-21	MAF GND	Mass Air Flow Sensor Ground	0 V
C1-23	SIG GND	Signal Ground	0 V
C1-24	SIG GND	Signal Ground	0 V
C1-30	ECM PWR OUT 3	ECM Power Output 3	B+
C1-33	ECM PWR OUT 1	ECM Power Output 1	B+
C1-34	CAN-BH	J1939 Datalink High	2.60 V
C1-36	VREF1	Voltage Reference 1	5.00 V
C1-37	VREF4	Voltage Reference 4	5.00 V
C1-39	NVOLT	Nernst Volt	2.93 V
C1-40	VIRGND	Virtual Ground	2.50 V
C1-42	ECM PWR OUT 2	ECM Power Output 2	B+
C1-44	MAF	Mass Air Flow Sensor	4.96 V
C1-46	HTR CTL	Oxygen Sensor Heater Control	B+ V
C1-47	CAN-BL	J1939 Datalink Low	2.45 V
C1-49	VREF4	Voltage Reference 4	5.00 V
C1-50	VREF5	Voltage Reference 5	5.00 V
C1-52	PUMPCUR	Pumping Current	2.85 V
C1-53	TRIMRES	Trim Resistor	2.85 V
C1-54	ECM PWR OUT 1	ECM Power Output 1	B+
C1-56	ERO	Engine Running Output	0 V
C1-58	EFS	Engine Fan Speed	5.00 V

C2 Connector

NOTE: Voltage measurements were taken with the ignition Key ON, Engine OFF (KOEO), battery charger connected, and the breakout connected between the Engine Control Module (ECM) and engine harness . See “APPENDIX A: PERFORMANCE SPECIFICATIONS” (page 1535) for actuator output voltages, sensor values, and component specifications in a wide range of conditions.

ECM 58-pin C2 Connector

ECM Pin	Abbreviation	Circuit Name	KOEO
C2-01	B+	Battery Power	B+
C2-02	GND	Ground	0 V
C2-08	VREF4	Voltage Reference 4	5.00 V
C2-09	TACH	Tachometer	11.93 V
C2-10	XCS	Transfer Case	0 V
C2-13	AES	Auxiliary Engine Switch	0 V
C2-14	WIFL	Water in Fuel Lamp	3.52 V
C2-15	WTSL	Wait to Start Lamp	3.50 V
C2-16	EGRP	Exhaust Gas Recirculation Position	2.78 V
C2-17	WEL	Warn Engine Lamp	3.53 V
C2-22	COO	Cruise On/Off Switch	0 V
C2-23	RAS	Resume Accel Switch	0 V
C2-26	TSA	Two-Speed Axle Switch	0 V
C2-27	ACD_Sw	A/C Demand Switch	0 V
C2-28	RSL	Red Stop Lamp	3.53 V
C2-30	VSS CAL	Vehicle Speed Sensor Calibration	B+
C2–33	BNO	Brake Normally Open	0 V
C2-34	SIG GND	Signal Ground	0 V
C2-35	RVAR	Remote Variable PTO	0 V
C2-36	CP_Sw	Clutch Position Switch	0 V
C2-37	WIF	Water in Fuel Sensor	3.73 V
C2-39	PB_Sw	Parking Brake Switch	0 V
C2-40	EB_Sw1	Engine Brake Switch 1	0 V
C2-43	SIG GND	Signal Ground	0 V
C2-46	RPAS	Remote Pedal Activation Switch	0 V
C2–47	ECL GND	Engine Coolant Level Ground	0 V
C2-48	RPRE	Remote Preset PTO	0 V
C2-49	ECL	Engine Coolant Level	0 V

ECM 58-pin C2 Connector			
ECM Pin	**Abbreviation**	**Circuit Name**	**KOEO**
C2-52	SCS	Speed Control Switch	0 V
C2-53	EB_Sw2	Engine Brake Switch 2	0 V
C2-54	APP1	Accelerator Pedal Position 1	0 V
C2-55	APP2	Accelerator Pedal Position 2	0.60 V

E1 Connector

NOTE: Voltage measurements were taken with the ignition Key ON, Engine OFF (KOEO), battery charger connected, and the breakout connected between the Aftertreatment Control Module (ACM) and vehicle harness. See “APPENDIX A: PERFORMANCE SPECIFICATIONS” (page 1535) for actuator output voltages, sensor values, and component specifications in a wide range of conditions.

ECM 98-pin E1 Connector

ECM Pin	Abbreviation	Circuit Name	KOEO
E1-03	IAHFS	Inlet Air Heater Fuel Solenoid	B+
E1-04	EBPV	Exhaust Back Pressure Valve	B+
E1-05	ECM PWR OUT 2	ECM Power Output 2	B+
E1-07	CCOSS-L	Crankcase Oil Separator Speed Low	2.49 V
E1–09	CAN_AH	CAN A High	2.51 V
E1-10	EOP	Engine Oil Pressure	0.50 V
E1-12	TC2CIT	Turbocharger 2 Compressor Inlet Temperature	2.47 V
E1-13	CACOT	Charge Air Cooler Outlet Temperature	2.42 V
E1-14	ECT1	Engine Coolant Temperature 1	2.55 V
E1-15	VSS-L	Vehicle Speed Sensor Low	2.41 V
E1-16	CKP-L	Crankshaft Position Low	2.45 V
E1-17	CMP-H	Camshaft Position High	2.54 V
E1-18	IMP	Intake Manifold Pressure	0.80 V
E1-19	SIG GND	Signal Ground	0 V
E1-20	SIG GND	Signal Ground	0 V
E1-21	SIG GND	Signal Ground	0 V
E1-22	SIG GND	Signal Ground	0 V
E1-23	SIG GND	Signal Ground	0 V
E1-24	ECM PWR OUT 3	ECM Power Output 3	B+
E1-25	FPCV 12V	Fuel Rail Pressure Control High	B+
E1-26	ECM PWR OUT 3	ECM Power Output 3	B+
E1-28	ECM PWR OUT 2	ECM Power Output 2	B+
E1-29	ECM PWR OUT 2	ECM Power Output 2	B+
E1-31	CCOSS-H	Crankcase Oil Separator Speed High	2.49 V
E1-33	CAN_AL	CAN A Low	2.42 V
E1-34	FRP	Fuel Rail Pressure	0.51 V
E1-35	FDP	Fuel Delivery Pressure	0.50 V
E1-36	EOT	Engine Oil Temperature	2.54 V

ECM 98-pin E1 Connector			
ECM Pin	**Abbreviation**	**Circuit Name**	**KOEO**
E1-37	IMT	Intake Manifold Temperature	2.52 V
E1-38	AIT	Air Inlet Temperature	2.60 V
E1-39	VSS-H	Vehicle Speed Sensor High	2.57 V
E1-40	CKP-H	Crankshaft Position High	2.54 V
E1-41	CMP-L	Camshaft Position Low	2.45 V
E1-42	AAT	Ambient Air Temperature	2.67 V at 70°
E1-43	SIG GND	Signal Ground	0 V
E1-44	SIG GND	Signal Ground	0 V
E1-45	SIG GND	Signal Ground	0 V
E1-46	SIG GND	Signal Ground	0 V
E1-47	ECB1	Engine Compression Brake 1	B+
E1-48	CMV	Coolant Mixer Valve	B+
E1-49	ECB2	Engine Compression Brake 2	0.89 V
E1-50	ECB2 12V	Engine Compression Brake 2 High	0.89 V
E1-52	TC2WC	Turbocharger 2 Wastegate Control	0.29 V
E1-54	ECM PWR OUT 2	ECM Power Output 2	B+
E1-55	SIG GND	Signal Ground	0 V
E1-57	ETP	Engine Throttle Position	2.82 V
E1-58	VREF4	Voltage Reference 4	5.00 V
E1-59	HS	Humidity Sensor	2.37 V
E1-61	TC1TOP	Turbocharger 1 Turbine Outlet Pressure	0.80 V
E1-63	SIG GND	Signal Ground	0 V
E1-64	EOL	Engine Oil Level	0.13 V
E1-67	IAHRD	Inlet Air Heater Relay Diagnostic	6.10 V
E1-68	SIG GND	Signal Ground	0 V
E1-71	ECT2	Engine Coolant Temperature 2	2.52 V
E1-72	CSRC	Cold Start Relay Control	0.59 V
E1-73	FPCV	Fuel Pressure Control Valve	9.6 V
E1-74	CFV	Coolant Flow Valve	B+
E1-75	ETC	Engine Throttle Control	8.13 V
E1-77	EGR-C	Exhaust Gas Recirculation Control	8.15 V
E1-79	TC2CIP	Turbocharger 2 Compression Inlet Pressure	1.06 V
E1-81	VREF5	Voltage Reference 5	5.00 V

ECM 98-pin E1 Connector			
ECM Pin	**Abbreviation**	**Circuit Name**	**KOEO**
E1-82	VREF5	Voltage Reference 5	5.00 V
E1-83	SIG GND	Signal Ground	0 V
E1-85	VREF2	Voltage Reference 2	5.00 V
E1-86	VREF2	Voltage Reference 2	5.00 V
E1-88	VREF6	Voltage Reference 6	5.00 V
E1-89	VREF3	Voltage Reference 3	5.00 V
E1-94	EGRT	EGR Temperature	0 V
E1-95	SIG GND	Signal Ground	4.67 V
E1-96	IAHRE	Inlet Air Heater Relay Enable	1.16 V

E2 Connector

NOTE: Resistance measurements were taken with the ignition Key OFF, the breakout connected to the Engine Control Module (ECM) E2 harness, and the DMM connected to the two pins listed. See “APPENDIX A: PERFORMANCE SPECIFICATIONS” (page 1535) for actuator output voltages, sensor values, and component specifications in a wide range of conditions.

ECM 16-pin E2 Connector			
Breakout Pin 1	**Breakout Pin 2**	**Circuit Name**	**Resistance**
E2-01	E2-16	Injector 6	0.7 Ω
E2-02	E2-15	Injector 5	0.7 Ω
E2-03	E2-14	Injector 4	0.7 Ω
E2-04	E2-13	Injector 3	0.7 Ω
E2-05	E2-12	Injector 1	0.7 Ω
E2–06	E2-11	Injector 2	0.7 Ω

Aftertreatment Control Module (ACM)

J1 Connector

NOTE: Voltage measurements were taken with the ignition Key ON, Engine OFF (KOEO), battery charger connected, and the breakout connected between the Engine Control Module (ECM) and engine harness. See “APPENDIX A: PERFORMANCE SPECIFICATIONS” (page 1535) for actuator output voltages, sensor values, and component specifications in a wide range of conditions.

ACM 96-pin J1 Connector

ECM Pin	Abbreviation	Circuit Name	KOEO
J1-04	DEF Suction L-HTR	Diesel Exhaust Fluid Suction Line Heater	0 V
J1-05	AFTFI-1	Aftertreatment Fuel Injector pin-1	B+
J1-07	DEF L-HTR Relay GND	Diesel Exhaust Fluid Line Heater Relay Ground	0 V
J1–08	DEF L-HTR Relay CTL	Diesel Exhaust Fluid Line Heater Relay Power	0 V
J1-15	CAN_BH	CAN B (Public) High	2.7 V
J1-16	CAN_BL	CAN B (Public) Low	2.38 V
J1-17	SIG GND	Signal Ground DEFLP	0 V
J1-18	SIG GND	Signal Ground AFTFP1	0 V
J1-28	DEF PRES L-HTR	Diesel Exhaust Fluid Pressure Line Heater	0 V
J1-29	AFTFI-2	Aftertreatment Fuel Injector pin-2	B+
J1-32	AFTPAV-1	Aftertreatment Purge Air Valve pin-1	0 V
J1-42	SIG GND	Signal Ground DPFDP/DPFOP	0 V
J1-52	DEF RTN L-HTR	Diesel Exhaust Fluid Return Line Heater	0 V
J1-53	DEFDV-2	Diesel Exhaust Fluid Doser Valve pin-2	B+
J1-55	DEFTHV GND	Diesel Exhaust Fluid Tank Heater Valve Ground	0 V
J1-56	DEFRV CTL	Diesel Exhaust Fluid Return Valve Control	0 V
J1-63	DEFTHV CTL	Diesel Exhaust Fluid Unit HTR Relay Ground	0 V
J1-70	DEFDP	Diesel Exhaust Fluid Differential Pressure	0.75 V
J1-72	AFTFP1	Aftertreatment Fuel Pressure 1	0.7 V
J1-77	DEFDV-1	Diesel Exhaust Fluid Doser Valve pin-1	B+

ACM 96-pin J1 Connector			
ECM Pin	**Abbreviation**	**Circuit Name**	**KOEO**
J1-79	AFTPAV-2	Aftertreatment Purge Air Valve pin-2	0 V
J1-89	VREF-4	Voltage Reference 4	5.00 V

J2 Connector

NOTE: Voltage measurements were taken with the ignition Key ON, Engine OFF (KOEO), battery charger connected, and the breakout connected between the Aftertreatment Control Module (ACM) and vehicle harness. See “APPENDIX A: PERFORMANCE SPECIFICATIONS” (page 1535) for actuator output voltages, sensor values, and component specifications in a wide range of conditions.

ACM 58-pin J2 Connector

ECM Pin	Abbreviation	Circuit Name	KOEO
J2-02	DEFSP GND	Diesel Exhaust Fluid Supply Pump Ground	0 V
J2-03	VBATT	Battery Positive supply	B+
J2-04	GND	Ground	0 V
J2-05	VBATT	Battery Positive supply	B+
J2-06	GND	Ground	2.7 V
J2-07	AFTFSV-H	AFT Fuel Shutoff Valve High	0 V
J2-14	CAN AH	CAN A (Private) High	2.54 V
J2-15	CAN AL	CAN A (Private) Low	2.45 V
J2-21	AFTFSV-L	AFT Fuel Shutoff Valve Low	0 V
J2-32	DPFOP	DPF Outlet Pressure	0.66 V
J2-33	DEF Unit HTR Relay CTL	Diesel Exhaust Fluid Dosing Unit Heater Relay Control	0 V
J2-34	DEFRV GND	Diesel Exhaust Fluid Return Valve Ground	0 V
J2-41	KEYPWR	Switched Ignition Key Power feed	B+
J2-42	VREF-4	Voltage Reference 4	5.00 V
J2-45	DEFLP	Diesel Exhaust Fluid Line Pressure	0.79 V
J2-46	DEFSP PWR	Diesel Exhaust Fluid Supply Pump Power	B+
J2-47	DEFTHV CTL	Diesel Exhaust Fluid Tank Heater Valve Control	0.38 V
J2-48	DEFSP Temp	Diesel Exhaust Fluid Supply Pump and Module Temperature	1 - 9 V
J2-57	VREF-4	Voltage Reference 4	5.00 V

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Description

Technical Service Information (TSI) letters are periodically published to inform service technicians of product enhancements and field service issues. File TSIs in this section for supplemental reference.

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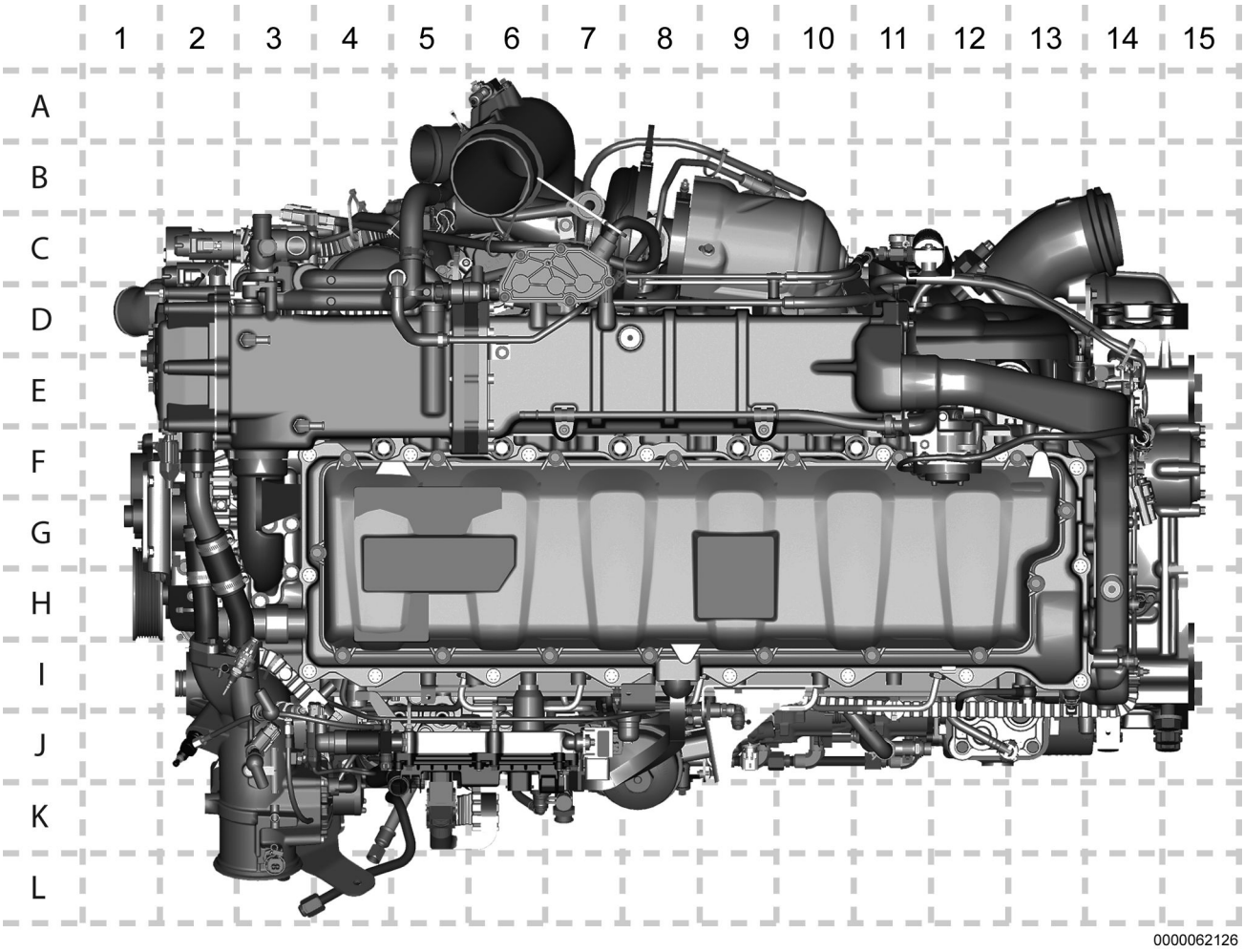
Top View



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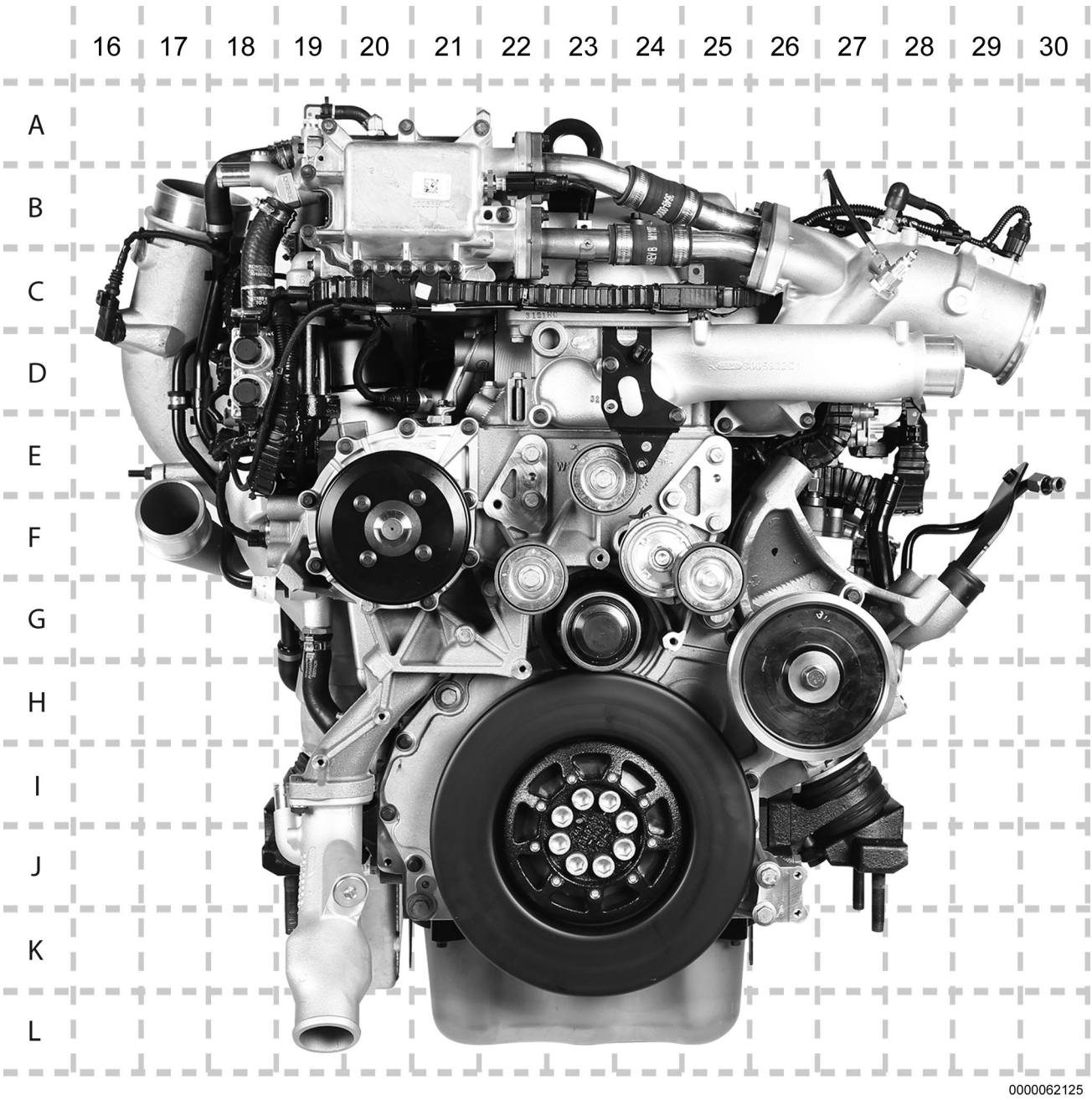
Front View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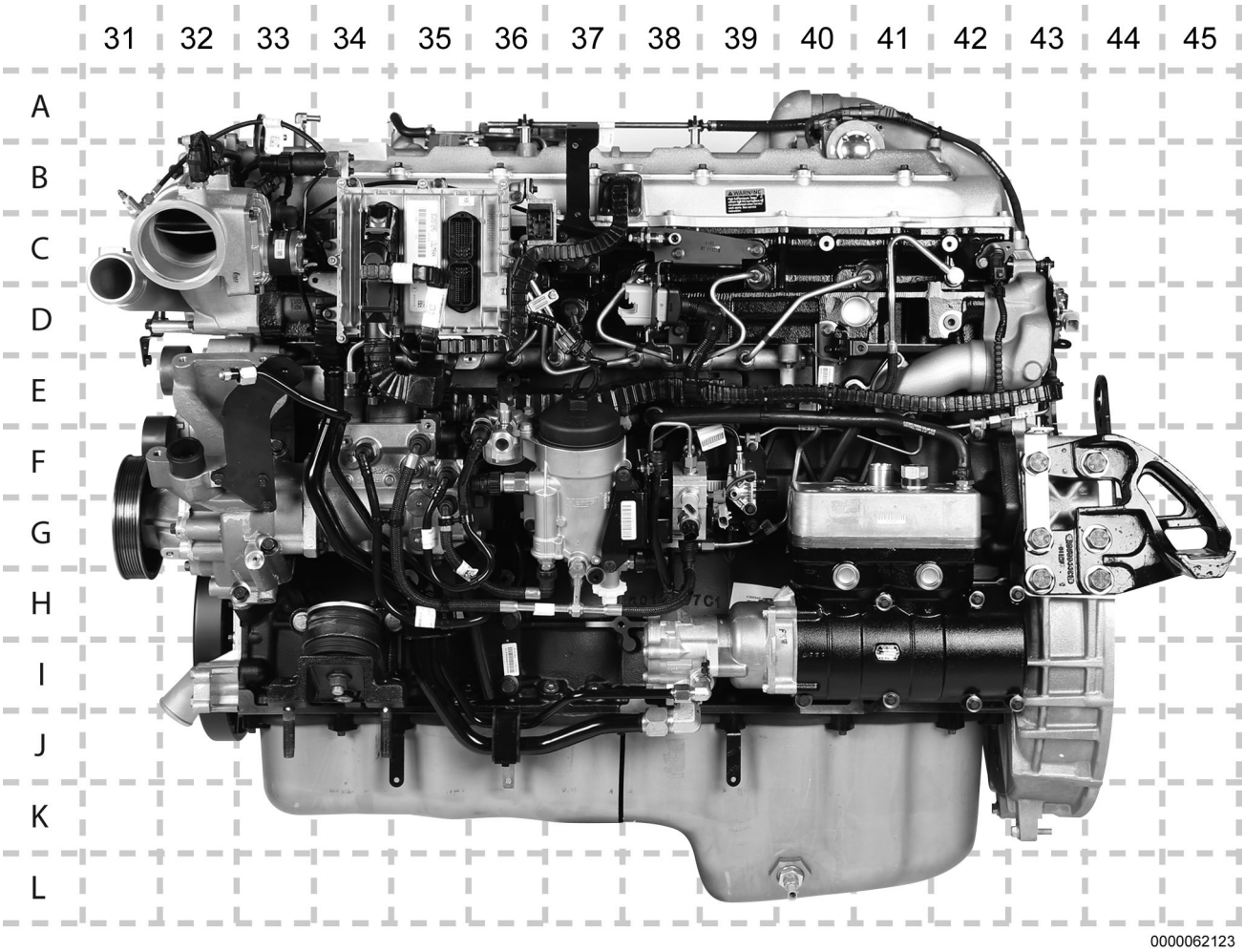
Left Side View



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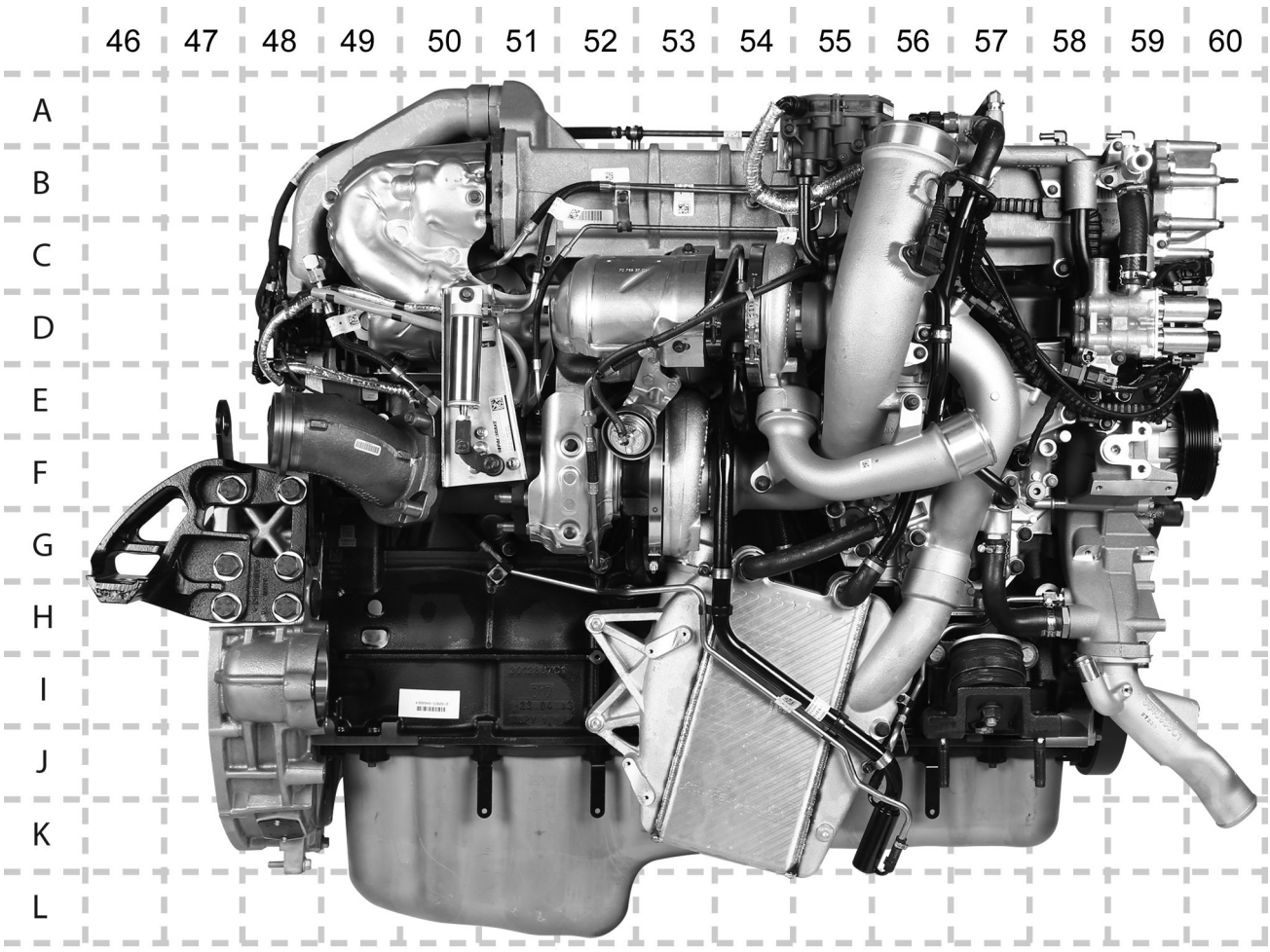
Right Side View



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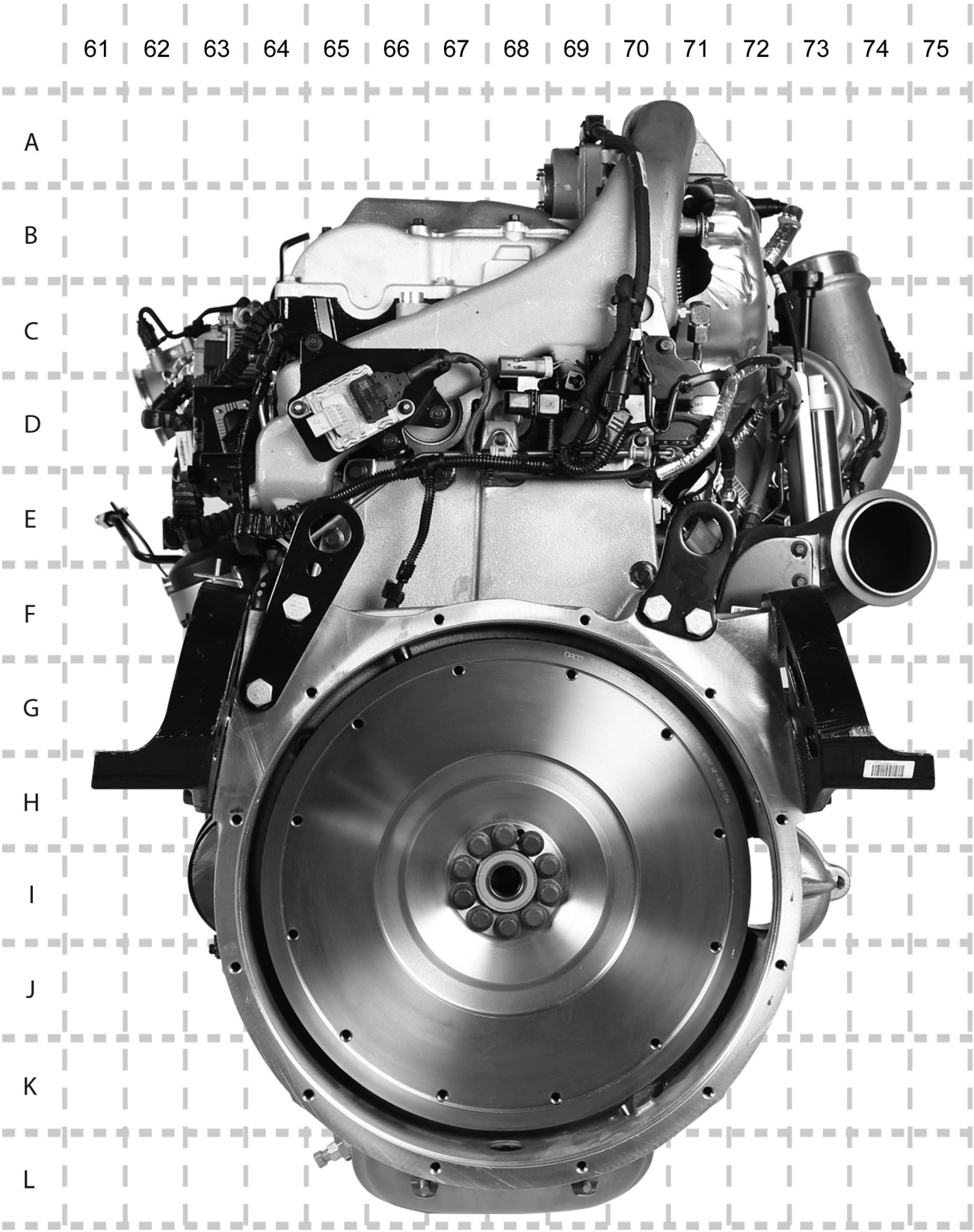
Back View



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Component Locator Table

Component	Location
Aftertreatment Fuel Doser (AFTFD) Module (AFTFD contains AFTFSV and AFTFP1)	G-38
Aftertreatment Fuel Injector (AFTFI)	E-49
Aftertreatment Purge Air Valve (AFTPAV)	F-39
Air compressor	I-41
Air Control Valve (ACV) Assembly	A-55, C-6
Air inlet duct	B-6, B-17
Camshaft Position (CMP) sensor	C-42
Charge-Air-Cooler Outlet Temperature (CACOT) sensor	B-29, B-32, K-13
Crankcase Oil Separator (CCOS) breather tube	K-55
Coolant Control Valve (CCV) assembly (CCV contains CMV and CFV)	D-18, D-59
Crank Shaft Position (CKP) sensor	F-66
Emission label	G-9
Engine coolant inlet	L-19
Engine coolant outlet	D-28
Engine Control Module (ECM) with Barometric Pressure (BARO) internal sensor	C-35
Engine Coolant Temperature 1 (ECT1) sensor	C-70
Engine Coolant Temperature 2 (ECT2) sensor	B-56 (behind Turbocharger 1 Inlet)
Engine mounted secondary fuel filter	F-37
Engine Oil Level (EOL) sensor	I-37
Engine Oil Pressure (EOP)	F-37
Engine Oil Temperature (EOT) sensor	C-59 (behind CCV), D-21
Engine Throttle Valve (ETV)	C-32
Exhaust Back Pressure Valve (EBPV)	E-50
Exhaust Gas Recirculation (EGR) cooler coolant manifold	E-13
Exhaust Gas Recirculation (EGR) cooler (high temperature stage)	E-10
Exhaust Gas Recirculation (EGR) cooler (low-temperature stage)	E-4
Exhaust Gas Recirculation (EGR) cooler outlet pipe (coolant)	G-3

Exhaust Gas Recirculation (EGR) cooler outlet tubes (gases)	G-2
Exhaust Gas Recirculation Temperature (EGRT) sensor	B-22
Exhaust Gas Recirculation (EGR) Valve	A-40, A-69
Flywheel Housing	I-43
Fuel Delivery Pressure (FDP) sensor	F-36
Fuel Pressure Control Valve (FPCV)	F-36 (back of high-pressure fuel pump)
Fuel primer pump assembly	E-36
Fuel rail Pressure (FRP) sensor (behind ECM, at front of the fuel rail)	D-35
High Pressure (HP) fuel pump	F-35
High Pressure (HP) pump pulley	H-26
High Pressure (HP) turbocharger	D-54
High Pressure (HP) turbocharger compressor outlet	F-56
Humidity / Inlet Air Temperature (IAT) sensor	C-16, C-56
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Inlet Air Heater Fuel Ignitor (IAHFI)	B-31, C-27
Inlet Air Heater Relay (IAHR)	C-37, J-7
Inlet Air Heater Fuel Solenoid (IAHFS)	B-33, J-4
Intake Manifold Pressure (IMP) sensor	B-28
Intake Manifold Temperature (IMT) sensor	D-37, J-3
Intake throttle duct assembly	C-29
Low Pressure Charge Air Cooler (LPCAC)	I-54
Low Pressure (LP) fuel pump	G-35
Low Pressure (LP) fuel pressure test port	E-36
Low Pressure (LP) turbocharger	F-53
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Oxygen Sensor (O_2S)	E-50 (behind EBPV), E-72
Thermostat housing	D-23
Turbocharger 2 compressor inlet sensor (TC2CIS)	D-56
Vibration damper	J-23
Coolant distribution housing	F-20