

2018 ENGINE PERFORMANCE

Engine Controls And Fuel - 1.6L (LH7) Diesel - Diagnostic Information And Procedures (P205B - P2BAA) And Testing - Equinox & Terrain

DIAGNOSTIC INFORMATION AND PROCEDURES

DTC P205B-P205D: REDUCTANT TANK TEMPERATURE SENSOR

Diagnostic Instructions

- Perform the [Diagnostic System Check - Vehicle](#) prior to using this diagnostic procedure.
- Review [Strategy Based Diagnosis](#) for an overview of the diagnostic approach.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptor

DTC P205B

Reductant Tank Temperature Sensor Performance

DTC P205C

Reductant Tank Temperature Sensor Circuit Low Voltage

DTC P205D

Reductant Tank Temperature Sensor Circuit High Voltage

Circuit/System Description

The reductant temperature sensor is a variable resistor used to measure the temperature inside the reductant tank. The sensor is wired to the reductant control module, which acquires the sensor signal and sends it to the engine control module via serial data. The reductant control module supplies 5 V to the reductant temperature sensor signal circuit and a ground for the low reference circuit.

Conditions for Running the DTC

P205B

- DTC P205C, P205D, or U010E is not set
- The ignition is ON and the engine is not running.
- The battery voltage is greater than 11 V.
- The ignition has been OFF for greater than 8 h
- This DTC runs continuously when the above conditions are met.

The DTC runs continuously when the above conditions are met.

P205C or P205D

- DTC P1051, P20B9, P20BB, P20BC or U010E is not set.
- The ignition is ON or the engine is running.
- The engine is not cranking.
- The battery voltage is greater than 11 V.

These DTCs runs continuously when the above conditions are met.

Conditions for Setting the DTC

DTC P205B

The difference between reductant temperature sensor signal and exhaust gas temperature sensor signals is outside a calibrated range.

DTC P205C

The ECM detects that the reductant temperature sensor signal is open or shorted to ground.

DTC P205D

The ECM detects that the temperature sensor signal is shorted to voltage.

Action Taken When the DTC Sets

- DTC P205B, P205C or P205D are Type A DTC.
- The reductant injector is shut off.
- The reductant tank and line heaters are shut off.
- The reductant pump is shut off.

Conditions for Clearing the DTC

DTC P205B, P205C or P205D are Type A DTC.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition OFF for least 8 h. Ignition ON, compare with a scan tool the IAT 2 parameter, the ambient air temperature parameter, and the Reductant Tank Temperature parameter the reading should be within 9Â°C (16Â°F) of each other
 - **If not within 9Â°C (16Â°F)**

Refer to Circuit/System testing
 - **Go to next step: If within 9Â°C (16Â°F)**
2. Engine running, verify that the Reductant Tank Temperature parameter is between -40 to +80Â°C (-40Â°F - 176Â°F) depending on the current Ambient Air Temperature, the engine run time, and the vehicle operating conditions.

- **If not between -40 to +80°C (-40°F - 176°F)**

Refer to Circuit/System Testing

- **Go to next step: If between -40 to +80°C (-40°F - 176°F)**

3. Verify with a scan tool that no other DTCs are set.

- **If any other DTCs are set**

Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) for further diagnosis.

- **Go to next step: If no other DTCs are set**

4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

5. Verify the DTC does not set.

- **If the DTC sets**

Refer to Circuit/System Testing.

- **Go to next step: If no DTC sets**

6. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the A38 Reductant Pump and Sensor Assembly. It may take up to 2 min for all vehicle systems to power down.

2. Test for less than 10 Ω between the low reference circuit terminal 2 and ground.

- **If 10 Ω or greater**

1. Ignition OFF, disconnect the X2 harness connector at the K115 Reductant Control Module.

2. Test for less than 2 Ω in the low reference circuit end to end.

- If 2 Ω or greater, repair the open/high resistance in the circuit.
- If less than 2 Ω, replace the K115 Reductant Control Module.

- **Go to next step: If less than 10 Ω**

3. Ignition ON, verify that the Reductant Tank Temperature is less than -35°C (-31°F).

- **If greater than -35°C (-31°F)**

1. Ignition OFF, disconnect the X2 harness connector at the K115 Reductant Control Module.

2. Test for infinite resistance between the signal circuit terminal 9 and ground.

- If less than infinite resistance, repair the short to ground in the circuit.
- If infinite resistance, replace the K115 Reductant Control Module.

- **Go to next step: If -35°C (-31°F) or less.**

4. Install a 3 A fused jumper wire between the signal circuit terminal 1 and the low reference circuit terminal 2.

5. Verify that the Reductant Tank Temperature sensor parameter is greater than 75°C (164°F).

- **If less than 75°C (164°F)**

1. Ignition OFF, disconnect the X2 harness connector at the K115 Reductant Control Module.

2. Test for less than 2 Ω in the signal circuit end to end.

- If 2 Ω or greater, repair the open/high resistance in the circuit.
- If less than 2 Ω, replace the K115 Reductant Control Module.

- **Go to next step: If 75°C (164°F) or greater**

6. Replace the A38 Reductant Pump and Sensor Assembly.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

Perform the [Reductant System Tamper Service Bay Test](#) after completing the repair to clear the Service Emission System or Service Exhaust Fluid System warning message, if displayed.

- Refer to [Emission Reduction Fluid Controller Replacement](#)
- Refer to [Emission Reduction Fluid Tank Replacement](#) for Reductant Pump and Sensor Assembly replacement.

DTC P205E: REDUCTANT TANK TEMPERATURE SENSOR CIRCUIT ERRATIC

Diagnostic Instructions

- Perform the [Diagnostic System Check - Vehicle](#) prior to using this diagnostic procedure.
- Review [Strategy Based Diagnosis](#) for an overview of the diagnostic approach.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptor

DTC P205E

Reductant Tank Temperature Sensor Circuit Erratic

Circuit/System Description

The reductant temperature sensor is a variable resistor used to measure the temperature inside the reductant tank. The sensor is wired to the reductant control module, which acquires the sensor signal and sends it to the engine control module via serial data. The reductant control module supplies 5 V to the reductant temperature sensor signal circuit and a ground for the low reference circuit.

Conditions for Running the DTC

- DTC P205C, P205D, or U010E is not set.
- The ignition is ON or the engine is running.
- The battery voltage is greater than 11 V.

The DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

The ECM detects that the reductant temperature sensor signal variation is greater than a calibrated value.

Action Taken When the DTC Sets

- DTC P205E is a Type A DTC.
- The reductant injector is shut off.
- The reductant tank and line heaters are shut off.
- The selective catalyst reduction system is put in standby mode.
- The Diesel Exhaust Fluid (DEF) Warning Strategy (Anti-Tampering) is activated.

Conditions for Clearing the DTC

DTC P205E is a Type A DTC.

Reference Information

Schematic Reference

[Engine Controls Wiring Schematics 1.6L \(LH7\)](#)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

DTC Type Reference

[Powertrain Diagnostic Trouble Code \(DTC\) Type Definitions](#)

Scan Tool Reference

[Control Module References](#) for scan tool information

Circuit/System Verification

1. Verify that DTCs P205C, P205D, or U10E are not set.
 - **If any of the DTCs are set**
 Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) for further diagnosis.
 - **Go to next step: If none of the DTCs are set**
2. Engine running, verify that the Reductant Tank Temperature parameter reading is between -40 to +80°C (-40°F - 176°F).
 - **If not between -40 and +80°C (-40°F - 176°F)**
 Refer to Circuit/System Testing
 - **Go to next step: If between -40 and +80°C (-40°F - 176°F)**
3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
4. Verify the DTC does not set.
 - **If the DTC sets**
 Refer to Circuit/System Testing.
 - **Go to next step: If no DTC sets**
5. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the A38 Reductant Pump and Sensor Assembly. It may take up to 2 min for all vehicle systems to power down.
2. Ignition On. Test for less than 25 Ω between the low reference circuit terminal 2 and ground.
 - **If 25 Ω or greater**
 1. Ignition OFF, disconnect the X2 connector at the K115 Reductant Control Module.
 2. Test for less than 2 Ω in the low reference circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω, replace the K115 Reductant Control Module.
 - **Go to next step: If less than 25 Ω**
3. Ignition ON, verify that the Reductant Tank Temperature is colder than -35°C (-31°F).
 - **If warmer than -35°C (-31°F)**
 1. Ignition OFF, disconnect the X2 connector at the K115 Reductant Control Module.
 2. Test for infinite resistance between the signal circuit terminal 9 and ground.
 - If less than infinite resistance, repair the short to ground in the circuit.
 - If infinite resistance, replace the K115 Reductant Control Module.
 - **Go to next step: If -35°C (-31°F) or colder.**

4. Install a 3 A fused jumper wire between the signal circuit terminal 1 and the low reference circuit terminal 2.
5. Verify that the Reductant Tank Temperature sensor parameter is warmer than 75°C (164°F).
 - **If less than 75°C (164°F)**
 1. Ignition OFF, disconnect the X2 connector at the K115 Reductant Control Module.
 2. Test for less than 2 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω, replace the K115 Reductant Control Module.
 - **Go to next step: If 75°C (164°F) or greater**
6. Replace the A38 Reductant Pump and Sensor Assembly.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

Perform the [Reductant System Tamper Service Bay Test](#) after completing the repair to clear the Service Emission System or Service Exhaust Fluid System warning message, if displayed.

- Refer to [Emission Reduction Fluid Controller Replacement](#) - K115 Reductant Control Module
- Refer to [Emission Reduction Fluid Tank Replacement](#) - A38 Reductant Pump and Sensor Assembly

DTC P206B-P206D: REDUCTANT QUALITY SENSOR CIRCUIT

Diagnostic Instructions

- Perform the [Diagnostic System Check - Vehicle](#) prior to using this diagnostic procedure.
- Review [Strategy Based Diagnosis](#) for an overview of the diagnostic approach.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptors

DTC P206B

Reductant Quality Sensor Circuit Performance

DTC P206C

Reductant Quality Sensor Circuit Low Voltage

DTC P206D

Reductant Quality Sensor Circuit High Voltage

Circuit/System Description

The reductant quality sensor is located in the reductant tank and uses an ultrasonic signal to measure reductant fluid quality. The reductant quality sensor includes an integrated temperature sensor to measure reductant fluid temperature. The reductant quality sensor communicates with the reductant control module using serial data.

Conditions for Running the DTC

P206B

- DTC P1015, P1016, P1017, P1018, P1019, P101A, P206C, P206D, P2ADA, P2ADB, P2ADC, P2ADD, or U010E is not set.
- The ignition is on or the engine is running.
- The ignition voltage is greater than 11 V.
- The reductant tank temperature sensor 2 is greater than 5°C (41°F).

- The reductant level is greater than 5 L (1 gal).

The DTCs run continuously when the above conditions are met.

P206C, P206D

- DTC U010E is not set.
- The ignition is on or the engine is running.
- The ignition voltage is greater than 11 V.

The DTCs run continuously when the above conditions are met.

Conditions for Setting the DTC

P206B

The reductant control module detects a performance fault on the reductant quality sensor for greater than 5 min.

P206C

The reductant control module detects that the reductant quality sensor signal is out of range low for greater than 5 s.

P206D

The reductant control module detects that the reductant quality sensor signal is out of range high for greater than 5 s.

Action Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type A DTC

- The reductant quality value is replaced with the last measured value.
- The reductant quality sensor temperature value is replaced with a default value
- The Warning/Inducement strategy is activated.

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type A DTC

Diagnostic Aids

Some reductant fluid (DEF) fill equipment may aerate the fluid which can temporarily affect the operation of the reductant quality sensor. A DTC may set and the Service Emission System message may display in the driver information center. The fluid aeration will quickly dissipate on its own and operation of the reductant quality sensor will return to normal. Filling the reductant fluid tank with the key off will help prevent the reductant quality sensor from being affected by this condition.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**

- [Wiring Repairs](#)

DTC Type Reference

[Powertrain Diagnostic Trouble Code \(DTC\) Type Definitions](#)

Scan Tool Reference

[Control Module References](#) for scan tool information

[Circuit/System Verification](#)

1. Ignition - On/Vehicle - In Service Mode
2. Verify the scan tool parameter: Reductant Concentration = The value should not spike or drop out.

Perform the action while monitoring the parameter:

- Wiggle the harness and connector: A39 Reductant Tank
- Wiggle the harness and connector: K115 Reductant Control Module
- **If the value spikes or drops out**

Repair as necessary - Wiring/Terminal (s)/Electrical Connector (s)

- **Go to next step: If the value does not spike or drop out**

3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Verify the DTC does not set.

- **If the DTC sets**

Refer to: Circuit/System Testing

- **Go to next step: If the DTC is not set**

4. All OK.

[Circuit/System Testing](#)

1. Ignition Off, disconnect the harness connector at the B295 Reductant Quality Sensor.
2. Ignition On.
3. Test for less than 20 Ω between low reference terminal 3 and ground.
 - **If greater than 20 Ω**
 1. Ignition Off, disconnect the X2 harness connector at the K115 Reductant Control Module.
 2. Test for less than 2 Ω in the low reference circuit end to end
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K115 Reductant Control Module.
 - **Go to next step: If less than 20 Ω**
4. Test for 4.8-5.2 V between 5 V reference circuit terminal 1 and ground
 - **If less than 4.8 V**
 1. Ignition Off, disconnect the X2 harness connector at the K115 Reductant Control Module.
 2. Test for less than 2 Ω in the 5 V reference circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω
 3. Test for infinite resistance between the 5 V reference circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K115 Reductant Control Module
 - **If greater than 5.2 V**

1. Ignition Off, disconnect the X2 harness connector at the K115 Reductant Control Module.
2. Test for less than 1 V between the 5 V reference circuit and ground.
 - If 1 V or greater, repair the short to voltage in the circuit.
 - If less than 1 V, replace the K115 Reductant Control Module
- **Go to next step: If between 4.8-5.2 V**
5. Ignition ON, test for 4.4-4.8 V between signal circuit terminal 2 and ground.
 - **If less than 4.4 V**
 1. Ignition Off, disconnect the X2 harness connector at the K115 Reductant Control Module.
 2. Test for less than 2 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω
 3. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K115 Reductant Control Module
 - **If greater than 4.8 V**
 1. Ignition Off, disconnect the X2 harness connector at the K115 Reductant Control Module.
 2. Ignition On, test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage in the circuit.
 - If less than 1 V, replace the K115 Reductant Control Module
 - **Go to next step: If between 4.4-4.8 V**
6. Replace the B295 Reductant Quality Sensor.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

- Refer to [Emission Reduction Fluid Tank Replacement](#) for reductant quality sensor replacement.
- Refer to [Emission Reduction Fluid Controller Replacement](#)

DTC P2081, P2085, P242E, P2472, OR P2484: EXHAUST GAS TEMPERATURE SENSOR 1, 2, 3 CIRCUIT INTERMITTENT

Diagnostic Instructions

- Perform the [Diagnostic System Check - Vehicle](#) prior to using this diagnostic procedure.
- Review [Strategy Based Diagnosis](#) for an overview of the diagnostic approach.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptors

DTC P2081

Exhaust Gas Temperature Sensor 1 Circuit Intermittent

DTC P2085

Exhaust Gas Temperature Sensor 2 Circuit Intermittent

DTC P242E

Exhaust Gas Temperature Sensor 3 Circuit Intermittent

Circuit/System Description

The exhaust gas temperature sensors are variable resistors that measures the temperature of the exhaust gas. The exhaust temperature sensor 1 is the first exhaust temperature sensor on the exhaust system, the following exhaust temperature sensors are counted upward from the engine outlet to the exhaust system end. The engine control module (ECM) supplies 5 V to the exhaust gas temperature signal circuit and

supplies a ground to the low reference circuit. The exhaust gas temperature sensor temperature information is used by the ECM during the exhaust gas particulate filter cleaning process.

Conditions for Running the DTC

- DTC P0545, P0546, P113B-P113F, P118E, P118F, P1196-P1198, P2032, P2033, P242C, P242D, P2470, P2471, P2481, or P2482 is not set.
- The engine is running.
- The ignition voltage is greater than 11 V.

These DTCs run continuously when the above conditions are met.

Conditions for Setting the DTC

The ECM detects that the exhaust gas temperature sensor resistance has changed greater than a calibrated amount in less than 1 s.

Action Taken When the DTC Sets

DTCs P2081, P2085, P242E, P2472, and P2484 are Type B DTCs.

Conditions for Clearing the DTC

DTCs P2081, P2085, P242E, P2472, and P2484 are Type B DTCs.

Diagnostic Aids

- After starting the engine, the exhaust gas temperature sensor temperature should rise steadily, then stabilize after the engine reaches operating temperature.
- Inspect the exhaust gas temperature sensor terminals for corrosion.
- Inspect the exhaust gas temperature sensor wiring for pinches, cuts, and damaged insulation.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

[Control Module References](#) for scan tool information

Circuit/System Verification

1. Verify that no other DTCs are set.
 - **If any other DTCs are set**

Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) for further diagnosis.

- **Go to next step: If no other DTC are set**
- 2. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
- 3. Verify DTC P2081, P2085, P242E, P2472, or P2484 does not set.
 - **If the DTC sets**

Refer to Circuit/System Testing.
 - **Go to next step: If the DTC does not set**
- 4. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the appropriate B131 Exhaust Temperature Sensor. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 Ω between the low reference circuit terminal 2 and ground.
 - **If 10 Ω or greater**
 1. Ignition OFF, disconnect the X3 harness connector at the K20 Engine Control Module.
 2. Test for less than 2 Ω in the low reference circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω

Replace the K20 Engine Control Module.
 - **Go to next step: If less than 10 Ω**
3. Ignition ON, test for 4.8 - 5.2 V between the signal circuit terminal 1 and ground.
 - **If less than 4.8 V**
 1. Ignition OFF.
 2. Disconnect the X3 harness connector at the K20 Engine Control Module.
 3. Test for infinite resistance between signal circuit and ground
 - If less than infinite resistance, repair the short to ground in the circuit.
 - If infinite resistance
 4. Test for less than 2 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω

Replace the K20 Engine Control Module.
 - **If greater than 5.2 V**
 1. Ignition OFF, disconnect the X3 harness connector at the K20 Engine Control Module.
 2. Test for less than 1 V between the signal circuit and ground
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 2 Ω

Replace the K20 Engine Control Module.
 - **Go to next step: If between 4.8 - 5.2 V**
4. Replace the appropriate B131 Exhaust Temperature Sensor.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

- Refer to [Exhaust Temperature Sensor Replacement - Position 1](#)
- Refer to [Exhaust Temperature Sensor Replacement - Position 2](#)
- Refer to [Exhaust Temperature Sensor Replacement - Position 3](#)

- Refer to [Control Module References](#) for engine control module replacement, programming, and setup.

DTC P208A, P208C, OR P208D: REDUCTANT PUMP CONTROL CIRCUIT

Diagnostic Instructions

- Perform the [Diagnostic System Check - Vehicle](#) prior to using this diagnostic procedure.
- Review [Strategy Based Diagnosis](#) for an overview of the diagnostic approach.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptors

DTC P208A

Reductant Pump Control Circuit

DTC P208C

Reductant Pump Control Circuit Low Voltage

DTC P208D

Reductant Pump Control Circuit High Voltage

Circuit/System Description

The selective catalytic reduction system reduces oxides of nitrogen (NOx) emissions by injecting a metered amount of reductant into the exhaust gas stream entering the selective catalytic reduction catalyst. Within the selective catalytic reduction catalyst, the reductant reacts with the NOx to form nitrogen, carbon dioxide, and water vapor. Upstream and downstream NOx sensors communicate with the engine control module and the reductant control module via serial data. The reductant control module varies the amount of reductant added by varying the reductant injector duty cycle in response to changes in engine-out NOx levels. The reductant control module supplies system voltage to the reductant pump motor. The reductant control module controls the solenoid by grounding the control circuit. The reductant control module can determine if the control circuit is open, shorted to ground, or shorted to a voltage by monitoring the feedback voltage.

Conditions for Running the DTC

- DTC U010E is not set.
- Ignition ON or engine running.
- The engine is not cranking.
- The battery voltage is greater than 11 V.

The DTCs run continuously when the above conditions are met.

Conditions for Setting the DTC

P208A

The reductant control module detects an open circuit in the control circuit.

P208C

The reductant control module detects a short to ground in the control circuit.

P208D

The reductant control module detects a short to voltage in the control circuit.

Action Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type A DTC

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type A DTC

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References

Circuit/System Verification

1. Ignition On
2. Verify that no DTC listed in the DTC Descriptor Category is set.
 - **If a DTC Is set**
Refer to Circuit/System Testing.
 - **Go to next step: If no DTC is set**
3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
4. Verify that no DTC listed in the DTC Descriptor Category is set.
 - **If a DTC sets**
Refer to Circuit/System Testing
 - **Go to next step: If a DTC does not set**
5. All OK.

Circuit/System Testing

1. Ignition Off, and all vehicle systems Off, disconnect the harness connector at the A38 Reductant Pump and Sensor Assembly. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 Ω between the low reference circuit terminal 15 and ground.
 - **If 10 Ω or greater**
 1. Ignition Off.
 2. Test for less than 2 Ω between A38 Reductant Pump and Sensor Assembly harness connector terminal 15 and K115 Reductant Control Module X2 harness connector terminal 5.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K115 Reductant Control Module.

- **Go to next step: If less than 10 Ω**

3. Disconnect the X2 harness connector at the K115 Reductant Control Module.

4. Test for less than 2 Ω between the control circuit terminals listed below:

- A38 Reductant Pump and Sensor Assembly harness connector terminal 16 and K115 Reductant Control Module X2 harness connector terminal 1
- A38 Reductant Pump and Sensor Assembly harness connector terminal 8 and K115 Reductant Control Module X2 harness connector terminal 2
- A38 Reductant Pump and Sensor Assembly harness connector terminal 7 and K115 Reductant Control Module X2 harness connector terminal 3
- **If greater than 2 Ω**

Repair the open/high resistance in the appropriate circuit.

- **Go to next step: If less than 2 Ω**

5. Ignition Off, test for infinite resistance between each control circuits listed above and ground.

- **If less than infinite resistance**

Repair the short to ground at the appropriate circuit.

- **Go to next step: If infinite resistance**

6. Ignition ON, test for less than 1 V between each control circuits listed above and ground.

- **If 1 V or greater**

Repair the short to voltage on the appropriate circuit.

- **Go to next step: If less than 1 V**

7. Replace the A38 Reductant Pump and Sensor Assembly.

8. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

9. Verify the DTC does not set.

- **If the DTC sets**

Replace the K115 Reductant Control Module

- **Go to next step: If the DTC does not set**

10. All OK.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

Perform the [Reductant System Tamper Service Bay Test](#) after completing the repair to clear the Service Emission System or Service Exhaust Fluid System warning message, if displayed.

- Refer to [Emission Reduction Fluid Controller Replacement](#) - K115 Reductant Control Module
- Refer to [Emission Reduction Fluid Supply Pump Module Replacement](#) - A38 Reductant Pump and Sensor Assembly

DTC P20B9-P20BF OR P20C0-P20C5: REDUCTANT HEATER 1-2

Diagnostic Instructions

- Perform the [Diagnostic System Check - Vehicle](#) prior to using this diagnostic procedure.
- Review [Strategy Based Diagnosis](#) for an overview of the diagnostic approach.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptors

DTC P20B9

DTC P20BA

Reductant Heater 1 Performance

DTC P20BB

Reductant Heater 1 Control Circuit Low Voltage

DTC P20BC

Reductant Heater 1 Control Circuit High Voltage

DTC P20BD

Reductant Heater 2 Control Circuit

DTC P20BE

Reductant Heater 2 Performance

DTC P20BF

Reductant Heater 2 Control Circuit Low Voltage

DTC P20C0

Reductant Heater 2 Control Circuit High Voltage

Circuit/System Description

As reductant will freeze at temperatures below -11°C (12°F), there are 2 reductant heaters located in the reductant tank. One heats the reductant in the tank and one heats the reductant supplied to the reductant injector supply pipe. The ECM monitors the reductant temperature in the tank in order to determine if reductant temperature is below its freeze point. If the ECM determines that the reductant may be frozen, it activates a "defrost strategy" energizing the reductant heater. This energizing action terminates when the temperature sensor measures a threshold value over which the heater must be deactivated.

Conditions for Running the DTCs

P20B9, P20BB, P20BC

- DTC P205B, P205C, P205D, or U010E is not set.
- The engine is running.
- The battery voltage is greater than 11 V.
- The reductant temperature is colder than 60°C (140°F).

The DTCs run continuously when the above conditions are met.

P20BA

- DTC P20B9, P20BB, P20BC, P248A, or U010E is not set.
- The engine is running.
- The battery voltage is greater than 11 V.
- The reductant tank heater is turned on.

The DTC runs continuously when the above conditions are met.

P20BD, P20BF, P20C0

- DTC U010E is not set.

- The engine is running.
- The battery voltage is greater than 11 V.
- The reductant temperature is colder than 60°C (140°F).

The DTCs run continuously when the above conditions are met.

P20BE

- DTC P20BD, P20BF, P20C0, P248C, or U010E is not set.
- The engine is running.
- The battery voltage is greater than 11 V.
- The reductant line heater is turned on.

The DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

P20B9

The ECM indicates the reductant tank heater control circuit is open for greater than 5 s.

P20BA

The ECM indicates the reductant tank heater resistance is greater or less than a calibrated value for greater than 6 s.

P20BB

The ECM indicates the reductant tank heater control circuit is shorted to ground or overloaded for greater than 5 s.

P20BC

The ECM indicates the reductant tank heater control circuit is shorted to a voltage for greater than 5 s.

P20BD

The ECM indicates the reductant line heater control circuit is open for greater than 5 s.

P20BE

The ECM indicates the reductant line heater resistance is greater or less than a calibrated value for greater than 6 s.

P20BF

The ECM indicates the reductant line heater control circuit is shorted to ground or overloaded for greater than 5 s.

P20C0

The ECM indicates the reductant line heater control circuit is shorted to a voltage for greater than 5 s.

Action Taken When the DTC Sets

DTCs P20B9, P20BA, P20BB, P20BC, P20BD, P20BE, P20BF and P20C0 are Type A DTCs.

- The reductant injector is disabled.
- The reductant heaters are disabled.
- The selective catalyst reduction system is put in standby mode.
- The Diesel Exhaust Fluid (DEF) Warning Strategy (Anti-Tampering) is activated.

Conditions for Clearing the DTC

DTCs P20B9, P20BA, P20BB, P20BC, P20BD, P20BE, P20BF and P20C0 are Type A DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

[Control Module References](#) for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify that DTCs P16D7, P16D8, P16D9, P248A, P248C, or U010E are not set.
 - **If any of the DTCs are set**
 - Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) for further diagnosis.
 - **Go to next step: If none of the DTCs are set**
3. Command the Reductant heater 1 and 2 ON and OFF with a scan tool and verify that Reductant Heater 1 and 2 Current parameters are between 0 - 25.5 A.
 - **If not between 0 - 25.5 A.**

Refer to Circuit/System Testing.

 - **Go to next step: If between 0 - 25.5 A**
4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
5. Verify the DTC does not set
 - **If the DTC sets**

Refer to Circuit/System Testing.

 - **Go to next step: If no DTC sets**
6. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect the X1 harness connector at the K115 Reductant Control Module.
2. Connect a test lamp between ignition voltage terminal 8 and ground.
3. Ignition ON, verify the test lamp illuminates.
 - **If the test lamp does not illuminate and fuse F45UA is good**
 1. Ignition OFF, remove KR121A Reductant Control Module Relay 1.
 2. Test for less than 2 Ω between ignition voltage terminal 8 and relay terminal 30.

- If 2 Ω or greater, repair the open/high resistance in the circuit
- If less than 2 Ω , replace the relay
- **If the test lamp does not illuminate and fuse F45UA is open**
 1. Ignition OFF, test for infinite resistance between ignition voltage terminal 8 and ground.
 - if less than infinite resistance, repair the short to ground in the circuit
- **Go to next step: If the test lamp illuminates**

DTCs P20B9, P20BA, P20BB or P20BC

1. Ignition OFF and all vehicle systems OFF. It may take up to 2 minutes for all vehicle systems to power down, disconnect the harness connector at the A38 Reductant Pump and Sensor Assembly.
2. Ignition On, test for 5 - 7.5 V between terminal 9 and Ground
 - **If less than 5 V**
 1. Ignition OFF, disconnect the X2 harness connector at the K115 Reductant Control Module.
 2. Test for infinite resistance between A38 Reductant Pump and Sensor Assembly harness connector terminal 9 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 Ω between A38 Reductant Pump and Sensor Assembly harness connector terminal 9 and K115 Reductant Control Module X2 harness connector terminal 11.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K115 Reductant Control Module.
 - **If greater than 7.5 V**
 1. Ignition OFF, disconnect the X2 harness connector at the K115 Reductant Control Module.
 2. Ignition On, test for greater than 1 V between A38 Reductant Pump and Sensor Assembly harness connector terminal 9 and ground
 - If greater than 1 V repair the short to voltage in the circuit
 - If less than 1 V replace the K115 Reductant Control Module
 - **Go to next step: If between 5 and 7.5 V**
3. Connect a test lamp between heater control circuit terminal 9 and low reference circuit terminal 11.
4. Ignition ON, verify the test lamp turns ON for several seconds while commanding Reductant Heater 1 ON with a scan tool.
 - **If the test lamp is always OFF**
 1. Ignition OFF, disconnect the X2 harness connector at the K115 Reductant Control Module.
 2. Test for infinite resistance between the A38 Reductant Pump and Sensor Assembly harness connector terminal 11 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 Ω between A38 Reductant Pump and Sensor Assembly harness connector terminal 11 and K115 Reductant Control Module X2 harness connector terminal 4.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω
 4. Test for less than 1.0 V between the A38 Reductant Pump and Sensor Assembly harness connector terminal 11 and ground.
 - If 1.0 V or greater, repair the short to voltage in the circuit.
 - If less than 1.0 V, replace the K115 Reductant Control Module.
 - **Go to next step: If the Test lamp turns ON and OFF**
5. Test or replace the A38 Reductant Pump and Sensor Assembly.

DTCs P20BD, P20BE, P20BF, P20C0

1. Ignition OFF and all vehicle systems OFF. It may take up to 2 minutes for all vehicle systems to power down, disconnect the harness connector at the E52 Reductant Line Heater.
2. Ignition On, test for 5 - 7.5 V between terminal 2 and ground
 - **If less than 5 V**
 1. Ignition OFF, disconnect the X2 harness connector at the K115 Reductant Control Module.
 2. Test for infinite resistance between E52 Reductant Line Heater harness connector terminal 2 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 Ω between E52 Reductant Line Heater harness connector terminal 2 and K115 Reductant Control Module X2 harness connector terminal 7.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K115 Reductant Control Module.
 - **If greater than 7.5 V**
 1. Ignition OFF, disconnect the X2 harness connector at the K115 Reductant Control Module.
 2. Ignition On, test for greater than 1 V between E52 Reductant Line Heater harness connector terminal 2 and ground
 - If greater than 1 V repair the short to voltage in the circuit
 - If less than 1 V replace the K115 Reductant Control Module
 - **Go to next step: If between 5 and 7.5 V**
3. Connect a test lamp between heater control circuit terminal 2 and low reference circuit terminal 1.
4. Ignition ON, verify the test lamp turns ON for several seconds while commanding Reductant Heater 2 ON with a scan tool.
 - **If the test lamp is always OFF**
 1. Ignition OFF, disconnect the X2 harness connector at the K115 Reductant Control Module.
 2. Test for infinite resistance between the E52 Reductant Line Heater harness connector terminal 1 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 Ω between E52 Reductant Line Heater harness connector terminal 1 and K115 Reductant Control Module X2 harness connector terminal 20.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω
 4. Test for less than 1.0 V between the E52 Reductant Line Heater harness connector terminal 1 and ground.
 - If 1.0 V or greater, repair the short to voltage in the circuit.
 - If less than 1.0 V, replace the K115 Reductant Control Module.
 - **Go to next step: If the Test lamp turns ON and OFF**
5. Test or replace the E52 Reductant Line Heater.

Component Testing

Reductant Tank Heater

1. Ignition OFF, disconnect the harness connector at the A38 Reductant Pump and Sensor Assembly.
2. Test for 1 - 3 Ω between terminals 9 and 11 of the A38 Reductant Pump and Sensor Assembly.
 - **If not within 1 - 3 Ω**

Replace the A38 Reductant Pump and Sensor Assembly.
 - **Go to next step: If within 1 - 3 Ω**

3. Test for infinite resistance between each terminal and the A38 Reductant Pump and Sensor Assembly housing/case.

- terminal 9
- terminal 11
- **If less than infinite resistance**

Replace the A38 Reductant Pump and Sensor Assembly.

- **Go to next step: If infinite resistance**

4. All OK.

Reductant Line Heater

1. Ignition OFF, disconnect the harness connector at the E52 Reductant Line Heater.

2. Test for 1 - 4 Ω between terminals 1 and 2 of the Reductant Line Heater.

- **If not within 1 - 4 Ω**

Replace the E52 Reductant Line Heater.

- **Go to next step: If within 1 - 4 Ω**

3. Test for infinite resistance between each terminal and the E52 Reductant Line Heater housing/case.

- terminal 1
- terminal 2
- **If less than infinite resistance**

Replace the E52 Reductant Line Heater.

- **Go to next step: If infinite resistance**

4. All OK.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

Perform the [Reductant System Tamper Service Bay Test](#) after completing the repair to clear the Service Emission System or Service Exhaust Fluid System warning message, if displayed.

- Refer to [Emission Reduction Fluid Supply Pump Module Replacement](#) for reductant pump and sensor assembly replacement.
- Refer to [Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe Replacement \(FWD\)](#), [Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe Replacement \(Front AWD\)](#), [Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe Replacement \(Rear AWD\)](#) for reductant line heater replacement.
- Refer to [Emission Reduction Fluid Controller Replacement](#)

DTC P20E8 OR P20E9: REDUCTANT LOW/HIGH PRESSURE

Diagnostic Instructions

- Perform the [Diagnostic System Check - Vehicle](#) prior to using this diagnostic procedure.
- Review [Strategy Based Diagnosis](#) for an overview of the diagnostic approach.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptors

DTC P20E8

Reductant Low Pressure

DTC P20E9

Reductant High Pressure

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
DEF Pump Supply Voltage	P208A, P20E8	P204F, P20E8	P20E9	P204F, P208B, P20E8, P20E9
DEF Pump Control	P208A, P20E8	P204F, P208A, P20E8	P208D, P20E9	P204F, P208B, P20E8, P20E9
DEF Pump Low Reference	P20E8	P204F, P208A, P20E8	P20E9	P204F, P208B, P20E8, P20E9

Typical Scan Tool Data

Reductant Pressure

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Reductant pump On Parameter Normal Range (Pump On): 425 - 575 kPa (62 - 83 psi) Parameter Normal Range (Pump Off): 0 - 50 kPa (0 - 7 psi)			
5 V Reference	0 kPa	0 kPa	0 kPa
DEF Pressure Sensor Signal	0 kPa	0 kPa	750 - 850 kPa
Low Reference	-	0 kPa	5 - 20 kPa

Circuit/System Description

The selective catalytic reduction (SCR) system reduces oxides of nitrogen (NOx) emissions by injecting a metered amount of diesel exhaust fluid (DEF) or reductant into the exhaust gas stream entering the SCR catalyst. Within the SCR catalyst, the DEF reacts with the NOx to form nitrogen, carbon dioxide, and water vapor. Upstream and downstream NOx sensors provide the engine control module (ECM) with engine-out and tailpipe-out NOx levels. The ECM varies the amount of reductant added by varying the reductant injector duty cycle in response to changes in engine-out NOx levels.

The ECM supplies system voltage to the reductant pump motor. The ECM controls the solenoid by grounding the control circuit with a solid state device called a driver. The driver is equipped with a feedback circuit that is pulled-up to a voltage. The ECM can determine if the control circuit is open, shorted to ground, or shorted to a voltage by monitoring the feedback voltage. The ECM supplies a ground to the low reference circuit. As the duty-cycle increases, the output of the reductant pump increases.

Conditions for Running the DTCs

P20E8

- DTCs P204B, P204C, P204D, P208B, P208D, P20A0, P20A2, P20A3 is not set.
- Engine speed is greater than 600 RPM for at least 10 s.
- Battery voltage is greater than 11 V for at least 3 s.
- Reductant pressure is less than 420 kPa (61 psi) for more than 60 s.
- Ambient air temperature is greater than -30°C (-22°F).
- Reductant Level must not be in restriction or empty level state.
- Reductant must not be frozen or one heating cycle must complete (up to one hour at -20°C (-4°F)).
- The DTC runs continuously when the above conditions are met.

P20E9

- Engine speed is greater than 600 RPM for at least 10 s.
- Battery voltage is greater than 11 V for at least 3 s.

- The reductant pressure is greater than 650 kPa (94 psi) for more than 10 s or greater than 795 kPa (115 psi) for more than 1 s.
- Ambient air temperature is greater than -30°C (-22°F).
- Reductant Level must not be in restriction or empty level state.
- Reductant must not be frozen or one heating cycle must complete (up to one hour at -20°C (-4°F)).
- The DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

P20E8

- The ECM detects the reductant pressure is less than a calibrated threshold.

P20E9

- The ECM detects the reductant pressure is greater than a calibrated threshold.

Action Taken When the DTC Sets

- DTCs P20E8 and P20E9 are Type A DTCs.
- The ECM inhibits the reductant system for P204F and P20E9.
- The ECM commands the engine to operate in Reduced Engine Power mode.
- The driver information center may display the Engine Power Is Reduced message.

Conditions for Clearing the DTC

- DTCs P20E8 and P20E9 are Type A DTCs.
- The DTCs must run and pass in order to clear the DIC message for P204F.

Diagnostic Aids

- A leak in the reductant system can be determined by inspecting for a build-up of crystallized reductant.
- Water content in the reductant will affect the freezing point.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

Powertrain Component Views

Description and Operation

- Diesel Exhaust Fluid (DEF) Warning Strategy (DEF Level)Diesel Exhaust Fluid (DEF) Warning Strategy (DEF Quality)Diesel Exhaust Fluid (DEF) Warning Strategy (Anti-tampering)Diesel Exhaust Fluid (DEF) Warning Strategy (Emission Control)
- Exhaust Aftertreatment System Description

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections

- [Wiring Repairs](#)

DTC Type Reference

[Powertrain Diagnostic Trouble Code \(DTC\) Type Definitions](#)

Scan Tool Reference

[Control Module References](#) for scan tool information

Circuit/System Verification

1. Ignition - On/Vehicle - In Service Mode
2. Verify there are no related DTCs set in the following system: Reductant System
 - **If any other DTCs are set**

Refer to: [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) , [Diagnostic Trouble Code \(DTC\) List - Vehicle](#)

- **Go to next step: If no other DTCs are set**
3. Verify that the scan tool Reductant Level is displaying at least 33%.
 - **If less than 33%**

Add reductant

- **Go to next step: If 33% or greater**

NOTE: The reductant must be thawed before continuing.

4. Command the Reductant System Leak Test On with a scan tool. Allow the pressure to build for at least 2 minutes. The first 60 s, the system performs a system purge. Observe the scan tool Reductant Pressure sensor parameter. The reading should be between 400-650 kPa (58-94 psi).
 - **If not between the specified values**

Refer to Circuit/System Testing

- **Go to next step: If between the specified values**
5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
 6. Verify the DTC does not set.
 - **If the DTC sets**

Refer to Circuit/System Testing.

- **Go to next step: If the DTC does not set**
7. All OK.

Circuit/System Testing

NOTE: The reductant temperature must be greater than -7Â°C (+19Â°F) before proceeding.

1. Test the reductant for contamination. Refer to [Contaminants-in-Fuel Diagnosis](#).
 - **If contaminated**

Repair as necessary

 - **Go to next step: If not contaminated**
2. Ignition - On/Vehicle - In Service Mode

3. Command the Reductant System Leak Test On with a scan tool. Allow the pressure to build for 2 minutes. Observe the scan tool Reductant Pressure sensor parameter.
4. Verify the scan tool parameter: Reductant Pressure Sensor = 400 to 650 kPa (58 to 94 PSI)
 - **If greater than 650 kPa (94 PSI)**

Replace the component: A38 Reductant Pump and Sensor Assembly
 - **If less than 400 kPa (58 PSI)**
 1. Verify there are no leaks in the reductant lines.
 - If a leak is found

Repair as necessary
 - If no leak is found
 2. Remove the Q61 Emission Reduction Fluid Injector from the exhaust pipe leaving the reductant line and electrical connector connected. Place the injector into a suitable container.
 3. Command the Reductant System Leak Test On with a scan tool. Allow the pressure to build.
 4. Verify the injector does not leak.
 - If a leak is found

Replace the Q61 Emission Reduction Fluid Injector
 - If no leak is found
 5. Replace the component: A38 Reductant Pump and Sensor Assembly
 - **Go to next step: If between 400 and 650 kPa (58 and 94 PSI)**
5. All OK.

Repair Instructions

- Perform the Diagnostic Repair Verification after completing the repair: [Diagnostic Repair Verification](#)
- Perform the scan tool function: [Reductant System Tamper Service Bay Test](#) - after completing the repair to clear the Service Emission System or Service Exhaust Fluid System warning message, if displayed.
- Refer to [Emission Reduction Fluid Tank Replacement](#)
- Refer to [Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe Replacement \(FWD\)](#), [Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe Replacement \(Front AWD\)](#), [Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe Replacement \(Rear AWD\)](#)
- Refer to [Emission Reduction Fluid Tank Replacement](#) for G33 Reductant Pump
- Refer to [Emission Reduction Fluid Tank Draining](#)

DTC P20EE, P249D, OR P249E: NOX CATALYST EFFICIENCY BELOW THRESHOLD/CLOSED LOOP REDUCTANT INJECTION CONTROL AT LIMIT - FLOW TOO LOW/HIGH

Diagnostic Instructions

- Perform the [Diagnostic System Check - Vehicle](#) prior to using this diagnostic procedure.
- Review [Strategy Based Diagnosis](#) for an overview of the diagnostic approach.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptor

DTC P20EE

NOx Catalyst Efficiency Below Threshold

DTC P249D

Closed Loop Reductant Injection Control At Limit - Flow Too Low

DTC P249E

Closed Loop Reductant Injection Control At Limit - Flow Too High

Circuit/System Description

The selective catalytic reduction (SCR) system reduces oxides of nitrogen (NOx) emissions by injecting a metered amount of diesel exhaust fluid or reductant into the exhaust gas stream entering the SCR. Within the selective catalytic reduction catalyst, the reductant reacts with the NOx to form nitrogen, carbon dioxide, and water vapor. Upstream and downstream NOx sensors provide the engine control module (ECM) with engine-out and tailpipe-out NOx levels. The ECM uses two (NOx) sensors to control exhaust NOx levels. The first NOx sensor is located upstream of the reductant fluid injector and monitors the engine out NOx. The second NOx sensor is located at the outlet of the SCR and monitors NOx levels exiting the SCR. The engine control module (ECM) varies the amount of diesel exhaust fluid (Reductant) or reductant added in response to changes in engine exhaust out NOx levels.

Conditions for Running the DTC

DTC P20EE

- DTC P0071, P0072, P0073, P0074, P00C7, P00E9, P00EA-P00EC, P0101, P0102, P0103, P0106, P0107, P0108, P0116, P0117, P0118, P0119, P0128, P0201-P0208, P020A-P020F, P0216, P021A, P021B, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0279, P0280, P0282, P0283, P02EE, P02EF, P02F0-P02F5, P0405, P0406, P049D, P062B, P062D, P0722, P0723, P111E, P113F, P115E, P115F, P1160, P116A-P116F, P1192-P1194, P1198, P119A-P119F, P11BE, P11BF, P11C0, P11C5-P11C8, P11CC, P11D0-P11D3, P11D5, P11D8, P11D9, P11DA-P11DE, P11FC-P11FE, P1248, P1249, P124A-P124F, P202E, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P2200, P2202, P2203, P2205-P2211, P220A, P220B, P2227, P2228, P2229, P2230, P228A, P228B, P229E, P229F, P22A0, P22A1, P22A3-P22A9, P22FE, P2452-P2456, P2481, P2482, P2483, P2484, P2BAA, U029D or U029E is not set.
- The engine is running.
- The barometric pressure is greater than 70 kPa (10.2 psi).
- The ambient air temperature is warmer than -7°C (19.4°F).
- The reductant tank is not frozen.
- Vehicle is not in a DPF regeneration.

The DTC runs when the above conditions are met.

DTC P249D, P249E

The DTCs run when the engine is running.

Conditions for Setting the DTC

The selective catalytic reduction measured NOx conversion efficiency is lower than expected.

Action Taken When the DTC Sets

- DTC P20EE is a Type A DTC.
- DTCs P249D and P249E are Type B DTCs.

Conditions for Clearing the DTC

- DTC P20EE is a Type A DTC.
- DTCs P249D and P249E are Type B DTCs.

Diagnostic Aids

- A leak in the reductant system can be located by inspecting for a build-up of crystallized diesel exhaust fluid (Reductant).
- Water in the Reductant tank will cause DTCs to set.
- Using the Reductant Injector Device Control, a ticking sound should be heard at the reductant injector.
- Using fuel other than ultra low sulfur content fuel will cause this DTC to set.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify that DTC P0071, P0072, P0073, P0074, P00C7, P00E9, P00EA-P00EC, P0101, P0102, P0103, P0106, P0107, P0108, P0116, P0117, P0118, P0119, P0128, P0201-P0208, P020A-P020F, P0216, P021A, P021B, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0279, P0280, P0282, P0283, P02EE, P02EF, P02F0-P02F5, P0405, P0406, P049D, P062B, P062D, P0722, P0723, P111E, P113F, P115E, P115F, P1160, P116A-P116F, P1192-P1194, P1198, P119A-P119F, P11BE, P11BF, P11C0, P11C5-P11C8, P11CC, P11D0-P11D3, P11D5, P11D8, P11D9, P11DA-P11DE, P11FC-P11FE, P1248, P1249, P124A-P124F, P202E, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P2200, P2202, P2203, P2205-P2211, P220A, P220B, P2227, P2228, P2229, P2230, P228A, P228B, P229E, P229F, P22A0, P22A1, P22A3-P22A9, P22FE, P2452-P2456, P2481, P2482, P2483, P2484, P2BAA, U029D or U029E is not set.

- **If any of the DTCs are set**

1. Refer to Diagnostic Trouble Code (DTC) List - Vehicle for further diagnosis.
2. Perform the scan tool control function: Reductant System Malfunction Service Bay Test after diagnosing other DTCs
 - If the test does not pass

Refer to Circuit/System Testing.

- If the test passes

All OK.

- **Go to next step: If no other DTCs are set**

2. Verify that DTC P20EE, P249D, or P249E is not set

- **If a DTC is set**

- **Go to next step: If no DTC is set**

3. All OK.

Circuit/System Testing

1. Ignition Off

2. Test the reductant system for contamination. Refer to [Contaminants-in-Diesel Exhaust Fluid Diagnosis](#).

- **If any conditions are found**

Repair as necessary.

- **Go to next step: If no conditions are found**

3. Ignition - On/Vehicle - In Service Mode

4. Perform the scan tool control function: Reductant System Leak Test - ON

5. Verify that the system is able to build up and reach the reductant pressure sensor parameter greater than 450 kPa.

- **If less than the specified range**

1. Command the Reductant Pump to 50% with a scan tool.

2. Verify the scan tool parameter: Desired Reductant Pump Speed = Reductant Pump Speed

- If not equal

Refer to [DTC P105A](#)

- If equal

- **Go to next step: If within the specified range**

6. Verify there are no leaks, kinks or restrictions in the reductant lines

- **If any condition is found**

Repair as necessary.

- **Go to next step: If no conditions are found**

7. Verify the [Reductant Injection Quantity Test](#) passes.

- **If the test does not pass**

Repair as necessary.

- **Go to next step: If the test passes**

8. Disconnect the Q61 Reductant Injector electrical connector.

9. Engine running and NOx sensors at operating temperature, verify NOx sensor 2 NOx Concentration is less than 50 ppm greater than NOx sensor 1 NOx Concentration.

- **If NOx sensor 2 NOx Concentration is 50 ppm or greater than NOx sensor 1 NOx Concentration**

Replace the B195B Nitrogen Oxides Sensor 2

- **Go to next step: If NOx sensor 2 NOx Concentration is less than 50 ppm greater than NOx sensor 1 NOx Concentration**

10. Idle engine at 1, 500 RPM for 10 min while monitoring Exhaust Gas Temperature Sensor 2.

11. Verify Exhaust Gas Temperature Sensor 2 is colder than 150Â°C (302Â°F)

- **If 150Â°C (302Â°F) or warmer**

1. Verify Exhaust Gas Temperature Sensor 2 is warmer than 150Â°C (302Â°F) For greater than 30 min, then continue to the next step.

- **If colder than 150Â°C (302Â°F)**

12. Verify NOx sensor 1 NOx Concentration and NOx sensor 2 NOx Concentration are within 50 ppm of each other.

- **If not within 50 ppm**

Replace the B195A Nitrogen Oxides Sensor 1

- **Go to next step: If within 50 ppm**

13. Connect the Q61 Reductant Injector electrical connector.

14. Verify none of the conditions listed below exist:

- Leaking fuel injectors. Refer to [Fuel Injector Balance Test with Scan Tool](#).
- Engine oil consumption. Refer to [Oil Consumption Diagnosis](#).
- Engine coolant consumption. Refer to [Coolant in Combustion Chamber](#).
- An engine mechanical condition. Refer to [Symptoms - Engine Mechanical](#).
- **If any condition is found**

Repair as necessary

- **Go to next step: If no condition is found**

15. Replace SCR Catalyst.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

- Refer to [Nitrogen Oxides Sensor Replacement - Position 1](#)
- Refer to [Nitrogen Oxides Sensor Replacement - Position 2](#)
- Refer to [Emission Reduction Fluid Supply Pump Module Replacement](#)
- Refer to [Emission Reduction Fluid Injector Replacement \(AWD\)](#), [Emission Reduction Fluid Injector Replacement \(FWD\)](#).
- Refer to [Exhaust Muffler Replacement \(LH7\)](#) - For SCR Replacement
- Refer to [Control Module References](#) for engine control module replacement, programming, and setup.

Repair Verification

NOTE: Before returning the vehicle to the customer, perform the scan tool Reductant System Malfunction Warning Service Bay Test to verify proper reductant system operation.

1. Perform the scan tool control function: [Reductant System Malfunction Service Bay Test](#)

- **If the test does not pass**

Refer to Circuit/System Testing.

- **Go to next step: If the test passes**

2. All OK.

DTC P20F8: INTAKE MANIFOLD RUNNER CONTROL VALVE CONTROL CIRCUIT PERFORMANCE

Diagnostic Instructions

- Perform the Diagnostic System Check prior to using this diagnostic procedure: [Diagnostic System Check - Vehicle](#)
- Review the description of Strategy Based Diagnosis: [Strategy Based Diagnosis](#)
- An overview of each diagnostic category can be found here: [Diagnostic Procedure Instructions](#)

DTC Descriptor

DTC P20F8

Intake Manifold Runner Control Valve Control Circuit Performance

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition	P2009, P201B	P2009, P2017	-	P2006, P200A, P20F8
Control	P2009	P2008	P2010	P2006, P200A, P20F8

Typical Scan Tool Data

Intake Manifold Runner Control Valve Feedback Signal

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine - Idling - At normal operating temperature Parameter Normal Range: 32%			
Ignition	0%	100%	100%
Control	0%	29%	29%

Circuit/System Description

Circuit	Description
Ignition	Supplied from a fuse.
Control	The output is PWM controlled.

Component	Description
K20 Engine Control Module	The control module contains a microprocessor used to process input data to control outputs. The control module controls a series of actuators to ensure optimal engine performance. The control module does this by reading values from a variety of sensors, interprets the data and adjusts the engine actuators accordingly.
M98 Intake Manifold Runner Valve Actuator	The intake manifold runner control solenoid valve is actuated by a DC motor. The control valve is spring loaded to the closed position. The motor overcomes the spring pressure to open the control valve. An increase in current flow through the motor increases the opening of the control valve.

Conditions for Running the DTC

- DTC P0071-P0074, P0116-P0119, P0128, P111E, P2008-P2010, P2015-P2017 = Not set
- Engine = Running
- Ignition Voltage = Greater than 11 V
- Engine Coolant Temperature = Greater than 59Â°C (138Â°F)
- Outside Ambient Air Temperature Sensor Signal = Greater than -7Â°C (19Â°F)
- Intake Manifold Runner Control Valve Command = ON For greater than 30 s
- Intake Manifold Runner Control Valve Command = Steady State For greater than 1 s
- Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

Control Circuit = Commanded state does not match the actual state - For greater than 1 s

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type B DTC

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type B DTC

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Powertrain Component Views

Powertrain Component Views

Electrical Information Reference

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References

Circuit/System Verification

1. Ignition - On/Vehicle - In Service Mode
2. Verify DTC P2008, P2009, P2010, P2015, P2016, P2017 is not set.
3. Perform the scan tool control function: Intake Manifold Runner Control Valve - Increase

Verify the scan tool parameter:

- Intake Manifold Runner Control Valve Control Circuit High Voltage Test Status = OK or Not Run
- Intake Manifold Runner Control Valve Control Circuit Open Test Status = OK or Not Run
- Intake Manifold Runner Control Valve Control Circuit Low Voltage Test Status = OK or Not Run
- **If not the specified state**

Refer to: Circuit/System Testing

- **Go to next step: If the specified state**

4. Perform the scan tool control function: Intake Manifold Runner Control Valve - Increase & Decrease - 30 to 80%

Verify the scan tool parameter: Intake Manifold Runner Control Valve Feedback Signal = Intake Manifold Runner Control Valve Command

- **If not the specified state**

Refer to: Circuit/System Testing

- **Go to next step: If the specified state**
5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Verify the DTC does not set.

- **If the DTC sets**

Refer to: Circuit/System Testing

- **Go to next step: If the DTC is not set**

6. All OK.

Circuit/System Testing

1. Ignition/Vehicle & All vehicle systems - Off
2. Disconnect the electrical connector: M98 Intake Manifold Runner Valve Actuator
3. Ignition - On/Vehicle - In Service Mode
4. Verify a test lamp does not turn On between the test points: Control circuit terminal 1 & B+
 - **If the test lamp turns On**
 1. Ignition/Vehicle - Off & Remove - Test lamp
 2. Disconnect the electrical connector: X2 @ K20 Engine Control Module
 3. Test for infinite resistance between the test points: Control circuit terminal 1 @ Component harness & Ground
 - If less than infinite resistance - Repair the short to ground on the circuit.
 - If infinite resistance - Replace the component: K20 Engine Control Module
 - **Go to next step: If the test lamp does not turn On**
5. Remove - Test Lamp
6. Verify the scan tool parameter: Intake Manifold Runner Control Valve Control Circuit High Voltage Test Status = OK
 - **If not the specified state**
 1. Ignition/Vehicle - Off
 2. Disconnect the electrical connector: X2 @ K20 Engine Control Module
 3. Ignition - On/Vehicle - In Service Mode
 4. Test for less than 1 V between the test points: Control circuit terminal 1 @ Component harness & Ground
 - If 1 V or greater - Repair the short to voltage on the circuit.
 - If less than 1 V - Replace the component: K20 Engine Control Module
 - **Go to next step: If the specified state**
7. Connect a 3 A fused jumper wire between the test points: Control circuit terminal 1 & Ignition circuit terminal 6
8. Perform the scan tool control function: Intake Manifold Runner Control Valve - Increase

Verify the scan tool parameter: Intake Manifold Runner Control Valve Control Circuit High Voltage Test Status = Malfunction

- **If not the specified state**
 1. Ignition/Vehicle - Off & Remove - Jumper wire (s)
 2. Disconnect the electrical connector: X2 @ K20 Engine Control Module
 3. Test for less than 2 between the test points: Control circuit terminal 1 @ Component harness & Terminal 54 @ Control module harness
 - If 2 or greater - Repair the open/high resistance in the circuit.
 - If less than 2 - Replace the component: K20 Engine Control Module
- **Go to next step: If the specified state**

9. Test or replace the component: M98 Intake Manifold Runner Valve Actuator

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: [Diagnostic Repair Verification](#)

- Refer to [Intake Manifold Cleaning and Inspection](#) - M98 Intake Manifold Runner Valve Actuator
- Refer to [Intake Manifold Replacement](#) - M98 Intake Manifold Runner Valve Actuator
- For control module replacement, programming, and setup refer to: [Control Module References](#)

DTC P2122, P2123, P2127, P2128, OR P2138: ACCELERATOR PEDAL POSITION (APP) SENSORS 1-2

Diagnostic Instructions

- Perform the Diagnostic System Check prior to using this diagnostic procedure: [Diagnostic System Check - Vehicle](#)
- Review the description of Strategy Based Diagnosis: [Strategy Based Diagnosis](#)
- An overview of each diagnostic category can be found here: [Diagnostic Procedure Instructions](#)

DTC Descriptor

DTC P2122

Accelerator Pedal Position (APP) Sensor 1 Circuit Low Voltage

DTC P2123

Accelerator Pedal Position (APP) Sensor 1 Circuit High Voltage

DTC P2127

Accelerator Pedal Position (APP) Sensor 2 Circuit Low Voltage

DTC P2128

Accelerator Pedal Position (APP) Sensor 2 Circuit High Voltage

DTC P2138

Accelerator Pedal Position (APP) Sensors 1-2 Not Plausible

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5V Reference - APP Sensor 1	P0193, P06A3, P127D	P2122, P2138	P0193, P06A3, P127D	P2138
Signal - APP Sensor 1	P2138	P2122, P2138	P2123	P2138
Low Reference - APP Sensor 1	-	P2138	-	P2138
5V Reference - APP Sensor 2	P0697	P2127, P2138	P0697	P2138
Signal - APP Sensor 2	P2127	P2127, P2138	P2128	P2138
Low Reference - APP Sensor 2	-	P2128, P2138	-	P2138

Typical Scan Tool Data

APP Sensor 1

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine = Idling Parameter Normal Range: 0.8 to 1.1 V			

Circuit	Short to Ground	Open	Short to Voltage
5 V Reference	0 V	0 V	2 to 3 V
Signal	0 V	0 V	4 to 5 V
Low Reference	-	4 to 5 V	-

APP Sensor 2

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine = Idling Parameter Normal Range: 0.4 to 0.6 V			
5 V Reference	0 V	0 V	1 to 3 V
Signal	0 V	0 V	2 to 5 V
Low Reference	-	4 to 5 V	-

Circuit/System Description

Circuit	Description
5 V Reference	Regulated voltage supplied by the control module.
Signal	The control module input circuit has an internal resistance connected to ground.
Low Reference	Grounded through the control module.

Component	Description
B107 Accelerator Pedal Position Sensor	The pedal assembly contains 2 potentiometer-type accelerator pedal position sensors, which are not serviceable. When the accelerator pedal is pressed, the voltage of one sensor goes up and the voltage of the other sensor goes down. This redundant design enables the control module to detect if the 2 signals indicate the same accelerator pedal position.
K20 Engine Control Module	The control module contains a microprocessor used to process input data to control outputs. The control module controls a series of actuators to ensure optimal engine performance. The control module does this by reading values from a variety of sensors, interprets the data and adjusts the engine actuators accordingly.

Conditions for Running the DTC

DTC P2122, P2123, P2127, P2128

- DTC P0697, P06A3 = Not set
- Ignition = On or Engine Running
- Ignition Voltage = Greater than 6.4 V
- Frequency the DTC runs = Continuously - After the running conditions are met

P2138

- DTC P0697, P06A3, P2122, P2123, P2127, P2128 = Not set
- Ignition Voltage = Greater than 6.4 V
- Reduced Engine Power = Inactive
- Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

P2122

APP Sensor 1 = Less than 0.46 V - For greater than 175 ms

P2123

APP Sensor 1 = Greater than 4.75 V - For greater than 175 ms

P2127

APP Sensor 2 = Less than 0.33 V - For greater than 175 ms

P2128

APP Sensor 2 = Greater than 2.6 V - For greater than 175 ms

P2138

- APP Sensor 1 and 2 Disagree = Greater than 5-10% Between Ranges - For greater than 188 ms
or
- APP Sensor 1, 2 Learned Released Position Disagree = Greater than 0.3 V - For greater than 188 ms

Action Taken When the DTC Sets

- DTCs listed in the DTC Descriptor Category = Type A DTC
- ECM commands the throttle actuator control (TAC) system to operate in a Reduced Engine Power mode.
- A message and/or warning indicator may be displayed to the driver.
- Under certain conditions, the control module commands the engine Off.

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type A DTC

Diagnostic Aids

- A high resistance condition on the component circuits may cause a DTC to set.
- Ensure that the inline harness connector seals are installed correctly. Incorrect installation could result in water intrusion into the connector and may cause a DTC to set.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References

Circuit/System Verification

1. Ignition - On/Vehicle - In Service Mode

2. Verify DTC P0697, P06A3 is not set.

- **If any of the DTCs are set**

Refer to: **DTC P0641, P0651, P0697, or P06A3**

- **Go to next step: If none of the DTCs are set**

3. Verify the scan tool parameter:

- APP Sensor 1 = 0.8 to 4.5 V - The value should not spike or drop out while moving the sensor through the entire range.
- APP Sensor 2 = 0.4 to 2.5 V - The value should not spike or drop out while moving the sensor through the entire range.
- **If not in the specified range or does not change**

Refer to: Circuit/System Testing

- **Go to next step: If in the specified range and changes**

4. Verify the scan tool parameter:

- APP Sensor 1 = The value should not spike or drop out.
- APP Sensor 2 = The value should not spike or drop out.
- Perform the action while monitoring the parameter:
- Wiggle the harness and connector: B107 Accelerator Pedal Position Sensor
- Wiggle the harness and connector: K20 Engine Control Module
- **If the value spikes or drops out**

Repair as necessary - Wiring/Terminal (s)/Electrical Connector (s)

- **Go to next step: If the value does not spike or drop out**

5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Verify the DTC does not set.

- **If the DTC sets**

Refer to: Circuit/System Testing

- **Go to next step: If the DTC does not set**

6. All OK.

Circuit/System Testing

NOTE: It may take up to 2 min for all vehicle systems to power down before an accurate ground or low reference circuit continuity test can be performed.

1. Ignition/Vehicle & All vehicle systems - Off

2. Disconnect the electrical connector: B107 Accelerator Pedal Position Sensor

3. Test for less than 5 ohms between the test points:

- {APP Sensor 1} Low Reference circuit terminal 4 & Ground
- {APP Sensor 2} Low Reference circuit terminal 5 & Ground
- **If 5 ohms or greater**

1. Disconnect the electrical connector: K20 Engine Control Module

2. Test for less than 2 ohms between the test points:

- {APP Sensor 1} Low Reference circuit terminal 4 @ Component harness & The other end of the circuit @ Control module harness

- {APP Sensor 2} Low Reference circuit terminal 5 @ Component harness & The other end of the circuit @ Control module harness
 - If 2 ohms or greater - Repair the open/high resistance in the circuit.
 - If less than 2 ohms - Replace the component: K20 Engine Control Module
 - **Go to next step: If less than 5 ohms**
4. Ignition - On/Vehicle - In Service Mode
5. Test for 4.8 to 5.2 V between the test points:
- {APP Sensor 1} 5 V Reference circuit terminal 2 & Low Reference circuit terminal 4
 - {APP Sensor 2} 5 V Reference circuit terminal 1 & Low Reference circuit terminal 5
 - **If less than 4.8 V**
1. Ignition/Vehicle - Off
 2. Disconnect the electrical connector: K20 Engine Control Module
 3. Test for infinite resistance between the test points:
 - 5 V Reference circuit terminal 2 @ Component harness & Ground
 - 5 V Reference circuit terminal 1 @ Component harness & Ground
 - If less than infinite resistance - Repair the short to ground on the circuit.
 - If infinite resistance
 4. Test for less than 2 ohms between the test points:
 - 5 V Reference circuit terminal 2 @ Component harness & The other end of the circuit @ Control module harness
 - 5 V Reference circuit terminal 1 @ Component harness & The other end of the circuit @ Control module harness
 - If 2 ohms or greater - Repair the open/high resistance in the circuit.
 - If less than 2 ohms - Replace the component: K20 Engine Control Module
 - **If greater than 5.2 V**
1. Ignition/Vehicle - Off
 2. Disconnect the electrical connector: K20 Engine Control Module
 3. Ignition - On/Vehicle - In Service Mode
 4. Test for less than 1 V between the test points:
 - 5 V Reference circuit terminal 2 @ Component harness & Ground
 - 5 V Reference circuit terminal 1 @ Component harness & Ground
 - If 1 V or greater - Repair the short to voltage on the circuit.
 - If less than 1 V - Replace the component: K20 Engine Control Module
 - **Go to next step: If between 4.8 and 5.2 V**
6. Verify the scan tool parameter:
- APP Sensor 1 = Less than 0.2 V
 - APP Sensor 2 = Less than 0.2 V
 - **If 0.2 V or greater**
1. Ignition/Vehicle - Off
 2. Disconnect the electrical connector: K20 Engine Control Module
 3. Ignition - On/Vehicle - In Service Mode
 4. Test for less than 1 V between the test points:
 - {APP Sensor 1} Signal circuit terminal 3 @ Component harness & Ground
 - {APP Sensor 2} Signal circuit terminal 6 @ Component harness & Ground
 - If 1 V or greater - Repair the short to voltage on the circuit.
 - If less than 1 V - Replace the component: K20 Engine Control Module
 - **Go to next step: If less than 0.2 V**
7. Connect a 3 A fused jumper wire between the test points:
- {APP Sensor 1} Signal circuit terminal 3 & 5 V Reference circuit terminal 2

- {APP Sensor 2} Signal circuit terminal 6 & 5 V Reference circuit terminal 1
8. Verify the scan tool parameter: = Greater than 4.7 V
 - **If 4.7 V or less**
 1. Ignition/Vehicle - Off & Remove - Jumper wire (s)
 2. Disconnect the electrical connector: K20 Engine Control Module
 3. Test for infinite resistance between the test points:
 - {APP Sensor 1} Signal circuit terminal 3 @ Component harness & Ground
 - {APP Sensor 2} Signal circuit terminal 6 @ Component harness & Ground
 - If less than infinite resistance - Repair the short to ground on the circuit.
 - If infinite resistance
 4. Test for less than 2 ohms between the test points:
 - {APP Sensor 1} Signal circuit terminal 3 @ Component harness & The other end of the circuit @ Control module harness
 - {APP Sensor 2} Signal circuit terminal 6 @ Component harness & The other end of the circuit @ Control module harness
 - If 2 ohms or greater - Repair the open/high resistance in the circuit.
 - If less than 2 ohms - Replace the component: K20 Engine Control Module
 - **Go to next step: If greater than 4.8 V**
 9. Test or replace the component: B107 Accelerator Pedal Position Sensor

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: [Diagnostic Repair Verification](#)

- Refer to [Accelerator Pedal Position Sensor Replacement](#) - B107 Accelerator Pedal Position Sensor
- For control module replacement, programming, and setup refer to: [Control Module References](#)

DTC P2147, P2148, P2150, OR P2151: INJECTOR HIGH CONTROL CIRCUIT GROUP 1-2 LOW/HIGH VOLTAGE

Diagnostic Instructions

- Perform the [Diagnostic System Check - Vehicle](#) prior to using this diagnostic procedure.
- Review [Strategy Based Diagnosis](#) for an overview of the diagnostic approach.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptors

DTC P2147

Injector High Control Circuit Group 1 Low Voltage

DTC P2148

Injector High Control Circuit Group 1 High Voltage

DTC P2150

Injector High Control Circuit Group 2 Low Voltage

DTC P2151

Injector High Control Circuit Group 2 High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
---------	-----------------	----------------------	------------------	--------------------

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Cylinder 1 Fuel Injector High Voltage Supply	P2147	P0201	P2148	P1248*
Cylinder 2 Fuel Injector High Voltage Supply	P2150	P0202	P2151	P1249*
Cylinder 3 Fuel Injector High Voltage Supply	P2150	P0203	P2151	P124A*
Cylinder 4 Fuel Injector High Voltage Supply	P2147	P0204	P2148	P124B*
Cylinder 1 Fuel Injector High Voltage Control	P0261	P0201	P0262, P2148	P1248*
Cylinder 2 Fuel Injector High Voltage Control	P0264	P0202	P0265, P2151	P1249*
Cylinder 3 Fuel Injector High Voltage Control	P0267	P0203	P0268, P2151	P124A*
Cylinder 4 Fuel Injector High Voltage Control	P0270	P0204	P0271, P2148	P124B*
* Short from Supply Circuit to Control Circuit				

Circuit/System Description

The engine control module (ECM) supplies voltage to each fuel injector on the injector positive voltage control circuits. The ECM energizes each fuel injector by grounding the control circuit of that fuel injector. The ECM monitors the status of the injector positive voltage control circuits and the fuel injector control circuits. The injectors are separated into the following two groups:

- Group 1 - Injectors 1 and 4
- Group 2 - Injectors 2 and 3

When a fuel injector circuit condition is detected by the ECM, the affected fuel injector will be disabled and may disable the affected group of fuel injectors.

Conditions for Running the DTC

- The engine is running.
- The ignition voltage is greater than 11 V.
- The DTCs run continuously when the above conditions are met.

Conditions for Setting the DTC

The ECM detects that the commanded state of the driver and the actual state of the control circuit do not match for greater than 0.5 s.

Action Taken When the DTC Sets

DTC P2147, P2148, P2150 and P2151 are Type A DTCs.

Conditions for Clearing the DTC

DTC P2147, P2148, P2150 and P2151 are Type A DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Powertrain Component Views

Description and Operation

Fuel System Description

Electrical Information Reference

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

[Control Module References](#) for scan tool information

Circuit/System Verification

1. Engine running, verify with a scan tool that DTCs P0201, P0202, P0203 or P0204 are not set.
 - **If DTCs P0201, P0202, P0203 or P0204 are set**
Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) .
 - **Go to next step: If DTCs P0201, P0202, P0203 or P0204 are not set**
2. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
 - **If DTC P2147, P2148, P2150, or P2151 is set**
Refer to Circuit/System Testing
 - **Go to next step: If DTC P2147, P2148, P2150, or P2151 is not set**
3. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems off.
2. It may take up to 2 min for all vehicle systems to power down.
3. Disconnect the harness connector at the appropriate Q17 Fuel Injector.
4. Ignition ON.
5. Test for 4.5 - 6.5 V between the high voltage supply circuit terminal 1 and ground.
 - **If less than 4.5 V**
 1. Ignition OFF.
 2. Disconnect the X2 harness connector at the K20 Engine Control Module.
 3. Test for infinite resistance between the supply circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 4. Test for less than 2 Ω in the supply circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **If greater 6.5 V**
 1. Ignition OFF.

2. Disconnect the harness connector X2 at the K20 Engine Control Module, Ignition ON.
3. Test for less than 1 V between the high voltage supply circuit terminal 1 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.
- **Go to next step: If between 4.5 - 6.5 V**
6. Test for 0.60 - 0.80 V between the high voltage control circuit terminal 2 and ground.
 - **If less than 0.60 V**
 1. Ignition OFF.
 2. Disconnect the harness connector X2 at the K20 Engine Control Module.
 3. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 4. Test for less than 2 Ω in the control circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **If greater than 0.80 V**
 1. Ignition OFF.
 2. Disconnect the harness connector X2 at the K20 Engine Control Module, Ignition ON.
 3. Test for less than 1 V between the control circuit terminal 2 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.
 - **Go to next step: If between 0.60 - 0.80 V**
7. Test or replace the appropriate Q17 Fuel Injector.

Component Testing

Static Test

1. Ignition OFF.
2. Disconnect the harness connector at the appropriate Q17 Fuel Injector.

NOTE: The DMM and test leads must be calibrated to 0 Ω in order to prevent misdiagnosis.

3. Test for 0.2 - 1.5 Ω between the supply terminal 1 and the control terminal 2.
 - **If not between 0.2 - 1.5 Ω**

Replace the appropriate Q17 Fuel Injector.
 - **Go to next step: If between 0.2 - 1.5 Ω**
4. Test for infinite resistance between each terminal and the injector housing/case.
 - **If less than infinite resistance**

Replace the appropriate Q17 Fuel Injector.
 - **Go to next step: If infinite resistance**
5. All OK

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

- Refer to [Fuel Injector Replacement](#)
- Refer to [Control Module References](#) for Engine Control Module replacement, programming and setup.

DTC P214E: REDUCTANT PUMP HIGH CURRENT

Diagnostic Instructions

- Perform the [Diagnostic System Check - Vehicle](#) prior to using this diagnostic procedure.
- Review [Strategy Based Diagnosis](#) for an overview of the diagnostic approach.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptors

DTC P214E

Reductant Pump High Current

Circuit/System Description

The selective catalytic reduction system reduces oxides of nitrogen (NOx) emissions by injecting a metered amount of reductant into the exhaust gas stream entering the selective catalytic reduction catalyst. Within the selective catalytic reduction catalyst, the reductant reacts with the NOx to form nitrogen, carbon dioxide, and water vapor. Upstream and downstream NOx sensors provides the engine control module and the reductant control module via serial data. The reductant control module varies the amount of reductant added by varying the reductant injector duty cycle in response to changes in engine-out NOx levels. The reductant control module supplies system voltage to the reductant pump motor. The reductant control module controls the solenoid by grounding the control circuit. The reductant control module can determine if the control circuit is open, shorted to ground, or shorted to a voltage by monitoring the feedback voltage.

Conditions for Running the DTC

- DTC U010E is not set.
- Ignition On or engine running.
- The battery voltage is greater than 11 V.

The DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

The reductant control module detects that the reductant pump motor current is too high.

Action Taken When the DTC Sets

DTC P214E is a Type A DTC.

Conditions for Clearing the DTC

DTC P214E is a Type A DTC.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References

Circuit/System Verification

1. Ignition On
2. Verify that DTC P214E is not set.
 - **If the DTC Is set**

Refer to Circuit/System Testing.
 - **Go to next step: If the DTC is not set**
3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
4. Verify that the DTC does not set.
 - **If the DTC sets**

Refer to Circuit/System Testing
 - **Go to next step: If the DTC does not set**
5. All OK.

Circuit/System Testing

1. Ignition Off, disconnect the X1 harness connector at the A38 Reductant Pump and Sensor Assembly. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 Ω between the low reference circuit terminal 15 and ground.
 - **If 10 Ω or greater**
 1. Ignition Off.
 2. Test for less than 2 Ω at the circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K115 Reductant Control Module.
 - **Go to next step: If less than 10 Ω**
3. Disconnect the X2 harness connector at the K115 Reductant Control Module.
4. Test for less than 2 Ω between the terminals listed below:
 - A38 Reductant Pump and Sensor Assembly harness connector terminal 16 and K115 Reductant Control Module harness connector terminal 1
 - A38 Reductant Pump and Sensor Assembly harness connector terminal 8 and K115 Reductant Control Module harness connector terminal 2
 - A38 Reductant Pump and Sensor Assembly harness connector terminal 7 and K115 Reductant Control Module harness connector terminal 3
 - **If greater than 2 Ω**

Repair the open/high resistance in the appropriate circuit.
 - **Go to next step: If less than 2 Ω**
5. Ignition Off, test for infinite resistance between each control circuit and ground.
 - **If less than infinite resistance**

Repair the short to ground at the appropriate circuit.
 - **Go to next step: If infinite resistance**
6. Ignition On, test for less than 1 V between each control circuit and ground.

- If 1 V or greater

Repair the short to voltage on the appropriate circuit.

- **Go to next step: If less than 1 V**

7. Replace the A38 Reductant Pump and Sensor Assembly.
8. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
9. Verify the DTC does not set.

- **If the DTC sets**

Replace the K115 Reductant Control Module

- **Go to next step: If the DTC does not set**

10. All OK.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

Perform the [Service Bay Test](#) after completing the repair to clear the Service Emission System or Service Exhaust Fluid System warning message, if displayed.

- Refer to [Emission Reduction Fluid Supply Pump Module Replacement](#)
- Refer to [Emission Reduction Fluid Tank Replacement](#) for reductant pump and sensor assembly replacement.

DTC P2199: INTAKE AIR TEMPERATURE (IAT) SENSOR 1-2 NOT PLAUSIBLE

Diagnostic Instructions

- Perform the [Diagnostic System Check - Vehicle](#) prior to using this diagnostic procedure.
- Review [Strategy Based Diagnosis](#) for an overview of the diagnostic approach.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptor

DTC P2199

Intake Air Temperature (IAT) Sensor 1-2 Not Plausible

Diagnostic Fault Information

IAT Sensor 1

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P0112, P2199	P0113, P2199	P0111*, P0113*, P0114, P2199	P0111*, P2199
Low Reference	-	P0097, P00F4, P0113, P227D	P0113*, P0114	-
* Internal ECM or sensor damage may occur if the circuit is shorted to B+.				

IAT Sensor 2 and Intake Air Humidity

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition Voltage	P0096, P0097, P00F4, P0102, P2199	P0096, P0097, P00F4, P0102, P2199	-	P0096
Signal	P0097, P00F5, P2199	P0097, P00F4, P2199	P0097*, P00F4*, P2199*	P0096
Ground	-	P0102	-	P0096
* Internal ECM or sensor damage may occur if the circuit is shorted to B+.				

Typical Scan Tool Data

IAT Sensor 1

Circuit	Short to Ground	Open or High Resistance	Short to Voltage
Operating Conditions: Engine Running Parameter Normal Range: Varies with ambient temperature			
Signal	150Â°C (302Â°F)	-40Â°C (-40Â°F)	-40Â°C (-40Â°F)*
Low Reference	-	-40Â°C (-40Â°F)	-40Â°C (-40Â°F)*
* Internal ECM or sensor damage may occur if the circuit is shorted to B+			

IAT Sensor 2 and Intake Air Humidity

Circuit	Short to Ground	Open or High Resistance	Short to Voltage
Operating Conditions: Engine Running Parameter Normal Range: Varies with ambient humidity, temperature, and engine bay conditions			
Ignition Voltage	-40Â°C (-40Â°F) 10 Hz 0%	-40Â°C (-40Â°F) 10 Hz 0%	-
Signal	-40Â°C (-40Â°F) 10 Hz 100%	-40Â°C (-40Â°F) 10 Hz 0%	-40Â°C (-40Â°F) 10 Hz* 0%
Ground	-	-40Â°C (-40Â°F) 10 Hz 0%	-
* Internal ECM or sensor damage may occur if the circuit is shorted to B+			

Circuit/System Description

The intake air temperature (IAT) sensor 1 is a variable resistor that measures the temperature of the air in the sensor bore. The engine control module (ECM) supplies 5 V to the IAT sensor 1 signal circuit and a ground for the IAT sensor 1 low reference circuit. The signal varies with inlet air temperature and is displayed by the scan tool as Â°C (Â°F).

The IAT sensor 2 produces a frequency signal, based on the inlet air temperature, which is equal to the humidity present within the sensor bore. The signal varies with inlet air temperature and is displayed by the scan tool as Â°C (Â°F) and Hertz (Hz) and the relative humidity is displayed in percent (%). The ECM supplies a regulated voltage to the signal circuit. The signal circuit is shared by the IAT sensor 2 and the humidity sensor. Ignition voltage and ground circuits are also supplied to the multifunction intake air sensor's internal circuits for these sensors:

- IAT sensor 2

- Humidity sensor
- MAF sensor

The multifunction intake air sensor houses the following:

- IAT sensor 1
- IAT sensor 2
- Humidity sensor
- MAF sensor
- Turbocharger inlet air pressure (TCIAP) sensor (BARO 2)

IAT Sensor 1 - Temperature, Resistance, Voltage Table

IAT Sensor 1	IAT Sensor 1 Resistance	IAT Sensor 1 Signal Voltage
Cold	High	High
Warm	Low	Low

IAT Sensor 2 - Temperature, Frequency Table

IAT Sensor 2	IAT Sensor 2 Frequency	IAT Sensor 2 Temperature
Cold	45 Hz	-40Â°C (-40Â°F)
Warm	302 Hz	104Â°C (219Â°F)

Conditions for Running the DTC

- The ignition is ON.
- Ignition 1 voltage is at least 11 V.
- This DTC runs continuously within the enabling conditions.

Conditions for Setting the DTC

The ECM detects that the absolute difference between the IAT sensor 1 and the IAT sensor 2 temperatures is greater than 55Â°C (99Â°F) for longer than 5 s.

Action Taken When the DTC Sets

DTC P2199 is a Type B DTC.

Conditions for Clearing the MIL/DTC

DTC P2199 is a Type B DTC.

Diagnostic Aids

- With the ignition ON, the engine OFF, if the engine is cold, a properly functioning IAT sensor 2 will gradually increase the scan tool IAT Sensor 2 parameter. This is due to the heat that is generated by the multifunction intake air sensor heating elements.
- The humidity sensor and the IAT sensor 2 signals are sent to the ECM on the same circuit. If the IAT Sensor 2 parameter displays the values: 10 Hz; -40Â°C (-40Â°F), and there are Humidity Sensor DTCs, check for a circuit problem.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Powertrain Component Views

Powertrain Component Views

Electrical Information Reference

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

Powertrain Component Views

Powertrain Component Views

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

[Control Module References](#) for scan tool information

Special Tools

EL-38522-A Variable Signal Generator

For equivalent regional tools, refer to [Special Tools \(Diagnostic Tools\)](#) [Special Tools \(Mechanical Tools\)](#).

Circuit/System Verification

1. Ignition On.
2. Verify that DTC P0097, P0098, P0099, P00F4, P00F5, P00F6, P0102, P0103, P0112, P0113, P0114, P0641, P0651, P0697, or P06A3 is not set.

- **If any of the DTCs are set**

Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) for further diagnosis.

- **Go to next step: If none of the DTCs are set**

NOTE: To minimize the effects of residual engine heat and sensor internal heating elements, perform Steps 3 and 4 of this verification procedure only if the ignition has been OFF for 8 hours or more.

3. Ignition ON.
4. Verify the following scan tool parameters are within 55Â°C (99Â°F) of each other.
 - Start-Up IAT Sensor 1
 - Start-Up IAT Sensor 2
 - Start-Up IAT Sensor 3
 - **If not within 55Â°C (99Â°F)**

Refer to Circuit/System Testing.

 - **Go to next step: If within 55Â°C (99Â°F)**
5. Engine running, verify the following scan tool parameters are between: -38 and +149Â°C (-36 and +300Â°F).
 - IAT Sensor 1
 - IAT Sensor 2
 - **If not between: -38 and +149Â°C (-36 and +300Â°F)**

Refer to Circuit/System Testing.

- **Go to next step: If between: -38 and +149Â°C (-36 and +300Â°F)**
6. Operate the vehicle within the conditions for running the DTC. You may also operate the vehicle within the conditions that you observed from the freeze frame/failure records data.
 7. Verify the DTC does not set.
 - **If the DTC sets**

Refer to Circuit/System Testing.
 - **Go to next step: If the DTC does not set**
 8. All OK

Circuit/System Testing

NOTE: You must perform the Circuit/System Verification before proceeding with Circuit/System Testing.

1. Check the integrity of the entire air induction system and verify that none of the following conditions exist:
 - A restricted or collapsed air intake duct
 - An intake manifold leak
 - A misaligned or damaged air intake duct
 - Any water intrusion in the induction system
 - **If a condition exists**

Repair or replace component as appropriate.
 - **Go to next step: If no condition exists**
2. Ignition Off, and all vehicle systems Off, it may take up to 2 min. for all vehicle systems to power down. Disconnect the harness connector at the B75C Multifunction Intake Air sensor.
3. Test for less than 5 Ω between the low reference circuit terminal 3 and ground.
 - **If 5 Ω or greater**
 1. Disconnect the harness connector X1 at the K20 Engine Control Module.
 2. Test for less than 2 Ω in the low reference circuit end to end.
 - If 2 Ω or greater, repair the open or high resistance in the circuit.
 - If less than 2 Ω replace the K20 Engine Control Module.
 - **Go to next step: If less than 5 Ω**
4. Test for less than 5 Ω between the ground circuit terminal 7 and ground.
 - **If 5 Ω or greater**
 1. Ignition Off.
 2. Test for less than 2 Ω in the ground circuit end to end.
 - If 2 Ω or greater, repair the open or high resistance in the circuit.
 - If less than 2 Ω , repair the open/high resistance in the ground connection.
 - **Go to next step: If less than 5 Ω**
5. Ignition On.
6. Verify the scan tool IAT Sensor 1 parameter is colder than -39Â°C (-38Â°F).
 - **If warmer than -39Â°C (-38Â°F).**
 1. Ignition Off, disconnect the harness connector X1 at the K20 Engine Control Module.
 2. Test for infinite resistance between the signal circuit terminal 1 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K20 Engine Control Module.
 - **Go to next step: If colder than -39Â°C (-38Â°F).**
7. Ignition Off, install a 3 A fused jumper wire between the IAT 1 signal circuit terminal 1 and the low reference circuit terminal 3.

8. Ignition On.

9. Verify the scan tool IAT Sensor 1 parameter is warmer than 148Â°C (298Â°F).

- **If colder than 148Â°C (298Â°F).**

1. Ignition Off, remove the jumper wire, disconnect the harness connector X1 at the K20 Engine Control Module.

2. Ignition On.

3. Test for less than 1 V between the signal circuit and ground.

- If 1 V or greater, repair the short to voltage on the circuit.
- If less than 1 V

4. Ignition Off.

5. Test for less than 2 Ω in the signal circuit end to end.

- If 2 Ω or greater, repair the open/high resistance in the circuit.
- If less than 2 Ω, replace the K20 Engine Control Module.

- **Go to next step: If warmer than 148Â°C (298Â°F).**

NOTE: The intake air temperature sensor 2 signal circuit is pulled up with low current voltage within the controller. Normally, a voltage can be measured on the circuit with a DMM, but the current will not be high enough to illuminate a test lamp.

10. Verify the scan tool Intake Air Humidity Sensor parameter is less than 1%.

- **If 1% or greater**

1. Ignition Off, disconnect the harness connector X3 at the K20 Engine Control Module.

2. Test for infinite resistance between the IAT 2 signal circuit terminal 8 and ground.

- If less than infinite resistance, repair the short to ground on the circuit.
- If infinite resistance, replace the K20 Engine Control Module.

- **Go to next step: If less than 1%**

11. Ignition Off, install a 3 A fused jumper wire between the IAT 2 signal circuit terminal 8 and the low reference circuit terminal 3.

12. Ignition On.

13. Verify the scan tool Intake Air Humidity Sensor parameter is greater than 99%.

- **If 99% or less**

NOTE: If the signal circuit is shorted to a voltage the engine control module or the sensor may be damaged.

1. Ignition Off, remove the jumper wire and disconnect the harness connector X3 at the K20 Engine Control Module.

2. Ignition On.

3. Test for less than 1 V between the IAT 2 signal circuit terminal 8 and ground.

- If 1 V or greater, repair the short to voltage on the circuit.
- If less than 1 V.

4. Ignition Off.

5. Test for less than 2 Ω in the signal circuit end to end.

- If 2 Ω or greater, repair the open/high resistance in the circuit.
- If less than 2 Ω, replace the K20 Engine Control Module.

- **Go to next step: If greater than 99%**

14. Test or replace the B75C Multifunction Intake Air sensor.

Component Testing

Multifunction Intake Air Sensor

1. Ignition Off, disconnect the harness connector at the B75C Multifunction Intake Air Sensor.
2. Connect a DMM between the IAT sensor 1 signal terminal 1 and the low reference terminal 3.

NOTE: A thermometer can be used to test the sensor off the vehicle.

3. Test the IAT sensor 1 by varying the sensor temperature while monitoring the sensor resistance. Compare the readings with the Temperature Versus Resistance - Intake Air Temperature Sensor table. The resistance values should be in range of the table values.
 - **If not within the specified range**
Replace the B75C Multifunction Intake Air Sensor.
 - **Go to next step: If within the specified range**
4. All OK.

Multifunction Intake Air Sensor

1. Test the IAT Sensor 2 by varying the sensor temperature while monitoring the air temperature with a thermometer. Compare the readings with the scan tool IAT Sensor 2 parameter. The values should be within 5%.
 - **If not within the specified range**
Replace the B75C Multifunction Intake Air Sensor.
 - **Go to next step: If within the specified range**
2. All OK.

Circuit Testing with EL-38522-A

NOTE: In-correct diagnosis will result if Circuit/System Testing is not completed before performing the following test.

1. Perform the following test using a **EL-38522-A** Variable Signal Generator or equivalent, if available.
2. Ignition Off, connect the leads of the **EL-38522-A** Variable Signal Generator as follows:
 1. Red lead to the IAT 2 signal circuit terminal 8 at the harness connector
 2. Black leads to ground
 3. Battery voltage supply lead to B+
3. Set the **EL-38522-A** Variable Signal Generator to the following specifications.
 - Signal switch to 5 V
 - Duty Cycle switch to 50% (Normal)
 - Frequency switch to 250 Hz
4. Ignition On.
5. Verify the scan tool IAT Sensor 2 parameters listed below are within the ranges listed below:
 - IAT Sensor 2 is between 248 - 252 Hz

NOTE: Changing the frequency should cause a warmer or colder IAT 2 temperature.

- IAT Sensor 2 is between 70 - 76Â°C (160 - 166Â°F)

NOTE: Increasing or decreasing the duty cycle should have an inverse affect on humidity.

- Intake Air Humidity Sensor is between 48 - 52%
- **If a parameter is not within the specified range**
 1. Ignition Off, disconnect the harness connector X3 at the K20 Engine Control Module.

2. Test for less than 2 Ω in the signal circuit end to end.

- If 2 Ω or greater, repair the open/high resistance in the circuit.
- If less than 2 Ω , replace the K20 Engine Control Module.

• **Go to next step: If all the parameters are within the specified range**

6. All OK.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

- Refer to [Mass Airflow Sensor Replacement](#) for multifunction intake air sensor replacement
- Refer to [Control Module References](#) for engine control module replacement, programming, and setup.

DTC P21CB: REDUCTANT CONTROL MODULE SUPPLY VOLTAGE LOW VOLTAGE

Diagnostic Instructions

- Perform the [Diagnostic System Check - Vehicle](#) prior to using this diagnostic procedure.
- Review [Strategy Based Diagnosis](#) for an overview of the diagnostic approach.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptors

DTC P21CB

Reductant Control Module Supply Voltage Low Voltage

Circuit/System Description

The selective catalytic reduction system reduces oxides of nitrogen (NOx) emissions by injecting a metered amount of reductant into the exhaust gas stream entering the selective catalytic reduction catalyst. Within the selective catalytic reduction catalyst, the reductant reacts with the NOx to form nitrogen, carbon dioxide, and water vapor. Upstream and downstream NOx sensors provides the engine control module and the reductant control module via serial data. The engine control module (ECM) controls the reductant injector duty cycle in response to changes in engine-out NOx levels. The reductant control module supplies system voltage to the reductant pump motor. The reductant control module controls the solenoid by grounding the control circuit. The reductant control module can determine if the control circuit is open, shorted to ground, or shorted to a voltage by monitoring the feedback voltage.

Conditions for Running the DTC

- DTC U010E is not set.
- The ignition voltage is greater than 11 V.
- The ignition ON.
- The engine is not cranking.

The DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

The reductant control module supply voltage is less than a calibrated value for greater than 5 s.

Action Taken When the DTC Sets

- DTC P21CB is a Type B DTC.

Conditions for Clearing the DTC

- DTC P21CB is a Type B DTC.

Reference Information

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

[Control Module References](#) for scan tool information

Circuit/System Verification

1. Ignition On
2. Verify that no module communication DTCs are set.
 - **If any other DTCs are set**
Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) .
 - **Go to next step: If no other DTCs are set**
3. Verify that DTC P21CB is not set.
 - **If a DTC Is set**
Refer to Circuit/System Testing.
 - **Go to next step: If no DTC is set**
4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
5. Verify that DTC P21CB is not set.
 - **If a DTC sets**
Refer to Circuit/System Testing
 - **Go to next step: If a DTC does not set**
6. All OK.

Circuit/System Testing

1. Ignition Off, disconnect the X1 harness connector at the K115 Reductant Control Module. Ignition ON.
2. Verify that a test lamp illuminates between the module ignition voltage circuit terminal 5 and ground.
 - **If the test lamp does not illuminate**
 1. Ignition Off, remove the test lamp and remove fuse F18 from the X50A Underhood Fuse Block.
 2. Test for less than 2Ω in the module ignition voltage circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.

- If less than 2 Ω
3. Test for infinite resistance between the module ignition voltage circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 - **Go to next step: If the test lamp illuminates**
 3. Ignition ON, verify that a test lamp illuminates between the module ignition voltage circuit terminal 8 and ground.
 - **If the test lamp does not illuminate**
 1. Ignition Off, remove the test lamp and remove the KR121A Reductant Control Module Relay 1 from the X50A Underhood Fuse Block.
 2. Test for less than 2 Ω in the module ignition voltage circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω
 3. Test for infinite resistance between the module ignition voltage circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 - **Go to next step: If the test lamp illuminates**
 4. Replace the K115 Reductant Control Module.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

Refer to [Emission Reduction Fluid Controller Replacement](#)

DTC P220A OR P220B: NOX SENSOR 1-2 SUPPLY VOLTAGE CIRCUIT

Diagnostic Instructions

- Perform the [Diagnostic System Check - Vehicle](#) prior to using this diagnostic procedure.
- Review [Strategy Based Diagnosis](#) for an overview of the diagnostic approach.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptor

DTC P220A

NOx Sensor 1 Supply Voltage Circuit

DTC P220B

NOx Sensor 2 Supply Voltage Circuit

Circuit/System Description

The NOx sensors are part of the selective catalytic reduction system, a device used to reduce NOx emission on diesel engines. There are two NOx sensors, one placed upstream of selective catalytic reduction, to measure inlet NOx concentration, and one placed downstream. They are connected with the control module via CAN and all the information is exchanged through it. Since it is a smart sensor, all the electrical monitoring is performed inside the sensor and only the results are sent to the ECM. Each NOx sensor contains a sensing cell, a pumping cell, and a heater. A sample of exhaust gas passes through a diffusion gap between the sensing cell and the pumping cell. The NOx sensor maintains a constant reference voltage across the sensing cell. An electronic circuit within sensor controls the pump current through the pumping cell in order to maintain a constant voltage in the sensing cell. The amount of current required to maintain the reference voltage in the sensing cell is proportional to the concentration of NOx in the exhaust. The ECM varies the amount of diesel exhaust fluid (reductant) added by varying the reductant injector duty cycle in response to changes in engine exhaust NOx levels. The smart NOx sensors consist of two components, the NOx module and the NOx sensor element that are serviced as a unit. A circuit or performance condition with a NOx sensor is detected by the NOx

sensor module. The smart NOx sensor module communicates the condition to the ECM over the serial data line. The ECM sets a DTC when a serial data message is received from the NOx sensor module.

Conditions for Running the DTC

- DTC U029D or U029E is not set
- The reductant control module relay 2 is ON for greater than 1 s.
- The ignition voltage is greater than 11 V
- The NOx Sensor 1 or 2 Heater Operation parameter displays Allowed

The DTCs run continuously when the above conditions are met.

Conditions for Setting the DTC

The sensor supply voltage is less than 10.8 V.

Action Taken When the DTC Sets

DTCs P220A and P220B are Type B DTCs.

Conditions for Clearing the DTC

DTCs P220A and P220B are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, verify that no other DTCs are set.

- **If any other DTCs are set**

Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#)

- **Go to next step: If no other DTCs are set**

2. Verify that DTC P220A or P220B is not set

- **If the DTC is set**

Refer to Circuit/System Testing

- **Go to next step: If the DTC is not set**

3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
4. Verify the DTC does not set.
 - **If the DTC sets**

Refer to Circuit/System Testing
 - **Go to next step: If the DTC does not set**
5. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at appropriate the B195 Nitrogen Oxides Sensor.
2. Ignition ON, verify that a test lamp illuminates between the voltage circuit terminal 1 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF.
 2. Test for less than 2 Ω in the voltage circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF.
 2. Test for infinite resistance between the voltage circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the appropriate B195 Nitrogen Oxides Sensor.
 - **Go to next step: If the test lamp illuminates**
3. Replace the appropriate B195 Nitrogen Oxides Sensor.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

Refer to [Nitrogen Oxides Sensor Replacement - Position 1](#)

Refer to [Nitrogen Oxides Sensor Replacement - Position 2](#)

DTC P2227-P2230: BAROMETRIC PRESSURE (BARO) SENSOR

Diagnostic Instructions

- Perform the [Diagnostic System Check - Vehicle](#) prior to using this diagnostic procedure.
- Review [Strategy Based Diagnosis](#) for an overview of the diagnostic approach.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptors

DTC P2227

Barometric Pressure (BARO) Sensor Performance

DTC P2228

Barometric Pressure (BARO) Sensor Circuit Low Voltage

DTC P2229

Barometric Pressure (BARO) Sensor Circuit High Voltage

DTC P2230

Circuit/System Description

The barometric pressure (BARO) sensor is integrated within the engine control module (ECM). The BARO sensor responds to changes in altitude and atmospheric conditions. The BARO sensor provides the ECM an indication of barometric pressure. The BARO sensor provides a voltage signal to the ECM relative to the atmospheric pressure changes. The ECM monitors the BARO sensor signal for a voltage outside of the normal range.

Conditions for Running the DTC**P2227 Condition 1**

- Before the ECM can report that DTC P2227 failed, DTCs P0107, P0108, P2228, P2229, P227C, and P227D must run and pass.
- DTC P0106, P0107, P0108, P2228, P2229, P2230, P227C, P227D or P2610 is not set.
- The ignition is ON, engine OFF.
- The time between the current ignition cycle and the previous drive cycle is greater than 5 s.
- DTC P2227 runs continuously when the conditions above exist.

P2227 Condition 2

- DTC P0101, P0102, P0103, P0107, P0108, P0116, P0117, P0118, P0119, P0128, P0201, P0202, P0203, P0204, P020A, P020B, P020C, P020D, P0216, P02EE, P02EF, P02E8, P02E9, P02F0, P02F1, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0335, P0336, P062B, P062D, P111E, P122D, P1248, P1249, P124A, P124B, P126A, P16A0, P16A1, P16A2, P2147, P2148, P2150, P2151, P2228, P2229, P2230, P227C, P227D, or P227E is not set.
- The engine is operating.
- The ignition voltage is greater than 11 V.
- The engine speed is less than 1, 100 RPM.
- The intake airflow valve position is greater than 90%.
- The engine coolant temperature (ECT) is warmer than 70°C (158°F)
- DTC P2227 runs continuously when the conditions above exist.

P2228, P2229, or P2230

- The ignition is ON or the engine is operating.
- The DTCs run continuously when the conditions above exist.

Conditions for Setting the DTC**P2227 Condition 1**

The ECM detects that the BARO sensor pressure is less than 50 kPa (7.3 PSI) or greater than 115 kPa (16.7 PSI), for greater than 62.5 ms.

P2227 Condition 2

The ECM detects that the BARO sensor pressure is not within range of the calculated pressure that is derived from a system of models for greater than 5 s.

DTC P2228

The ECM detects that the BARO sensor pressure is less than 50 kPa (7.3 PSI) for greater than 5 s.

DTC P2229

The ECM detects that the BARO sensor pressure is greater than 115 kPa (16.7 PSI) for greater than 5 s.

DTC P2230

The ECM detects that the BARO sensor pressure signal had an accumulated variation, over a 13 m sample period, of greater than 100 kPa (14.5 PSI) for greater than 50 s.

Action Taken When the DTC Sets

DTC P2227, P2228, P2229, and P2230 are Type B DTCs.

Conditions for Clearing the DTC

DTC P2227, P2228, P2229, and P2230 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

[Control Module References](#) for scan tool information

Circuit/System Verification

1. Ignition On.
2. Verify that DTCs P0101, P0102, P0103, P0107, P0108, P0116, P0117, P0118, P0119, P0128, P0201, P0202, P0203, P0204, P020A, P020B, P020C, P020D, P0216, P02EE, P02EF, P02E8, P02E9, P02F0, P02F1, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0335, P0336, P062B, P062D, P111E, P122D, P1248, P1249, P124A, P124B, P126A, P16A0, P16A1, P16A2, P2147, P2148, P2150, P2151, P227C, P227D, or P227E are not set.

- **If any of the DTCs are set**

Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) for further diagnosis.

- **Go to next step: If none of the DTCs are set**

3. Ignition Off.

4. Inspect the atmospheric vent on the K20 Engine Control Module case for the conditions listed below:

1. Moisture in the vent inlet
2. Debris in the vent inlet

- **If a condition exists**

Attempt to clean or dry the atmospheric inlet.

- **Go to next step: If a condition does not exist**

5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the freeze frame/failure records data.

6. Verify that the DTC does not set.

- **If the DTC sets**

Replace the K20 Engine Control Module

- **Go to next step: If DTCs does not set**

7. All OK.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

Refer to [Control Module References](#) for Engine Control Module replacement, programming and setup.

DTC P2264: WATER IN FUEL SENSOR CIRCUIT

Diagnostic Instructions

- Perform the [Diagnostic System Check - Vehicle](#) prior to using this diagnostic procedure.
- Review [Strategy Based Diagnosis](#) for an overview of the diagnostic approach.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptors

DTC P2264

Water in Fuel Sensor Circuit

Circuit/System Description

The water in fuel sensor is located in the fuel filter housing. The water in fuel sensor has a signal circuit, and a low reference circuit. The engine control module (ECM) monitors the signal circuit for a predetermined voltage through serial data from the fuel pump driver control module.

Conditions for Running the DTC

- DTC P1103, P16D7, P16D8, P16D9, or P262B is not set.
- The engine is running.
- Ignition voltage is greater than 11 V.
- KR73 Ignition Main Relay is commanded On.
- Engine run time is greater than 6 m.
- Fuel pump driver control module supply voltage is greater than 11 V.
- The DTC runs continuously once above condition is met.

Conditions for Setting the DTC

The water in fuel sensor signal circuit voltage is outside the expected range for more than 1 s.

Action Taken When the DTC Sets

DTC P2264 is a Type C DTC.

Conditions for Clearing the DTC

DTC P2264 is a Type C DTC.

Reference Information

Schematic Reference

[Engine Controls Wiring Schematics 1.6L \(LH7\)](#)

Connector End View Reference

Component View Reference

Powertrain Component Views

Description and Operation

Fuel System Description

Electrical Information Reference

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

[Control Module References](#) for scan tool information

Circuit/System Verification

1. Ignition On.
2. Verify DTC P1103, P16D7, P16D8, P16D9 or P262B is not set.
 - **If DTC P1103, P16D7, P16D8, P16D9 or P262B is set**
Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) .
 - **Go to next step: If DTC P1103, P16D7, P16D8, P16D9 or P262B is not set**
3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed in the Freeze Frame/Failure Records data.
4. Verify that DTC P2264 is not set.
 - **If DTC P2264 is set**
Refer to Circuit/System Testing
 - **Go to next step: If DTC P2264 is not set**
5. All OK

Circuit/System Testing

1. Ignition Off, and all vehicle systems Off, disconnect the harness connector at the B116 Water in Fuel Sensor. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 5 Ω between the ground circuit terminal 2 and ground.
 - **If 5 Ω or greater**
Repair the open or high resistance in the ground circuit.
 - **Go to next step: If less than 5 Ω**
3. Ignition On.
4. Test for 4.8 - 5.2 V between the 5V reference circuit terminal 1 and ground.
 - **Go to next step: If less than 4.8 V**
 1. Ignition Off.
 2. Disconnect the harness connector at the K111 Fuel Pump Driver Control Module.
 3. Test for infinite resistance between the 5V reference circuit and ground.

- If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
4. Test for less than 2 Ω in the 5V reference circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K111 Fuel Pump Driver Control Module.
 - **Go to next step: If greater than 5.2 V**
 1. Ignition Off.
 2. Disconnect the harness connector at the K111 Fuel Pump Driver Control Module, Ignition On.
 3. Test for less than 1 V between the 5V reference and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K111 Fuel Pump Driver Control Module.
 - **Go to next step: If between 4.8 - 5.2 V**
 5. Verify the scan tool parameter Water in Fuel displays No.
 - **Go to next step: If parameter does not display No**
 1. Ignition Off.
 2. Disconnect the harness connector at the K111 Fuel Pump Driver Control Module.
 3. Test for infinite resistance between the signal circuit terminal 3 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K111 Fuel Pump Driver Control Module.
 - **Go to next step: If parameter displays No**
 6. Install a 3 A fused jumper wire between the signal circuit terminal 3 and low reference circuit terminal 2.
 7. Verify the scan tool parameter Water in Fuel displays Yes.
 - **If the parameter does not display Yes**
 1. Ignition Off, remove jumper wire.
 2. Disconnect the harness connector at the K111 Fuel Pump Driver Control Module.
 3. Ignition On.
 4. Test for less than 1 V between the signal circuit terminal 3 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 5. Ignition Off.
 6. Test for less than 2 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K111 Fuel Pump Driver Control Module.
 - **Go to next step: If the parameter displays Yes**
 8. Replace the B116 Water in Fuel Sensor.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

- For B116 Water in Fuel Sensor replacement refer to: [Fuel Filter Assembly Replacement \(AWD\)](#), [Fuel Filter Assembly Replacement \(FWD\)](#).
- Refer to [Control Module References](#) for Control Module replacement, programming, and setup

DTC P227B: BAROMETRIC PRESSURE (BARO) SENSOR 2 PERFORMANCE

Diagnostic Instructions

- Perform the [Diagnostic System Check - Vehicle](#) prior to using this diagnostic procedure.
- Review [Strategy Based Diagnosis](#) for an overview of the diagnostic approach.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC P227B

Barometric Pressure (BARO) Sensor 2 Performance

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5V Reference	P0097, P00F4, P0641, P2199, P227C*	P0097, P00F4, P2199, P227C	P0641, P227D*	P00C7, P227B, P227E
Signal	P227C	P227B, P227D	P227D	P00C7, P227B, P227E
Low Reference	-	P0097, P00F4, P0113, P227D	-	P00C7, P2199, P227B, P227E
* Additional DTCs may set.				

Typical Scan Tool Data

BARO Sensor 2

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition ON, Engine OFF			
Parameter Normal Range: 56 - 105 kPa (8.1 - 15.2 PSI), varies with altitude			
5V Reference	0 kPa (0.0 PSI)	0 kPa	127 kPa (18.4 PSI)
Signal	0 kPa (0.0 PSI)	127 kPa (18.4 PSI)	127 kPa (18.4 PSI)
Low Reference	-	127 kPa (18.4 PSI)	-

Circuit/System Description

The barometric pressure (BARO) Sensor 2, also referred to as the turbocharger inlet air pressure (TIAP) sensor, is integral to the multifunction intake air sensor and is used for humidity sensor signal correction. The sensor responds to changes in altitude and atmospheric conditions and gives the engine control module (ECM) an indication of intake air pressure relative to humidity. The ECM provides a 5 V reference and signal circuits to the TIAP which shares a low reference circuit with IAT 1 and 2. Ignition voltage and ground circuits are also supplied to the multifunction intake air sensor internal circuits for these sensors:

- Intake air temperature (IAT) sensor 1
- IAT sensor 2
- Humidity sensor
- Mass air flow (MAF) sensor
- Turbocharger inlet air pressure (TIAP) sensor (BARO 2)

Conditions for Running the DTC

Condition 1

- Before the ECM can report that DTC P227B failed, DTCs P0107, P0108, P2228, P2229, P227C, and P227D must run and pass.
- DTC P0106, P0107, P0108, P2228, P2229, P2230, P227C, P227D, P227E or P2610 is not set.
- The ignition is ON, engine OFF.
- The time between the current ignition cycle and the previous drive cycle is greater than 5 s.

- DTC P227B runs continuously when the conditions above exist.

Condition 2

- DTC P0101, P0102, P0103, P0107, P0108, P0116, P0117, P0118, P0119, P0128, P0201, P0202, P0203, P0204, P020A, P020B, P020C, P020D, P0216, P02EE, P02EF, P02E8, P02E9, P02F0, P02F1, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0335, P0336, P062B, P062D, P111E, P122D, P1248, P1249, P124A, P124B, P126A, P16A0, P16A1, P16A2, P2147, P2148, P2150, P2151, P2228, P2229, P2230, P227C, P227D, or P227E is not set.
- The engine is operating.
- The ignition voltage is greater than 11 V.
- The engine speed is less than 1, 100 RPM.
- The intake airflow valve position is greater than 90%.
- The engine coolant temperature (ECT) is warmer than 70Â°C (158Â°F)
- DTC P227B runs continuously when the conditions above exist.

Conditions for Setting the DTC

Condition 1

The ECM detects that the BARO sensor 2 pressure is less than 50 kPa (7.3 PSI) or greater than 115 kPa (16.7 PSI), for greater than 62.5 ms.

Condition 2

The ECM detects that the BARO sensor 2 pressure is not within range of the calculated pressure that is derived from a system of models for greater than 5 s.

Action Taken When the DTC Sets

DTC P227B is Type B DTC.

Conditions for Clearing the DTC

DTC P227B is Type B DTC.

Diagnostic Aids

- This diagnostic is used to identify pressure sensor internal faults (measurements with an offset or a drift). The plausibility monitor compares the BARO, MAP and TIAP pressures when the Throttle valve is open, the engine is at idle, and the engine coolant temperature is warmer than a threshold. In that condition, the three sensors are expected to measure the same pressure. If a specific pressure sensor signal drifts from the other two signals, a sensor specific performance DTC sets.
- A skewed or stuck engine coolant temperature (ECT) or intake air temperature (IAT) may cause the calculated models to be inaccurate and may cause this DTC to run when it should not. Refer to the [Temperature Versus Resistance - Engine Coolant Temperature Sensor](#) , and [Temperature Versus Resistance - Intake Air Temperature Sensor](#) table.
- A skewed pressure sensor may cause the intake manifold models to disagree with the actual pressure sensor measurements. Use the scan tool and compare all the Pressure Sensor parameters to the [Altitude Versus Barometric Pressure](#) table, and to a known good vehicle, under various operating and extended soak conditions.

Reference Information

Schematic Reference

[Engine Controls Wiring Schematics 1.6L \(LH7\)](#)

Connector End View Reference

[COMPONENT CONNECTOR END VIEWS - INDEX](#)

Powertrain Component Views

Electrical Information Reference

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify that DTC P0101, P0102, P0103, P0107, P0108, P0116, P0117, P0118, P0119, P0128, P0201, P0202, P0203, P0204, P020A, P020B, P020C, P020D, P0216, P02EE, P02EF, P02E8, P02E9, P02F0, P02F1, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0335, P0336, P062B, P062D, P111E, P122D, P1248, P1249, P124A, P124B, P126A, P16A0, P16A1, P16A2, P2147, P2148, P2150, P2151, P2228, P2229, P2230, P227C, P227D, or P227E is not set.
 - **If any of the DTCs are set**

Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) for further diagnosis.
 - **Go to next step: If none of the DTCs are set**
3. Verify the scan tool BARO Sensor 2 parameter is within the range specified in the [Altitude Versus Barometric Pressure](#) table.
 - **If the parameter is not within the specified range**

Refer to Circuit/System Testing.
 - **Go to next step: If the parameter is within the specified range**
4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed in the Freeze Frame/Failure Records data.
5. Verify the DTC does not set.
 - **If the DTC sets**

Refer to Circuit/System Testing.
 - **Go to next step: If the DTC does not set**
6. All OK.

Circuit/System Testing

1. Verify the conditions listed below do not exist with the B75C Multifunction Intake Air Sensor:
 - Damage.
 - Restrictions in the inlet port.
 - **If a condition exists**

Repair or replace the B75C Multifunction Intake Air Sensor as necessary.
 - **Go to next step: If none of the conditions exist**

2. Ignition OFF, and all vehicle systems OFF, it may take up to 2 minutes for all vehicle systems to power down. Disconnect the harness connector at the B75C Multifunction Intake Air Sensor.

3. Test for less than 5 Ω between the low reference circuit terminal 3 and ground.

- **If 5 Ω or greater**

1. Ignition OFF, disconnect the harness connector X1 at the K20 Engine Control Module.

2. Test for less than 2 Ω in the low reference circuit end to end.

- If 2 Ω or greater, repair the open/high resistance in the circuit.
- If less than 2 Ω , replace the K20 Engine Control Module.

- **Go to next step: If less than 5 Ω**

4. Ignition ON.

5. Test for 4.8 - 5.2 V between the 5 V reference circuit terminal 2 and ground.

- **If less than 4.8 V**

1. Ignition OFF, disconnect the harness connector X3 at the K20 Engine Control Module.

2. Test for infinite resistance between the 5 V reference circuit and ground.

- If less than infinite resistance, repair the short to ground on the circuit.
- If infinite resistance

3. Test for less than 2 Ω in the 5 V reference circuit end to end.

- If 2 Ω or greater, repair the open/high resistance in the circuit.
- If less than 2 Ω , replace the K20 Engine Control Module.

- **If greater than 5.2 V**

1. Ignition OFF, disconnect the harness connector X3 at the K20 Engine Control Module, ignition ON.

2. Test for less than 1 V between the 5 V reference circuit and ground.

- If 1 V or greater, repair the short to voltage on the circuit.
- If less than 1 V, replace the K20 Engine Control Module.

- **Go to next step: If between 4.8 - 5.2 V**

6. Verify the scan tool BARO Sensor 2 parameter is greater than 4.7 V.

- **If 4.7 V or less**

1. Ignition OFF, disconnect the harness connector X3 at the K20 Engine Control Module.

2. Test for infinite resistance between the signal circuit terminal 4 and ground.

- If less than infinite resistance, repair the short to ground on the circuit.
- If infinite resistance, replace the K20 Engine Control Module.

- **Go to next step: If greater than 4.7 V**

NOTE: If the signal circuit is shorted to a voltage the ECM or the sensor may be damaged.

7. Connect a 3 A fused jumper wire between the signal circuit terminal 4 and the low reference circuit terminal 3.

8. Verify the scan tool BARO Sensor 2 parameter is less than 0.2 V.

- **If 0.2 V or greater**

1. Ignition OFF, remove the jumper wire, disconnect the harness connector X3 at the K20 Engine Control Module, ignition ON.

2. Test for less than 1 V between the signal circuit terminal 4 and ground.

- If 1 V or greater, repair the short to voltage on the circuit.
- If less than 1 V

3. Ignition Off

4. Test for less than 2 Ω in the signal circuit end to end.

- If 2 Ω or greater, repair the open or high resistance in the circuit.
- If less than 2 Ω , replace the K20 Engine Control Module.

- Go to next step: If less than 0.2 V

9. Test or replace the B75C Multifunction Intake Air Sensor.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

- Refer to [Mass Airflow Sensor Replacement](#) for B75C Multifunction Intake Air Sensor replacement.
- Refer to [Control Module References](#) for engine control module replacement, programming and setup.

DTC P227C-P227E: BAROMETRIC PRESSURE (BARO) SENSOR 2 CIRCUIT

Diagnostic Instructions

- Perform the [Diagnostic System Check - Vehicle](#) prior to using this diagnostic procedure.
- Review [Strategy Based Diagnosis](#) for an overview of the diagnostic approach.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptors

DTC P227C

Barometric Pressure (BARO) Sensor 2 Circuit Low Voltage

DTC P227D

Barometric Pressure (BARO) Sensor 2 Circuit High Voltage

DTC P227E

Barometric Pressure (BARO) Sensor 2 Circuit Erratic

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5V Reference	P0097, P00F4, P0641, P2199, P227C*	P0097, P00F4, P2199, P227C	P0641, P227D*	P00C7, P227B, P227E
Signal	P227C	P227B, P227D	P227D	P00C7, P227B, P227E
Low Reference	-	P0097, P00F4, P0113, P227D	-	P00C7, P2199, P227B, P227E
* Additional DTCs may set.				

Typical Scan Tool Data

BARO Sensor 2

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition ON, Engine OFF Parameter Normal Range: 56 - 105 kPa (8.1 - 15.2 PSI), varies with altitude			
5V Reference	0 kPa (0.0 PSI)	0 kPa	127 kPa (18.4 PSI)
Signal	0 kPa (0.0 PSI)	127 kPa (18.4 PSI)	127 kPa (18.4 PSI)

Circuit	Short to Ground	Open	Short to Voltage
Low Reference	-	127 kPa (18.4 PSI)	-

Circuit/System Description

The barometric pressure (BARO) Sensor 2, also referred to as the turbocharger inlet air pressure (TIAP) sensor, is integral to the multifunction intake air sensor and is used for humidity sensor signal correction. The sensor responds to changes in altitude and atmospheric conditions and gives the engine control module (ECM) an indication of intake air pressure relative to humidity. The ECM provides a 5 V reference and signal circuits to the TIAP which shares a low reference circuit with IAT 1 and 2. Ignition voltage and ground circuits are also supplied to the multifunction intake air sensor internal circuits for these sensors:

- Intake air temperature (IAT) sensor 1
- IAT sensor 2
- Humidity sensor
- Mass air flow (MAF) sensor
- Turbocharger inlet air pressure (TIAP) sensor (BARO 2)

Conditions for Running the DTC

- The ignition is ON or the engine is running
- The DTCs run continuously when the above condition is met.

Conditions for Setting the DTC

DTC P227C

The ECM detects that the BARO sensor 2 is less than 50 kPa (7.3 PSI) for greater than 5 s.

DTC P222D

The ECM detects that the BARO sensor 2 is greater than 115 kPa (16.7 PSI) for greater than 5 s.

DTC P227E

The ECM detects that the BARO sensor 2 signal had an accumulated variation, over a 13 ms sample period, of greater than 200 kPa (29.0 PSI) for greater than 50 s.

Action Taken When the DTC Sets

DTCs P227C, P227D and P227E are Type B DTCs.

Conditions for Clearing the DTC

DTCs P227C, P227D and P227E are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Powertrain Component Views

Powertrain Component Views

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

DTC Type Reference

[Powertrain Diagnostic Trouble Code \(DTC\) Type Definitions](#)

Scan Tool Reference

[Control Module References](#) for scan tool information

Circuit/System Verification

1. Ignition On.
2. Verify the scan tool BARO Sensor 2 parameter is within the range specified in the [Altitude Versus Barometric Pressure](#) table.
 - **If the parameter is not within the specified range**
Refer to Circuit/System Testing.
 - **Go to next step: If the parameter is within the specified range**
3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed in the Freeze Frame/Failure Records data.

Verify the DTC does not set.

- **If the DTC sets**
Refer to Circuit/System Testing.
 - **Go to next step: If the DTC does not set**
4. All OK.

Circuit/System Testing

1. Ignition OFF, and all vehicle systems OFF, it may take up to 2 minutes for all vehicle systems to power down. Disconnect the harness connector at the B75C Multifunction Intake Air Sensor.
2. Test for less than 5 Ω between the low reference circuit terminal 3 and ground.
 - **If 5 Ω or greater**
 1. Ignition OFF, disconnect the harness connector X1 at the K20 Engine Control Module.
 2. Test for less than 2 Ω in the low reference circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **Go to next step: If less than 5 Ω**
3. Ignition ON.
4. Test for 4.8 - 5.2 V between the 5 V reference circuit terminal 2 and ground.
 - **If less than 4.8 V**
 1. Ignition OFF, disconnect the harness connector X3 at the K20 Engine Control Module.
 2. Test for infinite resistance between the 5 V reference circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 Ω in the 5 V reference circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.

- If less than 2 Ω , replace the K20 Engine Control Module.
- **If greater than 5.2 V**
 1. Ignition OFF, disconnect the harness connector X3 at the K20 Engine Control Module, ignition ON.
 2. Test for less than 1 V between the 5 V reference circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.
- **Go to next step: If between 4.8 - 5.2 V**
- 5. Verify the scan tool BARO Sensor 2 parameter is greater than 4.7 V.
 - **If 4.7 V or less**
 1. Ignition OFF, disconnect the harness connector X3 at the K20 Engine Control Module.
 2. Test for infinite resistance between the signal circuit terminal 4 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K20 Engine Control Module.
 - **Go to next step: If greater than 4.7 V**

NOTE: If the signal circuit is shorted to a voltage the ECM or the sensor may be damaged.

6. Connect a 3 A fused jumper wire between the signal circuit terminal 4 and the low reference circuit terminal 3.
7. Verify the scan tool BARO Sensor 2 parameter is less than 0.2 V.
 - **If 0.2 V or greater**
 1. Ignition OFF, remove the jumper wire, disconnect the harness connector X3 at the K20 Engine Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit terminal 4 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 3. Ignition Off
 4. Test for less than 2 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open or high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **Go to next step: If less than 0.2 V**
8. Test or replace the B75C Multifunction Intake Air Sensor.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

- Refer to [Mass Airflow Sensor Replacement](#) for B75C Multifunction Intake Air Sensor replacement.
- Refer to [Control Module References](#) for engine control module replacement, programming and setup

DTC P228A OR P228B: FUEL PRESSURE REGULATOR 1-2 CONTROL - FORCED ENGINE SHUTDOWN

Diagnostic Instructions

- Perform the [Diagnostic System Check - Vehicle](#) prior to using this diagnostic procedure.
- Review [Strategy Based Diagnosis](#) for an overview of the diagnostic approach.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptors

DTC P228A

Fuel Pressure Regulator 1 Control - Forced Engine Shutdown

DTC P228B

Fuel Pressure Regulator 2 Control - Forced Engine Shutdown

Circuit/System Description

The engine control module (ECM) controls the fuel rail pressure by controlling fuel pressure regulator 1 and fuel pressure regulator 2 simultaneously to achieve the desired fuel rail pressure. The ECM compares the desired fuel pressure that is calculated and the actual fuel pressure reading from the fuel pressure sensor and monitors these two values to detect faults in the fuel system.

Conditions for Running the DTC

P228A

- The engine is running.
- Ignition voltage is greater than 11 V.
- The Fuel rail pressure is being controlled by fuel pressure regulator 1 in closed loop.
- The DTCs runs continuously once the above conditions are met.

P228B

- The engine is running.
- Ignition voltage is greater than 11 V.
- The Fuel rail pressure is being controlled by fuel pressure regulator 2 in closed loop.
- The DTCs runs continuously once the above conditions are met.

Conditions for Setting the DTC

P228A or P228B

The ECM detects that the fuel pressure regulator that is commanding the pressure is lower than the desired value for greater than 10 s.

Action Taken When the DTC Sets

- DTC P228A and P228B are Type A DTCs.

Conditions for Clearing the DTC

- DTC P228A and P228B are Type A DTCs.

Diagnostic Aids

- Water or contaminated fuel may cause this DTC to intermittently set. Refer to [Contaminants-in-Fuel Diagnosis](#).
- A restricted fuel supply line, a leakage in the high pressure section, too much or too little fuel in the low pressure line may cause DTCs to set. When ambient temperatures are below 0°C (32°F), the fuel tank pickup screen may be iced over from water in the fuel tank.
- Electrical faults in either circuit of the Fuel Pressure Regulator will cause a DTC to set.
- There are no driveability concerns associated with the fuel rail pressure regulator unless a DTC is present. One of the causes of these DTCs is a sticking fuel rail pressure regulator.
- If the fuel system pressure is actually too high, a fuel knock and a low pressure condition will exist.

Reference Information

Schematic Reference

Connector End View Reference

[COMPONENT CONNECTOR END VIEWS - INDEX](#)

Component View Reference

[Powertrain Component Views](#)

Description and Operation

[Fuel System Description](#)

Electrical Information Reference

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

DTC Type Reference

[Powertrain Diagnostic Trouble Code \(DTC\) Type Definitions](#)

Scan Tool Reference

[Control Module References](#) for scan tool information

[Circuit/System Verification](#)

1. Verify DTC P0627, P0628, P0629, P1255, P129B, P129C, P12A6, or P2635 is not set
 - **If any of the DTCs are set**

Refer to: [Diagnostic Trouble Code \(DTC\) List - Vehicle](#)
 - **Go to next step: If none of the DTCs are set**
2. Verify the proper fuel is used and there is no contamination. Refer to [Fuel System Specifications](#), and [Contaminants-in-Fuel Diagnosis](#).
3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
 - **If DTC P228A, or P228B is set**

Refer to Circuit/System Testing
 - **Go to next step: If DTC P228A, or P228B is not set**
4. All OK.

[Circuit/System Testing](#)

1. Verify there are no fuel system leaks. Refer to [Fuel Leak Diagnosis](#).
 - **If a fuel leak is found**

Repair as necessary.
 - **Go to next step: If a fuel leak is not found**

NOTE: Fuel temperature must be warmer than 20°C (68°F) before performing the next step or incorrect diagnosis may occur.

2. Engine cranking or running, verify scan tool parameter Fuel Pressure Sensor is between 370-450 kPa (54-65 PSI).

- *If not within 370-450 kPa (54-65 PSI)*

Refer to [Fuel System Diagnosis](#) for further diagnosis.

- *Go to next step: If within 370-450 kPa (54-65 PSI)*

3. Verify that no fuel injector nozzles are stuck in the open position. Refer to [Fuel Injector Balance Test with Scan Tool](#) and perform the procedure under Circuit/System Testing.

- **If a fuel injector nozzle is stuck open**

Replace the appropriate Q17 Fuel Injector.

- **Go to next step: If a fuel injector nozzle is not stuck open**

4. Perform the scan tool control function: Fuel Pressure Control - Regulator 1 - Increase & Decrease

Verify the scan tool parameter: Fuel Rail Pressure Sensor 1 = The value should change with each command.

- If the value does not change

Replace the component: Q18A Fuel Pressure Regulator 1

- If the value changes

5. Perform the scan tool control function: Fuel Pressure Control - Regulator 2 - Increase & Decrease

Verify the scan tool parameter: Fuel Rail Pressure Sensor 1 = The value should change with each command.

- If the value does not change

Replace the component: Q18B Fuel Pressure Regulator 2

- If the value changes

6. All OK.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

- Refer to [Fuel Injector Replacement](#)
- For Q18A Fuel Pressure Regulator 1 replacement, refer to: [Fuel Injection Pump Metering Valve Replacement](#)
- For Q18B Fuel Pressure Regulator 2 replacement refer to: [Fuel Injection Fuel Rail Assembly Replacement](#)
- For control module replacement, programming and setup refer to: [Control Module References](#)

DTC P2294-P2296: FUEL PRESSURE REGULATOR 2 CONTROL CIRCUIT

Diagnostic Instructions

- Perform the Diagnostic System Check prior to using this diagnostic procedure: [Diagnostic System Check - Vehicle](#)
- Review the description of Strategy Based Diagnosis: [Strategy Based Diagnosis](#)
- An overview of each diagnostic category can be found here: [Diagnostic Procedure Instructions](#)

DTC Descriptor

DTC P2294

Fuel Pressure Regulator 2 Control Circuit

DTC P2295

DTC P2296

Fuel Pressure Regulator 2 Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Control - High	P2295	P2294	P0690, P16B3	P2293
Control - Low	P2295	P2294	P0690, P16B3, P2296	P2293

Circuit/System Description

Circuit	Description
Control - High	The output circuit is switched to 12 V to activate the component. The output is PWM controlled.
Control - Low	The output circuit is switched to ground to activate the component. The output is PWM controlled.

Component	Description
Q18B Fuel Pressure Regulator 2	The fuel pressure regulator is the solenoid valve that controls the pressure in the fuel rail.
K20 Engine Control Module	The control module controls a series of actuators to ensure optimal engine performance. The control module does this by reading values from a variety of sensors, interprets the data and adjusts the engine actuators accordingly.

For an overview of the component/system, refer to: [Fuel System Description](#)

Conditions for Running the DTC

- Battery Voltage = Greater than 11 V
- Engine Running
- Fuel Rail Pressure is being controlled by Fuel Pressure Regulator 2.
- Ignition Voltage = Greater than 6 V

DTCs run continuously when the above conditions are met.

Conditions for Setting the DTC**P2294**

Control Circuit = Open - Greater than 0.275 s

P2295

Control Circuit = Short to Ground - Greater than 0.275 s

P2296

Control Circuit = Short to Voltage - Greater than 0.275 s

Actions Taken When the DTC Sets

DTC P2294, P2295, P2296 = Type B DTC

Conditions for Clearing the DTC

DTC P2294, P2295, P2296 = Type B DTC

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

Powertrain Component Views

Description and Operation

Fuel System Description

Electrical Information Reference

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References

Circuit/System Verification

1. Ignition - On/Vehicle - In Service Mode
2. Verify DTC P0191, P0192, P0193 is not set.

- If any of the DTCs are set

Refer to: [Diagnostic Trouble Code \(DTC\) List - Vehicle](#)

- If none of the DTCs are set

3. Perform the scan tool control function: Fuel Pressure Regulator 2 - On and Off

Verify the scan tool parameter:

- Fuel Pressure Regulator 2 Control Circuit High Voltage Test Status = OK or Not Run
- Fuel Pressure Regulator 2 Control Circuit Open Test Status = OK or Not Run
- Fuel Pressure Regulator 2 Control Circuit Low Voltage Test Status = OK or Not Run
- **If not the specified state**

Refer to: Circuit/System Testing

- **Go to next step: If the specified state**

4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

5. Verify the DTC does not set.

- **If the DTC sets**

Refer to: Circuit/System Testing

- **Go to next step: If the DTC does not set**

6. All OK.

Circuit/System Testing

1. Ignition/Vehicle - Off
2. Disconnect the electrical connector: Q18B Fuel Pressure Regulator 2
3. Connect a test lamp between the test points: Control circuit terminal 1 & Control circuit terminal 2
4. Ignition - On/Vehicle - In Service Mode
5. Perform the scan tool control function: Fuel Pressure Regulator 2 - On and Off

Verify the test lamp turns On and Off.

- **If the test lamp does not turn On and Off**

1. Ignition/Vehicle - Off & Remove - Test lamp
2. Disconnect the electrical connector: X2 @ K20 Engine Control Module
3. Ignition - On/Vehicle - In Service Mode
4. Test for less than 1 V between the test points:
 - Control circuit terminal 1 @ Component harness & Ground
 - Control circuit terminal 2 @ Component harness & Ground
 - If 1 V or greater - Repair the short to voltage on the circuit.
 - If less than 1 V
5. Ignition/Vehicle - Off
6. Test for infinite resistance between the test points:
 - Control circuit terminal 1 @ Component harness & Ground
 - Control circuit terminal 2 @ Component harness & Ground
 - If less than infinite resistance - Repair the short to ground on the circuit.
 - If infinite resistance
7. Test for less than 2 ohms between the test points:
 - Control circuit terminal 1 @ Component harness & Terminal 96 @ Control module harness
 - Control circuit terminal 2 @ Component harness & Terminal 76 @ Control module harness
 - If 2 ohms or greater - Repair the open/high resistance in the circuit.
 - If less than 2 ohms - Replace the component: K20 Engine Control Module

- **Go to next step: If the test lamp turns On and Off**

6. Replace the component: Q18B Fuel Pressure Regulator 2

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: [Diagnostic Repair Verification](#)

- Refer to [Fuel Injection Fuel Rail Assembly Replacement](#) - Q18B Fuel Pressure Regulator 2
- For control module replacement, programming, and setup refer to: [Control Module References](#)

DTC P2297 OR P2A00: HO2S PERFORMANCE SENSOR 1

Diagnostic Instructions

- Perform the [Diagnostic System Check - Vehicle](#) prior to using this diagnostic procedure.
- Review [Strategy Based Diagnosis](#) for an overview of the diagnostic approach.

- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptor

DTC P2297

HO2S Performance During Deceleration Fuel Cut-Off Sensor 1

DTC P2A00

HO2S Performance Sensor 1

Circuit/System Description

The oxygen content of the exhaust is measured via the nitrogen oxide (NOx) sensors. The nitrogen oxides (NOx) sensors are part of the selective catalytic reduction system, a device used to reduce NOx emission on diesel engines. There are two NOx sensors, one placed upstream of selective catalytic reduction, to measure inlet NOx concentration, and one placed downstream. They are connected with the control module via CAN and all the information is exchanged through it. Since it is a smart sensor, all the electrical monitoring is performed inside the sensor and only the results are sent to the ECM. Each NOx sensor contains a sensing cell, a pumping cell, and a heater. A sample of exhaust gas passes through a diffusion gap between the sensing cell and the pumping cell. The NOx sensor maintains a constant reference voltage across the sensing cell. An electronic circuit within sensor controls the pump current through the pumping cell in order to maintain a constant voltage in the sensing cell. The amount of current required to maintain the reference voltage in the sensing cell is proportional to the concentration of NOx in the exhaust. The ECM varies the amount of diesel exhaust fluid (reductant) added by varying the reductant injector duty cycle in response to changes in engine exhaust NOx levels. The smart NOx sensors consist of two components, the NOx module and the NOx sensor element that are serviced as a unit. A circuit or performance condition with a NOx sensor is detected by the NOx sensor module. The smart NOx sensor module communicates the condition to the ECM over the serial data line. The ECM sets a DTC when a serial data message is received from the NOx sensor module.

Conditions for Running the DTC

P2297

- DTC P0087, P00C7, P00E9, P00EA, P00EB, P00EC, P0101, P0102, P0103, P0106, P0107, P0108, P0116, P0117, P0118, P0119, P0128, P0201-P0208, P020A-P020F, P0216, P021A, P021B, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0279, P0280, P0282, P0283, P02EE, P02EF, P02F0-P02F5, P0403, P0405, P0406, P042E, P042F, P0489, P0490, P049D, P062B, P062D, P111E, P113B, P113C, P113D, P113F, P115E, P115F, P1160, P116A, P116B, P116C, P116D, P116E, P116F, P118E, P118F, P1192, P1193, P1194, P1196, P1198, P119A, P119B, P119C, P11C5, P11C6, P11DB, P11DD, P1248, P1249, P124A-P124F, P126A, P1402, P1407, P140F, P1424, P2032, P2033, P2080, P2081, P2084, P2085, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P2200, P2202, P2203, P2205, P2206, P2207, P2208, P2209, P220A, P2210, P2211, P2227, P2228, P2229, P2230, P228A, P228B, P242B-P242E, P2452-P2456, P2481-P2484, P2627, or P2628 is not set.
- The ignition voltage is greater than 11 V.
- The NOx sensor supply voltage is greater than 10.8 V.
- The engine speed is between 800-2, 500 RPM.
- The engine is operating under deceleration fuel cut-off.
- The exhaust gas recirculation (EGR) valve position is less than 10%.
- The NOx Sensor 1 Heater Operation parameter displays Allowed.
- The exhaust brake is not active.

DTC P2297 runs continuously when the above conditions are met.

P2A00

- DTC P0087, P00C7, P00E9, P00EA, P00EB, P00EC, P0101, P0102, P0103, P0106, P0107, P0108, P0116, P0117, P0118, P0119, P0128, P0201-P0208, P020A-P020F, P0216, P021A, P021B, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276,

P0277, P0279, P0280, P0282, P0283, P02EE, P02EF, P02F0-P02F5, P0405, P0406, P0489, P049D, P062B, P062D, P111E, P113B, P113C, P113D, P113F, P115E, P115F, P1160, P116A, P116B, P116C, P116D, P116E, P116F, P118E, P118F, P1192, P1193, P1194, P1196, P1198, P119A, P119B, P119C, P11C5, P11C6, P11DB, P11DD, P1248, P1249, P124A-P124F, P126A, P2032, P2033, P2080, P2081, P2084, P2085, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P2200, P2202, P2203, P2205, P2206, P2207, P2208, P2209, P220A, P2210, P2211, P2227, P2228, P2229, P2230, P228A, P228B, P242B-P242E, P2452-P2456, P2481-P2484, P2627, or P2628 is not set.

- The ignition voltage is greater than 11 V.
- The NOx sensor supply voltage is greater than 10.8 V.
- The NOx Sensor 1 Heater Operation parameter displays Allowed.
- The engine speed is between 600-3, 000 RPM.
- The engine is operating under deceleration fuel cut-off.

DTC P2A00 runs once per ignition cycle when the above conditions are met.

Conditions for Setting the DTC

The NOx sensor module detects a fault in the NOx sensor circuitry or a performance fault in the NOx sensor.

Action Taken When the DTC Sets

DTCs P2297 and P2A00 are Type B DTCs.

Conditions for Clearing the DTC

DTCs P2297 and P2A00 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

[Control Module References](#) for scan tool information

Circuit/System Verification

1. Ignition ON
2. Verify DTC P0087, P00C7, P00E9, P00EA, P00EB, P00EC, P0101, P0102, P0103, P0106, P0107, P0108, P0116, P0117, P0118, P0119, P0128, P0201-P0208, P020A-P020F, P0216, P021A, P021B, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0279, P0280, P0282, P0283, P02EE, P02EF, P02F0-P02F5, P0403, P0405, P0406, P042E, P042F, P0489, P0490, P049D, P062B, P062D, P111E, P113B, P113C, P113D, P113F,

P115E, P115F, P1160, P116A, P116B, P116C, P116D, P116E, P116F, P118E, P118F, P1192, P1193, P1194, P1196, P1198, P119A, P119B, P119C, P11C5, P11C6, P11DB, P11DD, P1248, P1249, P124A-P124F, P126A, P1402, P1407, P140F, P1424, P2032, P2033, P2080, P2081, P2084, P2085, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P2200, P2202, P2203, P2205, P2206, P2207, P2208, P2209, P220A, P2210, P2211, P2227, P2228, P2229, P2230, P228A, P228B, P242B-P242E, P2452-P2456, P2481-P2484, P2627, or P2628 is not set.

- **If any of the DTCs are set**

Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#).

- **Go to next step: If none of the DTCs are set**

3. Verify that none of the conditions listed below exist:

- Leaking or restricted intake system/charge air hoses. Refer to [Charge Air Cooler Diagnosis \(Leak Test\)](#)[Charge Air Cooler Diagnosis \(Smoke Test\)](#).
- Leaking exhaust system/turbocharger. Refer to [Exhaust Leakage](#).
- Contaminated fuel. Refer to [Contaminants-in-Fuel Diagnosis](#).
- **If a condition is found**

Repair as necessary.

- **Go to next step: If no condition is found**

4. Clear all DTCs with a scan tool

5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

6. Verify that DTCs P2297 or P2A00 are not set

- **If any of the DTCs are set**

Replace the B195A Nitrogen Oxides Sensor 1

- **Go to next step: If none of the DTCs are set**

7. All OK.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

Refer to [Nitrogen Oxides Sensor Replacement - Position 1](#)

DTC P244A: DIESEL PARTICULATE FILTER (DPF) LOW DIFFERENTIAL PRESSURE

Diagnostic Instructions

- Perform the [Diagnostic System Check - Vehicle](#) prior to using this diagnostic procedure.
- Review [Strategy Based Diagnosis](#) for an overview of the diagnostic approach.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptor

DTC P244A

Diesel Particulate Filter (DPF) Low Differential Pressure

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5V Reference	P0641	-	P0641	-
Signal	P2454	P2454	P2455	P2453
Low Reference	-	P2455	P2454	-

Circuit/System Description

The exhaust differential pressure sensor measures the pressure difference across the inlet and outlet of the diesel particulate filter. The pressure difference across the diesel particulate filter increases as captured particulates in the diesel particulate filter increases. The engine control module supplies a 5 V reference circuit and a ground on the low reference circuit. The exhaust differential pressure sensor provides a signal voltage to the engine control module, relative to the back pressure as a function of exhaust flow, diesel particulate filter temperature, and diesel particulate filter soot loading. The engine control module converts the signal voltage input to a pressure value.

Conditions for Running the DTC

- DTC P00C7, P0101, P0102, P0103, P113E, P1197, P2227, P2228, P2229, P2230, P2453, P2470, P2471, or P2472 is not set.
- Engine speed is greater than 800 RPM
- Engine coolant temperature is warmer than 40°C (104°F)

The DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

P244A

The ECM detects the diesel particulate filter exhaust differential pressure sensor is lower than the minimum threshold.

Action Taken When the DTC Sets

- DTC P244A is a Type A DTC.

Conditions for Clearing the DTC

- DTC P244A is a Type A DTC.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Exhaust Aftertreatment System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

Circuit/System Verification

1. Ignition ON.
2. Verify that DTCs P00C7, P0101, P0102, P0103, P0641, P113E, P113F, P2228, P2229, P2452, P2453, P2454, P2455, P2456, P2470, P2471, P2472, P2481, P2482, or P2484 are not set.

- **If any of the DTCs are set**

Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) for further diagnosis.

- **Go to next step: If none of the DTCs are set**

3. Ignition ON, verify that the diesel particulate filter (DPF) Differential Pressure parameter is between 0 to +1 kPa (0 to +0.14 PSI).

- **If not within the specified range**

Refer to Circuit/System Testing.

- **Go to next step: If within the specified range**

4. Engine running, verify that the DPF Differential Pressure parameter is greater than 0 kPa (0 PSI).

- **If not greater than 0 kPa (0 PSI)**

Refer to Circuit/System Testing.

- **Go to next step: If greater than 0 kPa (0 PSI)**

5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed in the Freeze Frame/Failure Records data.

6. Verify the DTC is not set.

- **If the DTC is set**

Refer to Circuit/System Testing.

- **Go to next step: If no DTC is set**

7. All OK.

Circuit/System Testing

1. Verify the integrity of the DPF system by visually and physically inspecting any of the following conditions:

- Any damaged exhaust system components
- Loose or improperly installed exhaust system components.
- Restrictions in the exhaust differential pressure sensor ports.
- Damaged, bent, restricted, or kinked exhaust differential pressure lines.
- **If a condition is found**

Repair as necessary.

- **Go to next step: If no condition is found**

2. Remove and inspect the flexible part of the exhaust differential pressure lines for internal restrictions.

- **If any restrictions are found**

Repair as necessary.

- **Go to next step: If no restrictions are found**

3. Connect the exhaust port of the EN 23738 - A vacuum gauge to port one (engine side) of the B154 Diesel Particulate Filter Exhaust Differential Pressure Sensor.

4. Ignition ON, using the EN 23738 - A vacuum gauge, slowly apply pressure to the sensor while observing the DPF Differential Pressure parameter.

5. Verify the parameter increases smoothly without spikes or dropouts.

- **If the parameter does not increase smoothly**

Replace the B154 Diesel Particulate Filter Exhaust Differential Pressure Sensor.

- **Go to next step: If the parameter increases smoothly**

6. Replace the Diesel Particulate Filter.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

- Refer to [Exhaust Pressure Differential Sensor Replacement](#)

Perform the scan tool DPF Pressure Sensor Reset after replacing the exhaust pressure differential sensor.

- Refer to [Oxidation Catalytic Converter Replacement \(LH7\)](#).

Perform the scan tool DPF/Catalyst 2 Reset after replacing the exhaust particulate filter.

DTC P244C: CATALYST LOW TEMPERATURE DURING REGENERATION

Diagnostic Instructions

- Perform the [Diagnostic System Check - Vehicle](#) prior to using this diagnostic procedure.
- Review [Strategy Based Diagnosis](#) for an overview of the diagnostic approach.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptor

DTC P244C

Catalyst Low Temperature During Regeneration

Circuit/System Description

The diesel exhaust aftertreatment system consists of an under hood pre-catalytic converter and an underbody catalyst converter. The underbody catalyst converter also consists of the main Diesel Oxidation Catalyst and the coated Diesel Particulate Filter (DPF). One of the main purposes of the DPF is to collect particulates from the engine exhaust in order to minimize discharge of soot to the atmosphere. The soot particles accumulate in the channels of the DPF and are burned off at regular intervals through a process called regeneration. This prevents the DPF from clogging. The ECM commands the DPF regeneration after calculating various vehicle conditions such as DPF pressure difference, exhaust gas temperature, engine oil quality, engine speed, etc. Excessive accumulation of the soot in the DPF can cause a drop in the engine performance. During regeneration, additional fuel is injected via multiple post injections in order to increase the exhaust gas temperature. During this period, the DPF temperature is raised to approximately 600°C (1, 112°F) and the accumulated soot is oxidized or burned off into carbon dioxide (CO₂).

Conditions for Running the DTC

The DTC runs during the DPF regeneration process.

Conditions for Setting the DTC

The exhaust gas temperature is too low during regeneration.

Action Taken When the DTC Sets

DTC P244C is a Type A DTC.

Conditions for Clearing the DTC

DTC P244C is a Type A DTC.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References

Circuit/System Verification

1. Ignition ON.
2. Verify that DTCs P113E, P2470, P2471, or P2472 are not set.
 - **If any of the DTCs are set**

Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) for further diagnosis.
 - **Go to next step: If none of the DTCs are set**
3. Verify the integrity of the entire air induction system and exhaust system, including all turbocharger components by inspecting for the conditions listed below:
 - Leaks or restrictions in the hoses and pipes to the B136 Exhaust Differential Pressure Sensor
 - Damage to induction system components, including the turbocharger and charge air cooler
 - Loose or improperly installed components
 - Air flow restrictions
 - Exhaust leaks, including the mating surface between the turbocharger and exhaust manifold
 - **If a condition is found**

Repair as necessary
 - **Go to next step: If no condition is found**
4. Perform the Diesel Particulate Filter Service Regeneration.
5. Verify the regeneration completed.
 - **If the regeneration did not complete**

Replace the Diesel Particulate Filter
 - **Go to next step: If the regeneration completed**
6. All OK.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

Refer to [Oxidation Catalytic Converter Replacement \(LH7\)](#).

Perform the scan tool DPF/Catalyst 2 Reset after replacing the exhaust particulate filter.

DTC P2452 OR P2454-P2456: DIESEL PARTICULATE FILTER (DPF) DIFFERENTIAL PRESSURE SENSOR CIRCUIT

Diagnostic Instructions

- Perform the [Diagnostic System Check - Vehicle](#) prior to using this diagnostic procedure.
- Review [Strategy Based Diagnosis](#) for an overview of the diagnostic approach.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptors

DTC P2452

Diesel Particulate Filter (DPF) Differential Pressure Sensor Circuit

DTC P2454

Diesel Particulate Filter (DPF) Differential Pressure Sensor Circuit Low Voltage

DTC P2455

Diesel Particulate Filter (DPF) Differential Pressure Sensor Circuit High Voltage

DTC P2456

Diesel Particulate Filter (DPF) Differential Pressure Sensor Circuit Intermittent

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5V Reference	P0097, P00F4, P018C, P0340, P0405, P0522, P0532, P0641, P2199, P227C, P2454	P2454	P018D, P0405, P0523, P0533, P0641, P227D, P2455	-
Signal	P2454	P2455	P2455	P2453
Low Reference	-	P2455	P2454	-

Circuit/System Description

The diesel exhaust aftertreatment system consists of an under hood catalyst and an underbody catalyst. The underbody catalyst also consists of the main Diesel Oxidation Catalyst and the coated Diesel Particulate Filter (DPF). One of the main purposes of the DPF is to collect particulates from the engine exhaust in order to minimize discharge of soot to the atmosphere. The soot particles accumulate in the channels of the DPF and are burned off at regular intervals through a process called regeneration. This prevents the DPF from clogging. The ECM commands the DPF regeneration after calculating various vehicle conditions such as DPF pressure difference, exhaust gas temperature, engine oil quality, engine speed, etc. Excessive accumulation of the soot in the DPF can cause a drop in the engine performance. During regeneration, additional fuel is injected via multiple post injections in order to increase the

exhaust gas temperature. During this period, the DPF temperature is raised to approximately 600°C (1,112°F) and the accumulated soot is oxidized or burned off into carbon dioxide (CO₂).

Conditions for Running the DTC

P2452

- DTCs P2453, P2454, P2455, P2456, or P262B are not set.
- The ignition has been OFF for greater than 10 s.
- The engine is not running.
- The ignition is ON.

The DTC runs when the above conditions are met.

P2454, P2455

- The ignition is On or the engine is running.
- The ignition voltage is greater than 11 V.

The DTCs run when the above conditions are met.

P2456

- DTCs P2454 and P2455 are not set.
- The ignition is On or the engine is running.
- The ignition voltage is greater than 11 V.

The DTC runs when the above conditions are met.

Conditions for Setting the DTC

P2452 and P2456

The ECM detects an implausible DPF differential pressure sensor signal.

P2454

The ECM detects a short to ground in the signal circuit.

P2455

The ECM detects an open circuit or a short to voltage in the signal circuit.

Action Taken When the DTC Sets

DTC P2452, P2454, P2455 and P2456 are Type B DTCs.

Conditions for Clearing the DTC

DTC P2452, P2454, P2455 and P2456 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

- Circuit Testing

- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

DTC Type Reference

[Powertrain Diagnostic Trouble Code \(DTC\) Type Definitions](#)

Scan Tool Reference

[Control Module References](#) for scan tool information

Circuit/System Verification

1. Verify the integrity of entire DPF system by inspecting for the following conditions:
 - Damaged components
 - Loose or improper installation
 - Leaks or restrictions in the B154 Exhaust Pressure Differential sensor lines or hoses. The pressure lines should be free from sharp bends, or kinks from the pressure sensor to the exhaust filter assembly.
 - **If a condition is found**
Repair as necessary
 - **Go to next step: If no condition is found**
2. Ignition On.
3. Observe the scan tool DPF Differential Pressure parameter. The value should be between -1.0 kPa and +0.4 kPa (-0.15 psi and +0.058 psi).
 - **If not between the specified values**
Refer to Circuit/System Testing
 - **Go to next step: If between the specified values**
4. Engine running at a warm stabilized idle, observe the scan tool DPF Differential Pressure parameter. The value should be between 0 - 3 kPa (-0.15 psi to +0.44 psi).
 - **If not between the specified values**
Refer to Circuit/System Testing
 - **Go to next step: If between the specified values**
5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
6. Verify the DTC does not reset.
 - **If the DTC sets**
Refer to Circuit/System Testing.
 - **Go to next step: If the DTC does not set**
7. All OK.

Circuit/System Testing

1. Ignition Off and all vehicle systems Off, disconnect the harness connector at the B154 Exhaust Pressure Differential sensor. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 5 Ω between the low reference circuit terminal 2 and ground.
 - **If 5 Ω or greater**
 1. Ignition Off, disconnect the X3 connector at the K20 Engine Control Module.
 2. Test for less than 2 Ω in the low reference circuit end to end.

- If 2 Ω or greater, repair the open/high resistance in the circuit.
- If less than 2 Ω , replace the K20 Engine Control Module.

- **Go to next step: If less than 5 Ω**

3. Ignition On.

4. Test for 4.8 - 5.2 V between the 5 V reference circuit terminal 1 and ground.

- **If less than 4.8 V**

1. Ignition Off, disconnect the X3 connector at the K20 Engine Control Module.

2. Test for infinite resistance between the 5 V reference circuit and ground.

- If less than infinite resistance, repair the short to ground on the circuit.
- If infinite resistance

3. Test for less than 2 Ω in the 5 V reference circuit end to end.

- If 2 Ω or greater, repair the open/high resistance in the circuit.
- If less than 2 Ω , replace the K20 Engine Control Module.

- **If greater than 5.2 V**

1. Ignition Off, disconnect the X2 connector at the K20 Engine Control Module, ignition On.

2. Test for less than 1 V between the 5 V reference circuit and ground.

- If 1 V or greater, repair the short to voltage on the circuit.
- If less than 1 V, replace the K20 Engine Control Module.

- **Go to next step: If between 4.8 - 5.2 V**

5. Connect the harness connector at the B154 Exhaust Pressure Differential sensor.

6. Verify the scan tool DPF Differential Pressure Sensor parameter is greater than 0.0 V or less than 4.8 V.

- **If between 4.8 - 5.2 V**

1. Ignition Off, disconnect the X2 connector at the K20 Engine Control Module.

2. Test for infinite resistance between the signal circuit terminal 3 and ground.

- If less than infinite resistance, repair the short to ground on the circuit.
- If infinite resistance

3. Test for less than 2 Ω in the signal circuit end to end.

- If 2 Ω or greater, repair the open/high resistance in the circuit.
- If less than 2 Ω , replace the K20 Engine Control Module.

- **If greater than 5.2 V**

1. Ignition Off, disconnect the harness connector at the B154 Exhaust Pressure Differential sensor and the X3 connector at the K20 Engine Control Module.

2. Ignition On.

3. Test for less than 1 V between the signal circuit and ground.

- If 1 V or greater, repair the short to voltage in the circuit.
- If less than 1 V

4. Ignition Off.

5. Test for less than 2 Ω in the signal circuit end to end.

- If 2 Ω or greater, repair the open/high resistance in the circuit.
- If less than 2 Ω , replace the K20 Engine Control Module.

- **If 0.0 V**

1. Ignition Off, disconnect the X3 connector at the K20 Engine Control Module.

2. Test for infinite resistance between the signal circuit terminal 3 and ground.

- If less than infinite resistance, repair the short to ground on the circuit.
- If infinite resistance, replace the K20 Engine Control Module.

- **Go to next step: If greater than 0.0 V and less than 4.8 V**

7. Test or replace the B154 Exhaust Pressure Differential sensor.

Perform the [Diagnostic Repair Verification](#) after completing the repair.

- Refer to [Exhaust Pressure Differential Sensor Replacement](#)

Perform the scan tool DPF Pressure Sensor Reset after replacing the exhaust pressure differential sensor.

- Refer to [Control Module References](#) for engine control module replacement, programming, and setup.

DTC P2453: DIESEL PARTICULATE FILTER (DPF) DIFFERENTIAL PRESSURE SENSOR PERFORMANCE

Diagnostic Instructions

- Perform the [Diagnostic System Check - Vehicle](#) prior to using this diagnostic procedure.
- Review [Strategy Based Diagnosis](#) for an overview of the diagnostic approach.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptor

DTC P2453

Diesel Particulate Filter (DPF) Differential Pressure Sensor Performance

Circuit/System Description

The exhaust differential pressure sensor measures the pressure of the diesel particulate filter. The engine control module supplies a 5 V reference circuit and a ground on the low reference circuit. The exhaust differential pressure sensor provides a signal voltage to the engine control module, relative to the back pressure as a function of exhaust flow, diesel particulate filter temperature, and diesel particulate filter soot loading. The engine control module converts the signal voltage input to a pressure value.

Conditions for Running the DTC

- DTCs P0101, P0102, P0103, P113E, P1197, P2452, P2454, P2455, P2456, P2470, P2471, or P2472 are not set.
- The ignition is On or the engine is running.
- The battery voltage is greater than 11 V.

The DTC runs continuously when the above conditions are met

Conditions for Setting the DTC

The ECM detects that the differential pressure is greater than or less than the calibrated threshold for greater than 1 s.

Action Taken When the DTC Sets

DTC P2453 is a Type B DTC.

Conditions for Clearing the DTC

DTC P2453 is a Type B DTC.

Diagnostic Aids

- A skewed or stuck exhaust differential pressure sensor will cause this DTC to set.
- The flexible part of the exhaust differential pressure lines are made of a high temperature hose that is protected by a braided covering. If the hoses are twisted or bent, they will not return to their normal size and shape. If the hoses are restricted, it may cause this DTC to set.

Reference Information

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

[Control Module References](#) for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify that no other DTCs are set.
 - **If any other DTCs are set**
Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#)
 - **Go to next step: If no other DTCs are set**
3. Ignition ON, verify that the DPF Differential Pressure parameter is between 0 and +3 kPa (0 and +0.14 PSI).
 - **If not within the specified range**
Refer to Circuit/System Testing.
 - **Go to next step: If within the specified range**
4. Engine running at a warm stabilized idle, observe the scan tool DPF Differential Pressure parameter. The value should be between 0 - 3 kPa (-0.15 psi and +0.44 psi).
 - **If not within the specified range**
Refer to Circuit/System Testing.
 - **Go to next step: If within the specified range**
5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed in the Freeze Frame/Failure Records data.
6. Verify the DTC is not set.
 - **If the DTC is set**
Refer to Circuit/System Testing.
 - **Go to next step: If no DTC is set**
7. All OK.

Circuit/System Testing

1. Verify the following conditions do not exist with the air induction system:
 - A loose air inlet duct

- A loose turbocharger air inlet clamp
- A damaged air cleaner housing
- A loose, leaking, or cracked intake manifold air resonator
- A cracked or damaged MAF sensor housing
- A skewed, stuck in range, or slow responding MAF sensor - Inspect the MAF sensor for contamination.
- **If a condition is found**

Repair as necessary

- **Go to next step: If no condition is found**

2. Verify the following conditions do not exist with the DPF, exhaust, and fuel system:

- Any damaged exhaust system components
- Loose or improperly installed exhaust system components.
- Restrictions in the B154 Exhaust Pressure Differential sensor ports
- Incorrect differential pressure line routing
- Damaged, bent, completely restricted, exhaust differential pressure lines
- Inspect for fuel contaminants. Refer to [Contaminants-in-Fuel Diagnosis](#).
- **If a condition is found**

Repair as necessary

- **Go to next step: If no condition is found**

3. Ignition Off and all vehicle systems Off, disconnect the harness connector at the B154 Exhaust Pressure Differential sensor. It may take up to 2 minutes for all vehicle systems to power down.

4. Test for less than 5 Ω between the low reference circuit terminal 2 and ground.

- **If 5 Ω or greater**

1. Ignition Off, disconnect the X2 connector at the K20 Engine Control Module.
2. Test for less than 2 Ω in the low reference circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.

- **Go to next step: If less than 5 Ω**

5. Ignition On.

6. Test for 4.8 - 5.2 V between the 5 V reference circuit terminal 1 and ground.

- **If less than 4.8 V**

1. Ignition Off, disconnect the X2 connector at the K20 Engine Control Module.
2. Test for infinite resistance between the 5 V reference circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance

3. Test for less than 2 Ω in the 5 V reference circuit end to end.

- If 2 Ω or greater, repair the open/high resistance in the circuit.
- If less than 2 Ω , replace the K20 Engine Control Module.

- **If greater than 5.2 V**

1. Ignition Off, disconnect the X2 connector at the K20 Engine Control Module, ignition On.
2. Test for less than 1 V between the 5 V reference circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.

- **Go to next step: If between 4.8 - 5.2 V**

7. Connect the harness connector at the B154 Exhaust Pressure Differential sensor.

8. Verify the scan tool DPF Differential Pressure Sensor parameter is greater than 0.0 V and less than 4.8 V.

- **If between 4.8 - 5.2 V**

1. Ignition Off, disconnect the X2 connector at the K20 Engine Control Module.
2. Test for infinite resistance between the signal circuit terminal 3 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
3. Test for less than 2 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.

- **If greater than 5.2 V**

1. Ignition Off, disconnect the harness connector at the B154 Exhaust Pressure Differential sensor and K20 Engine Control Module.
2. Ignition On.
3. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage in the circuit.
 - If less than 1 V
4. Ignition Off.
5. Test for less than 2 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.

- **If 0.0 V**

1. Ignition Off, disconnect the X2 connector at the K20 Engine Control Module.
2. Test for infinite resistance between the signal circuit terminal 3 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K20 Engine Control Module.

- **Go to next step: If greater than 0.0 V and less than 4.8 V**

9. Test or replace the B154 Exhaust Pressure Differential sensor.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

- Refer to [Exhaust Pressure Differential Sensor Replacement](#)

Perform the scan tool DPF Pressure Sensor Reset after replacing the exhaust pressure differential sensor.

- Refer to [Control Module References](#) for engine control module replacement, programming, and setup.

DTC P2457: EXHAUST GAS RECIRCULATION (EGR) COOLER LOW EFFICIENCY

Diagnostic Instructions

- Perform the [Diagnostic System Check - Vehicle](#) prior to using this diagnostic procedure.
- Review [Strategy Based Diagnosis](#) for an overview of the diagnostic approach.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptors

DTC 2457

Exhaust Gas Recirculation (EGR) Cooler Low Efficiency

Circuit/System Description

The exhaust gas recirculation (EGR) cooler has internal coolant passages and metal fins between the passages to help carry away excessive exhaust gas heat. Engine coolant flowing through the EGR cooler

helps cool the exhaust gases flowing to the EGR valve. The EGR cooler must remain within a specific temperature range to efficiently reduce emissions. The engine control module (ECM) determines the efficiency of the EGR cooler by monitoring both EGR temperature sensors while the EGR valve is active.

Conditions for Running the DTC

- DTC P0071, P0072, P0073, P0074, P00C7, P00E9, P00EA, P00EB, P00EC, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0119, P0128, P0335, P0336, P0405, P0406, P040B, P040C, P040D, P040E, P041B, P041C, P041D, P041E, P049D, P0722, P0723, P111E, P1428, P142A, P2227, P2228, P2229, P2230, P245C, or P262B is not set.
- The ignition is ON and the engine is running.
- The ignition voltage is greater than 11 V.
- The EGR temperature sensor 1 is between 95-850Â°C (203-1, 562Â°F).
- The barometric pressure is greater than 70 kPa (10.2 psi).
- The outside air temperature is warmer than -7Â°C (19.4Â°F).
- The engine coolant temperature is between 70-130Â°C (158 - 266Â°F).
- The engine speed is between 560-3, 100 RPM.

The DTC runs once per ignition cycle.

Conditions for Setting the DTC

The ECM detects that the EGR cooler efficiency is lower than a calibrated value for greater than 100 s.

Action Taken When the DTC Sets

DTC P2457 is a Type B DTC.

Conditions for Clearing the DTC

DTC P2457 is a Type B DTC.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

[Control Module References](#) for scan tool information

Circuit/System Verification

1. Ignition ON

2. Verify DTC P0071, P0072, P0073, P0074, P00C7, P00E9, P00EA, P00EB, P00EC, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0119, P0128, P0335, P0336, P0405, P0406, P040B, P040C, P040D, P040E, P041B, P041C, P041D, P041E, P049D, P0722, P0723, P111E, P1428, P142A, P2227, P2228, P2229, P2230, P245C, or P262B is not set.

- **If any of the DTCs are set**

Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#).

- **Go to next step: If none of the DTCs are set**

3. Verify that none of the conditions listed below exist:

- Low engine coolant level
- Contaminated engine coolant
- Damaged, leaking, or restricted engine cooling system
- Damaged, leaking, or restricted EGR cooler and cooler pipes/hoses
- Disconnected, damaged, or missing EGR cooler bypass valve linkage
- EGR cooler bypass valve binding or stuck
- **If a condition is found**

Repair as necessary.

- **Go to next step: If no condition is found**

4. Verify that DTC P2457 is not set.

- **If the DTC is set**

1. Clear all DTCs with a scan tool

2. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

3. Verify that DTC P2457 is not set.

- If a DTC is set, clean or replace the EGR cooler
- If no DTC is set.

4. All OK.

- **Go to next step: If no DTC is set**

5. All OK.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

Refer to [Exhaust Gas Recirculation Cooler Housing Replacement](#)

DTC P2459: DIESEL PARTICULATE FILTER (DPF) REGENERATION FREQUENCY

Diagnostic Instructions

- Perform the [Diagnostic System Check - Vehicle](#) prior to using this diagnostic procedure.
- Review [Strategy Based Diagnosis](#) for an overview of the diagnostic approach.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptors

DTC P2459

Diesel Particulate Filter (DPF) Regeneration Frequency

Circuit/System Description

The soot particles accumulate in the channels of the DPF and are burned off at regular intervals, through a process called regeneration or cleaning. The diesel particulate filter (DPF) cleaning process prevents the DPF from clogging. Excess soot in filter can cause a drop in engine performance and crack the filter during regeneration.

Conditions for Running the DTC

- The engine is running.
- The ignition voltage is greater than 11 V.

The DTC runs when the above conditions are met.

Conditions for Setting the DTC

The ECM detects that the actual soot level is greater than an expected soot level when regeneration is triggered.

Action Taken When the DTC Sets

DTC P2459 is a Type B DTC.

Conditions for Clearing the DTC

DTC P2459 is a Type B DTC.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

[Control Module References](#) for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify that no other DTCs are set.
 - **If any other DTCs are set**
Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#)
 - **Go to next step: If no other DTCs are set**
3. Verify the conditions listed below do not exist:
 - Any damaged exhaust system components
 - Loose or improperly installed exhaust system components.

- Restrictions in the exhaust differential pressure sensor ports.
- Damaged, bent, restricted, or kinked exhaust differential pressure lines.
- Induction system leaks.
- Loose or disconnected charge air cooler system components.
- **If a condition is found**

Repair as necessary

- **Go to next step: If no condition is found**

4. Ignition ON.

5. Verify DTC P2459 is not set.

- **If the DTC is set**

1. Perform the Diesel Particulate Filter Service Regeneration.

2. Verify the regeneration completed.

- If the regeneration did not complete, replace the Diesel Particulate Filter.
- If the regeneration completed

All OK.

- **Go to next step: If no DTC is set**

6. All OK.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

Refer to [Oxidation Catalytic Converter Replacement \(LH7\)](#).

Perform the scan tool DPF/Catalyst 2 Reset after replacing the exhaust particulate filter.

DTC P245A-P245D: EXHAUST GAS RECIRCULATION (EGR) COOLER BYPASS SOLENOID VALVE

Diagnostic Instructions

- Perform the [Diagnostic System Check - Vehicle](#) prior to using this diagnostic procedure.
- Review [Strategy Based Diagnosis](#) for an overview of the diagnostic approach.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptors

DTC P245A

Exhaust Gas Recirculation (EGR) Cooler Bypass Solenoid Valve Control Circuit

DTC P245B

Exhaust Gas Recirculation (EGR) Cooler Bypass Solenoid Valve Performance

DTC P245C

Exhaust Gas Recirculation (EGR) Cooler Bypass Solenoid Valve Control Circuit Low Voltage

DTC P245D

Exhaust Gas Recirculation (EGR) Cooler Bypass Solenoid Valve Control Circuit High Voltage

Circuit/System Description

The exhaust gas recirculation (EGR) cooler bypass solenoid valve is controlled by the Engine Control Module (ECM). At engine cold start, the EGR cooler bypass allows hot exhaust gas to heat the intake air

in the manifold. Once the engine operating temperature is reached, the ECM will close the EGR cooler bypass.

Conditions for Running the DTC

- The engine is running
- The ignition voltage is greater than 11 V.
- These DTCs run when the above conditions are met.

Conditions for Setting the DTC

P245A

The ECM detects an open circuit in the signal circuit.

P245B

The ECM detects that the intake air temperature is higher than maximum allowed value.

P245C

The ECM detects a short to ground in the control circuit.

P245D

The ECM detects a short to voltage in the control circuit.

Action Taken When the DTC Sets

DTCs P245A, P245B, P245C and P245D are Type B DTCs.

Conditions for Clearing the DTC

DTCs P245A, P245B, P245C and P245D are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

[Control Module References](#) for scan tool information

Special Tools

EL-23738-A Vacuum Pump

Circuit/System Verification

1. Disconnect the vacuum source from the EGR Cooler Bypass valve.
2. Connect the **EN-23738-A** Mityvac to the Q47 Exhaust Gas Recirculation Cooler Bypass Solenoid Valve vacuum supply hose.
3. Engine running, verify the vacuum is greater than -50 kPa (-7.25 PSI).
 - **If less than -50 kPa (-7.25 PSI)**
 1. Ignition OFF.
 2. Inspect the vacuum supply hose and filter for a leak or restriction
 - If the vacuum supply hose and filter are damaged, repair as necessary.
 - If the vacuum supply hose and filter are not damaged, replace the vacuum pump.
 - **Go to next step: If greater than -50 kPa (-7.25 PSI)**
4. Connect the vacuum source to the Q47 Exhaust Gas Recirculation Cooler Bypass Solenoid Valve. Engine running, command the EGR Cooler Bypass valve OFF with a scan tool.
5. Connect the **EN-23738-A** Mityvac to the EGR Cooler Bypass valve vacuum port on the EGR Cooler Bypass valve.
6. Verify the vacuum is at 0 kPa (0 PSI).
 - **If greater than 0 kPa (0 PSI)**

Replace the Q47 Exhaust Gas Recirculation Cooler Bypass Solenoid Valve.
 - **Go to next step: If 0 kPa (0 PSI)**
7. Command the EGR Cooler Bypass valve ON with a scan tool.
8. Verify the vacuum is greater than -50 kPa (-7.25 PSI).
 - **If less than -50 kPa (-7.25 PSI)**

Refer to Circuit/System Testing.
 - **Go to next step: If greater than -50 kPa (-7.25 PSI)**
9. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the Q47 Exhaust Gas Recirculation Cooler Bypass Solenoid Valve. Ignition ON.
2. Connect a test lamp between the control circuit terminal 2 and B+.
3. Verify the test lamp turns ON and OFF while commanding the Q47 Exhaust Gas Recirculation Cooler Bypass Solenoid Valve ON and OFF with a scan tool.
 - **If the test lamp is always ON**
 1. Ignition OFF, disconnect the X2 harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground.
 - If infinite resistance, replace the K20 Engine Control Module.
 - **If the test lamp is always OFF**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 3. Test for less than 2 Ω in the circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.

- **Go to next step: If the test lamp turns ON and OFF**

4. Ignition ON, verify a test lamp illuminates between the voltage circuit terminal 1 and ground

- **If the test lamp does not illuminate**

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.

2. Test for infinite resistance between the ignition circuit and ground.

- If less than infinite resistance, repair the short to ground on the circuit.
- If infinite resistance

3. Test for less than 2 Ω in the ignition circuit end to end.

- If 2 Ω or greater, repair the open/high resistance in the circuit.
- If less than 2 Ω , replace the K20 Engine Control Module.

- **Go to next step: If the test lamp illuminates**

5. Test or replace the Q47 Exhaust Gas Recirculation Cooler Bypass Solenoid Valve.

Component Testing

Static Test

1. Ignition OFF, disconnect the harness connector at the Q47 Exhaust Gas Recirculation Cooler Bypass Solenoid Valve.

2. Test for 25 - 35 Ω between the control terminal 1 and the voltage terminal 2 of the Q47 Exhaust Gas Recirculation Cooler Bypass Solenoid Valve.

- **If not within 20 - 35 Ω**

Replace the Q47 Exhaust Gas Recirculation Cooler Bypass Solenoid Valve.

- **Go to next step: If within 20 - 35 Ω**

3. Test for infinite resistance between each terminal and the Q47 Exhaust Gas Recirculation Cooler Bypass Solenoid Valve housing.

- **If less than infinite resistance**

Replace the Q47 Exhaust Gas Recirculation Cooler Bypass Solenoid Valve.

- **Go to next step: If infinite resistance**

4. All OK.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

Refer to [Control Module References](#) for Engine Control Module replacement, programming and setup.

Refer to [Exhaust Gas Recirculation Vacuum Regulator Solenoid Valve Replacement](#)

DTC P2463: DIESEL PARTICULATE FILTER (DPF) SOOT ACCUMULATION

Diagnostic Instructions

- Perform the [Diagnostic System Check - Vehicle](#) prior to using this diagnostic procedure.
- Review [Strategy Based Diagnosis](#) for an overview of the diagnostic approach.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptor

DTC P2463

Diesel Particulate Filter (DPF) Soot Accumulation

Circuit/System Description

The soot particles accumulate in the channels of the diesel particulate filter (DPF) and are burned off at regular intervals, through a process called regeneration or cleaning. The DPF cleaning process prevents the DPF from clogging. Excess soot in filter can cause a drop in engine performance and crack the filter during regeneration.

Conditions for Running the DTC

- DTC P00C7, P00E9, P00EA-P00EC, P0101, P0102, P0103, P0106, P0107, P0108, P0116, P0117, P0118, P0119, P0128, P0201-P0208, P020A-P020F, P0216, P021A, P021B, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0279, P0280, P0282, P0283, P02EE, P02EF, P02F0-P02F5, P0405, P0406, P049D, P062B, P062D, P0722, P0723, P111E, P113E, P1197, P1248, P1249, P124A-P124F, P2147, P2148, P2150, P2151, P2153, P2154, P2156, or P2157 is not set.
- Engine speed is greater than 800 RPM
- Ambient temperature is warmer than -40Â°C (-40Â°F)
- Engine coolant temperature is warmer than -40Â°C (-40Â°F)

The DTC runs continuously when the above conditions are met

Conditions for Setting the DTC

The ECM detects that the diesel particulate filter is clogged and needs service regeneration.

Action Taken When the DTC Sets

DTC P2463 is a Type A DTC.

Conditions for Clearing the DTC

DTC P2463 is a Type A DTC.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify DTC P0422, P244C, or P24A0 is not set.
 - If any of the DTCs are set
3. Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#)

- **Go to next step: If none of the DTCs are set**

4. Verify no other DTCs are set.

- **If any other DTC is set**

Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#)

- **Go to next step: If no other DTC is set**

5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

6. Verify the does not set.

- **If the DTC sets**

Refer to Circuit/System Testing.

- **Go to next step: If the DTC does not set**

7. All OK.

Circuit/System Testing

1. Verify the following conditions do not exist with the exhaust pressure differential system:

- Modifications.
- Externally damaged or worn components.
- Loose or improperly installed components.
- Improperly routed differential pressure lines - The exhaust differential pressure line should have a continuous downward gradient without any sharp bends or kinks from the sensor to the DPF.
- Leaks or internal restrictions from the B154 Exhaust Pressure Differential sensor lines.
- **If a condition is found**

Repair as necessary

- **Go to next step: If no condition is found**

NOTE: Pinhole size leaks in the induction system or exhaust system may cause this DTC to set. Verifying the integrity of these systems is critical to a proper diagnosis. The Full System Air Leak Test must be performed first, then the Induction System Smoke Test must be performed in order to identify any leaks that may exist.

2. Verify the following conditions do not exist:

- Charge air cooler (CAC) and Air induction system leaks. Perform the Full System Air Leak Test and then the Induction System Smoke Test. Refer to [Charge Air Cooler Diagnosis \(Leak Test\)](#)[Charge Air Cooler Diagnosis \(Smoke Test\)](#)
- Exhaust system leaks. An exhaust system leak may cause inaccurate B131 Exhaust Gas Temperature sensor or B154 Exhaust Pressure Differential sensor values causing this DTC to set - Refer to [Exhaust Leakage](#) .
- Water in fuel contamination - Refer to [Contaminants-in-Fuel Diagnosis](#).
- A cracked or damaged MAF sensor housing.
- A skewed, stuck in range, or slow responding MAF sensor. Inspect the MAF sensor for contamination. Refer to [DTC P0101](#) .
- A skewed or shifted B154 Exhaust Pressure Differential sensor. A sensor that is skewed will cause inaccuracies in the soot model and may cause this DTC to set.
- Failed, intermittent, improperly installed or loose B131 Exhaust Gas Temperature sensors will cause inaccuracies in the soot model and cause this DTC to set.
- Engine mechanical condition, for example low compression. Refer to [Symptoms - Engine Mechanical](#) .
- **If a condition is found**

Repair as necessary

- **Go to next step: If no condition is found**

3. Perform **Diesel Particulate Filter (DPF) Service Regeneration** .

- **If the DPF service regeneration does not complete**

Replace the diesel particulate filter.

- **Go to next step: If the DPF service regeneration completes**

4. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Refer to **Oxidation Catalytic Converter Replacement (LH7)**.

Perform the scan tool DPF/Catalyst 2 Reset after replacing the exhaust particulate filter.

DTC P248A-P248D: REDUCTANT HEATER 1-2 FEEDBACK CIRCUIT LOW/HIGH VOLTAGE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- Refer to **Diagnostic Procedure Instructions** to provide an overview of each diagnostic category.

DTC Descriptors

DTC P248A

Reductant Heater 1 Feedback Circuit Low Voltage

DTC P248B

Reductant Heater 1 Feedback Circuit High Voltage

DTC P248C

Reductant Heater 2 Feedback Circuit Low Voltage

DTC P248D

Reductant Heater 2 Feedback Circuit High Voltage

Circuit/System Description

As reductant will freeze at temperatures below -11°C (12°F), there are 2 reductant heaters located in the reductant tank. One heats the reductant in the tank and one heats the reductant supplied to the reductant injector supply pipe. The ECM monitors the reductant temperature in the tank in order to determine if reductant temperature is below its freeze point. If the ECM determines that the reductant may be frozen, it activates a "defrost strategy" energizing the reductant heater. This energizing action terminates when the temperature sensor measures a threshold value over which the heater must be deactivated.

Conditions for Running the DTCs

- DTC U010E is not set.
- The ignition voltage is greater than 11 V.
- The ignition is on or the engine is running.
- The reductant heaters are on.

The DTCs run continuously when the above conditions are met.

Conditions for Setting the DTC

P248A

There is greater than 3 V difference between battery voltage and reductant tank heater voltage.

P248C

There is greater than 3 V difference between battery voltage and reductant line heater voltage.

Action Taken When the DTC Sets

DTCs P248A, P248B, P248C and P248D are Type A DTCs.

- The reductant injector is disabled.
- The reductant heaters are disabled.
- The selective catalyst reduction system is put in standby mode.
- The Diesel Exhaust Fluid (DEF) Warning Strategy (Anti-Tampering) is activated.

Conditions for Clearing the DTC

DTCs P248A, P248B, P248C and P248D are Type A DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify that DTC U010E is not set.
 - **If the DTC is set**
 - Refer to **DTC U0100-U02FE** for further diagnosis.
 - **Go to next step: If the DTC is not set**
3. Command the Reductant heater 1 and 2 ON and OFF with a scan tool and verify that Reductant Heater 1 and 2 Current parameters are between 0 - 25.5 A.
 - **If not between 0 - 25.5 A.**

Refer to Circuit/System Testing.

- **Go to next step: If between 0 - 25.5 A**
- 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
- 5. Verify the DTC does not set
 - **If the DTC sets**

Refer to Circuit/System Testing.
 - **Go to next step: If no DTC sets**
- 6. All OK.

Circuit/System Testing

DTC P248A

1. Ignition OFF and all vehicle systems OFF. It may take up to 2 minutes for all vehicle systems to power down, disconnect the harness connector at the A38 Reductant Pump and Sensor Assembly.
2. Test for less than 10 Ω between the low reference circuit terminal 11 and ground.
 - **If 10 Ω or greater**
 1. Ignition OFF, disconnect the harness connector at the K115 Reductant Control Module.
 2. Test for less than 2 Ω in the low reference circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K115 Reductant Control Module.
 - **Go to next step: If less than 10 Ω**
3. Connect a test lamp between heater control circuit terminal 9 and ground.
4. Ignition ON, verify the test lamp turns ON and OFF while commanding Reductant Heater 1 ON and OFF with a scan tool.
 - **If the test lamp is always OFF**
 1. Ignition OFF, disconnect the harness connector at the K115 Reductant Control Module.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 Ω in the control circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K115 Reductant Control Module.
 - **If the Test lamp is always ON**
 1. Ignition OFF, disconnect the harness connector at the K115 Reductant Control Module, ignition ON
 2. Test for less than 1.0 V between the control circuit and ground
 - If 1.0 V or greater, repair the short to voltage in the circuit.
 - If less than 1.0 V, replace the K115 Reductant Control Module.
 - **Go to next step: If the Test lamp responds appropriately to the commanded states**
5. Test or replace the A38 Reductant Pump and Sensor Assembly.

DTC P248C

1. Ignition OFF and all vehicle systems OFF. It may take up to 2 minutes for all vehicle systems to power down, disconnect the harness connector at the E52 Reductant Line Heater.
2. Test for less than 10 Ω between the low reference circuit terminal 1 and ground.
 - **If 10 Ω or greater**
 1. Ignition OFF, disconnect the harness connector at the K115 Reductant Control Module.
 2. Test for less than 2 Ω in the low reference circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.

- If less than 2 Ω , replace the K115 Reductant Control Module.
 - **Go to next step: If less than 10 Ω**
3. Connect a test lamp between heater control circuit terminal 2 and ground.
 4. Ignition ON, Verify the test lamp turns ON and OFF while commanding Reductant Heater 2 ON and OFF with a scan tool.
 - **If the test lamp is always OFF**
 1. Ignition OFF, disconnect the harness connector at the K115 Reductant Control Module.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 Ω in the control circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K115 Reductant Control Module.
 - **If the Test lamp is always ON**
 1. Ignition OFF, disconnect the harness connector at the K115 Reductant Control Module, ignition ON
 2. Test for less than 1.0 V between the control circuit and ground
 - If 1.0 V or greater, repair the short to voltage in the circuit.
 - If less than 1.0 V, replace the K115 Reductant Control Module.
 - **Go to next step: If the Test lamp responds appropriately to the commanded states**
 5. Test or replace the E52 Reductant Line Heater.

Component Testing

Reductant Tank Heater

1. Ignition OFF, disconnect the harness connector at the A38 Reductant Pump and Sensor Assembly.
2. Test for 1 - 2 Ω between terminals 9 and 11 of the A38 Reductant Pump and Sensor Assembly.
 - **If not within 1 - 2 Ω**
 Replace the A38 Reductant Pump and Sensor Assembly.
 - **Go to next step: If within 1 - 2 Ω**
3. Test for infinite resistance between each terminal and the A38 Reductant Pump and Sensor Assembly housing/case.
 - terminal 9
 - terminal 11
 - **If less than infinite resistance**
 Replace the A38 Reductant Pump and Sensor Assembly.
 - **Go to next step: If infinite resistance**
4. All OK.

Reductant Line Heater

1. Ignition OFF, disconnect the harness connector at the E52 Reductant Line Heater.
2. Test for 1 - 2 Ω between terminals 1 and 2 of the Reductant Line Heater.
 - **If not within 1 - 2 Ω**
 Replace the E52 Reductant Line Heater.
 - **Go to next step: If within 1 - 2 Ω**
3. Test for infinite resistance between each terminal and the E52 Reductant Line Heater housing/case.

- terminal 1
- terminal 2
- **If less than infinite resistance**

Replace the E52 Reductant Line Heater.

- **Go to next step: If infinite resistance**

4. All OK.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

Perform the [Reductant System Tamper Service Bay Test](#) after completing the repair to clear the Service Emission System or Service Exhaust Fluid System warning message, if displayed.

- Refer to [Emission Reduction Fluid Tank Replacement](#) for reductant pump and sensor assembly replacement.
- Refer to [Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe Replacement \(FWD\)](#), [Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe Replacement \(Front AWD\)](#), [Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe Replacement \(Rear AWD\)](#) for reductant line heater replacement.
- Refer to [Emission Reduction Fluid Controller Replacement](#)

DTC P24A5: EXHAUST GAS RECIRCULATION (EGR) COOLER BYPASS VALVE STUCK

Diagnostic Instructions

- Perform the [Diagnostic System Check - Vehicle](#) prior to using this diagnostic procedure.
- Review [Strategy Based Diagnosis](#) for an overview of the diagnostic approach.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptors

DTC P24A5

Exhaust Gas Recirculation (EGR) Cooler Bypass Valve Stuck

Circuit/System Description

The exhaust gas recirculation (EGR) cooler bypass solenoid valve is controlled by the engine control module (ECM). At engine cold start, the EGR cooler bypass allows hot exhaust gas to heat the intake air in the manifold. Once the engine operating temperature is reached, the ECM will close the EGR cooler bypass.

The EGR cooler bypass valve is intrusively opened under stationary idle engine conditions. The ECM detects the change in temperature downstream of the EGR cooler while the bypass valve is closed and open.

Conditions for Running the DTC

- Engine speed is between 680 - 950 RPM.
- Vehicle speed is less than 2 km/h (1.2 MPH)
- Engine coolant temperature is between 70 - 117°C (158 - 243°F).
- Ignition voltage is greater than 11 V.
- DTC P24A5 runs when the above conditions are met.

The DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

The ECM detects that the absolute difference between temperature change after a change in the valve position and temperature change before change in the valve position is less than a calibrated threshold.

Action Taken When the DTC Sets

DTC P24A5 is a Type B DTC.

Conditions for Clearing the DTC

DTC P24A5 is a Type B DTC.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

[Control Module References](#) for scan tool information

Circuit/System Verification

1. Ignition On.
2. Verify DTC P0116, P0117, P0118, P0119, P011E, P0128, P040B, P040C, P040D, P040E, P041B, P041C, P041D, P041E, P042E, P042F, P0502, P0503, P0722, P0723, P1427, P1428, P1429, P142A, P245A, P245C, or P245D is not set.

- **If any of the DTCs are set**

Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) .

- **Go to next step: If none of the DTCs are set**

3. Ignition OFF, verify the conditions listed below do not exist:

NOTE: All vacuum lines, including those routed to the EGR cooler bypass valve and brake booster must be carefully inspected.

- Leaking, damaged, kinked, restricted or incorrectly routed vacuum lines.
- Damaged Q47 Exhaust Gas Recirculation Cooler Bypass Solenoid Valve.
- Damaged EGR cooler bypass actuator.
- Damaged or incorrect installation of power brake booster.
- **If a condition exists**

Repair or replace as necessary.

- **Go to next step: If none of the conditions exist**

4. Disconnect the vacuum supply hose at the Q47 Exhaust Gas Recirculation Cooler Bypass Solenoid Valve and connect the **GE 23738-A**, or a suitable vacuum gauge, to the hose.
5. Engine idling, verify the vacuum is 50 kPa (14.8 in. Hg.) or greater.

- **If less than 50 kPa (14.8 in. Hg.)**

Check the vacuum pump for proper operation and the vacuum reservoir for leaks.

- **Go to next step: If 50 kPa (14.8 in. Hg.) or greater**

6. Ignition Off, reconnect the vacuum supply hose to the Q47 Exhaust Gas Recirculation Cooler Bypass Solenoid Valve.
7. Disconnect the vacuum outlet hose from the Q47 Exhaust Gas Recirculation Cooler Bypass Solenoid Valve and connect the **GE 23738-A** to the outlet port on the valve.
8. Engine idling, verify the vacuum changes from 0 kPa (0 in. Hg.) to 40 kPa (11.8 in. Hg.) or greater while commanding the EGR Cooler Bypass Solenoid Valve On and Off with a scan tool.
 - If less than 40 kPa (11.8 in. Hg.)

Replace the Q47 Exhaust Gas Recirculation Cooler Bypass Solenoid Valve

- If 40 kPa (11.8 in. Hg.) or greater

9. Reconnect the vacuum hose at the Q47 Exhaust Gas Recirculation Cooler Bypass Solenoid Valve.
10. Verify the EGR cooler bypass actuator linkage extends and retracts while commanding the EGR Cooler Bypass Solenoid Valve On and Off with a scan tool.

- **If the linkage does not extend or retract**

1. Disconnect the EGR cooler bypass valve actuator linkage from the EGR manifold.
2. Verify the linkage extends and retracts while commanding the EGR Cooler Bypass Solenoid Valve On and Off with a scan tool.
 - If the linkage does not extend or retract, replace the EGR cooler bypass valve actuator.
 - If the linkage extends and retracts, repair or replace the EGR manifold as necessary.

- **Go to next step: If the linkage extends and retracts**

11. Clean or replace the EGR cooler.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

- Refer to [Exhaust Gas Recirculation Valve Replacement](#)
- Refer to [Control Module References](#) for engine control module replacement, programming and setup.

DTC P24B0-P24B6, P24C7, P24D0, OR P24D1: PARTICULATE MATTER SENSOR

Diagnostic Instructions

- Perform the [Diagnostic System Check - Vehicle](#) prior to using this diagnostic procedure.
- Review [Strategy Based Diagnosis](#) for an overview of the diagnostic approach.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptors

DTC P24B0

Particulate Matter Sensor Circuit Low Voltage

DTC P24B1

Particulate Matter Sensor Circuit High Voltage

DTC P24B3

DTC P24B4

Particulate Matter Sensor Heater Control Circuit Performance

DTC P24B5

Particulate Matter Sensor Heater Control Circuit Low Voltage

DTC P24B6

Particulate Matter Sensor Heater Control Circuit High Voltage

DTC P24C7

Particulate Matter Sensor Temperature Circuit Performance

DTC P24D0

Particulate Matter Sensor Supply Voltage Circuit Low Voltage

DTC P24D1

Particulate Matter Sensor Regeneration Incomplete

Circuit/System Description

The particulate matter (PM) sensor monitors the amount of the particulates (soot) in the diesel exhaust gas exiting the tailpipe. The PM sensor is similar to the heated oxygen sensor with a ceramic element, but also includes an individually calibrated sensor control unit (SCU). The sensing element includes comb-shaped interdigital electrodes (IDE), a heater and a positive temperature coefficient resistor for temperature measurement.

The operation of the PM Sensor is based on the electrical conductivity characteristic of the diesel particulate. As the exhaust gas flows over the sensing element, soot is absorbed in the combs between the electrodes, eventually creating a conductive path. When the path is formed, it generates a current based on the voltage being applied to the element. The measurement process continues until a preset current value is reached. To avoid misleading readings, the sensor performs a regeneration where the soot is cleaned off by heating up the element, before the measurement phase begins. The amount of regenerations is based on vehicle strategy; when the calibrated number of regenerations is reached, the cumulative current readings are used to determine the amount of soot concentration in the exhaust gas which in turn determines the collection efficiency of the diesel particulate filter (DPF).

Conditions for Running the DTCs

P24B0

- DTC P142C, P142D, P142E, P142F, P1474, P1474, P1476, P1477, P1478, P16D7, P16D8, P16D9, P24B1, P24B3, P24B5, P24B6, P24D0, or U02A3 is not set.
- The ignition is ON.
- The ignition voltage is greater than 11 V.
- The particulate matter sensor temperature is between 580 - 800Â°C (1, 076 - 1, 472Â°F).
- The reductant control module relay 2 is commanded ON.

The DTC runs continuously when the above conditions are met.

P24B1, P24B3, P24B5, P24B6, P24D0

- DTC P16D7, P16D8, or P16D9, P24D0, or U02A3 is not set.
- The ignition is ON and the engine is not cranking.
- The ignition voltage is greater than 11 V.

- The reductant control module relay 2 is commanded ON.

The DTCs run continuously when the above conditions are met.

P24C7

- DTC P0071, P0072, P0073, P00C7, P00E9, P00EA-P00EC, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0119, P0128, P0201-P0208, P020A-P020F, P0216, P021A, P021B, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0279, P0280, P0282, P0283, P02EE, P02EF, P02F0-P02F5, P0405, P0406, P049D, P062B, P062D, P0772, P0773, P111E, P113F, P1198, P1248, P1249, P124A-P124F, P126A, P142D, P142C, P142F, P142E, P1474, P1475, P1476, P1477, P1478, P16D7, P16D8, P16D9, P2032, P2033, P2084, P2085, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P2227, P2228, P2229, P2230, P2481, P2482, P2483, P2484, P24B0, P24B1, P24B3, P24B5, P24B6, P24D0, P262B, or U02A3 is not set.
- The ignition is ON and the engine is not cranking.
- The ignition voltage is greater than 11 V.
- The ambient temperature is warmer than -12Â°C (10Â°F).
- The barometric pressure is greater than 75 kPa (10.9 psi).
- The reductant control module relay 2 is commanded ON.
- The Particulate Matter Sensor Operation parameter displays Allowed.
- The time since particulate matter sensor regeneration is greater than 225 s.

The DTC runs continuously when the above conditions are met.

P24B4

- DTC P0071, P0072, P0073, P142C, P142D, P142E, P142F, P1474, P1474, P1476, P1477, P1478, P16D7, P16D8, or P16D9, P24B1, P24B3, P24B5, P24B6, P24D0, or U02A3 is not set.
- The ignition is ON and the engine is not cranking.
- The ignition voltage is greater than 11 V.
- The ambient temperature is warmer than -40Â°C (-40Â°F).
- The reductant control module relay 2 is commanded ON.

The DTC runs continuously when the above conditions are met.

P24D1

- DTC P00C7, P00E9, P00EA-P00EC, P0101, P0102, P0103, P0106, P0107, P0108, P0116, P0117, P0118, P0119, P0128, P0201-P0208, P020A-P020F, P0216, P021A, P021B, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0279, P0280, P0282, P0283, P02EE, P02EF, P02F0-P02F5, P0405, P0406, P049D, P062B, P062D, P0772, P0773, P111E, P113F, P1198, P1248, P1249, P124A-P124F, P126A, P16D7, P16D8, P16D9, P2032, P2033, P2084, P2085, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P2227, P2228, P2229, P2230, P2481, P2482, P2483, P2484, P262B, or U02A3 is not set.
- The ignition is ON.
- The ignition voltage is greater than 11 V.
- The reductant control module relay 2 is commanded ON.

The DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

The particulate matter sensor control unit detects an internal fault of the sensor, fault of the sensor circuitry, or low voltage on the sensor supply circuit.

Action Taken When the DTC Sets

DTCs P24B0, P24B1, P24B3, P24B5, P24B6, P24C7, P24D0, and P24D1 are Type B DTCs.

DTC P24B4 is a Type C DTC.

Conditions for Clearing the DTC

DTCs P24B0, P24B1, P24B3, P24B5, P24B6, P24C7, P24D0, and P24D1 are Type B DTCs.

DTC P24B4 is a Type C DTC.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

Powertrain Component Views

Description and Operation

Exhaust Aftertreatment System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information.

Circuit/System Verification

1. Ignition On.

Verify that DTC P0071, P0072, P0073, P00C7, P00E9, P00EA-P00EC, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0119, P0128, P0201-P0208, P020A-P020F, P0216, P021A, P021B, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0279, P0280, P0282, P0283, P02EE, P02EF, P02F0-P02F5, P0405, P0406, P049D, P062B, P062D, P0772, P0773, P111E, P113F, P1198, P1248, P1249, P124A-P124F, P126A, P142D, P142C, P142F, P142E, P1474, P1475, P1476, P1477, P1478, P16D7, P16D8, P16D9, P2032, P2033, P2084, P2085, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P2227, P2228, P2229, P2230, P2481, P2482, P2483, P2484, P262B, or U02A3 is not set.

- **If any of the DTCs are set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**

- **Go to next step: If none of the DTCs are set**

2. Verify DTC P24D0 is not set.

- **If the DTC sets**

Refer to Circuit/System Testing

- **Go to next step: If the DTC does not set**

3. Verify DTC P24B0, P24B1, P24B3, P24B4, P24B5, P24B6, P24C7, or P24D1 is not set.

- **If the DTC sets**

Replace the B136 Exhaust Particulate Matter Sensor.

- **Go to next step: If the DTC does not set**

4. All OK.

Circuit/System Testing

1. Ignition Off, disconnect the harness connector at the B136 Exhaust Particulate Matter Sensor, ignition On.

2. Verify that a test lamp illuminates between the sensor ignition voltage circuit terminal 6 and ground.

- **If the test lamp does not illuminate**

1. Ignition Off, remove the test lamp and remove fuse F19 from the X50A Underhood Fuse Block.

2. Test for less than 2Ω in the sensor ignition voltage circuit end to end.

- If 2Ω or greater, repair the open/high resistance in the circuit.
- If less than 2Ω

3. Test for infinite resistance between the sensor ignition voltage circuit and ground.

- If less than infinite resistance, repair the short to ground on the circuit.
- If infinite resistance

- **Go to next step: If the test lamp illuminates**

3. Replace the B136 Exhaust Particulate Matter Sensor.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

Refer to [Exhaust Particulate Sensor Replacement](#)

DTC P2544: TRANSMISSION TORQUE REQUEST CIRCUIT MESSAGE COUNTER INCORRECT

Diagnostic Instructions

- Perform the [Diagnostic System Check - Vehicle](#) prior to using this diagnostic procedure.
- Review [Strategy Based Diagnosis](#) for a overview of the diagnostic approach.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptors

DTC P2544

Transmission Torque Request Circuit Message Counter Incorrect

Circuit/System Description

To improve shift feel, the transmission control module (TCM) is constantly sending the engine control module (ECM) serial data messages with requests to modify engine speed or torque. These serial data messages are sent through two circuits which are part of a communication network called the controller area network (CAN). The ECM sets DTC P2544 when it detects a discrepancy in the structure of the message causing the integrity of the message to be questioned.

Conditions for Running the DTC

- The engine run time is greater than 0.5 s.
- No other CAN errors are present.

Conditions for Setting the DTC

The ECM detects that the engine speed and torque modification messages from the TCM are either corrupted or intermittently missing for greater than 4 s.

Action Taken When the DTC Sets

- DTC P2544 is a Type B DTC.
- The TCM commands maximum line pressure during shifts, which results in harsh shifts.
- The TCM freezes adaptive functions.

Conditions for Clearing the DTC

DTC P2544 is a Type B DTC.

Diagnostic Aids

An intermittent fault in the CAN circuits will cause the ECM to set DTC P2544.

Reference Information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

NOTE:

- **DTC P2544 is an informational DTC.**
- **Diagnose all other engine control module DTCs prior to DTC P2544.**

1. Verify that no other DTCs are set except for DTC P2544.

- **If any other DTCs are set**

Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) .

- **Go to next step: If only DTC P2544 is set**

2. Replace the K71 Transmission Control Module.

3. Operate the vehicle within the conditions for running the DTC. You may also operate the vehicle within the conditions that you observed from the freeze frame/failure records data.

4. Verify the DTC does not set.

- **If DTC sets**

Replace the K20 Engine Control Module.

- **Go to next step: If DTC does not set**

5. All OK.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

Refer to [Control Module References](#) for ECM or TCM replacement, programming, and setup

DTC P2564 OR P2565: TURBOCHARGER VANE POSITION SENSOR CIRCUIT LOW/HIGH VOLTAGE

Diagnostic Instructions

- Perform the Diagnostic System Check prior to using this diagnostic procedure: [Diagnostic System Check - Vehicle](#)
- Review the description of Strategy Based Diagnosis: [Strategy Based Diagnosis](#)

- An overview of each diagnostic category can be found here: [Diagnostic Procedure Instructions](#)

DTC Descriptor

DTC P2564

Turbocharger Vane Position Sensor Circuit Low Voltage

DTC P2565

Turbocharger Vane Position Sensor Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P0107, P0335, P0557, P057C, P0651, P0700, P16A0, P2564, P2803	P2564	P0651*	-
Signal	P2564	P2565	P2565	P0046, P2598, P2599
Low Reference	-	P2565	P2565	P0046, P2599
* Additional DTCs may set.				

Typical Scan Tool Data

Turbocharger Vane Position Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine - Idling - At normal operating temperature			
Parameter Normal Range: 85 to 95% 3 to 4 V			
5 V Reference	0% 0.0 V	0% 0.1 V	100% 5.0 V
Signal	0% 0.0 V	100% 5.0 V	100% 5.0 V
Low Reference	-	100% 5.0 V	-

Circuit/System Description

For an overview of the component/system, refer to: [Turbocharger System Description](#)

Circuit	Description
5 V Reference	Regulated voltage supplied by the control module.
Signal	The control module input circuit has an internal resistance connected to 5 V.
Low Reference	Grounded through the control module.

Component	Description
K20 Engine Control Module	The control module contains a microprocessor used to process input data to control outputs. The control module controls a series of actuators to ensure optimal engine performance. The control module does this by reading values from a variety of sensors, interprets the data and adjusts the engine actuators accordingly.

Component	Description
B112 Turbocharger Vane Position Sensor	The sensor is an analog potentiometer that varies its resistance proportionally with the position of the control rod. The variable geometry turbocharger includes a ring of aerodynamically shaped vanes in the turbine housing at the exhaust inlet. With changing the angle of the vanes it is possible to regulate the boost pressure. The vanes are rotated by a vacuum actuator which is controlled by a solenoid valve.

Conditions for Running the DTC

- Ignition = On or Engine = Running
- Ignition Voltage = Greater than 11 V
- Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

Turbocharger Vane Position Sensor = No Signal - For greater than 1 s

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type A DTC

Warning Message = Reduced Engine Power

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type A DTC

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

Powertrain Component Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References

Circuit/System Verification

1. Engine = Running

2. Verify the scan tool parameter: Turbocharger Vane Position Sensor = 0.5 to 4.5 V

- **If not between 0.5 and 4.5 V**

Refer to: Circuit/System Testing

- **Go to next step: If between 0.5 and 4.5 V**

3. Verify the scan tool parameter: Turbocharger Vane Position Sensor = The value should change with accelerator pedal input.

- **If the value does not change**

Refer to: Circuit/System Testing

- **Go to next step: If the value changes**

4. Perform the scan tool control function: Turbocharger Vane Position - Increase

Verify the scan tool parameter: Turbocharger Vane Position = The value should not spike or drop out while moving the sensor through the entire range.

- Perform the action while monitoring the parameter:
 - Wiggle the harness and connector: K20 Engine Control Module

WARNING: While engine is operating, the exhaust system will become extremely hot. To prevent burns avoid contacting a hot exhaust system.

- Wiggle the harness and connector: B112 Turbocharger Vane Position Sensor
- **If the value spikes or drops out**

Repair as necessary - Wiring/Terminal (s)/Electrical Connector (s)

- **Go to next step: If the value does not spike or drop out**

5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Verify the DTC does not set.

- **If the DTC sets**

Refer to: Circuit/System Testing

- **Go to next step: If the DTC is not set**

6. All OK.

Circuit/System Testing

NOTE: It may take up to 2 min for all vehicle systems to power down before an accurate ground or low reference circuit continuity test can be performed.

1. Ignition/Vehicle & All vehicle systems - Off

2. Disconnect the electrical connector: B112 Turbocharger Vane Position Sensor

3. Test for less than 5 ohms between the test points: Low Reference circuit terminal 2 & Ground

- **If 5 ohms or greater**

1. Disconnect the electrical connector: X2 @ K20 Engine Control Module

2. Test for less than 2 ohms between the test points: Low Reference circuit terminal 2 @ Component harness & The other end of the circuit @ Control module harness

- If 2 ohms or greater - Repair the open/high resistance in the circuit.
- If less than 2 ohms - Replace the component: K20 Engine Control Module
- **Go to next step: If less than 5 ohms**

4. Ignition - On/Vehicle - In Service Mode

5. Test for 4.8 to 5.2 V between the test points: 5 V Reference circuit terminal 3 & Low Reference circuit terminal 2

- **If less than 4.8 V**

1. Ignition/Vehicle - Off

2. Disconnect the electrical connector: X2 @ K20 Engine Control Module

3. Test for infinite resistance between the test points: 5 V Reference circuit terminal 3 @ Component harness & Ground

- If less than infinite resistance - Repair the short to ground on the circuit.
- If infinite resistance

4. Test for less than 2 ohms between the test points: 5 V Reference circuit terminal 3 @ Component harness & The other end of the circuit @ Control module harness

- If 2 ohms or greater - Repair the open/high resistance in the circuit.
- If less than 2 ohms - Replace the component: K20 Engine Control Module

- **If greater than 5.2 V**

1. Ignition/Vehicle - Off

2. Disconnect the electrical connector: X2 @ K20 Engine Control Module

3. Ignition - On/Vehicle - In Service Mode

4. Test for less than 1 V between the test points: 5 V Reference circuit terminal 3 @ Component harness & Ground

- If 1 V or greater - Repair the short to voltage on the circuit.
- If less than 1 V - Replace the component: K20 Engine Control Module

- **Go to next step: If between 4.8 and 5.2 V**

6. Verify the scan tool parameter: Turbocharger Vane Position = Greater than 4.7 V

- **If 4.7 V or less**

1. Ignition/Vehicle - Off

2. Disconnect the electrical connector: X2 @ K20 Engine Control Module

3. Test for infinite resistance between the test points: Signal circuit terminal 1 @ Component harness & Ground

- If less than infinite resistance - Repair the short to ground on the circuit.
- If infinite resistance - Replace the component: K20 Engine Control Module

- **Go to next step: If greater than 4.7 V**

7. Connect a 3 A fused jumper wire between the test points: Signal circuit terminal 1 & Low Reference circuit terminal 2

8. Verify the scan tool parameter: Turbocharger Vane Position = Less than 0.3 V

- **If 0.3 V or greater**

1. Ignition/Vehicle - Off & Remove - Jumper wire (s)

2. Disconnect the electrical connector: X2 @ K20 Engine Control Module

3. Ignition - On/Vehicle - In Service Mode

4. Test for less than 1 V between the test points: Signal circuit terminal 2 @ Component harness & Ground

- If 1 V or greater - Repair the short to voltage on the circuit.
- If less than 1 V

5. Ignition/Vehicle - Off

6. Test for less than 2 ohms between the test points: Signal circuit terminal 2 @ Component harness & The other end of the circuit @ Control module harness

- If 2 ohms or greater - Repair the open/high resistance in the circuit.
- If less than 2 ohms - Replace the component: K20 Engine Control Module

- **Go to next step: If less than 0.3 V**

9. Test or replace the component: B112 Turbocharger Vane Position Sensor

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: [Diagnostic Repair Verification](#)

- Refer to [Turbocharger Replacement](#) - B112 Turbocharger Vane Position Sensor
- For control module replacement, programming, and setup refer to: [Control Module References](#)

DTC P25BD: UNMETERED FUEL - FORCED ENGINE SHUTDOWN

Diagnostic Instructions

- Perform the [Diagnostic System Check - Vehicle](#) prior to using this diagnostic procedure.
- Review [Strategy Based Diagnosis](#) for an overview of the diagnostic approach.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptor

DTC P25BD

Unmetered Fuel - Forced Engine Shutdown

Circuit/System Description

Detects engine overspeed in the event that there is an error in the ECM or engine damage has occurred which is resulting in the engine speed increasing beyond desired control limits. Upon failure detection, the engine will be shutdown by closing the diesel intake air valve and disabling the fuel injectors.

Conditions for Running the DTC

- Ignition is ON.
- Engine speed is greater than 1500 RPM.
- DTC runs continuously when the above condition are met.

Conditions for Setting the DTC

The ECM detects that the engine speed is greater than 5200 RPM for greater than 100 s.

Action Taken When the DTC Sets

DTC P25BD is a Type A DTC.

The ECM commands the intake air valve closed.

The ECM disables the fuel injectors.

Conditions for Clearing the DTC

DTC P25BD is a Type A DTC.

Diagnostic Aids

Possible Causes of an Engine Overspeed

- Aftermarket power-up devices.
- Leaking or failed turbocharger oil seals
- Oil evident in the intake runners and compressor side of the turbocharger.
- Starting fluid use or alternative fuel added to the engine such as ether.
- Excessive oil build-up in the charge air cooler.

Reference Information

Schematic Reference

Connector End View Reference

[COMPONENT CONNECTOR END VIEWS - INDEX](#)

Component View Reference

[Powertrain Component Views](#)

Description and Operation

[Fuel System Description](#)

Electrical Information Reference

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

DTC Type Reference

[Powertrain Diagnostic Trouble Code \(DTC\) Type Definitions](#)

Scan Tool Reference

[Control Module References](#) for scan tool information

[Circuit/System Verification](#)

1. Verify that no other DTCs are set.

- **If any other DTCs are set**

Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) .

- **Go to next step: If any other DTCs are not set**

2. Review the Freeze Frame/Failure Records data, the Engine Speed should exceed 5200 RPM.

- **If greater than 5200 RPM**

Refer to Circuit/System Testing.

- **Go to next step: If less than 5200 RPM**

3. Verify there is no engine damage.

- **If there is engine damage**

Refer to [Symptoms - Engine Mechanical](#) .

- **Go to next step: If there is no engine damage**

4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

5. Verify DTC P25BD is not set.

- **If DTC P25BD is set**

Refer to Circuit/System Testing.

- **Go to next step: If DTC P25BD is not set**

6. All OK.

[Circuit/System Testing](#)

1. Review the Freeze Frame/Failure Records data to verify if Engine Speed exceeded 5200 RPM.

- **If the Engine Speed exceeded 5200 RPM**

Inspect the engine for the following:

- Aftermarket power-up devices.
- Modified fuel system.
- Contaminated engine oil.
- Un-metered fuel source.
- **Go to next step: If the Engine Speed did not exceed 5200 RPM.**

2. Replace the K20 Engine Control Module.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the diagnostic procedure.

Refer to [Control Module References](#) for ECM replacement, programming, and setup.

DTC P2627 OR P2628: HO2S PUMP CURRENT TRIM CIRCUIT LOW/HIGH VOLTAGE SENSOR 1

Diagnostic Instructions

- Perform the [Diagnostic System Check - Vehicle](#) prior to using this diagnostic procedure.
- Review [Strategy Based Diagnosis](#) for an overview of the diagnostic approach.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptor

DTC P2627

HO2S Pump Current Trim Circuit Low Voltage Sensor 1

DTC P2628

HO2S Pump Current Trim Circuit High Voltage Sensor 1

Circuit/System Description

The oxygen content of the exhaust is measured via the nitrogen oxide (NOx) sensors. The nitrogen oxides (NOx) sensors are part of the selective catalytic reduction system, a device used to reduce NOx emission on diesel engines. There are two NOx sensors, one placed upstream of selective catalytic reduction, to measure inlet NOx concentration, and one placed downstream. They are connected with the control module via CAN and all the information is exchanged through it. Since it is a smart sensor, all the electrical monitoring is performed inside the sensor and only the results are sent to the ECM. Each NOx sensor contains a sensing cell, a pumping cell, and a heater. A sample of exhaust gas passes through a diffusion gap between the sensing cell and the pumping cell. The NOx sensor maintains a constant reference voltage across the sensing cell. An electronic circuit within sensor controls the pump current through the pumping cell in order to maintain a constant voltage in the sensing cell. The amount of current required to maintain the reference voltage in the sensing cell is proportional to the concentration of NOx in the exhaust. The ECM varies the amount of diesel exhaust fluid (reductant) added by varying the reductant injector duty cycle in response to changes in engine exhaust NOx levels. The smart NOx sensors consist of two components, the NOx module and the NOx sensor element that are serviced as a unit. A circuit or performance condition with a NOx sensor is detected by the NOx sensor module. The smart NOx sensor module communicates the condition to the ECM over the serial data line. The ECM sets a DTC when a serial data message is received from the NOx sensor module.

Conditions for Running the DTC

P2627

- DTC P115E, P115F, P1160, P116A, P116B, P116C, P116D, P116E, P116F, P1192, P1193, P1194, P119A, P119B, P119C, P11C5, P11C6, P11DB, P11DD, P2200, P2205, P2206, P2207, P2208, P2209, P2210, P220A, or P2211 is not set.
- The engine is running.
- The ignition voltage is greater than 11 V.
- The NOx sensor supply voltage is greater than 10.8 V.
- The NOx Sensor 1 Heater Operation parameter displays Allowed.

The DTC runs continuously when the above conditions are met.

P2628

- DTC P00C7, P00E9, P00EA, P00EB, P00EC, P0101, P0102, P0103, P0106, P0107, P0108, P0116, P0117, P0118, P0119, P0128, P0201-P0208, P020A-P020F, P0216, P021A, P021B, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0279, P0280, P0282, P0283, P02EE, P02EF, P02F0-P02F5, P0405, P0406, P049D, P0546, P0545, P111E, P113B, P113C, P115E, P115F, P1160, P116A, P116B, P116C, P116D, P116E, P116F, P118E, P118F, P1192, P1193, P1194, P119A, P119B, P119C, P11C5, P11C6, P11DB, P11DD, P1248, P1249, P124A-P124F, P126A, P2032, P2033, P2081, P2085, P2200, P2205, P2206, P2207, P2208, P2209, P2210, P220A, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P2211, P2227, P2228, P2229, or P2230 is not set.
- The engine is running.
- The ignition voltage is greater than 11 V.
- The NOx sensor supply voltage is greater than 10.8 V.
- The NOx Sensor 1 Heater Operation parameter displays Allowed.

The DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

The NOx sensor module detects a fault in the NOx sensor circuitry.

Action Taken When the DTC Sets

DTCs P2627 and P2628 are Type B DTCs.

Conditions for Clearing the DTC

DTCs P2627 and P2628 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

[Control Module References](#) for scan tool information

Circuit/System Verification

1. Ignition ON
2. Verify DTC P00C7, P00E9, P00EA, P00EB, P00EC, P0101, P0102, P0103, P0106, P0107, P0108, P0116, P0117, P0118, P0119, P0128, P0201-P0208, P020A-P020F, P0216, P021A, P021B, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0279, P0280, P0282, P0283, P02EE, P02EF, P02F0-P02F5, P0405, P0406, P049D, P0546, P0545, P111E, P113B, P113C, P115E, P115F, P1160, P116A, P116B, P116C, P116D, P116E, P116F, P118E, P118F, P1192, P1193, P1194, P119A, P119B, P119C, P11C5, P11C6, P11DB, P11DD, P1248, P1249, P124A-P124F, P126A, P2032, P2033, P2081, P2085, P2200, P2205, P2206, P2207, P2208, P2209, P2210, P220A, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P2211, P2227, P2228, P2229, P2230, or U029D is not set.
 - **If any of the DTCs are set**

Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) .
 - **Go to next step: If none of the DTCs are set**
3. Verify that DTCs P2627 or P2628 are not set
 - **If any of the DTCs are set**

Replace the B195A Nitrogen Oxides Sensor 1
 - **Go to next step: If none of the DTCs are set**
4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
5. Verify the DTC does not set.
 - **If the DTC sets**

Replace the B195A Nitrogen Oxides Sensor 1
 - **Go to next step: If no DTC sets**
6. All OK.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

Refer to [Nitrogen Oxides Sensor Replacement - Position 1](#)

Perform the scan tool NOx Sensor 1 Reset after replacing the Nitrogen Oxides Sensor Position 1 replacement.

DTC P2635: FUEL PUMP FLOW PERFORMANCE

Diagnostic Instructions

- Perform the [Diagnostic System Check - Vehicle](#) prior to using this diagnostic procedure.
- Review [Strategy Based Diagnosis](#) for an overview of the diagnostic approach.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptor

DTC P2635

Fuel Pump Flow Performance

Circuit/System Description

After the vehicle has been powered Off for at least 2 min and the ignition is turned On, the engine control module (ECM) sends a signal via the fuel pump primary relay circuit to the fuel pump driver control module. The fuel pump driver control module enables the fuel pump for 30 s or continuously when the engine is running. The fuel pump driver control module actuates the brushless fuel pump by means of a high power three phase signal and controls the fuel pump speed according to serial data signals received from the ECM containing the desired fuel pump speed.

Conditions for Running the DTC

- DTC P018B, P018C, P018D, P0641, P1007, P1029, P102A, P102B, P102C, P1255, P129D, P129F, P12A6, P20CD, P2227, P2228, P2229, P2230, or U18A2 is not set.
- Fuel pump control is enabled.
- Ignition voltage is between 11 - 32 V.
- Engine is running for more than 40 s.
- KR73 Ignition Main Relay is commanded On.
- Low fuel level warning not present.

The DTC runs continuously when the conditions above are met.

Conditions for Setting the DTC

The ECM detects the actual fuel pressure is not within 40 kPa (5.8 PSI) of the commanded fuel pressure for greater than 30 s.

Action Taken When the DTC Sets

DTC P2635 is a Type B DTC.

Conditions for Clearing the DTC

DTC P2635 is a Type B DTC.

Diagnostic Aids

Using the Failure Records data may help locate an intermittent condition. If you cannot duplicate the DTC, the information in the Failure Records can help determine how many miles since the DTC set. The Fail Counter and Pass Counter can help determine how many ignition cycles that the diagnostic test reported a pass and/or a fail.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

Powertrain Component Views

Description and Operation

Fuel System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify that DTC P018B, P018C, P018D, P0641, P1007, P1029, P102A, P102B, P102C, P1255, P129D, P129F, P12A6, P20CD, P2227, P2228, P2229, P2230, or U18A2 is not set.
 - **If any of the DTCs are set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
 - **Go to next step: If none of the DTCs are set**
3. Verify scan tool parameters Fuel Pressure Sensor and Desired Fuel Pressure are within 40 kPa (5.8 psi) of each other while operating the vehicle through varying loads.
 - **If greater than 40 kPa (5.8 PSI)**

Refer to Circuit/System Testing.
 - **Go to next step: If less than 40 kPa (5.8 PSI)**
4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
5. Verify the DTC does not set.
 - **If the DTC sets**

Refer to Circuit/System Testing.
 - **Go to next step: If the DTC does not set**
6. All OK.

Circuit/System Testing

1. Verify no condition exist with the fuel system pressure. Refer to **Fuel System Diagnosis**.
 - **If a condition is found with the fuel system pressure**

Repair the fuel system as necessary.
 - **Go to next step: If a condition is not found with the fuel system pressure**
2. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- Refer to **Fuel Tank Fuel Pump Module Replacement (FWD)**, **Fuel Tank Fuel Pump Module Replacement (AWD)**.

DTC P2670 OR P2671: ACTUATOR HIGH CONTROL CIRCUIT GROUP 2 LOW/HIGH VOLTAGE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- Refer to **Diagnostic Procedure Instructions** to provide an overview of each diagnostic category.

DTC Descriptors

DTC P2670

Actuator High Control Circuit Group 2 Low Voltage

DTC P2671

Actuator High Control Circuit Group 2 High Voltage

Circuit/System Description

The DTCs apply to internal engine control module (ECM) high side driver voltage supply.

Conditions for Running the DTC

P2670

- The ignition is ON.
- The DTCs run continuously once the above condition is met.

Conditions for Setting the DTC

P2670

The ECM recognizes a short to ground on high side driver voltage supply to the turbocharger wastegate solenoid valve.

P2671

The ECM recognizes a short to voltage on high side driver voltage supply to the turbocharger wastegate solenoid valve.

Action Taken When the DTC Sets

DTC P2670 and P2671 are Type A DTCs.

Conditions for Clearing the DTC

DTC P2670 and P2671 are Type A DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the Q41 Turbocharger Vane Position Control Solenoid Valve.
2. Ignition ON, verify that a test lamp illuminates between the ignition circuit terminal 2 and ground.
 - **If the test lamp does not illuminate**
 1. Ignition OFF, disconnect the X2 harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between ignition circuit and ground.
 - If less than infinite resistance, repair the short to ground in the circuit.
 - If infinite resistance, replace the K20 Engine Control Module.
 - **Go to next step: If the test lamp illuminates**
3. Verify that a test lamp illuminates weakly between the ignition circuit terminal 2 and the control circuit terminal 1, while commanding the Turbocharger Vane Position Actuator with a scan tool.
 - **If the test lamp illuminates**
 1. Ignition OFF, disconnect the X2 harness connector at the K20 Engine Control Module.
 2. Test for less than 1.0 V between the control circuit and ground.
 - If greater than 1.0 V, repair the short to voltage in the circuit.
 - If less than 1.0 V, replace the K20 Engine Control Module.
 - **Go to next step: If the test lamp illuminates weakly**
4. Replace the Q41 Turbocharger Vane Position Control Solenoid Valve.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair

Refer to [Control Module References](#) for Engine Control Module replacement, programming and setup.

DTC P2687-P2689: FUEL HEATER RELAY CONTROL CIRCUIT

Diagnostic Instructions

- Perform the [Diagnostic System Check - Vehicle](#) prior to using this diagnostic procedure.
- Review [Strategy Based Diagnosis](#) for an overview of the diagnostic approach.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptors

DTC P2687

Fuel Heater Relay Control Circuit

DTC P2688

Fuel Heater Relay Control Circuit Low Voltage

DTC P2689

Fuel Heater Relay Control Circuit High Voltage

Circuit/System Description

Ignition voltage is supplied to the coil side of the fuel heater relay whenever the ignition is ON. The engine control module (ECM) provides a ground to control the fuel heater relay. When the ECM is commanding the fuel heater ON, the voltage of the control circuit should be low, near 0 V. When the ECM is commanding the fuel heater OFF, the voltage of the control circuit should be high, near battery voltage.

Conditions for Running the DTC

DTC P2687, P2688, or P2689

- Ignition voltage is greater than 11 V.

- Ignition On or engine running. (engine not cranking)

Conditions for Setting the DTC

DTC P2687

The ECM detects the fuel heater relay control circuit is open for greater than 1 s.

DTC P2688

The ECM detects the fuel heater relay control circuit is shorted to ground for greater than 1 s.

DTC P2689

The ECM detects the fuel heater relay control circuit is shorted to voltage for greater than 1 s.

Action Taken When the DTC Sets

DTC P2687, P2688, and P2689 are type C DTCs.

Conditions for Clearing the DTC

DTC P2687, P2688, and P2689 are type C DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

Powertrain Component Views

Description and Operation

Fuel System Description

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition On.
2. Command the Fuel Heater Relay On and Off with a scan tool. Verify that you hear or feel the KR22 Fuel Heater Relay click.
 - **If a click is not heard or felt**

Refer to Circuit/System Testing.

- **Go to next step: If a click is heard or felt**

3. Verify with a scan tool that the Fuel Temperature Sensor parameter slowly starts to rise when the fuel heater relay is commanded On.

- **If the fuel temperature does not rise**

Refer to [Fuel Heater Diagnosis](#).

- **Go to next step: If the fuel temperature rises**

4. All OK

Circuit/System Testing

1. Ignition Off.

2. Remove the KR22 Fuel Heater Relay from X50A Fuse Block-Underhood.

3. Ignition On.

4. Verify that a test lamp illuminates between the ignition voltage circuit terminal 1 and ground.

- **If the test lamp does not illuminate**

Refer to [DTC P0685-P0687, P0689, P0690, or P1682](#)

- **Go to next step: If the test lamp illuminates**

5. Connect a test lamp between the relay control circuit terminal 2 and a battery voltage.

6. Ignition On.

7. Verify the test lamp turns on and off when commanding the Fuel Heater parameter On and Off with a scan tool.

- **If the test lamp is always Off**

1. Ignition Off.

2. Disconnect the harness connector X3 at the K20 Engine Control Module.

3. Test for less than 2 Ω in the relay control circuit end to end.

- If 2 Ω or greater, repair the open/high resistance in the circuit.
- If less than 2 Ω

4. Ignition On, test for less than 1 V between the relay control circuit and ground.

5. If 1 V or greater, repair the short to voltage in the circuit.

6. If less than 1 V, replace the K20 Engine Control Module.

- **If the test lamp is always On**

1. Ignition Off.

2. Disconnect the harness connector X3 at the K20 Engine Control Module.

3. Test for infinite resistance between relay control circuit terminal 2 and ground.

- If less than infinite resistance, repair the short to ground in the circuit.
- If infinite resistance, replace the K20 Engine Control Module.

- **Go to next step: If the test lamp turns On and Off**

8. Test or replace the KR22 Fuel Heater Relay.

Component Testing

1. Ignition Off.

2. Remove the KR22 Fuel Heater Relay from X50A Fuse Block-Underhood.

3. Test for 70 - 110 Ω between terminals 1 and 2.

- **If not between 70 - 110 Ω**

Replace the KR22 Fuel Heater Relay.

- **Go to next step: If between 70 - 110 Ω**

4. Test for infinite resistance between the following terminals:

- 3 and 1
- 3 and 5
- 3 and 2
- 2 and 5
- **If less than infinite resistance**

Replace the KR22 Fuel Heater Relay.

- **Go to next step: If infinite resistance**

5. Install a 20 A fused jumper wire between relay terminal 1 and 12 V.

6. Install a jumper wire between relay terminal 2 and ground.

7. Test for less than 2 Ω between terminals 3 and 5.

- **If 2 Ω or greater**

Replace the KR22 Fuel Heater Relay.

- **Go to next step: If 2 Ω or less**

8. All OK

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

- Refer to [Relay Replacement \(Attached to Wire Harness\)](#) [Relay Replacement \(Within an Electrical Center\)](#).
- For control module replacement, programming and setup, refer to: [Control Module References](#)

DTC P268A: FUEL INJECTION CALIBRATION NOT PROGRAMMED

Diagnostic Instructions

- Perform the [Diagnostic System Check - Vehicle](#) prior to using this diagnostic procedure.
- Review [Strategy Based Diagnosis](#) for an overview of the diagnostic approach.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptor

DTC P268A

Fuel Injection Calibration Not Programmed

Circuit/System Description

The control functions for the fuel injection system are integrated in the ECM.

Conditions for Running the DTC

Ignition = On

Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

Control Module = Internal Malfunction or System Programming Malfunctions

Action Taken When the DTC Sets

DTC P268A is a Type A DTC.

Conditions for Clearing the DTC

DTC P268A is a Type A DTC.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Diagnostic Aids

Injector Flow Rate Programming is required after replacing the ECM or a fuel injector.

Perform the Fuel Injection Small Quantity Learn after Injector Flow Rate Programming.

Circuit/System Verification

1. Ignition ON.
2. Verify DTC P268A is not set.
 - **If DTC P268A is set**
 1. Perform the Fuel Injection Small Quantity Learn procedure with a scan tool.
 2. Verify the DTC does not set.
 - If DTC P268A is set, replace the K20 Engine Control Module.
 - If DTC P268A is not set
 - 3. All Ok.
 - **Go to next step: If DTC P268A is not set**
3. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.

Refer to Control Module References for Engine Control Module replacement, programming and setup.

DTC P268C-P268F: CYLINDER 1-4 INJECTOR CALIBRATION INCORRECT

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Refer to Diagnostic Procedure Instructions to provide an overview of each diagnostic category.

DTC Descriptors

DTC P268C

Cylinder 1 Injector Calibration Incorrect

DTC P268D

Cylinder 2 Injector Calibration Incorrect

DTC P268E

Cylinder 3 Injector Calibration Incorrect

DTC P268F

Cylinder 4 Injector Calibration Incorrect

Circuit/System Description

The control functions for the fuel injection system are integrated in the ECM. During the manufacturing process, each injector flow rate is measured and recorded as injection quantity adjustment flow rate data. This data, together with the injectors cylinder position, is stored in the ECM. When the ignition is turned ON, the ECM monitors the fuel injection flow rate numbers to ensure they are present.

Conditions for Running the DTC

The ignition is ON.

Conditions for Setting the DTC

The fuel injector injection quantity adjustment flow rate data is not programmed.

Action Taken When the DTC Sets

DTC P268C, P268D, P268E and P268F are Type A DTCs.

Conditions for Clearing the DTC

DTC P268C, P268D, P268E and P268F are Type A DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Diagnostic Aids

Verify that the ECM has the correct part number for the application.

Circuit/System Verification

1. Ignition ON.
2. Verify that DTCs P268C, P268D, P268E, or P268F are not set.
 - **If one of the DTC is Set**
 1. Perform the Injector Flow Rate Programming
 2. Ignition OFF and all vehicle systems OFF, it may take up to 2 min for all vehicle systems to power down.
 3. Verify the DTC does not set.
 - If one of the DTC resets, replace the K20 Engine Control Module.
 - If the DTC does not set
 - **Go to next step: If no DTC is set**
3. All OK

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

Refer to [Control Module References](#) for Engine Control Module replacement, programming and setup.

DTC P2ADA-P2ADD: REDUCTANT TANK TEMPERATURE SENSOR 2 CIRCUIT

Diagnostic Instructions

- Perform the [Diagnostic System Check - Vehicle](#) prior to using this diagnostic procedure.
- Review [Strategy Based Diagnosis](#) for an overview of the diagnostic approach.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptors

DTC P2ADA

Reductant Tank Temperature Sensor 2 Circuit Performance

DTC P2ADB

Reductant Tank Temperature Sensor 2 Circuit Low Voltage

DTC P2ADC

Reductant Tank Temperature Sensor 2 Circuit High Voltage

DTC P2ADD

Reductant Tank Temperature Sensor 2 Circuit Erratic

Circuit/System Description

The reductant quality sensor is located in the reductant tank and uses an ultrasonic signal to measure reductant fluid quality. The reductant quality sensor includes an integrated temperature sensor to measure reductant fluid temperature. The reductant quality sensor communicates with the reductant control module using serial data.

Conditions for Running the DTC

P2ADA

- DTC P1015, P1016, P1017, P1018, P1019, P101A, P262B, P2ADB, P2ADC, P2ADD, or U010E is not set.
- The ignition is on.

- The ignition voltage is greater than 11 V.
- The ignition has been off for greater than 8 h.

Frequency the DTC runs = Per ignition cycle - For 8 s - After the running conditions are met

P2ADB, P2ADC

- DTC P1015, P1016, P1017, P1018, P1019, P101A, or U010E is not set.
- The ignition is on.
- The ignition voltage is greater than 11 V.
- The reductant control module is not initializing.

The DTCs run continuously when the above conditions are met.

P2ADD

- DTC P1015, P1016, P1017, P1018, P1019, P101A, P206C, P206D, or U010E is not set.
- The ignition is on.
- The ignition voltage is greater than 11 V.
- The reductant control module is not initializing.

The DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

P2ADA, P2ADD

The reductant control module detects a performance fault on the reductant quality sensor temperature signal for greater than 1 s.

P2ADB

The reductant control module detects that the reductant quality sensor temperature signal is out of range low for greater than 1 s.

P2ADC

The reductant control module detects that the reductant quality sensor temperature signal is out of range high for greater than 1 s.

Action Taken When the DTC Sets

DTCs P2ADA, P2ADB, P2ADC, and P2ADD are Type A DTCs.

- The reductant quality value is replaced with the last measured value.
- The reductant quality sensor temperature value is replaced with a default value
- The Warning/Inducement strategy is activated.

Conditions for Clearing the DTC

DTCs P2ADA, P2ADB, P2ADC, and P2ADD are Type A DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

DTC Type Reference

[Powertrain Diagnostic Trouble Code \(DTC\) Type Definitions](#)

Scan Tool Reference

[Control Module References](#) for scan tool information

Circuit/System Verification

1. Verify that DTCs P2ADA, P2ADB, P2ADC, and P2ADD are not set.
 - **If any of the DTCs are set**
Refer to Circuit/System Testing
 - **Go to next step: If none of the DTC are set**
2. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
3. Verify that DTCs P2ADA, P2ADB, P2ADC, and P2ADD are not set.
 - **If any of the DTCs are set**
Refer to Circuit/System Testing
 - **Go to next step: If no DTC Is set**
4. All OK.

Circuit/System Testing

1. Ignition Off, disconnect the harness connector at the B295 Reductant Quality Sensor.
2. Ignition On.
3. Test for less than 20 Ω between low reference terminal 3 and ground.
 - **If greater than 20 Ω**
 1. Ignition Off, disconnect the X2 harness connector at the K115 Reductant Control Module.
 2. Test for less than 2 Ω in the low reference circuit end to end
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K115 Reductant Control Module.
 - **Go to next step: If less than 20 Ω**
4. Test for 4.8-5.2 V between 5 V reference circuit terminal 1 and ground
 - **If less than 4.8 V**
 1. Ignition Off, disconnect the X2 harness connector at the K115 Reductant Control Module.
 2. Test for less than 2 Ω in the 5 V reference circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω
 3. Test for infinite resistance between the 5 V reference circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K115 Reductant Control Module
 - **If greater than 5.2 V**
 1. Ignition Off, disconnect the X2 harness connector at the K115 Reductant Control Module.
 2. Test for less than 1 V between the 5 V reference circuit and ground.
 - If 1 V or greater, repair the short to voltage in the circuit.

- If less than 1 V, replace the K115 Reductant Control Module
 - **Go to next step: If between 4.8-5.2 V**
5. Ignition ON, test for 4.4-4.8 V between signal circuit terminal 2 and ground.
- **If less than 4.4 V**
 1. Ignition Off, disconnect the X2 harness connector at the K115 Reductant Control Module.
 2. Test for less than 2 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω
 3. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K115 Reductant Control Module
 - **If greater than 4.8 V**
 1. Ignition Off, disconnect the X2 harness connector at the K115 Reductant Control Module.
 2. Ignition On, test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage in the circuit.
 - If less than 1 V, replace the K115 Reductant Control Module
 - **Go to next step: If between 4.4-4.8 V**
6. Replace the B295 Reductant Quality Sensor.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

- Refer to [Emission Reduction Fluid Tank Replacement](#) for reductant quality sensor replacement.
- Refer to [Emission Reduction Fluid Controller Replacement](#)

DTC P2BAA: EXHAUST NOX CONCENTRATION HIGH - LOW REDUCTANT CONSUMPTION

Diagnostic Instructions

- Perform the [Diagnostic System Check - Vehicle](#) prior to using this diagnostic procedure.
- Review [Strategy Based Diagnosis](#) for an overview of the diagnostic approach.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptor

DTC P2BAA

Exhaust NOx Concentration High - Low Reductant Consumption

Circuit/System Description

The selective catalytic reduction (SCR) system reduces oxides of nitrogen (NOx) emissions by injecting a metered amount of diesel exhaust fluid or reductant into the exhaust gas stream entering the SCR. Within the selective catalytic reduction catalyst, the reductant reacts with the NOx to form nitrogen, carbon dioxide, and water vapor. Upstream and downstream NOx sensors provide the engine control module (ECM) with engine-out and tailpipe-out NOx levels. The ECM uses two (NOx) sensors to control exhaust NOx levels. The first NOx sensor is located upstream of the reductant fluid injector and monitors the engine out NOx. The second NOx sensor is located at the outlet of the SCR and monitors NOx levels exiting the SCR. The engine control module (ECM) varies the amount of diesel exhaust fluid (Reductant) or reductant added in response to changes in engine exhaust out NOx levels.

Conditions for Running the DTC

- DTCs related to the following system/component = Not Set
 - Reductant System
 - B9 Ambient Air Temperature Sensor

- B17 Barometric Pressure Sensor
- B34 Engine Coolant Temperature Sensor
- B66 Intake Air Temperature Sensor
- B75C Multifunction Intake Air Sensor
- B115 Vehicle Speed Sensor
- B195 Nitrogen Oxides Sensor
- Q14 Exhaust Gas Recirculation Valve
- Q17 Fuel Injector
- Ambient Air Temperature = Warmer than -20°C (-4°F)
- BARO Sensor = Greater than 70 kPa (10.2 PSI)
- ECT Sensor = Greater than 70°C (158°F)
- Engine = Running
- Fuel Level Sensor = Greater than 10%
- Reductant Level = Greater than 5 L (1.5 US Liquid Gal)
- Reductant Tank Temperature 1 = Greater than 5°C (41°F)
- Vehicle is not in or near a DPF regeneration.

The DTC runs when the above conditions are met.

Conditions for Setting the DTC

The ECM detects that the diesel exhaust fluid (DEF) delivery is lower than a calibrated amount.

Action Taken When the DTC Sets

- DTCs listed in the DTC Descriptor Category = Type A DTC

Conditions for Clearing the DTC

- DTCs listed in the DTC Descriptor Category = Type A DTC

Diagnostic Aids

- Using the Reductant Injector Device Control, a ticking sound should be heard at the reductant injector.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

1. Verify there are no DTCs set related to the following system/component:

- Reductant System
- B9 Ambient Air Temperature Sensor
- B17 Barometric Pressure Sensor
- B34 Engine Coolant Temperature Sensor
- B66 Intake Air Temperature Sensor
- B75C Multifunction Intake Air Sensor
- B115 Vehicle Speed Sensor
- B195 Nitrogen Oxides Sensor
- Q14 Exhaust Gas Recirculation Valve
- Q17 Fuel Injector
- **If a related DTC is set**

1. Refer to: [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) for further diagnosis.

2. Clear All Vehicle DTCs

3. Ignition/Vehicle - Off - For greater than 2 min

4. Engine - Running

5. Perform the scan tool control function: [Reductant System Tamper Service Bay Test](#)

6. Verify the procedure/test passes.

- If the procedure/test does not pass

Refer to Circuit/System Testing.

- If the procedure/test passes

All OK.

- **Go to next step: If a related DTC is not set**

2. Verify that DTC P2BAA is not set

- **If the DTC is set**

Refer to Circuit/System Testing

- **Go to next step: If the DTC is not set**

3. All OK.

Circuit/System Testing

1. Ignition Off

2. Test the reductant system for contamination. Refer to [Contaminants-in-Diesel Exhaust Fluid Diagnosis](#).

- **If any conditions are found**

Repair as necessary.

- **Go to next step: If no conditions are found**

3. Ignition - On/Vehicle - In Service Mode

4. Perform the scan tool control function: Reductant System Leak Test - ON

5. Verify that the system is able to build up and reach the reductant pressure sensor parameter greater than 450 kPa.

- **If less than the specified range**

1. Command the Reductant Pump to 50% with a scan tool.

2. Verify the scan tool parameter: Desired Reductant Pump Speed = Reductant Pump Speed

- If not equal

Refer to [DTC P105A](#)

- If equal

Refer to the next step

- **Go to next step: If greater than 450 kPa (66 PSI)**

6. Verify there are no leaks, kinks or restrictions in the reductant lines

- **If any condition is found**

Repair as necessary.

- **Go to next step: If no conditions are found**

7. Perform the scan tool control function: [Reductant Injection Quantity Test](#)

8. Verify the procedure/test passes.

- **If the procedure/test does not pass**

Repair as necessary.

- **Go to next step: If the procedure/test passes**

9. Ignition/Vehicle - Off - For greater than 2 min

10. Engine - Running

11. Perform the scan tool control function: [Reductant System Tamper Service Bay Test](#)

12. Verify the procedure/test passes.

- **If the test does not pass**

A condition with the system still exists. - Refer to step 1

- **Go to next step: If the test passes**

13. All OK.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

- Refer to [Emission Reduction Fluid Supply Pump Module Replacement](#)
- Refer to [Emission Reduction Fluid Injector Replacement \(AWD\)](#), [Emission Reduction Fluid Injector Replacement \(FWD\)](#).
- Refer to [Control Module References](#) for engine control module replacement, programming, and setup.

Repair Verification

NOTE: Before returning the vehicle to the customer, perform the scan tool Reductant System Malfunction Warning Service Bay Test to verify proper reductant system operation.

1. Perform the scan tool control function: [Reductant System Tamper Service Bay Test](#)

2. Verify the procedure/test passes.

- **If the test does not pass**

Refer to Circuit/System Testing.

- **Go to next step: If the test passes**

3. All OK.

SYMPTOMS - ENGINE CONTROLS

Diagnostic Instructions

- Perform the [Diagnostic System Check - Vehicle](#) prior to using this diagnostic procedure.
- Review [Strategy Based Diagnosis](#) for an overview of the diagnostic approach.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

Symptoms Description

Symptoms covers conditions that are not covered by DTCs. Certain conditions can cause multiple symptoms. These conditions are listed together under Symptoms Testing. Conditions that may only cause specific symptoms are listed separately under Additional Symptoms Testing. Perform the Symptoms Testing before using the Additional Symptoms Testing.

Symptoms Definition

Cuts Out, Misses

A steady pulsation or jerking that follows engine speed, which is usually more pronounced as the engine load increases. This condition is not normally felt above 1 500 RPM or 48 km/h (30 MPH). The exhaust has a steady spitting sound at idle or at low speed.

Hard Start

The engine cranks OK, but does not start for a long time. The vehicle does eventually run, or may start but immediately stall.

Hesitation, Sag, Stumble

A momentary lack of response as the accelerator is pushed down. This condition can occur at any vehicle speed. This condition is usually more pronounced when first trying to make the vehicle move, as from a stop. This condition may cause the engine to stall in severe conditions.

Lack of Power, Sluggishness, or Sponginess

The engine delivers less than expected power. Little or no increase in vehicle speed when the accelerator pedal is pushed down part way.

Poor Fuel Economy

Fuel economy, as measured by an actual road test, is noticeably lower than expected. Also, the fuel economy is noticeably lower than it was on this vehicle at one time, as previously shown by an actual road test.

Rough, Unstable, or Incorrect Idle and Stalling

The engine runs irregularly at idle. If the engine or the vehicle may shake. Engine idle speed may vary. Either condition may be severe enough to stall the engine.

Surges/Chuggles

An engine power variation under steady throttle or cruise. Feels like the vehicle speeds up and slows down with no change in the accelerator pedal position.

Fuel Knock/Combustion Noise

A mild to severe ping, usually worse under acceleration. The engine makes sharp metallic knocks that change with the throttle opening.

More than the customer would desire Smoke (Black)

Black smoke under load, idle or start up, hot or cold.

More than the customer would desire Smoke (White)

White smoke under load, idle or start up, hot or cold.

More than the customer would desire Smoke (Gray or Blue)

Gray or Blue smoke under load, idle or start up, hot or cold.

Reference Information

Electrical Information Reference

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

Scan Tool Reference

[Control Module References](#) for scan tool reference

Symptoms Verification

Verify the following conditions are true:

- The engine control module (ECM) and the malfunction indicator lamp (MIL) are operating correctly.
- There are no diagnostic trouble codes (DTCs) stored.
- The scan tool data is within a normal operating range.
- The fuel system is not leaking.
- The air filter element is not restricted.
- The vehicle tires are correctly inflated and meet original equipment specifications.

Symptoms Testing

Cuts Out/Misses, Hard Start, Hesitation/Sag/Stumble, Lack of Power/Sluggishness/Sponginess, Poor Fuel Economy, Rough, Unstable, or Incorrect Idle and Stalling, Fuel Knock/Combustion Noise, Surges/Chuggles, or more than the customer would desire Smoke - Black, White, Gray, or Blue

1. Test for the following conditions:

- The sensor systems for the following:
 - Inspect the mass air flow (MAF) sensor for obstruction, contamination, and damage. Refer to [Mass Airflow Sensor Replacement](#).
 - Test for an intermittent fuel rail pressure sensor signal by wiggling the harness between the sensor and the ECM with the ignition ON and the engine OFF, while monitoring the parameter with a scan tool.
 - Inspect for an intermittent crankshaft position sensor signal.
 - Inspect the engine coolant temperature (ECT) sensor. Use the scan tool in order to compare the ECT with the intake air temperature (IAT) sensor on a cold engine. The ECT should be within 3Â°C (5Â°F) of the IAT. If not within the specified range, inspect for a high resistance in the coolant sensor circuit or the sensor. Compare sensor resistance to the [Temperature Versus Resistance - Engine Coolant Temperature Sensor](#) tables.
- The Fuel System for the following:
 - Inspect for external fuel leaks.
 - Inspect for low fuel pressure. Refer to [Fuel System Diagnosis](#).
 - Inspect the fuel system for a plugged fuel filter or air in the fuel system. Refer to [Fuel System Diagnosis](#).
 - Inspect the fuel supply to the fuel injection pump. Refer to [Fuel System Diagnosis](#).
 - Inspect the fuel tank cap vent for proper operation.
 - Inspect the fuel quality. Refer to [Contaminants-in-Fuel Diagnosis](#).

- Observe the actual desired fuel rail pressure with a scan tool, with the engine idling.
- If the ECM or a fuel injector has recently been replaced, it may be necessary to confirm the fuel injector flow rate values.
- Inspect for restricted or plugged fuel injectors.
- Inspect for a sticking Fuel Pressure Regulator. The symptom for this condition will be an idle surge of at least 100 RPM. This surge will be from 50 RPM above Desired Idle Speed to 50 RPM below Desired Idle Speed.
- Engine mechanical for the following.
 - Improper valve timing
 - Worn rocker arms
 - Low engine compression. Refer to [Engine Compression Test](#).
 - Broken or weak valve springs
 - Worn camshaft lobes
 - More than the customer would desire oil in the combustion chamber. Leaking valve seals

2. If the above conditions do not address the symptom, refer to the additional symptoms tests.

Additional Symptoms Tests

Hard Start

- Verify the ECT has not shifted in value. Refer to [Temperature Versus Resistance - Engine Coolant Temperature Sensor](#).
- Inspect for a slow cranking speed. Refer to [Symptoms - Engine Electrical](#).
- Verify the engine electrical system for correct operation. Refer to [Symptoms - Engine Electrical](#).
- Verify the driver is using the correct starting procedure as described in the owner's manual.
- Inspect for a restriction in turbocharger inlet duct.
- Inspect for a restriction or a leak in the intake manifold.
- Inspect the exhaust system for a possible restriction. Refer to [Restricted Exhaust](#).
- Inspect for more than the customer would desire crankshaft end play that will cause the crankshaft position sensor reluctor wheel to move out of alignment with the crankshaft position sensor.

Hesitation, Sag, Stumble

- Test the generator. Refer to [Symptoms - Engine Electrical](#).
- Inspect for more than the customer would desire crankshaft end play that will cause the crankshaft position sensor reluctor wheel to move out of alignment with the crankshaft position sensor.

Poor Fuel Economy

- Heavy loads being carried or towed
- Acceleration rate too much or too often
- Inspect the brake system for brake drag.
- Inspect the tires for the correct air pressure.
- Inspect for incorrect operation of the speedometer.
- Inspect for an air leak in the charge air cooler.
- Inspect the air conditioning system for proper operation.
- Suggest to the owner to fill the fuel tank and inspect the fuel economy.
- Suggest to the driver to read the Important Facts on Fuel Economy in the Owner's Manual.
- Verify the ECT has not shifted in value. Refer to [Temperature Versus Resistance - Engine Coolant Temperature Sensor](#).

Lack of Power, Hesitation, or Cut Out

- Inspect the engine electrical system for correct operation. Refer to [Symptoms - Engine Electrical](#).
- Compare the vehicle with a similar model. Ensure the vehicle has an actual condition.
- Inspect for a proper transmission operation.
- Inspect the engine oil level and quality.
- Inspect for an air leak in the charge air cooler.
- Inspect for a worn or damaged turbo charger turbine wheel, shaft or compressor wheel.
- Inspect for a restricted or plugged exhaust. Refer to [Restricted Exhaust](#).
- Inspect for a restriction in the charge air cooler.
- Inspect for a skewed mass air flow (MAF) sensor.
- Inspect that the exhaust gas recirculation (EGR) valve is fully closing.
- Ensure that the EGR valve does not bind when manually moving the valve.
- Inspect the torque converter clutch (TCC) operation.
- Inspect the air conditioning system for the correct operation.

Rough, Unstable, or Incorrect Idle and Stalling

- Inspect the engine mounts.
- Inspect the intake and exhaust manifolds for casting flash.
- The exhaust system for damaged or collapsed pipes
- The exhaust manifold for a collapsed inner wall
- The mufflers for heat distress or possible internal failure
- Inspect the park neutral position switch circuit.

Surges/Chuggles

- Ensure the driver understands the torque converter clutch (TCC) operation.
- Ensure the driver understands the A/C compressor operation.
- Use the scan tool to ensure the vehicle speed sensor (VSS) reading matches the speedometer.

Fuel Knock/Combustion Noise

- Inspect for obvious overheating problems.
- Inspect for a low engine coolant level.
- Inspect for any restricted air flow through the radiator.
- Inspect for a malfunctioning or incorrect thermostat.
- Inspect for a correct coolant solution. The solution should be a 50/50 mix of anti-freeze and water.
- Perform the Small Quantity Learn.

More than the customer would desire Smoke (Black)

Normal Operation

- During light to moderate acceleration there should be no black smoke.
- During the 2 - 3 hard accelerations after normal light load driving there may be some black smoke momentarily but should not last for greater than 5 s.
- During hard acceleration there may always be a very faint puff of black smoke.

Abnormal Operation

- Black smoke during light to moderate acceleration
- Heavy black smoke during hard acceleration that lasts for greater than 5 s
- Heavy black smoke during every hard acceleration and/or during transmission shift transitions
- Inspect for an air leak in the charge air cooler or the air ducts between the turbocharger and the intake manifold.

- Inspect for a restriction in the turbocharger charge air cooler.
- Inspect for a restriction in the intake manifold.
- Inspect that the EGR valve is fully closing. Remove the EGR valve and visually inspect that there is no light seen between the valves and the valve seats.
- Ensure that the EGR valve does not bind when manually moving the valve.
- Inspect for more than the customer would desire oil entering the combustion chamber.

More than the customer would desire Smoke (White or Gray)

- Inspect the coolant level in the reservoir. White coolant smoke may be mistaken for blue/gray smoke. If the coolant level is low, refer to [Loss of Coolant](#)
- If more than the customer would desire smoke is present, inspect for a stuck open fuel injector by performing the following procedure:
 1. Disconnect the electrical connector at the fuel injection pump.
 2. Remove the glow plugs. Refer to [Glow Plug Replacement](#).

NOTE: Do not stand in front of the glow plug holes while cranking the engine.

3. Crank the engine while observing the glow plug holes for fuel spray.
 4. Replace the fuel injectors for the cylinders that spray fuel.
 5. Inspect for contaminated oil or high oil level.
- If the ECM or a fuel injector has recently been replaced, it may be necessary to confirm the fuel injector flow rate values.
 - Inspect the fuel injectors.

MALFUNCTION INDICATOR LAMP (MIL) DIAGNOSIS

Diagnostic Instructions

- Perform the [Diagnostic System Check - Vehicle](#) prior to using this diagnostic procedure.
- Review [Strategy Based Diagnosis](#) for an overview of the diagnostic approach.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

Circuit/System Description

Ignition voltage is supplied to the instrument cluster. The ECM turns the MIL ON by grounding the MIL control circuit.

Reference Information

Schematic Reference

[Engine Controls Wiring Schematics 1.6L \(LH7\)](#)

Connector End View Reference

[COMPONENT CONNECTOR END VIEWS - INDEX](#)

Electrical Information Reference

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

DTC Type Reference

[Diagnostic Trouble Code \(DTC\) List - Vehicle](#)

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, observe the DTC information with a scan tool. Verify that DTCs U0073, U0100, or U0155 are not set.

- **If any of the DTCs are set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

- **Go to next step: If no DTC is set**

2. Ignition ON.
3. Command the MIL with a scan tool ON and OFF.

- **If the MIL does not turn ON and OFF**

Refer to Circuit/System Testing.

- **Go to next step: If the MIL turns ON and OFF**

4. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect the appropriate harness connector at the P16 Instrument Cluster. Ignition ON.

2. Verify a test lamp illuminates between the Ignition voltage circuit terminal 1 and ground.

- **If the test lamp does not illuminate and the circuit fuse is good**

1. Ignition OFF.

2. Test for less than 2 Ω in the ignition voltage circuit end to end.

- If 2 Ω or greater, repair the open/high resistance in the circuit.
- If less than 2 Ω , verify the fuse is not open and there is voltage at the fuse.

- **If the test lamp does not illuminate and the circuit fuse is open**

1. Ignition OFF.

2. Test for infinite resistance between the ignition voltage circuit and ground.

- If less than infinite resistance, repair the short to ground on the circuit.
- If infinite resistance, test all components connected to the ignition voltage circuit and replace as necessary.

- **Go to next step: If the test lamp illuminates**

3. Ignition OFF, disconnect the appropriate harness connector at the P16 Instrument Cluster.

4. Ignition ON, command the malfunction indicator lamp OFF with a scan tool.

5. Verify that a test lamp does not illuminate between the X1 harness connector ignition circuit terminal 1 and the X1 harness connector control circuit terminal 18.

- **If the test lamp illuminates**

1. Ignition OFF, disconnect the X1 harness connector at the K20 Engine Control Module.

2. Test for infinite resistance between the control circuit and ground.

- If less than infinite resistance, repair the short to ground on the circuit.
- If infinite resistance, replace the K20 Engine Control Module.

- **Go to next step: If the test lamp does not illuminate**

6. Ignition ON, command the malfunction indicator lamp ON with a scan tool.

7. Verify that a test lamp does illuminate between the X1 harness connector ignition circuit terminal 1 and the X1 harness connector control circuit terminal 18.

- **If the test lamp is always OFF**

1. Ignition OFF, disconnect the X1 harness connector at the K20 Engine Control Module. Ignition ON.

2. Test for less than 1 V, between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
3. Test for less than 2 Ω in the control circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
- **Go to next step: If the test lamp is ON**
8. Test or replace the P16 Instrument Cluster.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

- Refer to [Instrument Cluster Replacement \(Equinox\)](#), [Instrument Cluster Replacement \(Terrain\)](#).
- Refer to [Control Module References](#) for ECM replacement programming and setup.

WATER-IN-FUEL LAMP DIAGNOSIS

Diagnostic Instructions

- Perform the [Diagnostic System Check - Vehicle](#) prior to using this diagnostic procedure.
- Review [Strategy Based Diagnosis](#) for an overview of the diagnostic approach.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

Circuit/System Description

The Water In Fuel Sensor monitors for the presence of water in the fuel. When water is present, the Engine Control Module (ECM) detects low voltage on the signal circuit and sends a request to the instrument panel cluster via the CAN communication circuit to display the WATER IN FUEL message.

Reference Information

Schematic Reference

[Engine Controls Wiring Schematics 1.6L \(LH7\)](#)

Connector End View Reference

[COMPONENT CONNECTOR END VIEWS - INDEX](#)

Component View Reference

[Powertrain Component Views](#)

Description and Operation

[Fuel System Description](#)

Electrical Information Reference

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

Scan Tool Reference

[Control Module References](#) for scan tool information

Circuit/System Verification

NOTE: If other contaminants are noticed in the fuel, a fuel system flush may be necessary.

1. Verify there is NO water in the fuel

Refer to [Water-in-Fuel Draining](#)

- **If there is water in the fuel**

Drain off the water completely.

- **Go to next step: If there is No water in the fuel**

2. Ignition ON.

3. Verify the WATER IN FUEL message is not displayed.

- **If the WATER IN FUEL message is displayed**

Refer to Circuit/System testing.

- **Go to next step: If the WATER IN FUEL message is not displayed**

4. All OK

Circuit/System Testing

NOTE: You must perform the Circuit/System Verification before proceeding with Circuit/System Testing.

1. Ignition OFF, and all vehicle systems OFF. Disconnect the harness connector at the E11A Fuel Heater/Water in Fuel Sensor. It may take up to 2 minutes for all vehicle systems to power down.

2. Test for less than 10 Ω between the Ground circuit terminal 4 and ground.

- **If 10 Ω or greater**

1. Ignition OFF, disconnect Ground G307.

Refer to [Ground Views](#) .

2. Test for less than 2 Ω in the ground circuit end to end.

- If 2 Ω or greater, repair the open or high resistance in the circuit.
- If less than 2 Ω , repair the open/high resistance in the ground connection.

- **Go to next step: If less than 10 Ω**

3. Reconnect the harness connector at the E11A Fuel Heater/Water in Fuel Sensor.

4. Ignition ON.

5. Using the scan tool, observe the Water in Fuel parameter. The parameter should display NO.

- **If No is not displayed**

1. Ignition OFF.

2. Test for infinite resistance between the Signal circuit terminal 3 and ground.

- If less than infinite resistance, repair the short to ground on the circuit.
- If infinite resistance, replace the K20 Engine Control Module.

- **Go to next step: If No is displayed**

6. Install a 3 A fused jumper wire between the Signal circuit terminal 3 and the Ground circuit terminal 4. The Water In Fuel Sensor parameter should display YES.

- **If the 3 A fuse opens and the Water In Fuel Sensor parameter does not display Yes**

Test the signal circuit for a short to voltage. If the circuit tests normal replace the K20 Engine Control Module.

- **If the 3 A fuse does not open and the Water In Fuel Sensor parameter does not display Yes**

Test the signal circuit for an open. If the circuit tests normal replace the K20 Engine Control Module.

- **Go to next step: If the 3 A fuse does not open and the Water In Fuel Sensor parameter displays Yes**

7. Replace the E11A Fuel Heater/Water in Fuel Sensor.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

- Refer to [Fuel Filter Assembly Replacement \(AWD\)](#), [Fuel Filter Assembly Replacement \(FWD\)](#) for E11A Fuel Heater/Water in Fuel Sensor.
- Refer to [Control Module References](#) for ECM replacement, programming, and setup.

ENGINE CRANKS BUT DOES NOT RUN

Diagnostic Instructions

- Perform the [Diagnostic System Check - Vehicle](#) prior to using this diagnostic procedure.
- Review [Strategy Based Diagnosis](#) for an overview of the diagnostic approach.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

Circuit/System Description

The Engine Cranks but Does Not Run diagnostic table is an organized approach to identifying a condition that causes an engine not to start. This diagnostic directs the service technician to the appropriate system diagnosis.

Diagnostic Aids

If the engine cranks but does not run condition occurs only in cold ambient temperatures, fuel contamination, poor fuel quality, or fuel waxing may be the cause. Fuel icing, due to water contamination, and fuel waxing may cause fuel system restrictions significant enough to prevent the engine from starting. A restriction will be indicated by a high vacuum in the fuel supply lines while cranking the engine in a cold state. The engine may start after the vehicle is brought into the service bay and the fuel is sufficiently warmed up. The use of an unapproved fuel, such as fuel containing greater than 20% bio-diesel, may cause severe fuel system restrictions. Unapproved fuel usage can also cause the engine to start and stall, or to start but have no acceleration. Engine block heaters may be used to alleviate some fuel icing and waxing concerns.

Reference Information

Schematic Reference

[Engine Controls Wiring Schematics 1.6L \(LH7\)](#)

Electrical Information Reference

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

Scan Tool Reference

[Control Module References](#)

Circuit/System Verification

NOTE: This diagnostic assumes the following:

- The battery is completely charged.

- **There is adequate fuel in the fuel tank.**

1. Engine cranking for 15 s, observe the DTC information with a scan tool. Verify that DTC P0090, P0190, P0191, P0335, P0602-P0607, P060A-P060C, P061C, P062B-P062F, P0627, P0630, P064C, P0670, P0671, P0672, P0673, P0674, P161C, P161E, P161F, P2146, P2149, P2510, P2687, or P268A is not set.

- **If any of the DTCs are set**

Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#)

- **Go to next step: If no DTCs are set**

2. Ignition ON

3. Verify the security indicator on the instrument panel cluster illuminates momentarily.

- **If the indicator stays illuminated or is flashing**

Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) , and [Immobilizer Description and Operation](#)

- **Go to next step: If the indicator does not stay illuminated or is not flashing**

4. Verify the scan tool Engine Speed parameter is greater than 0 RPM while cranking the engine.

- **If 0 RPM**

Refer to [DTC P0335 or P0336](#)

- **Go to next step: If greater than 0 RPM**

5. Verify the scan tool Engine Speed parameter, while cranking the engine, is greater than 50 RPM on a cold engine and 125 RPM on a hot engine.

- **If less than 50 RPM on a cold engine or less than 125 RPM on a hot engine**

Refer to [Engine Cranks Slowly](#).

- **Go to next step: If greater than 50 RPM on a cold engine or greater than 125 RPM on a hot engine**

6. Verify there are no fuel system leaks from the fuel tank to the high pressure pump.

- **If a fuel leak is present**

Refer to [Fuel Leak Diagnosis](#)

- **Go to next step: If a fuel leak is not present**

7. Ignition ON

8. Verify the Fuel Pressure Sensor 1 scan tool parameter displays 54 - 65 PSI when commanding the Fuel Pump Enable ON and OFF with a scan tool.

- **If the fuel pump does not turn ON and OFF**

Refer to [Fuel System Diagnosis](#)

- **Go to next step: If the fuel pump turns ON and OFF**

9. Verify the scan tool Fuel Rail Pressure Sensor parameter is greater than 10 MPa (1, 450 psi) while cranking the engine.

- **If not 10 MPa (1, 450 psi) or greater**

Refer to [Fuel System Diagnosis - High Pressure Side](#)

- **Go to next step: If greater than 10 MPa (1, 450 psi)**

10. Verify the following conditions do not exist:

- Collapsed or restricted air intake duct to the throttle body
- Restricted air filter element

- A skewed engine coolant temperature (ECT) sensor. Refer to [DTC P0117, P0118, or P0119](#)
 - Exhaust system restricted. Refer to [Restricted Exhaust](#) .
 - Fuel contamination. Refer to [Contaminants-in-Fuel Diagnosis](#).
 - Engine mechanical condition, for example, worn timing chain and gears or low compression. Refer to [Symptoms - Engine Mechanical](#) , or [Engine Compression Test](#) .
- **If a condition is found**

Repair as necessary.

- **Go to next step: If a condition is not found**

11. All OK

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

FUEL SYSTEM DIAGNOSIS

Diagnostic Instructions

- Perform the [Diagnostic System Check - Vehicle](#) prior to using this diagnostic procedure.
- Review [Strategy Based Diagnosis](#) for an overview of the diagnostic approach.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

Circuit/System Description

Low Pressure System

After the vehicle has been powered Off for at least 2 min and the ignition is turned On, the engine control module (ECM) sends a signal via the fuel pump primary relay circuit to the fuel pump driver control module. The fuel pump driver control module enables the fuel pump for 30 s or continuously when the engine is running. The fuel pump driver control module actuates the brushless fuel pump by means of a high power three phase signal and controls the fuel pump speed according to serial data signals received from the ECM containing the desired fuel pump speed.

The fuel tank stores the fuel supply and the brushless fuel pump, pumps fuel from the fuel tank through the fuel filter/heater element housing, which contains the water separator, water in fuel sensor, fuel heater element, fuel temperature sensor, and fuel filter element. The fuel pressure is sensed by the fuel pressure sensor and then delivered to the high-pressure pump.

The fuel return system uses the unused return fuel to cool and lubricate the fuel injectors and fuel injection pump. If the high side fuel pressure becomes excessive, fuel pressure regulator 2 releases the fuel into the fuel return system. The returned fuel travels through the fuel return lines and fuel cooler to the fuel tank.

During a cold start, in order to warm the fuel the high pressure pump operates at full output and the pressure in the rail is regulated by fuel pressure regulator 2. This mode is also active during fuel injection cut-off. When in this mode, the fuel return line can flow up to 230 l/h (60.8 g/h).

Reference Information

Schematic Reference

[Engine Controls Wiring Schematics 1.6L \(LH7\)](#)

Connector End View Reference

[COMPONENT CONNECTOR END VIEWS - INDEX](#)

Component View Reference

[Powertrain Component Views](#)

Fuel System Description

Electrical Information Reference

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

[Control Module References](#) for scan tool information

Special Tools

- **CH-37287-1A** Fuel Pressure Gauge Adapter
- **CH-48027** Digital Fuel Pressure Gauge

For equivalent regional tools refer to: [Special Tools \(Diagnostic Tools\)](#) [Special Tools \(Mechanical Tools\)](#).

Circuit/System Verification

1. Verify DTC P018B, P018C, or P018D is not set

- **If any of the DTCs are set**

Refer to: [Diagnostic Trouble Code \(DTC\) List - Vehicle](#)

- **If none of the DTCs are set**

Refer to Circuit/System Testing.

Circuit/System Testing

NOTE: It may be necessary to remove engine components for the visual inspections.

1. Verify the following conditions do not exist:

- Hoses and lines that have kinks that would restrict the flow of fuel
- Fuel leaks between the fuel tank and the fuel injection pump
- *If any conditions exist*

Repair or replace as necessary.

- *Go to next step: If no conditions exist*

2. Verify that adequate fuel is in the fuel tank.

NOTE: A fuel return line that is leaking, is a good indication there is a restriction in the return system.

3. Verify there are no leaks in the fuel return lines.

- **If a leak is found**

Refer to: [Fuel Return System Diagnosis](#)

- Go to next step: If a leak is not found

4. Ignition Off and all vehicle systems Off. It may take up to 2 minutes for all vehicle systems to power down.

NOTE: Fuel temperature must be warmer than 20°C (68°F) before performing the next step or incorrect diagnosis may occur.

5. Ignition On, verify scan tool parameter Fuel Pressure Sensor is between 370-450 kPa (54-65 PSI).

- *If not within 370-450 kPa (54-65 PSI)*

1. Ignition Off and all vehicle systems Off. It may take up to 2 minutes for all vehicle systems to power down.

2. Disconnect the fuel supply inlet line at the fuel filter assembly.

3. Install the **CH-37287-1A** Fuel Pressure Gauge Adapter and attach the **CH-48027** Digital Fuel Pressure Gauge.

4. Ignition On, verify the fuel pressure is between 370-450 kPa (54-65 PSI).

- If not within 370-450 kPa (54-65 PSI), replace the G12A Fuel Pump - Primary.
- If within 370-450 kPa (54-65 PSI), replace the fuel filter.

- *Go to next step: If within 370-450 kPa (54-65 PSI)*

6. Verify engine cranks and runs smoothly.

- *If engine cranks but does not run or starts but runs poorly*

Refer to [Fuel System Diagnosis - High Pressure Side](#).

- *Go to next step: If engine cranks and runs smoothly*

7. All OK

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the diagnostic procedure.

- Refer to [Fuel Filter Replacement \(AWD\)](#), [Fuel Filter Replacement \(FWD\)](#).
- Refer to [Fuel Tank Fuel Pump Module Replacement \(FWD\)](#), [Fuel Tank Fuel Pump Module Replacement \(AWD\)](#).

FUEL SYSTEM DIAGNOSIS - HIGH PRESSURE SIDE

Diagnostic Instructions

- Perform the [Diagnostic System Check - Vehicle](#) prior to using this diagnostic procedure.
- Review [Strategy Based Diagnosis](#) for an overview of the diagnostic approach.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

Circuit/System Description

High Pressure System

The fuel tank stores the fuel supply and contains an electric fuel pump that is controlled by the fuel pump driver control module and engine control module. Fuel is pumped from the fuel tank through the fuel feed line to the fuel filter assembly. The fuel filter assembly consists of a fuel filter/water separator, fuel heater, fuel temperature sensor, and a water in fuel sensor. Fuel flows out of the fuel filter assembly through the rear fuel feed pipe to the fuel pressure sensor and then to the high pressure fuel pump. High pressure fuel is supplied through the high pressure fuel line to the fuel rails and then through the fuel injector lines to the fuel injectors. High pressure fuel is controlled by the ECM, fuel pressure regulator 1 and fuel pressure regulator 2. Excess fuel returns to the fuel tank through the fuel return pipes.

Reference Information

Schematic Reference

[Engine Controls Wiring Schematics 1.6L \(LH7\)](#)

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

Powertrain Component Views

Description and Operation

Fuel System Description

Electrical Information Reference

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

[Control Module References](#) for scan tool information

Circuit/System Testing

1. Ignition Off.
2. Verify there are no external leaks or damage to the fuel return and supply lines.
 - **If external leaks or damage is found**
Refer to [Fuel Leak Diagnosis](#).
 - **Go to next step: If no external leaks or damage is found**
3. Verify that adequate fuel is in the fuel tank before proceeding.
4. Engine cranking or running, verify scan tool parameter Fuel Pressure Sensor is between 370-450 kPa (54-65 PSI).
 - **If not within 370-450 kPa (54-65 PSI)**
Refer to: [Fuel System Diagnosis](#)
 - **Go to next step: If within 370-450 kPa (54-65 PSI)**
5. Ignition Off, disconnect all the glow plug harness connector nuts and remove the glow plugs.
6. Using a scan tool, enable the control function Compression Test.
7. Hold a clean rag over the glow plug holes.
8. Crank the engine for 6 compression strokes. No fuel vapor should be emitted onto the rag.
 - **If fuel vapor is emitted**
Replace the appropriate Q17 Fuel Injector.
 - **Go to next step: If fuel vapor is not emitted**
9. Disconnect the Q18B Fuel Pressure Regulator 2 return hose and plug the hose to prevent fuel leakage.
10. Install a section of rubber fuel hose on the fuel pressure regulator 2 outlet and place the loose end of hose into a clean fuel container.
11. Perform the applicable test listed below:

ENGINE NO START:

1. Engine cranking for 15 seconds.
2. Observe the volume of fuel from fuel pressure regulator 2. The volume of fuel should be less than 10 ml (0.4 oz).
 - If greater than 10 ml (0.4 oz), replace Q18B Fuel Pressure Regulator 2.
 - If less than 10 ml (0.4 oz)

NOTE:

- **Perform the following two Sub-Steps for each injector.**
- **Complete the following two Sub-Steps on all of the fuel injectors before performing any repairs.**

3. Disconnect the electrical connector and the fuel return line from one of the fuel injectors.
4. Engine Cranking for 15 seconds, verify no fuel leaks from the fuel injector.
 - If fuel leaks from the fuel injector, replace the appropriate Q17 Fuel Injector.
 - If no fuel leaks from the fuel injector, replace the G18 High Pressure Fuel Pump.

ENGINE STARTS:

1. Disconnect the Q18B Fuel Pressure Regulator 2 return hose and plug the hose to prevent fuel leakage.
2. Install a section of rubber fuel hose on the fuel pressure regulator 2 outlet and place the loose end of hose into a clean fuel container.
3. Engine at idle.
4. Fuel temperature must be greater than -25Â°C (-13Â°F)
5. Engine at a stable idle.
6. Engine at normal operating temperature.

NOTE:

Engine speed greater than 1800 RPM will cause incorrect test results.

7. Slowly increase engine speed to 1700 RPM and then back to idle within 15 s.
8. Observe the volume of fuel from fuel pressure regulator 2. The volume of fuel should be less than 10 ml (0.4 oz).
 - If greater than 10 ml (0.4 oz), replace Q18B Fuel Pressure Regulator 2.
 - If less than 10 ml (0.4 oz)
9. Reconnect the Q18B Fuel Pressure Regulator 2 return line.
10. Engine Idling.

NOTE:

When commanding fuel rail pressure at idle the maximum achievable pressure will be approximately 120 MPa (17405 psi).

11. Command the fuel pressure incrementally through the entire fuel pressure range with a scan tool.
12. Verify the scan tool Fuel Rail Pressure Sensor 1 and the Desired Fuel Rail Pressure are within 2000 kPa (290 psi) for the entire fuel pressure range and note results.
 - **If the fuel pressure parameters are not within 2000 kPa (290 psi)**

Replace the Q18A Fuel Pressure Regulator 1.

• **Go to next step: If the fuel pressure parameters are within 2000 kPa (290 psi)**
13. Replace the G18 High Pressure Fuel Pump.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- For Q18A Fuel Pressure Regulator 1 replacement refer to: [Fuel Injection Pump Metering Valve Replacement](#)
- For Q18B Fuel Pressure Regulator 2 replacement refer to: [Fuel Injection Fuel Rail Assembly Replacement](#)
- Refer to [Fuel Injection Pump Replacement](#)
- Refer to [Fuel Injector Replacement](#)

FUEL RETURN SYSTEM DIAGNOSIS

Diagnostic Instructions

- Perform the [Diagnostic System Check - Vehicle](#) prior to using this diagnostic procedure.
- Review [Strategy Based Diagnosis](#) for an overview of the diagnostic approach.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

Circuit/System Description

The fuel return system is designed to cool and lubricate the fuel injectors and the fuel injection pump. If the high side fuel pressure becomes excessive, the fuel pressure regulators release the excess fuel into the fuel return side where it returns to the fuel tank.

Diagnostic Aids

Bent or pinched fuel return lines may cause engine performance concerns.

Reference Information

Schematic Reference

[Engine Controls Wiring Schematics 1.6L \(LH7\)](#)

Connector End View Reference

[COMPONENT CONNECTOR END VIEWS - INDEX](#)

Component View Reference

[Powertrain Component Views](#)

Description and Operation

[Fuel System Description](#)

Circuit/System Verification

1. Verify the following condition not exist:

NOTE: It may be necessary to remove engine components for visual inspections.

- Fuel return hoses and lines that are bent or kinked

NOTE: A fuel return line that is leaking, is a good indication a restriction exists in the fuel return system.

- Fuel return hoses and lines externally leaking in engine compartment
- Fuel return hoses and lines externally leaking between engine compartment and fuel tank
- **If any condition exist**

Repair or replace as necessary.

- **Go to next step: If no condition exist**

Circuit/System Testing

NOTE: **DO NOT apply more than the specified air pressure to the return line.**

1. Disconnect the fuel return line at the engine. Refer to.
2. Remove the fuel filler cap.
3. Apply 6.9 kPa (1 psi) of air pressure into the fuel return line at the engine.
4. Verify air flow can be detected exiting the fuel filler tube.
 - **If air flow was not detected**
 1. Disconnect the fuel return line at the fuel sender.
 2. Apply 6.9 kPa (1 psi) of air pressure into the fuel return line at the engine.
 3. Verify air flow can be detected exiting the fuel return line.
 - If air flow was present, replace the fuel sender assembly.
 - If no air flow was present, inspect for a restricted and replace the affected fuel return line.
 - **Go to next step: If air flow was detected**
5. All OK.

Repair Instructions

NOTE: **If a restriction was present it may be necessary to clean fuel system. Refer to [Fuel System Cleaning](#) .**

Perform the [Diagnostic Repair Verification](#) after completing the repair.

Refer to [Fuel Tank Fuel Pump Module Replacement \(FWD\)](#), [Fuel Tank Fuel Pump Module Replacement \(AWD\)](#).

FUEL LEAK DIAGNOSIS

Diagnostic Instructions

- Perform the Diagnostic System Check prior to using this diagnostic procedure: [Diagnostic System Check - Vehicle](#)
- Review the description of Strategy Based Diagnosis: [Strategy Based Diagnosis](#)
- An overview of each diagnostic category can be found here: [Diagnostic Procedure Instructions](#)

Diagnostic Aids

Fluorescent dye assists in locating leaks in the system. A high-intensity black light will make the dye glow. - Green or Yellow

Illuminate the area (s) of concern. For example:

- G18 High Pressure Fuel Pump
- Q17 Fuel Injector
- Fuel Line
- Fuel Rail
- {If equipped} Fuel Return Pipe

Reference Information

Special Tools

- **J-28428-E** High-Intensity Black Light Kit
- **J-42220** Universal 12 V Leak Detection Lamp

1. Perform the following action: Clean all of the components in the suspected area using a cleaning solution and allow the components to dry: Fuel System
2. Perform the following action: Add 237 mL (8 US fl oz) of GM Approved Oil Dye to the component: Fuel Tank - Primary
3. Engine - Idling - For 3 to 5 min
4. Perform the scan tool control function: Fuel Pressure Control - Regulator 1 - Increase - Maximum Pressure - If applicable

CAUTION: When performing a Fuel Leak Diagnosis, it is **VERY IMPORTANT** to use only GM approved Oil Dye, Part Number 88861206. If any other oil dye is used, it will cause damage to the fuel injection system components, as well as the emission control components. This will result in necessary replacement of the damaged components.

5. Use the special tool: **J-28428-E** High-Intensity Black Light Kit or J-42220 Universal 12 V Leak Detection Lamp - Illuminate the area (s) of concern.

Verify there are no leaks in the component/system: High Pressure Side of the Fuel System or Return Side of the Fuel System

- **{High Pressure Side of the Fuel System} If a leak is present**

Repair or replace as necessary.

- **{Return Side of the Fuel System} If a leak is present**

Refer to: [Diagnostic Procedure Instructions](#)

- **Go to next step: If no leak is present**

6. All OK.

FUEL SPECIFIC GRAVITY TESTING

The fuel quality hydrometer provides a general indication of fuel quality and should not be considered scientifically accurate.

Fuel Oil Specific Gravity Requirements

Specification	Number 2-Diesel	Number 1-Diesel	Tool
API Gravity	30 - 39	39 - 44	J 38641 B

1. Drain the fuel filter housing by following the steps below:
 1. Stop the engine.
 2. Place a container under the water drain valve on the bottom of the fuel filter.
 3. Open the drain valve.
 4. Fill a 1 l (0.95 quart) container with a sample of fuel.
 5. Close the drain valve.
2. Obtain a **J 38641-B** Diesel Fuel Quality Tester.
3. Fill the hydrometer with the fuel sample by doing the following:
 1. Squeeze the hydrometer bulb.
 2. Submerge the hydrometer tip into the sample.
 3. Release the bulb, allowing fuel to enter the glass tube until the fuel completely floats the glass bulb inside the tube.
 4. Gently spin the hydrometer to relieve the surface tension of the fuel sample. Read the scale on the glass bulb at the point where the top of the fuel sample contacts the scale. By reading this value, the value will give an approximate fuel oil specific gravity. Refer to tool instructions on how to determine API Gravity.

4. Refer to the Fuel Oil Specific Gravity Requirements table. If the correct fuel is being used in the conditions listed in Fuel Quality, and meets number 1-Diesel or number 2-Diesel fuel oil specific gravity requirements, fuel is OK. If not, the fuel should be replaced.

CHARGE AIR COOLER DIAGNOSIS (LEAK TEST)

Diagnostic Instructions

- Perform the [Diagnostic System Check - Vehicle](#) prior to using this diagnostic procedure.
- Review [Strategy Based Diagnosis](#) for an overview of the diagnostic approach.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

Reference Information

Special Tools

- **EN-47603** Compression Gauge Adapter
- **EN-46091** Charge Air Cooler Tester
- **EN-46091-10A** Diesel Engine Pressure Test Adapter

For equivalent regional tools, refer to [Special Tools \(Diagnostic Tools\)](#) [Special Tools \(Mechanical Tools\)](#) .

EN 46091-1 Pressure Regulator Adjustment

NOTE: Some EN-46091-1 regulators may have the adjusting knob riveted in place. The rivet head must be drilled out with a 5/16 inch drill bit before adjustment. Do not drill more than 1/8 inch in depth, or just enough to remove the rivet head. The rivet shaft does not have to be removed from the regulator.

1. Connect the **EN-47603** to the **EN-46091-1** gauge set outlet and connect shop air to the **EN-47603**.
2. Open the shutoff valve, then slowly adjust the regulator on the **EN-46091-1** until the gauge reads 55 kPa (8 psi).
3. Close the air supply valve and remove the **EN-47603** from the gauge assembly.
4. The gauge set is now calibrated to perform the test.

Induction System Inlet Connection

1. Loosen the rear air cleaner outlet duct clamp at the turbocharger compressor inlet.
2. Disconnect the rear air cleaner outlet duct from the air cleaner upper housing.
3. Use the existing clamp to attach the **EN-46091-10A** to the air cleaner outlet duct and tighten the clamp securely.
4. Tighten the rear air cleaner outlet duct clamp at the turbocharger compressor inlet.
5. Attach the safety cable on the **EN-46091-10A** to a suitable location.

Air Pressure Application

1. Attach the **EN-46091-1** outlet hose to the quick disconnect fitting on **EN-46091-10A** .
2. Connect the air supply to the air valve on the gauge/regulator assembly.
3. Open the air supply valve slowly, increasing the air pressure to a maximum of 55 kPa (8 psi).

Leak Test

1. Verify air leaks do not exist by listening for excessive hissing sounds and using a pump spray bottle to apply a soapy water solution, while observing for excessive soapy bubbles at the locations listed below:
 - All air induction system hose clamps.
 - Air cleaner outlet duct.

- Charge air cooler inlet and outlet hoses and ducts.
- Charge air cooler.
- Intake manifold gaskets and seals.
- **If an air leaks exists**

Repair or replace the affected gasket, seal, clamp or component as necessary and repeat step 1.

- **Go to next step: If no air leaks exist**

2. All OK

CHARGE AIR COOLER DIAGNOSIS (SMOKE TEST)

Diagnostic Instructions

- Perform the [Diagnostic System Check - Vehicle](#) prior to using this diagnostic procedure.
- Review [Strategy Based Diagnosis](#) for an overview of the diagnostic approach.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

Circuit/System Description

The purpose of the Induction System Smoke Test is to aid in finding an air leak anywhere in the induction system including the crankcase ventilation system.

Reference Information

Special Tools

- **GE-41413-A** Evaporative Emission System Tester (EEST)
- **GE-41413-311** Brass Cone Adapter
- **GE-41413-SPT** High Intensity White Light

For equivalent regional tools, refer to [Special Tools \(Diagnostic Tools\) Special Tools \(Mechanical Tools\)](#).

Smoke Test Application

1. Ignition OFF, disconnect the E45 Positive Crankcase Ventilation Heater from the air cleaner outlet duct, refer to [Air Cleaner Outlet Duct Replacement](#).
2. Remove the air cleaner element, refer to [Air Cleaner Element Replacement](#). Place a disposable plastic bag over the air outlet in the air cleaner housing.
3. Connect the **GE-41413-A** to the **GE-41413-311**.
4. Wrap a shop towel around the **GE-41413-311** to create a seal, and place the **GE-41413-311** into the opening for the PCV heater in the air cleaner outlet duct.
5. Apply smoke continuously while moving all duct work, pipes, and tubes.

NOTE:

- **To improve the visibility of the smoke exiting the engine, illuminate the suspected leak area with the GE-41413-SPT and observe the area from different angles.**
- **Commanding the intake air flow valve closed with a scan tool can help to increase the volume of smoke within the CAC and induction tubes.**

6. Verify smoke is not visible exiting the engine, including the components listed below:
 - All air induction system hose clamps.
 - Air cleaner outlet duct.
 - Charge air cooler inlet and outlet hoses.
 - Charge air cooler.

- Intake manifold gaskets and seals.
- Mass airflow sensor.
- Positive crankcase ventilation hoses/pipes/tubes.
- Positive crankcase ventilation oil separator.
- **If smoke is visible**

Repair or replace the affected gasket, seal, clamp or component as necessary and repeat step 5.

- **Go to next step: If smoke is not visible**

7. Refer to **Charge Air Cooler Diagnosis (Leak Test)****Charge Air Cooler Diagnosis (Smoke Test)** and perform the Charge Air Cooler Diagnosis (Induction System Air Leak Test).

CONTAMINANTS-IN-FUEL DIAGNOSIS

Fungi and other microorganisms can survive and multiply in diesel fuel if water is present. The fungi can be present in any part of the fuel handling system. These fungi grow into long strings and will form into large globules. The growths appear slimy and are usually black, green, or brown. The fungi may grow anywhere in the fuel but are most plentiful where diesel fuel and water meet. Service station tanks may contain fungi that could be pumped into a vehicle during refueling.

Fungi use the fuel as their main energy supply and need only trace amounts of water and minerals. As they grow and multiply, they change fuel into water, sludge, acids, and products of metabolism. The most common symptom is fuel filter plugging, however various metal fuel system components including fuel sender assembly, pipes, fuel injectors, and fuel injection pump can corrode.

WARNING: **Avoid physical contact with the biocides in order to avoid personal injury.**

If fungi have caused fuel system contamination, use a diesel fuel biocide to sterilize the fuel system. Do not exceed the dosage recommended on the label. Discontinue the use of a biocide when towing a trailer due to possible engine power loss. It is permissible to have biocide in the fuel when starting to tow, but do not add any biocide while towing.

Water or other like contaminants in fuel will also create driveability concerns and loss of engine power. If water is present in the fuel system, the fuel cannot cool and lubricate the components, causing overheating, rust and corrosion. This can result in component failure. Water can enter the fuel system in several ways, either through a contaminated refueling source, or through long term condensation the vehicle fuel tanks.

Like fungi and water, gasoline contamination will cause driveability concerns and a possible hard starting or a no start condition if the overall content is large enough. Gasoline raises the API rating and reduces cooling and lubrication, resulting in possible component failure.

It is acceptable to use diesel fuel containing up to 20 percent bio-diesel. Bio-diesel is produced from vegetable oils or animal fat that have been chemically modified to reduce the possibility of damage to the fuel system and engine components. Concentrations greater than B20 fuels or the use of unmodified bio-oils blended into diesel fuel at any concentration is not recommended and may cause driveability concerns or component failure.

Because of the cleansing properties of bio-diesel, switching from straight diesel to a bio-diesel blend can prematurely restrict the fuel filter with normal deposits in the fuel system. A fuel filter replacement might be required sooner than the recommended interval.

Diesel Fuel Containing Red Dye in the United States and Canada

The Governments of the United States and Canada impose an excise tax on diesel fuel. However, certain fuel uses are tax-exempt or subject to a reduced rate. These uses include: heating, farming, off-road vehicles, use by state or local governments or non-profit educational organizations, and boats engaged in fishing or transportation.

The red dye is added to ensure diesel fuels with high sulfur content are not used for on-road vehicles and to ensure tax-exempt diesel fuel is not used for taxable purposes. After 2012, the only diesel fuel

produced containing high-sulfur in the United States and Canada is heating oil.

The use of red diesel fuel will not cause any problems with the fuel or exhaust aftertreatment systems.

Inspecting for Fuel Contaminants

1. Test the fuel specific gravity and record the results. Refer to [Fuel Specific Gravity Testing](#)
2. Remove the fuel filter and inspect the inside area of the fuel filter for dirt, water deposits, microbial contamination, or other debris.
3. Drain the fuel filter into an approved clear container and allow the contents to settle. Observe the container for contaminant separation.

NOTE: **The presence of water or gasoline in diesel fuel may also cause damage to other fuel system components.**

4. If contaminants are present in the fuel or in any of the inspected areas, remove the fuel lines to the injectors and inspect the fuel injector return outlets and feed inlets for rust or corrosion.
 - Replace the fuel injectors if rust or corrosion is present. Refer to [Fuel Injector Replacement](#) , and [Fuel System Cleaning](#) .
 - If rust or corrosion was not present in the injectors, but contaminated fuel was present, refer to [Fuel System Cleaning](#) and attempt to start and run the engine after procedure is completed.
 - If rust, corrosion or water is present, test the Water in Fuel Sensor for proper operation. Refer to [Water-in-Fuel Lamp Diagnosis](#)

CONTAMINANTS-IN-DIESEL EXHAUST FLUID DIAGNOSIS

Description

Maximum oxides of nitrogen (NO_x) reduction efficiency of the selective catalyst reduction system requires the supply of diesel exhaust fluid (reductant). Consisting of a mixture of urea and deionized water, fresh reductant should be clear in color with an ammonia smell. Reductant designed for selective catalyst reduction systems should carry one or more of the following international certifications:

- DIN70700
- ISO 22241-1
- American Petroleum Institute (API) Certification

Inspecting for Contaminates

While contamination may result from any number of fluids, it's more likely that contamination will involve one the following common automotive fluids. As clean reductant is clear, contamination by any of these fluids will cause the reductant to exhibit a trace of color associated with a specific contaminate.

- Windshield washer solvent - orange, purple or blue
- Engine coolant - orange or green
- Engine oil - brown
- Transmission fluid - red or brown
- Diesel fuel - clear, yellow, green, red or brown

Clear fluid without the presence of an ammonia odor may indicate water or reductant diluted with water.

Reference Information

Scan Tool Reference

[Control Module References](#) for scan tool information

Special Tools

- **J 26568** Coolant and Battery Fluid Tester

OR

- EN 50422 Diesel Exhaust Fluid Refractometer

Circuit/System Testing

WARNING: Diesel Exhaust Fluid (DEF) is corrosive. Do not allow it to come in contact with your skin, eyes, or the finished surfaces of the vehicle. If exposed, it may cause skin and eye irritation. Wear skin and eye protection when handling. Inhalation may cause irritation to the upper respiratory tract. Store in a cool, well-ventilated area. For more safety information, see the label of the Diesel Exhaust Fluid container. Failure to follow this procedure may result in injury and/or vehicle damage.

1. Test a sample of reductant by collecting about 150 ml (5 oz) from the reductant tank in a clear container. Observe the reductant sample. The reductant sample should have an ammonia smell and should be clear with no obvious coloration when held up to a light.

- **If the sample does not have an ammonia smell or is discolored**

1. If the sample is contaminated with engine coolant or windshield washer solvent, flush the reductant system.

NOTE: If the engine was never started and the sample is contaminated with diesel fuel, engine oil, transmission oil, or other petroleum-based product, only replace the emission reduction fluid tank and flush the emission reduction fluid tank opening filler.

2. If the engine has been started and the sample is contaminated with diesel fuel, engine oil, transmission oil, or other petroleum-based product, flush the emission reduction fluid tank opening filler with fresh reductant, and replace the following components:

- Emission reduction fluid tank
- Emission reduction fluid reservoir assembly
- A38 Emission Reduction Fluid Pump Module
- Q61 Emission Reduction Fluid Injector
- Emission reduction fluid reduction injector supply pipe
- **Go to next step: If the sample has an ammonia smell and is not discolored**

2. Test the reductant sample using one of the tools listed below:

- **J 26568**

OR

- **EN 50422**

3. Verify the sample is within the range specified below:

- **J 26568** - Between 1.310 and 1.3843 at 20°C (68°F)
- **EN 50422** - Between 30% and 35%.
- **If not within the specified range**

Drain the remaining reductant and refill the tank with fresh reductant

- **Go to next step: If within the specified range**

4. Perform the Reductant System Tamper Warning Service Bay Test with a scan tool.

5. Verify the test passes.

- **If the test does not pass**

Replace the reductant

- **Go to next step: If the test passes**

6. All OK.

Repair Verification

1. Install any components or connectors that have been removed or replaced during diagnosis.
2. Perform any adjustment, programming, or setup procedures that are required when a component or module is removed or replaced.
3. Clear the DTCs.
4. Ignition Off, all vehicle systems Off, this may take up to 2 minutes.

NOTE: The reductant and ambient air temperatures must be greater than -7Â°C (19Â°F) before proceeding with this procedure.

5. Ignition On, command the Reductant System Leak Test On with a scan tool. Allow the pressure to build for at least 2 minutes.
6. Verify there are no leaks in the system.

- **If a leak is found**

Repair as necessary

- **Go to next step: If no leaks are found**

7. If the repair was related to a DTC, duplicate the Conditions for Running the DTC and use the Freeze Frame/Failure Records, if applicable, to verify the DTC does not set.

- **If a DTC sets**

Refer to the [Diagnostic Trouble Code \(DTC\) List - Vehicle](#)

- **Go to next step: If a DTC does not set**

8. All OK.

DIESEL EXHAUST FLUID (DEF) WARNING STRATEGY (DEF LEVEL)

An adequate on-board supply of Diesel Exhaust Fluid (DEF) is critical for the reduction of exhaust Oxides of Nitrogen (NOx) levels within the Selective Catalyst Reduction (SCR) stage. This vehicle provides the driver with an elaborate series of prompts and warnings that are initiated when the DEF level falls below a calibrated value.

The Engine Control Module (ECM) monitors the DEF level and consumption rate in order to calculate an estimated range in miles remaining until the DEF reservoir is empty. DEF levels are detected by the 3-position solid-state DEF level sensor. Typically, DEF warnings begin once the estimated mileage falls below 1,609 km (1,000 mi). Once initiated, DEF warnings grow increasingly more serious as the remaining mileage decreases without a DEF refill. The vehicle's current DEF warning level is displayed on the scan tool as Reductant Level Warning Indicator Command Level 1 through Level 14.

Warning Level 1

Warning Level 1 is triggered when the DEF level falls below the top-most position of the DEF Level Sensor and the estimated range remaining is greater than 1609 km (1000 mi). No prompts or warnings are presented to the driver.

Warning Level 2

Warning Level 2 is triggered when the estimated range remaining falls below 1,609 km (1,000 mi) based on current DEF consumption rates. The Driver Information Center (DIC) displays the message Exhaust Fluid Range X MI, where X is the estimated range remaining in miles. This message remains on the DIC until acknowledged by the driver.

Warning Level 3

Warning Level 2 automatically advances to Warning Level 3 when the ECM detects an ignition On to ignition Off event. A level 3 warning remains active as long as the estimated range remaining is greater than 483 km (300 mi) based on current DEF consumption rates.

Warning Level 4

Warning Level 4 is triggered when the estimated range remaining falls below 483 km (300 mi) based on current DEF consumption rates. The message Exhaust Fluid Range X MI, where X is the estimated range remaining in miles is displayed in the DIC. This message is also displayed at the beginning of each ignition cycle. This message remains on the DIC until acknowledged by the driver.

Warning Level 5

Warning Level 5 is triggered when the estimated range remaining is less than approximately 121 km (75 mi) based on current DEF consumption rates. The message Exhaust Fluid Low - Speed Limited Soon, is displayed on the DIC. This message is also displayed at the beginning of each ignition cycle. This message remains in the DIC until acknowledged by the driver.

Warning Level 6

Warning Level 6 is triggered when the estimated range remaining is less than approximately 0 km (0 mi) based on current DEF consumption rates. The driver will hear 4 chimes on entering Warning Level 6. The DIC displays the following messages:

For Non-Emergency vehicles and Emergency vehicles MY 2013 and older:

- Exhaust Fluid Empty Refill Now
- 644 km (400 miles) until 105 km/h (65 mph) Max Speed

For Emergency vehicles MY 2014 and newer:

- Exhaust Fluid Empty Refill Now
- 999 km (620 miles) until 105 km/h (65 mph) Max Speed

The messages are also displayed at the beginning of each ignition cycle. The Exhaust Fluid Empty Refill Now message remains on the DIC until acknowledged by the driver. The Max Speed mileage countdown until speed limitation will remain displayed in the DIC.

The DEF Indicator in the instrument panel is continuously illuminated. The vehicle remains in Warning Level 6 until the DEF reservoir is refilled or the first mileage countdown expires.

After the first mileage countdown expires, the system will advance from Warning Level 6 to Warning Level 7.

Warning Level 7

Warning Level 7 is active after the first mileage countdown expires. The driver will hear 4 chimes on entering Warning Level 7. The DIC displays the following messages:

- Exhaust Fluid Empty Refill Now
- Transitioning to 105 km/h (65 mph) Max Speed

The messages are alternately displayed every 5 seconds on the DIC. Exhaust Fluid Empty Refill Now remains on the DIC until acknowledged by the driver; however, the Transitioning to 105 km/h (65 mph) Max Speed remains displayed in the DIC.

The DEF Indicator in the instrument panel is continuously illuminated.

Vehicle speed limit is ramping down from Max Speed limit to the limit of 105 km/h (65 mph).

Warning Level 8

Warning Level 8 is triggered after the speed limit ramp-down is complete or a key cycle. The driver will hear 4 chimes on entering Warning Level 8. The DIC displays the following messages:

- Exhaust Fluid Empty Refill Now
- Speed Limited to 105 km/h (65 mph)

- 120 km (75 miles) until 89 km/h (55 mph) Max Speed

The messages are alternately displayed every 5 seconds on the DIC. The Exhaust Fluid Empty Refill Now message remains in the DIC until acknowledged by the driver and occurs every ignition cycle. The speed limited and mileage countdown for speed limitation remain displayed in the DIC

The DEF Indicator in the instrument panel is continuously illuminated. The vehicle remains in Warning Level 8 until the DEF reservoir is refilled or the second mileage countdown expires.

Vehicle speed is limited to 105 km/h (65 mph).

Warning Level 9

Warning Level 9 is triggered after the second mileage countdown expires without a refill of the DEF reservoir. The driver will hear 4 chimes on entering Warning Level 9. The DIC displays the following messages:

- Exhaust Fluid Empty Refill Now
- Transitioning to 89 km/h (55 mph) Max Speed

The messages are alternately displayed every 5 seconds on the DIC. Exhaust Fluid Empty Refill Now remains in the DIC until acknowledged by the driver; however, the Transitioning to 89 km/h (55 mph) Max Speed message remains displayed in the DIC.

The DEF Indicator in the instrument panel flashes continuously.

Vehicle speed limit is ramping down from 105 km/h (65 mph) Max Speed limit to 89 km/h (55 mph).

Warning Level 10

Warning Level 10 is triggered after the speed limit ramp-down is complete or a key cycle. The driver will hear 4 chimes on entering Warning Level 10. The 4 chimes are repeated 2 more times during this ignition cycle. The DIC displays the following messages:

- Exhaust Fluid Empty Refill Now
- Speed Limited to 89 km/h (55 mph)
- 120 km (75 miles) until 7 km/h (4 mph) Max Speed

The messages are alternately displayed every 5 seconds in the DIC. Exhaust Fluid Empty Refill Now remains in the DIC until acknowledged by the driver; however, the speed limited and mileage countdown for speed limitation remain displayed in the DIC.

The DEF Indicator in the instrument panel flashes continuously. The vehicle remains in Warning Level 10 until the DEF reservoir is refilled or the third mileage countdown expires.

Vehicle speed is limited to 89 km/h (55 mph).

Warning Level 11

Warning Level 11 is not used.

Warning Level 12

Warning Level 12 is not used.

Warning Level 13

Warning Level 13 is triggered after the third mileage countdown expires without a refill of the DEF reservoir. The driver will hear 4 chimes on entering Warning Level 13. The DIC displays the following messages:

- Exhaust Fluid Empty Refill Now
- Transitioning to 7 km/h (4 mph) Max Speed

The messages are alternately displayed every 5 seconds in the DIC. Exhaust Fluid Empty Refill Now remains in the DIC until acknowledged by the driver; however, the Transitioning to 7 km/h (4 mph) Max Speed message remains displayed in the DIC.

The DEF Indicator in the instrument panel flashes continuously. Vehicle speed limit is ramping down from 89 km/h (55 mph) max speed limit to 7 km/h (4 mph).

Warning Level 14

Warning Level 14 is triggered after the speed limit ramp-down is complete or a key cycle. The driver will hear 4 chimes on entering Warning Level 14. The 4 chimes are repeated every 3 minutes. The DIC displays the following messages:

- Exhaust Fluid Empty Refill Now
- Speed Limited to 7 km/h (4 mph)

The messages are alternately displayed every 5 seconds in the DIC. Exhaust Fluid Empty Refill Now remains in the DIC until acknowledged by the driver; however, the Speed Limited to 7 km/h (4 mph) message remains displayed in the DIC.

The DEF Indicator in the instrument panel flashes continuously. The vehicle remains in Warning Level 14 until the DEF reservoir is refilled.

Vehicle speed is limited to 7 km/h (4 mph).

DIESEL EXHAUST FLUID (DEF) WARNING STRATEGY (DEF QUALITY)

A supply of clean, fresh Diesel Exhaust Fluid (DEF) is critical for optimum Selective Catalyst Reduction (SCR) efficiency. SCR efficiency is determined by monitoring the Nitrogen Oxide (NOx) sensors located upstream and downstream of the SCR. This vehicle provides the driver with an elaborate series of prompts and warnings that are initiated when the Engine Control Module (ECM) detects a drop in the SCR NOx reduction efficiency suggesting a diluted or contaminated DEF supply.

When contaminated or diluted DEF is suspected, the ECM initiates the DEF Quality warning process. Once initiated, DEF quality warnings grow increasingly more serious as the vehicle continues to be driven. The vehicle's current DEF quality warning status is displayed on the scan tool. When a drop in SCR efficiency is detected, the normally Off Reductant Field Quality Warning Indicator Command will display Warning Level 1 through Warning Level 11 depending on the number of miles driven. The series of DEF Quality Warnings alert the driver that DEF system service is urgently needed.

Warning Level 1

Warning Level 1 is triggered when the ECM first detects the SCR efficiency is below a calibrated value. The Driver Information Center (DIC) displays the following messages:

For Non-Emergency vehicles and Emergency vehicles MY 2013 and older:

- Exhaust Fluid Quality Poor
- Refer to Owner's Manual Now
- 160 km (99 miles) until 105 km/h (65 mph) Max Speed

For Emergency vehicles MY 2014 and newer:

- Exhaust Fluid Quality Poor
- Refer to Owner's Manual Now
- 999 km (620 miles) until 105 km/h (65 mph) Max Speed

The messages alternate every 5 seconds until acknowledged by the driver; however, the mileage countdown remains displayed in the DIC. The DEF Indicator in the instrument panel is illuminated.

Warning Level 2

Warning Level 2 is triggered after the first mileage countdown expires without a DEF fluid service. The driver will hear 4 chimes on entering Warning Level 2. The DIC displays the following messages:

- Exhaust Fluid Quality Poor
- Refer to Owner's Manual Now
- Transitioning to 105 km/h (65 mph) Max Speed

The messages alternate every 5 seconds until acknowledged by the driver; however, the Transitioning to 105 km/h (65 mph) Max Speed remains displayed in the DIC. The DEF Indicator in the instrument panel is illuminated. Vehicle speed limit is ramping down from max speed limit to the limit of 105 km/h (65 mph).

Warning Level 3

Warning Level 2 automatically advances to Warning Level 3 after speed limit ramp down is complete or a key cycle. The driver will hear 4 chimes on entering Warning Level 3. The DIC displays the following messages:

- Exhaust Fluid Quality Poor
- Refer to Owner's Manual Now
- Speed Limited to 105 km/h (65 mph)
- 120 km (75 miles) Until 89 km/h (55 mph) Max Speed

The messages alternate every 5 seconds until acknowledged by the driver; however, the speed limitation and mileage countdown remains displayed on the DIC. The DEF Indicator in the instrument panel is illuminated.

Vehicle speed is limited to 105 km/h (65 mph).

Warning Level 4

Warning Level 4 is triggered after the second mileage countdown expires without a DEF fluid service. The driver will hear 4 chimes on entering Warning Level 4. The DIC displays the following messages:

- Exhaust Fluid Quality Poor
- Refer to Owner's Manual Now
- Transitioning to 89 km/h (55 mph)

The messages alternate every 5 seconds until acknowledged by the driver; however, the Transitioning to 89 km/h (55 mph) remains displayed in the DIC. The DEF Indicator in the instrument panel flashes continuously. Vehicle speed limit is ramping down from 105 km/h (65 mph) max speed limit to 89 km/h (55 mph).

Warning Level 5

Warning Level 5 is triggered after the speed limit ramp down is complete or a key cycle. The driver will hear 4 chimes on entering Warning Level 5. The series of 4 chimes will repeat 3 additional times every 3 minutes. The DIC displays the following messages:

- Exhaust Fluid Quality Poor
- Refer to Owner's Manual Now
- Speed Limited to 89 km/h (55 mph)
- 120 km (75 miles) Until 7 km/h (4 mph) Max Speed

The messages alternate every 5 seconds until acknowledged by the driver; however, the speed limitation and mileage countdown remains displayed in the DIC. The DEF Indicator in the instrument panel flashes continuously.

Vehicle speed is limited to 89 km/h (55 mph).

Warning Level 6

Warning Level 6 is not used.

Warning Level 7

Warning Level 7 is not used.

Warning Level 8

Warning Level 8 is not used.

Warning Level 9

Warning Level 9 is not used.

Warning Level 10

Warning Level 10 is triggered after the third mileage counter expires without a DEF fluid service. The driver will hear 4 chimes on entering Warning Level 10. The DIC displays the following messages:

- Exhaust Fluid Quality Poor
- Refer to Owner's Manual Now
- Transitioning to 7 km/h (4 mph) Max Speed

The messages alternate every 5 seconds until acknowledged by the driver; however, the Transitioning to 6 km/h (4 mph) Max Speed remains displayed in the DIC. The DEF Indicator in the instrument panel flashes continuously. Vehicle speed limit is ramping down from 89 km/h (55 mph) max speed limit to 7 km/h (4 mph).

Warning Level 11

Warning Level 11 is triggered after the speed limit ramp down is complete or a key cycle. The driver will hear 4 chimes every 3 minutes on entering Warning Level 11. The series of 4 chimes will repeat every 3 minutes. The DIC displays the following messages:

- Exhaust Fluid Quality Poor
- Refer to Owner's Manual Now
- Speed Limited to 7 km/h (4 mph) Max Speed

The messages alternate every 5 seconds until acknowledged by the driver; however, the Speed Limited to 7 km (4 mph) Max Speed remains displayed in the DIC. The DEF Indicator in the instrument panel flashes continuously.

Vehicle speed is limited to 7 km/h (4 mph).

DIESEL EXHAUST FLUID (DEF) WARNING STRATEGY (ANTI-TAMPERING)

The reductant system supplies the Selective Catalyst Reduction (SCR) stage of the vehicle's exhaust after treatment system with the Diesel Exhaust Fluid (DEF) required to reduce exhaust Oxides of Nitrogen (NOx) levels. The Engine Control Module (ECM) continuously monitors the performance of the reductant system during operation.

When the conditions associated with an attempt to disable reductant system operation are detected, the ECM activates the anti-tampering feature and presents the driver with a series of prompts and warnings.

Once initiated, anti-tampering warnings grow increasingly more serious as the vehicle continues to be driven. The vehicle's current warning status is displayed on the scan tool. When tampering is suspected, the normally Off Reductant System Malfunction Warning Indicator Command will display Warning Level 1 through Warning Level 11 depending on the number of miles driven. The series anti-tampering warnings alert the driver that reductant system service is urgently needed.

Warning Level 1

Warning Level 1 is triggered when the ECM first detects an abnormal value on a reductant system circuit. The Driver Information Center (DIC) displays the following messages:

For Non-Emergency vehicles and Emergency vehicles MY 2013 and older:

- Service Exhaust Fluid System
- Refer to Owner's Manual Now
- 160 km (99 miles) until 105 km/h (65 mph) Max Speed

For Emergency vehicles MY 2014 and newer:

- Service Exhaust Fluid System
- Refer to Owner's Manual Now
- 999 km (620 miles) until 105 km/h (65 mph) Max Speed

The messages alternate every 5 seconds in the DIC until acknowledged by the driver; however, the mileage countdown message remains in the DIC. The DEF Indicator in the instrument panel is illuminated.

Warning Level 2

Warning Level 2 is triggered after the first mileage counter expires. The driver will hear 4 chimes on entering Warning Level 2. The DIC displays the following messages:

- Service Exhaust Fluid System
- Refer to Owner's Manual Now
- Transitioning to 105 km/h (65 mph) Max Speed

The messages alternate every 5 seconds in the DIC until acknowledged by the driver; however, the Transitioning to 105 km/h (65 mph) Max Speed remains in the DIC. The DEF Indicator in the instrument panel is illuminated. Vehicle speed limit is ramping down from max speed limit to the limit of 105 km/h (65 mph).

Warning Level 3

Warning Level 2 automatically advances to Warning Level 3 after the speed limit ramp down is complete or a key cycle. The driver will hear 4 chimes on entering Warning Level 3. The DIC displays the following messages:

- Service Exhaust Fluid System
- Refer to Owner's Manual Now
- Speed Limited to 105 km/h (65 mph)
- 120 km (75 miles) Until 89 km/h (55 mph) Max Speed

The messages alternate every 5 seconds in the DIC until acknowledged by the driver; however, the Speed Limited to 105 km/h (65 mph) remains in the DIC. The DEF Indicator in the instrument panel is illuminated.

Vehicle speed is limited to 105 km/h (65 mph).

Warning Level 4

Warning Level 4 is triggered after the second mileage counter expires. The driver will hear 4 chimes on entering Warning Level 4. The DIC displays the following messages:

- Service Exhaust Fluid System
- Refer to Owner's Manual Now
- Transitioning to 89 km/h (55 mph) Max Speed

The messages alternate every 5 seconds until acknowledged by the driver; however, the Transitioning to 89 km/h (55 mph) Max Speed remain displayed in the DIC. The DEF Indicator in the instrument panel flashes continuously. Vehicle speed limit is ramping down from 105 km/h (65 mph) max speed limit to 89 km/h (55 mph).

Warning Level 5

Warning Level 4 automatically advances to Warning Level 5 after speed limit ramp down is complete or a key cycle. The driver will hear 4 chimes on entering Warning Level 5. The series of 4 chimes will repeat 3 times every 3 minutes during each ignition cycle until the vehicle is serviced. The DIC displays the following messages:

- Service Exhaust Fluid System
- Refer to Owner's Manual Now
- Speed Limited to 89 km/h (55 mph)
- 120 km (75 miles) Until 7 km/h (4 mph) Max Speed

The messages alternate every 5 seconds until acknowledged by the driver; however, the speed limitation and mileage countdown remains displayed in the DIC. The DEF Indicator in the instrument panel flashes continuously.

Vehicle speed is limited to 89 km/h (55 mph)

Warning Level 6

Warning Level 6 is not used

Warning Level 7

Warning Level 7 is not used

Warning Level 8

Warning Level 8 is not used

Warning Level 9

Warning Level 9 is not used

Warning Level 10

Warning Level 5 automatically advances to Warning Level 10 after third mileage counter expires or a key cycle. The driver will hear 4 chimes on entering Warning Level 10. The DIC displays the following messages:

- Service Exhaust Fluid System
- Refer to Owner's Manual Now
- Transitioning to 7 km/h (4 mph)

The messages alternate every 5 seconds until acknowledged by the driver; however, the Transitioning to 7 km/h (4 mph) remains displayed in the DIC. The DEF Indicator in the instrument panel flashes continuously. Vehicle speed limit is ramping down from 89 km/h (55 mph) max speed limit to 7 km/h (4 mph).

Warning Level 11

Warning Level 10 automatically advances to Warning Level 11 after speed limit ramp down is complete or a key cycle. The driver will hear 4 chimes on entering Warning Level 11. The series of 4 chimes will repeat every 3 minutes until the vehicle is serviced. The DIC displays the following messages:

- Service Exhaust Fluid System
- Refer to Owner's Manual Now
- Speed Limited to 7 km/h (4 mph)

The messages alternate every 5 seconds until acknowledged by the driver; however, the Speed Limited to 7 km/h (4 mph) remains displayed in the DIC. The DEF Indicator in the instrument panel flashes continuously.

Vehicle speed is limited to 7 km/h (4 mph).

DIESEL EXHAUST FLUID (DEF) WARNING STRATEGY (EMISSION CONTROL)

The reductant system supplies the Selective Catalyst Reduction (SCR) stage of the vehicle's exhaust aftertreatment system with the Diesel Exhaust Fluid (DEF) required to reduce exhaust Oxides of Nitrogen (NO_x) levels. The Engine Control Module (ECM) continuously monitors the performance of the emission system during operation

When the conditions associated with a fault in the emission system operation are detected, the ECM activates the emission control feature and presents the driver with a series of prompts and warnings.

Once initiated, emission control warnings grow increasingly more serious as the vehicle continues to be driven. The vehicle's current warning status is not displayed on the scan tool. The series emission control warnings alert the driver that EGR/SCR system service is urgently needed.

NOTE: **The Emission Control warning strategy is not used in model year 2014 and newer emergency vehicles.**

Warning Level 1

Warning Level 1 is triggered when the ECM first detects an EGR or SCR dosing inhibit fault. The Driver Information Center (DIC) displays the following messages:

- Service Emission System
- Refer to Owner's Manual Now
- 282 km (175 miles) until 105 km/h (65 mph) Max Speed

The messages alternate every 5 seconds and remain in the DIC until acknowledged by the driver, however the mileage countdown remains displayed in the DIC.

Warning Level 2

Warning Level 2 is triggered after the first mileage countdown expires without vehicle service. The driver will hear 4 chimes on entering Warning Level 2. The DIC displays the following messages:

- Service Emission System
- Refer to Owner's Manual Now
- Transitioning to 105 km/h (65 mph) Max Speed

The messages alternate every 5 seconds in the DIC until acknowledged by the driver.

Warning Level 3

Warning Level 2 automatically advances to Warning Level 3 after speed limit ramp down is complete or a key Off for at least 2 minutes. The driver will hear 4 chimes on entering Warning Level 3. The DIC displays the following messages:

- Service Emission System
- Refer to Owner's Manual Now
- Speed Limited to 105 km/h (65 mph)
- 120 km (75 miles) Until 89 km/h (55 mph) Max Speed

The messages alternate every 5 seconds until acknowledged by the driver; however, the Speed Limited to 105 km/h (65 mph), remains displayed in the DIC.

Vehicle speed is limited to 105 km/h (65 mph).

Warning Level 4

Warning Level 4 is not used.

Warning Level 5

Warning Level 5 is not used.

Warning Level 6

Warning Level 6 is triggered when the second mileage countdown expires without vehicle service. The driver will hear 4 chimes on entering Warning Level 6. The DIC displays the following messages:

- Service Emission System
- Refer to Owner's Manual Now
- Transitioning to 89 km/h (55 mph) Max Speed

The messages alternate every 5 seconds until acknowledged by the driver.

Warning Level 7

Warning Level 6 automatically advances to Warning Level 7 after speed limit ramp down is complete or a key Off for at least 2 minutes. The driver will hear 4 chimes upon entering Warning Level 7. The series of 4 chimes will repeat every 3 minutes until the vehicle is serviced. The DIC displays the following messages:

- Service Emission System
- Refer to Owner's Manual Now
- Speed Limited to 89 km/h (55 mph)

The messages alternate every 5 seconds until acknowledged by the driver, however, the Speed Limited to 89 km/h (55 mph), remains displayed in the DIC.

DIESEL PARTICULATE FILTER (DPF) REGENERATION ENABLE

Description

A service regeneration of the diesel particulate filter (DPF) is required when the scan tool DPF Accumulation Status parameter displays 30 grams or more of accumulated soot. When commanded, the engine control module (ECM) controls the service regeneration as follows:

1. The exhaust system is warmed up for about 8 minutes. Engine speed is slowly increased to 2,000 RPM and then to 2,500 RPM.
2. Once the DPF reaches its calibrated regeneration temperature, the ECM maintains engine speed between 2,000 - 2,500 RPM for about 20 minutes until regeneration is complete, is cancelled by the technician, or is aborted due to abnormal conditions.
3. The ECM then slowly decreases engine speed to 1600 RPM, then to 800 RPM, and finally to normal idle speed over a 5 minute period. This is done to allow the DPF to cool down.

The following conditions must be met in order to enable DPF Service Regeneration:

- DTCs P2463 is the only active DTC.
- The battery voltage is greater than 10 V.
- The engine speed is between 500 - 2,700 RPM.
- The vehicle speed is 0.
- The transmission is not in Drive or Reverse
- The exhaust gas temperature (EGT) sensors 1 is between 20 - 500°C (68 - 932°F).
- The exhaust gas temperature (EGT) sensors 3 is between 20 - 735°C (68 - 1,355°F).
- The engine coolant temperature (ECT) sensor is greater than 70°C (158°F).
- The fuel temperature is less than 150°C (302°F).
- The BARO pressure is greater than 40 kPa (5.8 psi)
- The APP sensor is less than 1 percent.
- The diesel exhaust fluid temperature is greater than -7°C (+19°F).

- The diesel exhaust fluid tank is not empty.
- The brake pedal and accelerator pedal are in the released position.
- The transmission is in Park or Neutral.

The DPF Service Regeneration will be terminated if any of the following conditions occur:

- The DPF Service Regeneration is commanded Off using the scan tool.
- The scan tool is disconnected from the vehicle.
- The vehicle is shifted out of Park or Neutral.
- The brake or accelerator pedal is applied.

Diagnostic Aids

The scan tool DPF Regeneration Inhibit reason parameter will display a reason for not enabling or aborting the DPF service regeneration. Refer to the reasons that are displayed and the corrective action for each reason.

Service Regeneration Unsuccessful

DPF Regeneration Parameters	Unsuccessful Regeneration - Number of Completed Regenerations Did Not Increment By One	Corrective Action For An Unsuccessful Regeneration
DPF Service Regeneration Inhibit Reason	APP - The APP position sensor indicated over 1 percent	Ensure the accelerator pedal was not applied during the service regeneration. • If the accelerator pedal was not applied, test the accelerator pedal position (APP) sensor.
	BPP Applied - The brake pedal position indicated Applied.	Ensure that the brake pedal was not applied during the service regeneration procedure. • If the brake pedal was not applied, test the brake pedal switch.
	NOTE: The scan tool must remain connected to the data communication link (DCL) during the entire service regeneration procedure. Device Control - The scan tool has interrupted service regeneration. A loss of communication between the scan tool and the vehicle has occurred.	• The scan tool Exit or Off soft key button was depressed. • Inspect for a poor connection at DCL.

DPF Regeneration Parameters	Unsuccessful Regeneration - Number of Completed Regenerations Did Not Increment By One	Corrective Action For An Unsuccessful Regeneration
	DPF Temperature - DPF service regeneration temperatures are less than a calibrated threshold.	- Observe the DTC information. - Test for a degraded diesel oxidation catalyst (DOC). - Test for a skewed exhaust temperature sensor, EGT sensor 2.
	Ignition Voltage - Battery voltage was less than 11 V.	Test the battery and charging system for proper operation.
	None	Refer to the DPF Regeneration Status parameter
	Not in Park - Transmission gear selector is not in Park.	Ensure that the transmission gear selector remained in Park during the Service Regeneration procedure. If the gear selector remained in the Park position, test the transmission range switch and circuits.
DPF Normal Regeneration Inhibit Reason	Regeneration Timed Out	A regeneration has timed out attempting a regeneration for greater than 90 minutes for this key cycle
	EGT 2 High	Exhaust temperature sensor 2 greater than 750°C (1382°F)
	EGT 1 High	Exhaust temperature 1 greater than 650°C (1202°F)
	DTC Set	An active DTC is set
	Axle Torque Limit	Torque Limiting is active to prevent an engine overheat condition
	Decel Too Long	A long decel condition of greater than 40 s was active
	Fuel Level	Fuel level is below 15%
	TC Temp Too High	Turbocharger temperature is too high
	TCM Override	A condition within the TCM is present
	Eng Run Time	Engine has not run long enough to complete a regeneration or has not warmed to operating temperature
	DLC Override	A scan tool is connected to the DLC
	Idle Spd Override	Vehicle is shifted into Park or Neutral while a normal regeneration is active

Exhaust Aftertreatment System Description

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

DPF Service Regeneration

WARNING: Tailpipe outlet exhaust temperature will be greater than 300°C (572°F) during this procedure. To help prevent personal injury or property damage from fire or burns, perform the following:

1. Do not connect any shop exhaust removal hoses to the vehicle tailpipe.
2. Park the vehicle outdoors and keep people, other vehicles, and combustible material away during this procedure.
3. Do not leave the vehicle unattended.

WARNING: To avoid extremely elevated exhaust temperatures, inspect and remove any debris or mud build up at the exhaust cooler located at the tailpipe.

CAUTION: Due to the elevated engine temperatures created while performing this procedure it is imperative to keep the front of vehicle in an open environment, with the hood open, away from any walls or buildings. This will ensure proper airflow across the radiator.

NOTE:

- If you were not referred to this procedure from another diagnostic, DO NOT perform the Service Regeneration.
- Do not refuel the vehicle during DPF Service Regeneration.
- The scan tool must remain connected to the data communication link (DCL) during the entire service regeneration procedure.
- Do not perform the DPF Service Regeneration if the diesel exhaust fluid temperature (DEF) is less than -7°C (+19°F).
- Fuel level should be greater 15% to ensure a successful regeneration.

1. Ignition On.
2. Park the vehicle outside the repair facility and away from any obstacles.
3. With the vehicle in Park, use the throttle to increase the engine speed to 3000 RPM while looking for the speedometer to move slightly (greater than 1 mph). If this signal noise exists, inch the vehicle forward, place in park and repeat until there is no response seen from the speedometer. This will avoid a vehicle speed based interrupt of the service regeneration.
4. Place the transmission in Park and apply the parking brake.
5. Clear the DTCs with a scan tool before commanding a DPF Service Regeneration.
6. Observe the scan tool DPF Regenerations Completed parameter and record the value.
7. Open the hood.
8. Check the following fluid levels before and after this procedure:
 - Reductant
 - Engine oil

- Engine coolant
- Power steering
- Transmission

NOTE: Step 10 only applies to 2013 through 2015 model year vehicle.

9. Perform the Ambient Air Temperature Reset with a scan tool if the vehicle has been driven in an outside temperature below -5°C (+23°F).
10. Select the DPF Service Regeneration in the Output Controls menu and follow the instruction on the scan tool.

NOTE: If a scan tool message of Oil Temperature Out Of Range is displayed once a service regeneration is commanded, disregard the message and command the service regeneration procedure.

11. Command the DPF Service Regeneration On with a scan tool.
 - If the service regeneration failed to start, repair the vehicle for the condition indicated by the scan tool DPF Regen Inhibit Reason parameter. Refer to the Service Regeneration Unsuccessful table.
12. When the service regeneration is complete, the DPF Regeneration Status parameter will display Complete and the DPF Regenerations Completed parameter will increment by 1 from the value previously recorded.
 - If the service regeneration failed to start, repair the vehicle for the condition indicated by the scan tool DPF Regen Inhibit Reason parameter. Refer to the Service Regeneration Unsuccessful table.

NOTE: DTC P202E may set after a DPF Service Regeneration. The excessive exhaust temperatures created during a DPF Service Regeneration causes the diesel exhaust fluid (DEF) to crystallize. The crystallize reductant will cause the Q61 Emission Reduction Fluid Injector to stick. Idling the engine for 15 minutes will cause the reductant to liquefy and un-stick the injector.

13. Allow the engine to cool by idling for an additional 15 minutes. Command the Reductant Injector On and Off several times with a scan tool.
14. Clear the DTCs with a scan tool.
15. Ignition Off for 90 s.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) .

Refer to [Oxidation Catalytic Converter Replacement \(LH7\)](#) .

REDUCTANT INJECTION QUANTITY TEST

Diagnostic Instructions

- Perform the [Diagnostic System Check - Vehicle](#) prior to using this diagnostic procedure.
- Review [Strategy Based Diagnosis](#) for an overview of the diagnostic approach.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

Circuit/System Description

The selective catalytic reduction (SCR) system reduces oxides of nitrogen (NOx) emissions by injecting a metered amount of diesel exhaust fluid (DEF) or reductant into the exhaust gas stream entering the SCR catalyst. Within the SCR catalyst, the reductant reacts with the NOx to form nitrogen, carbon dioxide, and water vapor. Upstream and downstream NOx sensors provide the engine control module (ECM) with engine-out and tailpipe-out NOx levels. The ECM varies the amount of reductant added by varying the reductant injector duty-cycle in response to changes in engine-out NOx levels.

The ECM supplies voltage to the reductant injector on the injector high control circuit. The ECM turns On the reductant injector by grounding the low control circuit of the injector.

Diagnostic Aids

It is common for reductant to crystallize over the nozzle of the reductant injector. The crystals will dissolve with use and the reductant injector will resume full functionality. The Reductant Quantity test may need to be performed multiple times to dissolve the crystallized reductant before diagnosing the reductant injector for performance issues.

Reference Information

Schematic Reference

- [Diesel Exhaust Fluid \(DEF\) Warning Strategy \(DEF Level\)](#)[Diesel Exhaust Fluid \(DEF\) Warning Strategy \(DEF Quality\)](#)[Diesel Exhaust Fluid \(DEF\) Warning Strategy \(Anti-tampering\)](#)[Diesel Exhaust Fluid \(DEF\) Warning Strategy \(Emission Control\)](#)
- [Engine Controls Wiring Schematics 1.6L \(LH7\)](#)

Connector End View Reference

[COMPONENT CONNECTOR END VIEWS - INDEX](#)

Component View Reference

[Powertrain Component Views](#)

Description and Operation

[Exhaust Aftertreatment System Description](#)

Electrical Information Reference

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

Scan Tool Reference

[Control Module References](#) for scan tool information

Special Tools

EN 50422 Emission Reduction Fluid Test Kit

J 45873 Fuel Return Volume Test Kit

Circuit/System Testing

WARNING: Diesel Exhaust Fluid (DEF) is corrosive. Do not allow it to come in contact with your skin, eyes, or the finished surfaces of the vehicle. If exposed, it may cause skin and eye irritation. Wear skin and eye protection when handling. Inhalation may cause irritation to the upper respiratory tract. Store in a cool, well-ventilated area. For more safety information, see the label of the Diesel Exhaust Fluid container. Failure to follow this procedure may result in injury and/or vehicle damage.

NOTE:

- Do not perform this diagnostic procedure unless you were sent here from another diagnostic procedure.

- Do not perform the Reductant Quantity Test if the reductant temperature is colder than -7°C (19.5°F).
- The Reductant Quantity Test may need to be run multiple times to dissolve crystallized reductant and to restore proper flow pattern.
- The NOx Catalyst Reductant-Load Adaptive Value can affect the quantity of reductant in the Reductant Injector Quantity Test. To reset this value and ensure the accuracy of the test, the scan tool NOx Catalyst Reductant Loading Reset must be performed prior to performing this test.
- Once the injector begins cycling, the Reductant Quantity Test takes approximately 5 minutes to run and the ECM will end the test after approximately 14 minutes.

1. Perform the scan tool [NOx Catalyst Reductant Loading Reset](#)

NOTE: The gasket for the Q61 Emission Reduction Fluid Injector must be replaced when the injector is removed from the exhaust pipe.

2. Remove the Q61 Emission Reduction Fluid Injector from the exhaust leaving the harness connector and reductant line connected.
3. Position the Q61 Emission Reduction Fluid Injector nozzle towards one of the graduated scale container from the **EN 50422**.

NOTE: It may take up to two minutes for the injector to begin cycling.

4. Command the Reductant Quantity Test On with a scan tool. Observe the injector spray pattern. 3 individual streams and atomization or mist of reductant should be observed.

- **If the function does not perform as specified**

1. Inspect the Q61 Emission Reduction Fluid Injector lines for damage or restrictions or for being plugged.
 - If a condition is found, repair as necessary
 - If no condition is found, replace the Q61 Emission Reduction Fluid Injector

- **Go to next step: If the function performs as specified**

5. When the test completes, verify an injector flow of between 40 and 50 ml of fluid into the container.

- **If not between 40 and 50 ml**

1. Disconnect the Q61 Emission Reduction Fluid Injector from the supply line.
2. Position the Q61 Emission Reduction Fluid Injector supply line towards the graduated scale container.

NOTE: The Reductant Injection Quantity Test runs for approximately 5 minutes when turned on and cannot be stopped with the scan tool. The step below is performed using the scan tool Reductant System Leak Test control function.

- 3.
4. Command the Reductant System Leak Test On with a scan tool.
5. Command the Reductant System Leak Test Off when the supply line has flowed 40 ml.
6. Verify 40 ml has flowed within 1 minute.
 - If not the specified value
 1. Inspect the Q61 Emission Reduction Fluid Injector supply line for damage or restrictions.
 - If a condition is found, repair or replace as necessary.
 - If no condition is found, replace the A38 Emission Reduction Fluid Supply Pump Module

- If the specified value
7. Replace the Q61 Emission Reduction Fluid Injector.
 - **Go to next step: If between 40 and 50 ml**
 6. Return to referring document.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- Refer to **Emission Reduction Fluid Injector Replacement (AWD)**, **Emission Reduction Fluid Injector Replacement (FWD)**.
- Refer to **Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe Replacement (FWD)**, **Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe Replacement (Front AWD)**, **Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe Replacement (Rear AWD)**.
- Refer to **Emission Reduction Fluid Supply Pump Module Replacement**

REDUCTANT SYSTEM MALFUNCTION SERVICE BAY TEST

Description

A Reductant System Malfunction Warning Service Bay Test is required when the Exhaust Fluid Quality Poor message is displayed on the driver information center (DIC). The Reductant System Malfunction Warning Service Bay Test is used to verify proper operation of the reductant system and clear the Diesel Exhaust Fluid Quality warning after the condition causing the warning has been repaired.

Conditions for Running

The following conditions must be met in order to enable the scan tool Reductant System Malfunction Warning Service Bay Test:

- Battery voltage is greater than 11 V.
- No DTCs are set.
- Vehicle speed is 0 km/h (MPH).
- Engine coolant temperature (ECT) sensor is between 60-100Â°C (140-212Â°F).
- Barometric pressure is greater than 70 kPa (10.2 PSI).
- Ambient air temperature is greater than -30Â°C (-22Â°F).
- Reductant temperature is greater than -7Â°C (19Â°F) and not frozen.
- Reductant level must be greater than 33%.
- Fuel temperature is less than 80Â°C (176Â°F).
- Engine is running.
- Brake pedal and accelerator pedal are in the released position.
- Clutch pedal (if equipped) is in the released position.
- Transmission is in Park or Neutral.
- Diesel particulate filter (DPF) regeneration is not active.
- Fuel tank is not empty.

Diagnostic Aids

The Reductant System Malfunction Warning Service Bay Test will not be allowed or will be terminated if any of the conditions listed below occur.

Reductant System Malfunction Warning Service Bay Test Inhibit Reason	Corrective action
Brake Pedal Applied	Verify the brake pedal was not applied during the Reductant System Malfunction Warning Service Bay

	Test. If the pedal was not applied, test the brake pedal position sensor.
Clutch Pedal Applied	Verify the clutch pedal was not applied during the Reductant System Malfunction Warning Service Bay Test. If the pedal was not applied, test the clutch pedal position sensor.
APP	Verify the accelerator pedal was not applied during the Reductant System Malfunction Warning Service Bay Test. If the pedal was not applied, test the accelerator pedal position sensor.
Transmission must be in Park or Neutral	Verify the transmission gear selector remained in Park or Neutral during the Reductant System Malfunction Warning Service Bay Test. If the gear selector remained in Park or Neutral, test the transmission range switch and circuits.
Vehicle speed too high	Vehicle speed must be 0 km/h (0 MPH)
Battery Voltage Exceeds Limits	Battery voltage must be greater than 11 V
Engine Coolant Temperature Out of Range	Coolant temperature must be between 60 - 100°C (140 - 212°F)
Incorrect Power Mode	Verify ignition is in Run position
Soot Accumulation Out of Range	Perform the Diesel Particulate Filter (DPF) Service Regeneration
Activation Timer Has Expired	Verify that engine and exhaust system are at operating temperature
Engine Speed Out of Range	Engine must be running
Exhaust Gas Temperature Out of Range	Exhaust system must be at operating temperature and engine must be operating properly
Diesel Particulate Filter Regeneration is Active	Diesel particulate filter must not be in regeneration mode
Fault Active	Repair the fault using the appropriate diagnostic procedure
Unable to build sufficient reductant pressure	Verify reductant fluid level and proper operation of the reductant pump assembly
Reductant System Pressure Out of Range	Verify proper operation of the reductant pump assembly
Vehicle Speed Fault	Repair the fault using the appropriate diagnostic procedure
Transmission gear data is not valid	Check the transmission gear switch
Air Flow Out of Range	Check the engine induction system
NOx Sensor Operating Conditions not reached.	Verify that engine and exhaust system are at operating temperature and NOx sensor heaters are operating
NOx Sensor 1 NOx concentration out of range	Verify proper operation of NOx Sensor 1. If NOx Sensor 1 is operating correctly, increasing engine load by turning on the A/C, headlights, seat heaters, etc. may help increase NOx concentration.

Reference Information

Description and Operation

Exhaust Aftertreatment System Description

Scan Tool Reference

Control Module References for scan tool information.

Reductant System Malfunction Service Bay Test

NOTE:

- If the reductant level warning status is at level 4 or higher, fill the DEF tank and perform the Reductant Fluid Tank Level Reset procedure.
- The scan tool must remain connected to the data link connector (DLC) during the entire Reductant System Malfunction Warning Service Bay Test.
- Do not perform the Reductant System Malfunction Service Bay Test if the diesel exhaust fluid (DEF) temperature is less than -7°C (19°F).
- If the nitrogen oxides catalytic converter has been replaced, perform the Diesel Particulate Filter Service Regeneration before performing the Reductant System Malfunction Service Bay Test.

1. Verify DEF tank is full and not in reductant warning level restriction.

- **If the reductant system is in restriction**

Fill the DEF tank and perform the scan tool Reductant Fluid Tank Level Reset procedure.

- **Go to next step: If the reductant system is not in restriction**

2. Perform the Ambient Air Temperature Reset with a scan tool if the vehicle has been driven in an outside temperature below -5°C (+23°F).

3. Engine idling and at operating temperature, observe the DTC information with a scan tool. Verify there are no DTCs set.

- **If a DTC is set**

Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#)

- **Go to next step: If a DTC is not set**

4. Disconnect scan tool.

5. Ignition Off for 2 minutes.

NOTE: Do not apply accelerator pedal after starting engine, otherwise the test will fail and will need to return to step 1 of the test.

6. Start engine.

7. Engine idling, connect scan tool and select the scan tool Reductant System Malfunction Service Bay Test in the Output Controls menu and follow the instructions.

NOTE: If the Reductant System Malfunction Service Bay Test reaches its time limit without reporting passed or failed and the Exhaust Fluid Quality Poor message is still displayed, a second Reductant System Malfunction Service Bay Test will be necessary

8. Command the Reductant System Malfunction Service Bay Test On with a scan tool. The Reductant System Malfunction Service Bay Test should start and run.

9. The Reductant System Malfunction Service Bay Test is complete when the Exhaust Fluid Quality Poor message turns Off.

- **If the DIC message does not clear**

1. Command a second Reductant System Malfunction Service Bay Test On with a scan tool.

- If the DIC message does not clear after the second test, a condition with the system still exists

- **Go to next step: If the DIC message clears**

10. All OK.

REDUCTANT SYSTEM TAMPER SERVICE BAY TEST

Description

A Reductant System Tamper Warning Service Bay Test is required when the Service Emission System message or Service Exhaust Fluid System message is displayed on the driver information center (DIC). The Reductant System Tamper Warning Service Bay Test is used to verify proper operation of the reductant system and clear the Diesel Exhaust Fluid Anti-Tampering Warning after the condition causing the warning has been repaired.

Conditions for Running

The following conditions must be met in order to enable the scan tool Reductant System Tamper Warning Service Bay Test:

- No DTCs are set.
- Battery voltage is greater than 11 V.
- Vehicle speed is 0 km/h (MPH).
- Engine coolant temperature (ECT) sensor is between 60-100°C (140-212°F).
- Barometric pressure is greater than 70 kPa (10.2 PSI).
- Ambient air temperature is greater than -30°C (-22°F).
- Reductant temperature is greater than -20°C (-4°F) and not frozen.
- Reductant level must be greater than 33%.
- Fuel temperature is less than 80°C (176°F).
- SCR catalyst temperature is less than 300°C (572°F).
- Brake pedal and accelerator pedal are in the released position.
- Clutch pedal (if equipped) is in the released position.
- Transmission is in Park or Neutral.
- Diesel particulate filter (DPF) regeneration is not active.
- Fuel tank is not empty.

Diagnostic Aids

The Reductant System Tamper Warning Service Bay Test will not be allowed or will be terminated if any of the conditions listed below occur.

Reductant System Tamper Warning Service Bay Test Inhibit Reason	Corrective action
Brake Pedal Applied	Verify the brake pedal was not applied during the Reductant System Tamper Warning Service Bay Test. If the pedal was not applied, test the brake pedal position sensor.
Clutch Pedal Applied	Verify the clutch pedal was not applied during the Reductant System Tamper Warning Service Bay Test. If the pedal was not applied, test the clutch pedal position sensor.
APP	Verify the accelerator pedal was not applied during the Reductant System Tamper Warning Service Bay Test. If the pedal was not applied, test the accelerator pedal position sensor.
Transmission must be in Park or Neutral	Verify the transmission gear selector remained in Park or Neutral during the Reductant System Tamper Warning Service Bay Test. If the gear selector remained in Park or Neutral, test the transmission range switch and circuits.
Vehicle speed too high	Vehicle speed must be 0 km/h (0 MPH)
Battery Voltage Exceeds Limits	Battery voltage must be greater than 11 V
Engine Coolant Temperature Out of Range	Coolant temperature must be between 60 - 100°C (140 - 212°F)
Incorrect Power Mode	Verify ignition is in Run position
Soot Accumulation Out of Range	Perform the Diesel Particulate Filter (DPF) Service

	Regeneration
Activation Timer Has Expired	Ensure engine and exhaust system are at operating temperature
Engine Speed Out of Range	Engine must be running
Exhaust Gas Temperature Out of Range	Exhaust system must be at operating temperature and engine must be operating properly
Diesel Particulate Filter Regeneration is Active	Diesel particulate filter must not be in regeneration mode
Fault Active	Repair the fault using the appropriate diagnostic procedure
Vehicle Speed Fault	Repair the fault using the appropriate diagnostic procedure
Transmission gear data is not valid	Check the transmission gear switch
Air Flow Out of Range	Check the engine induction system
Engine Position Information Invalid	Repair the fault using the appropriate diagnostic procedure
Vehicle Speed DTC Present	Repair the fault using the appropriate diagnostic procedure

Reference Information

Description and Operation

Exhaust Aftertreatment System Description

Scan Tool Reference

Control Module References for scan tool information.

Reductant System Tamper Warning Service Bay Test

NOTE:

- If the reductant level warning status is at level 4 or higher, fill the DEF tank and perform the Reductant Fluid Tank Level Reset procedure.
- The scan tool must remain connected to the data link connector (DLC) during the entire Reductant System Tamper Warning Service Bay Test.
- Do not perform the Reductant System Tamper Warning Service Bay Test if the diesel exhaust fluid (DEF) temperature is less than -7°C (19°F).

1. Verify DEF tank is full and not in reductant warning level restriction.

- **If the reductant system is in restriction**

Fill the DEF tank and perform the scan tool Reductant Fluid Tank Level Reset procedure.

- **Go to next step: If the reductant system is not in restriction**

2. Perform the Ambient Air Temperature Reset with a scan tool if the vehicle has been driven in an outside temperature below -5°C ($+23^{\circ}\text{F}$).

3. Engine idling and at operating temperature, observe the DTC information with a scan tool. Verify there are no DTCs set.

- **If a DTC is set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**

- **Go to next step: If a DTC is not set**

4. Disconnect scan tool.

5. Ignition Off for 2 minutes.

NOTE: Do not apply accelerator pedal after starting engine, otherwise the test will fail and will need to return to step 1 of the test.

6. Ignition on.

7. Connect the scan tool and select the scan tool Reductant System Tamper Warning Service Bay Test in the Output Controls menu and follow the instructions.

NOTE: If the Reductant System Tamper Warning Service Bay Test reaches its time limit without reporting passed or failed and the Service Emission System or the Service Exhaust System message is still displayed, a second Reductant System Tamper Warning Service Bay Test will be necessary

8. Command the Reductant System Tamper Warning Service Bay Test On with a scan tool. The Reductant System Tamper Warning Service Bay Test should start and run for up to 20 minutes.

9. The Reductant System Tamper Warning Service Bay Test is complete when the Service Emission System message or Service Exhaust System message turns Off.

- **If the DIC message does not clear**

- 1. Command a second Reductant System Tamper Warning Service Bay Test On with a scan tool.

- If the DIC message does not clear after the second test, a condition with the system still exists.

- **Go to next step: If the DIC message clears**

10. All OK.

FUEL HEATER DIAGNOSIS

Diagnostic Instructions

- Perform the [Diagnostic System Check - Vehicle](#) prior to using this diagnostic procedure.
- Review [Strategy Based Diagnosis](#) for an overview of the diagnostic approach.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

Circuit/System Description

Ignition voltage is supplied to the coil side of the fuel heater relay whenever the ignition is On. The Engine Control Module (ECM) provides a ground to control the fuel heater relay. When the ECM is commanding the fuel heater On, the voltage of the control circuit should be low, near 0 V. When the ECM is commanding the fuel heater Off, the voltage of the control circuit should be high, near battery voltage.

Reference Information

Schematic Reference

[Engine Controls Wiring Schematics 1.6L \(LH7\)](#)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

[Powertrain Component Views](#)

Description and Operation

[Fuel System Description](#)

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

DTC Type Reference

[Powertrain Diagnostic Trouble Code \(DTC\) Type Definitions](#)

Scan Tool Reference

[Control Module References](#) for scan tool information

Circuit/System Verification

1. Ignition On.
2. Command the Fuel Heater Relay On and Off with a scan tool. Verify that you hear or feel the KR22 Fuel Heater Relay click.
 - *If a click is not heard or felt*
Refer to [DTC P2687-P2689](#)
 - *Go to next step: If a click is heard or felt*
3. Verify with a scan tool that the Fuel Temperature Sensor parameter slowly starts to rise when the fuel heater relay is commanded On.
 - *If the fuel temperature does not start to rise*
Refer to Circuit/System Testing
 - *Go to next step: If the fuel temperature rises*
4. All OK

Circuit/System Testing

1. Ignition Off.
2. Disconnect the harness connector at the E11A Fuel Heater/Water in Fuel Sensor.
3. Connect a test lamp between voltage supply circuit terminal 2 and ground.
4. Ignition On.
5. Command the Fuel Heater On and Off with a scan tool. Verify the test lamp turns on and off.
 - *If the test lamp is always Off*
 1. Ignition Off.
 2. Remove the KR22 Fuel Heater Relay from X50A Fuse Block-Underhood.
 3. Verify that a test lamp illuminates between the fuel heater relay voltage supply circuit terminal 5 and ground.
 - If the test lamp is always Off
 1. Verify the fuse is good and there is voltage at the fuse.
 - If fuse is open, replace the fuse and repair the short to ground in the circuit.
 - If no voltage is present, repair the open/high resistance in the circuit.
 - If test lamp illuminates
 4. Test for infinite resistance between the fuel heater voltage supply circuit terminal 2 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 5. Test for less than 2 Ω in the fuel heater voltage supply circuit end to end.

- If greater than 2 Ω , repair the open/high resistance in the circuit.
- If less than 2 Ω , replace the KR22 Fuel Heater Relay.
- ***If the test lamp is always On***
 1. Ignition Off.
 2. Remove the KR22 Fuel Heater Relay from X50A Fuse Block-Underhood.
 3. Ignition On.
 4. Test for less than 1 V between the fuel heater voltage supply circuit terminal 2 and ground.
 - If 1 V or greater, repair the short to voltage in the circuit.
 - If less than 1 V, replace the KR22 Fuel Heater Relay.
 - ***Go to next step: If the test lamp turns On and Off***
- 6. Test for less than 10 Ω between the fuel heater ground circuit terminal 4 and ground.
 - ***If 10 Ω or greater***

Repair the open/high resistance in the circuit
 - ***Go to next step: If less than 10 Ω***
- 7. Replace the E11A Fuel Heater/Water in Fuel Sensor.

Component Testing

1. Ignition OFF.
2. Remove the KR22 Fuel Heater Relay from X50A Fuse Block-Underhood.
3. Test for 70 - 110 Ω between terminals 1 and 2.
 - ***If not between 70 - 110 Ω***

Replace the KR22 Fuel Heater Relay.
 - ***Go to next step: If between 70 - 110 Ω***
4. Test for infinite resistance between the following terminals:
 - 3 and 1
 - 3 and 5
 - 3 and 2
 - 2 and 5
 - ***If less than infinite resistance***

Replace the KR22 Fuel Heater Relay.
 - ***Go to next step: If infinite resistance***
5. Install a 20 A fused jumper wire between relay terminal 2 and 12 V.
6. Install a jumper wire between relay terminal 1 and ground.
7. Test for less than 2 Ω between terminals 3 and 5.
 - ***If 2 Ω or greater***

Replace the KR22 Fuel Heater Relay.
 - ***Go to next step: If 2 Ω or less***
8. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- For E11A Fuel Heater/Water in Fuel Sensor replacement refer to: **Fuel Filter Assembly Replacement (AWD) Fuel Filter Assembly Replacement (FWD)**.
- Refer to **Relay Replacement (Attached to Wire Harness) Relay Replacement (Within an Electrical Center)**.

FUEL INJECTOR BALANCE TEST WITH SCAN TOOL

Diagnostic Instructions

- Perform the [Diagnostic System Check - Vehicle](#) prior to using this diagnostic procedure.
- Review [Strategy Based Diagnosis](#) for an overview of the diagnostic approach.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

Circuit/System Description

The fuel injector balance test is performed when a misfire, knock, excessive smoke, or rough running condition exists with no electrical DTCs. This test uses the Fuel Injector Balance and Compression Tests to identify cylinders that are not producing the designed power output. During the Fuel Injector Balance portion of the test, the ECM turns OFF individual injectors while the engine is running. The ECM adjusts for the drop in engine RPM during cancellation and may not change on the scan tool display. The lack of power at the cancelled cylinder will feel like a misfiring cylinder or vibration. If a fuel injector is turned OFF and there is a no difference felt when compared to the other cylinders, that cylinder is identified with the concern. The Compression Test will identify a mechanical issue with a cylinder.

Circuit/System Verification

NOTE: If not referred to this test from another diagnostic, do not perform this procedure.

1. Ignition On.
2. Verify that no DTCs are set except for DTC P0300-P0308
 - If any other DTCs are set.

Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#)

- Go to next step: If no other DTCs are set

NOTE: The Cylinder Power Balance test disables each fuel injector for 30 s when activated.

3. Perform the scan tool Cylinder Power Balance test.
4. Verify an equally noticeable engine vibration and power difference exist with each cylinder cancellation.

- If one or more cylinders do not have a noticeable difference during cancellation

Refer to Circuit/System Testing.

- Go to next step: If all cylinders have an equally noticeable difference during cylinder cancellation.

5. All OK.

Circuit/System Testing

1. Perform the engine compression test. Refer to [Engine Compression Test](#) .
 - If one or more of the cylinders indicate low compression

Refer to: [Symptoms - Engine Mechanical](#)

- Go to next step: If all cylinders indicate normal compression

NOTE: During replacement of the injectors, inspect the inlet and outlet fittings for corrosion or contamination. Refer to [Contaminants-in-Fuel Diagnosis](#).

2. Replace the appropriate Q17 Fuel Injector on the cylinders that did not have a noticeable differences during cancellation.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

Refer to [Fuel Injector Replacement](#)

INSPECTION/MAINTENANCE SYSTEM CHECK

Diagnostic Instructions

- Perform the [Diagnostic System Check - Vehicle](#) prior to using this diagnostic procedure.
- Review [Strategy Based Diagnosis](#) for an overview of the diagnostic approach.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

Circuit/System Description

The purpose of the inspection maintenance (I/M) complete system set procedure is to satisfy the enabled criteria necessary to execute all of the I/M system monitors. When all system monitors are completed, the Inspection/Maintenance System Status or Data indicators are set to YES. Perform this procedure when more than one of the Inspection/Maintenance System Status or Data indicators are set to NO.

Conditions for Updating the I/M System Status

NOTE: New vehicles may not report an Inspection/Maintenance System Check pass or fail status for certain post catalyst oxygen sensor or heated oxygen sensor 2 diagnostics prior to 700 miles. After replacing a catalytic converter on a vehicle with greater than 700 miles, it may require up to an additional 700 miles to prevent a false failure status.

Each system monitor requires at least one, and sometimes several, diagnostic tests. The results of these tests are reported by a DTC. A system monitor completes when either all DTCs comprising the monitor have run and passed, or any DTC comprising the monitor has illuminated the malfunction indicator lamp (MIL). Once the monitor completes, the Inspection/Maintenance System Status or Data will indicate YES in the Completed or Value column. For example, when the Misfire Monitoring System Status display indicates YES, all of the misfire components have been diagnosed. The Inspection/Maintenance System Status or Data will indicate NO in the Completed or Value column when any of the required DTCs for that system have not run. The following is a list of conditions that would set the Inspection/Maintenance System Status or Data indicators to NO:

- The vehicle is new from the factory and has not yet been driven through the necessary drive conditions to complete the system monitor.
- The battery has been disconnected or discharged below operating voltage.
- The control module power or ground has been interrupted.
- The control module has been reprogrammed.
- The control module DTCs have been cleared as part of a service procedure.

Monitored Emission Control Systems

The OBD II system monitors all emission control systems that are on-board, but not all vehicles have a full complement of emission control systems. For example, a vehicle may not be equipped with exhaust gas recirculation (EGR). The OBD II regulations require monitoring of the following:

- Comprehensive component monitoring - Emission related inputs and outputs
- EGR system
- Misfire monitoring
- Catalyst monitoring
- Diesel Particulate Filter
- Exhaust after-treatment
- Fuel system
- Boost system

For the specific DTCs required for each system, refer to [Inspection/Maintenance \(I/M\) System DTC Table](#).

Circuit/System Verification

1. Verify that all Inspection/Maintenance System Status or Data indicators report YES, and that no I/M Test DTCs are present.

- **If any I/M Test DTCs are set**

Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#).

- **Go to next step: If no I/M Test DTCs are set**

2. All OK.

Circuit/System Testing

NOTE: Many DTC related repairs will instruct the technician to clear the DTC information. Clearing the DTC will reset the Inspection/Maintenance System Status or Data indicators to NO. Performing the I/M Complete System Set Procedure will set each of the I/M System Status indicators to YES.

1. Verify no I/M DTCs are present.

- **If an I/M DTC is set that would prevent the I/M System Status tests from completing, diagnose that DTC before continuing.**

Refer to [Inspection/Maintenance \(I/M\) System DTC Table](#).

- **Go to next step: If no I/M DTCs are set**

2. Review applicable service bulletins for software updates that would prevent the I/M System Status tests from completing.

- **If a control module re-program or other repair is required,**

Perform the [Inspection/Maintenance Complete System Set Procedure](#) after repair.

- **Go to next step: If no repair is required**

3. Observe the Inspection/Maintenance System Status or Data indicators.

- **If any Inspection/Maintenance System Status or Data indicators report NO**

Perform the [Inspection/Maintenance Complete System Set Procedure](#).

- **Go to next step: If no Inspection/Maintenance System Status or Data indicators report NO**

4. All OK.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the diagnostic procedure.

INSPECTION/MAINTENANCE COMPLETE SYSTEM SET PROCEDURE

Diagnostic Instructions

- Perform the [Diagnostic System Check - Vehicle](#) prior to using this diagnostic procedure.
- Review [Strategy Based Diagnosis](#) for an overview of the diagnostic approach.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

Circuit/System Description

The purpose of the inspection maintenance (I/M) complete system set procedure is to satisfy the enabled criteria necessary to execute all of the I/M system monitors. When all system monitors are completed,

the Inspection/Maintenance System Status or Data indicators are set to YES. Perform this procedure when more than one of the Inspection/Maintenance System Status or Data indicators are set to NO.

Conditions for Updating the I/M System Status

NOTE: New vehicles may not report an Inspection/Maintenance System Check pass or fail status for certain post catalyst oxygen sensor or heated oxygen sensor 2 diagnostics prior to 700 miles. After replacing a catalytic converter on a vehicle with greater than 700 miles, it may require up to an additional 700 miles to prevent a false failure status.

Each system monitor requires at least one, and sometimes several, diagnostic tests. The results of these tests are reported by a DTC. A system monitor completes when either all DTCs comprising the monitor have run and passed, or any DTC comprising the monitor has illuminated the malfunction indicator lamp (MIL). Once the monitor completes, the Inspection/Maintenance System Status or Data will indicate YES in the Completed or Value column. For example, when the Misfire Monitoring System Status display indicates YES, all of the misfire components have been diagnosed. The Inspection/Maintenance System Status or Data will indicate NO in the Completed or Value column when any of the required DTCs for that system have not run. The following is a list of conditions that would set the Inspection/Maintenance System Status or Data indicators to NO:

- The vehicle is new from the factory and has not yet been driven through the necessary drive conditions to complete the system monitor.
- The battery has been disconnected or discharged below operating voltage.
- The control module power or ground has been interrupted.
- The control module has been reprogrammed.
- The control module DTCs have been cleared as part of a service procedure.

Monitored Emission Control Systems

The OBD II system monitors all emission control systems that are on-board, but not all vehicles have a full complement of emission control systems. For example, a vehicle may not be equipped with exhaust gas recirculation (EGR). The OBD II regulations require monitoring of the following:

- Comprehensive component monitoring - Emission related inputs and outputs
- EGR system
- Misfire monitoring
- Catalyst monitoring
- Diesel Particulate Filter
- Exhaust after-treatment
- Fuel system
- Boost system

For the specific DTCs required for each system, refer to [Inspection/Maintenance \(I/M\) System DTC Table](#).

Circuit/System Verification

1. Verify that all Inspection/Maintenance System Status or Data indicators report YES, and that no I/M Test DTCs are present.

- If any I/M Test DTCs are set

Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) .

- Go to next step: If no I/M Test DTCs are set

2. All OK.

Circuit/System Testing

NOTE: Many DTC related repairs will instruct the technician to clear the

DTC information. Clearing the DTC will reset the Inspection/Maintenance System Status or Data indicators to NO. Performing the I/M Complete System Set Procedure will set each of the I/M System Status indicators to YES.

1. Verify no I/M DTCs are present.

- **If an I/M DTC is set that would prevent the I/M System Status tests from completing, diagnose that DTC before continuing.**

Refer to [Inspection/Maintenance \(I/M\) System DTC Table](#).

- **Go to next step: If no I/M DTCs are set**

2. Review applicable service bulletins for software updates that would prevent the I/M System Status tests from completing.

- **If a control module re-program or other repair is required,**

Perform the [Inspection/Maintenance Complete System Set Procedure](#) after repair.

- **Go to next step: If no repair is required**

3. Observe the Inspection/Maintenance System Status or Data indicators.

- **If any Inspection/Maintenance System Status or Data indicators report NO**

Perform the [Inspection/Maintenance Complete System Set Procedure](#).

- **Go to next step: If no Inspection/Maintenance System Status or Data indicators report NO**

4. All OK.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the diagnostic procedure.

INSPECTION/MAINTENANCE (I/M) SYSTEM DTC TABLE

System	DTCs Required to Set System Status to YES
If an I/M System Status indicator did NOT update to YES during the <u>Inspection/Maintenance Complete System Set Procedure</u> , review each indicator and reference this table to determine each DTC associated with the I/M System Status Indicator. Each DTC listed below has specific conditions that must be met for the diagnostic to run. Included within the conditions are additional DTCs which, if set, may inhibit the DTCs listed below from running. Reviewing and operating the vehicle within the Conditions for Running for each DTC listed below will allow the I/M System Status Indicators to transition to YES.	
Boost System	• <u>DTC P0234, P0299, or P2263</u> • <u>DTC P026A</u>
Catalyst	<u>DTC P0421</u>
DPF	• <u>DTC P144E or P144F</u> • <u>DTC P2002</u> • <u>DTC P2459</u>

System	DTCs Required to Set System Status to YES
EGR/CMP	• <u>DTC P0401 or P0402</u> • <u>DTC P0403, P0490, P1402, P1407, or P140F</u> • <u>DTC P0404-P0406</u> • <u>DTC P042E or P042F</u> • <u>DTC P140B or P140C</u> • <u>DTC P2457</u>
Exhaust Aftertreatment	<u>DTC P20EE, P249D, or P249E</u>
Exhaust Gas Sensor	• <u>DTC P1004, P119D-P119F, P11BE, P11BF, P11C0, P11C7, P11C8, P11D0-P11D2, P11D5, P11D8, P11D9, P11DA, P11DC, P11FC-P11FF, P22A0, P22A1, P22A3-P22A9, or P22FE</u> • <u>DTC P115E, P115F, P1160, P116A-P116F, P1192-P1194, P119A-P119C, P11C5, P11C6, P11CC, P11D3, P11DB, P2202, P2203, or P2205-P2211</u> • <u>DTC P1474-P1479, P147B, or P1488</u> • <u>DTC P220A or P220B</u> • <u>DTC P2297 or P2A00</u> • <u>DTC P24B0-P24B6, P24C7, P24D0, or P24D1</u> • <u>DTC P2627 or P2628</u>
Fuel System	• <u>DTC P01CB-P01CF or P01D0-P01D2</u> • <u>DTC P0087, P0089, P228C, P228D, or P2293</u>
Misfire	<u>DTC P0300</u>