DIAGNOSTIC INFORMATION AND PROCEDURES

DTC P0016

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 P0016

Crankshaft Position - Camshaft Position Not Plausible

Circuit/System Description

The ECM compares the signals of the crankshaft position sensor and both camshaft position sensors to detect if the signals are out of sync.

Conditions for Running the DTC

- DTC P0335, P0336, P0340, P0341, P0365, P0366, P0641, P0651 = Not set
- Crankshaft Position Sensor & Camshaft Position Sensor = Synchronized
- Engine = Cranking or Running
- Time since diagnostic ran last = For less than 1 s

Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

The camshaft position is less than -10B° in one direction or greater than 10B° in the other direction (measured in degrees of the crankshaft).

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References

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Circuit/System Verification

1. Ignition - On / Vehicle - In Service Mode
2. Verify DTC P0010, P0013, P0335, P0336, P0340, P0341, P0365, P0366, P0641, P0651 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. Engine - Idling - At normal operating temperature.
4. Verify DTC P0016 is not set.
    - **If the DTC is set**
    1. Ignition/Vehicle - Off
    2. Verify the following conditions do not exist:
        - B23 Camshaft Position Sensor - Incorrect installation
        - B26 Crankshaft Position Sensor - Incorrect installation
        - Q6 Camshaft Position Actuator Solenoid Valve - Incorrect installation/Stuck Closed/Stuck Open
        - Reluctor Ring - Misaligned @ Crankshaft
        - Timing Belt or Timing Chain - Excessive play
        - Timing Belt Tensioner or Timing Chain Tensioner - Incorrect installation
        - If a condition exists - Repair or replace as necessary
        - If none of the conditions exists - Refer to step 2.
    - **Go to next step: If the DTC is not 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.

   Verify the DTC does not set.

    - **If the DTC sets**

      One of the above conditions still exist.

    - **Go to next step: If the DTC is not set**
6. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Camshaft Position Sensor Replacement**
- **Crankshaft Position Sensor Replacement**
- **Timing Belt Pulley Cleaning and Inspection**

DTC P003A

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

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DTC P003A

Turbocharger Boost Control Position Not Learned

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
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.
M103 Turbocharger Vane Position Actuator	The assembly has several functions: • The component is actuated by a bidirectional DC motor. • The component M103 contains a contactless inductive position sensor. A fixed transmitter coil excites a movable rotor, which in turn induces a current in a fixed receiver coil. The current varies with the angle of the rotor. Electronics inside the sensor convert the current into digital data which is transmitted via a serial data circuit to the control module K20.

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 engine control module performs the learn function for the turbocharger vane position automatically in certain intervals.

Conditions for Running the DTC

- DTC P0046, P0071, P0072, P0073, P0074, P0116, P0117, P0118, P0119, P0128, P0234, P0299, P111E, P226B, P2599 = Not set
- Ignition Voltage = 9 to 30 V
- Ambient Air Temperature. = Warmer than 60B°C (140B°F)
- Engine Coolant Temperature Sensor = 10 to 129B°C (50 to 264B°F)
- Engine Speed = 700 to 900 RPM

Frequency the DTC runs = Once @ Ignition Off After the running conditions are met

Conditions for Setting the DTC

The difference between the desired and the actual turbocharger vane position exceeds a calibrated threshold during a vane position learn event.

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type A

- Reduced Engine Power = Enabled = Enabled

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- Warning Message = Reduced Engine Power

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type A

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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 P0045, P0234, P0299, P0651, P16B0-P16B2, P169E, P169F, P16FA, P2564, P2565, P2598, P2599 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. Engine - Idling
4. Perform the scan tool control function: Turbocharger Vane Position Actuator - Increase & Decrease

   Verify the control rod of the actuator moves smoothly over the full range.

    - **If the control rod does not move smoothly over the full range**

    1. Ignition/Vehicle - Off
    2. Verify the condition does not exist:
        - M103 Turbocharger Vane Position Actuator - Mechanically stuck control rod. / Visible Damage / Incorrect connection
        - Turbocharger - Debris / Restricted / Mechanically stuck/Mechanically damaged
        - If a condition exists

          Repair or replace as necessary - Refer to **Compressor Air Intake Turbocharger Cleaning and Inspection**

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- **Go to next step: If the control rod moves smoothly over the full range**

5. Ignition/Vehicle - Off - Greater than 1 min
6. Ignition - On / Vehicle - In Service Mode
7. Verify DTC P003A is not set.
   - **If the DTC sets**

     Test or replace the component: **Compressor Air Intake Turbocharger Replacement**

   - **Go to next step: If the DTC does not set**
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 DTC P003A is not set.
   - **If the DTC sets**

     Test or replace the component: **Compressor Air Intake Turbocharger Replacement**

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

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Compressor Air Intake Turbocharger Replacement** - M103 Turbocharger Vane Position Actuator
- For control module replacement, programming, and setup refer to **Control Module References**

DTC P0045, P0047, P0048, P169E, OR P169F

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 P0045

Turbocharger Boost Control Circuit

DTC P0047

Turbocharger Boost Control Circuit Low Voltage

DTC P0048

Turbocharger Boost Control Circuit High Voltage

DTC P169E

Turbocharger Boost Control Supply Circuit Low Voltage

DTC P169F

Turbocharger Boost Control Circuit Shorted

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Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Control - Terminal 1	P0047	P0045	P0048	P2598, P2599
Control - Terminal 2	P0047	P0045	P0048	P2598, P2599

Circuit/System Description

For an overview of the component/system, refer to **Compressor Air Intake Turbocharger System Description**

Circuit	Description
Control - Terminal 1	The output circuit is switched from ground to 12 V to activate the component. The output is PWM controlled.
Control - Terminal 2	The output circuit is switched from ground to 12 V to activate the component. The output is PWM controlled.

Component	Description
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.
M103 Turbocharger Vane Position Actuator	The assembly has several functions: • The component is actuated by a bidirectional DC motor. • The component M103 contains a contactless inductive position sensor. A fixed transmitter coil excites a movable rotor, which in turn induces a current in a fixed receiver coil. The current varies with the angle of the rotor. Electronics inside the sensor convert the current into digital data which is transmitted via a serial data circuit to the control module K20.

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Conditions for Running the DTC

- Ignition = On or Engine = Running
- Ignition Voltage = Greater than 11 V
- Engine Cranking

Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

P0045

The control module detects an open circuit.

P0047

The control module detects a short to ground.

P0048

The control module detects a short to voltage.

P169E

Control module K20 detects: System Voltage Low = Less than 6 V

P169F

Control module K20 detects: Circuit High Current = Greater than 8 A

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type A DTC

- Reduced Engine Power = Active
- Warning Message = Reduced Engine Power

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type A DTC

Diagnostic Aids

- A weak battery may cause this DTC to set.
- A high resistance condition on the throttle position and throttle actuator control circuits could cause a DTC to set.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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 P0689, P0690, P1402 is not set.
    - **If any of the DTCs are set**

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Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**

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

3. Engine - Idling
4. Verify DTC P0045, P0047, P0048, P169E, P169F is not set.
   - **If the DTC sets**

     Refer to: Circuit/System Testing

   - **Go to next step: If the DTC does not set**
5. Perform the scan tool control function: Turbocharger Vane Position - From 10 to 90% and back to 0%.

   Verify the scan tool parameter: Turbocharger Vane Position Sensor = Increase & Decrease

   - **If not the specified state**

     Refer to: Circuit/System Testing

   - **Go to next step: If the specified state**
6. Perform the action while monitoring the parameter: DTC P0045, P0047, P0048, P169E, P169F = Not set
   - Wiggle the harness and connector: M103 Turbocharger Vane Position Actuator
   - Wiggle the harness and connector: K20 Engine Control Module
   - **If the DTC sets**

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

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

Circuit/System Testing

1. Ignition/Vehicle - Off

NOTE: **Disconnecting the component electrical connector causes additional DTCs to set.**

2. Disconnect the electrical connector: M103 Turbocharger Vane Position Actuator
3. Ignition - On / Vehicle - In Service Mode
4. Test for 1.5 to 2.5 V between the test points: Control circuit terminal 1 & Ground
   - **If less than 1.5 V**
   1. Ignition/Vehicle - Off
   2. Disconnect the electrical connector: 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.

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- Go to next step: If infinite resistance

4. Test for infinite resistance between the test points: Control circuit terminal 1 & Control circuit terminal 2
    - If less than infinite resistance - Repair the short between the circuits.
    - Go to next step: If infinite resistance
5. Test for less than 2 ohms between the test points: Control 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 2.5 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: 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 between 1.5 and 2.5 V**

5. Connect a test lamp between the test points: Control circuit terminal 2 @ Component harness & B+
6. Ignition - On / Vehicle - In Service Mode
7. Verify the test lamp does not turn On.
    - **If the test lamp turns On**

    1. Ignition/Vehicle - Off
    2. Disconnect the electrical connector: K20 Engine Control Module
    3. Test for infinite resistance between the test points: Control circuit terminal 2 @ 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**

8. Test for 1.5 to 2.5 V between the test points: Control circuit terminal 1 & Control circuit terminal 2
    - **If less than 1.5 V**

    1. Ignition/Vehicle - Off
    2. Disconnect the electrical connector: K20 Engine Control Module
    3. Test for less than 2 ohms between the test points: Control 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

    - **If greater than 2.5 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: 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 - Replace the component: K20 Engine Control Module

    - **Go to next step: If between 1.5 and 2.5 V**

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9. Test or replace the component: M103 Turbocharger Vane Position Actuator

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Compressor Air Intake Turbocharger Replacement** - M103 Turbocharger Vane Position Actuator
- For control module replacement, programming, and setup refer to **Control Module References**

Additional Procedures

BARO Sensor Reset - Perform only when the following component/system is replaced or serviced:

- K20 Engine Control Module - Replaced
- M103 Turbocharger Vane Position Actuator - Cleaned/Replaced

DTC P0046, P2598, OR P2599

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 P0046

Turbocharger Boost Control Position Performance

DTC P2598

Turbocharger Vane Position Performance - Low Position

DTC P2599

Turbocharger Vane Position Performance - High Position

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Control - Terminal 1	P169E, P169F	P0045	P0048	P0046, P2598, P2599
Control - Terminal 2	P169E, P169F	P0045	P0048	P0046, P2598, P2599

Circuit/System Description

For an overview of the component/system, refer to **Compressor Air Intake Turbocharger System Description**

Circuit	Description
Control - Terminal 1	The output circuit is switched from ground to 12 V to activate the component. The output is PWM controlled.

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Circuit	Description
Control - Terminal 2	The output circuit is switched from ground to 12 V to activate the component. The output is PWM controlled.

Component	Description
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.
M103 Turbocharger Vane Position Actuator	The assembly has several functions: • The component is actuated by a bidirectional DC motor. • The component M103 contains a contactless inductive position sensor. A fixed transmitter coil excites a movable rotor, which in turn induces a current in a fixed receiver coil. The current varies with the angle of the rotor. Electronics inside the sensor convert the current into digital data which is transmitted via a serial data circuit to the control module K20.

Conditions for Running the DTC

P0046

- DTC P003A, P0071 - P0074, P0117 - P0119, P16B0, P16B1, P16B2, P2564, P2565 = Not set
- Engine Cranking
- Ignition Voltage = Greater than 11 V
- Turbocharger Vane Position Command = Steady State For greater than 500 ms

Frequency the DTC runs = Continuously - After the running conditions are met - For greater than 1 s

P2598, P2599

- DTC P003A, P0045, P0048, P16B0, P16B1, P16B2, P16FA, P169E, P169F, P2564, P2565 = Not set
- Ignition Voltage = Greater than 11 V
- Engine Cranking
- Engine Coolant Temperature = Warmer than -7B°C (19B°F)
- IAT Sensor 3 = Warmer than -7B°C (19B°F)
- Engine Speed = Greater than 1, 500 RPM
- Turbocharger Vane Position Command = Steady State

Frequency the DTC runs = Continuously - After the running conditions are met - For greater than 500 ms

Conditions for Setting the DTC

P0046

Turbocharger Vane Position Sensor & Desired Turbocharger Vane Position = Not within 16% of each other - For greater than 8 s

P2598

Turbocharger Vane Position Sensor & Desired Turbocharger Vane Position = Not within 25% of each other - More open than desired - For greater than 4 s

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P2599

Turbocharger Vane Position Sensor & Desired Turbocharger Vane Position = Not within 25% of each other - More closed than desired & DTC P0046 is set.

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type A DTC

- Engine = Reduced Engine Power
- Warning Message = Reduced Engine Power

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type A DTC

Reference Information

Component View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **Component Connector End Views - Index**

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 P003A, P0045, P0047, P0048, PP16FA, P16FC, 16B0, P16B1, P16B2, P169E, P169F, P2564, P2565 is not set.
   - **If the DTC is set**

     Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**

   - **Go to next step: If the DTC is not set**
3. Verify the scan tool parameter: Turbocharger Vane Position Sensor = Greater than 80%
   - **If not in the specified range**

     Refer to: Circuit/System Testing

   - **Go to next step: If in the specified range**
4. Engine - Idling
5. Verify the scan tool parameter: Turbocharger Vane Position Sensor = 80 - 100%
   - **If not in the specified range**

     Refer to: Circuit/System Testing

   - **Go to next step: If in the specified range**
6. Perform the scan tool control function: Turbocharger Vane Position - From 20 to 80% and back to 20%.

   Verify the difference between the following parameters is less than 15%:

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- Desired Turbocharger Vane Position
- Turbocharger Vane Position Sensor
- **If the difference is greater than 15%**

  Refer to: Circuit/System Testing

- **Go to next step: If the difference is less than 15%**

7. 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**

8. All OK.

Circuit/System Testing

1. Ignition/Vehicle - Off
2. Verify a condition does not exist with the component: Turbocharger @ M103 Turbocharger Vane Position Actuator
   - Mechanically stuck control rod. - Incorrect connection/Visible Damage
   - Blade - Binding or Sticking/Mechanically stuck @ Closed/Open
   - Mechanically damaged - Debris/ Visible Damage

     Refer to **Compressor Air Intake Turbocharger Cleaning and Inspection**

   - **If a condition exists**

     Replace the component: Turbocharger

   - **Go to next step: If no conditions exist**
3. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Compressor Air Intake Turbocharger Replacement** - M103 Turbocharger Vane Position Actuator
- For control module replacement, programming, and setup refer to **Control Module References**

DTC P007B OR P105D

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 P007B

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Charge Air Cooler Temperature Sensor 1 Performance

DTC P10D5

Charge Air Cooler Temperature Sensor 2 Performance

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P007C, P007E, P10D6, P10D8	P007D, P007E, P10D7, P10D8	P007D*, P007E*, P10D7*, P10D8*	P007B, P026A, P10D5
Low Reference	-	P007D, P007E, P10D7, P10D8	P007D*, P10D7	P007B, P026A, P10D5
*Component damage may occur if the circuit is shorted to B+.				

Typical Scan Tool Data

Charge Air Cooler Temperature Sensor 1 & Charge Air Cooler Temperature Sensor 2

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition - On / Vehicle - In Service Mode **Parameter Normal Range:** -39 to 198B°C (-38 to 388B°F)			
Signal	215B°C (419B°F)	-40B°C (-40B°F)	-40B°C (-40B°F)
Low Reference	-	-40B°C (-40B°F)	-40B°C (-40B°F)

Circuit/System Description

For an overview of the component/system, refer to **Compressor Air Intake Turbocharger System Description**

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

Component	Description
B193A Charge Air Cooler Inlet Temperature Sensor B193B Charge Air Cooler Outlet Temperature Sensor	The temperature sensor is a negative temperature coefficient thermistor, a resistor which changes based on temperature.
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 P007C, P007D, P007E, P00E9, P00EA, P00EB, P00EC, P0181, P10D6 - P10D8, P2610 = Not set
- Ignition = Off - For greater than 8 h
- Ignition = On - For less than 2 s
- Ignition Voltage = Greater than 11 V

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- Fuel Temperature & IAT Sensor 3Within 45B°C (81B°F) of each other

Frequency the DTC runs = Once - After the running conditions are met

Conditions for Setting the DTC

P007B

- The following parameters are not within 20B°C (36B°F) of each other:
  - Charge Air Cooler Temperature Sensor 1
  - Fuel Temperature Sensor
  - IAT Sensor 3

P10D5

- The following parameters are not within 20B°C (36B°F) of each other:
  - Charge Air Cooler Temperature Sensor 2
  - Fuel Temperature Sensor
  - IAT Sensor 3

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type B DTC

- Diesel Particulate Filter Regeneration is Not Allowed
- Driver Information Center Display = Service Emission System
- Reduced Engine Power is displayed.

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type B DTC

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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

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Circuit/System Verification

1. Ignition - On / Vehicle - In Service Mode
2. Verify DTC P00E9, P00EA, P00EB, P00EC, P007C, P007D, P007E, P10D6, P10D7, P10D8, P0181, P2610 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**

    NOTE: **To minimize the effects of residual engine heat and heating elements inside the sensor, perform step 3 of this procedure only if the ignition has been Off for longer than 8 h.**

3. Verify the following parameters are within 20B°C (36B°F) of each other:
    - Start-Up Charge Air Cooler Temperature
    - Start-Up Charge Air Cooler Temperature Sensor 2
    - Start-Up IAT Sensor 3
    - **If not in the specified range**
4. Refer to **DTC P007C-P007E or P10D6-P10D8**
    - **Go to next step: If in the specified range**
5. Engine - Idling
6. Verify the scan tool parameter:
    - Charge Air Cooler Temperature Sensor 1 = -39 to 215B°C (-38 to 419B°F) and changes
    - Charge Air Cooler Temperature Sensor 2 = -39 to 215B°C (-38 to 419B°F) and changes
    - **If not between -39 and 215B°C (-38 and 419B°F) or does not change**

      Refer to **DTC P007C-P007E or P10D6-P10D8**

    - **Go to next step: If between -39 and 215B°C (-38 and 419B°F) and changes**
7. Perform the action while monitoring the parameter:
    - Charge Air Cooler Temperature Sensor 1
    - Charge Air Cooler Temperature Sensor 2
    - Wiggle the harness and connector: B193A Charge Air Cooler Inlet Temperature Sensor - The value should not spike or drop out.
    - Wiggle the harness and connector: B193B Charge Air Cooler Outlet Temperature Sensor - The value should not spike or drop out.
    - Wiggle the harness and connector: K20 Engine Control Module - The value should not spike or drop out.
    - **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**
8. Ignition/Vehicle & All vehicle systems - Off
9. Verify the following conditions do not exist:
    - B65 Intake Manifold Pressure and Air Temperature Sensor - Leaking @ O-Ring - Missing / Visible Damage
    - Intake Air Duct - Collapsed/Loose Clamps/Restricted/Visible Damage

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- Intake Manifold - Cracked/Loose Clamps/Visible Damage - Refer to **Compressor Air Intake Turbocharger Cleaning and Inspection**
- Charge Air Cooler
  - Leaking - Loose Clamps/Visible Damage
  - Restricted - Moisture/Ice

    Refer to **Charge Air Cooler Diagnosis (Induction System Smoke Test)** , or **Charge Air Cooler Diagnosis (Full System Air Leak Test)**

  - If a condition exists - Repair or replace as necessary
  - Go to next step: If no conditions exist

10. All OK.

Component Testing

1. Ignition/Vehicle - Off
2. Disconnect the appropriate electrical connector:
   - B193A Charge Air Cooler Inlet Temperature Sensor
   - B193B Charge Air Cooler Outlet Temperature Sensor
3. Test for 150 to 133, 900 ohms between the test points: Signal terminal 1 & Low Reference terminal 2
   - **If not between 150 and 133, 900 ohms**

     Replace the component: B193A Charge Air Cooler Inlet Temperature Sensor or B193B Charge Air Cooler Outlet Temperature Sensor

   - **Go to next step: If between 150 and 133, 900 ohms**
4. Verify the value is within the range listed in the table: **Temperature Versus Resistance - Charge Air Cooler Temperature Sensor**
   - **If not in the specified range**

     Replace the component: B193A Charge Air Cooler Inlet Temperature Sensor or B193B Charge Air Cooler Outlet Temperature Sensor

   - **Go to next step: If in the specified range**
5. Test for infinite resistance between the test points: Each terminal of the component & The component's housing
   - **If less than infinite resistance**

     Replace the component: B193A Charge Air Cooler Inlet Temperature Sensor or B193B Charge Air Cooler Outlet Temperature Sensor

   - **Go to next step: If infinite resistance**
6. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Charge Air Cooler Air Temperature Sensor Replacement (Inlet Duct)** , or **Charge Air Cooler Air Temperature Sensor Replacement (Outlet Duct)** - B193A Charge Air Cooler Inlet Temperature Sensor & B193B Charge Air Cooler Outlet Temperature Sensor
- For control module replacement, programming, and setup refer to **Control Module References**

DTC P007C-P007E OR P10D6-P10D8

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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 P007C

Charge Air Cooler Temperature Sensor 1 Circuit Low Voltage

DTC P007D

Charge Air Cooler Temperature Sensor 1 Circuit High Voltage

DTC P007E

Charge Air Cooler Temperature Sensor 1 Circuit Erratic

DTC P10D6

Charge Air Cooler Temperature Sensor 2 Circuit Low Voltage

DTC P10D7

Charge Air Cooler Temperature Sensor 2 Circuit High Voltage

DTC P10D8

Charge Air Cooler Temperature Sensor 2 Circuit Erratic

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P007C, P007E, P10D6, P10D8	P007D, P007E, P10D7, P10D8	P007D*, P007E*, P10D7, P10D8*	P026A, P007B, P10D5
Low Reference	-	P007D, P007E, P10D7, P10D8	P007D*, P10D7, P10D8*	P026A, P007B, P10D5
*Internal control module or component damage may occur if the circuit shorts to B+.				

Typical Scan Tool Data

Charge Air Cooler Temperature Sensor 1 & Charge Air Cooler Temperature Sensor 2

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition On or Engine Running **Parameter Normal Range:** -39 to +198B°C (-38 to +388B°F)			
Signal	215B°C (419B°F)	-40B°C (-40B°F)	-40B°C (-40B°F)
Low Reference	-	-40B°C (-40B°F)	-40B°C (-40B°F)

Circuit/System Description

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For an overview of the component/system, refer to **Compressor Air Intake Turbocharger System Description**

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

Component	Description
B193A Charge Air Cooler Inlet Temperature Sensor B193B Charge Air Cooler Outlet Temperature Sensor	The temperature sensor is a negative temperature coefficient thermistor, a resistor which changes based on temperature.
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

P007C, P007D, P10D6, P10D7

- Engine = Not cranking
- Battery Voltage = Greater than 11 V

Frequency the DTC runs = Continuously - After the running conditions are met

P007E

- DTC P007C, P007D = Not set
- Engine = Not cranking
- Battery Voltage = Greater than 11 V

Frequency the DTC runs = Continuously - After the running conditions are met

P10D8

- DTC P10D6, P10D7 = Not set
- Engine = Not cranking
- Battery Voltage = Greater than 11 V

Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

P007C

Charge Air Cooler Temperature Sensor 1 = Warmer than 300B°C (572B°F) - For greater than 5 s

P007D

Charge Air Cooler Temperature Sensor 1 = Colder than -40B°C (-40B°F) - For greater than 5 s

P007E

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Charge Air Cooler Temperature Sensor 1 = Signal noisy or erratic - For greater than 5 s

P10D6

Charge Air Cooler Temperature Sensor 2 = Warmer than 300B°C (572B°F) - For greater than 5 s

P10D7

Charge Air Cooler Temperature Sensor 2 = Colder than -40B°C (-40B°F) - For greater than 5 s

P10D8

Charge Air Cooler Temperature Sensor 2 = Signal noisy or erratic - For greater than 5 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

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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

NOTE: **If you were sent here from DTC P026A - Refer to: Circuit/System Testing.**

1. Ignition - On / Vehicle - In Service Mode
2. Verify the scan tool parameter:
   - Charge Air Cooler Temperature Sensor 1 = -39 to 215B°C (-38 to 419B°F)
   - Charge Air Cooler Temperature Sensor 2 = -39 to 215B°C (-38 to 419B°F)
   - **If not between -39 and 215B°C (-38 and 419B°F)**

     Refer to: Circuit/System Testing

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- **Go to next step: If between -39 and 215B°C (-38 and 419B°F)**

3. Verify the scan tool parameter: Charge Air Cooler Temperature Sensor 1 & Charge Air Cooler Temperature Sensor 2 = The value should not spike or drop out.

   Perform the action while monitoring the parameter:

   - Wiggle the harness and connector: B193A Charge Air Cooler Inlet Temperature Sensor
   - Wiggle the harness and connector: B193B Charge Air Cooler Outlet Temperature 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**

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.

   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

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 appropriate electrical connector:
   - B193A Charge Air Cooler Inlet Temperature Sensor
   - B193B Charge Air Cooler Outlet Temperature 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 appropriate electrical connector: 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. Verify the appropriate scan tool parameter:
   - Charge Air Cooler Temperature Sensor 1 = Colder than -39B°C (-38B°F)
   - Charge Air Cooler Temperature Sensor 2 = Colder than -39B°C (-38B°F)
   - **If -39B°C (-38B°F) or warmer**
   1. Ignition/Vehicle - Off
   2. Disconnect the appropriate electrical connector: K20 Engine Control Module
   3. Test for infinite resistance between the test points: Signal circuit terminal 1 @ Component harness & Ground

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- 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 colder than -39B°C (-38B°F)**

6. Connect a 3 A fused jumper wire between the test points: Signal circuit terminal 1 & Low Reference circuit terminal 2
7. Verify the appropriate scan tool parameter:
   - Charge Air Cooler Temperature Sensor 1 = Warmer than 214B°C (417B°F)
   - Charge Air Cooler Temperature Sensor 2 = Warmer than 214B°C (417B°F)
   - **If 214B°C (417B°F) or colder**
   1. Ignition/Vehicle - Off & Remove - Jumper wire(s)
   2. Disconnect the appropriate electrical connector: 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 1 @ Component harness & Ground
      - If 1 V or greater - Repair the short to voltage on the circuit.
      - Go to next step: If less than 1 V
   5. Ignition/Vehicle - Off
   6. Test for less than 2 ohms between the test points: Signal 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
   - **Go to next step: If warmer than 214B°C (417B°F)**
8. Test or replace the component: B193A Charge Air Cooler Inlet Temperature Sensor or B193B Charge Air Cooler Outlet Temperature Sensor

Component Testing

1. Ignition/Vehicle - Off
2. Disconnect the appropriate electrical connector:
   - B193A Charge Air Cooler Inlet Temperature Sensor
   - B193B Charge Air Cooler Outlet Temperature Sensor
3. Test for 150 to 133, 900 ohms between the test points: Signal terminal 1 & Low Reference terminal 2
   - **If not between 150 and 133, 900 ohms**

     Replace the component: B193A Charge Air Cooler Inlet Temperature Sensor or B193B Charge Air Cooler Outlet Temperature Sensor

   - **Go to next step: If between 150 and 133, 900 ohms**
4. Verify the value is within the range listed in the table: **Temperature Versus Resistance - Charge Air Cooler Temperature Sensor**
   - **If not in the specified range**

     Replace the component: B193A Charge Air Cooler Inlet Temperature Sensor or B193B Charge Air Cooler Outlet Temperature Sensor

   - **Go to next step: If in the specified range**
5. Test for infinite resistance between the test points: Each terminal of the component & The component's housing
   - **If less than infinite resistance**

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Replace the component: B193A Charge Air Cooler Inlet Temperature Sensor or B193B Charge Air Cooler Outlet Temperature Sensor

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

6. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Charge Air Cooler Air Temperature Sensor Replacement (Inlet Duct)** , or **Charge Air Cooler Air Temperature Sensor Replacement (Outlet Duct)** - B193A Charge Air Cooler Inlet Temperature Sensor & B193B Charge Air Cooler Outlet Temperature Sensor
- For control module replacement, programming, and setup refer to **Control Module References**

DTC P0087, P0089, P228C, P228D, OR P2293

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 P0087

Fuel Rail Low Pressure

DTC P0089

Fuel Pressure Regulator 1 Performance

DTC P228C

Fuel Pressure Regulator Control Performance - Low Pressure

DTC P228D

Fuel Pressure Regulator Control Performance - High Pressure

DTC P2293

Fuel Pressure Regulator 2 Performance

Circuit/System Description

For an overview of the component/system, refer to **Fuel System Description**

Component	Description
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.
Q18A Fuel Pressure Regulator 1	The fuel pressure regulator is a solenoid valve that restricts the flow of fuel to the high pressure fuel pump and thereby controls the pressure the pump can produce.

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Component	Description
Q18B Fuel Pressure Regulator 2	The fuel pressure regulator is the solenoid valve that controls the pressure in the fuel rail.

Conditions for Running the DTC

P0087

- Engine = Running
- Ignition Voltage = Greater than 11 V

Frequency the DTC runs = Continuously - After the running conditions are met

P0089

- Engine = Running
- Fuel Rail Pressure is being controlled by Fuel Pressure Regulator 1.
- Ignition Voltage = Greater than 11 V

Frequency the DTC runs = Continuously - After the running conditions are met

P228C, P228D

- Ambient Air Temperature. = Warmer than -7B°C (19B°F)
- BARO Sensor 2 = Greater than 60 kPa (8.7 PSI)
- Engine = Running
- Fuel Rail Pressure is being controlled by Fuel Pressure Regulator 1.
- Ignition Voltage = Greater than 11 V
- Low Fuel Indicator = Off

Frequency the DTC runs = Continuously - After the running conditions are met

P2293

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

Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

P0087, P0089, P2293

Fuel Rail Pressure = Not within a calibrated range - For greater than 1 s

P228C, P228D

Fuel Rail Pressure = Not within a calibrated range - For greater than 6 s

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type A DTC - Exceptions listed below

DTC P228C, P228D = Type B DTC

Conditions for Clearing the DTC

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DTCs listed in the DTC Descriptor Category = Type A DTC - Exceptions listed below

DTC P228C, P228D = Type B DTC

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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 P0090, P0091, P0092, P0191, P0192, P0193, P0627, P0628, P0629, P163A, P163B, P2293, P2294, P2295, P2296, 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**
3. Engine - Cranking/Running
4. Verify the scan tool parameter: Fuel Rail Pressure Sensor 1 = Greater than 13 MPa (1885 PSI)
    - **If 13 MPa (1885 PSI) or less**

      Refer to **Fuel System Diagnosis**

    - **Go to next step: If greater than 13 MPa (1885 PSI)**
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.

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Circuit/System Testing

1. Ignition/Vehicle - Off
2. Verify the following conditions do not exist:
    - Q17 Fuel Injector - Leaking/Restricted

      Refer to **Cylinder Power Balance Test**
    - Direct Fuel Injection Fuel Rail - Leaking/Restricted

      Refer to **Fuel Leak Diagnosis**
    - Fuel - Contaminated/Poor Quality

      Refer to **Contaminants-in-Fuel Diagnosis**
    - Fuel Feed Pipe - Leaking/Restricted

      Refer to **Fuel Leak Diagnosis**
    - **If a condition exists**

      Repair or replace as necessary
    - **Go to next step: If no condition exists**
3. Engine - Idling
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
    - Go to next step: 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
    - Go to next step: If the value changes
6. Test or replace the component: G18 High Pressure Fuel Pump

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Fuel Injection Fuel Rail Assembly Replacement** - Q18B Fuel Pressure Regulator 2
- **Fuel Injection Pump Metering Valve Replacement** - Q18A Fuel Pressure Regulator 1
- **Fuel Injection Pump Replacement** - G18 High Pressure Fuel Pump
- **Fuel Injector Replacement (Cylinder #1, #2, #3)** , or **Fuel Injector Replacement (Cylinder #4)**

DTC P0090-P0092, P163A, P163B, OR P2294-P2296

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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 P0090

Fuel Pressure Regulator 1 Control Circuit

DTC P0091

Fuel Pressure Regulator 1 Control Circuit Low Voltage

DTC P0092

Fuel Pressure Regulator 1 Control Circuit High Voltage

DTC P163A

Control Module Fuel Pressure Regulator 1 Control System Circuitry Performance

DTC P163B

Control Module Fuel Pressure Regulator 2 Control System Circuitry Performance

DTC P2294

Fuel Pressure Regulator 2 Control Circuit

DTC P2295

Fuel Pressure Regulator 2 Control Circuit Low Voltage

DTC P2296

Fuel Pressure Regulator 2 Control Circuit High Voltage

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Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Control - Terminal 1 @ Q18A Fuel Pressure Regulator 1	P0091	P0090	P0092	P163A
Control - Terminal 2 @ Q18A Fuel Pressure Regulator 1	P0091	P0090	P0092	P163A
Control - Terminal 1 @ Q18B Fuel Pressure Regulator 2	P2295	P2294	P0690, P16B3, P2296	P163B, P2293
Control - Terminal 2 @ Q18B Fuel Pressure Regulator 2	P2295	P2294	P0690, P16B3, P2296	P163B, P2293

Typical Scan Tool Data

Fuel Pressure Regulator 1 - 2 Control Circuit High Voltage Test Status

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine Cranking or Engine Running **Parameter Normal Range:** Not Run or OK			
Control - Terminal 1	OK	OK	OK
Control - Terminal 2	OK	OK	Malfunction

Fuel Pressure Regulator 1 - 2 Control Circuit Low Voltage Test Status

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine Cranking or Engine Running **Parameter Normal Range:** Not Run or OK			
Control - Terminal 1	OK	OK	OK
Control - Terminal 2	Malfunction	OK	OK

Fuel Pressure Regulator 1 - 2 Control Circuit Open Test Status

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine Cranking or Engine Running **Parameter Normal Range:** Not Run or OK			
Control - Terminal 1	OK	OK	OK
Control - Terminal 2	OK	Malfunction	OK

Circuit/System Description

For an overview of the component/system, refer to **Fuel System Description**

Circuit	Description
Control - Terminal 1	The output circuit is switched to 12 V to activate the component. The output is PWM controlled.
Control - Terminal 2	The output circuit is switched to ground to activate the component. The output is PWM controlled.

Component	Description
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.
Q18A Fuel Pressure Regulator 1	The fuel pressure regulator is a solenoid valve that restricts the flow of fuel to the high pressure fuel pump and thereby controls the pressure the pump can produce.
Q18B Fuel Pressure Regulator 2	The fuel pressure regulator is the solenoid valve that controls the pressure in the fuel rail.

Conditions for Running the DTC

P0090 - P0092

- Battery Voltage = Greater than 11 V
- Engine = Running/Not cranking
- Fuel Rail Pressure is being controlled by Fuel Pressure Regulator 1.

Frequency the DTC runs = Continuously - After the running conditions are met

P163A

- DTC P0090, P0091, P0092 = Not set
- Battery Voltage = Greater than 11 V
- Fuel Rail Pressure is being controlled by Fuel Pressure Regulator 1.

Frequency the DTC runs = Continuously - After the running conditions are met

P163B

- DTC P2294, P2295, P2296 = Not set
- Battery Voltage = Greater than 11 V
- Fuel Rail Pressure is being controlled by Fuel Pressure Regulator 2.

Frequency the DTC runs = Continuously - After the running conditions are met

P2294 - P2296

- Battery Voltage = Greater than 11 V
- Engine = Not cranking
- Fuel Rail Pressure is being controlled by Fuel Pressure Regulator 2.
- Ignition Voltage = Greater than 6 V

Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

P0090 - P0092, P2294 - P2296

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

P163ACondition 1

Q18A Fuel Pressure Regulator 1 - Electrical Current = Not within a calibrated range - For less than 2 s

Condition 2

Q18A Fuel Pressure Regulator 1 - Control Circuit = High Resistance - For less than 2 s

P163BCondition 1

Q18B Fuel Pressure Regulator 2 - Electrical Current = Not within a calibrated range - For less than 2 s

Condition 2

Q18B Fuel Pressure Regulator 2 - Control Circuit = High Resistance - For less than 2 s

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type B DTC - Exceptions listed below

DTC P0090 = Type A DTC

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type B DTC - Exceptions listed below

DTC P0090 = Type A DTC

Diagnostic Aids

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High resistance in the circuits of the component Q18A /Q18B may set DTC P163A, P163B without setting control circuit DTC(s).

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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 P0689, P0690, P1682 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. Perform the appropriate scan tool control function: Fuel Pressure Regulator 1, 2 - On and Off

   Verify the appropriate scan tool parameter:

    - Fuel Pressure Regulator 1, 2 Control Circuit High Voltage Test Status = Not Runor OK
    - Fuel Pressure Regulator 1, 2 Control Circuit Low Voltage Test Status = Not Runor OK
    - Fuel Pressure Regulator 1, 2 Control Circuit Open Test Status = Not Runor OK
    - **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.

   Verify the DTC does not set.

    - **If the DTC sets**

      Refer to: Circuit/System Testing

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

5. All OK.

Circuit/System Testing

1. Ignition/Vehicle - Off
2. Disconnect the appropriate electrical connector:
    - Q18A Fuel Pressure Regulator 1
    - Q18B Fuel Pressure Regulator 2
3. Connect a test lamp between the test points: Control circuit terminal 2 & B+
4. Ignition - On / Vehicle - In Service Mode
5. Perform the appropriate scan tool control function: Fuel Pressure Regulator 1, 2 - On and Off

   Verify the test lamp turns On and changes brightness.

    - **If the test lamp is always Off**

    1. Ignition/Vehicle - Off & Remove - Test lamp
    2. Disconnect the appropriate electrical connector:
        - {Q18A Fuel Pressure Regulator 1} X1 @ K20 Engine Control Module
        - {Q18B Fuel Pressure Regulator 2} 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 2 @ Component harness & Ground
        - If 1 V or greater - Repair the short to voltage on the circuit.
        - Go to next step: If less than 1 V
    5. Ignition/Vehicle - Off
    6. Test for less than 2 ohms between the test points: Control 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

    - **If the test lamp turns On but does not change brightness**

    1. Ignition/Vehicle - Off & Remove - Test lamp
    2. Disconnect the appropriate electrical connector:
        - {Q18A Fuel Pressure Regulator 1} X1 @ K20 Engine Control Module
        - {Q18B Fuel Pressure Regulator 2} X2 @ K20 Engine Control Module
    3. Test for infinite resistance between the test points: Control circuit terminal 2 @ 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 turns On and changes brightness**

6. Connect a test lamp between the test points: Control circuit terminal 1 & Control circuit terminal 2
7. Perform the appropriate scan tool control function: Fuel Pressure Regulator 1, 2 - On and Off

   Verify the test lamp turns On and changes brightness.

    - **If the test lamp is always Off**

    1. Ignition/Vehicle - Off & Remove - Test lamp
    2. Disconnect the appropriate electrical connector:
        - {Q18A Fuel Pressure Regulator 1} X1 @ K20 Engine Control Module

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- {Q18B Fuel Pressure Regulator 2} 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.
   - Go to next step: If infinite resistance
4. Test for less than 2 ohms between the test points: Control 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 the test lamp turns On but does not change brightness**

1. Ignition/Vehicle - Off & Remove - Test lamp
2. Disconnect the appropriate electrical connector:
   - {Q18A Fuel Pressure Regulator 1} X1 @ K20 Engine Control Module
   - {Q18B Fuel Pressure Regulator 2} 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 test lamp turns On and changes brightness**

8. Test or replace the component: Q18 Fuel Pressure Regulator

Component Testing

1. Ignition/Vehicle - Off
2. Disconnect the appropriate electrical connector: Q18 Fuel Pressure Regulator

NOTE: **The component's temperature should be 24 to 26B°C (75 to 79B°F) while testing.**

3. Test for 2.6 to 3.0 ohms between the test points: Component terminal 1 & 2
   - **If not between 2.6 and 3.0 ohms**

     Replace the appropriate component: Q18 Fuel Pressure Regulator

   - **Go to next step: If between 2.6 and 3.0 ohms**
4. Test for infinite resistance between the test points: Each terminal of the component & The component's housing
   - **If less than infinite resistance**

     Replace the appropriate component: Q18 Fuel Pressure Regulator

   - **Go to next step: If infinite resistance**
5. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Fuel Injection Fuel Rail Assembly Replacement** - Q18B Fuel Pressure Regulator 2
- **Fuel Injection Pump Metering Valve Replacement** - Q18A Fuel Pressure Regulator 1
- For control module replacement, programming, and setup refer to **Control Module References**

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DTC P0096, P00E9, OR P0111

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 P0096

Intake Air Temperature (IAT) Sensor 2 Performance

DTC P00E9

Intake Air Temperature (IAT) Sensor 3 Circuit Performance - If equipped

DTC P0111

Intake Air Temperature (IAT) Sensor 1 Performance

Circuit/System Description

This system consists of the following components:

- B65 Intake Manifold Pressure and Air Temperature Sensor - IAT Sensor 3
- B75C Multifunction Intake Air Sensor - IAT Sensor 1 & IAT Sensor 2

This DTC sets when the sensor signals contradict each other.

Conditions for Running the DTC

- DTC P0097, P0098, P00EA, P00EB, P0112, P0113, P0117, P0118, P1682, P16A7, P16BC, P2610 = Not set
- Time between current ignition cycle and the last time the engine was running = Greater than 8 h
- Ignition Voltage = Greater than 10.9 V

Frequency the DTC runs = Once - After the running conditions are met

Conditions for Setting the DTC

The following parameters are not within 25B°C (45B°F) of each other:

- Start-Up IAT Sensor 1
- Start-Up IAT Sensor 2
- Start-Up IAT Sensor 3

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

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Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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 P0097, P0098, P00EA, P00EB, P0112, P0113, P0117, P0118, P1682, P16A7, P16BC, P2199, P2610 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**

   NOTE: **To minimize the effects of residual engine heat and heating elements inside the sensor, perform step 3 of this procedure only if the ignition has been Off for longer than 8 h.**

3. Verify the following parameters are within 25B°C (45B°F) of each other:
   - Start-Up IAT Sensor 1
   - Start-Up IAT Sensor 2
   - Start-Up IAT Sensor 3
   - **If not in the specified range**
   - {Start-Up IAT Sensor 1} Refer to **DTC P0112, P0113, or P0114**
   - {Start-Up IAT Sensor 2} Refer to **DTC P0097-P0099 or P00F4-P00F6**
   - {Start-Up IAT Sensor 3} Refer to **DTC P00EA-P00EC**
   - **Go to next step: If in the specified range**
4. Engine - Idling
5. Verify the scan tool parameter: = -39 to 149B°C (-38 to 300B°F) and changes
   - IAT Sensor 1
   - IAT Sensor 2
   - IAT Sensor 3
   - **If not in the specified range or does not change**

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- {IAT Sensor 1} Refer to **DTC P0112, P0113, or P0114**
- {IAT Sensor 2} Refer to **DTC P0097-P0099 or P00F4-P00F6**
- {IAT Sensor 3} Refer to **DTC P00EA-P00EC**
- **Go to next step: If in the specified range and changes**

6. Verify the appropriate scan tool parameter:
   - IAT Sensor 1
   - IAT Sensor 2
   - IAT Sensor 3

   Perform the action while monitoring the parameter:

   - Wiggle the harness and connector: B65 Intake Manifold Pressure and Air Temperature Sensor
   - Wiggle the harness and connector: B75C Multifunction Intake Air 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**
7. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

DTC P0097-P0099 OR P00F4-P00F6

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 P0097

Intake Air Temperature (IAT) Sensor 2 Circuit Low Voltage

DTC P0098

Intake Air Temperature (IAT) Sensor 2 Circuit High Voltage

DTC P0099

Intake Air Temperature (IAT) Sensor 2 Circuit Intermittent

DTC P00F4

Intake Air Humidity Sensor Circuit Low Voltage

DTC P00F5

Intake Air Humidity Sensor Circuit High Voltage

DTC P00F6

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Intake Air Humidity Sensor Circuit Erratic

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P0096, P0097, P00F4, P2199	P0096, P0098, P00F5, P2199	P0096, P0098*, P00F5, P2199	P0096, P00F6, P2199
Low Reference	-	P0096, P0098, P00F5, P2199, P2229	-	P0096, P2199, P2230
*Internal control module or component damage may occur if the circuit shorts to B+.				

Typical Scan Tool Data

IAT Sensor 2

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine = Idling **Parameter Normal Range:** -39 to 149B°C (-38 to 300B°F)			
Signal	-40B°C (-40B°F)	-40B°C (-40B°F)	-40B°C (-40B°F)
Low Reference	-	-40B°C (-40B°F)	-40B°C (-40B°F)

Typical Scan Tool Data

Intake Air Humidity Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine = Idling **Parameter Normal Range:** 5 to 95%			
Signal	100%	0%	0%
Low Reference	-	0%	-

Circuit/System Description

Circuit	Description
Signal	The control module input circuit has an internal resistance connected to 5 V.
Ground	Grounded through the control module.

Component	Description
B75C Multifunction Intake Air Sensor	The intake air temperature sensor 2 is integrated in the mass air flow sensor. The intake air temperature sensor 2 varies its resistance depending on the temperature. The intake air humidity sensor uses the same signal circuit as the intake air temperature sensor 2. The intake air humidity sensor modulates the pulse width of the signal. The intake air temperature sensor 2 modulates the frequency of the signal. That means the signal is both, PWM and FM modulated.
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

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- {DTC P00F6} DTC P1682 = Not set
- Ignition = On
- Ignition Voltage = Greater than 11 V

Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

P0097

NOTE: The scan tool display range is between -40 and +150B°C (-40 and +302B°F).

IAT Sensor 2 = Colder than -60B°C (-76B°F) For greater than 5 s

P0098

IAT Sensor 2 = Warmer than 150B°C (302B°F) For greater than 5 s

P0099

IAT Sensor 2 = Intermittent - For greater than 5 s

P00F4

Intake Air Humidity Sensor = Less than 5%For greater than 5 s

P00F5

Intake Air Humidity Sensor = Greater than 95%For greater than 5 s

P00F6

Intake Air Humidity Sensor = Intermittent - For greater than 5 s

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type B DTC - Additional actions taken:

Cooling Fan = On

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type B DTC

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **Component Connector End Views - Index**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**

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

Scan Tool Reference

Control Module References

Special Tools

<special tool><special tool-no>EL-38522</special tool-no><special tool-desc>Variable Signal Generator</special tool-desc></special tool>

Equivalent regional tools: **Special Tools ((Diagnosis Tools))**

Circuit/System Verification

NOTE: **If you were sent here from DTC P0096 - Refer to: Circuit/System Testing.**

1. Ignition - On / Vehicle - In Service Mode
2. Verify DTC P0102, P103, P0641, P0651, P0697, P06A3 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. Engine - Running
4. Verify the scan tool parameter:
   - Intake Air Humidity Sensor = 5 to 95% and changes
   - IAT Sensor 2 = -39 to 149B°C (-38 to 300B°F) and changes
   - **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**
5. Verify the appropriate scan tool parameter:
   - Intake Air Humidity Sensor
   - IAT Sensor 2

     Perform the action while monitoring the parameter:

   - Wiggle the harness and connector: B75C Multifunction Intake Air 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**
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.

   Verify the DTC does not set.

   - **If the DTC sets**

     Refer to: Circuit/System Testing

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

7. All OK.

Circuit/System Testing

NOTE: **Circuit/System Verification must be performed before proceeding with Circuit/System Testing.**

1. Ignition/Vehicle & All vehicle systems - Off 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.
2. Disconnect the electrical connector: B75C Multifunction Intake Air Sensor
3. Test for less than 5 ohms between the test points: Low Reference circuit terminal 3 & 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: Low Reference circuit terminal 3 @ Component harness & The other end of the circuit @ K20 Engine Control Module
      - 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. Verify the scan tool parameter: Intake Air Humidity Sensor = Less than 1%
   - **If 1% or greater**
   1. Ignition/Vehicle - Off
   2. Disconnect the electrical connector: K20 Engine Control Module
   3. Test for infinite resistance between the test points: Signal circuit terminal 8 & The other end of the circuit @ Chassis 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 less than 1%**
5. Ignition/Vehicle - Off
6. Connect a 3 A fused jumper wire between the test points: Signal circuit terminal 8 @ Component harness & Low Reference circuit terminal 3
7. Ignition - On / Vehicle - In Service Mode
8. Verify the scan tool parameter: Intake Air Humidity Sensor = Greater than 99%
   - **If less than 100%**

     NOTE: **Internal control module or component damage may occur if the circuit shorts to B+.**

   1. Ignition/Vehicle - Off & Remove - Jumper wire(s)
   2. Disconnect the electrical connector: X3 @ 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 8 & The other end of the circuit @ Chassis Ground
      - If 1 V or greater - Repair the short to voltage on the circuit.
      - Go to next step: If less than 1 V
   5. Ignition/Vehicle - Off
   6. Test for less than 2 ohms between the test points: Signal circuit terminal 8 & The other end of the circuit @ K20 Engine Control Module
      - If 2 ohms or greater - Repair the open/high resistance in the circuit.

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        - If less than 2 ohms - Replace the component: K20 Engine Control Module
    - **If greater than 99%**
9. Test or replace the component: B75C Multifunction Intake Air Sensor

Component Testing

NOTE: **Circuit/System Testing must be performed before proceeding with Component Testing.**

1. Ignition/Vehicle - Off
2. Disconnect the electrical connector: B75C Multifunction Intake Air Sensor
3. Install the special tool:<special tool><special tool-no>EL-38522</special tool-no><special tool-desc>Variable Signal Generator</special tool-desc></special tool>
    - Black lead @ Ground
    - Battery Cable Clip @ Battery
    - Red lead @ Signal circuit terminal 8
    - Set the voltage to 5 V
    - Set the frequency to 250 Hz
    - Set the duty cycle to 50%
4. Ignition - On / Vehicle - In Service Mode
5. Verify the scan tool parameter:
    - IAT Sensor 2 = 248 to 252 Hz
    - IAT Sensor 2 = 70 to 76B°C (160 to 166B°F)
    - Intake Air Humidity Sensor = 48 to 52%
    - **If not in the specified range or does not change**
    1. Ignition/Vehicle - Off
    2. Disconnect the electrical connector: K20 Engine Control Module
    3. Test for less than 2 ohms between the test points: Signal circuit terminal 8 @ B75C Multifunction Intake Air Sensor & The other end of the circuit @ K20 Engine Control Module
        - 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 in the specified range and changes**
6. Replace the component: B75C Multifunction Intake Air Sensor

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Mass Airflow Sensor with Intake Air Temperature Sensor Replacement**
- For control module replacement, programming, and setup refer to **Control Module References**

Additional Procedures

BARO Sensor Reset - Perform only when the following component/system is replaced or serviced:

- K20 Engine Control Module - Replaced
- B75C Multifunction Intake Air Sensor - Cleaned/Replaced

DTC P00C7

Diagnostic Instructions

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- 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 P00C7

Intake Air Pressure Measurement System - Multiple Sensors Not Plausible

Circuit/System Description

This system consists of the following components:

- B65 Intake Manifold Pressure and Air Temperature Sensor
- B75C Multifunction Intake Air Sensor - BARO Sensor 2
- K20 Engine Control Module - BARO Sensor 1

This DTC sets when the control module detects an inconsistency between the pressure sensors and cannot identify which sensor failed.

Conditions for Running the DTC

Condition 1

- DTC P0107, P0108, P2228, P2229, P227C, P227D = Not pending
- DTC P0106, P0107, P0108, P2227, P2228, P2229, P2230, P227B, P227C, P227D, P227E = Not set
- Engine = Not Running
- Time between current ignition cycle and the last time the engine was running = Greater than 5 s
- Manifold Absolute Pressure = 50 to 115 kPa (7.3 to 16.7 PSI)
- Barometric Pressure - BARO Sensor 1 = 50 to 115 kPa (7.3 to 16.7 PSI)
- Barometric Pressure - BARO Sensor 2 = 50 to 115 kPa (7.3 to 16.7 PSI)

Frequency the DTC runs = Continuously - After the running conditions are met

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, P2227, P2228, P2229, P2230, P227B, P227C, P227D, P227E = Not set
- Ignition Voltage = Greater than 11 V
- Engine = Running
- Engine Speed = Less than 1, 100 RPM
- Intake Air Flow Valve Position = Greater than 90%
- Calculated Fuel Flow = Less than a predefined threshold
- Engine Coolant Temperature = Warmer than 70B°C (158B°F)

Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

Manifold Absolute Pressure & Barometric Pressure = Not within 10 kPa (1.5 PSI) of each other.

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Actions 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

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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 P0106, P0107, P0108, P2227, P2228, P2229, P2230, P227B, P227C, P227D, P227E 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 the following conditions do not exist:
   - Q38 Throttle Body - Loose Clamps / Visible Damage
   - Air Cleaner Element - Dirty / Restricted
   - Intake Air Duct & Intake Manifold - Cracked / Loose Clamps / Visible Damage
   - B75C Multifunction Intake Air Sensor - Cracked / Loose Clamps / Visible Damage
   - Air Inlet Valve - BARO Sensor 1 @ K20 Engine Control Module / Leaking / Missing / Clogged /Visible Damage
   - O-Ring @ B65 Intake Manifold Pressure and Air Temperature Sensor / Leaking / Missing / Visible Damage
   - Positive Crankcase Ventilation System - Leaking / Incorrect connection / Restricted
   - Vacuum Hoses - Kinked / Leaking / Incorrect connection /Restricted
   - Vacuum leak @ Engine / Intake Manifold / Q38 Throttle Body

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- **If a condition exists**

  Repair or replace as necessary

- **Go to next step: If no condition exists**

4. Verify the scan tool parameter:
   - BARO Sensor 1 = **Altitude Versus Barometric Pressure** - The value should be within the range listed in the table.
   - BARO Sensor 2 = **Altitude Versus Barometric Pressure** - The value should be within the range listed in the table.
   - MAP Sensor = **Altitude Versus Barometric Pressure** - The value should be within the range listed in the table.
   - **If not in the specified range**
   - {BARO Sensor 1} Refer to **DTC P2227-P2230**
   - {BARO Sensor 2} Refer to **DTC P227B-P227E**
   - {MAP Sensor} Refer to **DTC P0106, P0107, or P0108**
   - **Go to next step: If in the specified range**
5. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

DTC P00EA-P00EC

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 P00EA

Intake Air Temperature (IAT) Sensor 3 Circuit Low Voltage

DTC P00EB

Intake Air Temperature (IAT) Sensor 3 Circuit High Voltage

DTC P00EC

Intake Air Temperature (IAT) Sensor 3 Circuit Erratic

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P00EA	P00EB	P00EB*	P00E9
Low Reference	-	P00EB**	P00EA, P00EC*	-
*Internal control module or component damage may occur if the circuit shorts to B+. **Additional DTCs may set.				

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Typical Scan Tool Data

IAT Sensor 3

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine = Idling **Parameter Normal Range:** -39 to +129B°C (-38 to +264B°F)			
Signal	150B°C (302B°F)	-40B°C (-40B°F)	-40B°C (-40B°F)
Low Reference	-	-40B°C (-40B°F)	-40B°C (-40B°F)

Circuit/System Description

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

Component	Description
B65 Intake Manifold Pressure and Air Temperature Sensor	The intake air temperature sensor 3 and the intake manifold pressure sensor are integrated in the same housing, which is located behind the throttle body.
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.

Conditions for Running the DTC

- Engine = Running
- Battery Voltage = Greater than 11 V

Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

P00EA

IAT Sensor 3 = Warmer than 149B°C (300B°F) - For greater than 5 s

P00EB

IAT Sensor 3 = Colder than -39B°C (-38B°F) - For greater than 5 s

P00EC

IAT Sensor 3 = Signal noisy or erratic - For greater than 5 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

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Engine Controls Wiring Schematics

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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

NOTE: **If you were sent here from DTC P0096, P00E9, P0101, P0111 - Refer to: Circuit/System Testing.**

1. Ignition - On / Vehicle - In Service Mode
2. Verify the scan tool parameter: IAT Sensor 3 = -39 to 149B°C (-38 to 300B°F)
   - **If not between -39 and 149B°C (-38 and 300B°F)**

     Refer to: Circuit/System Testing
   - **Go to next step: If between -39 and 149B°C (-38 and 300B°F)**
3. Verify the scan tool parameter: IAT Sensor 3 = The value should not spike or drop out.

   Perform the action while monitoring the parameter:
   - Wiggle the harness and connector: B65 Intake Manifold Pressure and Air Temperature Sensor
   - Wiggle the harness and connector: X2 @ 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**
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.

   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.

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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: B65 Intake Manifold Pressure and Air Temperature Sensor
3. Test for less than 5 ohms between the test points: Low Reference circuit terminal 3 & 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 1 @ Component harness & Terminal 80 @ 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. Verify the scan tool parameter: IAT Sensor 3 = Colder than -39B°C (-38B°F)
    - **If -39B°C (-38B°F) or warmer**
    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 2 @ 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 colder than -39B°C (-38B°F)**
6. Connect a 3 A fused jumper wire between the test points: Signal circuit terminal 2 & Low Reference circuit terminal 3
7. Verify the scan tool parameter: IAT Sensor 3 = Warmer than 149B°C (300B°F)
    - **If 149B°C (300B°F) or colder**
    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.
        - Go to next step: 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 & Terminal 26 @ 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 warmer than 149B°C (300B°F)**
8. Test or replace the component: B65 Intake Manifold Pressure and Air Temperature Sensor

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Throttle Inlet Absolute Pressure Sensor Replacement**

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- For control module replacement, programming, and setup refer to **Control Module References**

DTC P0101-P0103

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 P0101

Mass Air Flow (MAF) Sensor Performance

DTC P0102

Mass Air Flow (MAF) Sensor Circuit Low Frequency

DTC P0103

Mass Air Flow (MAF) Sensor Circuit High Frequency

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
12V Reference	P0102	P0100, P0102	P0690	P0101
Signal	P0102	P0100, P0102	P0103	P0101
Ground	-	P0100, P0102	-	-

Typical Scan Tool Data

MAF Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine = Running At Idle Speed **Parameter Normal Range: 8 to 20 g/s - 2, 700 to 3, 860 Hz**			
Ignition	0 Hz	0 Hz	-
Signal	0 Hz	0 Hz	0 Hz
Ground	-	0 Hz	-

Circuit/System Description

Circuit	Description
Ignition	Regulated voltage supplied by the control module.
Signal	The control module input circuit has an internal resistance connected to 5 V.
Ground	Chassis Ground

Component	Description
B75C Multifunction Intake Air Sensor	The assembly has several functions: • The mass air flow sensor is a hot film type sensor that measures the mass of air (not the volume) entering the engine. The signal varies with engine load and is

Component	Description

	displayed by the scan tool in Hertz (Hz) and grams per second (g/s).
	• The intake air humidity sensor uses the same signal circuit as the intake air temperature sensor 2. The intake air humidity sensor modulates the pulse width of the signal. The intake air temperature sensor 2 modulates the frequency of the signal. That means the signal is both, PWM and FM modulated.
	• The barometric pressure sensor generates an analog voltage that is proportional to the ambient air pressure.
	• The intake air temperature sensor 1 varies its resistance depending on the temperature.
	  • Low temperature produces a high resistance: 1, 166 ohms @ 40B°C (104B°F)
	  • High temperature produces a low resistance: 97 ohms @ 130B°C (266B°F)

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

P0101

- DTC P00C7, P0071-P0074, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0114, 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, P0405, P0406, P049D, P0502, P0503, P062B, P062D, P0722, P0723, P111E, P122D, P124A, P124B, P1248, P1249, P126A, P16A0, P16A1, P16A2, P2147, P2148, P2150, P2151, P2227, P2228, P2229, P2230 = Not set
- Battery Voltage = Greater than 11 V
- Engine Speed = 700 to 1, 200 RPM
- Ambient Air Temperature. = Warmer than -7B°C (19B°F)
- Engine Coolant Temperature = 40 to 130B°C (104 to 266B°F)
- Barometric Pressure = Greater than 69.5 kPa (10.1 PSI)
- Intake Air Flow Valve Position = Greater than 85%
- EGR Position Sensor = Less than 1%

Frequency the DTC runs = Continuously - After the running conditions are met - For greater than 1 s

P0102, P0103

- Battery Voltage = Greater than 11 V
- Engine Speed = Greater than 699 RPM

Frequency the DTC runs = Continuously - After the running conditions are met - For greater than 1 s

Conditions for Setting the DTC

P0101 Condition 1

The ratio between measured and estimated mass air flow is too low. - For greater than 1 s

Condition 2

The ratio between measured and estimated mass air flow is too high. - For greater than 1 s

P0102

MAF Sensor = Less than 200 Hz - For greater than 6 s

P0103

MAF Sensor = Greater than 13, 000 Hz - For greater than 6 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

Diagnostic Aids

- Inspect the sensing element for contamination and clean it if possible. If the sensing element cannot be cleaned - Replace the sensor.
- When the EGR valve is closed, the ideal Induction System Leak Indication parameter is 1.0:1; the normal range is between 0.80:1 and 1.20:1.
- A scan tool Induction System Leak Indication parameter greater than 1.20:1, when the EGR valve is commanded closed, may indicate:
  - A leak after the turbocharger
  - An inaccurate MAP sensor
  - An inaccurate IAT sensor 3
  - A skewed MAF sensor
- A scan tool Induction System Leak Indication parameter less than 0.80:1, when the EGR valve is commanded closed, may indicate:
  - A leak before the turbocharger
  - An inaccurate MAP sensor
  - An inaccurate IAT sensor 3
  - A skewed MAF sensor
  - A leaking EGR valve, when it is commanded closed
  - A leaking positive crankcase valve (PCV) system

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **Component Connector End Views - Index**

Electrical Information Reference

- **Circuit Testing**

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- **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

Special Tools

<special tool><special tool-no>EL-38522</special tool-no><special tool-desc>Variable Signal Generator</special tool-desc></special tool>

Equivalent regional tools: **Special Tools ((Diagnosis Tools))**

Circuit/System Verification

1. Engine - Idling
2. Verify the scan tool parameter: MAF Sensor = Greater than 0 Hz
   - **If 0 Hz or less**

     Refer to: Circuit/System Testing

   - **Go to next step: If greater than 0 Hz**
3. Verify DTC P0016, P007B-P007E, P00C7, P00E9, P00EA-P00EC, P0096-P0099, P0106-P0108, P0111-P0114, P0116-P0119, P0128, P0201-P0204, P020A-P020D, P0216, P02E8, P02E9, P0261, P0262, P0264, P0265, P0267, P0268, P026A, P0270, P0271, P0405, P0406, P049D, P0502, P0503, P062B, P062D, P062F, P0722, P0723, P10D5-P10D8, P122D, P12B0-P12B2, P12AF, P1248, P1249, P16A0-P16A2, P2004, P2006, P2008-P2010, P201B, P201D, P20F8, P2147, P2148, P2150, P2151, P2227-P2230 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**
4. Increase the engine speed slowly to 3k RPM and then back to idle.
5. Perform the scan tool function: Review Stored Data
6. Observe the scan tool parameter frame by frame with a scan tool: MAF Sensor

   Verify the parameter changes smoothly and gradually in the recorded data as the engine speed was increased and decreased.

   - **If the value does not change smoothly and gradually**

     Refer to: Circuit/System Testing

   - **Go to next step: If the value changes smoothly and gradually**
7. Verify the scan tool parameter: MAF Sensor = The value should not spike or drop out.

   Perform the action while monitoring the parameter:

   - Wiggle the harness and connector: B75C Multifunction Intake Air Sensor
   - Wiggle the harness and connector: K20 Engine Control Module

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- **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**

8. Perform the scan tool control function: Exhaust Gas Recirculation - Closed
9. Verify the scan tool parameter: Induction System Leak Indication = 0.75:1 to 1.25:1 - Stable
    - **If not in the specified range**
    1. Ignition/Vehicle & All vehicle systems - Off
    2. Verify the following conditions do not exist:
        - B75C Multifunction Intake Air Sensor - Contamination of the measuring element/Water intrusion/Leaking/Visible Damage
        - O-Ring @ B65 Intake Manifold Pressure and Air Temperature Sensor - Leaking/ Missing/Visible Damage
        - Q14 Exhaust Gas Recirculation Valve - Stuck Open/Leaking
        - Air Cleaner Element - Dirty/Restricted
        - Exhaust System - Loose/Missing components/Restricted/Visible Damage - Refer to **Symptoms - Engine Exhaust**
        - Intake Air Duct - Collapsed/Loose Clamps/Restricted/Visible Damage
        - Intake Manifold - Cracked/Loose Clamps/Visible Damage - Refer to **Intake Manifold Cleaning and Inspection**
        - Positive Crankcase Ventilation Oil Separator - Cracked/Leaking / Loose Clamps/Restricted
        - Charge Air Cooler - Leaking / Loose Clamps/ Restricted - Frozen /Visible Damage

          Refer to **Charge Air Cooler Diagnosis (Induction System Smoke Test)** , or **Charge Air Cooler Diagnosis (Full System Air Leak Test)**

        - If a condition exists - Repair or replace as necessary
    - **Go to next step: If in the specified range**
10. 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 is set**

      Refer to: Circuit/System Testing

    - **Go to next step: If the DTC is not set**
11. 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: B75C Multifunction Intake Air Sensor
3. Test for less than 5 ohms between the test points: Ground circuit terminal 7 & Ground
    - **If 5 ohms or greater**
    1. Disconnect the ground connection: G107

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2. Test for less than 2 ohms between the test points: Ground circuit terminal 7 @ Component harness & Ground terminal G107
    - If 2 ohms or greater - Repair the open/high resistance in the circuit.
    - If less than 2 ohms - Repair the open/high resistance in the ground connection.
- **Go to next step: If less than 5 ohms**

4. Ignition - On / Vehicle - In Service Mode
5. Verify a test lamp turns On between the test points: Ignition circuit terminal 5 & Ground
    - **If the test lamp does not turn On and the circuit fuse is OK**
    1. Ignition/Vehicle - Off & Remove - Test lamp
    2. Test for less than 2 ohms between the test points: Ignition circuit terminal 5 @ Component harness & Output terminal @ F11UA Fuse
        - If 2 ohms or greater - Repair the open/high resistance in the circuit.
        - If less than 2 ohms - Verify the fuse is OK and there is voltage at the fuse.
    - **If the test lamp does not turn On and the circuit fuse is open**
    1. Ignition/Vehicle - Off
    2. Replace the component: F11UA Fuse
    3. Ignition - On / Vehicle - In Service Mode
    4. Verify the fuse does not open.
        - If the fuse opens and there are components connected to the circuit - Disconnect a component and repeat procedure starting at step 5.1
        - If the fuse opens with all components disconnected from the circuit - Repair the short to ground on the circuit.
        - If the fuse does not open after disconnecting a component from the circuit - Replace the component disconnected last.
        - Go to next step: If the fuse does not open.

        NOTE: **It may be necessary to use a scan tool control function to operate a component.**

    5. Operate the component: Each component on the circuit - One at a time

        Verify the fuse does not open when any of the components are activated.

        - If the fuse opens - Replace the component that caused the fuse to open when activated.
        - Go to next step: If the fuse does not open.
    6. All OK.
    - **Go to next step: If the test lamp turns On**
6. Ignition - On / Vehicle - In Service Mode
7. Test for 4.8 to 5.2 V between the test points: Signal circuit terminal 6 & Ground
    - **If less than 4.8 V**
    1. Ignition/Vehicle - Off
    2. Disconnect the appropriate electrical connector: K20 Engine Control Module
    3. Test for infinite resistance between the test points: Signal circuit terminal 6 @ Component harness & Ground
        - If less than infinite resistance - Repair the short to ground on the circuit.
        - Go to next step: If infinite resistance
    4. Test for less than 2 ohms between the test points: 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.

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- 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 appropriate electrical connector: 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 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 between 4.8 and 5.2 V**

8. Replace the component: B75C Multifunction Intake Air Sensor

Component Testing

NOTE: **Circuit/System Testing must be performed before proceeding with Component Testing.**

1. Ignition/Vehicle - Off
2. Disconnect the electrical connector: B75C Multifunction Intake Air Sensor
3. Install the special tool:<special tool><special tool-no>EL-38522</special tool-no><special tool-desc>Variable Signal Generator</special tool-desc></special tool>
    - Red lead @ Signal circuit terminal 6
    - Black lead @ Ground
    - Set the voltage to 5 V
    - Set the frequency to 5 000 Hz
    - Set the duty cycle to 50%
4. Engine at Idle
5. Verify the scan tool parameter: MAF Sensor = 4 950 to 5 050 Hz
    - **If not between 4 950 and 5 050 Hz**

      Replace the component: K20 Engine Control Module

      1. Ignition/Vehicle - Off
      2. Disconnect the appropriate electrical connector: K20 Engine Control Module
      3. Test for less than 2 ohms between the test points: 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 between 4 950 and 5 050 Hz**
6. Replace the component: B75C Multifunction Intake Air Sensor

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Mass Airflow Sensor with Intake Air Temperature Sensor Replacement**
- For control module replacement, programming, and setup refer to **Control Module References**

Additional Procedures

BARO Sensor Reset - Perform only when the following component/system is replaced or serviced:

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- K20 Engine Control Module - Replaced
- B75C Multifunction Intake Air Sensor - Cleaned/Replaced
- {DTC P0101, P0103}

  NOTE: **The DTC causing the Driver Information Center message/speed limitation to set must run and pass before the message/speed limitation will clear. This may require driving the vehicle.**

  1. Ignition - On / Vehicle - In Service Mode
  2. Verify that all scan tool Event Data parameters under the following data list displays No: Exhaust Gas Recirculation System Malfunction Warning Event Data
     - **If not the specified state**

       Operate the vehicle within the Conditions for Running the DTC for the Event Data parameter that displays Yes.

     - **Go to next step: If the specified state**
  3. All OK.
- {DTC P0102}

  NOTE: **Performing this procedure will clear the Driver Information message for the applicable system.**

  - Perform the scan tool control function: **Reductant System Tamper Service Bay Test** - Perform only when the following warning message is displayed: Service Emission System/Service Exhaust Fluid System

DTC P0106, P0107, OR P0108

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 P0106

Manifold Absolute Pressure (MAP) Sensor Performance

DTC P0107

Manifold Absolute Pressure (MAP) Sensor Circuit Low Voltage

DTC P0108

Manifold Absolute Pressure (MAP) Sensor Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P0107, P0651	P0108	P0108, P0651	P00C7
Signal	P0107	P0108	P0108	P00C7

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Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Low Reference	-	P0108	-	P00C7

Typical Scan Tool Data

MAP Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: • Engine = Idling - At normal operating temperature. • Accessories = Off **Parameter Normal Range:** = BAROB± 5 kPa (B± 0.7 PSI)			
5 V Reference	0 kPa (0.0 PSI)	300 kPa (43.5 PSI)	300 kPa (43.5 PSI)
Signal	0 kPa (0.0 PSI)	300 kPa (43.5 PSI)	300 kPa (43.5 PSI)
Low Reference	-	300 kPa (43.5 PSI)	-

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 5 V.
Low Reference	Grounded through the control module.

Component	Description
B65 Intake Manifold Pressure and Air Temperature Sensor	The assembly has several functions: **Pressure** The signal voltage increases when the pressure increases. **Temperature** The temperature sensor is a negative temperature coefficient thermistor, a resistor which changes based on temperature. • Low temperature produces a high resistance: 1.2 kohms @ 40B°C (104B°F) • High temperature produces a low resistance: 109 ohms @ 120B°C (248B°F) The intake air temperature sensor 3 and the intake manifold pressure sensor are integrated in the same housing, which is located behind the throttle body. The sensor measures the temperature and pressure in the intake manifold between the throttle valve and the intake valves.
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.

The sensor measures the pressure in the intake manifold. The signal is used to determine the engine load. When the engine is off or idling, the sensor pressure should be the same as the barometric pressure. Under wide-open throttle conditions the pressure will increase considerably.

Conditions for Running the DTC

P0106 Condition 1

- DTC P0101, P0102, P0103, P0107, P0108, P0116, P0117, P0118, P0119, P0128, P0201, P0202, P0203, P0204, P0216, P020A, P020B, P020C, P020D, 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, P2227, P2228, P2229, P2230, P227C, P227D = Not set
- Engine Coolant Temperature = Warmer than 70B°C (158B°F)
- Engine Speed = Less than 1, 100 RPM
- Intake Air Flow Valve Position = Greater than 90%
- Ignition Voltage = Greater than 11.0 V

Frequency the DTC runs = Continuously - After the running conditions are met

Condition 2

- DTC P0107, P0108, P2228, P2229, P227C, P227D, P2610 = Not set
- DTC P0107, P0108, P2228, P2229 = Not pending
- Ignition = On & Engine = Off
- Time between current ignition cycle and the last time the engine was running = Greater than 5 s

Frequency the DTC runs = Continuously - After the running conditions are met

P0107, P0108

- Engine Cranking
- Ignition = On

Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

P0106Condition 1

MAP Sensor & BARO Sensor 1, 2 = Not within 10 kPa (1.4 PSI) of each other.

Condition 2

MAP Sensor Not between 50 and 115 kPa (7.2 and 16.2 PSI)

P0107

MAP Sensor = Less than 0.2 V - For greater than 4.0 s

P0108

MAP Sensor = Greater than 4.5 V - For greater than 4.0 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

Diagnostic Aids

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The following conditions could cause DTC P0106 to set:

Certain weather conditions during prolonged drive trips may cause ice to form in the area of the component: B65 Intake Manifold Pressure and Air Temperature Sensor

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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

Special Tools

<special tool><special tool-no>EN-23738-A</special tool-no><special tool-desc>Vacuum Pump</special tool-desc></special tool>

Equivalent regional tools: **Special Tools ((Diagnosis Tools))**

Circuit/System Verification

NOTE: **If you were sent here from DTC P00C7, P0100, P0101, P0102, P0103 - Refer to: Circuit/System Testing.**

1. Ignition - On / Vehicle - In Service Mode
2. Verify DTC P0641, P0651, P0697, P06A3, P06D2 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: MAP Sensor = The value should be within the range listed in the table: **Altitude Versus Barometric Pressure**
   - **If not in the specified range**

     Refer to: Circuit/System Testing

   - **Go to next step: If in the specified range**
4. Engine - Idling - At normal operating temperature.

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5. Accessories - Off
6. Verify the scan tool parameter:
    - MAP Sensor = The value should be within the range listed in the table: **Altitude Versus Barometric Pressure**
    - MAP Sensor = The value should change with accelerator pedal input.
    - **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**
7. Verify the scan tool parameter: MAP Sensor = The value should not spike or drop out.

   Perform the action while monitoring the parameter:

    - Wiggle the harness and connector: B65 Intake Manifold Pressure and Air Temperature 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**
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.

   Verify that no DTCs are set.

    - **If the DTC sets**

      Refer to: Circuit/System Testing

    - **Go to next step: If the DTC is not set**
9. All OK.

Circuit/System Testing

NOTE: **Circuit/System Verification must be performed before proceeding with Circuit/System Testing.**

1. Ignition/Vehicle & All vehicle systems - Off
2. Verify the following conditions do not exist:
    - B65 Intake Manifold Pressure and Air Temperature Sensor
        - Leaking @ O-Ring/Missing/Visible Damage
        - Restricted - Water intrusion/Moisture/Ice
    - B75C Multifunction Intake Air Sensor - Contamination of the measuring element/Leaking/Visible Damage/Water intrusion
    - Fresh Air Inlet @ Barometric Pressure Sensor - Missing/Restricted/Visible Damage/Water intrusion
    - Q20 Intake Air Flow Valve
        - Leaking - Loose Clamps/Visible Damage
        - Restricted - Moisture/Ice
    - Air Cleaner Element - Dirty/Restricted
    - Intake Air Duct - Cracked/Loose Clamps/Restricted/Visible Damage
    - Intake Manifold - Cracked/Restricted/Visible Damage

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- Fastener @ Intake Manifold - Loose
- Positive Crankcase Ventilation System
  - Leaking @ O-Ring - Missing/Visible Damage
  - Restricted - Moisture / Ice
  - Incorrect connection - Leaking/Restricted
- **If a condition exists**

  Repair or replace as necessary

- **Go to next step: If no condition exists**

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.**

3. Disconnect the electrical connector: B65 Intake Manifold Pressure and Air Temperature Sensor
4. Test for less than 5 ohms between the test points: Low Reference circuit terminal 1 & Ground
   - **If 5 ohms or greater**
   1. Disconnect the appropriate electrical connector: K20 Engine Control Module
   2. Test for less than 2 ohms between the test points: Low 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
   - **Go to next step: If less than 5 ohms**
5. Ignition - On / Vehicle - In Service Mode
6. Test for 4.8 to 5.2 V between the test points: 5 V Reference circuit terminal 3 & Low Reference circuit terminal 1
   - **If less than 4.8 V**
   1. Ignition/Vehicle - Off
   2. Disconnect the appropriate electrical connector: 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.
      - Go to next step: 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 appropriate 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 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**
7. Verify the scan tool parameter: MAP Sensor = Greater than 4.7 V
   - **If 4.7 V or less**
   1. Ignition/Vehicle - Off

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2. Disconnect the appropriate electrical connector: K20 Engine Control Module
3. Test for infinite resistance between the test points: Signal circuit terminal 4 @ 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**

8. Connect a 3 A fused jumper wire between the test points: Signal circuit terminal 4 & Low Reference circuit terminal 1
9. Verify the scan tool parameter: MAP Sensor = Less than 0.2 V
    - **If 0.2 V or greater**
    1. Ignition/Vehicle - Off & Remove - Jumper wire(s)
    2. Disconnect the appropriate electrical connector: 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 4 @ Component harness & Ground
        - If 1 V or greater - Repair the short to voltage on the circuit.
        - Go to next step: If less than 1 V
    5. Ignition/Vehicle - Off
    6. Test for less than 2 ohms between the test points: Signal circuit terminal 4 @ 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 0.2 V**
10. Test or replace the component: B65 Intake Manifold Pressure and Air Temperature Sensor

Component Testing

NOTE: **Circuit/System Testing must be performed before proceeding with Component Testing.**

Dynamic Test - Using Vehicle Harness

1. Ignition/Vehicle - Off
2. Remove the component: B65 Intake Manifold Pressure and Air Temperature Sensor - Leave the electrical connector connected.
3. Install the special tool:<special tool><special tool-no>EN-23738-A</special tool-no><special tool-desc>Vacuum Pump</special tool-desc></special tool> @ B65 Intake Manifold Pressure and Air Temperature Sensor
4. Use the tool to achieve a gauge reading between -13 and -21 kPa (-0.13 and -0.21 bar, -3.8 and -6.2 in Hg).

    Verify the scan tool parameter: MAP Sensor = Decreases between 13 and 21 kPa (1.9 and 3.0 PSI)

    - **If the parameter does not decrease between 13 and 21 kPa (1.9 and 3.0 PSI)**

        Replace the component: B65 Intake Manifold Pressure and Air Temperature Sensor

    - **Go to next step: If the parameter decreases between 13 and 21 kPa (1.9 and 3.0 PSI)**
5. Use the tool to achieve a gauge reading between -30 and -38 kPa (-0.3 and -0.38 bar, -8.8 and -11.2 in Hg).

    Verify the scan tool parameter: MAP Sensor = Decreases between 30 and 38 kPa (4.4 and 5.5 PSI)

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- **If the parameter does not decrease between 30 and 38 kPa (4.4 and 5.5 PSI)**

  Replace the component: B65 Intake Manifold Pressure and Air Temperature Sensor

- **Go to next step: If the parameter decreases between 30 and 38 kPa (4.4 and 5.5 PSI)**

6. All OK.

Dynamic Test - Using Jumper Wires

1. Ignition/Vehicle - Off
2. Remove the component: B65 Intake Manifold Pressure and Air Temperature Sensor
3. Connect a 3 A fused jumper wire between the test points: 5 V Reference terminal 3 & 5 V
4. Connect a jumper wire between the test points: Low Reference terminal 1 & Ground
5. Connect a DMM between the test points: Signal terminal 4 @ B65 Intake Manifold Pressure and Air Temperature Sensor & Ground
6. Install the special tool:<special tool><special tool-no>EN-23738-A</special tool-no><special tool-desc>Vacuum Pump</special tool-desc></special tool> @ B65 Intake Manifold Pressure and Air Temperature Sensor
7. Use the tool to achieve a gauge reading between 0 and -15 kPa (0 and -0.15 bar, 0 and -4.4 in Hg).

   Verify the DMM displays between 0.2 and 4.9 V. - The value should not spike or drop out.

   - **If not between 0.2 and 4.9 V or has spikes or drops out**

     Replace the component: B65 Intake Manifold Pressure and Air Temperature Sensor

   - **Go to next step: If between 0.2 and 4.9 V and there are no spikes or drops out**

8. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Throttle Inlet Absolute Pressure Sensor Replacement** - B65 Intake Manifold Pressure and Air Temperature Sensor
- For control module replacement, programming, and setup refer to **Control Module References**

Additional Procedures

BARO Sensor Reset - Perform only when the following component/system is replaced or serviced:

- B65 Intake Manifold Pressure and Air Temperature Sensor - Replaced
- K20 Engine Control Module - Replaced

DTC P0112, P0113, OR P0114

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 P0112

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Intake Air Temperature (IAT) Sensor 1 Circuit Low Voltage

DTC P0113

Intake Air Temperature (IAT) Sensor 1 Circuit High Voltage

DTC P0114

Intake Air Temperature (IAT) Sensor 1 Circuit Intermittent

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P0112, P0114	P0113, P0114	P0113*, P0114	P0111, P0114
Low Reference	-	P0113, P0114	-	P0111, P0114
*Internal control module or component damage may occur if the circuit shorts to B+.				

Typical Scan Tool Data

IAT Sensor 1

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine = Idling **Parameter Normal Range:** -39 to 130B°C (-38 to 266B°F)			
Signal	150B°C (302B°F)	-40B°C (-40B°F)	-40B°C (-40B°F)
Low Reference	-	-40B°C (-40B°F)	-40B°C (-40B°F)

Circuit/System Description

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

Component	Description
B75C Multifunction Intake Air Sensor	The assembly has several functions: • The mass air flow sensor is a hot film type sensor that measures the mass of air (not the volume) entering the engine. The signal varies with engine load and is displayed by the scan tool in Hertz (Hz) and grams per second (g/s). • The intake air humidity sensor uses the same signal circuit as the intake air temperature sensor 2. The intake air humidity sensor modulates the pulse width of the signal. The intake air temperature sensor 2 modulates the frequency of the signal. That means the signal is both, PWM and FM modulated. • The barometric pressure sensor generates an analog voltage that is proportional to the ambient air pressure. • The intake air temperature sensor 1 varies its resistance depending on the temperature. • Low temperature produces a high resistance: 1.2 kohms @ 40B°C (104B°F)

Component	Description
	• High temperature produces a low resistance: 109 ohms @ 120B°C (248B°F)
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

Engine = Running - For greater than 1 s

Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

P0112

NOTE: The scan tool display range is between -40 and 150B°C (-40 and 302B°F).

IAT Sensor 1 = Warmer than 149B°C (300B°F) For greater than 4 s

P0113

IAT Sensor 1 = Colder than -60B°C (-76B°F) For greater than 4 s

P0114

IAT Sensor 1 = Signal noisy or erratic - For greater than 4 s

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type B DTC

Cooling Fan = On

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type B DTC

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **Component Connector End Views - Index**

Electrical Information Reference

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

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- **Wiring Repairs**

Scan Tool Reference

Control Module References

Circuit/System Verification

NOTE: **If you were sent here from DTC P0096, P00E9, P0101, P0111 - Refer to: Circuit/System Testing.**

1. Engine - Idling
2. Verify the scan tool parameter: IAT Sensor 1 = -39 to 149B°C (-36 to 300B°F)
   - **If not between -39 and 149B°C (-36 and 300B°F)**

     Refer to: Circuit/System Testing

   - **Go to next step: If between -39 and 149B°C (-36 and 300B°F)**
3. Verify the scan tool parameter: IAT Sensor 1 = The value should not spike or drop out.

   Perform the action while monitoring the parameter:

   - Wiggle the harness and connector: B75C Multifunction Intake Air 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**
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.

   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**
5. 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: B75C Multifunction Intake Air Sensor
3. Test for less than 5 ohms between the test points: Low Reference circuit terminal 3 & The other end of the circuit @ Chassis 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: Low 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.

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- 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. Verify the scan tool parameter: IAT Sensor 1 = Colder than -39B°C (-38B°F)
   - **If -39B°C (-38B°F) or warmer**
   1. Ignition/Vehicle - Off
   2. Disconnect the electrical connector: K20 Engine Control Module
   3. Test for infinite resistance between the test points: Signal circuit terminal 1 @ Component harness & The other end of the circuit @ Chassis 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 colder than -39B°C (-38B°F)**
6. Connect a 3 A fused jumper wire between the test points: Signal circuit terminal 1 & Low Reference circuit terminal 3
7. Verify the scan tool parameter: IAT Sensor 1 = Warmer than 149B°C (300B°F)
   - **If 149B°C (300B°F) or colder**
   1. Ignition/Vehicle - Off & Remove - Jumper wire(s)
   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: Signal circuit terminal 1 @ Component harness & The other end of the circuit @ Chassis Ground
      - If 1 V or greater - Repair the short to voltage on the circuit.
      - Go to next step: If less than 1 V
   5. Ignition/Vehicle - Off
   6. Test for less than 2 ohms between the test points: Signal 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
   - **Go to next step: If warmer than 149B°C (300B°F)**
8. Test or replace the component: B75C Multifunction Intake Air Sensor

Component Testing

1. Ignition/Vehicle - Off
2. Disconnect the electrical connector: B75C Multifunction Intake Air Sensor
3. Test for 49 to 49, 882 ohms between the test points: Signal terminal 1 & Low Reference terminal 3
   - **If not between 49 and 49, 882 ohms**

     Replace the component: B75C Multifunction Intake Air Sensor

   - **Go to next step: If between 49 and 49, 882 ohms**
4. Verify the value is within the range listed in the table: **Temperature Versus Resistance - Intake Air Temperature Sensor**
   - **If not in the specified range**

     Replace the component: B75C Multifunction Intake Air Sensor

   - **Go to next step: If in the specified range**
5. Test for infinite resistance between the test points: Each terminal of the component & The component's housing

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- **If less than infinite resistance**

  Replace the component: B75C Multifunction Intake Air Sensor

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

6. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Mass Airflow Sensor with Intake Air Temperature Sensor Replacement**
- For control module replacement, programming, and setup refer to **Control Module References**

Additional Procedures

BARO Sensor Reset - Perform only when the following component/system is replaced or serviced:

- K20 Engine Control Module - Replaced
- B75C Multifunction Intake Air Sensor - Cleaned/Replaced

DTC P0117, P0118, OR P0119

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 P0117

Engine Coolant Temperature (ECT) Sensor Circuit Low Voltage

DTC P0118

Engine Coolant Temperature (ECT) Sensor Circuit High Voltage

DTC P0119

Engine Coolant Temperature (ECT) Sensor Circuit Intermittent

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P0117, P0119	P0118, P0119	P0118*, P0119	P0119, P0128
Low Reference	-	P0118, P0119**	*	P0119, P0128
*Internal control module or component damage may occur if the circuit shorts to B+. **Additional DTCs may set.				

Typical Scan Tool Data

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ECT Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine = Idling - At normal operating temperature. **Parameter Normal Range:** 88 to 105B°C (190 to 221B°F)			
Signal	150B°C (302B°F)	-40B°C (-40B°F)	-40B°C (-40B°F)
Low Reference	-	-40B°C (-40B°F)	-

Circuit/System Description

For an overview of the component/system, refer to **Cooling System Description and Operation (LGZ, LWN)**

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

Component	Description
B34 Engine Coolant Temperature Sensor	The sensor is a negative temperature coefficient thermistor. As the temperature of the air, fluid, or metal increases, the resistance of the sensor decreases, varying the voltage on the signal circuit.
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

P0117

Ignition = On

Frequency the DTC runs = Continuously - After the running conditions are met

P0118

- Engine = Running - For greater than 10 s
- IAT Sensor = Warmer than -7B°C (19B°F)

Frequency the DTC runs = Continuously - After the running conditions are met

P0119

DTC P0117, P0118 = Not set

Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

P0117

Engine Coolant Temperature = Warmer than 149B°C (300B°F) - For greater than 5 s

P0118

Engine Coolant Temperature = Colder than -39B°C (-38B°F) - For greater than 5 s

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P0119

Engine Coolant Temperature = Intermittent - For greater than 3 s

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type B DTC

- A/C Compressor = Off
- Cooling Fan = On
- Coolant Temperature Indicator = Inoperative

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type B DTC

Diagnostic Aids

After starting a cold engine, the following scan tool parameter value should rise steadily and then stabilize: Engine Coolant Temperature

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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 the scan tool parameter: ECT Sensor = -39 to 149B°C (-38 to 300B°F)
    - **If not between -39 and 149B°C (-38 and 300B°F)**

      Refer to: Circuit/System Testing

    - **Go to next step: If between -39 and 149B°C (-38 and 300B°F)**
3. Verify the scan tool parameter: ECT Sensor = The value should not spike or drop out.

   Perform the action while monitoring the parameter:

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- Wiggle the harness and connector: B34 Engine Coolant Temperature Sensor
- Wiggle the harness and connector: X2 @ 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**

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.

   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**

5. 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: B34 Engine Coolant Temperature Sensor
3. Test for less than 10 ohms between the test points: Low Reference circuit terminal 2 & Ground
   - **If 10 ohms or greater**
   1. Disconnect the appropriate electrical connector: 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 10 ohms**
4. Ignition - On / Vehicle - In Service Mode
5. Verify the scan tool parameter: ECT Sensor = Colder than -39B°C (-38B°F)
   - **If warmer than -39B°C (-38B°F)**
   1. Ignition/Vehicle - Off
   2. Disconnect the appropriate electrical connector: 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 colder than -39B°C (-38B°F)**
6. Connect a 3 A fused jumper wire between the test points: Signal circuit terminal 1 & Low Reference circuit terminal 2
7. Verify the scan tool parameter: ECT Sensor = Warmer than 149B°C (300B°F)
   - **If 149B°C (300B°F) or colder**
   1. Ignition/Vehicle - Off & Remove - Jumper wire(s)
   2. Disconnect the appropriate electrical connector: 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 1 @ Component harness & Ground
    - If 1 V or greater - Repair the short to voltage on the circuit.
    - Go to next step: If less than 1 V
5. Ignition/Vehicle - Off
6. Test for less than 2 ohms between the test points: Signal 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

- **Go to next step: If warmer than 149B°C (300B°F)**

8. Test or replace the component: B34 Engine Coolant Temperature Sensor

Component Testing

1. Ignition/Vehicle - Off
2. Disconnect the electrical connector: B34 Engine Coolant Temperature Sensor
3. Test the resistance between the test points: Signal terminal 1 & Low Reference terminal 2
4. Verify the value is within the range listed in the table: **Temperature Versus Resistance - Engine Coolant Temperature Sensor**
    - **If not in the specified range**

      Replace the component: B34 Engine Coolant Temperature Sensor

    - **Go to next step: If in the specified range**
5. Test for infinite resistance between the test points: Each terminal of the component & The component's housing
    - **If less than infinite resistance**

      Replace the component: B34 Engine Coolant Temperature Sensor

    - **Go to next step: If infinite resistance**
6. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Engine Coolant Temperature Sensor Replacement**
- For control module replacement, programming, and setup refer to **Control Module References**

DTC P0128 OR P01F0

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 P0128

Engine Coolant Temperature (ECT) Below Thermostat Regulating Temperature

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DTC P01F0

Coolant Temperature Dropped Below Diagnostic Monitoring Temperature

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P0117, P0119	P0118, P0119	P0118, P0119 *	P0116, P0119, P0128
Low Reference	-	P0118, P0119 **	*	P0119, P0128
*Internal control module or component damage may occur if the circuit shorts to B+. **Additional DTCs may set.				

Typical Scan Tool Data

ECT Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine = Idling - At normal operating temperature. **Parameter Normal Range:** 88 to 105B°C (190 to 221B°F)			
Signal	150B°C (302B°F)	-40B°C (-40B°F)	-40B°C (-40B°F)
Low Reference	-	-40B°C (-40B°F)	-

Circuit/System Description

For an overview of the component/system, refer to **Cooling System Description and Operation (LGZ, LWN)**

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

Component	Description
B34 Engine Coolant Temperature Sensor	The sensor is a negative temperature coefficient thermistor. As the temperature of the air, fluid, or metal increases, the resistance of the sensor decreases, varying the voltage on the signal circuit.
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

P0128

- DTCs related to the following system/component = Not Set
  - B34 Engine Coolant Temperature Sensor
  - B66 Intake Air Temperature Sensor
  - B75C Multifunction Intake Air Sensor
- Engine Off Time = For greater than 30 min
- Engine Run Time = 30 s to 30 min
- Start-Up ECT = -40 to 52B°C (-40 to 126B°F)

- Distance Traveled = Greater than 0.8 km (0.5 mi)

Frequency the DTC runs = Once - Per ignition cycle - After the running conditions are met

P01F0

- DTC P0117, P0118, P0119, P0128, P111E = Not set
- Ambient Air Temperature = Greater than -7B°C (19.4B°F)
- Engine Coolant Temperature = Greater than 70B°C (158B°F) - Once - Per ignition cycle
- Engine Run Time = For greater than 30 s
- Engine Speed = Greater than 600 RPM
- Vehicle Distance Traveled During Drive Cycle = Greater than 1.2 km (.8 mi)

Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

P0128

Engine Coolant Temperature = Not within a calibrated range

P01F0

Engine Coolant Temperature = Less than 70B°C (158B°F) - For greater than 60 s

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type B DTC

- A/C Compressor = Off
- Cooling Fan = On

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type B DTC

Diagnostic Aids

Coolant thermostat is stuck open.

High resistance in the circuits of the component may set DTC P0128, P01F0 without setting the DTC for the component: B34 Engine Coolant Temperature Sensor

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **Component Connector End Views - Index**

Electrical Information Reference

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

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- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References

Circuit/System Verification

1. Verify there are no DTCs set related to the following component/system:
   - {P0117, P0118, P0119} B34 Engine Coolant Temperature Sensor
   - B75C Multifunction Intake Air Sensor
   - **If a related DTC is set**

     Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**

   - **Go to next step: If a related DTC is not set**
2. Verify the condition does not exist: Incorrect fluid level or condition - Refer to **Loss of Coolant**
   - **If a condition exists**

     Repair or replace as necessary

   - **Go to next step: If no condition exists**
3. Engine - Running @ 3000 RPM

   Verify the scan tool parameter: ECT Sensor = Greater than 80B°C (176B°F) - Within 15 min

   - **If 80B°C (176B°F) or colder**

     Test or replace the component: Engine Coolant Thermostat

   - **Go to next step: If warmer than 80B°C (176B°F)**
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.

   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

> **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: B34 Engine Coolant Temperature Sensor
3. Test for less than 10 ohms between the test points: Low Reference circuit terminal 2/B & Ground
   - **If 10 ohms or greater**
   1. Disconnect the electrical connector: X2 @ K20 Engine Control Module

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2. Test for less than 2 ohms between the test points: Low Reference circuit terminal 2/B @ Component harness & Terminal 50 X2 @ 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 10 ohms**

4. Ignition - On / Vehicle - In Service Mode
5. Verify the scan tool parameter: ECT Sensor = Colder than -39B°C (-38B°F)
    - **If -39B°C (-38B°F) or warmer**
    1. Ignition/Vehicle - Off
    2. Disconnect the appropriate electrical connector: K20 Engine Control Module
    3. Test for infinite resistance between the test points: Signal circuit terminal 1/A @ 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 colder than -39B°C (-38B°F)**
6. Connect a 3 A fused jumper wire between the test points: Signal circuit terminal 1/A & Low Reference circuit terminal 2/B
7. Verify the scan tool parameter: ECT Sensor = Warmer than 149B°C (300B°F)
    - **If 149B°C (300B°F) or colder**
    1. Ignition/Vehicle - Off & Remove - Jumper wire(s)
    2. Disconnect the appropriate electrical connector: 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 1/A @ Component harness & Ground
        - If 1 V or greater - Repair the short to voltage on the circuit.
        - Go to next step: If less than 1 V
    5. Ignition/Vehicle - Off
    6. Test for less than 2 ohms between the test points: Signal circuit terminal 1/A @ Component harness & Terminal 30 X2 @ 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 warmer than 149B°C (300B°F)**
8. Test or replace the component: B34 Engine Coolant Temperature Sensor

Component Testing

1. Ignition/Vehicle - Off
2. Disconnect the electrical connector: B34 Engine Coolant Temperature Sensor
3. Test for 55 to 78, 834 ohms between the test points: Signal circuit terminal 1/A & Low Reference circuit terminal 2/B
    - **If not between 55 and 78, 834 ohms**

      Replace the component: B34 Engine Coolant Temperature Sensor

    - **Go to next step: If between 55 and 78, 834 ohms**
4. Verify the value is within the range listed in the table: **Temperature Versus Resistance - Engine Coolant Temperature Sensor**
    - **If not in the specified range**

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Replace the component: B34 Engine Coolant Temperature Sensor

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

5. Test for infinite resistance between the test points: Each terminal of the component & The component's housing
    - **If less than infinite resistance**

      Replace the component: B34 Engine Coolant Temperature Sensor

    - **Go to next step: If infinite resistance**
6. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Engine Coolant Temperature Sensor Replacement**
- **Engine Coolant Thermostat Replacement (LWN)**
- For control module replacement, programming, and setup refer to **Control Module References**

DTC P0171 OR P0172

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 P0171

Fuel Trim System Lean

DTC P0172

Fuel Trim System Rich

Circuit/System Description

For an overview of the component/system, refer to **Fuel System Description**

Conditions for Running the DTC

- DTCs related to the following system/component = Not Set
    - B9 Ambient Air Temperature Sensor
    - B34 Engine Coolant Temperature Sensor
    - B75C Multifunction Intake Air Sensor
- Ambient Air Temperature Greater than -7B°C (19.4B°F)
- Barometric Pressure = Greater than 72 kPa (10.4 PSI)
- Engine Coolant Temperature = Warmer than 45B°C (113B°F)
- Engine Running
- Ignition Voltage = Greater than 11 V
- Fuel level = Greater than 10%
- NOx Sensor 1 = Allowed

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Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

The limit to correct a rich air/fuel ratio has been exceeded. - After the running conditions are met - Greater than 14 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

Diagnostic Aids

Inspect for aftermarket devices which may affect the operation of the system.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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 there are no DTCs set related to the following component/system:
    - B9 Ambient Air Temperature Sensor
    - B34 Engine Coolant Temperature Sensor
    - B75C Multifunction Intake Air Sensor
    - **If a related DTC is set**

      Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**

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

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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 no DTC is set**
4. All OK.

Circuit/System Testing

1. Ignition - On / Vehicle - In Service Mode
2. Verify the scan tool parameter: MAF Sensor = 5 to 40 g/s
   - **If not between 5 and 40 g/s**

     Verify the following conditions do not exist:

     1. Intake Manifold - Leaking
     2. Intake Air Duct - Loose Clamps/Cracked/Visible Damage
     3. Mass Airflow Sensor - Contamination of the measuring element/Water intrusion
        - If a condition exists

          Repair or replace as necessary

        - If no condition exists

          Refer to **Diesel Particulate Filter (DPF) Service Regeneration**

   - **Go to next step: If between 5 and 40 g/s**
3. Ignition/Vehicle - Off
4. Verify a condition does not exist with the component:
   - Exhaust System - Leaking/Missing components/Restricted - Refer to **Symptoms - Engine Exhaust**
   - Fuel - Contaminated/Poor Quality - Refer to **Contaminants-in-Fuel Diagnosis** , & **Fuel System Specifications**
   - Q17 Fuel Injector - Leaking/Restricted - Refer to **Cylinder Power Balance Test** - Circuit/System Testing
   - **If a condition exists**

     Repair or replace as necessary

   - **Go to next step: If no condition exists**
5. Perform a conventional engine compression test. Refer to **Engine Compression Test**
   - **If one or more cylinders indicate low compression**

     Refer to **Symptoms - Engine Mechanical**

   - **Go to next step: If all cylinders indicate normal compression**
6. Replace the component: B195A Nitrogen Oxides Sensor 1

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

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- Nitrogen Oxides Sensor Replacement - Position 1
- Perform the special tool function: NOx Sensor 1 Reset

DTC P0181-P0184

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 P0181

Fuel Temperature Sensor Performance

DTC P0182

Fuel Temperature Sensor Circuit Low Voltage

DTC P0183

Fuel Temperature Sensor Circuit High Voltage

DTC P0184

Fuel Temperature Sensor Circuit Erratic

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P0182	P0183, P0184	P0183, P0184	P0181
Low Reference	-	P0183, P0184	P0184	P0181

Typical Scan Tool Data

Fuel Temperature Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine = Idling - At normal operating temperature. **Parameter Normal Range:** -29 to 108B°C (-21 to 227B°F)			
Signal	109B°C (228B°F)	-30B°C (-22B°F)	-30B°C (-22B°F)
Low Reference	-	-30B°C (-22B°F)	-

Circuit/System Description

For an overview of the component/system, refer to Fuel System Description

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

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Component	Description
E11A Fuel Heater/Water in Fuel Sensor	The sensor is a negative temperature coefficient thermistor. As the temperature of the air, fluid, or metal increases, the resistance of the sensor decreases, varying the voltage on the signal circuit.
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

P0181

- DTC P0182, P0183, P1103, P16D7, P16D8, P16D9, P262B = Not set
- Engine = Running
- Engine Off Time = Greater than 8 h
- Engine Run Time = 8 to 13 s
- Ignition Voltage = Greater than 11 V
- Start-Up ECT = Warmer than -40B°C (-40B°F)

Frequency the DTC runs = Once - Per drive cycle - After the running conditions are met

P0182, P0183

- Engine = Running
- Ignition Voltage = Greater than 11 V

Frequency the DTC runs = Continuously - After the running conditions are met

P0184

- DTC P0182, P0183 = Not set
- Ignition Voltage = Greater than 11 V

Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

P0181

An internal evaluation logic has detected a malfunction of the circuit.

P0182

Fuel Temperature Sensor = Warmer than 109B°C (228B°F) - For greater than 2 s

P0183

Fuel Temperature Sensor = Colder than -39B°C (-38B°F) - For greater than 2 s

P0184

Fuel Temperature Sensor - Signal = Intermittent - For greater than 1.5 s

Actions Taken When the DTC Sets

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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

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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 the scan tool parameter: Fuel Temperature Sensor = -29 to 108B°C (-21 to 227B°F) and changes
   - **If not between -29 and 108B°C (-21 and 227B°F) or does not change**

     Refer to: Circuit/System Testing

   - **Go to next step: If between -29 and 108B°C (-21 and 227B°F) and changes**
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

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.**

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1. Ignition/Vehicle & All vehicle systems - Off
2. Disconnect the electrical connector: E11A Fuel Heater/Water in Fuel Sensor
3. Test for less than 10 ohms between the test points: Low Reference circuit terminal 1 & Ground
    - **If 10 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 1 @ Component harness & Terminal 47 @ 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 10 ohms**
4. Ignition - On / Vehicle - In Service Mode
5. Verify the scan tool parameter: Fuel Temperature Sensor = Colder than -29B°C (-21B°F)
    - **If warmer than -29B°C (-21B°F)**
    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 2 @ 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 colder than -29B°C (-21B°F)**
6. Connect a 3 A fused jumper wire between the test points: Signal circuit terminal 2 & Low Reference circuit terminal 1
7. Verify the scan tool parameter: Fuel Temperature Sensor = Warmer than 108B°C (227B°F)
    - **If 108B°C (227B°F) or colder**
    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.
        - Go to next step: 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 & Terminal 27 @ 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 warmer than 108B°C (227B°F)**
8. Replace the component: E11A Fuel Heater/Water in Fuel Sensor

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Fuel Filter Assembly Replacement**
- For control module replacement, programming, and setup refer to **Control Module References**

DTC P0191-P0193, P127C, OR P127D

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 P0191

Fuel Rail Pressure Sensor 1 Performance

DTC P0192

Fuel Rail Pressure Sensor 1 Circuit Low Voltage

DTC P0193

Fuel Rail Pressure Sensor 1 Circuit High Voltage

DTC P127C

Fuel Rail Pressure Sensor 2 Circuit Low Voltage

DTC P127D

Fuel Rail Pressure Sensor 2 Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P0193, P06A3, P127D	P0193, P127D	P0193, P06A3, P127D	-
Signal - Fuel Rail Pressure Sensor 1	P0192	P0193	P0193	P0191
Signal - Fuel Rail Pressure Sensor 2	P127C	P127D	P127D	P0191
Low Reference	-	P0193, P127D	P0193, P127D	P0191

Typical Scan Tool Data

Fuel Rail Pressure Sensor 1

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine = Running **Parameter Normal Range:** 0.2 to 4.74 V			
5 V Reference	5 V	5 V	5 V
Signal	0 V	5 V	5 V
Low Reference	-	5 V	-

Fuel Rail Pressure Sensor 2

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine = Running **Parameter Normal Range:** 0.2 to 4.74 V			
5 V Reference	5 V	5 V	5 V
Signal	0 V	5 V	5 V
Low Reference	-	5 V	-

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Circuit/System Description

For an overview of the component/system, refer to **Fuel 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
B47B Fuel Rail Pressure Sensor	The sensor measures the pressure in the component: 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.

Conditions for Running the DTC

P0191

- DTC P0116-P0119, P0128, P0192, P0193, P111E, P262B = Not set
- ECT Sensor = Warmer than -40B°C (-40B°F)
- Engine Off Time = Greater than 5 min
- Ignition On or Engine Cranking - For greater than 15 s
- Ignition Voltage = Greater than 11 V

Frequency the DTC runs = Continuously - After the running conditions are met

P0192, P0193, P127C, P127D

- Battery Voltage = Greater than 8.4 V
- Ignition On or Engine Cranking - For greater than 15 s

Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

P0191

Fuel Rail Pressure Sensor 1 = Not within a calibrated range - For greater than 1 s

P0192

Fuel Rail Pressure Sensor 1 = Less than 0.2 V - For less than 1 s

P0193

Fuel Rail Pressure Sensor 1 = Greater than 4.74 V - For less than 1 s

P127C

Fuel Rail Pressure Sensor 2 = Less than 0.2 V - For less than 1 s

P127D

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Fuel Rail Pressure Sensor 2 = Greater than 4.74 V - For less than 1 s

Actions 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

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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 the scan tool parameter: Fuel Rail Pressure Sensor 1 & Fuel Rail Pressure Sensor 2 = 0.2 to 4.74 V and changes
   - **If not between 0.2 and 4.74 V or does not change**

     Refer to: Circuit/System Testing

   - **Go to next step: If between 0.2 and 4.74 V and changes**
3. Engine Running
4. Perform the scan tool control function: Fuel Rail Pressure - Increase & Decrease

   Verify the scan tool parameter: Fuel Rail Pressure Sensor 1, 2 = The value should change with each command.

   - **If the value does not change**

     Refer to: Circuit/System Testing

   - **Go to next step: If the value changes**

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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: B47B Fuel Rail Pressure Sensor
3. Test for less than 10 ohms between the test points: Low Reference circuit terminal 3 & Ground
   - **If 10 ohms or greater**
   1. Disconnect the electrical connector: K20 Engine Control Module
   2. Test for less than 2 ohms between the test points: Low 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
   - **Go to next step: If less than 10 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 1 & Low Reference circuit terminal 3
   - **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 1 @ Component harness & Ground
      - If less than infinite resistance - Repair the short to ground on the circuit.
      - Go to next step: If infinite resistance
   4. Test for less than 2 ohms between the test points: 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 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**

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6. Verify the scan tool parameter: Fuel Rail Pressure Sensor 1 & Fuel Rail Pressure Sensor 2 = Greater than 4.74 V
    - **If 4.74 V or less**
    1. Ignition/Vehicle - Off
    2. Disconnect the electrical connector: K20 Engine Control Module
    3. Test for infinite resistance between the test points:
        - Signal circuit terminal 4 @ Component harness & Ground
        - Signal circuit terminal 2 @ 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 4.74 V**
7. Connect a 3 A fused jumper wire between the test points:
    - Signal circuit terminal 4 & Ground
    - Signal circuit terminal 2 & Ground
8. Verify the scan tool parameter: Fuel Rail Pressure Sensor 1 & Fuel Rail Pressure Sensor 2 = Less than 0.2 V
    - **If 0.2 V or greater**
    1. Ignition/Vehicle - Off & Remove - Jumper wire(s)
    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:
        - Signal circuit terminal 4 @ Component harness & Ground
        - Signal circuit terminal 2 @ Component harness & Ground
        - If 1 V or greater - Repair the short to voltage on the circuit.
        - Go to next step: If less than 1 V
    5. Ignition/Vehicle - Off
    6. Test for less than 2 ohms between the test points:
        - Signal circuit terminal 4 @ Component harness & The other end of the circuit @ Control module harness
        - 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 0.2 V**
9. Test or replace the component: B47B Fuel Rail Pressure Sensor

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Fuel Rail Pressure Sensor Replacement**
- For control module replacement, programming, and setup refer to **Control Module References**

DTC P01CB-P01D2

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**

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- An overview of each diagnostic category can be found here: **Diagnostic Procedure Instructions**

DTC Descriptor

DTC P01CB

Cylinder 1 Injection Timing Retarded

DTC P01CC

Cylinder 1 Injection Timing Advanced

DTC P01CD

Cylinder 2 Injection Timing Retarded

DTC P01CE

Cylinder 2 Injection Timing Advanced

DTC P01CF

Cylinder 3 Injection Timing Retarded

DTC P01D0

Cylinder 3 Injection Timing Advanced

DTC P01D1

Cylinder 4 Injection Timing Retarded

DTC P01D2

Cylinder 4 Injection Timing Advanced

Circuit/System Description

For an overview of the component/system, refer to **Fuel System Description**

Circuit	Description
Control - Terminal 1	The output circuit is switched to 50 V to activate the component.
Control - Terminal 2	The output circuit is switched to ground to activate the component.

Component	Description
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.
Q17 Fuel Injector	Fuel injectors are solenoid valves that inject fuel either into the intake system or directly into the cylinder. The amount of fuel injected depends on the length of the electrical pulse that is applied.

To minimize engine vibrations at idle the engine control module can detect even small variations in engine speed and compensates these variations by adjusting the amount of injected fuel for each cylinder individually. This smooth-running control works only inside calibrated limits.

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Values that differ too much indicate that the injector is not working properly or that something is mechanically wrong with the cylinder.

- Fuel quantity based on the time the injector was turned on.
- Fuel quantity based on the increase in crankshaft speed when a specific cylinder fires.

Conditions for Running the DTC

- Accelerator Pedal Position = Less than 0.05%
- Ambient Air Temperature = Warmer than -20B°C (-4B°F)
- BARO Sensor 2 = Greater than 72 kPa (10 PSI)
- Deceleration Fuel Cut-Off = Active - Greater than 20 s
- ECT Sensor = 68 to 117B°C (154 to 243B°F)
- Engine Speed = 1350 to 2100 RPM
- Fuel Temperature = -20 to 70B°C (-4 to 158B°F)
- Low Fuel Indicator = Off
- Particulate Filter Regeneration Status = Not required
- Transmission = Gear 3, 4, 5, 6
- Vehicle Speed = Greater than 0 km/h (0 MPH)

Frequency the DTC runs = Once - Per drive cycle - After the running conditions are met

Conditions for Setting the DTC

Fuel Injection Quantity or Fuel Injection Timing = Out Of Range

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

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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

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Control Module References

Special Tools

- <special tool><special tool-no>CH-51450-A</special tool-no><special tool-desc> Oscilloscope Diagnostic Kit</special tool-desc></special tool>
- <special tool><special tool-no>CH-51450-LEAD-A</special tool-no><special tool-desc> Oscilloscope Basic Lead Kit</special tool-desc></special tool>

Equivalent regional tools: **Special Tools ((Diagnosis Tools))**

Circuit/System Verification

1. Verify 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 the condition does not exist:
   - Fuel Type - Incorrect
   - Fuel - Contaminated/Poor Quality
   - **If a condition exists**

     Refer to **Fuel System Specifications** , / **Contaminants-in-Fuel Diagnosis**

   - **Go to next step: If no condition exists**
3. Inspect for aftermarket devices which may affect the operation of the system.
   - **If a condition exists**

     Repair or replace as necessary

   - **Go to next step: If no condition exists**

   NOTE: **Time to set this DTC may take several drive cycles**

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.

   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**
5. All OK.

Circuit/System Testing

1. Ignition/Vehicle - Off
2. Verify the tool is available:<special tool><special tool-no>CH-51450-A</special tool-no><special tool-desc> Oscilloscope Diagnostic Kit</special tool-desc></special tool> & <special tool><special tool-no>CH-51450-LEAD-A</special tool-no><special tool-desc> Oscilloscope Basic Lead Kit</special tool-desc></special tool>
   - **If the tool is not available**

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1. Perform the following procedure/test: **Engine Compression Test**

   Verify the procedure/test passes.

   - If the procedure/test does not pass. Refer to **Symptoms - Engine Mechanical**
   - Go to next step: If the procedure/test passes

2. Test or replace the component: Q17 Fuel Injector

- **Go to next step: If the tool is available**

3. Perform the following procedure/test: **Relative Engine Compression Test**

   Verify the procedure/test passes.

   - **If the procedure/test does not pass**

     Refer to **Symptoms - Engine Mechanical**

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

4. Test or replace the component: Q17 Fuel Injector

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Fuel Injector Replacement (Cylinder #1, #2, #3)** , or **Fuel Injector Replacement (Cylinder #4)**
- For control module replacement, programming, and setup refer to **Control Module References**

DTC P0201-P0204, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P1248, P1249, P124A, P124B, P2147, P2148, P2150, OR P2151

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 P0201

Cylinder 1 Injector Control Circuit

DTC P0202

Cylinder 2 Injector Control Circuit

DTC P0203

Cylinder 3 Injector Control Circuit

DTC P0204

Cylinder 4 Injector Control Circuit

DTC P0261

Cylinder 1 Injector Control Circuit Low Voltage

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DTC P0262

Cylinder 1 Injector Control Circuit High Voltage

DTC P0264

Cylinder 2 Injector Control Circuit Low Voltage

DTC P0265

Cylinder 2 Injector Control Circuit High Voltage

DTC P0267

Cylinder 3 Injector Control Circuit Low Voltage

DTC P0268

Cylinder 3 Injector Control Circuit High Voltage

DTC P0270

Cylinder 4 Injector Control Circuit Low Voltage

DTC P0271

Cylinder 4 Injector Control Circuit High Voltage

DTC P1248

Cylinder 1 Injector High Control Circuit Shorted to Control Circuit

DTC P1249

Cylinder 2 Injector High Control Circuit Shorted to Control Circuit

DTC P124A

Cylinder 3 Injector High Control Circuit Shorted to Control Circuit

DTC P124B

Cylinder 4 Injector High Control Circuit Shorted to Control Circuit

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

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Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Short Between Circuits
Control - Voltage Control @ Q17A Fuel Injector 1	P0261	P0201	P0262	P1248
Control - Voltage Supply @ Q17A Fuel Injector 1	P2147	P0201	P2148	P1248
Control - Voltage Control @ Q17B Fuel Injector 2	P0264	P0202	P0265	P1249
Control - Voltage Supply @ Q17B Fuel Injector 2	P2150	P0202	P2151	P1249
Control - Voltage Control @ Q17C Fuel Injector 3	P0267	P0203	P0268	P124A
Control - Voltage Supply @ Q17C Fuel Injector 3	P2150	P0203	P2151	P124A
Control - Voltage Control @ Q17D Fuel Injector 4	P0270	P0204	P0271	P124B
Control - Voltage Supply @ Q17D Fuel Injector 4	P2147	P0204	P2148	P124B

Typical Scan Tool Data

Cylinder 1-4 Injector Control Circuit Status

Circuit	Short to Ground	Open	Short to Voltage	Short Between Circuits
Operating Conditions: Engine = Idling **Parameter Normal Range:** Not Run or OK				
Control - Terminal 1	High Control Circuit Low Voltage	Open	High Control Circuit High Voltage	High Control Circuit Shorted to Control Circuit
Control - Terminal 2	Control Circuit Low Voltage	Open	Control Circuit High Voltage	High Control Circuit Shorted to Control Circuit

Circuit/System Description

For an overview of the component/system, refer to **Fuel System Description**

Circuit	Description
Control - Terminal 1	The output circuit is switched to 50 V to activate the component.
Control - Terminal 2	The output circuit is switched to ground to activate the component.

Component	Description
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.
Q17 Fuel Injector	Fuel injectors are solenoid valves that inject fuel either into the intake system or directly into the cylinder. The amount of fuel injected depends on the length of the electrical pulse that is applied.

Conditions for Running the DTC

- Engine = Running
- Battery Voltage = Greater than 11 V

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 A DTC

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type A DTC

Diagnostic Aids

Cylinder 1 Injector & Cylinder 4 Injector = Group 1

Cylinder 2 Injector & Cylinder 3 Injector = Group 2

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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

   NOTE: **This step only applies to the following component DTCs: Q17 Fuel Injector**

2. Verify DTC P1248 - P124B is not set and no other DTCs are set.
   - **If DTC P1248 - P124B is not set and other DTCs are set**

     Refer to: Circuit/System Testing - Test 1

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- **If DTC P1248 - P124B is set and other DTCs are set**

  Refer to: Circuit/System Testing - Test 2

- **If DTC P1248 - P124B is set and no other DTCs are set**

  Refer to: Circuit/System Testing - Test 3

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

3. Engine - Running
4. Verify the scan tool parameter: Cylinder 1 - 4 Current Misfire Counter = Does not Increment

   Perform the action while monitoring the parameter:

   Wiggle the harness and connector: K20 Engine Control Module

   - **If the parameter value increments**

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

   - **Go to next step: If the parameter value does not increment**

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**

     Repeat the procedure starting at step 2

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

6. All OK.

Circuit/System Testing

Test 1

1. Ignition/Vehicle - Off

   NOTE:

   - **For detailed component terminal information, refer to Engine Controls Wiring Schematics**
   - **This procedure uses the following circuit names:**
     - **Voltage Supply @ Control circuit terminal 1**
     - **Voltage Control @ Control circuit terminal 2**
   - **Perform this diagnostic for the component that set the DTC.**

2. Disconnect the electrical connector: X2 @ K20 Engine Control Module
3. Test for infinite resistance between the test points: Control Circuit - Voltage Supply & Ground
   - **If less than infinite resistance**
   1. Disconnect the appropriate electrical connector: Q17 Fuel Injector
   2. Test for infinite resistance between the test points: Control Circuit - Voltage Supply @ Control module harness & Ground
      - If less than infinite resistance - Repair the short to ground on the circuit.
      - Go to next step: If infinite resistance

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3. Test for infinite resistance between the test points: Control Circuit - Voltage Control @ Control module harness & Ground
    - If less than infinite resistance - Repair the short to ground on the circuit.
    - If infinite resistance - Test or replace the component: Q17 Fuel Injector
- **Go to next step: If infinite resistance**

4. Ignition - On / Vehicle - In Service Mode
5. Test for less than 1 V between the test points: Control Circuit - Voltage Supply @ Control module harness & Ground
    - **If 1 V or greater**
    1. Disconnect the appropriate electrical connector: Q17 Fuel Injector
    2. Test for less than 1 V between the test points: Control Circuit - Voltage Supply @ Control module harness & Ground
        - If 1 V or greater - Repair the short to voltage on the circuit.
        - If less than 1 V - Repair the short to voltage on the circuit: Control Circuit - Voltage Control
    - **Go to next step: If less than 1 V**
6. Ignition/Vehicle - Off
7. Test for less than 3 ohms between the test points: Control Circuit - Voltage Supply & Control Circuit - Voltage Control @ Control module harness
    - **If 3 ohms or greater**
    1. Disconnect the appropriate electrical connector: Q17 Fuel Injector
    2. Test for less than 2 ohms between the test points:
        - Control Circuit - Voltage Control @ Control module harness & The other end of the circuit @ Component harness
        - Control Circuit - Voltage Supply @ Control module harness & The other end of the circuit @ Component harness
        - If 2 ohms or greater - Repair the open/high resistance in the circuit.
        - If less than 2 ohms - Test or replace the component: Q17 Fuel Injector
    - **Go to next step: If less than 3 ohms**
8. Replace the component: K20 Engine Control Module

Test 2

1. Ignition/Vehicle - Off

NOTE:

- **For detailed component terminal information, refer to Engine Controls Wiring Schematics**
- **This procedure uses the following circuit names:**
    - **Voltage Supply @ Control circuit terminal 1**
    - **Voltage Control @ Control circuit terminal 2**
- **Perform this diagnostic for the component that set the DTC.**

2. Disconnect the electrical connector: X2 @ K20 Engine Control Module
3. Test for infinite resistance between the test points: Control Circuit - Voltage Supply & Ground
    - **If less than infinite resistance**
    1. Disconnect the appropriate electrical connector: Q17 Fuel Injector
    2. Test for infinite resistance between the test points: Control Circuit - Voltage Supply @ Control module harness & Ground
        - If less than infinite resistance - Repair the short to ground on the circuit.

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- Go to next step: If infinite resistance

3. Test for infinite resistance between the test points: Control Circuit - Voltage Control @ Control module harness & Ground
    - If less than infinite resistance - Repair the short to ground on the circuit.
    - If infinite resistance - Test or replace the component: Q17 Fuel Injector
- **Go to next step: If infinite resistance**

4. Ignition - On / Vehicle - In Service Mode
5. Test for less than 1 V between the test points: Control Circuit - Voltage Supply @ Control module harness & Ground
    - **If 1 V or greater**
    1. Disconnect the appropriate electrical connector: Q17 Fuel Injector
    2. Test for less than 1 V between the test points: Control Circuit - Voltage Supply @ Control module harness & Ground
        - If 1 V or greater - Repair the short to voltage on the circuit.
        - If less than 1 V - Repair the short to voltage on the circuit: Control Circuit - Voltage Control
    - **Go to next step: If less than 1 V**
6. Ignition/Vehicle - Off
7. Disconnect the appropriate electrical connector: Q17 Fuel Injector
8. Test for less than 2 ohms between the test points:
    - Control Circuit - Voltage Control @ Control module harness & The other end of the circuit @ Component harness
    - Control Circuit - Voltage Supply @ Control module harness & The other end of the circuit @ Component harness
    - **If 2 ohms or greater**

      Repair the open/high resistance in the circuit.

    - **Go to next step: If less than 2 ohms**
9. Test for infinite resistance between the test points: Control circuit terminal 1 & Control circuit terminal 2 @ Component harness
    - **If less than infinite resistance**

      Repair the short between the circuits.

    - **Go to next step: If infinite resistance**
10. Perform the following procedure/test: Component Testing

    Verify the procedure/test passes.

    - **If the procedure/test does not pass**

      Replace the component: Q17 Fuel Injector

    - **Go to next step: If the procedure/test passes**
11. Replace the component: K20 Engine Control Module

Test 3

1. Ignition/Vehicle - Off
2. Disconnect the electrical connector: X2 @ K20 Engine Control Module
3. Disconnect the appropriate electrical connector: Q17 Fuel Injector

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4. Test for infinite resistance between the test points: Control circuit terminal 1 & Control circuit terminal 2 @ Component harness
    - **If less than infinite resistance**

      Repair the short between the circuits.

    - **Go to next step: If infinite resistance**
5. Perform the following procedure/test: Component Testing

   Verify the procedure/test passes.

    - **If the procedure/test does not pass**

      Replace the component: Q17 Fuel Injector

    - **Go to next step: If the procedure/test passes**
6. Replace the component: K20 Engine Control Module

Component Testing

1. Ignition/Vehicle - Off
2. Disconnect the appropriate electrical connector: Q17 Fuel Injector

   NOTE: **The specified resistances are valid for components at room temperature.**

3. Test for 0.2 to 1.5 ohms between the test points: Control terminal 1 & Control terminal 2
    - **If not between 0.2 and 1.5 ohms**

      Replace the component: Q17 Fuel Injector

    - **Go to next step: If between 0.2 and 1.5 ohms**
4. Test for infinite resistance between the test points: Each terminal of the component & The component's housing
    - **If less than infinite resistance**

      Replace the component: Q17 Fuel Injector

    - **Go to next step: If infinite resistance**
5. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Fuel Injector Replacement (Cylinder #1, #2, #3)** , or **Fuel Injector Replacement (Cylinder #4)**
- For control module replacement, programming, and setup refer to **Control Module References**

DTC P020A-P020D

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

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DTC P020A

Cylinder 1 Injection Timing

DTC P020B

Cylinder 2 Injection Timing

DTC P020C

Cylinder 3 Injection Timing

DTC P020D

Cylinder 4 Injection Timing

Circuit/System Description

For an overview of the component/system, refer to **Fuel System Description**

Circuit	Description
Control circuit terminal 1	The output circuit is switched to 50 V to activate the component.
Control circuit terminal 2	The output circuit is switched to ground to activate the component.

Component	Description
Q17 Fuel Injector	Fuel injectors are solenoid valves that inject fuel either into the intake system or directly into the cylinder. The amount of fuel injected depends on the length of the electrical pulse that is applied.
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.

Conditions for Running the DTC

- DTC P0201, P0202, P0203, P0204, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P062B, P062D, P1248, P1249, P124A, P124B, P2147, P2148, P2150, P2151 = Not set
- Engine is Running
- Ignition Voltage = Greater than 11 V

Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

The time to build up sufficient current to open the injector is below or above a predetermined threshold.

Actions 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

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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 DTC P0201, P0202, P0203, P0204, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P062B, P062D, P1248, P1249, P124A, P124B, P2147, P2148, P2150, P2151 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. 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 DTC P020A, P020B, P020C, P020D is not set.
    - **If any of the DTCs are set**

      Refer to: Circuit/System Testing

    - **Go to next step: If none of the DTCs are set**
5. All OK.

Circuit/System Testing

1. Ignition/Vehicle - Off
2. Disconnect the appropriate electrical connector: Q17 Fuel Injector
3. Ignition - On / Vehicle - In Service Mode
4. Test for 4.5 to 6.5 V between the test points: Control circuit terminal 1 & Ground
    - **If less than 4.5 V**
    1. Ignition/Vehicle - Off

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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.
    - Go to next step: If infinite resistance
4. Test for less than 2 ohms between the test points: Control circuit terminal 1 @ Component harness &
    - {Q17A Fuel Injector 1} Terminal 4 @ Control module harness
    - {Q17B Fuel Injector 2} Terminal 1 @ Control module harness
    - {Q17C Fuel Injector 3} Terminal 2 @ Control module harness
    - {Q17D Fuel Injector 4} Terminal 3 @ 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 6.5 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: 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 between 4.5 and 6.5 V**

5. Test for 0.60 to 0.80 V between the test points: Control circuit terminal 2 @ Component harness & Ground
    - **If less than 0.60 V**

    1. Ignition/Vehicle - Off
    2. Disconnect the electrical connector: X2 @ K20 Engine Control Module
    3. Test for infinite resistance between the test points: Control circuit terminal 2 @ Component harness & Ground
        - If less than infinite resistance - Repair the short to ground on the circuit.
        - Go to next step: If infinite resistance
    4. Test for less than 2 ohms between the test points: Control circuit terminal 2 @ Component harness &
        - {Q17A Fuel Injector 1} Terminal 8 @ Control module harness
        - {Q17B Fuel Injector 2} Terminal 5 @ Control module harness
        - {Q17C Fuel Injector 3} Terminal 6 @ Control module harness
        - {Q17D Fuel Injector 4} Terminal 7 @ 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 0.80 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: 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 - Replace the component: K20 Engine Control Module

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- **Go to next step: If between 0.60 and 0.80 V**

6. Test or replace the component: Q17 Fuel Injector

Component Testing

1. Ignition/Vehicle - Off
2. Disconnect the electrical connector: Q17 Fuel Injector

NOTE: **The specified resistances are valid for components at room temperature.**

3. Test for 0.2 to 1.5 ohms between the test points: Component terminal 1 & Component terminal 2
   - **If not between 0.2 and 1.5 ohms**

     Replace the component: Q17 Fuel Injector

   - **Go to next step: If between 0.2 and 1.5 ohms**
4. Test for infinite resistance between the test points: Each terminal of the component & The component's housing
   - **If less than infinite resistance**

     Replace the component: Q17 Fuel Injector

   - **Go to next step: If infinite resistance**
5. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Fuel Injector Replacement (Cylinder #1, #2, #3)** , or **Fuel Injector Replacement (Cylinder #4)**
- For control module replacement, programming, and setup refer to **Control Module References**

DTC P0216

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 P0216

Injection Timing Control Circuit

Circuit/System Description

For an overview of the component/system, refer to **Fuel System Description**

Circuit	Description
Control - Terminal 1	The output circuit is switched to 50 V to activate the component.
Control - Terminal 2	The output circuit is switched to ground to activate the component.

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Component	Description
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.
Q17 Fuel Injector	Fuel injectors are solenoid valves that inject fuel either into the intake system or directly into the cylinder. The amount of fuel injected depends on the length of the electrical pulse that is applied.

Conditions for Running the DTC

- DTC P0201-P0204, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P062B, P062D, P1248-P124B, P2147, P2148, P2150, P2151 = Not set
- Battery Voltage = Greater than 11 V
- Engine = Running

Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

The energizing time for the Injector is greater than a specified threshold

Actions 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

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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

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1. Verify there are no DTCs set related to the following component/system: Q17 Fuel Injector
    - **If a related DTC is set**

      Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**

    - **Go to next step: If a related DTC is not set**
2. Ignition - On / Vehicle - In Service Mode
3. Verify the scan tool parameter: Cylinder 1-4 Injector Control Circuit Status = OK

   Perform the action while monitoring the parameter:

    - Wiggle the harness and connector: K20 Engine Control Module
    - Wiggle the harness and connector: Q17 Fuel Injector
    - **If not the specified state**

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

    - **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**

      Replace the component: K20 Engine Control Module

    - **Go to next step: If the DTC is not set**
6. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

For control module replacement, programming, and setup refer to **Control Module References**

DTC P0234, P0299, OR P2263

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 P0234

Engine Overboost

DTC P0299

Engine Underboost

DTC P2263

Turbocharger Boost System Performance

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Circuit/System Description

For an overview of the component/system, refer to **Compressor Air Intake Turbocharger System Description**

Circuit	Description
Control - Terminal 4	The output circuit is switched from ground to 12 V to activate the component. The output is PWM controlled.
Control - Terminal 5	The output circuit is switched from ground to 12 V to activate the component. 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.
M103 Turbocharger Vane Position Actuator	The assembly has several functions: • The valve is actuated by a 12 V DC motor. A spring is used to keep the valve in the open position. The valve actuator motor moves the valve in the closed direction. The more current flows through the motor, the more the valve closes. • The component M103 contains a contactless inductive position sensor. A fixed transmitter coil excites a movable rotor, which in turn induces a current in a fixed receiver coil. The current varies with the angle of the rotor. Electronics inside the sensor convert the current into digital data which is transmitted via a serial data circuit to the control module K20.

Conditions for Running the DTC

P0234

- DTC P003A, P0045 - P0048, P0071 - P0074, P00C7, P0106 - P0108, P0116 - P0119, P0128, P02E1, P02E8, P02E9, P111E, P122D, P169E, P169F, P16A0 - P16A2, P16B0 - P16B2, P16FA, P16FC, P2227 - P2230 = Not set
- Ambient Air Temperature = -7 to 55B°C (19 to 131B°F)
- BARO Sensor 1 = 70 to 110 kPa (10.1 to 15.9 PSI)
- Desired Boost Pressure = -18 to 24 kPa (-2.6 to 3.4 PSI) & Stable
- Engine Coolant Temperature = 60 to 117B°C (140 to 243B°F)
- Engine Speed = 1, 800 to 2, 500 RPM
- Ignition Voltage = Greater than 11 V
- Intake Air Flow Valve Position = Greater than 99% - Commanded Off
- Intake Air Flow Valve Position = Greater than 74% - Commanded On

Frequency the DTC runs = Continuously - After the running conditions are met - For greater than 1 s

P0299

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- DTC P003A, P0045 - P0048, P0071 - P0074, P00C7, P0106 - P0108, P0116 - P0119, P0128, P02E1, P02E8, P02E9, P111E, P122D, P169E, P169F, P16FA, P16FC, P2227 - P2230, U0654, U0656 = Not set
- Ambient Air Temperature = -20 to 55B°C (-4 to 131B°F)
- BARO Sensor 1 = 70 to 110 kPa (10.1 to 15.9 PSI)
- Desired Boost Pressure = 80 to 180 kPa (11.6 to 26.1 PSI)
- Engine Coolant Temperature = 50 to 130B°C (122 to 266B°F)
- Engine Speed = 1, 200 to 3, 000 RPM
- Ignition Voltage = Greater than 11 V
- Intake Air Flow Valve Position = Greater than 84% - Commanded Off
- Intake Air Flow Valve Position = Greater than 74% - Commanded On
- Turbocharger Boost Control Command = Stable

Frequency the DTC runs = Continuously - After the running conditions are met - For greater than 1 s

Conditions for Setting the DTC

Boost Pressure = Actual pressure is not equal to the desired pressure - For greater than 10 s

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

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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 P003A, P0045 - P0048, P0071 - P0074, P00C7, P0106 - P0108, P0116 - P0119, P0128, P02E1, P02E8, P02E9, P111E, P122D, P169E, P169F, P16FA, P16FC, P2227 - P2230, U0654, U0656 is

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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 the scan tool parameter: MAP Sensor = The value should be within the range listed in the table: **Altitude Versus Barometric Pressure**
   - **If not in the specified range**

     Refer to **DTC P0106, P0107, or P0108**

   - **Go to next step: If in the specified range**
4. Engine - Idling - At normal operating temperature.
5. Verify the scan tool parameter: MAP Sensor = The value should change with accelerator pedal input.
   - **If the value does not change**

     Refer to **DTC P0106, P0107, or P0108**

   - **Go to next step: If the value changes**
6. Perform the scan tool control function: Turbocharger Vane Position - Increase & Decrease

   Verify the scan tool parameter: Turbocharger Vane Position Sensor = Desired Turbocharger Vane Position

   - **If not the specified state**

     Refer to: Circuit/System Testing

   - **Go to next step: If the specified state**
7. Perform the scan tool control function: Exhaust Gas Recirculation - Closed
8. Verify the scan tool parameter: Induction System Leak Indication = 0.75:1 to 1.25:1 - Stable
   - **If not in the specified range**

     Refer to: Circuit/System Testing

   - **Go to next step: If in the specified range**
9. 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**
10. All OK.

Circuit/System Testing

NOTE: **Circuit/System Verification must be performed before proceeding to Circuit/System Testing.**

1. Verify the conditions listed below do not exist:
   - B65 Intake Manifold Pressure and Air Temperature Sensor
     - Leaking @ O-Ring - Missing / Visible Damage

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        - Restricted - Moisture/Ice
        - Skewed
    - B75C Multifunction Intake Air Sensor - Contamination of the measuring element /Cracked/Loose Clamps / Visible Damage/Water intrusion
    - M103 Turbocharger Vane Position Actuator - Linkage Binding or Sticking/Loose/Worn/Visible Damage
    - Q14 Exhaust Gas Recirculation Valve - Leaking /Restricted/ Visible Damage
    - Q20 Intake Air Flow Valve
        - Coking/Loose Clamps /Visible Damage
        - Restricted - Moisture/Ice
    - Air Cleaner Element - Dirty / Restricted
    - Charge Air Cooler
        - Leaking / Incorrect connection
        - Restricted - Moisture/Ice

          Refer to **Charge Air Cooler Diagnosis (Induction System Smoke Test)** , or **Charge Air Cooler Diagnosis (Full System Air Leak Test)**

    - Engine - Mechanical Condition - Refer to **Symptoms - Engine Mechanical**
    - Exhaust System - Leaking /Restricted/ Visible Damage - Refer to **Symptoms - Engine Exhaust**
    - Intake Air Duct - Cracked / Loose Clamps / Restricted - Collapsed / Visible Damage
    - Intake Manifold - Cracked - Leaking/ Loose Clamps / Restricted /Visible Damage
    - Mechanically damaged turbocharger. - Refer to **Compressor Air Intake Turbocharger Cleaning and Inspection**
    - Positive Crankcase Ventilation System
        - Leaking @ O-Ring - Missing / Visible Damage
        - Restricted - Moisture/Ice
        - Incorrect connection /Leaking / Restricted
    - **If a condition exists**

      Repair or replace as necessary

    - **Go to next step: If no condition is found**
2. Replace the component: Turbocharger

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Compressor Air Intake Turbocharger Replacement**
- For control module replacement, programming, and setup refer to **Control Module References**

DTC P026A

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.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P026A

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Charge Air Cooler (CAC) Low Efficiency

Diagnostic Fault Information

CAC Inlet Temperature Sensor

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P007C, P007E	P007C, P007E	P007D*, P007E*	P007B, P026A
Low Reference	-	P007D*, P007E*	P007D*	P007B, P026A
*Internal ECM or sensor damage may occur if the circuit is shorted to B+.				

CAC Outlet Temperature Sensor

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P10D6, P10D8	P10D7, P10D8	P10D7*, P10D8	P026A, P10D5
Low Reference	-	P10D7, P10D8	P10D7*	P026A, P10D5
*Internal ECM or sensor damage may occur if the circuit is shorted to B+.				

Typical Scan Tool Data

Charge Air Cooler Temperature

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition ON or Engine Running **Parameter Normal Range:** -39 to +1988B°C (-38 to +388B°F)			
Signal	215B°C (419B°F)	-40B°C (-40B°F)	-40B°C (-40B°F)*
Low Reference	-	-40B°C (-40B°F)	-40B°C (-40B°F)*
*Internal ECM or sensor damage may occur if the circuit is shorted to B+.			

Charge Air Cooler Outlet Temperature

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition ON or Engine Running **Parameter Normal Range:** -39 to +1988B°C (-38 to +388B°F)			
Signal	215B°C (419B°F)	-40B°C (-40B°F)	-40B°C (-40B°F)*
Low Reference	-	-40B°C (-40B°F)	-40B°C (-40B°F)*
*Internal ECM or sensor damage may occur if the circuit is shorted to B+.			

Circuit/System Description

The engine control module (ECM) monitors the ambient air temperature, and the charge air temperature before and after the charge air cooler to calculate the efficiency of the charge air cooler (CAC). The charge air cooler systems' function is to reduce the temperature of the induction air charge that is heated by the turbocharger to improve the efficiency and performance of the engine.

The charge air cooler inlet temperature sensor, located at the outlet of the turbocharger, the charge air cooler outlet temperature sensor, located near the intake air flow valve are variable resistors. The ECM supplies 5 V to the signal circuit, and a ground for the sensors' low reference circuits.

Conditions for Running the DTC

- DTCs P00C7, P0071, P0072, P0073, P0074, P007B, P007C, P007D, P007E, P0101, P0102, P0103, P00E9, P00EA, P00EB, P00EC, P0106, P0107, P0108, P0116, P0117, P0118, P0119, P02E8, P02E9, P0502, P0503, P0722, P0723, P10D5, P10D6, P10D7, P10D8, P111E, P122D, P16A0, P16A1, P16A2, P2227, P2228, P2229, or P2230 are not set.

- Vehicle speed is greater than 64 KPH (39 MPH).
- The intake airflow valve position is greater than 85%.
- The engine coolant temperature (ECT) is warmer than 70B°C (+158B°F).
- The mass air flow is between 0.2 and 0.5 gm/s.
- The difference between the CAC inlet air temperature and the ambient air temperature is greater than 36B°C (97B°F).
- Ambient temperature is greater than -7B°C (19B°F).
- The barometric pressure is greater than 69.6 kPa (10.09 PSI).
- This DTC runs continuously when the above conditions exist for greater than 9 s.

Conditions for Setting the DTC

The CAC efficiency is computed as a ratio between CAC inlet temperature - CAC outlet temperature and CAC inlet temperature - ambient air temperature.

The ECM detects that the average temperature reduction ratio of the CAC is less than 25% for greater than 20 s.

Action Taken When the DTC Sets

DTC P026A is a Type B DTC.

Conditions for Clearing the DTC

DTC P026A is a Type B DTC.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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-38522-A Variable Signal Generator

For equivalent regional tools, refer to **Special Tools ((Diagnosis Tools))** .

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Circuit/System Verification

1. Ignition ON.
2. Verify that DTC P00C7, P0071, P0072, P0073, P0074, P007B, P007C, P007D, P007E, P0101, P0102, P0103, P0106, P0107, P0108, P0119, P02E8, P02E9, P0502, P0503, P0722, P0723, P105D, P10D6, P10D7, P10D8, P122D, P16A0, P16A1, P16A2, P2227, P2228, P2229, or P2230 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 Step 3 of this verification procedure only if the ignition has been OFF for 8 hours or more.**
- **The vehicle sitting in direct sun light or having the block heater ON will skew the results.**

WARNING: **Refer to Road Test Warning .**

3. Verify the following scan tool parameters are within 10B°C (18B°F) of each other.
   - Charge Air Cooler Temperature
   - Charge Air Cooler Outlet Temperature
   - Ambient Air Temperature
   - **If not within 10B°C (18B°F)**
   - Refer to **DTC P007C-P007E or P10D6-P10D8** for further diagnosis of the Charge Air Cooler Inlet Temperature Sensor.
   - Refer to **DTC P0071-P0074** for further diagnosis of the Ambient Air Temperature Sensor.
   - **Go to next step: If within 10B°C (18B°F)**
4. Road test the vehicle under various operating conditions.
5. Verify the following scan tool parameters change temperature.
   - Charge Air Cooler Temperature
   - Charge Air Cooler Outlet Temperature
   - **If the temperature does not change**
   - Refer to **DTC P007C-P007E or P10D6-P10D8** for further diagnosis of the Charge Air Cooler Inlet Temperature Sensor.
   - **Go to next step: If the temperature changes**
6. Operate the vehicle within the Conditions for Running the DTC.
7. Verify the scan tool parameter Charge Air Cooler Outlet Temperature is cooler than the scan tool parameter Charge Air Cooler Temperature.
   - **If not cooler**

     Refer to Circuit/System Testing.

   - **Go to next step: If cooler**
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.

   Verify the DTC does not set.

   - **If the DTC sets**

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Refer to Circuit/System Testing.

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

9. All OK.

Circuit/System Testing

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

1. Check the engine cooling system and front of the vehicle to verify that none of the conditions listed below exist:
   - Obstruction of the grille
   - Debris in the radiator, condenser, or CAC fins

     Refer to **Engine Radiator Cleaning** .

   - Bent radiator, condenser, or CAC fins
   - Engine overheating

     Refer to **Engine Overheating** .

   - **If a condition exists**

     Repair or replace as appropriate.

   - **Go to next step: If no condition exists**
2. Replace the Charge Air Cooler.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Charge Air Cooler Replacement**
- **Control Module References** for engine control module replacement, programming, and setup

DTC P026B, P05EC, P0601-P0607, P060A, P060B, P0610, P061C, P062B, P062F, P0630, P064D, P064E, P134C, P160A, P160D, P160E, P161C, P16E9-P16F0, P16F3, P2610, P262B, P264F, P27B5, P30D6-P30DD, P3186, OR P3191

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 P026B

Fuel Injection Timing Performance

DTC P05EC

Cold Start Injection Timing Performance

DTC P0601

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Control Module Read Only Memory Performance

DTC P0602

Control Module Not Programmed

DTC P0603

Control Module Long Term Memory Reset

DTC P0604

Control Module Random Access Memory Performance

DTC P0605

Control Module Programming Read Only Memory Performance

DTC P0606

Control Module Processor Performance

DTC P0607

Control Module Performance

DTC P060A

Control Module Monitoring Processor Performance

DTC P060B

Control Module Analog to Digital Converter Performance

DTC P0610

Control Module Vehicle Options Incorrect

DTC P061C

Control Module Engine Speed System Circuitry Performance

DTC P062B

Control Module Fuel Injector Control Performance

DTC P062F

Control Module Long Term Memory Performance

DTC P0630

VIN Not Programmed or Mismatched - Engine/Powertrain Control Module

DTC P064D

Control Module Heated Oxygen Sensor System Circuitry Performance

DTC P064E

Control Module Heated Oxygen Sensor System Circuitry Performance Bank 2

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DTC P134C

Internal Control Module Torque Algorithm Performance

DTC P160A

Vehicle Speed Limit Not Programmed

DTC P160D

Incorrect Engine Calibration Detected

DTC P160E

Engine Calibration Monitoring Not Programmed

DTC P161C

Tire Size Not Programmed

DTC P16E9

Control Module Serial Peripheral Interface Bus 2

DTC P16EA

Control Module Serial Peripheral Interface Bus 3

DTC P16EB

Control Module Serial Peripheral Interface Bus 4

DTC P16EC

Control Module Serial Peripheral Interface Bus 5

DTC P16EE

Control Module Serial Peripheral Interface Bus 6

DTC P16EF

Control Module Serial Peripheral Interface Bus 7

DTC P16F0

Control Module Serial Peripheral Interface Bus 8

DTC P16F3

Control Module Redundant Memory Performance

DTC P2610

Control Module Ignition Off Timer Performance

DTC P262B

Control Module Power Off Timer Performance

DTC P264F

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Engine Serial Number Not Programmed

DTC P27B5

Control Module Transmission Gear Ratio Control Performance

DTC P30D6

Control Module Processor Serial Peripheral Interface Bus

DTC P30D7

Control Module Processor Serial Peripheral Interface Bus 2

DTC P30D8

Control Module Processor Serial Peripheral Interface Bus 3

DTC P30D9

Control Module Processor Serial Peripheral Interface Bus 4

DTC P30DA

Control Module Processor Serial Peripheral Interface Bus 5

DTC P30DB

Control Module Processor Serial Peripheral Interface Bus 6

DTC P30DC

Control Module Processor Serial Peripheral Interface Bus 7

DTC P30DD

Control Module Processor Serial Peripheral Interface Bus 8

DTC P3186

Control Module Security Peripheral Hardware Performance

DTC P3191

Internal Control Module Fuel Pressure Performance

Circuit/System Description

These DTCs apply to microprocessor integrity conditions within the engine control module. This diagnostic also checks if the ECM is programmed.

Conditions for Running the DTC

P026B, P05EC, P16F3

- DTC P0101, P0102, P0103, P0106, P0107, P0108, P2227, P2228, P2229, P2230 = Not set
- Engine Speed = Greater than 680 RPM
- Frequency the DTC runs = Continuously - After the running conditions are met

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P0601, P0602, P0604, P0605, P0607, P060A, P060B, P0610, P061C, P0630, P160A, P160D, P160E, P161C, P264F, P3191

- Ignition = On
- Frequency the DTC runs = Continuously - After the running conditions are met

P0603, P062F

- Ignition = On
- Frequency the DTC runs = Once - Per drive cycle - After the running conditions are met

P0606, P062B, P16E9-P16F0, P30D6-P30DD

- Run/Crank = Greater than 11 V
- Frequency the DTC runs = Continuously - After the running conditions are met

P064D, P064E, P134C, P27B5

- Battery Voltage = Greater than 11 V
- Engine = Running - Greater than 3 min

P2610, P262B

- Run/Crank = Inactive
- Frequency the DTC runs = Once - After ignition Off - After the running conditions are met - For 20 s

Conditions for Setting the DTC

Control Module = Internal Malfunction or System Programming Malfunctions

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type A DTC - Exceptions listed below

- DTC P026B, P05EC, P064D, P064E, P2610, P262B = Type B DTC
- DTC P3191 = Type C DTC

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type A DTC - Exceptions listed below

- DTC P026B, P05EC, P064D, P064E, P2610, P262B = Type B DTC
- DTC P3191 = Type C DTC

Diagnostic Aids

A weak battery, low component/system voltage, or poor connections may cause this DTC to set.

Reference Information

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **Component Connector End Views - Index**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**

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- **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 P0602, P0630, P160A, P160D, P160E, P161C, P264F is not set.
    - **If the DTC is set**
    1. Perform all necessary programming and setup procedures for the control module: K20 Engine Control Module
    2. Verify the DTC does not set.
        - If the DTC sets - Replace the component: K20 Engine Control Module
        - Go to next step: If the DTC does not set
    3. All OK.
    - **Go to next step: If the DTC is not set**
3. Verify DTC P026B, P05EC, P0605, P0607, P060A, P060B, P0610, P061C, P064D, P064E, P134C, P2610, P27B5, P3191 is not set.
    - **If the DTC is set**

      Replace the component: K20 Engine Control Module

    - **Go to next step: If the DTC is not set**
4. Verify DTC P0685 - P0690, P1682, P16A7, P16AF, P16B3, P16BC, P16BD, P16BF is not set.
    - **If the DTC is set**

      Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**

    - **Go to next step: If the DTC is not set**
5. Verify DTC P0601, P0603, P0604, P0606, P062B, P062F, P16F3, P16E9-P16F0, P262B, P30D6-P30DD is not set.
    - **If the DTC is set**
    1. Ignition - On / Vehicle - In Service Mode
    2. Verify the scan tool parameter: Battery Voltage = The value should not spike or drop out.

       Perform the action while monitoring the parameter:

        - Wiggle the harness and connector: K20 Engine Control Module
        - Wiggle the harness and connector: X50A Fuse Block - Underhood
        - If the value spikes or drops out - Repair as necessary - B+ circuit or Ground
        - If the value does not spike or drop out - Replace the component: K20 Engine Control Module
    - **Go to next step: If the DTC is not set**
6. All OK.

Repair Instructions

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Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

For control module replacement, programming, and setup refer to **Control Module References**

DTC P026C OR P026D

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 P026C

Injection Quantity Too Low

DTC P026D

Injection Quantity Too High

Circuit/System Description

For an overview of the component/system, refer to:

- **Exhaust Aftertreatment System Description**
- **Fuel System Description**

Component	Description
B195 Nitrogen Oxides Sensor	NOx sensors work similar to wide-band O2 sensors. The sensors consist of two measuring cells. In the first cell, an electric pump current is used to separate out the oxygen in the exhaust. The NOx remains and is conveyed into the second chamber. Here a second pump current decomposes the NOx into nitrogen and oxygen. The oxygen concentration is measured and from there the NOx concentration can be calculated.
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.
Q17 Fuel Injector	Fuel injectors are solenoid valves that inject fuel either into the intake system or directly into the cylinder. The amount of fuel injected depends on the length of the electrical pulse that is applied.

Conditions for Running the DTC

- Ambient Air Temperature = Warmer than -7B°C (19B°F)
- BARO Sensor 2 = Greater than 67 kPa (9.7 PSI)
- Battery Voltage = Greater than 11 V
- Engine = Running
- Engine Coolant Temperature = Greater than 69B°C (156B°F)
- Engine Speed = 400 to 1200 RPM
- Fuel level = Greater than 10%

- NOx Sensor 1 Heater Operation = Allowed
- PTO = Inactive - If equipped
- Transmission = In Gear
- Vehicle Speed = Less than 3 km/h (2 MPH)

Frequency the DTC runs = Once - Per drive cycle - After the running conditions are met - For greater than 10 s

Conditions for Setting the DTC

P026C

Fuel Injection Quantity = Less than a predefined threshold - For greater than 10 s

P026D

Fuel Injection Quantity = Greater than a predefined threshold - For greater than 10 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

Diagnostic Aids

- A malfunction in the following components may also cause DTC P026C, P026D to set:
  - B75C Multifunction Intake Air Sensor
  - B195A Nitrogen Oxides Sensor 1
  - Q14 Exhaust Gas Recirculation Valve
- B74 Manifold Absolute Pressure Sensor - Flow Restricted
- Q14 Exhaust Gas Recirculation Valve - Binding or Sticking
- Modifications to the intake air systems may cause this DTC to set.
- Fuel - Contamination

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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

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Scan Tool Reference

Control Module References

Circuit/System Verification

1. Verify there are no DTCs set related to the following component/system:
    - B9 Ambient Air Temperature Sensor
    - B14A Transmission Output Shaft Speed Sensor
    - B26 Crankshaft Position Sensor
    - B34 Engine Coolant Temperature Sensor
    - B115 Vehicle Speed Sensor
    - Exhaust Aftertreatment System
    - Fuel System
    - Induction System
    - **If a related DTC is set**

      Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**

    - **Go to next step: If a related DTC is not set**
2. Ignition - On / Vehicle - In Service Mode
3. Verify the scan tool parameter: MAF Sensor = 0 to 0.2 g/s
    - **If not between 0 and 0.2 g/s**

      Refer to **DTC P0101-P0103**

    - **Go to next step: If between 0 and 0.2 g/s**
4. Engine - Running
5. Verify the scan tool parameter: MAF Sensor = 5 to 40 g/s
    - **If not between 5 and 40 g/s**
    1. Verify the following conditions do not exist:
        - B75 Mass Air Flow Sensor - Contamination of the measuring element/Water intrusion
        - Intake Air Duct - Cracked/Leaking/Loose Clamps/Restrictions/Visible Damage
        - If a condition exists - Repair or replace as necessary
        - If no condition exists - Refer to **Diesel Particulate Filter (DPF) Service Regeneration**
    - **Go to next step: If between 5 and 40 g/s**
6. Verify the following conditions do not exist:
    - B74 Manifold Absolute Pressure Sensor - Flow Restricted
    - Q14 Exhaust Gas Recirculation Valve - Binding or Sticking
    - **If a condition exists**

      Repair or replace as necessary

    - **Go to next step: If no condition exists**
7. Verify a condition does not exist with the component: Exhaust System - Leaking/Missing components/Restricted - Refer to **Exhaust Leakage**
    - **If a condition exists**

      Repair or replace as necessary

    - **Go to next step: If no condition exists**

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8. Perform the following procedure/test: **Cylinder Power Balance Test**

   Verify the procedure/test passes.

   - **If the procedure/test does not pass**

     Replace the component that failed the test: Q17 Fuel Injector

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

9. Test or replace the component: B195A Nitrogen Oxides Sensor 1

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Fuel Injector Replacement (Cylinder #1, #2, #3)** , or **Fuel Injector Replacement (Cylinder #4)**
- **Nitrogen Oxides Sensor Replacement - Position 1**

DTC P02CC-P02D3

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 P02CC

Cylinder 1 Injector Exceeded Minimum Learning Limit

DTC P02CD

Cylinder 1 Injector Exceeded Maximum Learning Limit

DTC P02CE

Cylinder 2 Injector Exceeded Minimum Learning Limit

DTC P02CF

Cylinder 2 Injector Exceeded Maximum Learning Limit

DTC P02D0

Cylinder 3 Injector Exceeded Minimum Learning Limit

DTC P02D1

Cylinder 3 Injector Exceeded Maximum Learning Limit

DTC P02D2

Cylinder 4 Injector Exceeded Minimum Learning Limit

DTC P02D3

Cylinder 4 Injector Exceeded Maximum Learning Limit

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Circuit/System Description

For an overview of the component/system, refer to **Fuel System Description**

Circuit	Description
Control - Terminal 1	The output circuit is switched to 50 V to activate the component.
Control - Terminal 2	The output circuit is switched to ground to activate the component.

Component	Description
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.
Q17 Fuel Injector	Fuel injectors are solenoid valves that inject fuel either into the intake system or directly into the cylinder. The amount of fuel injected depends on the length of the electrical pulse that is applied.

The engine control module calculates the injected fuel quantity in two different ways:

- Fuel quantity based on the time the injector was turned on.
- Fuel quantity based on the increase in crankshaft speed when a specific cylinder fires.

Conditions for Running the DTC

- Accelerator Pedal Position = Less than 0.05%
- Engine Coolant Temperature = 68 to 126B°C (154 to 259B°F)
- Engine Speed = 1200 to 2100 RPM
- Engine = Running
- Exhaust Brake = OFF
- Deceleration Fuel Cut-Off = Active
- Fuel Temperature = 0 to 70B°C (32 to 190B°F)
- Transmission gear allowed = Gear 3, 4, 5, 6
- Vehicle Speed = Greater than 0 km/h (0 MPH)
- 4WD Low = Disabled

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

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

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Engine Controls Wiring Schematics

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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

Special Tools

- <special tool><special tool-no>CH-51450-A</special tool-no><special tool-desc> Oscilloscope Diagnostic Kit</special tool-desc></special tool>
- <special tool><special tool-no>CH-51450-LEAD-A</special tool-no><special tool-desc> Oscilloscope Basic Lead Kit</special tool-desc></special tool>

Equivalent regional tools: **Special Tools ((Diagnosis Tools))**

Circuit/System Verification

1. Ignition - On / Vehicle - In Service Mode
2. Verify there are no DTCs set related to the following component/system:
    - Cooling System
    - Exhaust Gas Recirculation System
    - Fuel System
    - Ignition System
    - Induction System
    - Vehicle Speed Sensor
    - If a related DTC is set

      Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**

    - Go to next step: If a related 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 is not set**
5. All OK.

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Circuit/System Testing

1. Ignition/Vehicle - Off
2. Disconnect the appropriate electrical connector: Q17 Fuel Injector
3. Ignition - On / Vehicle - In Service Mode
4. Test for 4.5 to 6.5 V between the test points: Control circuit terminal 1 & Ground
    - **If not between 4.5 and 6.5 V**

      Refer to **DTC P0201-P0204, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P1248, P1249, P124A, P124B, P2147, P2148, P2150, or P2151**

    - **Go to next step: If between 4.5 and 6.5 V**
5. Test for 0.60 to 0.80 V between the test points: Control circuit terminal 2 @ Component harness & Ground
    - **If not between 0.60 and 0.80 V**

      Refer to **DTC P0201-P0204, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P1248, P1249, P124A, P124B, P2147, P2148, P2150, or P2151**

    - **Go to next step: If between 0.60 and 0.80 V**
6. Verify a condition does not exist with the component: Q17 Fuel Injector - Refer to: Component Testing
    - **If a condition exists**

      Replace the component: Q17 Fuel Injector

    - **Go to next step: If no condition exists**
7. Verify the tool is available:<special tool><special tool-no>CH-51450-A</special tool-no><special tool-desc> Oscilloscope Diagnostic Kit</special tool-desc></special tool> & <special tool><special tool-no>CH-51450-LEAD-A</special tool-no><special tool-desc> Oscilloscope Basic Lead Kit</special tool-desc></special tool>
    - **If the tool is not available**
    1. Perform the following procedure/test: **Engine Compression Test**

       Verify the procedure/test passes.

        - If the procedure/test does not pass. Refer to **Symptoms - Engine Mechanical**
        - Go to next step: If the procedure/test passes
    2. Test or replace the component: Q17 Fuel Injector
    - **Go to next step: If the tool is available**
8. Perform the following procedure/test: **Relative Engine Compression Test**

   Verify the procedure/test passes.

    - **If the procedure/test does not pass**

      Refer to **Symptoms - Engine Mechanical**

    - **Go to next step: If the procedure/test passes**
9. Test or replace the component: Q17 Fuel Injector

Component Testing

1. Ignition/Vehicle - Off
2. Disconnect the appropriate electrical connector: Q17 Fuel Injector

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NOTE: **The specified resistances are valid for components at room temperature.**

3. Test for 0.2 to 1.5 ohms between the test points: Control terminal 1 & Control terminal 2
   - **If not between 0.2 and 1.5 ohms**

     Replace the component: Q17 Fuel Injector

   - **Go to next step: If between 0.2 and 1.5 ohms**
4. Test for infinite resistance between the test points: Each terminal of the component & The component's housing
   - **If less than infinite resistance**

     Replace the component: Q17 Fuel Injector

   - **Go to next step: If infinite resistance**
5. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Fuel Injector Replacement (Cylinder #1, #2, #3)** , or **Fuel Injector Replacement (Cylinder #4)**
- For control module replacement, programming, and setup refer to **Control Module References**

DTC P02E0, P02E2, P02E3, P02EB, P122B, P122C, OR P1425

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 P02E0

Intake Air Flow Valve Control Circuit

DTC P02E2

Intake Air Flow Valve Control Circuit Low Voltage

DTC P02E3

Intake Air Flow Valve Control Circuit High Voltage

DTC P02EB

Intake Air Flow Valve Control Motor Current Performance

DTC P122B

Intake Air Flow Valve Control Supply Voltage Circuit

DTC P122C

Intake Air Flow Valve Control Circuit Shorted

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DTC P1425

Intake Air Flow Valve Control Motor Overtemperature

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Control - Terminal 1	P122C	P02E0	P122C, P122D	P02E1, P1425
Control - Terminal 2	P122C	P02E0	P122C, P122D	P02E1, P1425

Circuit/System Description

For an overview of the component/system, refer to **Intake Airflow Valve System Description**

Circuit	Description
Control - Terminal 1	The output circuit is switched from ground to 12 V to activate the component. The output is PWM controlled.
Control - Terminal 2	The output circuit is switched from ground to 12 V to activate the component. 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.
Q20 Intake Air Flow Valve	The intake air flow valve of diesel engines reduces the intake air flow rate in part load operation so that a higher exhaust gas recirculation rate can be achieved.

Conditions for Running the DTC

- DTC P02E8, P02E9, P0651, P16A0 - P16A2 = Not set
- Ignition = On or Engine = Running
- Engine Cranking
- Ignition Voltage = Greater than 11 V
- Intake Air Flow Valve Motor Command = On and Off

Frequency the DTC runs = Continuously - After the running conditions are met - For greater than 2 s

Conditions for Setting the DTC

P02E0

Control Circuit = The control module detects an open circuit. - For greater than 1 s

P02E2

Control Circuit = The control module detects a short to ground. - For greater than 1 s

P02E3

Control Circuit = The control module detects a short to voltage. - For greater than 1 s

P02EB

Control Circuit = Greater than 5.5 A - For greater than 1 s

P122B

Control Circuit System Voltage Out of Range = Less than 6 V - For greater than 1 s

P122C

Control Circuit = The control module detects a short circuit in the wiring harness. - For greater than 1 s

P1425

Control Circuit = Component or System Overtemperature - For greater than 1 s

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type A DTC - Additional actions taken:

- Reduced Engine Power = Active
- P16 Instrument Cluster = Reduced Engine Power

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 the DTC to set.
- A weak battery may cause this DTC to set.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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

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1. Engine at Idle
2. Verify the scan tool parameter:
    - Intake Air Flow Valve Control Circuit Open Test Status = OK or Not Run
    - Intake Air Flow Valve Control Circuit Low Voltage Test Status = OK or Not Run
    - Intake Air Flow Valve Control Circuit High Voltage Test Status = OK or Not Run
    - Intake Air Flow Valve Control Circuit Shorted Test Status = OK or Not Run
    - **If not the specified state**

      Refer to: Circuit/System Testing

    - **Go to next step: If the specified state**
3. Clear the DTCs.
4. Ignition Off - For greater than 1 min
5. Ignition - On / Vehicle - In Service Mode
6. Verify DTC P02E0, P02E2, P02E3, P02EB, P122B, P122C, P1425 is not set.
    - **If the DTC sets**

      Refer to: Circuit/System Testing

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

Circuit/System Testing

1. Ignition/Vehicle - Off
2. Verify the following conditions do not exist: Blade @ Q20 Intake Air Flow Valve

   WARNING: **Turn OFF the ignition before inserting fingers into the throttle bore. Unexpected movement of the throttle blade could cause personal injury.**

    - Binding or Sticking @ Open/Close - Position
    - Closed @ Engine Off
    - Coking/Debris / Dirty / Visible Damage
    - Open/Close - Without spring pressure
    - **If a condition exists**

      Replace the component: Q20 Intake Air Flow Valve

    - **Go to next step: If no condition exists**

NOTE: **Disconnecting the component electrical connector causes additional DTCs to set.**

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3. Disconnect the electrical connector: Q20 Intake Air Flow Valve
4. Ignition - On / Vehicle - In Service Mode
5. Test for 1.5 to 2.5 V between the test points: Control circuit terminal 1 & Ground
    - **If less than 1.5 V**
    1. Ignition/Vehicle - Off
    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.
        - Go to next step: If infinite resistance
    4. Test for infinite resistance between the test points: Control circuit terminal 1 & Control circuit terminal 2
        - If less than infinite resistance - Repair the short between the circuits.
        - Go to next step: If infinite resistance
    5. Test for less than 2 ohms between the test points: Control 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 2.5 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: 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 between 1.5 and 2.5 V**
6. Verify a test lamp does not turn On between the test points: Control circuit terminal 2 & 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**
7. Verify a test lamp does not turn On between the test points: Control circuit terminal 2 & Ground
    - **If the test lamp turns On**
    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 2 @ 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 test lamp does not turn On**
8. Test for 1.5 to 2.5 V between the test points: Control circuit terminal 1 & Control circuit terminal 2

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- **If not between 1.5 and 2.5 V**

1. Ignition/Vehicle - Off
2. Disconnect the electrical connector: X2 @ K20 Engine Control Module
3. Test for less than 2 ohms between the test points: Control 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 between 1.5 and 2.5 V**

9. Test or replace the component: Q20 Intake Air Flow Valve

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Throttle Body Assembly Replacement** - Q20 Intake Air Flow Valve
- For the system learn/reset procedure refer to **Control Module References**
- For control module replacement, programming, and setup refer to **Control Module References**

DTC P02E1, P02E4, OR P02E5

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 P02E1

Intake Air Flow Valve Control Performance

DTC P02E4

Intake Air Flow Valve Stuck Open

DTC P02E5

Intake Air Flow Valve Stuck Closed

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Control - Terminal 1	P122C	P02E0	P122C, P122D	P1425
Control - Terminal 2	P122C	P02E0	P122C, P122D	P1425

Circuit/System Description

For an overview of the component/system, refer to **Intake Airflow Valve System Description**

Circuit	Description
Control - Terminal 1	The output circuit is switched from ground to 12 V to activate the component. The output is PWM controlled.

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Circuit	Description
Control - Terminal 2	The output circuit is switched from ground to 12 V to activate the component. 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.
Q20 Intake Air Flow Valve	The intake air flow valve of diesel engines reduces the intake air flow rate in part load operation so that a higher exhaust gas recirculation rate can be achieved.

Conditions for Running the DTC

- DTC P02E8, P02E9, P0651, P16A0 - P16A2 = Not set
- Ignition = On or Engine = Running
- Ignition Voltage = Greater than 5 V

Frequency the DTC runs = Continuously - After the running conditions are met - For greater than 2 s

Conditions for Setting the DTC

P02E1

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

P02E4

Actual & Desired Intake Air Flow Valve Position Not within 16% of each other - Commanded duty cycle = Less than 34%

P02E5

Actual & Desired Intake Air Flow Valve Position Not within 16% of each other - Commanded duty cycle = Greater than 34%

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type A DTC

- Reduced Engine Power = Active
- P16 Instrument Cluster = Reduced Engine Power
- 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 the DTC to set.
- A weak battery may cause this DTC to set.

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- Inspect for a condition in which the throttle blade may have been held open. For example, ice may have formed in the throttle bore causing the throttle blade not to close.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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 P02E8, P02E9, P16A0-P16A2 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. Engine at Idle Verify the scan tool parameter:
    - Intake Air Flow Valve Control Circuit Open Test Status = OK or Not Run
    - Intake Air Flow Valve Control Circuit Low Voltage Test Status = OK or Not Run
    - Intake Air Flow Valve Control Circuit High Voltage Test Status = OK or Not Run
    - Intake Air Flow Valve Control Circuit Shorted 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. Clear the DTCs.
5. Ignition Off - For greater than 1 min
6. Ignition - On / Vehicle - In Service Mode
7. Verify DTC P02E1, P02E4, P02E5 is not set.
    - **If the DTC sets**

      Refer to: Circuit/System Testing

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

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.

   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**

9. All OK.

Circuit/System Testing

1. Ignition/Vehicle - Off
2. Verify a condition does not exist with the component: Blade @ Q20 Intake Air Flow Valve

   WARNING: **Turn OFF the ignition before inserting fingers into the throttle bore. Unexpected movement of the throttle blade could cause personal injury.**

   - Binding or Sticking @ Open/Close - Position
   - Closed @ Engine Off
   - Coking/Debris/Dirty/Ice/Visible Damage
   - Open/Close - Without spring pressure
   - **If a condition exists**

     Replace the component: Q20 Intake Air Flow Valve

   - **Go to next step: If no condition exists**

   NOTE: **Disconnecting the component electrical connector causes additional DTCs to set.**

3. Disconnect the electrical connector: Q20 Intake Air Flow Valve
4. Ignition - On / Vehicle - In Service Mode
5. Test for 1.5 to 2.5 V between the test points: Control circuit terminal 1 & Ground
   - **If less than 1.5 V**
   1. Ignition/Vehicle - Off
   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.
      - Go to next step: If infinite resistance
   4. Test for infinite resistance between the test points: Control circuit terminal 1 & Control circuit terminal 2
      - If less than infinite resistance - Repair the short between the circuits.
      - Go to next step: If infinite resistance
   5. Test for less than 2 ohms between the test points: Control 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.

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- If less than 2 ohms - Replace the component: K20 Engine Control Module

- **If greater than 2.5 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: 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 between 1.5 and 2.5 V**

6. Verify a test lamp does not turn On between the test points: Control circuit terminal 2 & 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**
7. Verify a test lamp does not turn On between the test points: Control circuit terminal 2 & Ground
    - **If the test lamp turns On**
    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 2 @ 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 test lamp does not turn On**
8. Test for 1.5 to 2.5 V between the test points: Control circuit terminal 1 & Control circuit terminal 2
    - **If not between 1.5 and 2.5 V**
    1. Ignition/Vehicle - Off
    2. Disconnect the electrical connector: X2 @ K20 Engine Control Module
    3. Test for less than 2 ohms between the test points: Control 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 between 1.5 and 2.5 V**
9. Test or replace the component: Q20 Intake Air Flow Valve

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Throttle Body Assembly Replacement** - Q20 Intake Air Flow Valve
- For the system learn/reset procedure refer to **Control Module References**
- For control module replacement, programming, and setup refer to **Control Module References**

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DTC P02E8, P02E9, OR U0654

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 P02E8

Intake Air Flow Valve Position Sensor Circuit Low Voltage

DTC P02E9

Intake Air Flow Valve Position Sensor Circuit High Voltage

DTC U0654

Lost Communication with Intake Air Flow Valve Position Sensor

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P0651*	U0654	P0651*	-
Serial Data	U0654, P02E8	U0654	U0654, P02E9	U0654
Low Reference	-	U0654	-	-
*Additional DTCs may set.				

Typical Scan Tool Data

Intake Air Flow Valve Position Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: • Engine = Running • Accessories = Off **Parameter Normal Range:** 3.75 to 4.75 V			
5 V Reference	5.0 V	5.0 V	5.0 V
Serial Data	0.0 V	0.0 V	5.0 V
Low Reference	-	0.0 V	-

Circuit/System Description

For an overview of the component/system, refer to **Intake Airflow Valve System Description**

Circuit	Description
5 V Reference	Regulated voltage supplied by the control module.
Serial Data	The control module input circuit has an internal resistance connected to 5 V. Digitally encoded information for communication between devices.

Circuit	Description
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.
Q20 Intake Air Flow Valve	The assembly has several functions: • The valve is actuated by a 12 V DC motor. A spring is used to keep the valve in the open position. The valve actuator motor moves the valve in the closed direction. The more current flows through the motor, the more the valve closes. • The component Q20 contains a contactless inductive position sensor. A fixed transmitter coil excites a movable rotor, which in turn induces a current in a fixed receiver coil. The current varies with the angle of the rotor. Electronics inside the sensor convert the current into digital data which is transmitted via a serial data circuit to the control module K20.

Conditions for Running the DTC

P02E8, P02E9

- DTC U0654 = Not set
- Ignition = On or Engine = Running
- Ignition Voltage = Greater than 11 V
- Starter Relay Command = Off

Frequency the DTC runs = Continuously - After the running conditions are met

U0654

- Ignition Voltage = Greater than 11 V
- Starter Relay Command = Off

Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

P02E8

Serial Data circuit = Less than 0.5 V - For greater than 3 s

P02E9

Serial Data circuit = Greater than 4.6 V - For greater than 3 s

U0654

Serial Data circuit = Message Counter Incorrect/Too Many Pulses/Too Few Pulses - For greater than 3 s

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Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type A DTC

- Reduced Engine Power = Active
- P16 Instrument Cluster = Reduced Engine Power
- Warning Message = Service Emission System/Service Exhaust Fluid System

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 the DTC to set.
- A weak battery may cause this DTC to set.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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 P0651 is not set.
    - **If the DTC is set**

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

    - **Go to next step: If the DTC is not set**
3. Verify DTC P02E8, P02E9, U0654 is not set.
    - **If only DTC P02E8, P02E9 is set**

      Replace the component: Q20 Intake Air Flow Valve

    - **If DTC U0654 and one or more of the DTCs P02E8, P02E9 is set**

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Refer to: Circuit/System Testing

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

4. Perform the scan tool control function: Intake Air Flow Valve Position - Increase & Decrease

   Verify the scan tool parameter: Intake Air Flow Valve Position = Desired Intake Air Flow Valve Position

   - **If not the specified state**

     Refer to: Circuit/System Testing

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

5. Perform the action while monitoring the parameter: Intake Air Flow Valve Position Sensor
   - Wiggle the harness and connector: Q20 Intake Air Flow Valve - The value should not spike or drop out.
   - Wiggle the harness and connector: K20 Engine Control Module - The value should not spike or drop out.
   - **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**

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.

   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:

- **Disconnecting the component electrical connector causes additional DTCs to set.**
- **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: Q20 Intake Air Flow Valve
3. Test for less than 5 ohms between the test points: Low Reference circuit terminal 4 & Ground
   - **If 5 ohms or greater**
   1. Disconnect the appropriate electrical connector: K20 Engine Control Module
   2. Test for less than 2 ohms between the test points: Low Reference circuit terminal 4 @ 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

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5. Test for 4.8 to 5.2 V between the test points: 5 V Reference circuit terminal 5 & Low Reference circuit terminal 4
    - **If less than 4.8 V**
    1. Ignition/Vehicle - Off
    2. Disconnect the appropriate electrical connector: K20 Engine Control Module
    3. Test for infinite resistance between the test points: 5 V Reference circuit terminal 5 @ Component harness & Ground
        - If less than infinite resistance - Repair the short to ground on the circuit.
        - Go to next step: If infinite resistance
    4. Test for less than 2 ohms between the test points: 5 V 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
    - **If greater than 5.2 V**
    1. Ignition/Vehicle - Off
    2. Disconnect the appropriate 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 5 @ 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. Test for 4.8 to 5.2 V between the test points: Serial Data circuit terminal 3 @ Component harness & Ground
    - **If less than 4.8 V**
    1. Ignition/Vehicle - Off
    2. Disconnect the appropriate electrical connector: K20 Engine Control Module
    3. Test for infinite resistance between the test points: Serial Data circuit terminal 3 @ Component harness & Ground
        - If less than infinite resistance - Repair the short to ground on the circuit.
        - Go to next step: If infinite resistance
    4. Test for less than 2 ohms between the test points: Serial Data 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 appropriate electrical connector: K20 Engine Control Module
    3. Ignition - On / Vehicle - In Service Mode
    4. Test for less than 1 V between the test points: Serial Data circuit terminal 3 @ Component harness & Ground
        - If 1 V or greater - Repair the short to voltage on the circuit.
        - Go to next step: If less than 1 V - Replace the component: K20 Engine Control Module
    - **Go to next step: If between 4.8 and 5.2 V**
7. Test or replace the component: Q20 Intake Air Flow Valve

Repair Instructions

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Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Throttle Body Assembly Replacement** - Q20 Intake Air Flow Valve
- For control module replacement, programming, and setup refer to **Control Module References**

Additional Procedures

BARO Sensor Reset - Perform only when the following component/system is replaced or serviced: K20 Engine Control Module

> **NOTE:** **The DTC causing the Driver Information Center message/speed limitation to set must run and pass before the message/speed limitation will clear. This may require driving the vehicle.**

1. Ignition - On / Vehicle - In Service Mode
2. Verify that all scan tool Event Data parameters under the following data list displays No: Exhaust Gas Recirculation System Malfunction Warning Event Data
   - **If not the specified state**

     Operate the vehicle within the Conditions for Running the DTC for the Event Data parameter that displays Yes.

   - **Go to next step: If the specified state**
3. All OK.

DTC P0300-P0304

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 P0300

Engine Misfire Detected

DTC P0301

Cylinder 1 Misfire Detected

DTC P0302

Cylinder 2 Misfire Detected

DTC P0303

Cylinder 3 Misfire Detected

DTC P0304

Cylinder 4 Misfire Detected

Circuit/System Description

For an overview of the component/system, refer to **Fuel System Description**

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A misfiring cylinder causes slight variations in the rotational speed of the crankshaft. The engine control module (ECM) is able to detect these variations by closely monitoring the crankshaft position sensor signal. The signals of the camshaft position sensors are used to determine which cylinder is misfiring. If the ECM detects a misfire rate sufficient to cause emission levels to exceed mandated standards, a misfire DTC will set.

Conditions for Running the DTC

- DTC P0016, P00C7, P0101 - P0103, P0106 - P0108, P0111 - P0114, P0117 - P0119, P0128, P0191 - P0193, P0335, P0336, P0340, P0341, P0601, P0604, P0606, P0641, P0651, P0697, P06A3, P122B - P122D, P16A0, P16A1, P16A2, P16F3, P2122, P2123, P2127, P2128, P2138, P2227 - P2230, P227B - P227E = Not set
- Crankshaft Position Sensor & Camshaft Position Sensor = Synchronized
- Engine Coolant Temperature = -9 to 131B°C (16 to 268B°F)
- Engine Load = 0%
- Engine Speed = Greater than 1, 000 RPM - DTC P0315 is set.
- Engine Speed = 450 to 3, 200 RPM
- Fuel Cut-Off System = Inactive
- Fuel Level = Greater than 11%
- Rough Road Signal = Not Detected
- System Voltage = 9 to 32 V

Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

The control module K20 detects a crankshaft rotation speed variation indicating a single cylinder misfire rate sufficient to cause emissions levels to exceed mandated standards.

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

Diagnostic Aids

- High resistance in the circuits of the component may set DTC P0300 without setting the DTC for the component: Q17 Fuel Injector
- If the condition is intermittent, wiggle the related wiring harnesses and connectors, with the ignition/vehicle on or engine running, while monitoring the scan tool circuit status parameters for the component. The parameters will display if there is a condition with the circuit or a connection.
- The following conditions could cause DTC P0300 to set:
  - Accessory drive bracket - Defective/Loose/Visible Damage
  - Belt Driven Device - Defective/Loose/Visible Damage
  - Brake Rotor - Excessive runout
  - Component Malfunction - Transmission
  - Drive Belt - Defective/Loose/Visible Damage
  - Drive Shaft - Excessive runout
  - During certain road conditions: Rough
- Tire and wheel assemblies which exhibit excessive runout can produce vibrations even if the assemblies are balanced.

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Reference Information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References

Circuit/System Verification

1. Engine - Idling
2. Verify there is no abnormal noise from the component: Engine
   - **If an abnormal noise is present**

     Refer to **Symptoms - Engine Mechanical**

   - **Go to next step: If no abnormal noise is present**
3. Perform the scan tool learn/reset function: **Crankshaft Position Variation Learn**
4. Verify there are no DTCs set related to the following component/system:
   - B23 Camshaft Position Sensor
   - B26 Crankshaft Position Sensor
   - E12 Glow Plug
   - Q17 Fuel Injector
   - Fuel System
   - Mechanical Condition
   - **If a related DTC is set**

     Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**

   - **Go to next step: If a related DTC is not set**
5. Verify the scan tool parameter: Cylinder 1 - 4 Current Misfire Counter = Does not Increment
   - **If the parameter value increments**

     Refer to: Circuit/System Testing

   - **Go to next step: If the parameter value does not increment**

   NOTE: **The scan tool control function disables the following component(s) for 30 s when activated: Q17 Fuel Injector**

6. Perform the scan tool control function: Cylinder Power Balance - Enable

   Verify the sound of the engine changes the same way when turning off each individual injector.

   - **If the engine sound does not change the same way for one or more cylinders**

     Refer to: Circuit/System Testing

   - **Go to next step: If the engine sound changes the same way for all cylinders**
7. Verify the scan tool parameter: Cylinder 1 - 4 Current Misfire Counter = Does not Increment

   Perform the action while monitoring the parameter:

   - Wiggle the harness and connector: K20 Engine Control Module

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- Wiggle the harness and connector: Q17 Fuel Injector
- **If the parameter value increments**

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

- **Go to next step: If the parameter value does not increment**

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.

   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**

9. All OK.

Circuit/System Testing

1. Ignition/Vehicle - Off
2. Verify the tool is available:<special tool><special tool-no>CH-51450-A</special tool-no><special tool-desc> Oscilloscope Diagnostic Kit</special tool-desc></special tool> & <special tool><special tool-no>CH-51450-LEAD-A</special tool-no><special tool-desc> Oscilloscope Basic Lead Kit</special tool-desc></special tool>
   - **If the tool is not available**

     Refer to step 4

   - **Go to next step: If the tool is available**
3. Perform the following procedure/test: **Relative Engine Compression Test**

   Verify the procedure/test passes.

   - **If the procedure/test does not pass**

     Refer to **Symptoms - Engine Mechanical**

   - **Go to next step: If the procedure/test passes**
4. Verify the following conditions do not exist:
   - Q17 Fuel Injector - Incorrect connection/Leaking/Loose/Visible Damage
   - Fuel - Fill Level = Low
   - Fuel Line (All) - Blocked/Incorrect connection/Kinked/Leaking/Loose/Visible Damage
   - **If a condition exists**

     Repair or replace as necessary

   - **Go to next step: If no conditions exist**
5. Perform the following procedure/test: **Fuel System Diagnosis**
   - **If the procedure/test does not pass**

     Repair or replace as necessary

   - **Go to next step: If the procedure/test passes**
6. Test or replace the component: K20 Engine Control Module

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Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

Engine Control Module Replacement

DTC P0315

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 P0315

Crankshaft Position System Variation Not Learned

Circuit/System Description

The crankshaft position sensor variation or reluctor ring learn is used to calculate reference period errors caused by slight tolerance variations in the crankshaft and the crankshaft position sensor. The calculated error allows the ECM to accurately compensate for reference period variations. This enhances the ability of the ECM to detect misfire events over a wider range of engine speed and load. The compensation values are stored in ECM memory after a learn procedure has been performed.

Conditions for Running the DTC

Engine = Running

Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

Crankshaft Position Variation Learn = Not Learned

Actions 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

This test procedure requires that the vehicle battery has passed a load test and is completely charged. Refer to **Battery Inspection/Test**

Reference Information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References

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Circuit/System Verification

1. Ignition - On / Vehicle - In Service Mode
2. Perform the scan tool learn/reset function: **Crankshaft Position Variation Learn**
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**

     Replace the component: K20 Engine Control Module

   - **Go to next step: If the DTC is not set**
4. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

For control module replacement, programming, and setup refer to **Control Module References**

DTC P0335 OR P0336

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 P0335

Crankshaft Position Sensor Circuit

DTC P0336

Crankshaft Position Sensor Performance

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P0335, P0651*	P0335	P0335, P0651*	P0336
Signal	P0335	P0335	P0335	P0336
Low Reference	-	P0335	-	P0336
*Additional DTCs may set.				

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 5 V.
Low Reference	Grounded through the control module.

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Component	Description
B26 Crankshaft Position Sensor	The sensor contains a hall-effect sensor and additional electronics that processes the signal. It detects the change of strength of the magnetic field caused by the reluctor ring. When the strength changes, the sensor changes the amount of current it consumes. This results in a square wave signal of the current, while the voltage stays constant. The control module detects the frequency in which the current changes, which is proportional to the rotational speed.
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.
Reluctor Ring	There are 58 teeth or invisible magnetic segments on the edge of the crankshaft position reluctor ring mounted on the crankshaft. Each tooth or magnetic segment on the ring is spaced at a 60 segment spacing with 2 missing segments for a reference gap.

The ECM uses information from the crankshaft position sensor and the camshaft position sensor(s) for sequencing and timing of the spark events.

Conditions for Running the DTC

P0335Condition 1

- M64 Starter Motor = Active
- Camshaft Position Sensor = Signal received

Condition 2

- DTC P0101, P0102, P0103 = Not set
- MAF Sensor = Greater than 2.0 g/s

Condition 3

- Engine = Running
- M64 Starter Motor = Inactive

Condition 4

- DTC P0340, P0341 = Not set
- Engine = Running

Condition 5

- DTC P0340, P0341 = Not set
- M64 Starter Motor = Active

Frequency the DTC runs = Continuously - After the running conditions are met

P0336Condition 1

- DTC P0335 = Not set
- Engine Speed = Greater than 450 RPM
- MAF Sensor = Greater than 2.0 g/s

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Condition 2

- Engine = Running
- M64 Starter Motor = Inactive

Condition 3

- M64 Starter Motor = Active
- Camshaft Position Sensor = Signal received

Condition 4

- DTC P0101, P0102, P0103 = Not set
- MAF Sensor = Greater than 2.0 g/s

Condition 5

- DTC P0340, P0341 = Not set
- Engine = Running

Condition 6

- DTC P0340, P0341 = Not set
- M64 Starter Motor = Active

Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

P0335 Condition 1

Crankshaft Position Sensor = No Signal - For greater than 4 s

Condition 2

Crankshaft Position Sensor = No Signal - For greater than 0.3 s

Condition 3

Crankshaft Position Sensor = No Signal - During 2 engine revolution(s)

P0336 Condition 1

Crankshaft Position Sensor = Signal synchronization lost 10 times within 10 s.

Condition 2

Crankshaft Position Sensor = Sync gap not detected - For greater than 0.4 s

Condition 3

Crankshaft Position Sensor = Sync gap not detected - Since last starter engagement - For greater than 1.5 s

Condition 4

Crankshaft Position Sensor = Less than 51 pulse(s) or Greater than 65 pulses - During 1 engine revolution(s) - For 8 out of 10 engine revolutions

Frequency the DTC runs = Continuously - After the running conditions are met

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Actions 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

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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 P0651 is not set.
    - **If the DTC is set**

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

    - **Go to next step: If the DTC is not set**
3. Engine - Running
4. Verify DTC P0335 is not set.
    - **If the DTC is set**

      Refer to: Circuit/System Testing

    - **Go to next step: If the DTC is not set**
5. Verify the scan tool parameter: Crankshaft Position Active Counter = Increments
    - **If the parameter value does not increment**

      Refer to: Circuit/System Testing

    - **Go to next step: If the parameter value increments**

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6. Verify the scan tool parameter: Crankshaft Position Resync Counter = 0 Counts - The engine should not stumble/stall.

   Perform the action while monitoring the parameter:

   - Wiggle the harness and connector: B26 Crankshaft Position Sensor
   - Wiggle the harness and connector: K20 Engine Control Module
   - **If greater than 0 counts**

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

   - **Go to next step: If 0 counts**
7. 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**
8. 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: B26 Crankshaft Position Sensor
3. Test for less than 10 ohms between the test points: Low Reference circuit terminal 2 & Ground
   - **If 10 ohms or greater**
   1. Disconnect the electrical connector: 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 10 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 1 & Ground
   - **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 1 @ Component harness & Ground
      - If less than infinite resistance - Repair the short to ground on the circuit.
      - Go to next step: If infinite resistance
   4. Test for less than 2 ohms between the test points: 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

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- **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 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. Rapidly tap a 3 A fused jumper wire between the test points: Signal circuit terminal 3 & Ground

   Verify the scan tool parameter: Crankshaft Position Active Counter = Increments

- **If the parameter value does not increment**

1. Ignition/Vehicle - Off
2. Disconnect the appropriate electrical connector: 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 3 @ Component harness & Ground
    - If 1 V or greater - Repair the short to voltage on the circuit.
    - Go to next step: If less than 1 V

1. Ignition/Vehicle - Off
2. Test for infinite resistance between the test points: Signal circuit terminal 3 @ Component harness & Ground
    - If less than infinite resistance - Repair the short to ground on the circuit.
    - Go to next step: If infinite resistance
3. Test for less than 2 ohms between the test points: Signal 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

- **Go to next step: If the parameter value increments**

7. Verify DTC P0336 is not set.
    - **If the DTC is set**

      Inspect for the following conditions:

    - B26 Crankshaft Position Sensor - Incorrect installation
    - B26 Crankshaft Position Sensor & Reluctor Ring - Excessive play/Foreign material passing between the components/Incorrect air gap /Loose/Visible Damage
    - Camshaft Sprocket - Visible Damage /Worn
    - Crankshaft Sprocket - Visible Damage /Worn
    - Engine Oil - Contaminated/Dirty
    - Timing Chain or Timing Belt - Visible Damage /Worn
    - Timing Chain Tensioner or Timing Belt Tensioner - Visible Damage /Worn
        - If a condition exists - Repair or replace as necessary
        - If all conditions test normal - Test or replace the component: B26 Crankshaft Position Sensor
    - **Go to next step: If the DTC is not set**
8. Test or replace the component: B26 Crankshaft Position Sensor

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Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Crankshaft Position Sensor Replacement**
- For control module replacement, programming, and setup refer to **Control Module References**

DTC P0340 OR P0341

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 P0340

Camshaft Position Sensor Circuit

DTC P0341

Camshaft Position Sensor Performance

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P0641*	P0340	P0641*	-
Signal	P0340	P0340	P0340	P0341
Low Reference	-	P0340	P0340	-
*Additional DTCs may set.				

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 5 V.
Low Reference	Grounded through the control module.

Component	Description
B23 Camshaft Position Sensor	The sensor contains a hall-effect sensor and additional electronics that processes the signal. It detects the change of strength of the magnetic field caused by the reluctor ring. When the strength changes, the sensor changes the amount of current it consumes. This results in a square wave signal of the current, while the voltage stays constant. The control module detects the frequency in which the current changes, which is proportional to the rotational speed.
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.

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Component	Description
Reluctor Ring	There are 4 equally spaced teeth on the edge of the camshaft position reluctor ring mounted on the camshaft.

The ECM uses information from the crankshaft position sensor and the camshaft position sensor(s) for sequencing and timing of the spark events.

Conditions for Running the DTC

P0340Condition 1

- DTC P0101, P0102, P0103 = Not set
- MAF Sensor = Greater than 2.0 g/s

Condition 2

- M64 Starter Motor = Active
- Crankshaft Position Sensor = Signal received

Condition 3

- M64 Starter Motor = Inactive
- Engine = Running

Condition 4

- DTC P0335, P0336, P641, P0651 = Not set
- M64 Starter Motor = Active
- Crankshaft = Synchronized

Condition 5

- DTC P0335, P0336, P0641, P0651 = Not set
- Crankshaft = Synchronized

Frequency the DTC runs = Continuously - After the running conditions are met

P0341Condition 1

- DTC P0335, P0336, P0641, P0651 = Not set
- M64 Starter Motor = Active
- Crankshaft = Synchronized

Condition 2

- DTC P0335, P0336, P0641, P0651 = Not set
- Crankshaft = Synchronized

Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

P0340Condition 1

Camshaft Position Sensor = No Signal - For greater than 5.5 s

Condition 2

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Camshaft Position Sensor = No Signal - For greater than 4 s - Starter is engaged.

Condition 3

Camshaft Position Sensor = Less than 4 pulse(s) - For greater than 3 s

Condition 4

Camshaft Position Sensor = No Signal - During the first 1 engine revolutions.

Condition 5

Camshaft Position Sensor = No Signal - During 100 engine revolution(s)

P0341Condition 1

Camshaft Position Sensor = Less than 4 pulse(s) - During 1 engine revolution(s)

Condition 2

Camshaft Position Sensor = Greater than 6 pulses - During 1 engine revolution(s)

Condition 3

Camshaft Position Sensor = Less than 398 pulse(s) - Greater than 402 pulses - During 100 engine revolution(s)

Actions 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

If there is a condition with the component/system, extended crank time during start-up may be observed.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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

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Scan Tool Reference

Control Module References

Circuit/System Verification

1. Ignition - On / Vehicle - In Service Mode
2. Verify DTC P0641 is not set.
    - **If the DTC is set**

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

    - **Go to next step: If the DTC is not set**
3. Engine - Running
4. Verify DTC P0341 is not set.
    - **If the DTC is set**

      Refer to: Circuit/System Testing

    - **Go to next step: If the DTC is not set**
5. Verify the scan tool parameter: Camshaft Position Active Counter = Increments
    - **If the parameter value does not increment**

      Refer to: Circuit/System Testing

    - **Go to next step: If the parameter value increments**
6. Verify the scan tool parameter: Camshaft Position Active Counter = Increments

   Perform the action while monitoring the parameter:

    - Wiggle the harness and connector: B23 Camshaft Position Sensor
    - Wiggle the harness and connector: K20 Engine Control Module
    - **If the parameter value does not increment**

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

    - **Go to next step: If the parameter value increments**
7. 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**
8. 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: B23 Camshaft Position Sensor

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3. Test for less than 10 ohms between the test points: Low Reference circuit terminal 2 & Ground
    - **If 10 ohms or greater**
    1. Disconnect the appropriate electrical connector: 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 10 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 1 & Ground
    - **If less than 4.8 V**
    1. Ignition/Vehicle - Off
    2. Disconnect the appropriate electrical connector: K20 Engine Control Module
    3. Test for infinite resistance between the test points: 5 V Reference circuit terminal 1 @ Component harness & Ground
        - If less than infinite resistance - Repair the short to ground on the circuit.
        - Go to next step: If infinite resistance
    4. Test for less than 2 ohms between the test points: 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 appropriate 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 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. Test for 4.8 to 5.2 V between the test points: Signal circuit terminal 3 & Ground
    - **If less than 4.8 V**
    1. Ignition/Vehicle - Off
    2. Disconnect the appropriate electrical connector: K20 Engine Control Module
    3. Test for infinite resistance between the test points: Signal circuit terminal 3 @ Component harness & Ground
        - If less than infinite resistance - Repair the short to ground on the circuit.
        - Go to next step: If infinite resistance
    4. Test for less than 2 ohms between the test points: Signal 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 appropriate electrical connector: K20 Engine Control Module
    3. Ignition - On / Vehicle - In Service Mode

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4. Test for less than 1 V between the test points: Signal 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**

7. Verify DTC P0341 is not set.
    - **If the DTC is set**

      Verify the following conditions do not exist:

    - B23 Camshaft Position Sensor & Reluctor Ring - Excessive play/Foreign material passing between the components/Incorrect air gap /Incorrect installation/Loose/Visible Damage
    - Engine Oil - Contaminated/Dirty
    - Timing Chain or Timing Belt - Visible Damage /Worn
    - Timing Chain Tensioner or Timing Belt Tensioner - Visible Damage /Worn
        - If a condition exists - Repair or replace as necessary
        - If all conditions test normal - Test or replace the component: B23 Camshaft Position Sensor
    - **Go to next step: If the DTC is not set**
8. Test or replace the component: B23 Camshaft Position Sensor

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Camshaft Position Sensor Replacement**
- For control module replacement, programming, and setup refer to **Control Module References**

DTC P037A, P037B, OR P0381

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 P037A

Wait to Start Indicator Control Circuit Low Voltage

DTC P037B

Wait to Start Indicator Control Circuit High Voltage

DTC P0381

Wait to Start Indicator Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition @ P16 Instrument	P0381	P0381	-	-

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Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Cluster				
Control @ K20 Engine Control Module	P0381, P037A*	P0381, P037A	P037B	-
*Wait to Start Indicator = Always On				

Circuit/System Description

Circuit	Description
Ignition @ P16 Instrument Cluster	Supplied from a fuse.
Control @ K20 Engine Control Module	The output circuit is switched to ground to activate the component.

Component	Description
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.
P16 Instrument Cluster	The instrument cluster houses several displays and gauges to inform the driver about various parameters of the vehicle.

Conditions for Running the DTC

- Ignition = On
- Ignition Voltage = Greater than 11 V
- M64 Starter Motor = Inactive

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**
- **Instrument Cluster Wiring Schematics**

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **Component Connector End Views - Index**

Electrical Information Reference

- **Circuit Testing**

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- **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. Perform the scan tool control function: Wait to Start Indicator - On and Off

   Verify the scan tool parameter:

   - Wait to Start Indicator Control Circuit High Voltage Test Status = Not Run or OK
   - Wait to Start Indicator Control Circuit Low Voltage Test Status = Not Run or OK
   - Wait to Start Indicator Control Circuit Open Test Status = Not Run or OK
   - **If not the specified state**

     Refer to: Circuit/System Testing

   - **Go to next step: If the specified state**
3. Perform the scan tool control function: Wait to Start Indicator - On and Off

   Verify the component turns On and Off: Wait to Start Indicator @ P16 Instrument Cluster

   - **If the component does not turn On and Off**

     Refer to: Circuit/System Testing

   - **Go to next step: If the component turns On and Off**
4. Perform the scan tool control function: Wait to Start Indicator - On

   Verify a condition does not exist with the component: Wait to Start Indicator @ P16 Instrument Cluster - Turns Off

   - Perform the action while monitoring the component: Wiggle the harness and connector: K20 Engine Control Module
   - **If a condition exists**

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

   - **Go to next step: If no condition exists**
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 that no DTCs are set.

   - **If the DTC sets**

     Refer to: Circuit/System Testing

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

6. All OK.

Circuit/System Testing

1. Verify the ignition fuse that supplies voltage to the component is not open: P16 Instrument Cluster
   - **If the fuse is open**
   1. Ignition/Vehicle - Off
   2. Disconnect the electrical connector: P16 Instrument Cluster
   3. Test for infinite resistance between the test points: Ignition circuit terminal 8 & Ground
      - If less than infinite resistance - Repair the short to ground on the circuit.
      - If infinite resistance - Replace the component: P16 Instrument Cluster
   - **Go to next step: If the fuse is not open**
2. Ignition/Vehicle - Off
3. Disconnect the appropriate electrical connector: K20 Engine Control Module
4. Ignition - On / Vehicle - In Service Mode
5. Verify the component works as specified: Wait to Start Indicator = Off
   - **If the component does not work as specified**
   1. Ignition/Vehicle - Off
   2. Test for infinite resistance between the test points: Control circuit terminal 32 & Ground
      - If less than infinite resistance - Repair the short to ground on the circuit.
      - If infinite resistance - Replace the component: P16 Instrument Cluster
   - **Go to next step: If the component works as specified**
6. Ignition/Vehicle - Off
7. Connect a 3 A fused jumper wire between the test points: Control circuit terminal 32 & Ground
8. Ignition - On / Vehicle - In Service Mode
9. Verify the component works as specified: Wait to Start Indicator = On
   - **If the component does not work as specified**
   1. Ignition/Vehicle - Off & Remove - Jumper wire(s)
   2. Disconnect the appropriate electrical connector: P16 Instrument Cluster
   3. Ignition - On / Vehicle - In Service Mode
   4. Test for less than 1 V between the test points: Control circuit terminal 19 X1 @ Control module harness & Ground
      - If 1 V or greater - Repair the short to voltage on the circuit.
      - Go to next step: If less than 1 V
   5. Ignition/Vehicle - Off
   6. Test for less than 2 ohms between the test points: Control circuit terminal 32 @ Component harness & The other end of the circuit @ Control module harness
      - If 2 ohms or greater - Repair the open/high resistance in the circuit.
      - Go to next step: If less than 2 ohms
   1. Test for less than 2 ohms between the test points: Ignition circuit terminal 8 @ Component harness & Output terminal @ Fuse
      - If 2 ohms or greater - Repair the open/high resistance in the circuit.
      - If less than 2 ohms - Replace the component: P16 Instrument Cluster
   - **Go to next step: If the component works as specified**
10. Replace the component: K20 Engine Control Module

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Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Instrument Cluster Replacement**
- For control module replacement, programming, and setup refer to **Control Module References**

DTC P037E OR P037F

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 P037E

Glow Plug Feedback Circuit Low Voltage

DTC P037F

Glow Plug Feedback Circuit High Voltage

Circuit/System Description

For an overview of the component/system, refer to **Glow Plug System Description**

The control module K20 controls the component: Glow Plugs

Conditions for Running the DTC

- DTC P066A - P066F, P0671 - P0674, P067A, P067B = Not set
- Glow Plugs = Enabled
- Ignition = On
- Ignition Voltage = 9 to 16 V

Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

K20 Engine Control Module = Internal Malfunction - 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

Connector End View Reference

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Master Electrical Component List , or Inline Harness Connector End Views - Index or 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. Ignition - On / Vehicle - In Service Mode
2. Verify DTC P066A - P066F, P0671 - P0674, P067A, P067B 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. 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**

      Replace the component: K20 Engine Control Module

    - **Go to next step: If the DTC is not set**
4. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: Diagnostic Repair Verification

For control module replacement, programming, and setup refer to Control Module References

DTC P0400-P0402

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

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DTC Descriptor

DTC P0401

Exhaust Gas Recirculation (EGR) Flow Insufficient

DTC P0402

Exhaust Gas Recirculation (EGR) Flow Excessive

Circuit/System Description

For an overview of the component/system, refer to **Exhaust Gas Recirculation (EGR) System Description**

Conditions for Running the DTC

- DTC P262B = Not set
- DTCs related to the following system/component = Not Set
  - B9 Ambient Air Temperature Sensor
  - B34 Engine Coolant Temperature Sensor
  - B65 Intake Manifold Pressure and Air Temperature Sensor
  - B75C Multifunction Intake Air Sensor
  - B115 Vehicle Speed Sensor
- Ambient Air Temperature = Warmer than -7B°C (19.4B°F)
- Barometric Pressure = Greater than 69.6 kPa (10.1 PSI)
- Engine Coolant Temperature = Warmer than 60B°C (140B°F)
- Engine Speed = 1, 800 to 2, 400 RPM & Steady State
- Fuel Control Loop Status = Closed Loop
- Ignition Voltage = Greater than 11 V
- Intake Air Flow Valve Position = Greater than 85%

Frequency the DTC runs = Continuously - After the running conditions are met - For greater than 7 s

Conditions for Setting the DTC

Mass Air Flow = Not within a calibrated range - For greater than 7.5 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

Diagnostic Aids

- Inspect for aftermarket devices which may affect the operation of the system.
- Contamination of the measuring element - Mass Air Flow

Reference Information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

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Control Module References

Circuit/System Verification

1. Verify there are no DTCs set related to the following component/system:
    - B9 Ambient Air Temperature Sensor
    - B34 Engine Coolant Temperature Sensor
    - B65 Intake Manifold Pressure and Air Temperature Sensor
    - B75C Multifunction Intake Air Sensor
    - B115 Vehicle Speed Sensor
    - **If a related DTC is set**

      Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**

    - **Go to next step: If a related DTC is not set**
2. Verify the following conditions do not exist:
    - Q20 Intake Air Flow Valve - Binding or Sticking/Restricted
    - Air Cleaner Element - Restricted/Saturated with water
    - EGR Cooler - Leaking/Restricted
    - EGR Valve - Binding or Sticking/Restricted/Visible Damage
    - Exhaust Gas Recirculation System - Leaking/Restricted
    - Exhaust System - Leaking/Missing components/Restricted/Visible Damage
    - Induction System - /Leaking/Restricted - Refer to **Charge Air Cooler Diagnosis (Induction System Smoke Test)** , or **Charge Air Cooler Diagnosis (Full System Air Leak Test)**
    - Mass Air Flow Sensor - Contaminated/Skewed
    - Turbocharger - Leaking/Restricted
    - **If a condition exists**

      Repair or replace as necessary

    - **Go to next step: If no condition exists**
3. Clear the DTCs.
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 component: Q14 Exhaust Gas Recirculation Valve

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

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

Exhaust Gas Recirculation Valve Replacement

DTC P0403, P1402, P1407, P140F, OR P1424

Diagnostic Instructions

- Perform the Diagnostic System Check prior to using this diagnostic procedure: **Diagnostic System Check - Vehicle**

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- 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 P0403

Exhaust Gas Recirculation (EGR) Control Circuit

DTC P1402

Exhaust Gas Recirculation (EGR) Motor Supply Circuit

DTC P1407

Exhaust Gas Recirculation (EGR) Motor Control Circuit Shorted

DTC P140F

Exhaust Gas Recirculation (EGR) Current Performance

DTC P1424

Exhaust Gas Recirculation Motor High Temperature

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Control - Terminal 1	P042F	P0403, P1402	P042F, P1407	P140F
Control - Terminal 5	-	P0403, P1402	P042F, P1407	P140F

Circuit/System Description

For an overview of the component/system, refer to **Exhaust Gas Recirculation (EGR) System Description**

Circuit	Description
Control - Terminal 1	The output circuit is switched from ground to 12 V to activate the component.
Control - Terminal 5	The output circuit is switched from ground to 12 V to activate the component.

Component	Description
Q14 Exhaust Gas Recirculation Valve	Redirecting the exhaust gas back into the intake system aids in reducing the amount of oxygen that enters the cylinders. This reduces the amount of nitrogen oxide (NOx) that is produced during combustion. The component is actuated by a bidirectional DC motor.
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

- Engine = Running

- Ignition Voltage = Greater than 11 V

Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

P0403, P1402

Control Circuit = Low Voltage/Open - For greater than 2.5 s

P1407

Control Circuit = Control Circuit Shorted to Control Circuit - For greater than 2.5 s

P140F

EGR Valve = Commanded state does not match the actual state

P1424

EGR Control Driver Overtemperature = 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

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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 P0400, P0401, P0405, P0406, P042E, P42F, P049D is not set.

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- **If DTC P0400, P0401, P0405, P0406, P042E, P42F, P049D is set**

  Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**

- **Go to next step: If DTC P0400, P0401, P0405, P0406, P042E, P042F, P049D is not set**

3. Perform the scan tool function: EGR Valve - Increase

   Verify the scan tool parameter: EGR Valve Position Sensor = 0 to 60% and changes

   - **If not between 0 and 60% or does not change**

     Refer to: Circuit/System Testing

   - **Go to next step: If between 0 and 60% and changes**

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.

   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**

5. All OK.

Circuit/System Testing

1. Verify a condition does not exist with the component: Q14 Exhaust Gas Recirculation Valve
   - Corrosion - Electrical Connector
   - Visible Damage
   - Stuck/Restricted
   - **If a condition exists**

     Repair as necessary

   - **Go to next step: If no conditions exist**
2. Ignition/Vehicle & All vehicle systems - Off
3. Disconnect the electrical connector: Q14 Exhaust Gas Recirculation Valve
4. Ignition - On / Vehicle - In Service Mode
5. Test for 0.1 to 0.5 V between the test points: Control circuit terminal 5 & Ground
   - **If greater than 0.5 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: Control circuit terminal 5 @ 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
   - **If less than 0.1 V**
   1. Ignition/Vehicle - Off
   2. Disconnect the electrical connector: K20 Engine Control Module

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3. Test for less than 2 ohms between the test points: Control circuit terminal 5 @ Component harness & Terminal 70 X2 @ Control module harness
    - If 2 ohms or greater - Repair the open/high resistance in the circuit.
    - Go to next step: If less than 2 ohms
4. Test for infinite resistance between the test points: Control circuit terminal 5 @ 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 between 0.1 and 0.5 V**

6. Test for 1 to 3 V between the test points: Control circuit terminal 1 @ Component harness & Ground
    - **If greater than 3 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: 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
    - **If less than 1 V**
    1. Ignition/Vehicle - Off
    2. Disconnect the electrical connector: K20 Engine Control Module
    3. Test for less than 2 ohms between the test points: Control circuit terminal 1 @ Component harness & Terminal 71 X2 @ Control module harness
        - If 2 ohms or greater - Repair the open/high resistance in the circuit.
        - Go to next step: If less than 2 ohms
    4. 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 between 1 and 3 V**
7. Replace the component: Q14 Exhaust Gas Recirculation Valve

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Exhaust Gas Recirculation Valve Replacement**
- For control module replacement, programming, and setup refer to **Control Module References**

DTC P0404 OR P042E

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 P0404

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Exhaust Gas Recirculation (EGR) Open Position Performance

DTC P042E

Exhaust Gas Recirculation (EGR) Closed Position Performance

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Control - Terminal 1	P0404	P0403	P0404	P0404, P140F
Control - Terminal 5	-	P0403	P0404	P0404, P140F

Circuit/System Description

For an overview of the component/system, refer to **Exhaust Gas Recirculation (EGR) System Description**

Circuit	Description
Control - Terminal 1	The output circuit is switched from ground to 12 V to activate the component.
Control - Terminal 5	The output circuit is switched from ground to 12 V to activate the component.

Component	Description
Q14 Exhaust Gas Recirculation Valve	Redirecting the exhaust gas back into the intake system aids in reducing the amount of oxygen that enters the cylinders. This reduces the amount of nitrogen oxide (NOx) that is produced during combustion. The component is actuated by a bidirectional DC motor.
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 P0403, P0405, P0406, P0489, P0490, P049D, P1402, P1407, P140F, P1424 = Not set
- Engine = Running
- Ignition Voltage = Greater than 11 V

Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

EGR Valve = Commanded state does not match the actual state - For greater than 2.5 s

Actions 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

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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 the scan tool parameter: EGR Position Sensor = 0.25 to 4.75 V
   - **If not in the specified range**

     Refer to **DTC P0405 or P0406**

   - **Go to next step: If in 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 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**
4. All OK.

Circuit/System Testing

1. Verify a condition does not exist with the component: Q14 Exhaust Gas Recirculation Valve
   - Stuck
   - Debris on the component.
   - Coking
   - **If a condition exists**

     Repair as necessary

   - **Go to next step: If no condition exists**
2. Ignition/Vehicle & All vehicle systems - Off

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3. Disconnect the electrical connector: Q14 Exhaust Gas Recirculation Valve
4. Ignition - On / Vehicle - In Service Mode
5. Test for 0.1 to 0.5 V between the test points: Control circuit terminal 5 & Ground
    - **If greater than 0.5 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: Control circuit terminal 5 @ 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
    - **If less than 0.1 V**
    1. Ignition/Vehicle - Off
    2. Disconnect the electrical connector: K20 Engine Control Module
    3. Test for less than 2 ohms between the test points: Control circuit terminal 5 @ Component harness & Terminal 70 X2 @ Control module harness
        - If 2 ohms or greater - Repair the open/high resistance in the circuit.
        - Go to next step: If less than 2 ohms
    4. Test for infinite resistance between the test points: Control circuit terminal 5 @ 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 between 0.1 and 0.5 V**
6. Test for 1 to 3 V between the test points: Control circuit terminal 1 @ Component harness & Ground
    - **If greater than 3 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: 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
    - **If less than 1 V**
    1. Ignition/Vehicle - Off
    2. Disconnect the electrical connector: K20 Engine Control Module
    3. Test for less than 2 ohms between the test points: Control circuit terminal 1 @ Component harness & Terminal 71 X2 @ Control module harness
        - If 2 ohms or greater - Repair the open/high resistance in the circuit.
        - Go to next step: If less than 2 ohms
    4. 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 between 1 and 3 V**
7. Replace the component: Q14 Exhaust Gas Recirculation Valve

Repair Instructions

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Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Exhaust Gas Recirculation Valve Replacement**
- For control module replacement, programming, and setup refer to **Control Module References**

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Engine Controls And Fuel - 2.8L (LWN) Diesel - Diagnostic Information And Procedures (2 Of 3) - Canyon, Colorado

DIAGNOSTIC INFORMATION AND PROCEDURES

DTC P0405 OR P0406

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 P0405

Exhaust Gas Recirculation (EGR) Position Sensor Circuit Low Voltage

DTC P0406

Exhaust Gas Recirculation (EGR) Position Sensor Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P0405, P0641*	P0405	P0406, P0641*	P0404
Signal	P0405	P0405	P0406	P0404
Low Reference	-	P0406	P0406	P0404
*Additional DTCs may set.				

Circuit/System Description

For an overview of the component/system, refer to **Exhaust Gas Recirculation (EGR) 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
Q14 Exhaust Gas Recirculation Valve	Redirecting the exhaust gas back into the intake system aids in reducing the amount of oxygen that enters the cylinders. This reduces the amount of nitrogen oxide (NOx) that is produced during combustion. The component is actuated by a bidirectional DC motor.
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

Component	Description
	reading values from a variety of sensors, interprets the data and adjusts the engine actuators accordingly.

Conditions for Running the DTC

- Engine = Running
- Ignition Voltage = Greater than 11 V

Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

P0405

EGR Position Sensor = Short to Ground/Open/High Resistance - For greater than 1 s

P0406

EGR Position Sensor = Short to Voltage - 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

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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 the scan tool parameter: EGR Position Sensor = 0.25 to 4.75 V

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- **If not between 0.25 and 4.75 V**

  Refer to: Circuit/System Testing

- **Go to next step: If between 0.25 and 4.75 V**

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

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: Q14 Exhaust Gas Recirculation Valve

   Test for less than 10 ohms between the test points: Low Reference circuit terminal 4 & Ground

   - **If 10 ohms or greater**
   1. Disconnect the electrical connector: K20 Engine Control Module
   2. Test for less than 2 ohms between the test points: Low Reference circuit terminal 4 @ Component harness & Terminal 57 X2 @ 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 10 ohms**
3. Ignition - On / Vehicle - In Service Mode
4. Test for 4.8 to 5.2 V between the test points: 5 V Reference circuit terminal 6 & Low Reference circuit terminal 4
   - **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 6 @ Component harness & Ground
      - If less than infinite resistance - Repair the short to ground on the circuit.
      - Go to next step: If infinite resistance
   4. Test for less than 2 ohms between the test points: 5 V Reference circuit terminal 6 @ Component harness & Terminal 59 X2 @ 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

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4. Test for less than 1 V between the test points: 5 V Reference 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 between 4.8 and 5.2 V**

5. Verify the scan tool parameter: EGR Position Sensor = 0 V
    - **If greater than 0 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: 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 - Replace the component: K20 Engine Control Module
    - **Go to next step: If 0 V**
6. Connect a 3 A fused jumper wire between the test points: Signal circuit terminal 2 & 5 V Reference circuit terminal 6
7. Verify the scan tool parameter: EGR Position Sensor = 4.8 to 5.2 V
    - **If not between 4.8 and 5.2 V**
    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: Signal circuit terminal 2 @ Component harness & Ground
        - If less than infinite resistance - Repair the short to ground on the circuit.
        - Go to next step: If infinite resistance
    4. Test for less than 2 ohms between the test points: Signal circuit terminal 2 @ Component harness & Terminal 58 X2 @ 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 between 4.8 and 5.2 V**
8. Test or replace the component: Q14 Exhaust Gas Recirculation Valve

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Exhaust Gas Recirculation Valve Replacement**
- For control module replacement, programming, and setup refer to **Control Module References**

DTC P040B-P040E OR P041B-P041E

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 P040B

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Exhaust Gas Recirculation (EGR) Temperature Sensor 2 Performance

DTC P040C

Exhaust Gas Recirculation (EGR) Temperature Sensor 2 Circuit Low Voltage

DTC P040D

Exhaust Gas Recirculation (EGR) Temperature Sensor 2 Circuit High Voltage

DTC P040E

Exhaust Gas Recirculation (EGR) Temperature Sensor 2 Circuit Intermittent

DTC P041B

Exhaust Gas Recirculation (EGR) Temperature Sensor 1 Performance

DTC P041C

Exhaust Gas Recirculation (EGR) Temperature Sensor 1 Circuit Low Voltage

DTC P041D

Exhaust Gas Recirculation (EGR) Temperature Sensor 1 Circuit High Voltage

DTC P041E

Exhaust Gas Recirculation (EGR) Temperature Sensor 1 Circuit Intermittent

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P040C, P041C	P040D, P040E, P041D, P041E	P040D, P041D	P040B, P041B
Low Reference	-	P040D, P040E, P041D, P041E	-	P040B, P041B

Circuit/System Description

For an overview of the component/system, refer to **Exhaust Gas Recirculation (EGR) System Description**

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

Component	Description
B130 Exhaust Gas Recirculation Temperature Sensor	The temperature sensor is a negative temperature coefficient thermistor, a resistor which changes based on temperature. The input voltage varies depending on the temperature of the sensor.
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

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Component	Description
	by reading values from a variety of sensors, interprets the data and adjusts the engine actuators accordingly.

Conditions for Running the DTC

P040B, P041B

- DTC P262B = Not set
- Engine Off Time = Greater than 8 h
- Engine Running
- Ignition Voltage = Greater than 11 V

Frequency the DTC runs = Continuously - After the running conditions are met

P040C, P040D, P040E, P041C, P041D, P041E

- Ignition On
- Ignition Voltage = Greater than 11 V

Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

P040B, P041B

EGR Cooler Temperature Sensor 1, 2 = The temperature does not change within a predetermined time. - Cold Start-Up

P040C, P041C

EGR Cooler Temperature Sensor 1, 2 = Colder than -39B°C (-38B°F) - For greater than 5 s

P040D, P041D

EGR Cooler Temperature Sensor 1, 2 = Warmer than 999B°C (1830B°F) - For greater than 5 s

P040E, P041E

EGR Cooler Temperature Sensor 1, 2 = Intermittent - For greater than 1 s

Actions Taken When the DTC Sets

- DTCs listed in the DTC Descriptor Category = Type B DTC
- EGR Cooler Temperature Sensor 1, 2 = 200B°C (392B°F)
- Reduced Engine Power is displayed.

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type B DTC

Diagnostic Aids

If the condition is intermittent or cannot be duplicated, disconnect the connectors and add dielectric grease or lubricant (Nyogel 760G or equivalent, meeting GM specification 9986087). This procedure may correct the high resistance condition due to terminal fretting corrosion.

EGR Cooler Temperature Sensor 1, 2 & ECT Sensor = Within 3B°C (5B°F) of each other - Engine Off Time = Greater than 8 h

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Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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 the scan tool parameter: EGR Cooler Temperature Sensor 1, 2 = -39 to 999B°C (-38 to 1830B°F) and changes
   - **If not between -39 and 999B°C (-38 and 1830B°F) or does not change**

     Refer to: Circuit/System Testing

   - **Go to next step: If between -39 and 999B°C (-38 and 1830B°F) and changes**
3. Verify the scan tool parameter: EGR Cooler Temperature Sensor 1, 2 = The value should not spike or drop out.

   Perform the action while monitoring the parameter:

   - Wiggle the harness and connector: B130 Exhaust Gas Recirculation Temperature Sensor
   - Wiggle the harness and connector: X3 @ 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**
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.

   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**

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5. 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 appropriate electrical connector: B130 Exhaust Gas Recirculation Temperature Sensor
3. Test for less than 10 ohms between the test points: Low Reference circuit terminal 1 & Ground
    - **If 10 ohms or greater**
    1. Disconnect the electrical connector: K20 Engine Control Module
    2. Test for less than 2 ohms between the test points:
        - {Sensor 1} Low Reference circuit terminal 1 @ Component harness & Terminal 19 X3 @ Control module harness
        - {Sensor 2} Low Reference circuit terminal 1 @ Component harness & Terminal 10 X3 @ 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 10 ohms**
4. Ignition - On / Vehicle - In Service Mode
5. Test for 4.8 to 5.2 V between the test points: EGR Cooler Temperature Sensor 1, 2Signal circuit terminal 2 & Ground
    - **If less than 4.8 V**
    1. Ignition/Vehicle - Off
    2. Disconnect the electrical connector: K20 Engine Control Module
    3. Test for less than 2 ohms between the test points:
        - {Sensor 1} Signal circuit terminal 2 @ Component harness & Terminal 20 X3 @ Control module harness
        - {Sensor 2} Signal circuit terminal 2 @ Component harness & Terminal 24 X3 @ Control module harness
        - If 2 ohms or greater - Repair the open/high resistance in the circuit.
        - Go to next step: If less than 2 ohms
    4. Test for infinite resistance between the test points: Signal circuit terminal 2 @ 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
    - **If greater than 5.2 V**
    1. 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 - Replace the component: K20 Engine Control Module
    - **Go to next step: If between 4.8 and 5.2 V**
6. Replace the appropriate component: B130 Exhaust Gas Recirculation Temperature Sensor
7. 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.
8. Verify the DTC does not set.
    - **If the DTC sets**

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Replace the component: K20 Engine Control Module

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

9. All OK.

Component Testing

1. Ignition/Vehicle - Off
2. Disconnect the appropriate electrical connector: B130 Exhaust Gas Recirculation Temperature Sensor
3. Test the resistance between the test points: Signal circuit terminal 2 & Low Reference terminal 1 @ Component
4. Verify the value is within the range listed in the table: **Temperature Versus Resistance - Exhaust Gas Temperature Sensor**
    - **If not in the specified range**

      Replace the component: B130 Exhaust Gas Recirculation Temperature Sensor

    - **Go to next step: If in the specified range**
5. Test for infinite resistance between the test points: Each terminal of the component & The component's housing
    - **If less than infinite resistance**

      Replace the component: B130 Exhaust Gas Recirculation Temperature Sensor

    - **Go to next step: If infinite resistance**
6. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Exhaust Gas Recirculation Cooler Temperature Sensor Replacement - Position 1**
- **Exhaust Gas Recirculation Cooler Temperature Sensor Replacement - Position 2**
- For control module replacement, programming, and setup refer to **Control Module References**

DTC P0421

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 P0421

Catalyst 1 Low Efficiency

Circuit/System Description

For an overview of the component/system, refer to **Exhaust Aftertreatment System Description**

Conditions for Running the DTC

DTCs related to the following system/component = Not Set

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- DTCs related to the following system/component = Not Set
  - B9 Ambient Air Temperature Sensor
  - B34 Engine Coolant Temperature Sensor
  - B75C Multifunction Intake Air Sensor
  - B131 Exhaust Temperature Sensor
  - B136 Exhaust Particulate Matter Sensor
  - Q14 Exhaust Gas Recirculation Valve
  - Q17 Fuel Injector
  - Engine Control Module
- Ambient Air Temperature = Warmer than -7B°C (19.4B°F)
- Barometric Pressure = Greater than 70 kPa (10.2 PSI)
- DPF Regeneration Enable = Active
- Engine Running
- Vehicle Speed = Less than 48 km/h (29 MPH)

Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

Oxygen storage capacity of the catalyst = Less than a predefined threshold

Actions 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

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 there are no DTCs set related to the following component/system:
   - B9 Ambient Air Temperature Sensor
   - B34 Engine Coolant Temperature Sensor
   - B75C Multifunction Intake Air Sensor
   - B131 Exhaust Temperature Sensor
   - B136 Exhaust Particulate Matter Sensor
   - Q14 Exhaust Gas Recirculation Valve
   - Q17 Fuel Injector
   - Engine Control Module
   - **If a related DTC is set**

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Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**

- **Go to next step: If a related 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.

   Verify the DTC does not set.

   - **If the DTC sets**

     Refer to: Circuit/System Testing

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

4. All OK.

Circuit/System Testing

1. Verify a condition does not exist with the component:
   - Induction System - Leaking/Loose Clamps/Restricted/Visible Damage
   - Q67 Exhaust Aftertreatment Fuel Injector - Leaking/Restricted - Refer to **Exhaust Aftertreatment Fuel Injector Diagnosis**
2. Verify the following conditions do not exist:
   - Coolant consumption - Refer to **Loss of Coolant**
   - Fuel - Contaminated/Poor Quality - Refer to **Contaminants-in-Fuel Diagnosis** , & **Fuel System Specifications**
   - Oil consumption - Refer to **Oil Consumption Diagnosis**
   - **If a condition exists**

     Repair or replace as necessary

   - **Go to next step: If no condition exists**
3. Verify a condition does not exist with the component: Exhaust System & Oxidation Catalytic Converter
   - Cracked
   - Internal component rattle
   - Leaking - Refer to **Exhaust Leakage**
   - Loose Clamps
   - Missing components
   - Restrictions - Refer to **Restricted Exhaust**
   - Severe discoloration caused by excessive temperatures
   - Visible Damage
   - **If a condition exists**

     Repair or replace as necessary

   - **Go to next step: If no condition exists**
4. Retrieve the value from the time the DTC was set by using the Freeze Frame/Failure Records.
5. Temperature sensor 1 must be at least 100B°C (212B°F) cooler than temperature sensor 2.
   - **If within 100B°C (212B°F) of each other**

     Replace the component: Catalytic Converter

   - **Go to next step: If not within 100B°C (212B°F) of each other**

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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.

   Verify the DTC does not set.

   - **If the DTC sets**

     Refer to step 1

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

7. All OK.

Repair Instructions

- Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**
- Perform the diesel particulate filter (DPF) regeneration enable. **Diesel Particulate Filter (DPF) Regeneration Enable**
- **Catalytic Converter Replacement (LWN)**

DTC P0422

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 P0422

Catalyst 2 Low Efficiency

Circuit/System Description

For an overview of the component/system, refer to **Exhaust Aftertreatment System Description**

Conditions for Running the DTC

DTCs related to the following system/component = Not Set

- DTCs related to the following system/component = Not Set
  - B9 Ambient Air Temperature Sensor
  - B34 Engine Coolant Temperature Sensor
  - B75C Multifunction Intake Air Sensor
  - B131 Exhaust Temperature Sensor
  - B136 Exhaust Particulate Matter Sensor
  - Q14 Exhaust Gas Recirculation Valve
  - Q17 Fuel Injector
  - Engine Control Module
- Ambient Air Temperature = Warmer than -7B°C (19.4B°F)
- Barometric Pressure = Greater than 70 kPa (10.2 PSI)
- DPF Regeneration Enable = Active
- Engine Running

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Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

Oxygen storage capacity of the catalyst = Less than a predefined threshold

Actions 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

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 there are no DTCs set related to the following component/system:
    - B9 Ambient Air Temperature Sensor
    - B34 Engine Coolant Temperature Sensor
    - B75C Multifunction Intake Air Sensor
    - B131 Exhaust Temperature Sensor
    - B136 Exhaust Particulate Matter Sensor
    - Q14 Exhaust Gas Recirculation Valve
    - Q17 Fuel Injector
    - Engine Control Module
    - **If a related DTC is set**

      Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**

    - **Go to next step: If a related 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.

   Verify the DTC does not set.

    - **If the DTC sets**

      Refer to: Circuit/System Testing

    - **Go to next step: If no DTC is set**
4. All OK.

Circuit/System Testing

1. Verify a condition does not exist with the component:
    - Induction System - Leaking/Loose Clamps/Restricted/Visible Damage

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- Q67 Exhaust Aftertreatment Fuel Injector - Leaking/Restricted - Refer to **Exhaust Aftertreatment Fuel Injector Diagnosis**

2. Verify the following conditions do not exist:
   - Coolant consumption - Refer to **Loss of Coolant**
   - Fuel - Contaminated/Poor Quality - Refer to **Contaminants-in-Fuel Diagnosis** , & **Fuel System Specifications**
   - Oil consumption - Refer to **Oil Consumption Diagnosis**
   - **If a condition exists**

     Repair or replace as necessary

   - **Go to next step: If no condition exists**
3. Verify a condition does not exist with the component: Exhaust System & Oxidation Catalytic Converter
   - Cracked
   - Internal component rattle
   - Leaking - Refer to **Exhaust Leakage**
   - Loose Clamps
   - Missing components
   - Restrictions - Refer to **Restricted Exhaust**
   - Severe discoloration caused by excessive temperatures
   - Visible Damage
   - **If a condition exists**

     Repair or replace as necessary

   - **Go to next step: If no condition exists**
4. Retrieve the value from the time the DTC was set by using the Freeze Frame/Failure Records.
5. Verify the scan tool Freeze Frame/Failure Records parameter: Exhaust Gas Temperature Sensor 3 & Exhaust Gas Temperature Sensor 4 = Not within 100B°C (212B°F) of each other
   - **If within 100B°C (212B°F) of each other**

     Replace the component: Diesel Particulate Filter

   - **Go to next step: If not within 100B°C (212B°F) of each other**
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.

   Verify the DTC does not set.

   - **If the DTC sets**

     Refer to step 1

   - **Go to next step: If no DTC is set**
7. All OK.

Repair Instructions

- Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**
- Perform the diesel particulate filter (DPF) regeneration enable. **Diesel Particulate Filter (DPF) Regeneration Enable**
- **Exhaust Particulate Filter Replacement (LWN)** - Diesel Particulate Filter

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DTC P049D

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 P049D

Exhaust Gas Recirculation (EGR) Position Not Learned

Circuit/System Description

For an overview of the component/system, refer to **Exhaust Gas Recirculation (EGR) System Description**

Component	Description
Q14 Exhaust Gas Recirculation Valve	Redirecting the exhaust gas back into the intake system aids in reducing the amount of oxygen that enters the cylinders. This reduces the amount of nitrogen oxide (NOx) that is produced during combustion. The component is actuated by a bidirectional DC motor.
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

- DTCs related to the following system/component = Not Set
  - B34 Engine Coolant Temperature Sensor
  - Q14 Exhaust Gas Recirculation Valve
- Ignition On - Engine Off
- ECT Sensor = Greater than 60B°C (140B°F)

Frequency the DTC runs = Once - Per ignition cycle - After ignition Off

Conditions for Setting the DTC

EGR Valve = Commanded state does not match the actual state

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type B

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type B

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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. Clear the DTCs.
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**

     Replace the component: Q14 Exhaust Gas Recirculation Valve

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

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Exhaust Gas Recirculation Valve Replacement**
- For control module replacement, programming, and setup refer to **Control Module References**

DTC P0506 OR P0507

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 P0506

Idle Speed Low

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DTC P0507

Idle Speed High

Circuit/System Description

For an overview of the component/system, refer to **Fuel System Description**

Conditions for Running the DTC

- DTC P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0114, P0116, P0117, P0118, P0119, P0128, P0171, P0172, P0300, P0301, P0302, P0303, P0304, P0400, P0401, P0402, P0403, P0405, P0406, P042E, P042F, P0462, P0463, P0489, P0490, P049D, P062D, P0502, P0503, P0722, P0723, P0806, P0807, P0808, P140B, P140C, P2227, P2228, P2229, P2230, P2271 = Not set
- Barometric Pressure = Greater than 70 kPa (10 PSI)
- {If equipped} Clutch Pedal = Not Pressed
- {If equipped} Clutch Pedal = Engaged Less than 12%
- {If equipped} Clutch Pedal = Engaged Greater than 75%
- Engine = Running - For greater than 1 min
- Engine = Idling - For greater than 5 s
- Engine Coolant Temperature = Greater than 60B°C (140B°F)
- Engine speed varies less than +/-25 RPM
- Ignition Voltage = 11 to 32 V
- Intake Air Temperature Sensor = Greater than -20B°C (-4B°F)
- Scan Tool Control Function = Inactive
- Torque Converter Clutch = Inactive
- Transmission = Not Shifting
- Vehicle Speed = Less than 1.6 km/h (1 MPH)

Frequency the DTC runs = Continuously - After the running conditions are met - For greater than 10 s

Conditions for Setting the DTC

P0506

Engine Speed = 94 RPM Less than desired - For greater than 10 s

P0507

Engine Speed = 188 RPM Greater than desired - For greater than 10 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

Connector End View Reference

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Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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 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. Engine - Idling - At normal operating temperature.
4. Verify the scan tool parameter: Engine Speed = -100 to +200 RPM of the Desired Idle Speed
   - **Go to next step: If not the specified state**

     Go to next step: 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.
6. Verify the DTC does not set.
   - **Go to next step: If the DTC sets**

     Go to next step: Refer to: Circuit/System Testing

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

Circuit/System Testing

P0506

1. Verify the following conditions do not exist:
   - Exhaust System - Restricted
   - Mechanical Condition - Engine Speed = Limited
   - Engine - Parasitic Load
   - **If a condition exists**

     Repair as necessary

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- **Go to next step: If no conditions exist**

2. All OK.

P0507

1. Verify the following conditions do not exist:
   - Fuel Injector - Leaking
   - Engine Oil - Contamination/ Fuel
   - Aftermarket equipment/accessories: Fuel System
   - **If a condition exists**

     Repair as necessary

   - **Go to next step: If no conditions exist**
2. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

DTC P053A-P053C

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.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P053A

Positive Crankcase Ventilation Heater Control Circuit

DTC P053B

Positive Crankcase Ventilation Heater Control Circuit Low Voltage

DTC P053C

Positive Crankcase Ventilation Heater Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Positive Crankcase Ventilation Heater Control Circuit	P053B	P053A	P053C	-
Ignition Circuit	P053A*	P053A	-	-
*Opens circuit fuse or opens circuit.				

Typical Scan Tool Data

Positive Crankcase Ventilation Heater Control Circuit Open Test Status

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition ON, component commanded Off. **Parameter Normal Range:** OK/Not Run			

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Circuit	Short to Ground	Open	Short to Voltage
Positive Crankcase Ventilation Heater Control	OK/Not Run	Malfunction	OK/Not Run

Positive Crankcase Ventilation Heater Control Circuit Low Voltage Test Status

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition ON, component commanded Off. **Parameter Normal Range:** OK/Not Run			
Positive Crankcase Ventilation Heater Control	Malfunction	OK/Not Run	OK/Not Run

Positive Crankcase Ventilation Heater Control Circuit High Voltage Test Status

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition ON, component commanded On. **Parameter Normal Range:** OK/Not Run			
Positive Crankcase Ventilation Heater Control	OK/Not Run	OK/Not Run	Malfunction

Circuit/System Description

The positive crankcase ventilation heater is controlled by the ECM. Ignition voltage is directly supplied to the positive crankcase ventilation heater and the ECM provides a controlled ground circuit.

Conditions for Running the DTC

- Ignition ON or engine operating.
- Battery voltage is greater than 11 V.
- Engine temperature is less than 90B°C (194B°F).
- The DTCs run continuously when the above conditions are met.

Conditions for Setting the DTC

P053A

The ECM detects an open circuit on the positive crankcase ventilation heater control circuit for greater than 5 s.

P053B

The ECM detects a short to ground on the positive crankcase ventilation heater control circuit for greater than 5 s.

P053C

The ECM detects a short to voltage on the positive crankcase ventilation heater control circuit for greater than 5 s.

Action Taken When the DTC Sets

DTCs P053A, P053B and P053C are Type C DTCs.

Conditions for Clearing the DTC

DTCs P053A, P053B and P053C are Type C DTCs.

Reference Information

Schematic Reference

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Engine Controls Wiring Schematics

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **Component Connector End Views - Index**

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 Positive Crankcase Ventilation Heater ON and OFF with a scan tool while observing the following control circuit status parameters:
   - Positive Crankcase Ventilation Heater Control Circuit Open Test Status
   - Positive Crankcase Ventilation Heater Control Circuit Low Voltage Test Status
   - Positive Crankcase Ventilation Heater Control Circuit High Voltage Test Status

     Each parameter should not display Malfunction.

   - **If Malfunction is displayed**

     Refer to Circuit/System Testing.

   - **Go to next step: If Malfunction is not displayed**
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.
2. Disconnect the harness connector at the E45 Positive Crankcase Ventilation Heater.

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3. Ignition ON.
4. Connect a test lamp between the Ignition Circuit terminal 2 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 circuit end to end.
        - If 2 Ω or greater, repair the open or 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 circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance, replace the E45 Positive Crankcase Ventilation Heater.
    - **Go to next step: If the test lamp illuminates**
5. Connect a test lamp between the control circuit terminal 1 and the ignition circuit terminal 2.
6. Verify the test lamp turns ON and OFF when commanding the Positive Crankcase Ventilation Heater from OFF to ON and back to OFF with a scan tool.
    - **If the test lamp is always OFF**
    1. Ignition OFF, disconnect the 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.
        - Go to next step: If less than 1 V.
    3. Ignition OFF.
    4. Test for less than 2 Ω in the control 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.
    - **If the test lamp is always ON**
    1. Ignition OFF.
    2. Disconnect the harness connector 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, replace the E45 Positive Crankcase Ventilation Heater.
    - **Go to next step: If the test lamp turns ON and OFF**
7. Replace the E45 Positive Crankcase Ventilation Heater.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Valve Rocker Arm Cover Replacement** for E45 Positive Crankcase Ventilation Heater replacement.
- **Control Module References** for ECM replacement, setup, and programming

DTC P0545, P0546, P2032, P2033, P242C, P242D, P2470, P2471, P2481, OR P2482

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**

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DTC Descriptor

DTC P0545

Exhaust Gas Temperature Sensor 1 Circuit Low Voltage

DTC P0546

Exhaust Gas Temperature Sensor 1 Circuit High Voltage

DTC P2032

Exhaust Gas Temperature Sensor 2 Circuit Low Voltage

DTC P2033

Exhaust Gas Temperature Sensor 2 Circuit High Voltage

DTC P242C

Exhaust Gas Temperature Sensor 3 Circuit Low Voltage

DTC P242D

Exhaust Gas Temperature Sensor 3 Circuit High Voltage

DTC P2470

Exhaust Gas Temperature Sensor 4 Circuit Low Voltage

DTC P2471

Exhaust Gas Temperature Sensor 4 Circuit High Voltage

DTC P2481

Exhaust Gas Temperature Sensor 5 Circuit Low Voltage

DTC P2482

Exhaust Gas Temperature Sensor 5 Circuit High Voltage

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Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P0545, P2032, P242C, P2470, P2481	P0546, P2033, P242D, P2471, P2482	P0546, P2033, P242D, P2471, P2482	P118E, P118F, P1196, P1197, P1198 *
Low Reference	-	P0546, P2033, P242D, P2471, P2482	-	P118E, P118F, P1196, P1197, P1198 *
*Additional DTCs may set.				

Typical Scan Tool Data

Exhaust Gas Temperature Sensor 1, 2, 3, 4, 5

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine = Idling **Parameter Normal Range:** -39 to 999B°C (-38 to 1830B°F)			
Signal	-40B°C (-40B°F)	1, 000B°C (1, 832B°F)	1, 000B°C (1, 832B°F)
Low Reference	-	1, 000B°C (1, 832B°F)	1, 000B°C (1, 832B°F)

Circuit/System Description

For an overview of the component/system, refer to **Exhaust Aftertreatment System Description**

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

Component	Description
B131 Exhaust Temperature Sensor	The temperature sensor is a positive temperature coefficient thermistor, a resistor which changes based on temperature.
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

Ignition = On

Ignition Voltage = Greater than 11 V

Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

P0545, P2032, P242C, P2470, P2481

Exhaust Temperature Sensor = Colder than -39B°C (-38B°F)

P0546, P2033, P242D, P2471, P2482

Exhaust Temperature Sensor = Warmer than 999B°C (1, 830B°F)

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

Diagnostic Aids

After starting a cold engine, the following scan tool parameter value should rise steadily and then stabilize: Exhaust Gas Temperature Sensor 1, 2, 3, 4, 5

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Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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

Special Tools

<special tool><special tool-no>EL-25070</special tool-no><special tool-desc>Heat Gun 260 to 400B°C (500 to 750B°F)</special tool-desc></special tool>

Equivalent regional tools: **Special Tools ((Diagnosis Tools))**

Circuit/System Verification

1. Ignition - On / Vehicle - In Service Mode
2. Verify the scan tool parameter: Exhaust Gas Temperature Sensor 1, 2, 3, 4, 5 = -39 to 999B°C (-38 to 1, 830B°F)
   - **If not between -39 and 999B°C (-38 and 1, 830B°F)**

     Refer to: Circuit/System Testing

   - **Go to next step: If between -39 and 999B°C (-38 and 1, 830B°F)**
3. Verify the scan tool parameter: Exhaust Gas Temperature Sensor 1, 2, 3, 4, 5 = The value should not spike or drop out.

   Perform the action while monitoring the parameter:

   - Wiggle the harness and connector: B131 Exhaust Temperature Sensor
   - Wiggle the harness and connector: X3 @ 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**
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.

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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**

5. 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 appropriate electrical connector: B131 Exhaust Temperature Sensor
3. Test for less than 10 ohms between the test points: Low Reference circuit terminal 1 & Ground
   - **If 10 ohms or greater**
   1. Disconnect the electrical connector: X3 @ K20 Engine Control Module
   2. Test for less than 2 ohms between the test points:
      - {Sensor 1} Low Reference circuit terminal 1 @ Component harness & Terminal 27 @ Control module harness
      - {Sensor 2} Low Reference circuit terminal 1 @ Component harness & Terminal 13 @ Control module harness
      - {Sensor 3} Low Reference circuit terminal 1 @ Component harness & Terminal 12 @ Control module harness
      - {Sensor 4} Low Reference circuit terminal 1 @ Component harness & Terminal 11 @ Control module harness
      - {Sensor 5} Low Reference circuit terminal 1 @ Component harness & Terminal 9 @ 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 10 ohms**
4. Ignition - On / Vehicle - In Service Mode
5. Verify the scan tool parameter: Exhaust Gas Temperature Sensor 1, 2, 3, 4, 5 = Warmer than 999B°C (1, 830B°F)
   - **If 999B°C (1, 830B°F) or colder**
   1. Ignition/Vehicle - Off
   2. Disconnect the electrical connector: X3 @ K20 Engine Control Module
   3. Test for infinite resistance between the test points: Signal circuit terminal 2 @ 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 warmer than 999B°C (1830B°F)**
6. Connect a 3 A fused jumper wire between the test points: Signal circuit terminal 2 & Low Reference circuit terminal 1
7. Verify the scan tool parameter: Exhaust Gas Temperature Sensor 1, 2, 3, 4, 5 = Colder than -39B°C (-38B°F)
   - **If -39B°C (-38B°F) or warmer**
   1. Ignition/Vehicle - Off & Remove - Jumper wire(s)

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2. Disconnect the electrical connector: X3 @ 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.
    - Go to next step: If less than 1 V
5. Ignition/Vehicle - Off
6. Test for less than 2 ohms between the test points:
    - {Sensor 1} Signal circuit terminal 2 @ Component harness & Terminal 14 @ Control module harness
    - {Sensor 2} Signal circuit terminal 2 @ Component harness & Terminal 28 @ Control module harness
    - {Sensor 3} Signal circuit terminal 2 @ Component harness & Terminal 26 @ Control module harness
    - {Sensor 4} Signal circuit terminal 2 @ Component harness & Terminal 25 @ Control module harness
    - {Sensor 5} Signal circuit terminal 2 @ Component harness & Terminal 23 @ 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 colder than -39B°C (-38B°F)**

8. Test or replace the component: B131 Exhaust Temperature Sensor

Component Testing

1. Ignition/Vehicle - Off
2. Disconnect the appropriate electrical connector: B131 Exhaust Temperature Sensor

> **NOTE:** **Use the special tool:<special tool><special tool-no>EL-25070</special tool-no><special tool-desc>Heat Gun 260 to 400B°C (500 to 750B°F) </special tool-desc></special tool>**

3. Test the resistance between the test points: Signal terminal 2 & Low Reference terminal 1

   Verify the value is within the range listed in the table: **Temperature Versus Resistance - Exhaust Gas Temperature Sensor**

    - **If not in the specified range**

      Replace the component: B131 Exhaust Temperature Sensor

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

4. Test for infinite resistance between the test points: Each terminal of the component & The component's housing
    - **If less than infinite resistance**

      Replace the component: B131 Exhaust Temperature Sensor

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

5. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

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- **Exhaust Temperature Sensor Replacement - Position 1**
- **Exhaust Temperature Sensor Replacement - Position 2**
- **Exhaust Temperature Sensor Replacement - Position 3**
- **Exhaust Temperature Sensor Replacement - Position 4**
- **Exhaust Temperature Sensor Replacement - Position 5**
- For control module replacement, programming, and setup refer to **Control Module References**

DTC P054E OR P054F

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 P054E

Idle Control - Fuel Quantity Lower Than Expected

DTC P054F

Idle Control - Fuel Quantity Higher Than Expected

Circuit/System Description

For an overview of the component/system, refer to **Fuel System Description**

Component	Description
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.
Q17 Fuel Injector	Fuel injectors are solenoid valves that inject fuel either into the intake system or directly into the cylinder. The amount of fuel injected depends on the length of the electrical pulse that is applied.

Conditions for Running the DTC

- Accelerator Pedal Position Sensor = Less than 0.05%
- Ambient Air Temperature = Warmer than -20B°C (-4B°F)
- Battery Voltage = Greater than 11 V
- Engine Speed = 546 to 1560 RPM
- Engine Coolant Temperature = Warmer than -20B°C (-4B°F)
- Transmission = Park/Neutral
- Vehicle Speed = Less than 3 km/h (1.86 MPH)

Frequency the DTC runs = Continuously - After the running conditions are met - For greater than 5 s

Conditions for Setting the DTC

P054E

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Fuel Injection Quantity = Less than a predefined threshold - For greater than 24 s

P054F

Fuel Injection Quantity = Greater than a predefined threshold - For greater than 24 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

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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. Verify there are no DTCs set related to the following component/system:
    - B9 Ambient Air Temperature Sensor
    - B14A Transmission Output Shaft Speed Sensor
    - B26 Crankshaft Position Sensor
    - B34 Engine Coolant Temperature Sensor
    - B115 Vehicle Speed Sensor
    - Exhaust Aftertreatment System
    - Fuel System
    - Induction System
    - **If a related DTC is set**

      Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**

    - **Go to next step: If a related DTC is not set**
2. Verify the condition does not exist:

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- Aftermarket equipment/accessories: Performance Components - Installed
- Accessory drive belt component - Worn / Failed
- Fuel - Contamination Refer to **Contaminants-in-Fuel Diagnosis**
- **If a condition exists**

  Repair or replace as necessary

- **Go to next step: If no condition exists**

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 does not set**

4. All OK.

Circuit/System Testing

1. Perform the scan tool control function: Cylinder Power Balance

   Refer to **Cylinder Power Balance Test**

   - **If a condition exists**

     Repair or replace as necessary

   - **Go to next step: If no condition exists**

2. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Fuel Injector Replacement (Cylinder #1, #2, #3)** , or **Fuel Injector Replacement (Cylinder #4)**

DTC P057B-P057E

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 P057B

Brake Pedal Position Sensor Performance

DTC P057C

Brake Pedal Position Sensor Circuit Low Voltage

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DTC P057D

Brake Pedal Position Sensor Circuit High Voltage

DTC P057E

Brake Pedal Position Sensor Circuit Erratic

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P057C, P0651*	P057C	P0651*	-
Signal	P057C	P057C	P057D	P057B
Low Reference	-	P057D	-	-
*Additional DTCs may set.				

Typical Scan Tool Data

Brake Pedal Position Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition = On **Parameter Normal Range:** 0.7 to 2.7 V			
5 V Reference	0 V	0 V	2.2 V
Signal	0 V	0 V	5 V
Low Reference	-	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
B22 Brake Pedal Position Sensor	The input voltage varies depending on the position of the sensor.
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.

The pedal assembly contains 2 potentiometer-type brake pedal position sensors. When the pedal is pressed, the voltage of one sensor goes up and the voltage of the other sensor goes down.

Conditions for Running the DTC

P057B

- DTC P057C, P057D = Not set
- Accelerator Pedal Position = Less than 5%
- Ignition Voltage = Greater than 10 V
- Shift Lever = Park - At least 1 time(s) during the ignition cycle
- Shift Lever = Not in Park

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- Vehicle Speed = Greater than 8 km/h (5 MPH)

Frequency the DTC runs = Once - After the running conditions are met

P057C, P057D, P057E

Ignition Voltage = Greater than 10 V

Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

P057B

Brake Pedal Position Sensor = Stuck in range - For greater than 1 s

P057C

Brake Pedal Position Sensor = Less than 0.25 V - For greater than 1 s

P057D

Brake Pedal Position Sensor = Greater than 4.75 V - For greater than 1 s

P057E

Brake Pedal Position Sensor = Signal noisy or erratic

Actions 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

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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

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Control Module References

Circuit/System Verification

1. Ignition - On / Vehicle - In Service Mode
2. Verify the scan tool parameter: Brake Pedal Position Sensor = 0.26 to 4.74 V
   - **If not between 0.26 and 4.74 V**

     Refer to: Circuit/System Testing

   - **Go to next step: If between 0.26 and 4.74 V**
3. Verify the scan tool parameter: Brake Pedal Position Sensor = The value should change while moving the sensor through the entire range.
   - **If the value does not change**

     Refer to: Circuit/System Testing

   - **Go to next step: If the value changes**
4. Verify the scan tool parameter: Brake Pedal Position Sensor = The value should not spike or drop out.

   Perform the action while monitoring the parameter:

   - Wiggle the harness and connector: B22 Brake 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 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: B22 Brake Pedal Position Sensor
3. Test for less than 10 ohms between the test points: Low Reference circuit terminal 5 & Ground
   - **If 10 ohms or greater**
   1. Disconnect the appropriate electrical connector: K20 Engine Control Module
   2. Test for less than 2 ohms between the test points: 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

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- **Go to next step: If less than 10 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 6 & Low Reference circuit terminal 5
    - **If less than 4.8 V**
    1. Ignition/Vehicle - Off
    2. Disconnect the appropriate electrical connector: K20 Engine Control Module
    3. Test for infinite resistance between the test points: 5 V Reference circuit terminal 6 @ Component harness & Ground
        - If less than infinite resistance - Repair the short to ground on the circuit.
        - Go to next step: If infinite resistance
    4. Test for less than 2 ohms between the test points: 5 V Reference 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
    - **If greater than 5.2 V**
    1. Ignition/Vehicle - Off
    2. Disconnect the appropriate 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 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 between 4.8 and 5.2 V**
6. Verify the scan tool parameter: Brake Pedal Position Sensor = Less than 0.25 V
    - **If 0.25 or greater**
    1. Ignition/Vehicle - Off
    2. Disconnect the appropriate electrical connector: 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 4 @ 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 0.25 V**
7. Connect a 3 A fused jumper wire between the test points: Signal circuit terminal 4 & 5 V Reference circuit terminal 6
8. Verify the scan tool parameter: Brake Pedal Position Sensor = Greater than 4.8 V
    - **If 4.8 V or less**
    1. Ignition/Vehicle - Off & Remove - Jumper wire(s)
    2. Disconnect the appropriate electrical connector: K20 Engine Control Module
    3. Test for infinite resistance between the test points: Signal circuit terminal 4 @ Component harness & Ground
        - If less than infinite resistance - Repair the short to ground on the circuit.
        - Go to next step: If infinite resistance
    4. Test for less than 2 ohms between the test points: Signal circuit terminal 4 @ Component harness & The other end of the circuit @ Control module harness
        - If 2 ohms or greater - Repair the open/high resistance in the circuit.

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- 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: B22 Brake Pedal Position Sensor

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Brake Pedal Position Sensor Replacement**
- For control module replacement, programming, and setup refer to **Control Module References**

DTC P0627-P0629

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 P0627

Fuel Pump Relay Control Circuit Open

DTC P0628

Fuel Pump Relay Control Circuit Low Voltage

DTC P0629

Fuel Pump Relay Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Control	P0628	P0627	P0629	-
Ground	-	P0627	-	-

Typical Scan Tool Data

Fuel Pump Relay Control Circuit High Voltage Test Status

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine = Idling **Parameter Normal Range:** OK or Not Run			
Control	OK	OK	Malfunction
Ground	OK	OK	OK

Fuel Pump Relay Control Circuit Low Voltage Test Status

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine = Idling **Parameter Normal Range:** OK or Not Run			
Control	Malfunction	OK	OK
Ground	OK	OK	OK

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Fuel Pump Relay Control Circuit Open Test Status

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine = Idling **Parameter Normal Range:** OK or Not Run			
Control	OK	Malfunction	OK
Ground	OK	Malfunction	OK

Circuit/System Description

For an overview of the component/system, refer to **Fuel System Description**

Circuit	Description
Control	The output circuit is switched to 12 V to activate the component.
Ground	The output circuit is switched to ground to activate the component.

Component	Description
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.
KR23A Fuel Pump Relay	A relay is a switch that is actuated by a solenoid.

Conditions for Running the DTC

- Ignition = On or Engine = Running
- Battery Voltage = Greater than 11 V

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

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **Component Connector End Views - Index**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**

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- **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:
   - Fuel Pump Relay Control Circuit High Voltage Test Status = OK
   - Fuel Pump Relay Control Circuit Low Voltage Test Status = OK
   - Fuel Pump Relay Control Circuit Open Test Status = OK
   - **If not the specified state**

     Refer to: Circuit/System Testing

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

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. Remove the component: KR23A Fuel Pump Relay
3. Test for less than 10 ohms between the test points: Ground circuit terminal 86 & Ground
   - **If 10 ohms or greater**
   1. Disconnect the ground connection: @ The other end of the circuit
   2. Test for less than 2 ohms between the test points: Ground & Terminal 86
      - If 2 ohms or greater - Repair the open/high resistance in the circuit.
      - If less than 2 ohms - Repair the open/high resistance in the ground connection.
   - **Go to next step: If less than 10 ohms**
4. Ignition - On / Vehicle - In Service Mode
5. Verify a test lamp does not turn On between the test points: Control circuit terminal 85 & Ground
   - **If the test lamp turns On**
   1. Ignition/Vehicle - Off & Remove - Test lamp

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2. Disconnect the electrical connector: X1 @ 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 85 @ Relay Socket & 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 test lamp does not turn On**

6. Remove - Test Lamp
7. Perform the scan tool control function: Fuel Pump Relay - On

   Verify the scan tool parameter: Fuel Pump Relay Control Circuit Low Voltage Test Status = OK

    - **If not the specified state**
    1. Ignition/Vehicle - Off
    2. Disconnect the electrical connector: X1 @ K20 Engine Control Module
    3. Test for infinite resistance between the test points: Control circuit terminal 85 @ Relay Socket & 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 specified state**
8. Connect a 3 A fused jumper wire between the test points: Control circuit terminal 85 @ Relay Socket & Ground circuit terminal 86 @ Relay Socket
9. Perform the scan tool control function: Fuel Pump Relay - On

   Verify the scan tool parameter: Fuel Pump Relay Control Circuit Low Voltage Test Status = Malfunction

    - **If not the specified state**
    1. Ignition/Vehicle - Off & Remove - Jumper wire(s)
    2. Disconnect the electrical connector: X1 @ K20 Engine Control Module
    3. Test for less than 2 ohms between the test points: Control circuit terminal 85 @ Relay Socket & Terminal 50 @ 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 specified state**
10. Test or replace the component: KR23A Fuel Pump Relay

Component Testing

Relay Test

1. Ignition/Vehicle - Off
2. Remove the component: KR23A Fuel Pump Relay
3. Test for 70 to 110 ohms between the test points: Component terminal 85 & 86
    - **If not between 70 and 110 ohms**

      Replace the component: KR23A Fuel Pump Relay

    - **Go to next step: If between 70 and 110 ohms**
4. Test for infinite resistance between the test points:
    - Component terminal 30 & 86
    - Component terminal 30 & 87

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- Component terminal 30 & 85
- Component terminal 85 & 87
- **If less than infinite resistance**

  Replace the component: KR23A Fuel Pump Relay

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

5. Connect a 3 A fused jumper wire between the test points: Component terminal 85 & B+

   Connect a jumper wire between the test points: Component terminal 86 & Ground

6. Test for less than 2 ohms between the test points: Component terminal 30 & Component terminal 87
   - **If 2 ohms or greater**

     Replace the component: KR23A Fuel Pump Relay

   - **Go to next step: If less than 2 ohms**
7. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Electrical Relay Replacement (Attached to Wire Harness)** , or **Electrical Relay Replacement (Within an Electrical Center)**
- For control module replacement, programming, and setup refer to **Control Module References**

DTC P062D

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 P062D

Control Module Fuel Injector Driver Performance

Circuit/System Description

The control module monitors the fuel injector supply voltage to determined if the voltage is within a calibrated range.

Conditions for Running the DTC

- Battery Voltage = Greater than 11 V
- Engine = Running

Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

Condition 1

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Control module K20 detects: Open/High Resistance @ Ignition circuit - For less than 1 s

Condition 2

Control module K20 detects: Internal Malfunction - For less than 1 s

Actions 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

High resistance in the circuits of the component Q17 may set DTC P062D without setting control circuit DTC(s).

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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 there are no DTCs set related to the following component/system: KR75 Engine Controls Ignition Relay
   - **If a related DTC is set**

     Refer to **DTC P0685-P0687, P0689, P0690, P1682, P16A7, P16AF, or P16B3**

   - **Go to next step: If a related DTC is not set**
3. Engine - Cranking - For 10 s

   Verify the function: Engine = Running

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- **If the function does not work**

  Refer to: Circuit/System Testing

- **Go to next step: If the function works**

4. Verify a condition does not exist with the component: Engine - The engine should not stumble/stall.

   Perform the action while monitoring the component:

   - Wiggle the harness and connector: K20 Engine Control Module
   - Wiggle the harness and connector: X50A Fuse Block - Underhood
   - **If a condition exists**

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

   - **Go to next step: If no condition exists**

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. Verify the fuse is not open: F10UA Fuse @ X50A Fuse Block - Underhood
   - **If the fuse is open**
   1. Disconnect the electrical connector: X1 @ K20 Engine Control Module
   2. Test for infinite resistance between the test points: Output terminal @ F10UA Fuse & 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 fuse is not open**
3. Disconnect the electrical connector: X1 @ K20 Engine Control Module

   NOTE: **A high resistance condition on the component circuits may cause the DTC to set.**

4. Test for less than 2 ohms between the test points: Ignition circuit terminal 1 @ Control module harness & Output terminal @ F10UA Fuse
   - **If 2 ohms or greater**

     Repair the open/high resistance in the circuit.

   - **Go to next step: If less than 2 ohms**
5. Replace the component: K20 Engine Control Module

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

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For control module replacement, programming, and setup refer to **Control Module References**

DTC P0641, P0651, P0697, OR P06A3

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 P0641

5V Reference 1 Circuit

DTC P0651

5V Reference 2 Circuit

DTC P0697

5V Reference 3 Circuit

DTC P06A3

5V Reference 4 Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5V Reference 1	P0641	-	P0641	-
5V Reference 2	P0651	-	P0651	-
5V Reference 3	P0697	-	P0697	-
5V Reference 4	P06A3	-	P06A3	-

Typical Scan Tool Data

5V Reference 1 - 4

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition = On **Parameter Normal Range:** OK			
5 V Reference	Malfunction	OK	Malfunction

Circuit/System Description

Circuit	Description
5 V Reference	Regulated voltage supplied by 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

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Component	Description
	by reading values from a variety of sensors, interprets the data and adjusts the engine actuators accordingly.

The control module consists of 4 internal 5 V reference circuits. The 5 V reference circuit provides 5 V for one or more sensors. All sensors will be affected when a short to ground or voltage is on a shared 5 V reference circuit.

Conditions for Running the DTC

Condition 1

Ignition Voltage = Greater than 6.4 V

M64 Starter Motor = Inactive

Condition 2

Ignition Voltage = Greater than 8.4 V

M64 Starter Motor = Active

Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

Condition 1

5V Reference Circuit = Less than 4.88 V

Condition 2

5V Reference Circuit = Greater than 5.13 V

Condition 3

The following parameters are not within 0.05 V of each other:

- 5V Reference 1
- 5V Reference 2
- 5V Reference 3
- 5V Reference 4

Actions 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

Connector End View Reference

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Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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

Special Tools

Circuit/System Verification

1. Ignition - On / Vehicle - In Service Mode
2. Verify the scan tool parameter: 5V Reference 1 - 4 Circuit Status = OK
   - **If not the specified state**

     Refer to: Circuit/System Testing

   - **Go to next step: If the specified state**
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/Vehicle - Off

   NOTE: Additional DTCs will set when disconnecting the components.

2. Disconnect the electrical connector at one of the following components, depending on the DTC that is set:

   P0641

   - B1 A/C Refrigerant Pressure Sensor
   - B23 Camshaft Position Sensor
   - B154 Diesel Particulate Filter Exhaust Differential Pressure Sensor
   - Q14 Exhaust Gas Recirculation Valve

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P0651

- B22 Brake Pedal Position Sensor
- B26 Crankshaft Position Sensor
- B65 Intake Manifold Pressure and Air Temperature Sensor
- B115 Vehicle Speed Sensor
- M103 Turbocharger Vane Position Actuator
- Q20 Intake Air Flow Valve

P0697

- B107 Accelerator Pedal Position Sensor - Sensor 2

P06A3

- B47B Fuel Rail Pressure Sensor
- B107 Accelerator Pedal Position Sensor - Sensor 1

3. Ignition - On / Vehicle - In Service Mode
4. Verify the scan tool parameter: 5V Reference 1 - 4 Circuit Status = Malfunction - For the circuit that set the DTC.
    - **If not the specified state after disconnecting a component from the circuit**

      Test or replace the component: The component that was disconnected last.

    - **If the specified state and there are components connected to the circuit**

      Disconnect a component and repeat step 4.

    - **Go to next step: If the specified state with all components disconnected from the circuit**
5. Test for 4.8 to 5.2 V between the test points:

P0641 - 5V Reference 1 Circuit

- 5 V Reference circuit terminal 1 @ B1 A/C Refrigerant Pressure Sensor & Ground
- 5 V Reference circuit terminal 1 @ B23 Camshaft Position Sensor & Ground
- 5 V Reference circuit terminal 3 @ B154 Diesel Particulate Filter Exhaust Differential Pressure Sensor & Ground
- 5 V Reference circuit terminal 6 @ Q14 Exhaust Gas Recirculation Valve & Ground

P0651 - 5V Reference 2 Circuit

- {LHD} 5 V Reference circuit terminal 5 @ B22 Brake Pedal Position Sensor & Ground
- 5 V Reference circuit terminal 1 @ B26 Crankshaft Position Sensor & Ground
- 5 V Reference circuit terminal 3 @ B65 Intake Manifold Pressure and Air Temperature Sensor & Ground
- {NQV} 5 V Reference circuit terminal 1 @ B115 Vehicle Speed Sensor & Ground
- {- NQV} 5 V Reference circuit terminal 3 @ B115 Vehicle Speed Sensor & Ground
- 5 V Reference circuit terminal 5 @ M103 Turbocharger Vane Position Actuator & Ground
- 5 V Reference circuit terminal 5 @ Q20 Intake Air Flow Valve & Ground

P0697 - 5V Reference 3 Circuit

- 5 V Reference circuit terminal 1 @ B107 Accelerator Pedal Position Sensor - Sensor 2 & Ground

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P06A3 - 5V Reference 4 Circuit

- 5 V Reference circuit terminal 3 @ B47B Fuel Rail Pressure Sensor & Ground
- 5 V Reference circuit terminal 2 @ B107 Accelerator Pedal Position Sensor - Sensor 1 & Ground
- **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:

P0641

- 5 V Reference circuit terminal 42 X2 @ Control module harness & Ground
- 5 V Reference circuit terminal 48 X1 @ Control module harness & Ground
- 5 V Reference circuit terminal 52 X3 @ Control module harness & Ground
- 5 V Reference circuit terminal 57 X2 @ Control module harness & Ground

P0651

- 5 V Reference circuit terminal 31 X1 @ Control module harness & Ground
- 5 V Reference circuit terminal 33 X3 @ Control module harness & Ground
- 5 V Reference circuit terminal 43 X1 @ Control module harness & Ground
- 5 V Reference circuit terminal 45 X2 @ Control module harness & Ground
- 5 V Reference circuit terminal 80 X2 @ Control module harness & Ground
- 5 V Reference circuit terminal 85 X2 @ Control module harness & Ground

P0697

- 5 V Reference circuit terminal 16 X1 @ Control module harness & Ground

P06A3

- 5 V Reference circuit terminal 27 X1 @ Control module harness & Ground
- 5 V Reference circuit terminal 69 X2 @ Control module 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

- **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:

P0641

- 5 V Reference circuit terminal 42 X2 @ Control module harness & Ground
- 5 V Reference circuit terminal 48 X1 @ Control module harness & Ground
- 5 V Reference circuit terminal 52 X3 @ Control module harness & Ground
- 5 V Reference circuit terminal 57 X2 @ Control module harness & Ground

P0651

- 5 V Reference circuit terminal 31 X1 @ Control module harness & Ground
- 5 V Reference circuit terminal 33 X3 @ Control module harness & Ground

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- 5 V Reference circuit terminal 43 X1 @ Control module harness & Ground
- 5 V Reference circuit terminal 45 X2 @ Control module harness & Ground
- 5 V Reference circuit terminal 80 X2 @ Control module harness & Ground
- 5 V Reference circuit terminal 85 X2 @ Control module harness & Ground

P0697

- 5 V Reference circuit terminal 16 X1 @ Control module harness & Ground

P06A3

- 5 V Reference circuit terminal 27 X1 @ Control module harness & Ground
- 5 V Reference circuit terminal 69 X2 @ Control module 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. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Accelerator Pedal Position Sensor Replacement**
- **Air Conditioning Refrigerant Pressure Sensor Replacement (LCV, LWN)**
- **Brake Pedal Position Sensor Replacement**
- **Camshaft Position Sensor Replacement**
- **Compressor Air Intake Turbocharger Replacement**
- **Crankshaft Position Sensor Replacement**
- **Engine Oil Pressure Switch Replacement**
- **Exhaust Gas Recirculation Valve Replacement**
- **Exhaust Pressure Differential Sensor Replacement**
- **Fan Blade Clutch Replacement (LWN)**
- **Fuel Rail Pressure Sensor Replacement**
- **Intake Manifold Tuning Valve Vacuum Control Solenoid Valve Replacement**
- **Mass Airflow Sensor with Intake Air Temperature Sensor Replacement**
- **Throttle Body Assembly Replacement**
- For control module replacement, programming, and setup refer to **Control Module References**

DTC P064C

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 P064C

Glow Plug Control Module Performance

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Circuit/System Description

For an overview of the component/system, refer to **Glow Plug System Description**

The control module K20 controls the component: Glow Plugs

Conditions for Running the DTC

- DTC P161E, P0671-P0674 = Not set
- Glow Plugs = On
- Ignition Voltage = Greater than 11 V

Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

K20 Engine Control Module - Glow Plug Control = Internal Malfunction 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

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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 P161E is not set.
    - **If DTC P161E is set**

      Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**

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- Go to next step: If DTC P161E is not set

3. Verify DTC P064C is not set.
   - **If the DTC is set**

     Replace the component: K20 Engine Control Module

   - **Go to next step: If the DTC is not set**
4. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

For control module replacement, programming, and setup refer to **Control Module References**

DTC P0650, P263A, OR P263B - MALFUNCTION INDICATOR LAMP (MIL) MALFUNCTION (LWN)

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

NOTE: **Use this procedure only if the control module is equipped with a hard-wired control circuit for the indicator. If the control module controls the indicator with a serial data message, refer to Symptoms - Displays and Gauges**

DTC P0650

Malfunction Indicator Lamp (MIL) Control Circuit

DTC P263A

Malfunction Indicator Lamp (MIL) Control Circuit Low Voltage

DTC P263B

Malfunction Indicator Lamp (MIL) Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition @ P16 Instrument Cluster	P0650	P0650	-	-
Control @ K20 Engine Control Module	P0650, P263A*	P0650, P263A	P263B	-
*Malfunction Indicator Lamp (MIL) = Always On				

Circuit/System Description

Circuit	Description
Ignition @ P16 Instrument Cluster	Supplied from a fuse.

Circuit	Description
Control @ K20 Engine Control Module	The output circuit is switched to ground to activate the component.

Component	Description
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.
P16 Instrument Cluster	The instrument cluster houses several displays and gauges to inform the driver about various parameters of the vehicle.

Conditions for Running the DTC

- Ignition = On
- Ignition Voltage = Greater than 11 V
- Remote Vehicle Start = Inactive

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**
- **Instrument Cluster Wiring Schematics**

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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

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Circuit/System Verification

1. Ignition - On / Vehicle - In Service Mode
2. Perform the scan tool control function: Malfunction Indicator Lamp (MIL) - On and Off

   Verify the scan tool parameter:

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

     Refer to: Circuit/System Testing

   - **Go to next step: If the specified state**
3. Perform the scan tool control function: Malfunction Indicator Lamp (MIL) - On and Off

   Verify the component turns On and Off: Malfunction Indicator Lamp (MIL) @ P16 Instrument Cluster

   - **If the component does not turn On and Off**

     Refer to: Circuit/System Testing

   - **Go to next step: If the component turns On and Off**
4. Verify a condition does not exist with the component: Malfunction Indicator Lamp (MIL) @ P16 Instrument Cluster - Turns Off

   Perform the action while monitoring the component: Wiggle the harness and connector: X1 @ K20 Engine Control Module

   - **If a condition exists**

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

   - **Go to next step: If no condition exists**
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 that no DTCs are 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 ignition fuse that supplies voltage to the component is not open: P16 Instrument Cluster
   - **If the fuse is open**
   1. Ignition/Vehicle - Off
   2. Disconnect the electrical connector: P16 Instrument Cluster
   3. Test for infinite resistance between the test points: Ignition circuit terminal 8 & Ground
      - If less than infinite resistance - Repair the short to ground on the circuit.
      - If infinite resistance - Replace the component: P16 Instrument Cluster

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- **Go to next step: If the fuse is not open**

2. Ignition/Vehicle - Off
3. Disconnect the appropriate electrical connector: K20 Engine Control Module
4. Ignition - On / Vehicle - In Service Mode
5. Verify the component works as specified: Malfunction Indicator Lamp (MIL) = Off
    - **If the component does not work as specified**
    1. Ignition/Vehicle - Off
    2. Test for infinite resistance between the test points: Control circuit terminal 18 X1 & Ground
        - If less than infinite resistance - Repair the short to ground on the circuit.
        - If infinite resistance - Replace the component: P16 Instrument Cluster
    - **Go to next step: If the component works as specified**
6. Ignition/Vehicle - Off
7. Connect a 3 A fused jumper wire between the test points: Control circuit terminal 18 X1 & Ground
8. Ignition - On / Vehicle - In Service Mode
9. Verify the component works as specified: Malfunction Indicator Lamp (MIL) = On
    - **If the component does not work as specified**
    1. Ignition/Vehicle - Off & Remove - Jumper wire(s)
    2. Disconnect the appropriate electrical connector: P16 Instrument Cluster
    3. Ignition - On / Vehicle - In Service Mode
    4. Test for less than 1 V between the test points: Control circuit terminal 18 X1 @ Control module harness & Ground
        - If 1 V or greater - Repair the short to voltage on the circuit.
        - Go to next step: If less than 1 V
    5. Ignition/Vehicle - Off
    6. Test for less than 2 ohms between the test points: Control circuit terminal 16 @ Component harness & The other end of the circuit @ Control module harness
        - If 2 ohms or greater - Repair the open/high resistance in the circuit.
        - Go to next step: If less than 2 ohms
    1. Test for less than 2 ohms between the test points: Ignition circuit terminal 8 @ Component harness & Output terminal @ Fuse
        - If 2 ohms or greater - Repair the open/high resistance in the circuit.
        - If less than 2 ohms - Replace the component: P16 Instrument Cluster
    - **Go to next step: If the component works as specified**
10. Replace the component: K20 Engine Control Module

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Instrument Cluster Replacement**
- For control module replacement, programming, and setup refer to **Control Module References**

DTC P0658 OR P0659

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**

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- An overview of each diagnostic category can be found here: **Diagnostic Procedure Instructions**

DTC Descriptor

DTC P0658

Actuator High Control Circuit Group 1 Low Voltage

DTC P0659

Actuator High Control Circuit Group 1 High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition	P0102, P0658	P0102	P0659, P0690	P0101

Typical Scan Tool Data

MAF Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine = Running - At Idle Speed **Parameter Normal Range:** 2, 700 to 3, 860 Hz			
Ignition	0 Hz	0 Hz	-
Signal	0 Hz	0 Hz	0 Hz
Ground	-	0 Hz	-

Circuit/System Description

Circuit	Description
Ignition	Regulated voltage supplied by the control module.
Signal	The control module input circuit has an internal resistance connected to 5 V.
Ground	Chassis Ground

Component	Description
B75C Multifunction Intake Air Sensor	The assembly has several functions: • The mass air flow sensor is a hot film type sensor that measures the mass of air (not the volume) entering the engine. The signal varies with engine load and is displayed by the scan tool in Hertz (Hz) and grams per second (g/s). • The intake air humidity sensor uses the same signal circuit as the intake air temperature sensor 2. The intake air humidity sensor modulates the pulse width of the signal. The intake air temperature sensor 2 modulates the frequency of the signal. That means the signal is both, PWM and FM modulated. • The barometric pressure sensor generates an analog voltage that is proportional to the ambient air pressure. • The intake air temperature sensor 1 varies its resistance depending on the temperature. • Low temperature produces a high resistance: 1, 166 ohms @ 40B°C (104B°F)

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Component	Description
	• High temperature produces a low resistance: 97 ohms @ 130B°C (266B°F)

Conditions for Running the DTC

- Engine = Not Running
- Ignition = On
- Ignition Voltage = Greater than 11 V

Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

Control Module Voltage Signal = Commanded state does not match the actual state

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

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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. Verify the vehicle is equipped as specified: Stop/Start System (KL9)
   - **If not equipped as specified**

     DTC P0658, P0659 is not applicable, no action required

   - **Go to next step: If equipped as specified**

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2. Ignition - On / Vehicle - In Service Mode
3. Verify DTC P0102, P0103 is not set.
    - **If any of the DTCs are set**

      Refer to **DTC P0101-P0103**

    - **Go to next step: If none of the DTCs are set**
4. Verify the scan tool parameter: MAF Sensor = The value should not spike or drop out.

   Perform the action while monitoring the parameter:

    - Wiggle the harness and connector: B75C Multifunction Intake Air 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 is set**

      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: B75C Multifunction Intake Air Sensor
3. Ignition - On / Vehicle - In Service Mode
4. Verify a test lamp turns On between the test points: Ignition circuit terminal 3 & Ground
    - **If the test lamp does not turn On and the circuit fuse is OK**
    1. Ignition/Vehicle - Off & Remove - Test lamp
    2. Test for less than 2 ohms between the test points: Ignition circuit terminal 3 & Output terminal @ Fuse
        - If 2 ohms or greater - Repair the open/high resistance in the circuit.
        - If less than 2 ohms - Verify the fuse is OK and there is voltage at the fuse.
    - **If the test lamp does not turn On and the circuit fuse is open**
    1. Ignition/Vehicle - Off & Remove - Test lamp
    2. Test for infinite resistance between the test points: Ignition circuit terminal 3 & Ground
        - If less than infinite resistance - Repair the short to ground on the circuit.
        - Go to next step: If infinite resistance
    - **Go to next step: If the test lamp turns On**
5. Test or replace the component: B75C Multifunction Intake Air Sensor

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

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- Mass Airflow Sensor with Intake Air Temperature Sensor Replacement
- For control module replacement, programming, and setup refer to Control Module References

Additional Procedures

BARO Sensor Reset - Perform only when the following component/system is replaced or serviced:

B75C Multifunction Intake Air Sensor - Cleaned/Replaced

DTC P066A-P066F, P0671-P0674, P067A, OR P067B

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 P066A

Cylinder 1 Glow Plug Control Circuit Low Voltage

DTC P066B

Cylinder 1 Glow Plug Control Circuit High Voltage

DTC P066C

Cylinder 2 Glow Plug Control Circuit Low Voltage

DTC P066D

Cylinder 2 Glow Plug Control Circuit High Voltage

DTC P066E

Cylinder 3 Glow Plug Control Circuit Low Voltage

DTC P066F

Cylinder 3 Glow Plug Control Circuit High Voltage

DTC P0671

Cylinder 1 Glow Plug Control Circuit

DTC P0672

Cylinder 2 Glow Plug Control Circuit

DTC P0673

Cylinder 3 Glow Plug Control Circuit

DTC P0674

Cylinder 4 Glow Plug Control Circuit

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DTC P067A

Cylinder 4 Glow Plug Control Circuit Low Voltage

DTC P067B

Cylinder 4 Glow Plug Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Control - Terminal 1/A @ E12A Glow Plug 1	P066A	P0671	P066B	-
Control - Terminal 1/A @ E12B Glow Plug 2	P066C	P0672	P066D	-
Control - Terminal 1/A @ E12C Glow Plug 3	P066E	P0673	P066F	-
Control - Terminal 1/A @ E12D Glow Plug 4	P067A	P0674	P067B	-

Typical Scan Tool Data

Cylinder 1 - 4 Glow Plug Control Circuit High Voltage Test Status

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition On **Parameter Normal Range:** OK or Not Run			
Control - Terminal 1/A	-	-	Malfunction

Cylinder 1 - 4 Glow Plug Control Circuit Low Voltage Test Status

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition On **Parameter Normal Range:** OK or Not Run			
Control - Terminal 1/A	Malfunction	-	-

Cylinder 1 - 4 Glow Plug Control Circuit Open Test Status

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition On **Parameter Normal Range:** OK or Not Run			
Control - Terminal 1/A	-	Malfunction	-

Circuit/System Description

For an overview of the component/system, refer to **Glow Plug System Description**

Circuit	Description
Control	The output circuit is switched to 12 V to activate the component. When the output is commanded On, the voltage can range between 6.8 and 12 V. The output is PWM controlled.

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Component	Description
E12 Glow Plug	Glow plugs are electric heating devices in the combustion chambers of diesel engines.
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.

Conditions for Running the DTC

- Ignition = On
- Engine cranking. = No
- Ignition Voltage = Greater than 11 V
- E12 Glow Plug = On

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

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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

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2. Verify DTC P066A - P066F, P0671 - P0674, P067A, or P067B is not set.
    - **If DTC P066A - P066F, P0671 - P0674, P067A, or P067B is set**

      Refer to: Circuit/System Testing

    - **Go to next step: If DTC P066A - P066F, P0671 - P0674, P067A, or P067B 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.

   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/Vehicle - Off
2. Disconnect the appropriate electrical connector: E12 Glow Plug
3. Ignition - On / Vehicle - In Service Mode
4. Connect a test lamp between the test points: Control circuit terminal 1/A & Ground
5. Perform the scan tool control function: Glow Plugs - On and Off

   Verify the test lamp turns On and Off.

    - **If the test lamp is always Off**
    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/A @ Component harness & Ground
        - If less than infinite resistance - Repair the short to ground on the circuit.
        - Go to next step: If infinite resistance
    4. Test for less than 2 ohms between the test points: Control circuit terminal 1/A @ 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 the test lamp is always On**
    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/A @ 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 test lamp turns On and Off**
6. Test or replace the component: E12 Glow Plug

Component Testing

1. Ignition/Vehicle - Off

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2. Disconnect the appropriate electrical connector: E12 Glow Plug
3. Test for 0.3 to 1.0 ohms between the test points: Control terminal 1/A & The component's housing
    - **If not between 0.3 and 1.0 ohms**

      Replace the component: E12 Glow Plug

    - **Go to next step: If between 0.3 and 1.0 ohms**
4. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Glow Plug Replacement**
- For control module replacement, programming, and setup refer to **Control Module References**

DTC P0685-P0687, P0689, P0690, P1682, P16A7, P16AF, OR P16B3

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 P0685

Engine Controls Ignition Relay Control Circuit

DTC P0686

Engine Controls Ignition Relay Control Circuit Low Voltage

DTC P0687

Engine Controls Ignition Relay Control Circuit High Voltage

DTC P0689

Engine Controls Ignition Relay Feedback Circuit Low Voltage

DTC P0690

Engine Controls Ignition Relay Feedback Circuit High Voltage

DTC P1682

Ignition 1 Switch Circuit 2

DTC P16A7

Engine Controls Ignition Relay Feedback Circuit 2

DTC P16AF

Engine Controls Ignition Relay Feedback Circuit 2 Low Voltage

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DTC P16B3

Engine Controls Ignition Relay Feedback Circuit 2 High Voltage

Diagnostic Fault Information

Circuit*	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+ - Relay Coil	P0689, P1682	P0685, P0689, P1682, P16A7, P16AF	-	-
B+ - Relay Switch	P0689, P1682	P0685, P0689, P1682, P16A7, P16AF	-	-
Control - Component	P0689, P1682	P0685, P0689, P1682, P16A7, P16AF	P0690, P16B3, P16BF	-
Control - Relay Coil	P0686, P0690	P0685, P0689, P1682, P16A7, P16AF	P0685, P0687, P0689, P1682	-
*For detailed component terminal information, refer to: Diagnostic Aids				

Circuit/System Description

Circuit*	Description
B+ - Relay Coil	Supplied directly from the battery.
B+ - Relay Switch	Supplied directly from the battery.
Control - Component	The output circuit is switched to 12 V to activate the component.
Control - Relay Coil	The output circuit is switched to ground to activate the component.
*For detailed component terminal information, refer to: Diagnostic Aids	

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.
KR75 Engine Controls Ignition Relay	Relays are used to control a high power circuit with a low power signal.

2 ignition voltage circuits supply the ECM. The 2 circuits are supplied by 2 relay(s):KR73 Ignition Main Relay & KR75 Engine Controls Ignition Relay

The ECM monitors and compares the voltages supplied by the relay(s).

Conditions for Running the DTC

P0685, P0686, P0687

- Ignition Voltage = Greater than 11 V

Frequency the DTC runs = Continuously - After the running conditions are met

P0689, P16AF

- Engine Controls Ignition Relay Command = On
- Ignition Voltage = Greater than 9 V

Frequency the DTC runs = Continuously - After the running conditions are met

P0690

- DTC P0685, P0686, P0687 = Not set
- Engine Controls Ignition Relay Command = Off - For greater than 2 s

Frequency the DTC runs = Continuously - After the running conditions are met

P1682, P16A7

- Engine Controls Ignition Relay Command = On
- Ignition Voltage = Greater than 5.5 V

Frequency the DTC runs = Continuously - After the running conditions are met

P16B3

- Engine Controls Ignition Relay Command = Inactive

Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

P0685, P0686, P0687

Control Circuit = Commanded state does not match the actual state - Greater than 2 s

P0689, P16AF

Engine Controls Ignition Relay Feedback Signal = Commanded state does not match the actual state - Greater than 6 s

P0690, P16B3

Engine Controls Ignition Relay Feedback Signal = Commanded state does not match the actual state - Greater than 6 s

P1682, P16A7

The following parameters are not within 3 V of each other:

- Ignition 1 Signal
- Engine Controls Ignition Relay Feedback Signal
- Engine Controls Ignition Relay Feedback 2 Signal

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type B DTC - Exceptions listed below

DTC P1682, P16A7 = Type A DTC

DTC P16AF = Type C DTC

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Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type B DTC - Exceptions listed below

DTC P1682, P16A7 = Type A DTC

DTC P16AF = Type C DTC

Diagnostic Aids

Use the schematics to identify the items/configurations listed below:

Terminal Identification

Circuit	Configuration 1	Configuration 2	Configuration 3	Configuration 4	Configuration 5
B+ - Relay Coil	85	85	86	30	1
B+ - Relay Switch	30	87	30	86	3
Control - Component	87	30	87	85	5
Control - Relay Coil	86	86	85	87	2

Reference Information

Schematic Reference

- **Engine Controls Wiring Schematics**
- **Power Distribution Wiring Schematics**

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **Component Connector End Views - Index**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Electrical Relay Replacement (Attached to Wire Harness)** , or **Electrical Relay Replacement (Within an Electrical Center)**
- **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 - Cycle Off and On & Cycle On and Off

   Verify a click can be heard or felt at the component when the ignition was cycled: KR75 Engine Controls Ignition Relay

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- **If a click cannot be heard or felt**

  Refer to: Circuit/System Testing

- **Go to next step: If a click can be heard or felt**

2. Verify the following parameters are within 3 V of each other:
   - Engine Controls Ignition Relay Feedback Signal
   - Ignition 1 Signal

     or

   - Engine Controls Ignition Relay Feedback 2 Signal
   - Ignition 1 Signal
   - **If not within 3 V of each other**

     Refer to: Circuit/System Testing

   - **Go to next step: If within 3 V of each other**
3. Verify the scan tool parameter:
   - Engine Controls Ignition Relay Feedback Signal = The value should not spike or drop out.
   - Engine Controls Ignition Relay Feedback 2 Signal = The value should not spike or drop out.
   - Perform the action while monitoring the parameter:
   - Wiggle the harness and connector: K20 Engine Control Module
   - Wiggle the harness and connector: X50A Fuse Block - Underhood
   - **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**
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.

   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

NOTE:

- **For detailed component terminal information, refer to: Diagnostic Aids**
- **Circuit 5290 / 5291 / 5292 referenced in this procedure are not applicable to all applications.**

1. Ignition/Vehicle & All vehicle systems - Off
2. Remove the component: KR75 Engine Controls Ignition Relay
3. Ignition - On / Vehicle - In Service Mode
4. Verify a test lamp turns On between the test points:
   - B+ - Relay Coil & Ground

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- B+ - Relay Switch & Ground
- **If the test lamp does not turn On**

  Replace the component: X50A Fuse Block - Underhood

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

5. Connect a test lamp between the test points: B+ - Relay Coil & Control - Relay Coil
6. Perform the scan tool control function: Engine Controls Ignition Relay - On and Off

   Verify the test lamp turns On and Off.

   - **If the test lamp is always Off**
   1. Ignition/Vehicle - Off & Remove - Test lamp
   2. Disconnect the appropriate electrical connector: K20 Engine Control Module
   3. Ignition - On / Vehicle - In Service Mode
   4. Test for less than 1 V between the test points: Control - Relay Coil @ Relay Socket & Ground
      - If 1 V or greater - Repair the short to voltage on the circuit.
      - Go to next step: If less than 1 V
   5. Ignition/Vehicle - Off
   6. Test for less than 2 ohms between the test points: Control - Relay Coil @ Relay Socket & 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 the test lamp is always On**
   1. Ignition/Vehicle - Off & Remove - Test lamp
   2. Disconnect the appropriate electrical connector: K20 Engine Control Module
   3. Test for infinite resistance between the test points: Control - Relay Coil @ Relay Socket & 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 turns On and Off**
7. Verify the fuse that supplies voltage to the following circuit(s) is not open: 5290 / 5291 / 5292 - For the circuit that set the DTC.
   - **If the fuse is open**
   1. Ignition/Vehicle & All vehicle systems - Off
   2. Disconnect the appropriate electrical connector: K20 Engine Control Module
   3. Test for infinite resistance between the test points: Output terminal @ Fuse & 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 fuse is not open**
8. Verify a test lamp does not turn On between the test points: Control - Component @ Relay Socket & Ground
   - **Go to next step: If the test lamp turns On**
   1. Ignition/Vehicle & All vehicle systems - Off
   2. Disconnect the appropriate electrical connector: K20 Engine Control Module
   3. Ignition - On / Vehicle - In Service Mode
   4. Test for less than 1 V between the circuits: 5290 / 5291 / 5292 @ Control module harness & Ground
      - If 1 V or greater - Repair the short to voltage on the circuit.

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- If less than 1 V - Replace the component: K20 Engine Control Module
- **Go to next step: If the test lamp does not turn On**

9. Ignition/Vehicle - Off
10. Connect a 30 A fused jumper wire between the test points: Control - Component & B+ - Relay Switch @ Relay Socket
11. Ignition - On / Vehicle - In Service Mode
12. Verify the scan tool parameter:
    - Engine Controls Ignition Relay Feedback Signal = Within 1 V of the battery voltage
    - Engine Controls Ignition Relay Feedback 2 Signal = Within 1 V of the battery voltage
    - **If not within 1 V of the battery voltage**
    1. Ignition/Vehicle - Off & Remove - Jumper wire(s)
    2. Disconnect the appropriate electrical connector: K20 Engine Control Module
    3. Test circuit 5290 / 5291 / 5292 for less than 2 between the test points: Control - Component @ Relay Socket & 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 within 1 V of the battery voltage**
13. Test or replace the component: KR75 Engine Controls Ignition Relay

Component Testing

NOTE: **For detailed component terminal information, refer to: Diagnostic Aids**

1. Ignition/Vehicle - Off
2. Remove the component: KR75 Engine Controls Ignition Relay
3. Test for 70 to 110 ohms between the test points: B+ - Relay Coil & Control - Relay Coil
    - **If not between 70 and 110 ohms**

      Replace the component: KR75 Engine Controls Ignition Relay

    - **Go to next step: If between 70 and 110 ohms**
4. Test for infinite resistance between the test points:
    - B+ - Relay Switch & B+ - Relay Coil
    - B+ - Relay Switch & Control - Relay Coil
    - B+ - Relay Switch & Control - Component
    - B+ - Relay Coil & Control - Component
    - **If less than infinite resistance**

      Replace the component: KR75 Engine Controls Ignition Relay

    - **Go to next step: If infinite resistance**
5. Connect a 3 A fused jumper wire between the test points: B+ - Relay Coil & B+

   Connect a jumper wire between the test points: Control - Relay Coil & Ground

6. Test for less than 2 ohms between the test points: B+ - Relay Switch & Control - Component
    - **If 2 ohms or greater**

      Replace the component: KR75 Engine Controls Ignition Relay

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

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7. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Fuse Block Replacement**
- **Electrical Relay Replacement (Attached to Wire Harness)** , or **Electrical Relay Replacement (Within an Electrical Center)**
- For control module replacement, programming, and setup refer to **Control Module References**

DTC P0700

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 P0700

Transmission Control Module Requested MIL Illumination

Circuit/System Description

The DTC is an informational DTC. The DTC indicates an emission related DTC set in the following control module: K71 Transmission Control Module

The control module K20 turns on the malfunction indicator lamp (MIL) when the requesting control module sends a message over serial data.

Conditions for Running the DTC

Ignition = On or Engine = Running - For greater than 3 s

Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

An emission related DTC set in the following control module: K71 Transmission Control Module

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type A DTC

Malfunction Indicator Lamp (MIL) = On

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type A DTC

Reference Information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

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Control Module References

Circuit/System Verification

NOTE:

- **Do NOT replace the control module if DTC P0700 is set.**
- **DTC P0700 is an informational DTC.**
- **Correct any Engine Controls and Serial Data DTCs before diagnosing the following system/component DTCs: Transmission**

1. Verify there are no DTCs set related to the following component/system:
   - Engine Controls and Fuel
   - Serial Data
   - **If a related DTC is set**

     Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**

   - **Go to next step: If a related DTC is not set**
2. Verify there are no DTCs set related to the following component/system: Transmission
   - **If a related DTC is set**

     Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**

   - **Go to next step: If a related 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.

   Verify no other DTCs are set.

   - **If other DTCs are set**

     Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**

   - **Go to next step: If no other DTCs are set**
4. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

DTC P1000, P1001, P1003, P1009, P10C6, P10F5, P1100, P1103, P11FF, P1200, P128C, P128D, P128F, P129E, P12A8, P130F, P139A, P139B, P14CD, P14CE, P14D4-P14D6, P15F9, P15FB, P165C, P167F, P16FF, P175F, P1772, P30DE, P314E, OR P316B

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 P1000

Fuel Pump Driver Control Module Reset Count Message Counter Incorrect

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DTC P1001

Evaporative Emission (EVAP) System Signals Message Counter Incorrect

DTC P1003

Fuel Composition Signals Message Counter Incorrect

DTC P1009

Fuel Pump Driver Control Module Temperature High Signal Message Counter Incorrect

DTC P10C6

Engine Diagnostic Status Signal Message Counter Incorrect

DTC P10F5

EVAP Purge Pump Status Message Counter Incorrect

DTC P1100

Fuel Level Sensor 2 Signal Message Counter Incorrect

DTC P1103

Water in Fuel Signal Message Counter Incorrect

DTC P11FF

Fuel Pump Command Signal Message Counter Incorrect

DTC P1200

Fuel Level Sensor 1 Signal Message Counter Incorrect

DTC P128C

Fuel Rail Temperature Sensor 1 Signal Message Counter Incorrect

DTC P128D

Fuel Rail Temperature Sensor 2 Signal Message Counter Incorrect

DTC P128F

Fuel Rail Pressure Sensors 1 and 2 Signals Message Counter Incorrect

DTC P129E

Fuel Level Sensor Control Module Signal Message Counter Incorrect or Fuel Pump Driver Control Module Signal Message Counter Incorrect

DTC P12A8

Fuel Pump Control Status Signal Message Counter Incorrect

DTC P130F

Ignition On/Start Voltage Signal Message Counter Incorrect

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DTC P139A

Glow Plug Control Module Diagnostic Status Signal 1 Message Counter Incorrect

DTC P139B

Glow Plug Control Module Diagnostic Status Signal 2 Message Counter Incorrect

DTC P14CD

Fuel Pump Driver Control Module Configuration Command Signal 1 Message Counter Incorrect

DTC P14CE

Fuel Pump Driver Control Module Configuration Status Signal Message Counter Incorrect

DTC P14D4

Fuel Pump Driver Control Module Configuration Command Signal 2 Message Counter Incorrect

DTC P14D5

Fuel Pump Driver Control Module Configuration Command Signal 3 Message Counter Incorrect

DTC P14D6

Fuel Pump Driver Control Module Configuration Command Signal 5 Message Counter Incorrect

DTC P15F9

Hybrid/EV System Engine Speed Control Intervention Request Type Signal Message Counter Incorrect

DTC P15FB

Brake Pedal Position Sensor Signal Message Counter Incorrect

DTC P165C

Sensor Reference Voltage Status Message Counter Incorrect

DTC P167F

Battery Voltage Signal Message Counter Incorrect

DTC P16FF

Engine Controls Ignition Relay Request Signal Message Counter Incorrect

DTC P175F

Acceleration Sensor Signal Message Counter Incorrect

DTC P1772

Powerflow Engaged Signal Message Counter Incorrect

DTC P30DE

Fuel Rail Pressure Sensor 2 Signal Message Counter Incorrect

DTC P314E

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Fuel Heater Control Module Status Signal Message Counter Incorrect

DTC P316B

Secondary Fuel System Requests Signal Message Counter Incorrect

Circuit/System Description

Control modules connected to the serial data circuits monitor the communication during normal vehicle operation. Operating information and commands are exchanged among the control modules. Each module on the serial data circuit maintains a transmit error counter and a receive error counter. The counter values increase with detected errors and decrease with error-free messages.

Conditions for Running the DTC

- Ignition = On - For greater than 3 s
- Serial Data = Enabled

Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

Serial Data = Message Counter Incorrect - Component

The above condition(s) must occur 5 times.

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type B DTC - Exceptions listed below

- DTC P10C6, P128F, P14CE, P15F2, P30DE, P316B = Type A DTC
- DTC P1103, P155D, P15FB, P175F = Type C DTC

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type B DTC - Exceptions listed below

- DTC P10C6, P128F, P14CE, P15F2, P30DE, P316B = Type A DTC
- DTC P1103, P155D, P15FB, P175F = Type C DTC

Reference Information

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 there are no DTCs set related to the following component/system: Serial Data
   - **If a related DTC is set**

     Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**

   - **Go to next step: If a related DTC is not set**
3. Clear the DTCs.

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4. Operate the vehicle within the Conditions for Running the DTC.

   Verify the DTC does not set.

   - **If the DTC sets**

   1. Ignition/Vehicle - Off
   2. Replace the component: Transmitting Component - Refer to **Transmitting and Receiving Components**
   3. Operate the vehicle within the Conditions for Running the DTC.

      Verify the DTC does not set.

      - If the DTC sets

        Replace the component: Receiving Component - Refer to **Transmitting and Receiving Components**

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

   4. All OK.

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

5. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

For control module replacement, programming, and setup refer to **Control Module References**

DTC P1004, P119D-P119F, P11BE, P11BF, P11C0, P11C7, P11C8, P11D0-P11D2, P11D5, P11D8, P11D9, P11DA, P11DC, P11FC-P11FE, P22A0, P22A1, P22A3-P22A9, OR P22FE

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.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P119D

NOx Sensor 2 Signal Circuit

DTC P119E

NOx Sensor 2 Signal Circuit Low Voltage

DTC P119F

NOx Sensor 2 Signal Circuit High Voltage

DTC P11BE

O2 Reference Voltage Circuit (NOx Sensor 2)

DTC P11BF

O2 Reference Voltage Circuit Low Voltage (NOx Sensor 2)

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DTC P11C0

O2 Reference Voltage Circuit High Voltage (NOx Sensor 2)

DTC P11C7

NOx Sensor 2 Heater Ground Circuit

DTC P11C8

NOx Sensor 2 Heater Ground Circuit High

DTC P11D0

O2 Signal Circuit (NOx Sensor 2)

DTC P11D1

O2 Signal Circuit Low Voltage (NOx Sensor 2)

DTC P11D2

O2 Signal Circuit High Voltage (NOx Sensor 2)

DTC P11D5

NOx Sensor 2 Exceeded Minimum Learning Limit

DTC P11D8

O2 Pump Current Control Circuit (NOx Sensor 2)

DTC P11D9

O2 Pump Current Control Circuit Low Voltage (NOx Sensor 2)

DTC P11DA

O2 Pump Current Control Circuit High Voltage (NOx Sensor 2)

DTC P11DC

NOx Sensor 2 Current Performance

DTC P11FC

O2 Low Reference Circuit (NOx Sensor 2)

DTC P11FD

O2 Low Reference Circuit Low Voltage (NOx Sensor 2)

DTC P11FE

O2 Low Reference Circuit High Voltage (NOx Sensor 2)

DTC P22A0

NOx Sensor 2 Circuit Low Voltage

DTC P22A1

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NOx Sensor 2 Circuit High Voltage

DTC P22A3

NOx Sensor 2 Heater Control Circuit

DTC P22A4

NOx Sensor 2 Heater Control Circuit Low Voltage

DTC P22A5

NOx Sensor 2 Heater Control Circuit High Voltage

DTC P22A6

NOx Sensor 2 Heater Feedback Circuit

DTC P22A7

NOx Sensor 2 Heater Feedback Performance

DTC P22A8

NOx Sensor 2 Heater Feedback Circuit Low Voltage

DTC P22A9

NOx Sensor 2 Heater Feedback Circuit Low Voltage

DTC P22FE

NOx Sensor 2 Performance - Sensing Element

Circuit/System Description

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 the 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 DTCs

P119D, P119E, P119F, P11BE, P11BF, P11C0, P11C7, P11C8, P11D0, P11D1, P11D2, P11D8, P11D9, P11DA, P11FC, P11FD, P11FE, P22A3, P22A4, P22A5, P22A6, P22A8, P22A9

- DTC U029E is not set
- The ignition voltage is greater than 11 V

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- The NOx Sensor 2 Heater Operation parameter displays Allowed
- The NOx sensor supply voltage is greater than 10.8 V.

These DTCs run continuously when the above conditions are met

P11D5

- DTC P003A, P0087, P00C7, P00E9, P00EA-P00EC, P0101, P0102, P0103, P0106, P0107, P0108, P0116, P0117, P0118, P0119, P0128, P0201-P0204, P020A-P020D, P0216, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P02E0, P02E2-P02E5, P02E8, P02E9, P02EB, P02EE, P02EF, P02F0, P02F1, P0335, P0336, P0400, P0403, P0405, P0406, P042E, P042F, P049D, P0490, P062B, P062D, P111E, P119D-P119F, P11BE, P11BF, P11C0, P11C7, P11C8, P11D0-P11D2, P11D8, P11D9, P11DA, P11DC, P11DE, P11FC-P11FE, P122B-P122D, P1248, P1249, P124A, P124B, P1402, P1407, P140F, P1424, P1425, P16A0, P16A1, P16A2, P16D7-P16D9, P2147, P2148, P2150, P2151, P220B, P228A, P228B, P229E, P22A0, P22A1, P22A3-P22A9, P22FE, P2459, P245C, P2262, U029E is not set
- The ignition voltage is greater than 11 V
- The NOx Sensor 2 Heater Operation parameter displays Allowed
- The NOx sensor supply voltage is greater than 10.8 V.
- The engine speed is between 550 - 4, 500 RPM.
- The injection fuel quantity is less than $20mm^3$.
- Time elapsed since diesel particulate filter regeneration is greater than 300 s.

These DTCs run continuously when the above conditions are met

P11DC

- DTC P119D-P119F, P11BE, P11BF, P11C0, P11C7, P11C8, P11D0-P11D2, P11D8, P11D9, P11DA, P11DE, P11FC-P11FE, P220B, P229E, P22A3-P22A9, or U029E is not set.
- The engine is running.
- The ignition voltage is greater than 11 V.
- The NOx Sensor 2 Heater Operation parameter displays Allowed.
- The injection fuel quantity is less than $35mm^3$.
- The NOx sensor supply voltage is greater than 10.8 V.

The DTC runs continuously when the above conditions are met.

P22A0, P22A1

- DTC P119D-P119F, P11BE, P11BF, P11C0, P11C7, P11C8, P11D0-P11D2, P11D8, P11D9, P11DA, P11DC, P11DE, P11FC-P11FE, P220B, P229E, P22A3-P22A9, or U029E is not set.
- The engine is running.
- The ignition voltage is greater than 11 V.
- The NOx Sensor 2 Heater Operation parameter displays Allowed
- The NOx sensor supply voltage is greater than 10.8 V.

These DTCs run continuously when the above conditions are met.

P22A7

- DTC U029E is not set
- The ignition voltage is greater than 11 V.
- The NOx Sensor 2 Heater Operation parameter displays Allowed
- The NOx sensor supply voltage is greater than 10.8 V.

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The DTC runs continuously when the above conditions are met for greater than 180 s.

P22FE

- DTC P0070, P0071, P0072, P0073, P00C7, P0E9, P0EA-P0EC, P0101, P0102, P0103, P0106, P0107, P0108, P0116, P0117, P0118, P0119, P0128, P0201-P0204, P020A-P020D, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P02EE, P02EF, P02F0, P02F1, P0335, P0336, P0405, P0406, P049D, P0545, P0546, P062B, P062D, P111E, P113B, P113C, P113D, P113F, P115E, P115F, P1160, P116A, P116B, P116C, P116D, P116E, P116F, P118E, P118F, P1192-P1194, P1196, P1198, P119A-P119F, P11BE, P11BF, P11C0, P11C5-P11C8, P11CC, P11D0-P11D2, P11D8, P11D9, P11DA-P11DD, P11FC-P11FE, P1248, P1249, P124A, P124B, P2032, P2033, P2081, P2085, P20CB, P20CD, P20CE, P2147, P2148, P2150, P2151, P2200, P2205-P2211, P220A, P220B, P2227, P2228, P2229, P2230, P229E, P22A0, P22A1, P22A3-P22A9, P22F9, P22FA, P242C, P242D, P242E, P2452, P2453, P2454, P2455, P2456, P2481, P2482, P2484, P262B, P2670, U029D or U029E is not set
- The Engine Controls Ignition Relay Feedback Signal voltage is greater than 11 V
- The NOx Sensor 1 and 2 Heater Operation parameters display Allowed
- The NOx sensor supply voltage is greater than 10.8 V.
- The engine speed is between 0 - 1, 500 RPM.

The DTC runs up to 10 times 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 for greater than 2 s.

Action Taken When the DTC Sets

DTCs P119E, P119F, P11BF, P11C0, P11C8, P11D1, P11D2, P11D5, P11D9, P11DA, P11DC, P11FD, P11FE, P22A0, P22A1, P22A4, P22A5, P22A7, P22A8, and P22A9 are Type B DTCs.

DTCs P119D, P11BE, P11C7, P11D0, P11D8, P11FC, P22A3, P22A6, and P22FE are Type A DTCs.

Conditions for Clearing the DTC

DTCs P119E, P119F, P11BF, P11C0, P11C8, P11D1, P11D2, P11D5, P11D9, P11DA, P11DC, P11FD, P11FE, P22A0, P22A1, P22A4, P22A5, P22A7, P22A8, and P22A9 are Type B DTCs.

DTCs P119D, P11BE, P11C7, P11D0, P11D8, P11FC, P22A3, P22A6, and P22FE are Type A DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **Component Connector End Views - Index**

Electrical Information Reference

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

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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 P119D, P119E, P119F, P11BE, P11BF, P11C0, P11C7, P11C8, P11D0, P11D1, P11D2, P11D5, P11D8, P11D9, P11DA, P11DC, P11FC, P11FD, P11FE, P22A0, P22A1, P22A3, P22A4, P22A5, P22A6, P22A7, P22A8, P22A9, or P22FE are not set
   - **If any of the DTCs are set**

     Replace the B195B Nitrogen Oxides Sensor 2

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

     Replace the B195B Nitrogen Oxides Sensor 2

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

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Nitrogen Oxides Sensor Replacement - Position 2

DTC P1008, P103D, P103E, P10C7, P10C8, P117A, P1436, P143A, P143B, P30B4, P30B5, P30BC, OR P30D5

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 P1008

Engine Coolant Bypass Valve Command Signal Message Counter Incorrect

DTC P103D

Engine Coolant Pump Control Signal Message Counter Incorrect

DTC P103E

Auxiliary Coolant Pump Control Signal Message Counter Incorrect

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DTC P10C7

Reductant Control System Signal Message Counter Incorrect

DTC P10C8

Reductant Temperature Signal Message Counter Incorrect

DTC P117A

Engine Block Coolant Valve Signal Message Counter Incorrect

DTC P1436

Particulate Matter Sensor Control Module Temperature Signal Message Counter Incorrect

DTC P143A

Reductant Control System Diagnostic Signal Message Counter Incorrect

DTC P143B

Reductant Control System Information Signal Message Counter Incorrect

DTC P30B4

NOx Sensor 1 Signal Message Counter Incorrect

DTC P30B5

NOx Sensor 2 Signal Message Counter Incorrect

DTC P30BC

Particulate Matter Sensor Control Module Status Signal Message Counter Incorrect

DTC P30D5

NOx Sensor 3 Signal Message Counter Incorrect

Circuit/System Description

Control modules connected to the serial data circuits monitor the communication during normal vehicle operation. Operating information and commands are exchanged among the control modules. Each module on the serial data circuit maintains a transmit error counter and a receive error counter. The counter values increase with detected errors and decrease with error-free messages.

Conditions for Running the DTC

- Ignition = On - For greater than 3 s
- Serial Data = Enabled

Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

Serial Data = Message Counter Incorrect - Component

The above condition(s) must occur 5 times.

Actions Taken When the DTC Sets

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DTCs listed in the DTC Descriptor Category = Type B DTC - Exceptions listed below

- DTC P103D, P117A, P143B = Type A DTC
- DTC P10C8 = Type C DTC

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type B DTC - Exceptions listed below

- DTC P103D, P117A, P143B = Type A DTC
- DTC P10C8 = Type C DTC

Reference Information

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 there are no DTCs set related to the following component/system: Serial Data
   - **If a related DTC is set**

     Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**

   - **Go to next step: If a related DTC is not set**
3. Clear the DTCs.
4. Operate the vehicle within the Conditions for Running the DTC.

   Verify the DTC does not set.

   - **If the DTC sets**

   1. Ignition/Vehicle - Off
   2. Replace the component: Transmitting Component - Refer to **Transmitting and Receiving Components**
   3. Operate the vehicle within the Conditions for Running the DTC.

      Verify the DTC does not set.

      - If the DTC sets

        Replace the component: Receiving Component - Refer to **Transmitting and Receiving Components**

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

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

Repair Instructions

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Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

For control module replacement, programming, and setup refer to **Control Module References**

DTC P100A, P135C-P135E, P14A0, OR P14B6

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 P100A

Turbocharger Boost Control Signal Message Counter Incorrect

DTC P135C

Cooling Fan 1 Status Signals Message Counter Incorrect

DTC P135D

Cooling Fan 2 Status Signals Message Counter Incorrect

DTC P135E

Cooling Fan 3 Status Signals Message Counter Incorrect

DTC P14A0

Charge Air Cooler Coolant Pump Status Signal Message Counter Incorrect

DTC P14B6

Mass Air Flow Sensor Signal Message Counter Incorrect

Circuit/System Description

Control modules connected to the serial data circuits monitor the communication during normal vehicle operation. Operating information and commands are exchanged among the control modules. Each module on the serial data circuit maintains a transmit error counter and a receive error counter. The counter values increase with detected errors and decrease with error-free messages.

Conditions for Running the DTC

- Ignition = On - For greater than 3 s
- Serial Data = Enabled

Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

Serial Data = Message Counter Incorrect - Component

The above condition(s) must occur 5 times.

Actions Taken When the DTC Sets

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DTCs listed in the DTC Descriptor Category = Type B DTC - Exceptions listed below

- DTC P100A = Type A DTC

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type B DTC - Exceptions listed below

- DTC P100A = Type A DTC

Reference Information

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 there are no DTCs set related to the following component/system: Serial Data
   - **If a related DTC is set**

     Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**

   - **Go to next step: If a related DTC is not set**
3. Clear the DTCs.
4. Operate the vehicle within the Conditions for Running the DTC.

   Verify the DTC does not set.

   - **If the DTC sets**

   1. Ignition/Vehicle - Off
   2. Replace the component: Transmitting Component - Refer to **Transmitting and Receiving Components**
   3. Operate the vehicle within the Conditions for Running the DTC.

      Verify the DTC does not set.

      - If the DTC sets

        Replace the component: Receiving Component - Refer to **Transmitting and Receiving Components**

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

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

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

For control module replacement, programming, and setup refer to **Control Module References**

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DTC P1015-P1019 OR P101A

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 P1015

Reductant Control Module Sensor Serial Communication Circuit Low Voltage

DTC P1016

Reductant Control Module Sensor Serial Communication Circuit High Voltage

DTC P1017

Reductant Control Module Sensor Serial Communication Circuit Performance

DTC P1018

Reductant Control Module Sensor Communication Voltage Supply Circuit Low Voltage

DTC P1019

Reductant Control Module Sensor Communication Voltage Supply Circuit High Voltage

DTC P101A

Reductant Control Module Sensor Communication Ground Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P1018	P1019	P1019	-
Serial Data	P1015	P1016	P1016	P1017
Low Reference	-	P101A	P101A	-

Circuit/System Description

For an overview of the component/system, refer to **Exhaust Aftertreatment System Description**

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

Component	Description
B212 Reductant Sensor Module	The sensor sends measured values and state of health information via serial data to the ECM and the reductant control module.

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Component	Description
K115 Reductant Control Module	The control module controls the heating and dosing of the reductant.

Conditions for Running the DTC

- {P1015, P1016} DTC U010E = Not set
- {P1017} DTC P1015, P1016, U010E = Not set
- {P1018, P1019, P101A} DTC P1015, P1016, P1017, U010E = Not set
- Engine = Running
- Ignition Voltage = Greater than 11 V
- Control Module = Not Initialized

Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

P1015

Serial Data circuit = Short to Ground - For greater than 1 s

P1016

Serial Data circuit = Short to Voltage - For greater than 1 s

P1017

Not within a calibrated range - For greater than 1 s

P1018

5V Reference Circuit = Short to Ground - For greater than 1 s

P1019

5V Reference Circuit = Short to Voltage - For greater than 1 s

P101A

Low Reference circuit = Short to Voltage - For greater than 1 s

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type A DTC

- The control module uses default replacement values.
- Warning = Service Emission Systemor Service Exhaust Fluid System

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type A DTC

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

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Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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 the scan tool parameter: Reductant Quality Sensor Status = OK or Not Ready
   - **If not the specified state**

     Refer to: Circuit/System Testing

   - **Go to next step: If the specified state**
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/Vehicle & All vehicle systems - Off
2. Disconnect the electrical connector: B212 Reductant Sensor Module
3. Ignition - On / Vehicle - In Service Mode
4. Test for less than 20 ohms between the test points: Low Reference circuit terminal 3 & Ground
   - **If 20 ohms or greater**
   1. Ignition/Vehicle - Off
   2. Disconnect the electrical connector: X2 @ K115 Reductant Control Module
   3. Test for less than 2 ohms between the test points: Low Reference circuit terminal 3 @ Component harness & Terminal 6 X2 @ Control module harness
      - If 2 ohms or greater - Repair the open/high resistance in the circuit.
      - If less than 2 ohms - Replace the component: K115 Reductant Control Module
   - **Go to next step: If less than 20 ohms**
5. Test for 4.8 to 5.2 V between the test points: 5 V Reference circuit terminal 1 & Low Reference circuit terminal 3

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- **If less than 4.8 V**

1. Ignition/Vehicle - Off
2. Disconnect the electrical connector: K115 Reductant Control Module
3. Test for infinite resistance between the test points: 5 V Reference circuit terminal 1 @ Component harness & Ground
    - If less than infinite resistance - Repair the short to ground on the circuit.
    - Go to next step: If infinite resistance
4. Test for less than 2 ohms between the test points: 5 V Reference circuit terminal 1 @ Component harness & Terminal 19 X2 @ Control module harness
    - If 2 ohms or greater - Repair the open/high resistance in the circuit.
    - If less than 2 ohms - Replace the component: K115 Reductant Control Module

- **If greater than 5.2 V**

1. Ignition/Vehicle - Off
2. Disconnect the electrical connector: K115 Reductant 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 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: K115 Reductant Control Module

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

6. Test for 4.4 to 4.8 V between the test points: Serial Data circuit terminal 2 & Ground
    - **If less than 4.4 V**

    1. Ignition/Vehicle - Off
    2. Disconnect the electrical connector: K115 Reductant Control Module
    3. Test for infinite resistance between the test points: Serial Data circuit terminal 2 @ Component harness & Ground
        - If less than infinite resistance - Repair the short to ground on the circuit.
        - Go to next step: If infinite resistance
    4. Test for less than 2 ohms between the test points: Serial Data circuit terminal 2 @ Component harness & Terminal 18 X2 @ Control module harness
        - If 2 ohms or greater - Repair the open/high resistance in the circuit.
        - If less than 2 ohms - Replace the component: K115 Reductant Control Module

    - **If greater than 4.8 V**

    1. Test for less than 1 V between the test points: Serial Data circuit terminal 2 @ Component harness & Ground
        - If 1 V or greater - Repair the short to voltage on the circuit.
        - If less than 1 V - Replace the component: K115 Reductant Control Module

    - **Go to next step: If between 4.4 and 4.8 V**

7. Test or replace the component: B212 Reductant Sensor Module

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Emission Reduction Fluid Tank Replacement** - B212 Reductant Sensor Module
- **Reductant Control Module Replacement** - K115 Reductant Control Module
- For control module replacement, programming, and setup refer to **Control Module References**

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DTC P103F, P1040, P208A, P208C, P208D, OR P214E

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 P103F

Reductant Pump Driver High Temperature

DTC P1040

Reductant Pump Control Circuit Shorted

DTC P208A

Reductant Pump Control Circuit

DTC P208C

Reductant Pump Control Circuit Low Voltage

DTC P208D

Reductant Pump Control Circuit High Voltage

DTC P214E

Reductant Pump High Current

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Control - Terminal 7 @ A38 Reductant Pump and Sensor Assembly	P208C, P1040	P208A, P214E *	P208D, P1040	P103F *
Control - Terminal 8 @ A38 Reductant Pump and Sensor Assembly	P208C, P1040	P208A, P214E *	P208D, P1040	P103F *
Control - Terminal 16 @ A38 Reductant Pump and Sensor Assembly	P208C, P1040	P208A, P214E *	P208D, P1040	P103F *
Low Reference	-	P208A, P214E *	-	-
*Additional DTCs may set.				

Circuit/System Description

For an overview of the component/system, refer to **Exhaust Aftertreatment System Description**

Circuit	Description
Control	The output circuit varies between ground and 12 V. The motor is bidirectional.

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Circuit	Description
Low Reference	Grounded through the control module.

Component	Description
A38 Reductant Pump and Sensor Assembly	The supply pump and the backflow pump are combined in the reductant pump module, which is part of the reductant fluid reservoir assembly. Both pumps are designed as vibration pumps. In this type of pump a solenoid attracts a piston against the force of a spring. At the same time, the piston sucks in fluid through an inlet check-valve. When the current through the solenoid is turned off, the spring pushes the piston forward and the fluid is pushed through an outlet check-valve. The frequency in which the solenoid is turned on/off determines how much fluid is conveyed.
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 U010E = Not set
- {P208A, P208C, P208D} Reductant Pump = Active
- 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

P103F

Control module K115 detects: Overtemperature

P1040

Control module K115 detects: Circuit Shorted

P208A

Control Circuit = Open

P208C

Control Circuit = Short to Ground

P208D

Control Circuit = Short to Voltage

P214E

Control module K115 detects: Circuit High Current

Actions Taken When the DTC Sets

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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

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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 no other DTCs are set.
   - **If other DTCs are set**

     Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**

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

   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

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.**

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1. Ignition/Vehicle & All vehicle systems - Off
2. Disconnect the electrical connector: A38 Reductant Pump and Sensor Assembly
3. Test for less than 10 ohms between the test points: Low Reference circuit terminal 15 & Ground
    - **If 10 ohms or greater**
    1. Disconnect the electrical connector: X2 @ K115 Reductant Control Module
    2. Test for less than 2 ohms between the test points: Low Reference circuit terminal 15 @ Component harness & Terminal 5 X2 @ Control module harness
        - If 2 ohms or greater - Repair the open/high resistance in the circuit.
        - If less than 2 ohms - Replace the component: K115 Reductant Control Module
    - **Go to next step: If less than 10 ohms**
4. Disconnect the electrical connector: X2 @ K115 Reductant Control Module
5. Test for less than 2 ohms between the test points:
    - Control circuit terminal 7 @ Component harness & Terminal 3 X2 @ Control module harness
    - Control circuit terminal 8 @ Component harness & Terminal 2 X2 @ Control module harness
    - Control circuit terminal 16 @ Component harness & Terminal 1 X3 @ Control module harness
    - **If greater than 2 ohms**

      Repair the open/high resistance in the circuit:

    - **Go to next step: If less than 2 ohms**
6. Test for infinite resistance between the test points:
    - Control circuit terminal 7 @ Component harness & Ground
    - Control circuit terminal 8 @ Component harness & Ground
    - Control circuit terminal 16 @ Component harness & Ground
    - **If less than infinite resistance**

      Repair short to ground on the circuit.

    - **Go to next step: If infinite resistance**
7. Ignition - On / Vehicle - In Service Mode
8. Test for less than 1 V between the test points:
    - Control circuit terminal 7 @ Component harness & Ground
    - Control circuit terminal 8 @ Component harness & Ground
    - Control circuit terminal 16 @ Component harness & Ground
    - **If greater than 1 V**

      Repair the short to voltage on the circuit:

    - **Go to next step: If less than 1 V**
9. Replace the component: A38 Reductant Pump and Sensor Assembly
10. 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**

      Replace the component: K115 Reductant Control Module

    - **Go to next step: If the DTC is not set**
11. All OK.

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Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Emission Reduction Fluid Supply Pump Module Replacement**
- **Reductant Control Module Replacement**
- For control module replacement, programming, and setup refer to **Control Module References**

Additional Procedures

Perform the scan tool control function: **Reductant System Tamper Service Bay Test** - Perform only when the following warning message is displayed: Service Emission System/Service Exhaust Fluid System

DTC P1048, P1049, OR P2047-P2049

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 P1048

Reductant Injector High Control Circuit Low Voltage

DTC P1049

Reductant Injector High Control Circuit High Voltage

DTC P2047

Reductant Injector Control Circuit

DTC P2048

Reductant Injector Control Circuit Low Voltage

DTC P2049

Reductant Injector Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Control Terminal 2	P1048	P2047	P1049	-
Control Terminal 1	P2048	P2047	P2049	-

Circuit/System Description

For an overview of the component/system, refer to **Exhaust Aftertreatment System Description**

Circuit	Description
Control - Terminal 2	The output circuit is switched to 12 V to activate the component.

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Circuit	Description
Control - Terminal 1	The output circuit is switched to ground to activate the component.

Component	Description
Q61 Reductant Injector	The reductant injector is used to dose and atomize the reductant into the exhaust system.
K115 Reductant Control Module	The control module controls the heating and dosing of the reductant.

Conditions for Running the DTC

P1048, P2047, P2049

- Ignition On or Engine Running
- Ignition Voltage = Greater than 11 V
- Injector Duty Cycle = Greater than 10%

Frequency the DTC runs = Continuously - After the running conditions are met

P1049, P2048

- Ignition On or Engine Running
- Ignition Voltage = Greater than 11 V
- Injector Duty Cycle = 0%

Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

P1048, P2048

The control module detects a short to ground.

P1049, P2049

The control module detects a short to voltage.

P2047

The control module detects an open circuit.

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type A DTC

Reductant Injector = Off

Reductant Tank Heaters = Off

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type A DTC

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

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Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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. Perform the scan tool control function: Reductant Injector - On and Off
3. Verify a click can be heard or felt at the following component(s) when the scan tool control function was commanded: Q61 Reductant Injector
   - **If a click cannot be heard or felt**

     Refer to: Circuit/System Testing

   - **Go to next step: If a click can be heard or felt**
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.

   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**
5. All OK.

Circuit/System Testing

1. Ignition/Vehicle - Off
2. Disconnect the electrical connector: Q61 Reductant Injector
3. Connect a test lamp between the test points: Control circuit terminal 1 & B+
4. Ignition - On / Vehicle - In Service Mode
5. Perform the scan tool control function: Reductant Injector - On and Off

   Verify the test lamp turns On and Off.

   - **If the test lamp is always Off**
   1. Ignition/Vehicle - Off & Remove - Test lamp
   2. Disconnect the electrical connector: K20 Engine Control Module

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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.
    - Go to next step: If less than 1 V
5. Ignition/Vehicle - Off
6. Test for less than 2 ohms between the test points: Control circuit terminal 1 @ Component harness & Terminal 1 X3 @ 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 the test lamp is always On**

1. Ignition/Vehicle - Off & Remove - Test lamp
2. Disconnect the electrical connector: 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 turns On and Off**

6. Connect a test lamp between the test points: Control circuit terminal 2 & Control circuit terminal 1
7. Perform the scan tool control function: Reductant Injector - On

   Verify the test lamp turns On. - Flashing Slow

- **If the test lamp is always Off**

1. Ignition/Vehicle - Off & Remove - Test lamp
2. Disconnect the electrical connector: K20 Engine Control Module
3. Test for infinite resistance between the test points: Control circuit terminal 2 @ Component harness & Ground
    - If less than infinite resistance - Repair the short to ground on the circuit.
    - Go to next step: If infinite resistance
4. Test for less than 2 ohms between the test points: Control circuit terminal 2 @ Component harness & Terminal 15 X3 @ 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 the test lamp is always On**

1. Ignition/Vehicle - Off & Remove - Test lamp
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: 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 - Replace the component: K20 Engine Control Module

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

8. Test or replace the component: Q61 Reductant Injector

Component Testing

Static Test

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1. Ignition/Vehicle - Off
2. Disconnect the electrical connector: Q61 Reductant Injector
3. Test for 10 to 14 ohms between the test points: Control terminal 1 & Control terminal 2
    - **If not between 10 and 14 ohms**

      Replace the component: Q61 Reductant Injector

    - **Go to next step: If between 10 and 14 ohms**
4. Test for infinite resistance between the test points: Each terminal of the component & The component's housing
    - **If less than infinite resistance**

      Replace the component: Q61 Reductant Injector

    - **Go to next step: If infinite resistance**
5. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Reductant Fluid Injector Replacement** - Q61 Reductant Injector
- For control module replacement, programming, and setup refer to **Control Module References**

Additional Procedures

Reductant System Tamper Service Bay Test - Perform only when the following component/system is replaced or serviced:

- K20 Engine Control Module
- Q61 Reductant Injector

DTC P1051, P20B9, P20BA-P20BC, P248A, OR P248B

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 P1051

Reductant Heater 1 Driver High Temperature

DTC P20B9

Reductant Heater 1 Control Circuit

DTC P20BA

Reductant Heater 1 Performance

DTC P20BB

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Reductant Heater 1 Control Circuit Low Voltage

DTC P20BC

Reductant Heater 1 Control Circuit High Voltage

DTC P248A

Reductant Heater 1 Feedback Circuit Low Voltage

DTC P248B

Reductant Heater 1 Feedback Circuit High Voltage

Circuit/System Description

For an overview of the component/system, refer to **Exhaust Aftertreatment System Description**

Circuit	Description
Control - Terminal 9	The output circuit is switched to 12 V to activate the component.
Control - Terminal 11	The output circuit is switched to ground to enable the component(s).

Component	Description
A38 Reductant Pump and Sensor Assembly	The supply pump and the backflow pump are combined in the reductant pump module, which is part of the reductant fluid reservoir assembly. Both pumps are designed as vibration pumps. In this type of pump a solenoid attracts a piston against the force of a spring. At the same time, the piston sucks in fluid through an inlet check-valve. When the current through the solenoid is turned off, the spring pushes the piston forward and the fluid is pushed through an outlet check-valve. The frequency in which the solenoid is turned on/off determines how much fluid is conveyed.
K115 Reductant Control Module	The control module controls the heating and dosing of the reductant.

Conditions for Running the DTC

P1051, P20B9, P20BB, P20BC

- DTC P205B, P205C, P205D, U010E = Not set
- Ignition On or Engine Running
- Ignition Voltage = Greater than 11 V

Frequency the DTC runs = Continuously - After the running conditions are met

P20BA

- DTC P20B9, P20BB, P20BC, P248A, U010E = Not set
- Ignition On or Engine Running
- Ignition Voltage = Greater than 11 V
- Reductant Heater 1 = On

Frequency the DTC runs = Continuously - After the running conditions are met

P248A, P248B

- DTC P205B, P205C, P205D, U010E = Not set
- Ignition On or Engine Running
- Ignition Voltage = Greater than 11 V
- Reductant Heater 1 = On

Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

P1051, P20BA

Reductant Heater 1 = Not within a calibrated range - For greater than 8 s

P20B9

Control Circuit = Open - For greater than 5 s

P20BB

Control Circuit = Short to Ground - For greater than 4 s

P20BC

Control Circuit = Short to Voltage - For greater than 4 s

P248A, P248B

Battery Voltage & Reductant Heater 1 = Not within 3 V of each other

Actions Taken When the DTC Sets

DTC P1051 = DTCs listed in the DTC Descriptor Category = Type A DTC - No additional actions taken

DTC P20B9, P20BA, P20BB, P20BC, P20BD, P248A, P248B = DTCs listed in the DTC Descriptor Category = Type A DTC - Additional actions taken:

- Driver Information Display = Service Emission System/Service Exhaust Fluid System
- Reductant Heater 1 = Disabled
- Reductant Injector = Disabled

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type A DTC

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **Component Connector End Views - Index**

Electrical Information Reference

- **Circuit Testing**

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- **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. Perform the scan tool control function: Reductant Heater 1 - On

   Verify the scan tool parameter: Reductant Heater 1 Current = 5 to 10 A

   - **If not the specified value**

     Refer to: Circuit/System Testing

   - **Go to next step: If the specified value**
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/Vehicle & All vehicle systems - Off
2. Disconnect the electrical connector: A38 Reductant Pump and Sensor Assembly
3. Ignition - On / Vehicle - In Service Mode
4. Test for 5 to 7.5 V between the test points: Control circuit terminal 9 & Ground
   - **If less than 5 V**
   1. Ignition/Vehicle & All vehicle systems - Off
   2. Disconnect the electrical connector: X2 @ K115 Reductant Control Module
   3. Test for infinite resistance between the test points: Control circuit terminal 9 & Ground
      - If less than infinite resistance - Repair the short to ground on the circuit.
      - Go to next step: If less than infinite resistance
   4. Test for less than 2 ohms between the test points: Control circuit terminal 9 @ Component harness & Terminal 11 X2 @ Control module harness
      - If 2 ohms or greater - Repair the open/high resistance in the circuit.
      - If less than 2 ohms - Replace the component: K115 Reductant Control Module
   - **If greater than 7.5 V**
   1. Ignition/Vehicle & All vehicle systems - Off

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2. Disconnect the electrical connector: X2 @ K115 Reductant Control Module
3. Ignition - On / Vehicle - In Service Mode
4. Test for less than 1 V between the test points: Control circuit terminal 9 @ Component harness & Ground
    - If 1 V or greater - Repair the short to voltage on the circuit.
    - If less than 1 V - Replace the component: K115 Reductant Control Module
- **Go to next step: If between 5 and 7.5 V**

5. Connect a test lamp between the test points: Control circuit terminal 9 & Control circuit terminal 11
6. Ignition - On / Vehicle - In Service Mode
7. Perform the scan tool control function: Reductant Heater 1 - On and Off

   Verify the test lamp turns On and Off.

- **If the test lamp is always Off**

1. Ignition/Vehicle - Off & Remove - Test lamp
2. Disconnect the electrical connector: X2 @ K115 Reductant Control Module
3. Test for infinite resistance between the test points: Control circuit terminal 11 @ Component harness & Ground
    - If less than infinite resistance - Repair the short to ground on the circuit.
    - Go to next step: If infinite resistance
4. Test for less than 2 ohms between the test points: Control circuit terminal 11 @ Component harness & Terminal 4 X2 @ Control module harness
    - If 2 ohms or greater - Repair the open/high resistance in the circuit.
    - If less than 2 ohms - Replace the component: K115 Reductant Control Module
- **Go to next step: If the test lamp turns On and Off**

8. Test or replace the component: A38 Reductant Pump and Sensor Assembly

Component Testing

Static Test

1. Ignition/Vehicle - Off
2. Disconnect the electrical connector: A38 Reductant Pump and Sensor Assembly
3. Test for 1 to 2 ohms between the test points: Control terminal 9 & Low Reference terminal 11
    - **If not between 1 and 2 ohms**

      Replace the component: A38 Reductant Pump and Sensor Assembly

    - **Go to next step: If between 1 and 2 ohms**
4. Test for infinite resistance between the test points: Each terminal of the component & The component's housing
    - **If less than infinite resistance**

      Replace the component: A38 Reductant Pump and Sensor Assembly

    - **Go to next step: If infinite resistance**
5. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Emission Reduction Fluid Supply Pump Module Replacement**

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- Reductant Control Module Replacement
- For control module replacement, programming, and setup refer to Control Module References

Additional Procedures

Perform the scan tool control function: Reductant System Tamper Service Bay Test - Perform only when the following warning message is displayed: Service Emission System/Service Exhaust Fluid System

DTC P1052, P20BD-P20BF, P20C0, P248C, OR P248D

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 P1052

Reductant Heater 2 Driver High Temperature

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

DTC P248C

Reductant Heater 2 Feedback Circuit Low Voltage

DTC P248D

Reductant Heater 2 Feedback Circuit High Voltage

Circuit/System Description

For an overview of the component/system, refer to Exhaust Aftertreatment System Description

Circuit	Description
Control - Terminal 2	The output circuit is switched to 12 V to activate the component.
Control - Terminal 1	The output circuit is switched to ground to enable the component(s).

Component	Description
E52 Reductant Line Heater	The pressure line is a hose with integrated heating wires.

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Component	Description
K115 Reductant Control Module	The control module controls the heating and dosing of the reductant.

Conditions for Running the DTC

P1052, P20BD, P20BF, P20C0

- DTC P205B, P205C, P205D, U010E = Not set
- Ignition On or Engine Running
- Ignition Voltage = Greater than 11 V

Frequency the DTC runs = Continuously - After the running conditions are met

P20BE

- DTC P20BD, P20BF, P20C0, P248C, U010E = Not set
- Ignition On or Engine Running
- Ignition Voltage = Greater than 11 V
- Reductant Heater 1 = On

Frequency the DTC runs = Continuously - After the running conditions are met

P248C, P248D

- DTC P205B, P205C, P205D, U010E = Not set
- Ignition On or Engine Running
- Ignition Voltage = Greater than 11 V
- Reductant Heater 1 = On

Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

P1052, P20BE

Reductant Heater 2 = Not within a calibrated range - For greater than 8 s

P20BD

Control Circuit = Open - For greater than 4 s

P20BF

Control Circuit = Short to Ground - For greater than 4 s

P20C0

Control Circuit = Short to Voltage - For greater than 4 s

P248C, P248D

Battery Voltage & Reductant Heater 2 = Not within 3 V of each other

Actions Taken When the DTC Sets

DTC P1052 = DTCs listed in the DTC Descriptor Category = Type A DTC - No additional actions taken

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DTC P20BD, P20BE, P20BF, P20C0, P248C, P248D = DTCs listed in the DTC Descriptor Category = Type A DTC - Additional actions taken:

- Driver Information Display = Service Emission System/Service Exhaust Fluid System
- Reductant Heater 1 = Disabled
- Reductant Injector = Disabled

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type A DTC

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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. Perform the scan tool control function: Reductant Heater 2 - On

   Verify the scan tool parameter: Reductant Heater 2 Current = 3 to 6 A

   - **If not the specified value**

     Refer to: Circuit/System Testing

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

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4. All OK.

Circuit/System Testing

1. Ignition/Vehicle & All vehicle systems - Off
2. Disconnect the electrical connector: E52 Reductant Line Heater
3. Ignition - On / Vehicle - In Service Mode
4. Test for 5 to 7.5 V between the test points: Control circuit terminal 2 & Ground
    - **If less than 5 V**
    1. Ignition/Vehicle & All vehicle systems - Off
    2. Disconnect the electrical connector: X2 @ K115 Reductant Control Module
    3. Test for infinite resistance between the test points: Control circuit terminal 2 & Ground
        - If less than infinite resistance - Repair the short to ground on the circuit.
        - Go to next step: If less than infinite resistance
    4. Test for less than 2 ohms between the test points: Control circuit terminal 2 @ Component harness & Terminal 7 X2 @ Control module harness
        - If 2 ohms or greater - Repair the open/high resistance in the circuit.
        - If less than 2 ohms - Replace the component: K115 Reductant Control Module
    - **If greater than 7.5 V**
    1. Ignition/Vehicle & All vehicle systems - Off
    2. Disconnect the electrical connector: X2 @ K115 Reductant Control Module
    3. Ignition - On / Vehicle - In Service Mode
    4. Test for less than 1 V between the test points: 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 - Replace the component: K115 Reductant Control Module
    - **Go to next step: If between 5 and 7.5 V**
5. Connect a test lamp between the test points: Control circuit terminal 2 & Control circuit terminal 1
6. Ignition - On / Vehicle - In Service Mode
7. Perform the scan tool control function: Reductant Heater 2 - On and Off

    Verify the test lamp turns On and Off.

    - **If the test lamp is always Off**
    1. Ignition/Vehicle - Off & Remove - Test lamp
    2. Disconnect the electrical connector: X2 @ K115 Reductant 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.
        - Go to next step: If infinite resistance
    4. Test for less than 2 ohms between the test points: Control circuit terminal 1 @ Component harness & Terminal 20 X2 @ Control module harness
        - If 2 ohms or greater - Repair the open/high resistance in the circuit.
        - If less than 2 ohms - Replace the component: K115 Reductant Control Module
    - **Go to next step: If the test lamp turns On and Off**
8. Test or replace the component: E52 Reductant Line Heater

Component Testing

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Static Test

1. Ignition/Vehicle - Off
2. Disconnect the electrical connector: E52 Reductant Line Heater
3. Test for 2 to 4 ohms between the test points: Control circuit terminal 1 & Control circuit terminal 2
    - **If not between 2 and 4 ohms**

      Replace the component: E52 Reductant Line Heater

    - **Go to next step: If between 2 and 4 ohms**
4. Test for infinite resistance between the test points: Each terminal of the component & The component's housing
    - **If less than infinite resistance**

      Replace the component: E52 Reductant Line Heater

    - **Go to next step: If infinite resistance**
5. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe Replacement**
- **Reductant Control Module Replacement**
- For control module replacement, programming, and setup refer to **Control Module References**

Additional Procedures

Perform the scan tool control function: **Reductant System Tamper Service Bay Test** - Perform only when the following warning message is displayed: Service Emission System/Service Exhaust Fluid System

DTC P105A

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 P105A

Reductant Pump Low Speed

Circuit/System Description

For an overview of the component/system, refer to **Exhaust Aftertreatment System Description**

Component	Description
G33 Reductant Pump	The supply pump and the backflow pump are combined in the reductant pump module, which is part of the reductant fluid reservoir assembly. Both pumps are designed as vibration pumps. In this type of pump a solenoid attracts a piston against the force of a spring. At the same time, the

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Component	Description
	piston sucks in fluid through an inlet check-valve. When the current through the solenoid is turned off, the spring pushes the piston forward and the fluid is pushed through an outlet check-valve. The frequency in which the solenoid is turned on/off determines how much fluid is conveyed.
K115 Reductant Control Module	The control module controls the heating and dosing of the reductant.

Conditions for Running the DTC

- DTC P103F, P0140, P208A, P208C, P208D, P214E, U010E = Not set
- Ignition On or Engine Running
- Ignition Voltage = Greater than 11 V
- Reductant Fluid Reservoir = Not Frozen
- Reductant Pump = Active

Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

Reductant Pump = Not Moving - For greater than 5 s

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type A DTC

- Reductant Injector = Disabled
- Reductant Pump = Disabled
- Reductant Tank Heaters = Disabled

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type A DTC

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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

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Control Module References

Circuit/System Verification

1. Ignition - On / Vehicle - In Service Mode
2. Verify DTC P013F, P1040, P208A, P2083C, P208D, P214E, U010E is not set.
   - **If DTC P013F, P1040, P208A, P2083C, P208D, P214E, U010E is set**

     Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**

   - **Go to next step: If DTC P013F, P1040, P208A, P2083C, P208D, P214E, U010E is not set**
3. Perform the scan tool control function: Reductant Pump - 50%

   Verify the scan tool parameter:

   - Reductant Pump Control Circuit High Voltage Test Status = OK or Not Run
   - Reductant Pump Control Circuit Low Voltage Test Status = OK or Not Run
   - Reductant Pump Control Circuit Open 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.

   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

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: A38 Reductant Pump and Sensor Assembly
3. Test for less than 10 ohms between the test points: Low Reference terminal 15 & Ground
   - **If 10 ohms or greater**
   1. Disconnect the electrical connector: K115 Reductant Control Module
   2. Test for less than 2 ohms between the test points: Low Reference terminal 15 @ Component harness & Terminal 5 X2 @ Control module harness
      - If 2 ohms or greater - Repair the open/high resistance in the circuit.
      - If less than 2 ohms - Replace the component: K115 Reductant Control Module
   - **Go to next step: If less than 10 ohms**
4. Disconnect the electrical connector: X2 @ K115 Reductant Control Module
5. Test for less than 2 ohms between the test points:

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- Control circuit terminal 16 @ Component harness & Terminal 1 X2 @ Control module harness
- Control circuit terminal 8 @ Component harness & Terminal 2 X2 @ Control module harness
- Control circuit terminal 7 @ Component harness & Terminal 3 X2 @ Control module harness
- **If 2 ohms or greater**

  Repair the open/high resistance in the circuit:

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

6. Test for infinite resistance between the test points:
   - Control circuit terminal 16 @ Component harness & Ground
   - Control circuit terminal 8 @ Component harness & Ground
   - Control circuit terminal 7 @ Component harness & Ground
   - **If less than infinite resistance**

     Repair the short to ground on the circuit:

   - **Go to next step: If infinite resistance**
7. Ignition - On / Vehicle - In Service Mode
8. Test for less than 1 V between the test points:
   - Control circuit terminal 16 @ Component harness & Ground
   - Control circuit terminal 8 @ Component harness & Ground
   - Control circuit terminal 7 @ Component harness & Ground
   - **If 1 V or greater**

     Repair the short to voltage on the circuit:

   - **Go to next step: If less than 1 V**
9. Replace the component: A38 Reductant Pump and Sensor Assembly

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Emission Reduction Fluid Supply Pump Module Replacement**
- **Reductant Control Module Replacement**
- For control module replacement, programming, and setup refer to **Control Module References**

Additional Procedures

Perform the scan tool control function: **Reductant System Tamper Service Bay Test** - Perform only when the following warning message is displayed: Service Emission System/Service Exhaust Fluid System

DTC P1089

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 P1089

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Fuel Rail Pressure Performance During Deceleration Fuel Cut-Off

Circuit/System Description

For an overview of the component/system, refer to **Fuel System Description**

Component	Description
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.
Q18A Fuel Pressure Regulator 1	The fuel pressure regulator is a solenoid valve that restricts the flow of fuel to the high pressure fuel pump and thereby controls the pressure the pump can produce.
Q18B Fuel Pressure Regulator 2	The fuel pressure regulator is the solenoid valve that controls the pressure in the fuel rail.

Conditions for Running the DTC

- Battery Voltage = Greater than 11 V
- Deceleration Fuel Cut-Off = Active - For greater than 13 s
- Engine Coolant Temperature = 68 to 117B°C (154 to 243B°F)
- Engine Speed = Greater than 1500 RPM
- Fuel Temperature = 0 to 70B°C (32 to 158B°F)

Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

NOTE: **Time to set this DTC may take several drive cycles - Deceleration time is cumulative**

Fuel Rail Pressure = Not within a calibrated range - For greater than 10 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

Diagnostic Aids

A weak battery, low component/system voltage, or poor connections may cause this DTC to set.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **Component Connector End Views - Index**

Electrical Information Reference

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- 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 there are no DTCs set related to the following component/system: Fuel System
   - **If a related DTC is set**

     Refer to Diagnostic Trouble Code (DTC) List - Vehicle

   - **Go to next step: If a related DTC is not set**
3. Verify the following conditions do not exist:
   - Aftermarket equipment/accessories: Performance Components - Installed
   - Fuel - Contamination. Refer to Fuel System Specifications , & Contaminants-in-Fuel Diagnosis
   - **If a condition exists**

     Repair or replace as necessary

   - **Go to next step: If no condition exists**
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.

   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. Verify the condition does not exist: Fuel System - Leaking
   - **If the condition exists**

     Refer to Fuel Leak Diagnosis

   - **Go to next step: If no condition exists**
2. Engine - Idling
3. Verify the scan tool parameter: Fuel Pressure Sensor = 370 to 450 kPa (54 to 65 PSI)
   - **If less than 370 kPa (54 PSI)**

     Refer to Fuel System Diagnosis

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- **If greater than 450 kPa (65 PSI)**

  Refer to **Fuel Return System Diagnosis**

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

4. Perform the following procedure/test: **Cylinder Power Balance Test**

   Verify the procedure/test passes.

   - **If the procedure/test does not pass**

     Replace the component that failed the test: Q17 Fuel Injector

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

5. 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

   - **Go to next step: If the value changes**

6. 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

   - **Go to next step: If the value changes**

7. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Fuel Injection Fuel Rail Assembly Replacement** - Q18B Fuel Pressure Regulator 2
- **Fuel Injection Pump Metering Valve Replacement** - Q18A Fuel Pressure Regulator 1
- **Fuel Injector Replacement (Cylinder #1, #2, #3)** , or **Fuel Injector Replacement (Cylinder #4)**
- For control module replacement, programming, and setup refer to **Control Module References**

DTC P10D1

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 P10D1

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Reductant Injector Temperature - Exhaust Gas Temperature Not Plausible

Circuit/System Description

For an overview of the component/system, refer to **Exhaust Aftertreatment System Description**

Circuit	Description
Control - Terminal 2	The output circuit is switched to 12 V to activate the component.
Control - Terminal 1	The output circuit is switched to ground to activate the component.

Component	Description
Q61 Reductant Injector	The reductant injector is used to dose and atomize the reductant into the exhaust system.
K115 Reductant Control Module	The control module controls the heating and dosing of the reductant.

Conditions for Running the DTC

- Ignition Off Time = For greater than 8 h
- 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

Temperature = Not within a calibrated range

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

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **Component Connector End Views - Index**

Electrical Information Reference

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

DTC Type Reference

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Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References

Circuit/System Verification

1. Ignition - On / Vehicle - In Service Mode
2. Perform the scan tool control function: Reductant Injector - On and Off
3. Verify a click can be heard or felt at the following component(s) when the scan tool control function was commanded: Q61 Reductant Injector
   - **If a click cannot be heard or felt**

     Refer to: Circuit/System Testing

   - **Go to next step: If a click can be heard or felt**
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.

   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**
5. All OK.

Circuit/System Testing

1. Ignition/Vehicle - Off
2. Disconnect the electrical connector: Q61 Reductant Injector
3. Connect a test lamp between the test points: Control circuit terminal 1 & B+
4. Ignition - On / Vehicle - In Service Mode
5. Perform the scan tool control function: Reductant Injector - On and Off

   Verify the test lamp turns On and Off.

   - **If the test lamp is always Off**
   1. Ignition/Vehicle - Off & Remove - Test lamp
   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: Control circuit terminal 1 @ Component harness & Ground
      - If 1 V or greater - Repair the short to voltage on the circuit.
      - Go to next step: If less than 1 V
   5. Ignition/Vehicle - Off
   6. Test for less than 2 ohms between the test points: Control circuit terminal 1 @ Component harness & Terminal 1 X3 @ 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 the test lamp is always On**
   1. Ignition/Vehicle - Off & Remove - Test lamp

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2. Disconnect the electrical connector: 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 turns On and Off**

6. Connect a test lamp between the test points: Control circuit terminal 2 & Control circuit terminal 1
7. Perform the scan tool control function: Reductant Injector - On

   Verify the test lamp turns On. - Flashing Slow

- **If the test lamp is always Off**

1. Ignition/Vehicle - Off & Remove - Test lamp
2. Disconnect the electrical connector: K20 Engine Control Module
3. Test for infinite resistance between the test points: Control circuit terminal 2 @ Component harness & Ground
    - If less than infinite resistance - Repair the short to ground on the circuit.
    - Go to next step: If infinite resistance
4. Test for less than 2 ohms between the test points: Control circuit terminal 2 @ Component harness & Terminal 15 X3 @ 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 the test lamp is always On**

1. Ignition/Vehicle - Off & Remove - Test lamp
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: 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 - Replace the component: K20 Engine Control Module

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

8. Test or replace the component: Q61 Reductant Injector

Component Testing

Static Test

1. Ignition/Vehicle - Off
2. Disconnect the electrical connector: Q61 Reductant Injector
3. Test for 10 to 14 ohms between the test points: Control terminal 1 & Control terminal 2
    - **If not between 10 and 14 ohms**

      Replace the component: Q61 Reductant Injector

    - **Go to next step: If between 10 and 14 ohms**
4. Test for infinite resistance between the test points: Each terminal of the component & The component's housing
    - **If less than infinite resistance**

      Replace the component: Q61 Reductant Injector

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

5. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Reductant Fluid Injector Replacement** - Q61 Reductant Injector
- For control module replacement, programming, and setup refer to **Control Module References**

DTC P111E

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 P111E

Engine Coolant Temperature Sensor Not Plausible

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P0117, P0119	P0118, P0119	P0118*, P0119	P0119, P0128, P111E
Low Reference	-	P0118, P0119**	*	P0119, P0128
*Internal control module or component damage may occur if the circuit shorts to B+. **Additional DTCs may set.				

Typical Scan Tool Data

ECT Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine = Idling - At normal operating temperature. **Parameter Normal Range:** 88 to 105B°C (190 to 221B°F)			
Signal	150B°C (302B°F)	-40B°C (-40B°F)	-40B°C (-40B°F)
Low Reference	-	-40B°C (-40B°F)	-

Circuit/System Description

For an overview of the component/system, refer to **Cooling System Description and Operation (LGZ, LWN)**

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

Component	Description
B34 Engine Coolant Temperature Sensor	The sensor is a negative temperature coefficient thermistor. As the temperature of the air, fluid, or metal increases, the

Component	Description
	resistance of the sensor decreases, varying the voltage on the signal circuit.
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 P0070 - P0074, P0111, P0112, P0113, P0114, P0117, P0118, P0119, P0128, P0601, P112F, P1621, P2610 = Not set
- Ambient Air Temperature = Greater than -7B°C (19.4B°F)
- Engine Block Heater = Inactive
- Engine Cranking = Less than 10 s
- Fuel level = Greater than 10%
- Ignition = Off - For greater than 8 h

Frequency the DTC runs = Once - Per ignition cycle - After the running conditions are met

Conditions for Setting the DTC

Condition 1

- Ignition On - Engine Off
- ECT Sensor & IAT Sensor & Ambient Air Temperature Sensor Not within 15.8B°C (28B°F) of each other

Condition 2

- Ignition On - Engine Off
- ECT Sensor = Warmer than 15.8B°C (60B°F)
- Engine Block Heater = Not Detected
- IAT Sensor & Ambient Air Temperature Sensor = Colder than 15.8B°C (60B°F)

Condition 3

- Ignition On - Engine Off
- ECT Sensor = Colder than 15.8B°C (60B°F) - IAT Sensor & Ambient Air Temperature Sensor

Condition 4

- Engine Cranking
- ECT Sensor & IAT Sensor & Ambient Air Temperature Sensor = Not within 15.8B°C (28B°F) of each other - For greater than 10 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

Diagnostic Aids

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After starting a cold engine, the following scan tool parameter value should rise steadily and then stabilize: ECT Sensor/IAT Sensor/Ambient Air Temperature Sensor

High resistance in the circuits of the component may set DTC P111E without setting the DTC for the component: ECT Sensor/IAT Sensor/Ambient Air Temperature Sensor

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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. Verify DTC P0070 - P0074, P0111, P0112, P0113, P0114, P0117, P0118, P0119, P0128, P0601, P112F, P1621, P2610 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. Ignition - On / Vehicle - In Service Mode
3. Verify the following parameters are within 15.8B°C (60B°F) of each other:
    - Ambient Air Temperature Sensor
    - ECT Sensor
    - IAT Sensor 1
    - **If not within 15.8B°C (60B°F) of each other**

      {Ambient Air Temperature Sensor} Refer to **DTC P0071-P0074**

      {ECT Sensor} Refer to: Circuit/System Testing

      {IAT Sensor 1} Refer to **DTC P0112, P0113, or P0114**

    - **Go to next step: If within 15.8B°C (60B°F) of each other**

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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.

   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**

5. 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: B34 Engine Coolant Temperature Sensor
3. Test for less than 10 ohms between the test points: Low Reference circuit terminal 2/B & Ground
   - **If 10 ohms or greater**
   1. Disconnect the appropriate electrical connector: K20 Engine Control Module
   2. Test for less than 2 ohms between the test points: Low Reference circuit terminal 2/B @ 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 10 ohms**
4. Ignition - On / Vehicle - In Service Mode
5. Verify the scan tool parameter: ECT Sensor = Colder than -39B°C (-38B°F)
   - **If warmer than -39B°C (-38B°F)**
   1. Ignition/Vehicle - Off
   2. Disconnect the appropriate electrical connector: K20 Engine Control Module
   3. Test for infinite resistance between the test points: Signal circuit terminal 1/A @ 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 colder than -39B°C (-38B°F)**
6. Connect a 3 A fused jumper wire between the test points: Signal circuit terminal 1/A & Low Reference circuit terminal 2/B
7. Verify the scan tool parameter: ECT Sensor = Warmer than 149B°C (300B°F)
   - **If 149B°C (300B°F) or colder**
   1. Ignition/Vehicle - Off & Remove - Jumper wire(s)
   2. Disconnect the appropriate electrical connector: 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 1/A @ Component harness & Ground
      - If 1 V or greater - Repair the short to voltage on the circuit.
      - Go to next step: If less than 1 V
   5. Ignition/Vehicle - Off

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6. Test for less than 2 ohms between the test points: Signal circuit terminal 1/A @ 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 warmer than 149B°C (300B°F)**

8. Test or replace the component: B34 Engine Coolant Temperature Sensor

Component Testing

1. Ignition/Vehicle - Off
2. Disconnect the electrical connector: B34 Engine Coolant Temperature Sensor
3. Test for 42 to 78, 834 ohms between the test points: Signal terminal 1/A & Low Reference terminal 2/B
    - **If not between 42 and 78, 834 ohms**

      Replace the component: B34 Engine Coolant Temperature Sensor

    - **Go to next step: If between 42 and 78, 834 ohms**
4. Verify the value is within the range listed in the table: **Temperature Versus Resistance - Engine Coolant Temperature Sensor**
    - **If not in the specified range**

      Replace the component: B34 Engine Coolant Temperature Sensor

    - **Go to next step: If in the specified range**
5. Test for infinite resistance between the test points: Each terminal of the component & The component's housing
    - **If less than infinite resistance**

      Replace the component: B34 Engine Coolant Temperature Sensor

    - **Go to next step: If infinite resistance**
6. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Engine Coolant Temperature Sensor Replacement**
- For control module replacement, programming, and setup refer to **Control Module References**

DTC P113B-P113F, P118E, P118F, P1196-P1198, P2081, P2085, P242E, P2472, OR P2484

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 P113B

Exhaust Gas Temperature Sensor 1 Not Plausible

DTC P113C

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Exhaust Gas Temperature Sensor 2 Not Plausible

DTC P113D

Exhaust Gas Temperature Sensor 3 Not Plausible

DTC P113E

Exhaust Gas Temperature Sensor 4 Not Plausible

DTC P113F

Exhaust Gas Temperature Sensor 5 Not Plausible

DTC P118E

Exhaust Gas Temperature Sensor 1 Performance - Engine Running

DTC P118F

Exhaust Gas Temperature Sensor 2 Performance - Engine Running

DTC P1196

Exhaust Gas Temperature Sensor 3 Performance - Engine Running

DTC P1197

Exhaust Gas Temperature Sensor 4 Performance - Engine Running

DTC P1198

Exhaust Gas Temperature Sensor 5 Performance - Engine Running

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

DTC P2472

Exhaust Gas Temperature Sensor 4 Circuit Intermittent

DTC P2484

Exhaust Gas Temperature Sensor 5 Circuit Intermittent

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P0545, P2032, P242C, P2470,	P0546, P2033, P242D, P2471,	P0546, P2033, P242D, P2471,	P118E, P118F, P1196, P1197,

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Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
	P2481	P2482	P2482	P1198 *
Low Reference	-	P0546, P2033, P242D, P2471, P2482	-	P118E, P118F, P1196, P1197, P1198 *
*Additional DTCs may set.				

Typical Scan Tool Data

Exhaust Gas Temperature Sensor 1, 2, 3, 4, 5

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine = Idling **Parameter Normal Range:** -39 to 999B°C (-38 to 1830B°F)			
Signal	-40B°C (-40B°F)	1, 000B°C (1, 832B°F)	1, 000B°C (1, 832B°F)
Low Reference	-	1, 000B°C (1, 832B°F)	1, 000B°C (1, 832B°F)

Circuit/System Description

For an overview of the component/system, refer to **Exhaust Aftertreatment System Description**

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

Component	Description
B131 Exhaust Temperature Sensor	The temperature sensor is a positive temperature coefficient thermistor, a resistor which changes based on temperature.
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 P0545, P0546, P2032, P2033, P242C, P242D, P2470, P2471, P2481, P2482 = Not set
- {P118E, P118F, P1196-P1198, P2081, P2085, P242E, P2472, P2484} Engine Running
- {P113B-P113F} Ignition = Off - For greater than 8 h
- Ignition = On
- Ignition Voltage = Greater than 11 V

Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

{P113B-P113F} Exhaust Temperature Sensor & Ambient Air Temperature = Not within 20B°C (36B°F) of each other - Cold Start-Up

Exhaust Temperature Sensor = Not within a calibrated range - 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

Diagnostic Aids

After starting a cold engine, the following scan tool parameter value should rise steadily and then stabilize: Exhaust Gas Temperature Sensor 1, 2, 3, 4, 5

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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

Special Tools

<special tool><special tool-no>EL-25070</special tool-no><special tool-desc>Heat Gun 260 to 400B°C (500 to 750B°F)</special tool-desc></special tool>

Equivalent regional tools: **Special Tools ((Diagnosis Tools))**

Circuit/System Verification

1. Ignition - On / Vehicle - In Service Mode
2. Verify the scan tool parameter: Exhaust Gas Temperature Sensor 1, 2, 3, 4, 5 = -39 to 999B°C (-38 to 1, 830B°F)
   - **If not the specified value**

     Refer to: Circuit/System Testing

   - **Go to next step: If the specified value**
3. Verify the scan tool parameter: Exhaust Gas Temperature Sensor 1, 2, 3, 4, 5 = The value should not spike or drop out.

   Perform the action while monitoring the parameter:

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- Wiggle the harness and connector: B131 Exhaust Temperature Sensor
- Wiggle the harness and connector: X3 @ 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**

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.

   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**

5. 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 appropriate electrical connector: B131 Exhaust Temperature Sensor
3. Test for less than 10 ohms between the test points: Low Reference circuit terminal 1 & Ground
   - **If 10 ohms or greater**
   1. Disconnect the electrical connector: X3 @ K20 Engine Control Module
   2. Test for less than 2 ohms between the test points:
      - {Sensor 1} Low Reference circuit terminal 1 @ Component harness & Terminal 27 @ Control module harness
      - {Sensor 2} Low Reference circuit terminal 1 @ Component harness & Terminal 13 @ Control module harness
      - {Sensor 3} Low Reference circuit terminal 1 @ Component harness & Terminal 12 @ Control module harness
      - {Sensor 4} Low Reference circuit terminal 1 @ Component harness & Terminal 11 @ Control module harness
      - {Sensor 5} Low Reference circuit terminal 1 @ Component harness & Terminal 9 @ 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 10 ohms**
4. Ignition - On / Vehicle - In Service Mode
5. Verify the scan tool parameter: Exhaust Gas Temperature Sensor 1, 2, 3, 4, 5 = Warmer than 999B°C (1, 830B°F)
   - **If 999B°C (1, 830B°F) or colder**
   1. Ignition/Vehicle - Off
   2. Disconnect the electrical connector: X3 @ K20 Engine Control Module
   3. Test for infinite resistance between the test points: Signal circuit terminal 2 @ Component harness & Ground

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- 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 warmer than 999B°C (1830B°F)**

6. Connect a 3 A fused jumper wire between the test points: Signal circuit terminal 2 & Low Reference circuit terminal 1
7. Verify the scan tool parameter: Exhaust Gas Temperature Sensor 1, 2, 3, 4, 5 = Colder than -39B°C (-38B°F)
   - **If -39B°C (-38B°F) or warmer**
   1. Ignition/Vehicle - Off & Remove - Jumper wire(s)
   2. Disconnect the electrical connector: X3 @ 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.
      - Go to next step: If less than 1 V
   5. Ignition/Vehicle - Off
   6. Test for less than 2 ohms between the test points:
      - {Sensor 1} Signal circuit terminal 2 @ Component harness & Terminal 14 @ Control module harness
      - {Sensor 2} Signal circuit terminal 2 @ Component harness & Terminal 28 @ Control module harness
      - {Sensor 3} Signal circuit terminal 2 @ Component harness & Terminal 26 @ Control module harness
      - {Sensor 4} Signal circuit terminal 2 @ Component harness & Terminal 25 @ Control module harness
      - {Sensor 5} Signal circuit terminal 2 @ Component harness & Terminal 23 @ 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 colder than -39B°C (-38B°F)**
8. Test or replace the component: B131 Exhaust Temperature Sensor

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Component Testing

1. Ignition/Vehicle - Off
2. Disconnect the appropriate electrical connector: B131 Exhaust Temperature Sensor

NOTE: **Use the special tool:<special tool><special tool-no>EL-25070</special tool-no><special tool-desc>Heat Gun 260 to 400B°C (500 to 750B°F) </special tool-desc></special tool>**

3. Test the resistance between the test points: Signal terminal 2 & Low Reference terminal 1

   Verify the value is within the range listed in the table: **Temperature Versus Resistance - Exhaust Gas Temperature Sensor**

   - **If not in the specified range**

     Replace the component: B131 Exhaust Temperature Sensor

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

4. Test for infinite resistance between the test points: Each terminal of the component & The component's housing
    - **If less than infinite resistance**

      Replace the component: B131 Exhaust Temperature Sensor

    - **Go to next step: If infinite resistance**
5. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Exhaust Temperature Sensor Replacement - Position 1**
- **Exhaust Temperature Sensor Replacement - Position 2**
- **Exhaust Temperature Sensor Replacement - Position 3**
- **Exhaust Temperature Sensor Replacement - Position 4**
- **Exhaust Temperature Sensor Replacement - Position 5**
- For control module replacement, programming, and setup refer to **Control Module References**

DTC P115E, P115F, P1160, P116A-P116F, P1192-P1194, P119A-P119C, P11C5, P11C6, P11CC, P11D3, P11DB, P2202, P2203, P2205-P2211, P22F9, OR P22FA

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.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P115E

O2 Reference Voltage Circuit (NOx Sensor 1)

DTC P115F

O2 Reference Voltage Circuit Low Voltage (NOx Sensor 1)

DTC P1160

O2 Reference Voltage Circuit High Voltage (NOx Sensor 1)

DTC P116A

O2 Signal Circuit (NOx Sensor 1)

DTC P116B

O2 Signal Circuit Low Voltage (NOx Sensor 1)

DTC P116C

O2 Signal Circuit High Voltage (NOx Sensor 1)

DTC P116D

O2 Pump Current Control Circuit (NOx Sensor 1)

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DTC P116E

O2 Pump Current Control Circuit Low Voltage (NOx Sensor 1)

DTC P116F

O2 Pump Current Control Circuit High Voltage (NOx Sensor 1)

DTC P1192

O2 Low Reference Circuit (NOx Sensor 1)

DTC P1193

O2 Low Reference Circuit Low Voltage (NOx Sensor 1)

DTC P1194

O2 Low Reference Circuit High Voltage (NOx Sensor 1)

DTC P119A

NOx Sensor 1 Signal Circuit

DTC P119B

NOx Sensor 1 Signal Circuit Low Voltage

DTC P119C

NOx Sensor 1 Signal Circuit High Voltage

DTC P11C5

NOx Sensor 1 Heater Ground Circuit

DTC P11C6

NOx Sensor 1 Heater Ground Circuit High

DTC P11CC

NOx Sensor 1 Performance - Signal Low

DTC P11D3

NOx Sensor 1 Exceeded Minimum Learning Limit

DTC P11DB

NOx Sensor 1 Current Performance

DTC P2202

NOx Sensor 1 Circuit Low Voltage

DTC P2203

NOx Sensor 1 Circuit High Voltage

DTC P2205

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NOx Sensor 1 Heater Control Circuit

DTC P2206

NOx Sensor 1 Heater Control Circuit Low Voltage

DTC P2207

NOx Sensor 1 Heater Control Circuit High Voltage

DTC P2208

NOx Sensor 1 Heater Feedback Circuit

DTC P2209

NOx Sensor 1 Heater Feedback Performance

DTC P2210

NOx Sensor 1 Heater Feedback Circuit Low Voltage

DTC P2211

NOx Sensor 1 Heater Feedback Circuit Low Voltage

DTC P22FA

NOx Sensor 1 Performance - Slow Response High to Low

Circuit/System Description

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

P115E, P115F, P1160, P116A, P116B, P116C, P116D, P116E, P116F, P1192, P1193, P1194, P119A, P119B, P119C, P11C5, P11C6, P2205, P2206, P2207, P2208, P2210, P2211

- DTC U029D is not set
- The Engine Controls Ignition Relay Feedback Signal voltage is greater than 11 V
- The NOx Sensor 1 Heater Operation parameter displays Allowed
- The NOx sensor supply voltage is greater than 10.8 V.

These DTCs run continuously when the above conditions are met

P11CC

- DTC P0033, P0034, P0035, P003A, P0045, P0047, P0048, P0070, P0071, P0072, P0073, P0074, P0087, P0096, P0097, P0098, P0099, P00C7, P00E9, P00EA P00EB, P00EC, P00F4, P00F5, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0119, P0128, P0191. P0192, P0193, P0194, P0201-P0204, P020A-P020D, P0216, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P02EE, P02EF, P02F0, P02F1, P0335, P0336, P0400, P0403, P0405, P0406, P041B, P041C, P041D, P041E, P042E, P042F, P0489, P0490, P049D, P0545, P0546, P062B, P062D, P111E, P113B-P0113F, 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, P124B, P126A, P1402, P1407, P140F, P1424, P1425, P1428, P169E, P169F, P16A0, P16A1, P16A2, P16B0, P16B1, P16B2, P16FA, P16FC, P2032, P2033, P2080, P2081, P2084, P2085, P2147, P2148, P2150, P2151, P2200, P2202, P2203, P2205, P2206, P2207, P2208, P2209, P220A, P2210, P2211, P2227, P2228, P2229, P2230, P2262, P2263, P228A, P228B, P22CF, P22D0, P22D1, P2452-P2456, P2459, P2481-P2484, P2564, P2565, P2598, P2599, P262B, or U029D is not set.
- The engine is running.
- The ignition voltage is greater than 11 V.
- The NOx Sensor 1 Heater Operation parameter displays Allowed.
- The barometric pressure is greater than 70 kPa (10.2 psi).
- The coolant temperature is between 70 - 128B°C (158 - 262B°F).
- The ambient temperature is greater than -7B°C (19.4B°F).
- The manifold absolute pressure is less than 250 kPa (36.3 psi).
- The injection fuel quantity is between $15mm^3$ -$45mm^3$.
- The engine speed is between 1, 200 - 2, 000 RPM.

The DTC runs continuously when the above conditions are met.

P11D3

- DTC P0071, P0072, P0073, P0074, P0087, P00C7, P00E9, P00EA, P00EB, P00EC, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0119, P0128, P0201-P0204, P020A-P020D, P0216, P021A, P021B, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P02E0, P02E3-P02E5, P02E8, P02E9, P02EB, P02EE, P02EF, P02F0, P02F1, P0335, P0336, P0400, P0403, P0405, P0406, P042E, P042F, P049D, P0490, P0545, P0546, P062B, P062D, P111E, P113B, P115E, P115F, P1160, P116A, P116B, P116C, P116D, P116E, P116F, P118E, P1192, P1193, P1194, P119A, P119B, P119C, P11C5, P11C6, P11CC, P11DB, P11DD, P122B-P122D, P1248, P1249, P124A, P124B, P1402, P1407, P140F, P1424, P1425, P16A0-P16A2, P16D7-P16D9, P2081, P2082, P2147, P2148, P2150, P2151, P2200, P2202, P2203, P2205, P2206, P2207, P2208, P2209, P220A, P2210, P2211, P2227, P2228, P2229, P2230, P2262, P228A, P228B, P22F9, P22FA, P2459, P245C, P262B, or U029D is not set.
- The engine is running.
- The ignition voltage is greater than 11 V.
- The NOx Sensor 1 Heater Operation parameter displays Allowed.
- The injection fuel quantity is less than $20mm^3$.
- The engine speed is between 550 - 4, 500 RPM.

The DTC runs continuously when the above conditions are met.

P11DB

- DTC P115E, P115F, P1160, P116A, P116B, P116C, P116D, P116E, P116F, P1192, P1193, P1194, P119A, P119B, P119C, P11C5, P11C6, P11DD, P2200, P2205, P2206, P2207, P2208, P2209, P220A,

P2210, P2211, or U029D is not set.
- The engine is running.
- The ignition voltage is greater than 11 V.
- The NOx Sensor 1 Heater Operation parameter displays Allowed.
- The injection fuel quantity is less than 35mm^3 .
- The NOx sensor supply voltage is greater than 10.8 V.

The DTC runs continuously when the above conditions are met.

P2202, P2203

- 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, P220A, P2210, P2211, or U029D is not set.
- The engine is running.
- The ignition voltage is greater than 11 V.
- The NOx Sensor 1 Heater Operation parameter displays Allowed.
- The NOx sensor supply voltage is greater than 10.8 V.

The DTC runs continuously when the above conditions are met.

P2209

- DTC U029D is not set
- The ignition voltage is greater than 11 V.
- The NOx Sensor 1 Heater Operation parameter displays Allowed.
- The NOx sensor supply voltage is greater than 10.8 V.

These DTCs run continuously when the above conditions are met for greater than 180 s.

P22FA

- DTC P0033, P0034, P0035, P003A, P0045, P0047, P0048, P0070-P0074, P0087, P0096-P0099, P00C7, P00E9, P00EA-P00EC, P00F4, P00F5, P0101-P0103, P0106-P0108, P0111-P0114, P0116-P0119, P0128, P0191-P0193, P0201-P0204, P020A-P020D, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P02E0, P02E2, P02E3-P02E5, P02E8, P02E9, P02EB, P02EE, P02EF, P02F0, P02F1, P0335, P0336, P0400, P0403, P0405, P0406, P041B, P041C, P041D, P041E, P042E, P042F, P049D, P0490, P0545, P0546, P062B, P062D, P111E, P113B, P115E, P115F, P1160, P116A-P116F, P118E, P1192-P1194, P119A-P119C, P11C5, P11C6, P11CC, P11DB, P11DD, P122B-P122D, P1248, P1249, P124A, P124B, P1402, P1407, P140F, P1424, P1425, P1428, P169E, P169F, P16A0-P16A2, P16B0, P16B1, P16B2, P16FA, P16FC, P2080, P2081, P2147, P2148, P2150, P2151, P2200, P2202, P2203, P2205, P2206, P2207, P2208, P2209, P220A, P2210, P2211, P2227, P2228, P2229, P2230, P2262, P2263, P228A, P228B, P22CF, P22D0, P22D1, P2459, P245C, P2564, P2565, P2598, P2599, P262B, or U029D is not set.
- The engine is running.
- The ignition voltage is greater than 11 V.
- The NOx Sensor 1 Heater Operation parameter displays Allowed.
- The injection fuel quantity is between 15mm^3 -80mm^3 .
- The engine speed is between 1, 000 - 3, 500 RPM.

The DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

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The NOx sensor module detects a fault in the NOx sensor circuitry or a performance fault in the NOx sensor for greater than 2 s.

Action Taken When the DTC Sets

- DTCs P115E, P116A, P116D, P1192, P119A, P11C5, P2205, and P2208 are Type A DTCs.
- DTCs P115F, P1160, P116B, P116C, P116E, P116F, P1193, P1194, P119B, P119C, P11C6, P11CC, P11D3, P11DB, P2202, P2203, P2206, P2207, P2209, P2210, P2211, and P22FA are Type B DTCs.
- Warning lamp shall be activated
- Selective catalytic reduction monitoring is disabled
- NOx concentration measured by NOx Sensor 2 is used for a calculated value.

Conditions for Clearing the DTC

- DTCs P115E, P116A, P116D, P1192, P119A, P11C5, P2205, and P2208 are Type A DTCs.
- DTCs P115F, P1160, P116B, P116C, P116E, P116F, P1193, P1194, P119B, P119C, P11C6, P11CC, P11D3, P11DB, P2202, P2203, P2206, P2207, P2209, P2210, P2211, and P22FA are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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 P11CC is not set
    - **If the DTC is set**
3. Verify the none of the conditions listed below exist:
    - Intake system leaks
    - Exhaust system leaks
    - A loose or disconnected charge air cooler hose or pipe
    - Physical damage
    - Soot plugged B195 Nitrogen Oxide Sensor

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- Loose B195 Nitrogen Oxide sensors or B131 Exhaust Temperature Sensors
- Loose or missing hardware
  - If a condition is found

    Repair as necessary

  - Go to next step: If no condition is found

    Go to next step: Replace the B195A Nitrogen Oxides Sensor 1
- **Go to next step: If the DTC is not set**

4. Verify that DTCs P115E, P115F, P1160, P116A, P116B, P116C, P116D, P116E, P116F, P1192, P1193, P1194, P119A, P119B, P119C, P11C5, P11C6, P11CC, P11D3, P11DB, P2202, P2203, P2205, P2206, P2207, P2208, P2209, P2210, P2211, or P22FA 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**
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**

     Replace the B195A Nitrogen Oxides Sensor 1

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

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Nitrogen Oxides Sensor Replacement - Position 1

DTC P118B

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 P118B

Particulate Matter Sensor Temperature Performance

Circuit/System Description

For an overview of the component/system, refer to **Exhaust Aftertreatment System Description**

Component	Description
B136 Exhaust Particulate Matter Sensor	The sensor measures the particulate matter in the form of soot in the exhaust.

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Component	Description
K115 Reductant Control Module	The control module controls the heating and dosing of the reductant.

The actual sensor surface is only a few square millimeters in size. On the surface there are 2 microscopic comb-shaped electrodes with intertwined tines (electrical traces) to have the longest possible route of transitions from one to the other electrode. Soot is conductive, therefore when soot deposits between the electrodes, electrical current can flow from one electrode to the other. The more soot deposits between the electrodes, the lower the resistance. To measure the resistance, voltage is applied to the electrodes. The voltage also generates an electrical field that attracts the soot. If the sensor surface is saturated, the sensor is electrically heated to burn off the soot.

Conditions for Running the DTC

- DTC P142C, P142D, P142E, P142F, P1474, P1475, P1476, P1477, P1478, P16D7, P16D8, P16D9, P2227, P2228, P2229, P2230, P24B0, P24B1, P24B3, P24B5, P24B6, P24D0, P262B, U02A3 = Not set
- Ignition Off Time = For greater than 8 h
- Ignition On
- Ignition Voltage = Greater than 11 V

Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

Control module K115 detects: Circuit Current Out Of Range - Particulate Matter Sensor

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type B

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type B

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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

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Control Module References

Circuit/System Verification

1. Ignition - On / Vehicle - In Service Mode
2. Clear the DTCs.
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**

     Replace the component: B136 Exhaust Particulate Matter Sensor

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

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Exhaust Particulate Matter Sensor Replacement**
- For control module replacement, programming, and setup refer to **Control Module References**

DTC P11B3, P22B6, P22B7, OR P2A01

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 P11B3

HO2S Performance During Deceleration Fuel Cut-Off Bank 1 Sensor 2

DTC P22B6

HO2S Pump Current Trim Circuit Low Voltage Sensor 2

DTC P22B7

HO2S Pump Current Trim Circuit High Voltage Sensor 2

DTC P2A01

HO2S Performance Sensor 2

Circuit/System Description

For an overview of the component/system, refer to **Exhaust Aftertreatment System Description**

Component	Description
B195B Nitrogen Oxides Sensor 2	The sensor delivers signals for wide-band lambda, digital lambda and NOx concentration.

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Component	Description
K115 Reductant Control Module	The control module controls the heating and dosing of the reductant.

NOx sensors work similar to wide-band O2 sensors. The sensors consist of two measuring cells. In the first cell, an electric pump current is used to separate out the oxygen in the exhaust. The NOx remains and is conveyed into the second chamber. Here a second pump current decomposes the NOx into nitrogen and oxygen. The oxygen concentration is measured and from there the NOx concentration can be calculated.

Conditions for Running the DTC

P11B3

- DTC U029D, U029E = Not set
- Verify there are no DTCs set related to the following component/system:
  - B66 Intake Air Temperature Sensor
  - B75C Multifunction Intake Air Sensor
  - B195 Nitrogen Oxides Sensor - Circuit
  - Q14 Exhaust Gas Recirculation Valve
  - Q17 Fuel Injector
- Engine = Running
- Ignition Voltage = Greater than 11 V
- NOx Sensor 2 Heater Mode = Allowed

Frequency the DTC runs = Continuously - After the running conditions are met

P22B6

- DTC P119D-P119F, P11BE, P11BF, P11C0, P11C7, P11C8, P11D0-P11D2, P11D8, P11D9, P11DA, P11DC, P11DE, P11FC-P11FE, P220B, P229E, P22A3-P22A9, U029E = Not set
- Engine = Running
- Ignition Voltage = Greater than 11 V
- NOx Sensor 2 Heater Mode = Allowed

Frequency the DTC runs = Continuously - After the running conditions are met

P22B7

- Verify there are no DTCs set related to the following component/system:
  - B66 Intake Air Temperature Sensor
  - B75C Multifunction Intake Air Sensor
  - B195 Nitrogen Oxides Sensor - Circuit
  - Q14 Exhaust Gas Recirculation Valve
  - Q17 Fuel Injector
- Engine = Running
- Ignition Voltage = Greater than 11 V
- NOx Sensor 2 Heater Mode = Allowed

Frequency the DTC runs = Continuously - After the running conditions are met

P2A01

- DTC U029D, U029E = Not set

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- Verify there are no DTCs set related to the following component/system:
  - B66 Intake Air Temperature Sensor
  - B75C Multifunction Intake Air Sensor
  - B195 Nitrogen Oxides Sensor - Circuit
  - Q14 Exhaust Gas Recirculation Valve
  - Q17 Fuel Injector
  - Fuel System
- Engine Speed = 1, 500 to 3, 500 RPM
- Ignition Voltage = Greater than 11 V
- NOx Sensor 1, 2 Heater Mode = Allowed

Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

Control module K115 detects: Circuit Current Out Of Range - NOx Sensor 2

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type B

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type B

Diagnostic Aids

Control modules connected to the serial data circuits monitor the communication during normal vehicle operation. Operating information and commands are exchanged among the control modules. Each module on the serial data circuit maintains a transmit error counter and a receive error counter. The counter values increase with detected errors and decrease with error-free messages.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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

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Circuit/System Verification

1. Ignition - On / Vehicle - In Service Mode
2. Verify there are no DTCs set related to the following component/system:
    - B66 Intake Air Temperature Sensor
    - B75C Multifunction Intake Air Sensor
    - B195 Nitrogen Oxides Sensor - Circuit
    - Q14 Exhaust Gas Recirculation Valve
    - Q17 Fuel Injector
    - Fuel System
    - **If a related DTC is set**

      Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**

    - **Go to next step: If a related 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.

   Verify the DTC does not set.

    - **If the DTC sets**

      Replace the component: B195B Nitrogen Oxides Sensor 2

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

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Nitrogen Oxides Sensor Replacement - Position 2**
- For control module replacement, programming, and setup refer to **Control Module References**

DTC P122D

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 P122D

Intake Air Flow Valve Position Sensor Exceeded Learning Limit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Control - Terminal 1	P122C	P02E0	P122C, P122D	P02E4, P02E5
Control - Terminal 2	P122C	P02E0	P122C, P122D	P02E4, P02E5

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Circuit/System Description

For an overview of the component/system, refer to **Intake Airflow Valve System Description**

Circuit	Description
Control - Terminal 1	The output circuit is switched from ground to 12 V to activate the component. The output is PWM controlled.
Control - Terminal 2	The output circuit is switched from ground to 12 V to activate the component. The output is PWM controlled.

Component	Description
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.
Q20 Intake Air Flow Valve	The intake air flow valve of diesel engines reduces the intake air flow rate in part load operation so that a higher exhaust gas recirculation rate can be achieved. The component is actuated by a bidirectional DC motor. Not Activated = Open

Conditions for Running the DTC

- DTC P0071 - P0074, P0116 - P0119, P02E0 - P02E5, P02E8, P02E9, P02EB, P0651, P122B, P122C, P16A0 - P16A2 = Not set
- Ambient Air Temperature = Warmer than 49B°C (120B°F)
- Engine Coolant Temperature = 50 to 150B°C (122 to 302B°F)
- Ignition Key = Off
- Ignition Voltage = Greater than 10 V
- Intake Air Flow Valve Motor Command = Learning - Complete

Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

Intake Air Flow Valve Learned Closed Position 4.3 to 4.6 V

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type A DTC - Additional actions taken:

- Reduced Engine Power = Active
- P16 Instrument Cluster = Reduced Engine Power

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type A DTC

Diagnostic Aids

- Certain weather conditions during prolonged drive trips may cause ice to form in the area of the component: Q20 Intake Air Flow Valve
- If ice is found in the area of the component Q20, clean and dry the component and retest to verify the issue has been corrected.

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Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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 P02E0 - P02E5, P02E8, P02E9, P02EB, P122B, P122C, P16A0 - P16A2 is not set.
    - **If the DTC is set**

      Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**

    - **Go to next step: If the DTC is not set**
3. Clear the DTCs.
4. Ignition Off - For greater than 1 min
5. Ignition - On / Vehicle - In Service Mode
6. Verify DTC P122D is not set.
    - **If the DTC sets**

    1. Ignition/Vehicle - Off
    2. Verify the following conditions do not exist: Blade @ Q20 Intake Air Flow Valve

       WARNING: **Turn OFF the ignition before inserting fingers into the throttle bore. Unexpected movement of the throttle blade could cause personal injury.**

       - Binding or Sticking @ Open/Close - Position
       - Closed @ Engine Off
       - Coking/Debris / Dirty / Visible Damage
       - Open/Close - Without spring pressure
       - Water intrusion - Ice

         Refer to: Diagnostic Aids

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- If a condition exists - Repair or replace as necessary
- **Go to next step: If the DTC does not set**

7. 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**

     Repeat step 2

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

8. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Throttle Body Assembly Replacement** - Q20 Intake Air Flow Valve
- For control module replacement, programming, and setup refer to **Control Module References**

DTC P1307-P130A

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.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P1307

Cylinder 1 Glow Plug Resistance

DTC P1308

Cylinder 2 Glow Plug Resistance

DTC P1309

Cylinder 3 Glow Plug Resistance

DTC P130A

Cylinder 4 Glow Plug Resistance

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage
Cylinder 1 Glow Plug Control	P1307, P066A	P1307, P0671	P1307, P066B
Cylinder 2 Glow Plug Control	P1308, P066C	P1308, P0672	P1308, P066D
Cylinder 3 Glow Plug Control	P1309, P066E	P1309, P0673	P1309, P066F
Cylinder 4 Glow Plug Control	P130A, P067A	P130A, P0674	P130A, P067B

Circuit/System Description

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The glow plug control module is integrated in the engine control module (ECM) and is a solid state device which operates the glow plugs. The temperature and the power consumption is controlled within a wide range to suit the engine pre-heating requirements. The glow plug initial ON time will vary based on the system voltage and temperature. Lower temperatures cause longer ON times.

Conditions for Running the DTC

- The engine is running.
- Ignition voltage is greater than 11 V.
- The glow plug are commanded ON.
- The DTC runs continuously when conditions above are met.

Conditions for Setting the DTC

The ECM detects the glow plug electrical resistance is outside a calibratable range for greater than 2 s.

Action Taken When the DTC Sets

DTCs P1307, P1308, P1309, and P130A are Type B DTCs.

Conditions for Clearing the DTC

DTCs P1307, P1308, P1309, and P130A are Type B DTCs.

Diagnostic Aids

If the battery is connected with the ignition ON, the glow plugs could be damaged without finding any circuit fault.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **Component Connector End Views - Index**

Description and Operation

Glow Plug 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

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Circuit/System Verification

1. Ignition ON.
2. Verify DTC P037E, P037F, P066A-P066F, P0671 - P0674, P067A, or P067B is not set.
   - **If DTC P037E, P037F, P066A-P066F, P0671 - P0674, P067A, or P067B is set**

     Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

   - **Go to next step: If a DTC P037E, P037F, P066A-P066F, P0671 - P0674, P067A, or P067B is not set**
3. Ignition ON.
4. Using a scan tool observe the following parameters.

   Verify that NO parameters display Malfunction.

   - Cylinder 1, 2, 3, or 4 Glow Plug Control Open Test Status
   - Cylinder 1, 2, 3, or 4 Glow Plug Control High Voltage Test Status
   - Cylinder 1, 2, 3, or 4 Glow Plug Control Low Voltage Test Status
   - **If Malfunction is displayed**

     Refer to Circuit/System Testing.

   - **Go to next step: If Malfunction is not displayed**
5. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not set. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
   - **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

NOTE: **If a glow plug is replaced and the tip is missing or burned off, the cylinder head must be removed and all debris be cleaned out of the cylinder.**

1. Ignition OFF, disconnect the harness connector at the appropriate E12 Glow Plug, Ignition ON.
2. Glow plugs not commanded ON, verify that a test lamp does not illuminate between the appropriate Glow Plug Supply Voltage circuit terminal 1 and ground.
   - **If the test lamp illuminates**
   1. Ignition OFF, disconnect the X2 harness connector at the K20 Engine Control Module.
   2. Ignition ON.
   3. Test for less than 1 V between the appropriate glow plug supply voltage circuit and ground.
      - If 1 V or greater, repair the short to voltage in the circuit.
      - If less than 1 V, replace the K20 Engine Control Module.
   - **Go to next step: If the test lamp does not illuminate**
3. Command the Glow Plugs ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.
   - **If the test lamp does not turn ON and OFF**
   1. Ignition OFF, disconnect the X2 harness connector at the K20 Engine Control Module.
   2. Test for infinite resistance between the appropriate glow plug supply voltage circuit and ground.

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- If less than infinite resistance, repair the short to ground in the circuit.
- Go to next step: If infinite resistance.

3. Test for less than 2Ω in the glow plug supply voltage circuit end to end.
    - If 2Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2Ω, replace the K20 Engine Control Module.
- **Go to next step: If the test lamp turns ON and OFF**

4. Replace the appropriate E12 Glow Plug.

Component Testing

1. Ignition OFF.
2. Disconnect the harness connector of the appropriate glow plug.
3. Test for less than 2 Ω between glow plug terminal and ground.
    - **If the resistance is more than 2 Ω**

      Replace the affected glow plug.

    - **Go to next step: If the resistance is less than 2 Ω**
4. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Glow Plug Replacement**
- **Control Module References** for control module replacement, programming, and setup.

DTC P140B OR P140C

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 P140B

Exhaust Gas Recirculation (EGR) Slow Response - Increasing Flow

DTC P140C

Exhaust Gas Recirculation (EGR) Slow Response - Decreasing Flow

Circuit/System Description

For an overview of the component/system, refer to **Exhaust Gas Recirculation (EGR) System Description**

Component	Description
Q14 Exhaust Gas Recirculation Valve	Redirecting the exhaust gas back into the intake system aids in reducing the amount of oxygen that enters the cylinders. This reduces the amount of nitrogen oxide (NOx) that is produced during combustion. The component is actuated by a bidirectional DC motor.

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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.

Conditions for Running the DTC

- DTC P2459, P262B = Not set
- DTCs related to the following system/component = Not Set
  - B9 Ambient Air Temperature Sensor
  - B17 Barometric Pressure Sensor
  - B26 Crankshaft Position Sensor
  - B34 Engine Coolant Temperature Sensor
  - B47B Fuel Rail Pressure Sensor
  - B65 Intake Manifold Pressure and Air Temperature Sensor
  - B75C Multifunction Intake Air Sensor
  - B115 Vehicle Speed Sensor
  - B130 Exhaust Gas Recirculation Temperature Sensor
  - B131 Exhaust Gas Temperature Sensor
  - B154 Diesel Particulate Filter Exhaust Differential Pressure Sensor
  - M103 Turbocharger Vane Position Actuator
  - Q14 Exhaust Gas Recirculation Valve
  - Q17 Fuel Injector
- Ambient Air Temperature = Greater than -20B°C (-4B°F)
- Barometric Pressure = Greater than 72 kPa (10.4 PSI)
- Desired EGR Position = Greater than 0%
- Engine = Running
- Engine Speed = 1, 500 to 1, 850 RPM
- Ignition Voltage = Greater than 11 V

Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

P140B

Desired EGR Position = Slow Response - Increasing - For greater than 5 s

P140C

Desired EGR Position = Slow Response - Decreasing - For greater than 5 s

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type B

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type B

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Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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 there are no DTCs set related to the following component/system:
    - B9 Ambient Air Temperature Sensor
    - B17 Barometric Pressure Sensor
    - B26 Crankshaft Position Sensor
    - B34 Engine Coolant Temperature Sensor
    - B47B Fuel Rail Pressure Sensor
    - B65 Intake Manifold Pressure and Air Temperature Sensor
    - B75C Multifunction Intake Air Sensor
    - B115 Vehicle Speed Sensor
    - B130 Exhaust Gas Recirculation Temperature Sensor
    - B131 Exhaust Gas Temperature Sensor
    - B154 Diesel Particulate Filter Exhaust Differential Pressure Sensor
    - M103 Turbocharger Vane Position Actuator
    - Q14 Exhaust Gas Recirculation Valve
    - Q17 Fuel Injector
    - **If a related DTC is set**

      Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**

    - **Go to next step: If a related DTC is not set**
3. Verify the condition does not exist:
    - Air Cleaner Element - Saturated with water/Restricted
    - Exhaust System - Leaking/Missing components/Restricted - Refer to **Symptoms - Engine Exhaust**

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- Intake Manifold - Leaking
- Intake Air Duct - Loose Clamps/Cracked/Visible Damage
- Mass Airflow Sensor - Contamination of the measuring element/Water intrusion
- **If a condition exists**

  Repair or replace as necessary

- **Go to next step: If no condition exists**

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.

   Verify the DTC does not set.

   - **If the DTC sets**

     Replace the component: Q14 Exhaust Gas Recirculation Valve

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

5. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Exhaust Gas Recirculation Valve Replacement**
- For control module replacement, programming, and setup refer to **Control Module References**

DTC P1428 OR P142A

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 P1428

EGR Temperature Sensor 1 - Intake Air Temperature 2 Not Plausible

DTC P142A

EGR Temperature Sensor 2 - Intake Air Temperature 2 Not Plausible

Circuit/System Description

For an overview of the component/system, refer to **Exhaust Gas Recirculation (EGR) System Description**

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

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Component	Description
B130 Exhaust Gas Recirculation Temperature Sensor	The temperature sensor is a positive temperature coefficient thermistor, a resistor which changes based on temperature.
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 P00E9, P010B, P0111, P0114, P0116, P0117, P0118, P0119, P0128, P017B, P017C, P017D, P111E, P117B, P117C, P117D, P117E, P117F, P262B = Not set
- Engine Cranking or Engine Running
- Ignition = Off - For greater than 8 h
- Ignition Voltage = Greater than 11 V

Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

EGR Temperature Sensor 1, 2 & IAT Sensor 2 = Not within 20B°C (36B°F) of each other @ Cold Start-Up

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

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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

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Special Tools

<special tool><special tool-no>EL-25070</special tool-no><special tool-desc>Heat Gun 260 to 400B°C (500 to 750B°F)</special tool-desc></special tool>

Equivalent regional tools: **Special Tools ((Diagnosis Tools))**

Circuit/System Verification

1. Ignition - On / Vehicle - In Service Mode
2. Verify there are no DTCs set related to the following component/system:
   - B34 Engine Coolant Temperature Sensor
   - B66 Intake Air Temperature Sensor
   - B75C Multifunction Intake Air Sensor
   - Fuel System
   - **If a related DTC is set**

     Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**

   - **Go to next step: If a related DTC is not set**
3. Verify the scan tool parameter: EGR Temperature Sensor 1, 2 = -39 to 999B°C (-38 to 1, 830B°F)
   - **If not the specified value**

     Refer to: Circuit/System Testing

   - **Go to next step: If the specified value**
4. Verify the scan tool parameter: EGR Temperature Sensor 1, 2 & IAT Sensor 2 = Not within 20B°C (36B°F) of each other
   - **If not the specified value**

     Refer to: Circuit/System Testing

   - **Go to next step: If the specified value**
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 appropriate electrical connector: B130 Exhaust Gas Recirculation Temperature Sensor
3. Test for less than 10 ohms between the test points: Low Reference circuit terminal 1 & Ground
   - **If 10 ohms or greater**
   1. Disconnect the electrical connector: K20 Engine Control Module

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2. Test for less than 2 ohms between the test points:
    - {Sensor 1} Low Reference circuit terminal 1 @ Component harness & Terminal 19 X3 @ Control module harness
    - {Sensor 2} Low Reference circuit terminal 1 @ Component harness & Terminal 10 X3 @ 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 10 ohms**

4. Ignition - On / Vehicle - In Service Mode
5. Test for 4.8 to 5.2 V between the test points: EGR Cooler Temperature Sensor 1, 2Signal circuit terminal 2 & Ground
    - **If less than 4.8 V**
    1. Ignition/Vehicle - Off
    2. Disconnect the electrical connector: K20 Engine Control Module
    3. Test for less than 2 ohms between the test points:
        - {Sensor 1} Signal circuit terminal 2 @ Component harness & Terminal 20 X3 @ Control module harness
        - {Sensor 2} Signal circuit terminal 2 @ Component harness & Terminal 24 X3 @ Control module harness
        - If 2 ohms or greater - Repair the open/high resistance in the circuit.
        - Go to next step: If less than 2 ohms
    4. Test for infinite resistance between the test points: Signal circuit terminal 2 @ 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
    - **If greater than 5.2 V**
    1. 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 - Replace the component: K20 Engine Control Module
    - **Go to next step: If between 4.8 and 5.2 V**
6. Replace the appropriate component: B130 Exhaust Gas Recirculation Temperature Sensor
7. 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.
8. Verify the DTC does not set.
    - **If the DTC sets**

      Replace the component: K20 Engine Control Module

    - **Go to next step: If the DTC is not set**
9. All OK.

Component Testing

1. Ignition/Vehicle - Off
2. Disconnect the appropriate electrical connector: B130 Exhaust Gas Recirculation Temperature Sensor

NOTE: **Use the special tool:<special tool><special tool-no>EL-25070</special tool-no><special tool-desc>Heat Gun 260 to 400B°C (500 to 750B°F) </special tool-desc></special tool>**

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3. Test the resistance between the test points: Signal terminal 2 & Low Reference terminal 1
4. Verify the value is within the range listed in the table: **Temperature Versus Resistance - Exhaust Gas Temperature Sensor**
    - **If not in the specified range**

      Replace the component: B130 Exhaust Gas Recirculation Temperature Sensor

    - **Go to next step: If in the specified range**
5. Test for infinite resistance between the test points: Each terminal of the component & The component's housing
    - **If less than infinite resistance**

      Replace the component: B130 Exhaust Gas Recirculation Temperature Sensor

    - **Go to next step: If infinite resistance**
6. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Exhaust Gas Recirculation Cooler Temperature Sensor Replacement - Position 1**
- **Exhaust Gas Recirculation Cooler Temperature Sensor Replacement - Position 2**
- For control module replacement, programming, and setup refer to **Control Module References**

DTC P142B-P142F, P1435, OR P1436

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 P142B

Particulate Matter Sensor Control Module High Temperature

DTC P142C

Particulate Matter Sensor Control Module Temperature Sensor 1 Low Voltage

DTC P142D

Particulate Matter Sensor Control Module Temperature Sensor 1 High Voltage

DTC P142E

Particulate Matter Sensor Control Module Temperature Sensor 2 Low Voltage

DTC P142F

Particulate Matter Sensor Control Module Temperature Sensor 2 High Voltage

DTC P1435

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Particulate Matter Sensor Control Module Temperature Sensors 1-2 Not Plausible

DTC P1436

Particulate Matter Sensor Control Module Temperature Signal Message Counter Incorrect

Circuit/System Description

For an overview of the component/system, refer to **Exhaust Aftertreatment System Description**

Component	Description
B136 Exhaust Particulate Matter Sensor	The sensor measures the particulate matter in the form of soot in the exhaust.
K115 Reductant Control Module	The control module controls the heating and dosing of the reductant.

The actual sensor surface is only a few square millimeters in size. On the surface there are 2 microscopic comb-shaped electrodes with intertwined tines (electrical traces) to have the longest possible route of transitions from one to the other electrode. Soot is conductive, therefore when soot deposits between the electrodes, electrical current can flow from one electrode to the other. The more soot deposits between the electrodes, the lower the resistance. To measure the resistance, voltage is applied to the electrodes. The voltage also generates an electrical field that attracts the soot. If the sensor surface is saturated, the sensor is electrically heated to burn off the soot.

Conditions for Running the DTC

P142B, P1435

- DTC P142C, P142D, P142E, P142F, P1474, P1475, P1476, P1477, P1478, P16D7, P16D8, P16D9, P24B0, P24B1, P24B3, P24B5, P24B6, P24D0, U02A3 = Not set
- Ignition On
- Ignition Voltage = Greater than 11 V
- Reductant Control Module Relay = ON

Frequency the DTC runs = Continuously - After the running conditions are met

P142C, P142D, P142E, P142F, P1436

- DTC P16D7, P16D8, P16D9, P24D0, U02A3 = Not set
- Ignition On
- Ignition Voltage = Greater than 11 V
- Reductant Control Module Relay = ON

Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

Control module K115 detects: Circuit Current Out Of Range - Particulate Matter Sensor

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type B

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type B

Reference Information

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Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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 P1474, P1475, P1476, P1477, P1478, P16D7, P16D8, P16D9, P24B0, P24B1, P24B3, P24B5, P24B6, P24D0, U02A3 is not set.
   - **If any DTC is set**

     Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**

   - **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.

   Verify DTC P142B, P142C, P142D, P142E, P142F, P1435, P1436 is not set.

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

     Replace the component: B136 Exhaust Particulate Matter Sensor

   - **Go to next step: If none of the DTCs are set**
4. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Exhaust Particulate Matter Sensor Replacement**
- For control module replacement, programming, and setup refer to **Control Module References**

DTC P144E

Diagnostic Instructions

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- 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 P144E

Closed Loop Diesel Particulate Filter (DPF) Regeneration Control At Limit - Stage 2 Low Temperature

Circuit/System Description

For an overview of the component/system, refer to **Exhaust Aftertreatment System Description**

Component	Description
B131 Exhaust Temperature Sensor	The temperature sensor is a positive temperature coefficient thermistor, a resistor which changes based on temperature.
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 P142C, P142D, P142E, P142F, P1474, P1475, P1476, P1477, P1478, P16D7, P16D8, P16D9, P2227, P2228, P2229, P2230, P24B0, P24B1, P24B3, P24B5, P24B6, P24D0, P262B, U02A3 = Not set
- DPF Regeneration = Active
- Ignition Voltage = Greater than 11 V
- Vehicle Speed = Greater than 3 km/h (1.8 MPH)

Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

Exhaust Temperature Sensor - Position 2 = Not within a calibrated range

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type B

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type B

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **Component Connector End Views - Index**

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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 there are no DTCs set related to the following component/system:
    - B34 Engine Coolant Temperature Sensor
    - B66 Intake Air Temperature Sensor
    - B75C Multifunction Intake Air Sensor
    - Q17 Fuel Injector
    - **If a related DTC is set**

      Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**

    - **Go to next step: If a related DTC is not set**
3. Verify the scan tool parameter:
    - Exhaust Gas Temperature Sensor 1 = **Temperature Versus Resistance - Exhaust Gas Temperature Sensor** - The value should be within the range listed in the table.
    - Exhaust Gas Temperature Sensor 2 = **Temperature Versus Resistance - Exhaust Gas Temperature Sensor** - The value should be within the range listed in the table.
    - **If not the specified value**

      Replace the appropriate component: B131 Exhaust Temperature Sensor

    - **Go to next step: If the specified value**
4. Verify the following conditions do not exist:
    - Exhaust System - Leaking/Missing components/Restricted - Refer to **Exhaust Leakage**
    - Charge Air Duct - Leaking/Loose/Restricted
    - **If a condition exists**

      Repair or replace as necessary

    - **Go to next step: If no condition exists**
5. Perform the scan tool control function: DPF Service Regeneration
6. Verify sensor 2 is at least 100B°C (180B°F) warmer than sensor 1:
    - Exhaust Gas Temperature Sensor 1
    - Exhaust Gas Temperature Sensor 2
    - **If sensor 2 is not at least 100B°C (180B°F) warmer than sensor 1**

      Replace the component: Oxidation Catalytic Converter

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- **Go to next step: If sensor 2 is at least 100B°C (180B°F) warmer than sensor 1**

7. 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**

     Replace the component: Oxidation Catalytic Converter

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

8. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Catalytic Converter Replacement (LWN)** - Oxidation Catalytic Converter
- **Exhaust Temperature Sensor Replacement - Position 1**
- **Exhaust Temperature Sensor Replacement - Position 2**
- For control module replacement, programming, and setup refer to **Control Module References**

Additional Procedures

Catalyst Reset - Perform only when the following component/system is replaced or serviced:

Oxidation Catalytic Converter

DTC P1474-P1479, P147B, OR P1488

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 P1474

Particulate Matter Sensor Sensing Element Supply Circuit Open

DTC P1475

Particulate Matter Sensor Sensing Element Supply Circuit Low Voltage

DTC P1476

Particulate Matter Sensor Sensing Element Supply Circuit High Voltage

DTC P1477

Particulate Matter Sensor Temperature Circuit Low Voltage

DTC P1478

Particulate Matter Sensor Temperature Circuit High Voltage

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DTC P1479

Particulate Matter Sensor Sensitivity Factor Performance

DTC P147B

Particulate Matter Sensor Shunt Circuit High Current

DTC P1488

Particulate Matter Sensor Protection Tube Performance

Circuit/System Description

For an overview of the component/system, refer to **Exhaust Aftertreatment System Description**

Component	Description
B136 Exhaust Particulate Matter Sensor	The sensor measures the particulate matter in the form of soot in the exhaust.
K115 Reductant Control Module	The control module controls the heating and dosing of the reductant.

The actual sensor surface is only a few square millimeters in size. On the surface there are 2 microscopic comb-shaped electrodes with intertwined tines (electrical traces) to have the longest possible route of transitions from one to the other electrode. Soot is conductive, therefore when soot deposits between the electrodes, electrical current can flow from one electrode to the other. The more soot deposits between the electrodes, the lower the resistance. To measure the resistance, voltage is applied to the electrodes. The voltage also generates an electrical field that attracts the soot. If the sensor surface is saturated, the sensor is electrically heated to burn off the soot.

Conditions for Running the DTC

P1474, P1475, P1476, P1477, P1478

- DTC P16D7, P16D8, P16D9, P24D0, U02A3 = Not set
- Ignition On
- Ignition Voltage = Greater than 11 V
- Reductant Control Module Relay = ON

Frequency the DTC runs = Continuously - After the running conditions are met

P1479, P147B

- DTC P142C, P142D, P142E, P142F, P1474, P1475, P1476, P1477, P1478, P16D7, P16D8, P16D9, P24B0, P24B1, P24B3, P24B5, P24B6, P24D0, U02A3 = Not set
- Ignition On
- Ignition Voltage = Greater than 11 V
- Particulate Matter Sensor = 200 to 425B°C (392 to 797B°F)
- Reductant Control Module Relay = ON

Frequency the DTC runs = Continuously - After the running conditions are met

P1488

- DTC U02A3 = Not set
- Verify there are no DTCs set related to the following component/system:
  - B66 Intake Air Temperature Sensor

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    - B75C Multifunction Intake Air Sensor
    - Q14 Exhaust Gas Recirculation Valve
    - Q17 Fuel Injector
- Ignition On
- Ignition/Vehicle - Off - For greater than 8 h
- Ignition Voltage = Greater than 11 V
- Particulate Matter Sensor = 0 to 300B°C (32 to 572B°F)
- Reductant Control Module Relay = ON

Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

Control module K115 detects: Circuit Current Out Of Range - Particulate Matter Sensor

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type B

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type B

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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 P142B, P142C, P142D, P142E, P142F, P1435, P1436 is not set.
    - **If any of the DTCs are set**

      Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**

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

   Verify DTC P1474, P1475, P1475, P1476, P1477, P1478, P1479, P147B, P1488 is not set.

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

     Replace the component: B136 Exhaust Particulate Matter Sensor

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

4. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Exhaust Particulate Matter Sensor Replacement**

DTC P150C, P155D, P15F2, P1762, P1773, P1775, P188B, P18EF, P1919, OR P2544

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 P150C

Transmission Control Module Engine Speed Request Signal Message Counter Incorrect

DTC P155D

Hill Descent Control Message Counter Incorrect

DTC P15F2

Engine Torque Command Signal Message Counter Incorrect

DTC P1762

Transmission Mode Switch Signal Message Counter Incorrect

DTC P1773

Internal Mode Switch State Signal Message Counter Incorrect

DTC P1775

Transmission Range Request Signal Message Counter Incorrect

DTC P188B

Transmission Range Signal Message Counter Incorrect

DTC P18EF

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Continuously Variable Transmission Torque Ratio Signal Message Counter Incorrect

DTC P1919

Transmission Neutral Locked Turbine Signal Message Counter Incorrect

DTC P2544

Transmission Torque Request Signal Message Counter Incorrect

Circuit/System Description

Control modules connected to the serial data circuits monitor the communication during normal vehicle operation. Operating information and commands are exchanged among the control modules. Each module on the serial data circuit maintains a transmit error counter and a receive error counter. The counter values increase with detected errors and decrease with error-free messages.

Conditions for Running the DTC

- Ignition = On - For greater than 3 s
- Serial Data = Enabled

Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

Serial Data = Message Counter Incorrect - Component

The above condition(s) must occur 5 times.

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type B DTC - Exceptions listed below

- DTC P15F2, P188B, P18EF = Type A DTC
- DTC P155D = Type C DTC

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type B DTC - Exceptions listed below

- DTC P15F2, P188B, P18EF = Type A DTC
- DTC P155D = Type C DTC

Reference Information

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 there are no DTCs set related to the following component/system: Serial Data
    - **If a related DTC is set**

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Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**

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

3. Clear the DTCs.
4. Operate the vehicle within the Conditions for Running the DTC.

   Verify the DTC does not set.

   - **If the DTC sets**

   1. Ignition/Vehicle - Off
   2. Replace the component: Transmitting Component - Refer to **Transmitting and Receiving Components**
   3. Operate the vehicle within the Conditions for Running the DTC.

      Verify the DTC does not set.

      - If the DTC sets

        Replace the component: Receiving Component - Refer to **Transmitting and Receiving Components**

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

   4. All OK.

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

5. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

For control module replacement, programming, and setup refer to **Control Module References**

DTC P157A OR P16D7-P16D9

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 P157A

Sensor Supply Voltage Relay Feedback Circuit High Voltage

DTC P16D7

Sensor Supply Voltage Relay Control Circuit

DTC P16D8

Sensor Supply Voltage Relay Control Circuit Low Voltage

DTC P16D9

Sensor Supply Voltage Relay Control Circuit High Voltage

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Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Control - Component @ KR121B Reductant Control Module Relay 2	-	-	P157A	-
Control - Relay Coil @ KR121A Reductant Control Module Relay 1	P16D8	P16D7	P16D9	-
Control - Relay Coil @ KR121B Reductant Control Module Relay 2	P16D8	P16D7	P16D9	-
Ground - Relay Coil @ KR121A Reductant Control Module Relay 1	-	P16D7	-	-
Ground - Relay Coil @ KR121B Reductant Control Module Relay 2	-	P16D7	-	-

Circuit/System Description

For an overview of the component/system, refer to **Exhaust Aftertreatment System Description**

Circuit	Description
B+ - Relay Coil	Supplied from a fuse.
B+ - Relay Switch	Supplied from a fuse.
Control - Component	The output circuit is switched to 12 V to activate the component.
Control - Relay Coil	The output circuit is switched to ground to activate the component.
Ground - Component	Chassis Ground

Component	Description
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.
KR121A Reductant Control Module Relay 1	A relay is a switch that is actuated by a solenoid.
KR121B Reductant Control Module Relay 2	A relay is a switch that is actuated by a solenoid.

Conditions for Running the DTC

P157A, P16D7, P16D8

- Battery Voltage = Greater than 11 V
- KR121A Reductant Control Module Relay 1 = The component is commanded Off
- KR121B Reductant Control Module Relay 2 = The component is commanded Off

Frequency the DTC runs = Continuously - After the running conditions are met

P16D9

- KR121A Reductant Control Module Relay 1 = The component is commanded On
- KR121B Reductant Control Module Relay 2 = The component is commanded On

Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

P157A

Control Circuit - Component = Short to Voltage - For greater than 1 s

P16D7, P16D8, P16D9

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 A DTC - Exceptions listed below

DTC P157A = Type B DTC

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type A DTC - Exceptions listed below

DTC P157A = Type B DTC

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **Component Connector End Views - Index**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Electrical Relay Replacement (Attached to Wire Harness)** , or **Electrical Relay Replacement (Within an Electrical Center)**
- **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 P157A is not set and no other DTCs are set.

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- **If DTC P157A is not set and other DTCs are set**

  Refer to: Circuit/System Testing - Test 1

- **If DTC P157A is set and other DTCs are set**

  Refer to: Circuit/System Testing - Test 1

- **If DTC P157A is set and no other DTCs are set**

  Refer to: Circuit/System Testing - Test 2

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

3. Perform the scan tool control function: Sensor Supply Voltage Relay - On and Off

   Verify a click can be heard or felt at the following component(s) when the scan tool control function was commanded: KR121A Reductant Control Module Relay 1 & KR121B Reductant Control Module Relay 2

   - **If a click cannot be heard or felt**

     Refer to: Circuit/System Testing - Test 1

   - **Go to next step: If a click can be heard or felt**

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.

   Verify the DTC does not set.

   - **If the DTC sets**

     Repeat step 2

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

5. All OK.

Circuit/System Testing

Test 1

1. Ignition/Vehicle & All vehicle systems - Off
2. Remove the component: KR121A Reductant Control Module Relay 1 & KR121B Reductant Control Module Relay 2
3. Ignition - On / Vehicle - In Service Mode
4. Verify a test lamp turns On between the test points:
   - {KR121A Reductant Control Module Relay 1} B+ circuit terminal 86 & Ground
   - {KR121B Reductant Control Module Relay 2} B+ circuit terminal 85 & Ground
   - **If the test lamp does not turn On and the circuit fuse is OK**
   1. Ignition/Vehicle - Off & Remove - Test lamp
   2. Test for less than 2 ohms between the test points:
      - {KR121A Reductant Control Module Relay 1} B+ circuit terminal 86 @ Relay Socket & Output terminal @ F5UB Fuse
      - {KR121B Reductant Control Module Relay 2} B+ circuit terminal 85 @ Relay Socket & Output terminal @ F5UB Fuse
      - If 2 ohms or greater - Repair the open/high resistance in the circuit.

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- If less than 2 ohms - Verify the fuse is OK and there is voltage at the fuse.

- **If the test lamp does not turn On and the circuit fuse is open**

1. Ignition/Vehicle - Off & Remove - Test lamp
2. Test for infinite resistance between the test points:
    - {KR121A Reductant Control Module Relay 1} B+ circuit terminal 86 & Ground
    - {KR121B Reductant Control Module Relay 2} B+ circuit terminal 85 & Ground
    - If less than infinite resistance - Repair the short to ground on the circuit.
    - If infinite resistance - Replace the component: KR121A Reductant Control Module Relay 1 or KR121B Reductant Control Module Relay 2

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

5. Connect a test lamp between the test points:
    - {KR121A Reductant Control Module Relay 1} B+ circuit terminal 86 & Control circuit terminal 85
    - {KR121B Reductant Control Module Relay 2} B+ circuit terminal 85 & Control circuit terminal 86
6. Perform the scan tool control function: Sensor Supply Voltage Relay - On and Off

   Verify the test lamp turns On and Off.

- **If the test lamp is always Off**

1. Ignition/Vehicle - Off & Remove - Test lamp
2. Disconnect the electrical connector: X3 @ K20 Engine Control Module
3. Ignition - On / Vehicle - In Service Mode
4. Test for less than 1 V between the test points:
    - {KR121A Reductant Control Module Relay 1} Control circuit terminal 85 @ Relay Socket & Ground
    - {KR121B Reductant Control Module Relay 2} Control circuit terminal 86 @ Relay Socket & Ground
    - If 1 V or greater - Repair the short to voltage on the circuit.
    - Go to next step: If less than 1 V
5. Ignition/Vehicle - Off
6. Test for less than 2 ohms between the test points:
    - {KR121A Reductant Control Module Relay 1} Control circuit terminal 85 @ Relay Socket & The other end of the circuit @ Control module harness
    - {KR121B Reductant Control Module Relay 2} Control circuit terminal 86 @ Relay Socket & 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 the test lamp is always On**

1. Ignition/Vehicle - Off & Remove - Test lamp
2. Disconnect the electrical connector: X3 @ K20 Engine Control Module
3. Test for infinite resistance between the test points:
    - {KR121A Reductant Control Module Relay 1} Control circuit terminal 85 @ Relay Socket & Ground
    - {KR121B Reductant Control Module Relay 2} Control circuit terminal 86 @ Relay Socket & Ground
    - If less than infinite resistance - Repair the short to ground on the circuit.
    - If infinite resistance - Replace the component: K20 Engine Control Module

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

7. Test or replace the component: KR121A Reductant Control Module Relay 1 or KR121B Reductant Control Module Relay 2

Test 2

1. Ignition/Vehicle & All vehicle systems - Off
2. Remove the component: KR121B Reductant Control Module Relay 2
3. Test for less than 1 V between the test points: Control circuit terminal 87 & Ground
   - **If 1 V or greater**

     Repair the short to voltage on the circuit:

   - **Go to next step: If less than 1 V**
4. Test or replace the component: KR121B Reductant Control Module Relay 2

Component Testing

Relay Test

1. Ignition/Vehicle - Off
2. Remove the component: KR121A Reductant Control Module Relay 1 or KR121B Reductant Control Module Relay 2
3. Test for 70 to 110 ohms between the test points: Component terminal 2/85 & 1/86
   - **If not between 70 and 110 ohms**

     Replace the component: KR121A Reductant Control Module Relay 1 or KR121B Reductant Control Module Relay 2

   - **Go to next step: If between 70 and 110 ohms**
4. Test for infinite resistance between the test points:
   - Component terminal 3/30 & 2/85
   - Component terminal 3/30 & 1/86
   - Component terminal 3/30 & 5/87
   - Component terminal 2/85 & 5/87
   - **If less than infinite resistance**

     Replace the component: KR121A Reductant Control Module Relay 1 or KR121B Reductant Control Module Relay 2

   - **Go to next step: If infinite resistance**
5. Connect a 3 A fused jumper wire between the test points: Component terminal 2/85 & 12 V

   Connect a jumper wire between the test points: Component terminal 1/86 & Ground

6. Test for less than 2 ohms between the test points: Component terminal 3/30 & 5/87
   - **If 2 ohms or greater**

     Replace the component: KR121A Reductant Control Module Relay 1 or KR121B Reductant Control Module Relay 2

   - **Go to next step: If less than 2 ohms**
7. All OK.

Repair Instructions

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Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Electrical Relay Replacement (Attached to Wire Harness)** , or **Electrical Relay Replacement (Within an Electrical Center)**
- For control module replacement, programming, and setup refer to **Control Module References**

DTC P161E

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 P161E

Glow Plug Supply Voltage Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	P161E	P161E	-	-
Control - Cylinder 1 Glow Plug	P066A	P0671	P066B	-
Control - Cylinder 2 Glow Plug	P066C	P0672	P066D	-
Control - Cylinder 3 Glow Plug	P066E	P0673	P066F	-
Control - Cylinder 4 Glow Plug	P067A	P0674	P067B	-

Circuit/System Description

For an overview of the component/system, refer to **Glow Plug System Description**

Circuit	Description
B+	Supplied from a fuse.

Component	Description
E12 Glow Plug	Glow plugs are electric heating devices in the combustion chambers of diesel engines.
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.

Conditions for Running the DTC

- Ignition = On
- Engine cranking. = No
- Ignition Voltage = Greater than 11 V
- E12 Glow Plug = On

Frequency the DTC runs = Continuously - After the running conditions are met

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Conditions for Setting the DTC

B+ circuit = Less than 6 V - Greater than 1 s

Actions Taken When the DTC Sets

DTC P161E = Type B DTC

Conditions for Clearing the DTC

DTC P161E = Type B DTC

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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 P161E 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.

   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.

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Circuit/System Testing

1. Ignition/Vehicle & All vehicle systems - Off
2. Disconnect the electrical connector: X1 @ K20 Engine Control Module
3. Verify a test lamp turns On between the test points: B+ circuit terminal 5 & Ground
    - **If the test lamp does not turn On and the circuit fuse is OK**
    1. Ignition/Vehicle - Off & Remove - Test lamp
    2. Test for less than 2 ohms between the test points: B+ circuit terminal 5 & Output terminal @ F36UA Fuse
        - If 2 ohms or greater - Repair the open/high resistance in the circuit.
        - If less than 2 ohms - Verify the fuse is OK and there is voltage at the fuse.
    - **If the test lamp does not turn On and the circuit fuse is open**
    1. Ignition/Vehicle - Off & Remove - Test lamp
    2. Test for infinite resistance between the test points: B+ circuit terminal 5 & 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 turns On**
4. Replace the component: K20 Engine Control Module

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

For control module replacement, programming, and setup refer to **Control Module References**

DTC P16FA OR P16FC

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.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P16FA

Turbocharger Boost Control Motor High Current

DTC P16FC

Turbocharger Vane Position Actuator High Temperature

Circuit/System Description

The turbocharger increases engine power by pumping compressed air into the combustion chambers, allowing a greater quantity of fuel to combust at the optimal air/fuel ratio. The turbine spins as exhaust gas flows out of the engine and over the turbine blades, and turns the compressor wheel at the other end of the turbine shaft, pumping more air into the intake system.

The engine control module (ECM) controls the vanes of variable geometry turbine. The vanes are used to vary the amount of boost pressure and can control the boost pressure independent of engine speed. The vanes mount to the compressor unison ring of turbocharger, which is rotated to change the vane angle. The ECM will vary the vane angle which adjusts boost depending on the load requirements of the engine.

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The turbocharger vanes are normally open when the engine is not under load. However, the ECM will often close the turbocharger vanes to create back pressure to drive exhaust gas through the exhaust gas recirculation (EGR) valve as required. At extreme cold temperatures, the ECM may close the vanes at low load conditions in order to accelerate engine coolant heating.

The variable geometry turbine assembly contains a contact-less inductive position sensing element that is managed by a customized integrated circuit. The variable geometry position sensor is mounted within the turbocharger assembly and is not serviceable. The ECM supplies the variable geometry turbine assembly with a 5V reference circuit, a low reference circuit, an H-bridge motor directional control circuit, and an asynchronous signal/serial data circuit.

Conditions for Running the DTC

- Ignition On or the engine is running, cranking excluded.
- Ignition voltage is greater than 11 V.
- The DTCs run continuously once the above conditions are met.

Conditions for Setting the DTC

P16FA

During commanded state the ECM detects the variable geometry turbine DC motor is drawing an excessive amount of current for greater than 4 s.

P16FC

During commanded state the ECM detects the variable geometry turbine DC motor has reached an excessive temperature for greater than 7 s.

Action Taken When the DTC Sets

DTC P16FA is a Type A DTC.

Conditions for Clearing the DTC

DTC P16FA is a Type A DTC.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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

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Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition On.
2. Verify DTC P003A, P0045, P0046, P0047, P0048, P0685, P0686, P0687 P0689, P0690 P16B0, P16B1, P16B2, P169E, P169F, P2564, P2565, P2598, or P2599 is not set.
   - **If a DTC is set**

     Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
   - **Go to next step: If none of the DTCs are set**
3. Engine idling at the normal operating temperature.

   NOTE: It may be necessary to clear the DTC to allow the control function to operate.
4. Verify the scan tool Turbocharger Vane Position parameter increases and decreases when commanding the Turbocharger Vane Position to 80% and then back to 0% with a scan tool.
   - **If the parameter does not increase and decrease**

     Refer to Circuit/System Testing.
   - **Go to next step: If the parameter increases and decreases**
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

1. 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 M103 Turbocharger Vane Position Actuator.
2. Verify that the conditions listed below do not exist:
   - Damage or corrosion in the turbocharger wiring harness, terminals, or harness connector.
   - Binding or damaged turbocharger vane control actuator.
   - Binding or damaged turbocharger vanes.
   - **If a condition exists**

     Repair as necessary.
   - **Go to next step: If a condition does not exist**
3. Ignition On, test for 1.5 - 2.5 V between the control open circuit terminal 1 and ground.
   - **If less than 1.5 V**
   1. Ignition Off, disconnect the X2 harness connector at the K20 Engine Control Module.
   2. Test for infinite resistance between control circuit terminal 1 and ground.

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- If less than infinite resistance, repair the short to ground in the circuit.
- Go to next step: If infinite resistance.

3. Test for infinite resistance between the motor control circuit terminals 1 and 2.
   - If less than infinite resistance, repair the short between the control circuits.
4. Test for less than 2 Ω in the control circuit, end to end.
   - If 2 Ω or greater, repair open/high resistance in the circuit.
   - If less than 2 Ω, replace the K20 Engine Control Module.

- **If greater than 2.5 V**

1. Ignition Off, disconnect the X2 harness connector at the K20 Engine Control Module.
2. Ignition On.
3. Test for less than 1 V between the control 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 1.5 - 2.5 V**

4. Connect a test lamp between the control close circuit terminal 2 and B+.
5. Ignition On, verify the test lamp does not illuminate.
   - **If the test lamp illuminates**

   1. Ignition Off, remove the test lamp.
   2. Disconnect the X2 harness connector at the K20 Engine Control Module.
   3. Test for infinite resistance between control circuit terminal 2 and ground.
      - If less than infinite resistance, repair the short to ground in the control circuit.
      - If infinite resistance, replace the K20 Engine Control Module.

   - **Go to next step: If the test lamp does not illuminate**

6. Connect a test lamp between the control close circuit terminal 2 and ground.
7. Ignition On, verify the test lamp does not illuminate.
   - **If the test lamp illuminates**

   1. Ignition Off, remove the test lamp.
   2. Disconnect the X2 harness connector 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 in the circuit.
      - If less than 1 V, replace the K20 Engine Control Module.

   - **Go to next step: If the test lamp does not illuminate**

8. Remove the test lamp.
9. Test for 1.5 - 2.5 V between the control open circuit terminal 1 and the control close circuit terminal 2.
   - **If not within the specified range**

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

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

10. Test or replace the M103 Turbocharger Vane Position Actuator.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Control Module References** for engine control module replacement, programming and setup

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- **Compressor Air Intake Turbocharger Replacement** for M103 Turbocharger Vane Position Actuator replacement.

DTC P2002

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 P2002

Diesel Particulate Filter (DPF) Low Efficiency

Circuit/System Description

For an overview of the component/system, refer to **Exhaust Aftertreatment System Description**

Conditions for Running the DTC

- DTC P200C, P262B = Not set
- DTCs related to the following system/component = Not Set
  - B9 Ambient Air Temperature Sensor
  - B17 Barometric Pressure Sensor
  - B26 Crankshaft Position Sensor
  - B34 Engine Coolant Temperature Sensor
  - B47B Fuel Rail Pressure Sensor
  - B65 Intake Manifold Pressure and Air Temperature Sensor
  - B75C Multifunction Intake Air Sensor
  - B115 Vehicle Speed Sensor
  - B130 Exhaust Gas Recirculation Temperature Sensor
  - B131 Exhaust Temperature Sensor
  - B136 Exhaust Particulate Matter Sensor
  - B154 Diesel Particulate Filter Exhaust Differential Pressure Sensor
  - B195 Nitrogen Oxides Sensor
  - B345R Exhaust Pressure Differential Sensor - Exhaust Gas Recirculation
  - M103 Turbocharger Vane Position Actuator
  - Q14 Exhaust Gas Recirculation Valve
  - Q17 Fuel Injector
  - Q38 Throttle Body
- Ambient Air Temperature = Warmer than -20B°C (-4B°F)
- Engine = Running
- Ignition Voltage = Greater than 11 V
- NOx Sensor 1 Heater Operation = Allowed
- Particulate Matter Sensor Operation = Ready

Frequency the DTC runs = Continuously - After the running conditions are met

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Conditions for Setting the DTC

Soot Accumulation = Greater than a predefined threshold

Actions 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

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 there are no DTCs set related to the following component/system:
    - B9 Ambient Air Temperature Sensor
    - B17 Barometric Pressure Sensor
    - B26 Crankshaft Position Sensor
    - B34 Engine Coolant Temperature Sensor
    - B47B Fuel Rail Pressure Sensor
    - B65 Intake Manifold Pressure and Air Temperature Sensor
    - B75C Multifunction Intake Air Sensor
    - B115 Vehicle Speed Sensor
    - B130 Exhaust Gas Recirculation Temperature Sensor
    - B131 Exhaust Temperature Sensor
    - B136 Exhaust Particulate Matter Sensor
    - B154 Diesel Particulate Filter Exhaust Differential Pressure Sensor
    - B195 Nitrogen Oxides Sensor
    - M103 Turbocharger Vane Position Actuator
    - Q14 Exhaust Gas Recirculation Valve
    - Q17 Fuel Injector
    - Q38 Throttle Body
    - **If a related DTC is set**
    - Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**
    - **Go to next step: If a related DTC is not set**
3. Verify the following conditions do not exist:
    - Induction System - Leaking/Restricted - Refer to **Charge Air Cooler Diagnosis (Induction System Smoke Test)** , or **Charge Air Cooler Diagnosis (Full System Air Leak Test)**
    - Exhaust System/Turbocharger - Leaking/Restricted - Refer to **Exhaust Leakage**
    - **If a condition exists**

      Repair or replace as necessary

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- **Go to next step: If no condition exists**

4. Replace the component: Exhaust Particulate Filter

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

Exhaust Particulate Filter Replacement (LWN)

Additional Procedures

Perform the scan tool control function: **DPF Reset** - Perform only when the following component/system is replaced or serviced: Exhaust Particulate Filter

DTC P200C

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 P200C

Diesel Particulate Filter (DPF) High Temperature

Circuit/System Description

For an overview of the component/system, refer to **Exhaust Aftertreatment System Description**

Conditions for Running the DTC

- DTC P113E, P1197, P2470, P2471, P2472 = Not set
- Engine = Running
- Ignition Voltage = Greater than 11 V

Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

Exhaust Gas Temperature Sensor 4, 5 = Greater than 850B°C (1, 562B°F) - For greater than 30 s

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type A DTC - Additional actions taken:

- Cooling Fan = Active
- DPF Regeneration = Inhibited
- Reduced Engine Power/Engine Shutdown

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type A DTC

Diagnostic Aids

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After starting a cold engine, the following scan tool parameter value should rise steadily and then stabilize: Exhaust Gas Temperature Sensor 1-5

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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 there are no DTCs set related to the following component/system:
    - B17 Barometric Pressure Sensor
    - B66 Intake Air Temperature Sensor
    - B75C Multifunction Intake Air Sensor
    - Q17 Fuel Injector
    - Q67 Exhaust Aftertreatment Fuel Injector
    - **If a related DTC is set**
    - Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**
    - **Go to next step: If a related 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.

    Verify DTC P200C is not set.

    - **If DTC P200C is set**

      Refer to: Circuit/System Testing

    - **Go to next step: If DTC P200C is not set**
4. All OK.

Circuit/System Testing

1. Verify a condition does not exist with the component: Exhaust System & Turbocharger

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- Cracked
- Internal component rattle
- Leaking - Refer to **Exhaust Leakage**
- Loose Clamps
- Missing components
- Restrictions - Refer to **Restricted Exhaust**
- Visible Damage
- **If a condition exists**

  Repair or replace as necessary

- **Go to next step: If no condition exists**

2. Verify a condition does not exist with the component: Induction System
   - Intake Air Duct - Collapsed
   - Intake Air Duct Seal - Leaking
   - Loose Clamps
   - Missing components
   - Visible Damage
   - **If a condition exists**

     Repair or replace as necessary

   - **Go to next step: If no condition exists**
3. Verify the condition does not exist: Oil consumption - Refer to **Oil Consumption Diagnosis**
   - **If a condition exists**

     Repair or replace as necessary

   - **Go to next step: If no condition exists**
4. Perform the following procedure/test: DPF Service Regeneration - Refer to **Diesel Particulate Filter (DPF) Service Regeneration**
   - **If the procedure was not successful**

     Replace the component: Exhaust Particulate Filter

   - **Go to next step: If the procedure was successful**
5. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Exhaust Particulate Filter Replacement (LWN)**
- For control module replacement, programming, and setup refer to **Control Module References**

Additional Procedures

DPF Reset - Perform only when the following component/system is replaced or serviced:

Exhaust Particulate Filter

DTC P200E

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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 P200E

Catalyst System High Temperature

Circuit/System Description

For an overview of the component/system, refer to **Exhaust Aftertreatment System Description**

Conditions for Running the DTC

- DTC P113C, P118F, P2032, P2033, P2084, P2085, U029D = Not set
- Engine = Running
- Ignition Voltage = Greater than 11 V

Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

Exhaust Gas Temperature Sensor 2 = Greater than 850B°C (1, 562B°F) - For greater than 10 s

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type A DTC - Additional actions taken:

- Cooling Fan = Active
- DPF Regeneration = Inhibited
- Reduced Engine Power/Engine Shutdown

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type A DTC

Diagnostic Aids

After starting a cold engine, the following scan tool parameter value should rise steadily and then stabilize: Exhaust Gas Temperature Sensor 2

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **Component Connector End Views - Index**

Electrical Information Reference

- **Circuit Testing**

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- **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 there are no DTCs set related to the following component/system:
   - B17 Barometric Pressure Sensor
   - B66 Intake Air Temperature Sensor
   - B75C Multifunction Intake Air Sensor
   - Q17 Fuel Injector
   - Q67 Exhaust Aftertreatment Fuel Injector
   - **If a related DTC is set**
   - Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**
   - **Go to next step: If a related 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.

   Verify DTC P200E is not set.

   - **If DTC P200E is set**

     Refer to: Circuit/System Testing

   - **Go to next step: If DTC P200E is not set**
4. All OK.

Circuit/System Testing

1. Verify a condition does not exist with the component: Exhaust System & Turbocharger
   - Cracked
   - Internal component rattle
   - Leaking - Refer to **Exhaust Leakage**
   - Loose Clamps
   - Missing components
   - Restrictions - Refer to **Restricted Exhaust**
   - Visible Damage
   - **If a condition exists**

     Repair or replace as necessary

   - **Go to next step: If no condition exists**
2. Verify a condition does not exist with the component: Induction System
   - Intake Air Duct - Collapsed

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- Intake Air Duct Seal - Leaking
- Loose Clamps
- Missing components
- Visible Damage
- **If a condition exists**

  Repair or replace as necessary

- **Go to next step: If no condition exists**

3. Verify the condition does not exist: Oil consumption - Refer to **Oil Consumption Diagnosis**
   - **If a condition exists**

     Repair or replace as necessary

   - **Go to next step: If no condition exists**
4. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

For control module replacement, programming, and setup refer to **Control Module References**

DTC P203B-P203D

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 P203B

Reductant Level Sensor 1 Performance

DTC P203C

Reductant Level Sensor 1 Circuit Low Voltage

DTC P203D

Reductant Level Sensor 1 Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	U010E	U010E	U010E	P203B
Serial Data	U010E	U010E	U010E	P203B
Low Reference	-	U010E	U010E	P203B

Circuit/System Description

For an overview of the component/system, refer to **Exhaust Aftertreatment System Description**

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

Component	Description
B212 Reductant Sensor Module	The sensor sends measured values and state of health information via serial data to the ECM and the reductant control module.
K115 Reductant Control Module	The control module controls the heating and dosing of the reductant.

Conditions for Running the DTC

- DTC U010E = Not set
- Ignition = On
- Ignition Voltage = Greater than 11 V

Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

P203B

Reductant Level Sensor = Not within a calibrated range

P203C

Serial Data circuit = Greater than a predefined threshold - For greater than 5 s

P203D

Serial Data circuit = Less than a predefined threshold - For greater than 5 s

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type A DTC - Exceptions listed below

P203B, P203D = Type B DTC

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type A DTC - Exceptions listed below

P203B, P203D = Type B DTC

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **Component Connector End Views - Index**

Electrical Information Reference

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- **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 P203B, P203C, P203D is not set.
   - **If DTC P203B, P203C, P203D is set**

     Refer to: Circuit/System Testing

   - **Go to next step: If DTC P203B, P203C, P203D 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.

   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/Vehicle & All vehicle systems - Off
2. Disconnect the electrical connector: B212 Reductant Sensor Module
3. Ignition - On / Vehicle - In Service Mode
4. Test for less than 20 ohms between the test points: Low Reference circuit terminal 3 & Ground
   - **If 20 ohms or greater**
   1. Ignition/Vehicle - Off
   2. Disconnect the electrical connector: X2 @ K115 Reductant Control Module
   3. Test for less than 2 ohms between the test points: Low Reference circuit terminal 3 @ Component harness & Terminal 6 X2 @ Control module harness
      - If 2 ohms or greater - Repair the open/high resistance in the circuit.
      - If less than 2 ohms - Replace the component: K115 Reductant Control Module
   - **Go to next step: If less than 20 ohms**
5. Test for 4.8 to 5.2 V between the test points: 5 V Reference circuit terminal 1 & Low Reference circuit terminal 3
   - **If less than 4.8 V**
   1. Ignition/Vehicle - Off
   2. Disconnect the electrical connector: K115 Reductant Control Module

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3. Test for infinite resistance between the test points: 5 V Reference circuit terminal 1 @ Component harness & Ground
    - If less than infinite resistance - Repair the short to ground on the circuit.
    - Go to next step: If infinite resistance
4. Test for less than 2 ohms between the test points: 5 V Reference circuit terminal 1 @ Component harness & Terminal 19 X2 @ Control module harness
    - If 2 ohms or greater - Repair the open/high resistance in the circuit.
    - If less than 2 ohms - Replace the component: K115 Reductant Control Module

- **If greater than 5.2 V**

1. Ignition/Vehicle - Off
2. Disconnect the electrical connector: K115 Reductant 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 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: K115 Reductant Control Module

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

6. Test for 4.4 to 4.8 V between the test points: Serial Data circuit terminal 2 & Ground
    - **If less than 4.4 V**

    1. Ignition/Vehicle - Off
    2. Disconnect the electrical connector: K115 Reductant Control Module
    3. Test for infinite resistance between the test points: Serial Data circuit terminal 2 @ Component harness & Ground
        - If less than infinite resistance - Repair the short to ground on the circuit.
        - Go to next step: If infinite resistance
    4. Test for less than 2 ohms between the test points: Serial Data circuit terminal 2 @ Component harness & Terminal 18 X2 @ Control module harness
        - If 2 ohms or greater - Repair the open/high resistance in the circuit.
        - If less than 2 ohms - Replace the component: K115 Reductant Control Module

    - **If greater than 4.8 V**

    1. Test for less than 1 V between the test points: Serial Data circuit terminal 2 @ Component harness & Ground
        - If 1 V or greater - Repair the short to voltage on the circuit.
        - If less than 1 V - Replace the component: K115 Reductant Control Module

    - **Go to next step: If between 4.4 and 4.8 V**

7. Test or replace the component: B212 Reductant Sensor Module

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Emission Reduction Fluid Tank Replacement** - B212 Reductant Sensor Module
- **Reductant Control Module Replacement** - K115 Reductant Control Module
- For control module replacement, programming, and setup refer to **Control Module References**

DTC P204B-P204D

Diagnostic Instructions

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- 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 P204B

Reductant Pressure Sensor Performance

DTC P204C

Reductant Pressure Sensor Circuit Low Voltage

DTC P204D

Reductant Pressure Sensor Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P204C, P204B	P204C	P204D, P204B	P204B
Signal	P204D, P204B	P204D, P204B	P204D, P204B	P204B
Low Reference	-	P204D, P204B	-	P204B

Circuit/System Description

For an overview of the component/system, refer to **Exhaust Aftertreatment 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
B194 Reductant Pressure Sensor	The sensor is a capacitive pressure transducer. Electronics in the sensor convert pressure into an analog voltage signal.
K115 Reductant Control Module	The control module controls the heating and dosing of the reductant.

Conditions for Running the DTC

P204B

- DTC P103F, P1040, P1048, P1049, P2047, P2048, P2049, P204C, P204D, P208A, P208C, P208D, P20E9, P214E = Not set
- After-Run = Complete
- Ignition Voltage = Greater than 11 V
- Reductant System = Not Frozen
- Reductant System = Warmer than -7B°C (19B°F)

Frequency the DTC runs = After ignition Off - After the running conditions are met

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P204C, P204D

- Ignition = On
- Ignition Voltage = Greater than 11 V

Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

P204B

Reductant Pressure = Not within a calibrated range - For greater than 5 s

P204C

The control module detects a short to ground.

P204D

The control module detects a short to voltage.

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type A DTC - Additional actions taken:

- Reductant Injector = Disabled
- Reductant Tank Heaters = Disabled
- Reductant Pump = Disabled

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type A DTC

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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

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Circuit/System Verification

1. Ignition - On / Vehicle - In Service Mode
2. Verify DTC P208A, P20E8, P20E9 is not set.
    - **If DTC P208A, P20E8, P20E9 is set**

      Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**

    - **Go to next step: If DTC P208A, P20E8, P20E9 is not set**
3. Perform the scan tool control function: Reductant Pump - ON - For 20 s
4. Wait for greater than 10 s. - After the pump turns off.
5. Verify the scan tool parameter: Reductant Pressure Sensor = -7 to 7 kPa (-1 to 1 PSI)
    - **If not the specified value**

      Refer to: Circuit/System Testing

    - **Go to next step: If the specified value**
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.

   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**
7. 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: A38 Reductant Pump and Sensor Assembly
3. Ignition - On / Vehicle - In Service Mode
4. Test for less than 25 ohms between the test points: Low Reference circuit terminal 3 & Ground
    - **If 25 ohms or greater**
    1. Disconnect the electrical connector: K115 Reductant Control Module
    2. Test for less than 2 ohms between the test points: Low Reference circuit terminal 3 @ Component harness & Terminal 14 X2 @ Control module harness
        - If 2 ohms or greater - Repair the open/high resistance in the circuit.
        - If less than 2 ohms - Replace the component: K115 Reductant Control Module
    - **Go to next step: If less than 25 ohms**
5. Test for 4.8 to 5.2 V between the test points: 5 V Reference circuit terminal 5 & Ground
    - **If less than 4.8 V**
    1. Ignition/Vehicle - Off
    2. Disconnect the electrical connector: K115 Reductant Control Module
    3. Test for infinite resistance between the test points: 5 V Reference circuit terminal 5 @ Component harness & Ground
        - If less than infinite resistance - Repair the short to ground on the circuit.

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- Go to next step: If infinite resistance

4. Test for less than 2 ohms between the test points: 5 V Reference circuit terminal 5 @ Component harness & Terminal 12 X2 @ Control module harness
    - If 2 ohms or greater - Repair the open/high resistance in the circuit.
    - If less than 2 ohms - Replace the component: K115 Reductant Control Module

- **If greater than 5.2 V**

1. Ignition/Vehicle - Off
2. Disconnect the electrical connector: K115 Reductant 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 5 @ Component harness & Ground
    - If 1 V or greater - Repair the short to voltage on the circuit.
    - If less than 1 V - Replace the component: K115 Reductant Control Module

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

6. Verify the scan tool parameter: Reductant Pressure Sensor = 0 V
    - **If greater than 0 V**

    1. Ignition/Vehicle - Off
    2. Disconnect the electrical connector: K115 Reductant Control Module
    3. Ignition - On / Vehicle - In Service Mode
    4. Test for less than 1 V between the test points: Signal circuit terminal 4 @ Component harness & Ground
        - If 1 V or greater - Repair the short to voltage on the circuit.
        - If less than 1 V - Replace the component: K115 Reductant Control Module

    - **Go to next step: If 0 V**

7. Connect a 3 A fused jumper wire between the test points: Signal circuit terminal 4 & 5 V Reference circuit terminal 5
8. Verify the scan tool parameter: Reductant Pressure Sensor = Greater than 4.5 V
    - **If 4.5 V or less**

    1. Ignition/Vehicle - Off & Remove - Jumper wire(s)
    2. Disconnect the electrical connector: K115 Reductant Control Module
    3. Test for infinite resistance between the test points: Signal circuit terminal 4 @ Component harness & Ground
        - If less than infinite resistance - Repair the short to ground on the circuit.
        - Go to next step: If infinite resistance
    4. Test for less than 2 ohms between the test points: Signal circuit terminal 4 @ Component harness & Terminal 13 X2 @ Control module harness
        - If 2 ohms or greater - Repair the open/high resistance in the circuit.
        - If less than 2 ohms - Replace the component: K115 Reductant Control Module

    - **Go to next step: If greater than 4.5 V**

9. Test or replace the component: A38 Reductant Pump and Sensor Assembly

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Reductant Control Module Replacement**
- **Emission Reduction Fluid Supply Pump Module Replacement**
- For control module replacement, programming, and setup refer to **Control Module References**

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Additional Procedures

NOTE: **Performing this procedure will clear the Driver Information message for the applicable system.**

Perform the scan tool control function: **Reductant System Tamper Service Bay Test** - Perform only when the following warning message is displayed: Service Emission System/Service Exhaust Fluid System

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DIAGNOSTIC INFORMATION AND PROCEDURES

DTC P205B-P205E

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 P205B

Reductant Tank Temperature Sensor Performance

DTC P205C

Reductant Tank Temperature Sensor Circuit Low Voltage

DTC P205D

Reductant Tank Temperature Sensor Circuit High Voltage

DTC P205E

Reductant Tank Temperature Sensor Circuit Erratic

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P205C, P205B	P205D, P205E	P205D, P205E	P205B, P205E
Low Reference	-	P205D, P205E	*	P205B, P205E

Circuit/System Description

For an overview of the component/system, refer to Cooling System Description and Operation (LGZ, LWN)

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

Component	Description
B214 Reductant Temperature Sensor	The sensor is a negative temperature coefficient thermistor. As the temperature of the air, fluid, or metal increases, the resistance of the sensor decreases, varying the voltage on the signal circuit.
K115 Reductant Control Module	The control module controls the heating and dosing of the reductant.

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Conditions for Running the DTC

P205B

- DTC P205C, P205D, U010E = Not set
- Engine Off Time = Greater than 8 h
- Ignition = On
- Ignition Voltage = Greater than 11 V

Frequency the DTC runs = 8 s - Per ignition cycle - After the running conditions are met

P205C, P205D

- DTC P0071-P0074, P209B, P20BB, P20BC, P1051, U010E = Not set
- Ignition On or Engine Running
- Ignition Voltage = Greater than 11 V

Frequency the DTC runs = Continuously - After the running conditions are met

P205E

- DTC P205C, P205D, U010E = Not set
- 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

P205B

Signal circuit = Not within a calibrated range

P205C

Reductant Temperature = Warmer than 80B°C (176B°F)

P205D

Reductant Temperature = Colder than -39B°C (-38B°F)

P205E

Signal circuit = Intermittent

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type A DTC - Additional actions taken:

- Reductant Injector = Disabled
- Reductant Tank Heaters = Disabled
- Reductant Pump = Disabled
- Driver Information Center Display = Service Exhaust Fluid System

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type A DTC

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Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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 the scan tool parameter: Reductant Temperature = -39 to 75B°C (-38 to 164B°F)
   - **If not between -39 and 75B°C (-38 and 164B°F)**

     Refer to: Circuit/System Testing

   - **Go to next step: If between -39 and 75B°C (-38 and 164B°F)**
3. Verify the scan tool parameter: Reductant Temperature = The value should not spike or drop out.

   Perform the action while monitoring the parameter:

   - Wiggle the harness and connector: A38 Reductant Pump and Sensor Assembly
   - Wiggle the harness and connector: X2 @ 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**
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.

   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**
5. All OK.

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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: A38 Reductant Pump and Sensor Assembly
3. Test for less than 10 ohms between the test points: Low Reference circuit terminal 2/B & Ground
    - **If 10 ohms or greater**
    1. Disconnect the appropriate electrical connector: K115 Reductant Control Module
    2. Test for less than 2 ohms between the test points: Low Reference circuit terminal 2/B @ 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: K115 Reductant Control Module
    - **Go to next step: If less than 10 ohms**
4. Ignition - On / Vehicle - In Service Mode
5. Verify the scan tool parameter: Reductant Temperature = Colder than -39B°C (-38B°F)
    - **If warmer than -39B°C (-38B°F)**
    1. Ignition/Vehicle - Off
    2. Disconnect the appropriate electrical connector: K115 Reductant Control Module
    3. Test for infinite resistance between the test points: Signal circuit terminal 1/A @ Component harness & Ground
        - If less than infinite resistance - Repair the short to ground on the circuit.
        - If infinite resistance - Replace the component: K115 Reductant Control Module
    - **Go to next step: If colder than -39B°C (-38B°F)**
6. Connect a 3 A fused jumper wire between the test points: Signal circuit terminal 1/A & Low Reference circuit terminal 2/B
7. Verify the scan tool parameter: Reductant Temperature = Warmer than 75B°C (164B°F)
    - **If 75B°C (164B°F) or colder**
    1. Ignition/Vehicle - Off & Remove - Jumper wire(s)
    2. Disconnect the appropriate electrical connector: K115 Reductant Control Module
    3. Ignition - On / Vehicle - In Service Mode
    4. Test for less than 1 V between the test points: Signal circuit terminal 1/A @ Component harness & Ground
        - If 1 V or greater - Repair the short to voltage on the circuit.
        - Go to next step: If less than 1 V
    5. Ignition/Vehicle - Off
    6. Test for less than 2 ohms between the test points: Signal circuit terminal 1/A @ 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: K115 Reductant Control Module
    - **Go to next step: If warmer than 75B°C (164B°F)**
8. Test or replace the component: A38 Reductant Pump and Sensor Assembly

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Reductant Control Module Replacement** - K115 Reductant Control Module

- Emission Reduction Fluid Supply Pump Module Replacement - A38 Reductant Pump and Sensor Assembly
- For control module replacement, programming, and setup refer to Control Module References

Additional Procedures

NOTE: Performing this procedure will clear the Driver Information message for the applicable system.

Perform the scan tool control function: Reductant System Tamper Service Bay Test - Perform only when the following warning message is displayed: Service Emission System/Service Exhaust Fluid System

DTC P206B-P206D

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 P206B

Reductant Quality Sensor Performance

DTC P206C

Reductant Quality Sensor Circuit Low Voltage

DTC P206D

Reductant Quality Sensor Circuit High Voltage

Circuit/System Description

For an overview of the component/system, refer to Exhaust Aftertreatment System Description

Circuit	Description
5 V Reference	Regulated voltage supplied by the control module.
Serial Data	The serial data circuits are used to exchange information between the control modules.
Low Reference	Grounded through the control module.

Component	Description
B212 Reductant Sensor Module	The sensor sends measured values and state of health information via serial data to the ECM and the reductant control module.
K115 Reductant Control Module	The control module controls the heating and dosing of the reductant.

Conditions for Running the DTC

P206B

- DTC P1015, P1016, P1017, P1018, P1019, P101A, P206C, P206D, P2ADA, P2ADB, P2ADC, P2ADD, U010E = Not set

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- Engine Running
- Ignition Voltage = Greater than 11 V
- Reductant Tank Temperature 2 = Greater than 5B°C (41B°F)
- Reductant Level = Greater than 5 L {Express/Savanna = Greater than 7.5 L}

Frequency the DTC runs = Continuously - After the running conditions are met

P206C, P206D

- DTC U010E = Not set
- 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

P206B

Reductant Quality Sensor = Not within a calibrated range - For greater than 7 min

P206C, P206D

Reductant Quality Sensor = Not within a calibrated range - For greater than 5 s

Actions 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

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. The operation of the reductant quality sensor may also be affected by a concentration of reductant crystals around it that forms when reductant freezes and thaws. Agitation of the reductant during normal driving will cause the crystallized reductant to disperse and allow the sensor to return to normal operation. If the tank has been frozen, the vehicle should be parked inside overnight to allow the reductant system to warm to greater than 5B°C (41B°F).

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **Component Connector End Views - Index**

Electrical Information Reference

- **Circuit Testing**

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- 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 P206B, P206C, P206D is not set.
    - **If any of the DTCs are set**
    1. Verify the scan tool parameter: Reductant Quality Sensor Status = OK
        - If not the specified state

        NOTE: **This action should dissipate air bubbles or crystallized reductant that adversely affect the performance of the sensor.**

        NOTE: **If the reductant has been frozen, the vehicle should be parked inside overnight to allow the reductant system to warm to greater than 5B°C (41B°F).**

        WARNING: **Refer to Road Test Warning .**

        1. Operate the vehicle under the following conditions: Accelerate/Stop - For greater than 10 min. Refer to step 2.2
        - Go to next step: If the specified state
    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. - For greater than 7 min

        Verify the DTC does not set.

        - If the DTC sets

            Replace the component: B212 Reductant Sensor Module

        - Go to next step: If the DTC is not set
    3. All OK.
    - **Go to next step: If none of the DTCs are set**
3. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: Diagnostic Repair Verification

Emission Reduction Fluid Tank Replacement - B212 Reductant Sensor Module

DTC P20CB, P20CD, P20CE, P2670, OR P2671

Diagnostic Instructions

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- 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 P20CB

Exhaust Aftertreatment Fuel Injector Control Circuit

DTC P20CD

Exhaust Aftertreatment Fuel Injector Control Circuit Low Voltage

DTC P20CE

Exhaust Aftertreatment Fuel Injector Control Circuit High Voltage

DTC P2670

Actuator High Control Circuit Group 2 Low Voltage

DTC P2671

Actuator High Control Circuit Group 2 High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Control - Terminal 1	P20CD, P2670	P20CB	P20CE, P2671	-
Control - Terminal 2	P20CD	P20CB	P20CE, P2671	-
B				

Typical Scan Tool Data

Exhaust Aftertreatment Fuel Injector Control Circuit High Voltage Test Status

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine = Running **Parameter Normal Range:** Not Run / OK			
Control - Terminal 1	Not Run / OK	Not Run / OK	Malfunction
Control - Terminal 2	Not Run / OK	Not Run / OK	Malfunction

Exhaust Aftertreatment Fuel Injector Control Circuit Low Voltage Test Status

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine = Running **Parameter Normal Range:** Not Run/OK			
Control - Terminal 1	Malfunction	Not Run/OK	Not Run/OK
Control - Terminal 2	Malfunction	Not Run/OK	Not Run/OK

Exhaust Aftertreatment Fuel Injector Control Circuit Open Test Status

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine = Running **Parameter Normal Range:** Not Run/OK			
Control - Terminal 1	Not Run/OK	Malfunction	Not Run/OK

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Circuit	Short to Ground	Open	Short to Voltage
Control - Terminal 2	Not Run/OK	Malfunction	Not Run/OK

Circuit/System Description

For an overview of the component/system, refer to **Exhaust Aftertreatment System Description**

Circuit	Description
Control - Terminal 1	The output circuit is switched to 12 V to activate the component.
Control - Terminal 2	The output circuit is switched to ground to activate the component.

Component	Description
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.
Q67 Exhaust Aftertreatment Fuel Injector	A solenoid valve is an electro-mechanically operated valve. The valve is controlled by an electric current through the solenoid.

Conditions for Running the DTC

P20CB, P20CD, P20CE

- Battery Voltage = Greater than 11 V
- Q67 Exhaust Aftertreatment Fuel Injector - High Side Driver = Commanded On

Frequency the DTC runs = Continuously - After the running conditions are met

P2670, P2671

- Battery Voltage = Greater than 11 V
- KR75 Engine Controls Ignition Relay = On

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 2 s

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type B DTC - Exceptions listed below

DTC P20CD = Type A DTC

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type B DTC - Exceptions listed below

DTC P20CD = Type A DTC

Reference Information

Schematic Reference

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Engine Controls Wiring Schematics

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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. Engine - Running
2. Perform the scan tool control function: Exhaust Aftertreatment Fuel Injector - From 0 to 50% and back to 0%.

   Verify the scan tool parameter:

   - Exhaust Aftertreatment Fuel Injector Control Circuit High Voltage Test Status = Not Run or OK
   - Exhaust Aftertreatment Fuel Injector Control Circuit Low Voltage Test Status = Not Run or OK
   - Exhaust Aftertreatment Fuel Injector Control Circuit Open Test Status = Not Run or OK
   - **If not the specified state**

     Refer to: Circuit/System Testing

   - **Go to next step: If the specified state**
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/Vehicle - Off
2. Disconnect the electrical connector: Q67 Exhaust Aftertreatment Fuel Injector
3. Ignition - On / Vehicle - In Service Mode
4. Verify a test lamp turns On between the test points: Control circuit terminal 2 & Ground

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

1. Ignition/Vehicle - Off
2. Disconnect the electrical connector: X2 @ K20 Engine Control Module
3. Test for infinite resistance between the test points: Control circuit terminal 2 @ Component harness & Ground
    - If less than infinite resistance - Repair the short to ground on the circuit.
    - Go to next step: If infinite resistance
4. Test for less than 2 ohms between the test points: Control 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 the test lamp turns On**

5. Test for 2.3 to 2.7 V between the test points: Control circuit terminal 1 & Ground
    - **If less than 2.3 V**

    1. Ignition/Vehicle - Off
    2. Disconnect the electrical connector: X1 @ 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.
        - Go to next step: If infinite resistance
    4. Test for less than 2 ohms between the test points: Control 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 2.7 V**

    1. Ignition/Vehicle - Off
    2. Disconnect the electrical connector: X1 @ K20 Engine Control Module
    3. Ignition/Vehicle - Off
    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 between 2.3 and 2.7 V**

6. Test or replace the component: Q67 Exhaust Aftertreatment Fuel Injector

Component Testing

Static Test

1. Ignition/Vehicle - Off
2. Disconnect the electrical connector: Q67 Exhaust Aftertreatment Fuel Injector
3. Test for 10 to 14 ohms between the test points: Control terminal 1 & Control terminal 2
    - **If not between 10 and 14 ohms**

      Replace the component: Q67 Exhaust Aftertreatment Fuel Injector

    - **Go to next step: If between 10 and 14 ohms**
4. All OK.

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Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Low Pressure Diesel Hydrocarbon Injector Replacement** - Q67 Exhaust Aftertreatment Fuel Injector
- For control module replacement, programming, and setup refer to **Control Module References**

DTC P20E8 OR P20E9

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 P20E8

Reductant Low Pressure

DTC P20E9

Reductant High Pressure

Circuit/System Description

For an overview of the component/system, refer to **Exhaust Aftertreatment System Description**

Conditions for Running the DTC

- DTC P103F, P1040, P1048, P1049, P1056, P1057, P1058, P1059, P105A, P2047, P2048, P2049, P204B, P204C, P204D, P208A, P208C, P208D, P214E = Not set
- Engine Running
- Ignition Voltage = Greater than 11 V
- Reductant Fluid Reservoir = Not Frozen

Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

P20E8

Reductant Pressure = Less than a predefined threshold - For greater than 20 s

P20E9

Reductant Pressure = Greater than a predefined threshold - For greater than 20 s

Actions 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

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DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References

Circuit/System Verification

NOTE: **Verify the fuel tank is not empty before proceeding. - Reductant Fluid Reservoir**

1. Ignition - On / Vehicle - In Service Mode
2. Verify no other DTCs are set.
   - **If 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 scan tool parameter: Reductant Tank Level = Full or OK
   - **If not the specified state**

     Fill the reductant tank to a minimum of 8 L.

   - **Go to next step: If the specified state**
4. Perform the scan tool control function: Reductant System Leak Test

   Verify the scan tool parameter: Reductant Pressure = 450 to 550 kPa (65 to 80 PSI)

   - **If not between 450 and 550 kPa (65 and 80 PSI)**

     Refer to: Circuit/System Testing

   - **Go to next step: If between 450 and 550 kPa (65 and 80 PSI)**
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.
   - **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. Verify the condition does not exist: Contamination - Emission Reduction Fluid - Refer to **Contaminants-in-Diesel Exhaust Fluid Diagnosis**
   - **If a condition exists**

     Repair or replace as necessary

   - **Go to next step: If no condition exists**
2. Perform the scan tool control function: Reductant System Leak Test

   Verify the condition does not exist: Leaking - Hoses / Lines

   - **If a condition exists**

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Repair or replace as necessary

- **Go to next step: If no condition exists**

3. Remove the component: Q61 Reductant Injector - Leave the reductant line and the electrical connector connected.
4. Place the injector into a suitable container.
5. Perform the scan tool control function: Reductant System Leak Test

   Verify the condition does not exist: Leaking - Reductant Injector

   - **If a condition exists**

     Replace the component: Q61 Reductant Injector

   - **Go to next step: If no condition exists**

6. Perform the scan tool control function: Reductant System Leak Test

   Verify the scan tool parameter: Reductant Pressure = 450 to 550 kPa (65 to 80 PSI)

   - **If not between 450 and 550 kPa (65 and 80 PSI)**

     Replace the component: A38 Reductant Pump and Sensor Assembly

   - **Go to next step: If between 450 and 550 kPa (65 and 80 PSI)**

7. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Reductant Fluid Injector Replacement** - Q61 Reductant Injector
- **Reductant Control Module Replacement** - A38 Reductant Pump and Sensor Assembly
- For control module replacement, programming, and setup refer to **Control Module References**

Additional Procedures

NOTE: **Performing this procedure will clear the Driver Information message for the applicable system.**

Perform the scan tool control function: Reductant System Tamper Warning Service Bay Test - Perform only when the following warning message is displayed: Service Emission System/Service Exhaust Fluid System

DTC P20EE, P249D, OR P249E

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.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P20EE

NOx Catalyst Efficiency Below Threshold

DTC P249D

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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

- The barometric pressure is greater than 70 kPa (10.2 psi).
- The ambient air and reductant temperatures are greater than -7B°C (19.4B°F).
- Engine running.
- Vehicle is not in a DPF regeneration.
- DTC P20EE runs when the above conditions are met.

DTC P249D, P249E

- Engine running.
- Vehicle is not in a DPF regeneration.
- DTCs P249D and P249E run when the above conditions are met.

Conditions for Setting the DTC

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

Action Taken When the DTC Sets

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

Conditions for Clearing the DTC

- DTCs 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).
- The reductant injector may temporarily stick after the engine is off for a short period and cause DTC P20EE or P2BAA to set. The reductant injector may unstick after exposure to elevated exhaust temperatures after the engine is restarted.
- 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.

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- Using fuel other than ultra low sulfur content fuel will cause this DTC to set.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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 P0070, P0071, P0072, P0073, P0074, P00C7, P00E9, P00EA, P00EB, P00EC, P0100, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0119, P0128, P0201, P0202, P0203, P0204, P020A, P020B, P020C, P020D, P0216, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P02EE, P02EF, P02F0, P02F1, P0405, P0406, P049D, P0502, P0503, P062B, P062D, P0722, P0723, P111E, P1248, P1249, P124A, P124B, P126A, P202E, P2147, P2148, P2150, P2151, P2227, P2228, P2229, or P2230 are 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 Reductant System Malfunction Warning Service Bay Test after diagnosing other DTCs
        - If the test does not pass

          Refer to Circuit/System Testing.

        - Go to next step: If the test passes

          Go to next step: 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**

      Refer to Circuit/System Testing

    - **Go to next step: If no DTC is set**
3. All OK.

Circuit/System Testing

1. Ignition OFF. 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**
2. Ignition ON, command the Reductant System Priming and Leak Test Device Control.
3. 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 Duty Cycle Command Device Control to 50% with a scan tool.
    2. Verify that the desired Reductant Pump Speed and actual Reductant Pump Speed parameters are equal.
        - If not equal

          Refer to **DTC P105A**

        - Go to next step: If equal
    - **Go to next step: If within the specified range**
4. 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**
5. Verify the **Reductant Fluid Injector Quantity Test** passes.
    - **If the test does not pass**

      Repair as instructed per the test.

    - **Go to next step: If the test passes**
6. Disconnect the Q61 Reductant Injector electrical connector.
7. NOx sensors at operating temperature and engine idling, verify NOx sensor 2 NOx concentration less than 50 ppm greater than NOx sensor 1 NOx Concentration.
    - **If NOx sensor 2 NOx Concentration is 50 ppm or more 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**
8. Idle engine at 1 500 RPM for 10 min and verify Exhaust Gas Temperature Sensor 2 is cooler than 150B°C (302B°F). If warmer than 150B°C (302B°F), verify Exhaust Gas Temperature Sensor 2 is warmer than 180B°C (356B°F) for 30 minutes.
9. Verify NOx sensor 1 NOx Concentration and NOx sensor 2 NOx Concentration are within 50 ppm of each other
    - **If not within the specified range**

      Replace the B195A Nitrogen Oxides Sensor 1

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

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10. Connect the Q61 Reductant Injector electrical connector.
11. Verify none of the conditions listed below exist:
    - Leaking fuel injectors. Refer to **Cylinder Power Balance Test**.
    - 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**
12. Replace the Nitrogen Oxides Catalytic Converter.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Nitrogen Oxides Sensor Replacement - Position 1**
- **Nitrogen Oxides Sensor Replacement - Position 2**
- **Emission Reduction Fluid Supply Pump Module Replacement**
- **Reductant Fluid Injector Replacement**
- **Nitrogen Oxides Catalytic Converter Replacement (LWN)**
- **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 Reductant System Malfunction Warning 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 P2122, P2123, P2127, P2128, OR P2138

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

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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
12V Reference - APP Sensor 1	P0193, P06A3, P127D	P2122, P2138	P0193, P06A3, P127D	-
Signal - APP Sensor 1	P2122	P2122, P2138	P2123	P2138
Low Reference - APP Sensor 1	-	P2123, P2138	-	P2138
12V Reference - APP Sensor 2	P0697	P2127	P0697	-
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:** 0.88 to 1.08 V			
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:** 0.39 to 0.59 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 sensor is an input to the control module. The input voltage varies depending on the position of the sensor.

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Component	Description
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.

The pedal assembly contains 2 potentiometer-type accelerator pedal position sensors, which are not serviceable. When the accelerator pedal is pressed, the voltages of both sensors goes up. This redundant design enables the ECM to detect if the 2 signals indicate the same accelerator pedal position.

Conditions for Running the DTC

DTC P2122, P2123, P2127, P2128

- DTC P0697, P06A3 = Not set
- Ignition On - Engine Running

DTC runs continuously when the above conditions are met.

P2138

- DTC P0697, P06A3, P2122, P2123, P2127, P2128 = Not set
- Ignition Voltage = Greater than 6.4 V
- Reduced Engine Power = Inactive

DTCs run continuously when the above conditions are met.

Conditions for Setting the DTC

P2122

APP Sensor 1 = Less than 0.32 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 0.16 V - For greater than 175 ms

P2128

APP Sensor 2 = Greater than 2.4 V - For greater than 175 ms

P2138

APP Sensor 1 and 2 = Not within a calibrated range - For greater than 188 ms

Action Taken When the DTC Sets

- DTCs P2122, P2123, P2127, P2128, 2138 are Type A DTCs.
- A message and/or warning indicator may be displayed to the driver.

Conditions for Clearing the DTC

DTCs P2122, P2123, P2127, P2128, 2138 are Type A DTCs.

Diagnostic Aids

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- A high resistance condition on the component circuits may cause the 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

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **Component Connector End Views - Index**

Description and Operation

Accelerator Pedal Position 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 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 Circuit Status = OK
    - APP Sensor 2 Circuit Status = OK
    - **If not the specified state**

      Refer to: Circuit/System Testing

    - **Go to next step: If the specified state**
4. 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.

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- **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**

5. Verify the scan tool parameter: APP Sensor 1 and 2 = Agree
   - **If not the specified state**

     Refer to: Circuit/System Testing

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

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- 5 V Reference circuit terminal 1 @ Component harness & Ground
- If less than infinite resistance - Repair the short to ground on the circuit.
- Go to next step: 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 4.8 V
    - **If 4.8 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.
        - Go to next step: If infinite resistance
    4. Test for less than 2 ohms between the test points:

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- {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**

- **Accelerator Pedal Position Sensor Replacement**
- For control module replacement, programming, and setup refer to **Control Module References**

DTC P2199

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 P2199

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

Diagnostic Fault Information

IAT Sensor 1

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P0112, P0114, P2199	P0111, P0113, P0114, P2199	P0113, P0114, P2199*	P0111, P2199
Low Reference	-	P0111, P0113, P0114, P2199, P2227, P2228, P2229	P0113, P0114, P2199, P2227, P2229*	-
Internal control module or component damage may occur if the circuit shorts to B+.				

IAT Sensor 2

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition	P0096, P0097, P00F4, P0102, P0178, P2199	P0096, P0097, P00F4, P0101, P0102, P2199, P2230	P0690	P0096, P0101, P0103
Signal	P0096, P0097, P00F5, P2199	P0096, P0097, P00F4, P2199	P0096, P0097, P00F4, P2199*	P0096
Ground	-	P0096, P0097, P00F4, P0102,	-	P0096, P0102

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Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
		P2199, P2130		
Internal control module or component damage may occur if the circuit shorts to B+.				

Typical Scan Tool Data

IAT Sensor 1

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine = Idling **Parameter Normal Range:** -39 to 149B°C (-38 to 300B°F)			
Signal	150B°C (302B°F)	-40B°C (-40B°F)	-40B°C (-40B°F)
Low Reference	-	-40B°C (-40B°F)	-40B°C (-40B°F)

IAT Sensor 2

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine = Idling **Parameter Normal Range:** -39 to 149B°C (-38 to 300B°F)			
Signal	150B°C (302B°F)	-40B°C (-40B°F)	-40B°C (-40B°F)
Ground	-	-40B°C (-40B°F)	-40B°C (-40B°F)

Circuit/System Description

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

Component	Description

B75C Multifunction Intake Air Sensor	The assembly has several functions:
	• The mass air flow sensor is a hot film type sensor that measures the mass of air (not the volume) entering the engine. The signal varies with engine load and is displayed by the scan tool in Hertz (Hz) and grams per second (g/s).
	• The intake air humidity sensor uses the same signal circuit as the intake air temperature sensor 2. The intake air humidity sensor modulates the pulse width of the signal. The intake air temperature sensor 2 modulates the frequency of the signal. That means the signal is both, PWM and FM modulated.
	• The barometric pressure sensor generates an analog voltage that is proportional to the ambient air pressure.
	• The intake air temperature sensor 1 varies its resistance depending on the temperature.
	  • Low temperature produces a high resistance: 1, 166 ohms @ 40B°C (104B°F)
	  • High temperature produces a low resistance: 97 ohms @ 130B°C (266B°F)

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

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Component	Description
	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 1682 = Not set
- Ignition = On
- Battery Voltage = Greater than 11 V

Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

The following parameters are not within 55B°C (99B°F) of each other: - For greater than 5 s

- IAT Sensor 1
- IAT Sensor 2

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

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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

Special Tools

<special tool><special tool-no>EL-38522</special tool-no><special tool-desc>Variable Signal Generator</special tool-desc></special tool>

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Equivalent regional tools: **Special Tools ((Diagnosis Tools))**

Circuit/System Verification

1. Ignition - On / Vehicle - In Service Mode
2. Verify DTC P0097, P0098, P0099, P00F4, P00F5, P00F6, P0102, P0103, P0112, P0113, P0114, P0641, P0651, P0697, P06A3 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**

   NOTE: **To minimize the effects of residual engine heat and heating elements inside the sensor, perform step 3 of this procedure only if the ignition has been Off for longer than 8 h.**

3. Verify the following parameters are within 25B°C (45B°F) of each other:
   - Start-Up IAT Sensor 1
   - Start-Up IAT Sensor 2
   - Start-Up ECT
   - **If not in the specified range**

     Refer to: Circuit/System Testing

   - **Go to next step: If in the specified range**
4. Engine - Idling - At normal operating temperature
5. Verify the following parameters are within 55B°C (99B°F) of each other:
   - IAT Sensor 1
   - IAT Sensor 2
   - **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**
6. Verify the appropriate scan tool parameter:
   - IAT Sensor 1
   - IAT Sensor 2
   - Wiggle the harness and connector: B75C Multifunction Intake Air 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**
7. All OK.

Circuit/System Testing

NOTE: **Circuit/System Verification must be performed before proceeding with Circuit/System Testing.**

1. Verify the following conditions do not exist:

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- B75C Multifunction Intake Air Sensor - Contamination of the measuring element/Cracked/Visible Damage/Water intrusion
- Intake Air Duct - Cracked/Incorrect connection/Restricted/Visible Damage
- **If a condition exists**

  Repair or replace as necessary

- **Go to next step: If no condition exists**

1. Ignition/Vehicle & All vehicle systems - Off
2. Disconnect the electrical connector: B75C Multifunction Intake Air Sensor
3. Test for less than 5 ohms between the test points: Ground circuit terminal 7 & Ground
   - **If 5 ohms or greater**
   1. Disconnect the ground connection: 107
   2. Test for less than 2 ohms between the test points: Ground circuit terminal 4 @ Component harness & Ground terminal G107
      - If 2 ohms or greater - Repair the open/high resistance in the circuit.
      - If less than 2 ohms - Repair the open/high resistance in the ground connection.
   - **Go to next step: If less than 5 ohms**
4. Test for less than 5 ohms between the test points: Low Reference circuit terminal 3 & Ground
   1. Disconnect the electrical connector: X1 @ K20 Engine Control Module
   2. Test for less than 2 ohms between the test points: Low Reference circuit terminal 3 @ Component harness & The other end of the circuit @ K20 Engine Control Module
      - 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**
5. Ignition - On / Vehicle - In Service Mode
6. Verify a test lamp turns On between the test points: Ignition circuit terminal 5 & Ground
   - **If the test lamp does not turn On and the circuit fuse is OK**
   1. Ignition/Vehicle - Off & Remove - Test lamp
   2. Test for less than 2 ohms between the test points: Ignition circuit terminal 5 @ Control module harness & Output terminal @ F11UA Fuse
      - If 2 ohms or greater - Repair the open/high resistance in the circuit.
      - If less than 2 ohms - Verify the fuse is OK and there is voltage at the fuse.
   - **If the test lamp does not turn On and the circuit fuse is open**
   1. Ignition/Vehicle - Off
   2. Replace the component: F11UA Fuse
   3. Ignition - On / Vehicle - In Service Mode
   4. Verify the fuse does not open.
      - If the fuse opens and there are components connected to the circuit - Disconnect a component and repeat procedure starting at step 5.1
      - If the fuse opens with all components disconnected from the circuit - Repair the short to ground on the circuit.
      - If the fuse does not open after disconnecting a component from the circuit - Replace the component disconnected last.
      - Go to next step: If the fuse does not open.

NOTE: **It may be necessary to use a scan tool control function to operate a component.**

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5. Operate the component: Each component on the circuit - One at a time

   Verify the fuse does not open when any of the components are activated.

   - If the fuse opens - Replace the component that caused the fuse to open when activated.
   - Go to next step: If the fuse does not open.

6. All OK.

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

7. Verify the scan tool parameter: IAT Sensor 1 = Colder than -39B°C (-38B°F)
   - **If -39B°C (-38B°F) or warmer**
   1. Ignition/Vehicle - Off
   2. Disconnect the appropriate electrical connector: 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 colder than -39B°C (-38B°F)**
8. Connect a 3 A fused jumper wire between the test points: Signal circuit terminal 1 & Low Reference circuit terminal 3
9. Verify the scan tool parameter: IAT Sensor 1 = Warmer than 149B°C (300B°F)
   - **If 149B°C (300B°F) or colder**
   1. Ignition/Vehicle - Off & Remove - Jumper wire(s)
   2. Disconnect the appropriate electrical connector: 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 1 @ Component harness & Ground
      - If 1 V or greater - Repair the short to voltage on the circuit.
      - Go to next step: If less than 1 V
   5. Ignition/Vehicle - Off
   6. Test for less than 2 ohms between the test points: Signal 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
   - **Go to next step: If warmer than 149B°C (300B°F)**
10. Verify the scan tool parameter: Intake Air Humidity Sensor = Less than 1%
    - **If 1% or greater**
    1. Ignition/Vehicle - Off
    2. Disconnect the appropriate electrical connector: K20 Engine Control Module
    3. Test for infinite resistance between the test points: Signal circuit terminal 8 & 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 less than 1%**
11. Ignition/Vehicle - Off
12. Connect a 3 A fused jumper wire between the test points: Signal circuit terminal 8 @ Component harness & Low Reference circuit terminal 3
13. Ignition - On / Vehicle - In Service Mode
14. Verify the scan tool parameter: Intake Air Humidity Sensor = Greater than 99%

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- **If less than 99%**

  NOTE: **Internal control module or component damage may occur if the circuit shorts to B+.**

  1. Ignition/Vehicle - Off & Remove - Jumper wire(s)
  2. Disconnect the appropriate electrical connector: 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 8 & Ground
     - If 1 V or greater - Repair the short to voltage on the circuit.
     - Go to next step: If less than 1 V
  5. Ignition/Vehicle - Off
  6. Test for less than 2 ohms between the test points: Signal circuit terminal 8 & 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 99%**

15. Test or replace the component: B75C Multifunction Intake Air Sensor

Component Testing

IAT Sensor 1

1. Ignition/Vehicle - Off
2. Disconnect the electrical connector: B75C Multifunction Intake Air Sensor
3. Test for 49 to 49, 882 ohms between the test points: Signal terminal 1 & Low Reference terminal 3
   - **If not between 49 and 49, 882 ohms**

     Replace the component: B75C Multifunction Intake Air Sensor

   - **Go to next step: If between 49 and 49, 882 ohms**
4. Verify the value is within the range listed in the table: **Temperature Versus Resistance - Intake Air Temperature Sensor**
   - **If not in the specified range**

     Replace the component: B75C Multifunction Intake Air Sensor

   - **Go to next step: If in the specified range**
5. Test for infinite resistance between the test points: Each terminal of the component & The component's housing
   - **If less than infinite resistance**

     Replace the component: B75C Multifunction Intake Air Sensor

   - **Go to next step: If infinite resistance**
6. All OK.

IAT Sensor 2

NOTE: **Circuit/System Testing must be performed before proceeding with Component Testing.**

1. Ignition/Vehicle - Off

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2. Disconnect the electrical connector: B75C Multifunction Intake Air Sensor
3. Install the special tool:<special tool><special tool-no>EL-38522</special tool-no><special tool-desc>Variable Signal Generator</special tool-desc></special tool>
    - Black lead @ Ground
    - Battery Cable Clip @ Battery
    - Red lead @ Signal circuit terminal 8
    - Set the voltage to 5 V
    - Set the frequency to 250 Hz
    - Set the duty cycle to 50%
4. Ignition - On / Vehicle - In Service Mode
5. Verify the scan tool parameter:
    - IAT Sensor 2 = 248 to 252 Hz
    - IAT Sensor 2 = 70 to 76B°C (160 to 166B°F)
    - Intake Air Humidity Sensor = 48 to 52%
    - **If not in the specified range or does not change**
    1. Ignition/Vehicle - Off
    2. Disconnect the electrical connector: X1 @ K20 Engine Control Module
    3. Test for less than 2 ohms between the test points: Signal circuit terminal 8 @ B75C Multifunction Intake Air Sensor & The other end of the circuit @ K20 Engine Control Module
        - 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 in the specified range and changes**
6. Replace the component: B75C Multifunction Intake Air Sensor

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Mass Airflow Sensor with Intake Air Temperature Sensor Replacement**
- For control module replacement, programming, and setup refer to **Control Module References**

Additional Procedures

BARO Sensor Reset - Perform only when the following component/system is replaced or serviced:

- K20 Engine Control Module - Replaced
- B75C Multifunction Intake Air Sensor - Cleaned/Replaced

DTC P21C5

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 P21C5

Reductant Level Sensor Stuck

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Circuit/System Description

For an overview of the component/system, refer to **Exhaust Aftertreatment System Description**

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

Component	Description
B212 Reductant Sensor Module	The sensor sends measured values and state of health information via serial data to the ECM and the reductant control module.
K115 Reductant Control Module	The control module controls the heating and dosing of the reductant.

Conditions for Running the DTC

- DTC U010E = Not set
- 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

Reductant Level Sensor = Stuck - For greater than 5 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

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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

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Scan Tool Reference

Control Module References

Circuit/System Verification

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

   Perform the action while monitoring the parameter:

   - Wiggle the harness and connector: B212 Reductant Sensor Module
   - 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/Vehicle & All vehicle systems - Off
2. Disconnect the electrical connector: B212 Reductant Sensor Module
3. Ignition - On / Vehicle - In Service Mode
4. Test for less than 25 ohms between the test points: Low Reference circuit terminal 3 & Ground
   - **If 25 ohms or greater**
   1. Disconnect the electrical connector: X2 @ K115 Reductant Control Module
   2. Test for less than 2 ohms between the test points: Low Reference circuit terminal 3 @ Component harness & Terminal 6 X2 @ Control module harness
      - If 2 ohms or greater - Repair the open/high resistance in the circuit.
      - If less than 2 ohms - Replace the component: K115 Reductant Control Module
   - **Go to next step: If less than 25 ohms**
5. Test for 4.8 to 5.2 V between the test points: 5 V Reference circuit terminal 1 & Low Reference circuit terminal 3
   - **If less than 4.8 V**
   1. Ignition/Vehicle - Off
   2. Disconnect the electrical connector: X2 @ K115 Reductant Control Module
   3. Test for infinite resistance between the test points: 5 V Reference circuit terminal 1 @ Component harness & Ground
      - If less than infinite resistance - Repair the short to ground on the circuit.
      - Go to next step: If infinite resistance

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4. Test for less than 2 ohms between the test points: 5 V Reference circuit terminal 1 @ Component harness & Terminal 19 X2 @ Control module harness
    - If 2 ohms or greater - Repair the open/high resistance in the circuit.
    - If less than 2 ohms - Replace the component: K115 Reductant Control Module
- **If greater than 5.2 V**

1. Ignition/Vehicle - Off
2. Disconnect the electrical connector: X2 @ K115 Reductant 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 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: K115 Reductant Control Module
- **Go to next step: If between 4.8 and 5.2 V**

6. Ignition/Vehicle - Off
7. Disconnect the electrical connector: B212 Reductant Sensor Module
8. Test for infinite resistance between the test points: Signal circuit terminal 2 @ Component harness & Ground
    - **If less than infinite resistance**

      Repair the short to ground on the circuit.

    - **Go to next step: If infinite resistance**
9. Test for less than 2 ohms between the test points: Signal circuit terminal 2 @ Component harness & Terminal 18 X2 @ Control module harness
    - **If 2 ohms or greater**

      Repair the open/high resistance in the circuit.

    - **Go to next step: If 2 ohms or less**
10. Ignition - On / Vehicle - In Service Mode
11. 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.

    - **Go to next step: If less than 1 V**
12. Replace the component: B212 Reductant Sensor Module

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Emission Reduction Fluid Tank Replacement** - B212 Reductant Sensor Module
- **Reductant Control Module Replacement** - K115 Reductant Control Module
- For control module replacement, programming, and setup refer to **Control Module References**

Additional Procedures

NOTE: **Performing this procedure will clear the Driver Information message for the applicable system.**

Perform the scan tool control function: **Reductant System Tamper Service Bay Test** - Perform only when the following warning message is displayed: Service Emission System/Service Exhaust Fluid System

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DTC P21CB

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.
- **Diagnostic Procedure Instructions** provides 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

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **Component Connector End Views - Index**

Electrical Information Reference

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- **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 F40 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.
      - Go to next step: 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.
      - Go to next step: 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.

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- **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 2Ω in the module ignition voltage circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - Go to next step: If less than 2 Ω
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.
    - Go to next step: 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.

Reductant Control Module Replacement

DTC P220A OR P220B

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.
- **Diagnostic Procedure Instructions** provides 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

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- The reductant control module relay 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

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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**

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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.

Nitrogen Oxides Sensor Replacement - Position 1

Nitrogen Oxides Sensor Replacement - Position 2

DTC P2227-P2230

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 P2227

Barometric Pressure (BARO) Sensor Performance

DTC P2228

Barometric Pressure (BARO) Sensor Circuit Low Voltage

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DTC P2229

Barometric Pressure (BARO) Sensor Circuit High Voltage

DTC P2230

Barometric Pressure (BARO) Sensor Circuit Erratic

Circuit/System Description

For an overview of the component/system, refer to **Engine Control Module Description**

Component	Description
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.

Conditions for Running the DTC

P2227Condition 1

- DTC P0100-P0103, P0107, P0108, P0116-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, P02E8, P02E9, P02EE, P02EF, P02F0- P02F5, P0335, P0336, P062B, P062D, P111E, P122D, P1248, P1249, P124A- P124F, P126A, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P2228- P2230, P227E, U0654 = Not set
- Engine = Running - For greater than 30 s
- Engine Coolant Temperature = Greater than 70B°C (158B°F)
- Engine Speed = Greater than 950 RPM
- Ignition Voltage = Greater than 11 V
- Intake Air Flow Valve Position = Greater than 90%

Condition 2, 3

- DTC P0107, P0108, P0237, P0238, P2610 = Not set
- Engine = Off - For greater than 5 s
- Ignition = On

Frequency the DTC runs = Continuously - After the running conditions are met

P2228, P2229, P2230

Ignition = On or Engine = Running

Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

P2227Condition 1

The following parameters are not within 46 kPa (6.7 PSI) of each other:

- BARO Sensor 1
- BARO Sensor 2
- MAP Sensor

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Condition 2

BARO = Not between 50 and 115 kPa (7 and 17 PSI)

Condition 3

The following parameters are not within 10 kPa (1.5 PSI) of each other:

- BARO Sensor 1
- BARO Sensor 2
- MAP Sensor

The above condition(s) must occur for greater than 1 s.

P2228

BARO = Less than 1.8 V - For greater than 5 s

P2229

BARO = Greater than 4.7 V - For greater than 5 s

P2230

BARO = Signal noisy or erratic - For greater than 5 s

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type A DTC

Warning Message = Service Emission System/Service Exhaust Fluid System

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type A DTC

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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

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Control Module References

Circuit/System Verification

1. Ignition - On / Vehicle - In Service Mode
2. Verify the scan tool parameter:
   - BARO Sensor 2 = The value should be within the range listed in the table: **Altitude Versus Barometric Pressure**
   - MAP Sensor = The value should be within the range listed in the table: **Altitude Versus Barometric Pressure**
   - **If not in the specified range**
   - {BARO Sensor 2} Refer to **DTC P227B-P227E**
   - {MAP Sensor} Refer to **DTC P0106, P0107, or P0108**
   - **Go to next step: If in the specified range**
3. Verify the scan tool parameter: BARO Sensor 1 = The value should be within the range listed in the table: **Altitude Versus Barometric Pressure**
   - **If not in the specified range**
4. Ignition/Vehicle - Off
5. Verify a condition does not exist with the component: Vent @ K20 Engine Control Module
   - Debris/Dirty
   - Moisture/Ice/Water
   - **If a condition exists**

     Repair or replace as necessary

   - **Go to next step: If no conditions exist**
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.

   Verify the DTC does not set.

   - **If the DTC sets**

     Replace the component: K20 Engine Control Module

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

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Engine Control Module Replacement** - K20 Engine Control Module
- For control module replacement, programming, and setup refer to **Control Module References**

Additional Procedures

NOTE: **The DTC causing the Driver Information Center message/speed limitation to set must run and pass before the message/speed limitation will clear. This may require driving the vehicle.**

1. Ignition - On / Vehicle - In Service Mode
2. Verify that all scan tool Event Data parameters under the following data list displays No: Exhaust Gas Recirculation System Malfunction Warning Event Data

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- **If not the specified state**

  Operate the vehicle within the Conditions for Running the DTC for the Event Data parameter that displays Yes.

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

3. All OK.

DTC P2264

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 P2264

Water in Fuel Sensor Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	DTC P2264	DTC P2264	-	DTC P2264
Ground	-	DTC P2264	DTC P2264	DTC P2264

Typical Scan Tool Data

Water in Fuel

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition = On **Parameter Normal Range:** No			
Signal	Yes	No	No
Ground	No	No	No

Circuit/System Description

For an overview of the component/system, refer to **Fuel System Description**

Circuit	Description
Signal	The control module input circuit has an internal resistance connected to 5 V.
Ground	Chassis Ground

Component	Description
E11A Fuel Heater/Water in Fuel Sensor	The sensor uses two electrodes to measure the electric conductivity of the fluid in the fuel filter assembly. Since water has a higher conductivity than diesel fuel, it can be determined how much water is in the filter.
K20 Engine Control Module	The control module controls a series of actuators to ensure optimal engine performance. The control module does this

Component	Description
	by reading values from a variety of sensors, interprets the data and adjusts the engine actuators accordingly.

Conditions for Running the DTC

- DTC P1103, P16D7, P16D8, P16D9, P262B = Not set
- Ignition = On
- Ignition Off Time = Greater than 8 h
- Ignition Voltage = Greater than 11 V

Frequency the DTC runs = Once - Per drive cycle - After the running conditions are met

Conditions for Setting the DTC

Water In Fuel Sensor = Not within a calibrated range - For greater than 1 s

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type C DTC

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type C DTC

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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 the scan tool parameter: Water in Fuel = No
    - **If not the specified state**
    1. Verify the condition does not exist: Water @ Fuel Filter Water Bleed Screw

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Refer to **Water-in-Fuel Draining**

- If a condition exists - Refer to **Contaminants-in-Fuel Diagnosis**
- If no condition exists - Refer to: Circuit/System Testing

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

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

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: E11A Fuel Heater/Water in Fuel Sensor
3. Test for less than 10 ohms between the test points: Ground circuit terminal 4 & Ground
   - **If 10 ohms or greater**
   1. Disconnect the ground connection: G307
   2. Test for less than 2 ohms between the test points: Ground circuit terminal 4 @ Component harness & Terminal G307
      - If 2 ohms or greater - Repair the open/high resistance in the circuit.
      - If less than 2 ohms - Repair the open/high resistance in the ground connection.
   - **Go to next step: If less than 10 ohms**
4. Ignition - On / Vehicle - In Service Mode
5. Verify the scan tool parameter: Water in Fuel = No
   - **If not the specified state**
   1. Ignition/Vehicle - Off
   2. Disconnect the electrical connector: X1 @ K20 Engine Control Module
   3. Test for infinite resistance between the test points: Signal circuit terminal 3 @ 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 specified state**
6. Connect a 3 A fused jumper wire between the test points: Signal circuit terminal 3 & Ground circuit terminal 4
7. Verify the scan tool parameter: Water in Fuel = Yes
   - **If not the specified state**
   1. Ignition/Vehicle - Off & Remove - Jumper wire(s)
   2. Disconnect the electrical connector: X1 @ 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 3 @ Component harness & Ground

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- If 1 V or greater - Repair the short to voltage on the circuit.
- Go to next step: If less than 1 V

5. Ignition/Vehicle - Off
6. Test for less than 2 ohms between the test points: Signal circuit terminal 3 @ Component harness & Terminal 11 @ 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 specified state**

8. Test or replace the component: E11A Fuel Heater/Water in Fuel Sensor

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Fuel Filter Assembly Replacement** - E11A Fuel Heater/Water in Fuel Sensor
- For control module replacement, programming, and setup refer to **Control Module References**

DTC P2269

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 P2269

Water in Fuel

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	DTC P2264	DTC P2264	-	DTC P2269
Ground	-	DTC P2264	DTC P2264	DTC P2269

Typical Scan Tool Data

Water in Fuel

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition = On **Parameter Normal Range:** No			
Signal	Yes	No	No
Ground	No	No	No

Circuit/System Description

For an overview of the component/system, refer to **Fuel System Description**

Circuit	Description
Signal	The control module input circuit has an internal resistance connected to 5 V.

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Circuit	Description
Ground	Chassis Ground

Component	Description
B116 Water in Fuel Sensor	The sensor uses two electrodes to measure the electric conductivity of the fluid in the fuel filter assembly. Since water has a higher conductivity than diesel fuel, it can be determined how much water is in the filter.
K111 Fuel Pump Driver Control Module	The control module K111 supplies the fuel pump with a 3-phase voltage in order to achieve the desired pump speed required for building fuel line pressure.

Conditions for Running the DTC

- Ignition = On
- Ignition Voltage = Greater than 11 V

Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

Water In Fuel Sensor - Signal circuit = Less than 4.5 V - For greater than 1 s

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type C DTC

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type C DTC

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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

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1. Ignition - On / Vehicle - In Service Mode
2. Verify the scan tool parameter: Water in Fuel = No
    - **If not the specified state**
    1. Verify the condition does not exist: Water @ Fuel Filter Water Bleed Screw

       Refer to **Water-in-Fuel Draining**

        - If a condition exists - Refer to **Contaminants-in-Fuel Diagnosis**
        - If no condition exists - Refer to: Circuit/System Testing
    - **Go to next step: If the specified state**
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

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: B116 Water in Fuel Sensor
3. Test for less than 10 ohms between the test points: Low Reference circuit terminal 2 & Ground
    - **If 10 ohms or greater**
    1. Disconnect the electrical connector: K111 Fuel Pump Driver 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: K111 Fuel Pump Driver Control Module
    - **Go to next step: If less than 10 ohms**
4. Ignition - On / Vehicle - In Service Mode
5. Verify the scan tool parameter: Water in Fuel = No
    - **If not the specified state**
    1. Ignition/Vehicle - Off
    2. Disconnect the electrical connector: K111 Fuel Pump Driver Control Module
    3. Test for infinite resistance between the test points: Signal circuit terminal 3 @ Component harness & Ground
        - If less than infinite resistance - Repair the short to ground on the circuit.
        - If infinite resistance - Replace the component: K111 Fuel Pump Driver Control Module
    - **Go to next step: If the specified state**
6. Connect a 3 A fused jumper wire between the test points: Signal circuit terminal 3 & Low Reference circuit terminal 2
7. Verify the scan tool parameter: Water in Fuel = Yes
    - **If not the specified state**

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1. Ignition/Vehicle - Off & Remove - Jumper wire(s)
2. Disconnect the electrical connector: K111 Fuel Pump Driver Control Module
3. Ignition - On / Vehicle - In Service Mode
4. Test for less than 1 V between the test points: Signal circuit terminal 3 @ Component harness & Ground
    - If 1 V or greater - Repair the short to voltage on the circuit.
    - Go to next step: If less than 1 V
5. Ignition/Vehicle - Off
6. Test for less than 2 ohms between the test points: Signal 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
- **Go to next step: If the specified state**

8. Test or replace the component: B116 Water in Fuel Sensor

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Fuel Filter Assembly Replacement** - B116 Water in Fuel Sensor
- For control module replacement, programming, and setup refer to **Control Module References**

DTC P226D

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.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P226D

Diesel Particulate Filter (DPF) Deteriorated

Circuit/System Description

The diesel exhaust aftertreatment system consists of an under hood pre-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 600B°C (1 112B°F) and the accumulated soot is oxidized or burned off into carbon dioxide (CO2).

Conditions for Running the DTC

- DTCs related to the following system/component = Not Set
    - B17 Barometric Pressure Sensor
    - B34 Engine Coolant Temperature Sensor

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    - B65 Intake Manifold Pressure and Air Temperature Sensor
    - B75C Multifunction Intake Air Sensor
    - B131 Exhaust Temperature Sensor
    - B154 Diesel Particulate Filter Exhaust Differential Pressure Sensor
    - M103 Turbocharger Vane Position Actuator
    - Q14 Exhaust Gas Recirculation Valve
    - Q17 Fuel Injector
- The engine speed is greater than 500 RPM.
- The ambient temperature is warmer than -20B°C (-4B°F).
- The Exhaust Gas Temperature Sensor 4 is between 0-600B°C (32-1, 112B°F) for greater than 2 s.
- The DPF is not in regeneration.

The DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

The ECM detects that the pressure difference over the DPF is less than a set threshold.

Action Taken When the DTC Sets

DTC P226D is a type B DTC.

Conditions for Clearing the DTC

DTC P226D is a type B DTC.

Diagnostic Aids

- Certain weather conditions during prolonged drive trips may cause ice to form in the area of the component: B154 Diesel Particulate Filter Exhaust Differential Pressure Sensor
- If ice is found in the area of the component B154, clean and dry the component and retest to verify the issue has been corrected.
- The differential pressure sensor lines should slope downward continuously toward the exhaust to allow condensed water to drain.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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

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Scan Tool Reference

Control Module References

Circuit/System Verification

1. Ignition ON.
2. Verify there are no DTCs set related to the following component/system:
    - B17 Barometric Pressure Sensor
    - B34 Engine Coolant Temperature Sensor
    - B65 Intake Manifold Pressure and Air Temperature Sensor
    - B75C Multifunction Intake Air Sensor
    - B131 Exhaust Temperature Sensor
    - B154 Diesel Particulate Filter Exhaust Differential Pressure Sensor
    - M103 Turbocharger Vane Position Actuator
    - Q14 Exhaust Gas Recirculation Valve
    - Q17 Fuel Injector
    - **If a related DTC is set**

      Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

    - **Go to next step: If a related DTC is not set**
3. Ignition ON, verify that the 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**

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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 EN 23738 - A vacuum gauge to port two (rear of particulate filter) of the B154 Diesel Particulate Filter Exhaust Differential Pressure Sensor.
4. Ignition ON, using the EN 23738 - A vacuum gauge, slowly apply -10 kPa (3 in Hg) vacuum 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 Exhaust Particulate Filter.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Exhaust Particulate Filter Replacement (LWN)

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

DTC P227B-P227E

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 P227B

Barometric Pressure (BARO) Sensor 2 Performance

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

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Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P0641, P227C	P227B, P227D	P0641, P227D	P00C7, P0106, P2227, P227B
Signal	P2227, P2228	P2227, P2229	P2227, P2229	P00C7, P0106, P2227, P227B
Low Reference	-	P227D	-	P00C7, P0106, P2227, P227B

Typical Scan Tool Data

BARO Sensor 2

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition - On / Vehicle - In Service Mode & Engine - Off **Parameter Normal Range:** 56 to 105 kPa (8.1 to 15.2 PSI)			
5 V Reference	0 kPa (0.0 PSI)	0 kPa (0.0 PSI)	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

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

B75C Multifunction Intake Air Sensor	The assembly has several functions:
	• The mass air flow sensor is a hot film type sensor that measures the mass of air (not the volume) entering the engine. The signal varies with engine load and is displayed by the scan tool in Hertz (Hz) and grams per second (g/s).
	• The intake air humidity sensor uses the same signal circuit as the intake air temperature sensor 2. The intake air humidity sensor modulates the pulse width of the signal. The intake air temperature sensor 2 modulates the frequency of the signal. That means the signal is both, PWM and FM modulated.
	• The barometric pressure sensor generates an analog voltage that is proportional to the ambient air pressure.
	• The intake air temperature sensor 1 varies its resistance depending on the temperature.
	  • Low temperature produces a high resistance: 5.6 kohms @ 0B°C (32B°F)
	  • High temperature produces a low resistance: 187 ohms @ 100B°C (212B°F)

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.

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Conditions for Running the DTC

P227BCondition 1

- DTC P0102, P0103, P0107, P0108, P0117, P0118, P0119, P0335, P0336, P2228, P2229, P227C, P227D = Not set
- DTCs related to the following system/component = Not Set - Q17 Fuel Injector
- Ignition Voltage = Greater than 11 V
- Engine = Running
- Engine Speed = Less than 950 RPM
- Intake Air Flow Valve Position = Greater than 90%
- Engine Coolant Temperature = Warmer than 70B°C (158B°F)

Frequency the DTC runs = Continuously - After the running conditions are met

Condition 2

- DTC P0107, P0108, P2228, P2229, P2230, P227C, P227D, P227E, P2610 = Not set
- Ignition = On
- Engine Off = Greater than 5 s

Frequency the DTC runs = Continuously - After the running conditions are met

P227C, P227D

Engine Running = Greater than 30 s

Frequency the DTC runs = Continuously - After the running conditions are met

P227E

- DTC P0102, P0103, P0107, P0108, P0117, P0118, P0119, P0335, P0336, P2228, P2229, P227C, P227D = Not set
- Ignition = On

Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

P227BCondition 1

The following parameters are not within 15 kPa (2.2 PSI) of each other:

- BARO Sensor 1
- BARO Sensor 2
- MAP Sensor

Condition 2

BARO Sensor 2 50 to 115 kPa (7.3 to 16.7 PSI)

P227C

BARO Sensor 2 = Less than 1.8 V - For greater than 5 s

P227D

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BARO Sensor 2 = Greater than 4.5 V - For greater than 5 s

P227E

BARO Sensor 2 = Signal noisy or erratic - For greater than 5 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

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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 P0107, P0108, P0641, P0651, P0697, P06A3, P2228, P2229 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. Determine the current vehicle testing altitude.
4. Verify the scan tool parameter: MAP Sensor = The value should be within the range listed in the table: **Altitude Versus Barometric Pressure**
    - **If not in the specified range**

      Refer to **DTC P0106, P0107, or P0108**

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

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5. Verify the scan tool parameter: BARO Sensor 1 = The value should be within the range listed in the table: **Altitude Versus Barometric Pressure**
    - **If not in the specified range**

      Refer to **DTC P2227-P2230**

    - **Go to next step: If in the specified range**
6. Verify the scan tool parameter: BARO Sensor 2 = The value should be within the range listed in the table: **Altitude Versus Barometric Pressure**
    - **If not in the specified range**

      Refer to: Circuit/System Testing

    - **Go to next step: If in the specified range**
7. Verify the scan tool parameter: BARO Sensor 2 = The value should not spike or drop out.

   Perform the action while monitoring the parameter:

    - Wiggle the harness and connector: B75C Multifunction Intake Air 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
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.

   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**
9. 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: B75C Multifunction Intake Air Sensor
3. Test for less than 5 ohms between the test points: Low Reference circuit terminal 3 & 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: Low 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
    - **Go to next step: If less than 5 ohms**
4. Ignition - On / Vehicle - In Service Mode

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5. Test for 4.8 to 5.2 V between the test points: 5 V Reference circuit terminal 2 & Low Reference circuit terminal 3
    - **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
        - If less than infinite resistance - Repair the short to ground on the circuit.
        - Go to next step: 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
        - 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
        - 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: BARO = Greater than 4.7 V
    - **If 4.7 V or less**
    1. Ignition/Vehicle - Off
    2. Disconnect the electrical connector: K20 Engine Control Module
    3. Test for infinite resistance between the test points: Signal circuit terminal 4 @ 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 4 & Low Reference circuit terminal 3
8. Verify the scan tool parameter: BARO = Less than 0.2 V
    - **If 0.2 V or greater**
    1. Ignition/Vehicle - Off & Remove - Jumper wire(s)
    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: Signal circuit terminal 4 @ Component harness & Ground
        - If 1 V or greater - Repair the short to voltage on the circuit.
        - Go to next step: If less than 1 V
    5. Ignition/Vehicle - Off
    6. Test for less than 2 ohms between the test points: Signal circuit terminal 4 @ 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

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- **Go to next step: If less than 0.2 V**

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

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Mass Airflow Sensor with Intake Air Temperature Sensor Replacement** - B75C Multifunction Intake Air Sensor
- For control module replacement, programming, and setup refer to **Control Module References**

Additional Procedures

BARO Sensor Reset - Perform only when the following component/system is replaced or serviced:

- K20 Engine Control Module - / Replaced
- B75C Multifunction Intake Air Sensor - Cleaned/Replaced

DTC P228A OR P228B

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 P228A

Fuel Pressure Regulator 1 Control - Forced Engine Shutdown

DTC P228B

Fuel Pressure Regulator 2 Control - Forced Engine Shutdown

Circuit/System Description

For an overview of the component/system, refer to **Fuel System Description**

Component	Description
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.
Q18A Fuel Pressure Regulator 1	The fuel pressure regulator is a solenoid valve that restricts the flow of fuel to the high pressure fuel pump and thereby controls the pressure the pump can produce.
Q18B Fuel Pressure Regulator 2	The fuel pressure regulator is the solenoid valve that controls the pressure in the fuel rail.

Conditions for Running the DTC

P228A

- Engine = Running - For greater than 30 s
- Fuel Rail Pressure is being controlled by Fuel Pressure Regulator 1.

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- Ignition Voltage = Greater than 11 V

Frequency the DTC runs = Continuously - After the running conditions are met

P228B

- Engine = Running - For greater than 30 s
- Fuel Rail Pressure is being controlled by Fuel Pressure Regulator 2.
- Ignition Voltage = Greater than 11 V

Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

Fuel Rail Pressure = Commanded state does not match the actual state - For greater than 4 s

Actions 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

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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 there are no DTCs set related to the following component/system: Fuel System
    - **If a related DTC is set**

      Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**

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

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3. Verify the following conditions do not exist:
    - Aftermarket equipment/accessories: Performance Components - Installed
    - Fuel - Contamination. Refer to **Fuel System Specifications** , or **Contaminants-in-Fuel Diagnosis**
    - **If a condition exists**

      Repair or replace as necessary

    - **Go to next step: If no condition exists**
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.

   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**
5. All OK.

Circuit/System Testing

1. Ignition/Vehicle - Off
2. Verify the condition does not exist: Fuel System - Leaking
    - **If the condition exists**

      Refer to **Fuel Leak Diagnosis**

    - **Go to next step: If no condition exists**
3. Engine - Idling
4. Verify the scan tool parameter: Fuel Pressure Sensor = 370 to 450 kPa (54 to 65 PSI)
    - **If less than 370 kPa (54 PSI)**

      Refer to **Fuel System Diagnosis**

    - **If greater than 450 kPa (65 PSI)**

      Refer to **Fuel Return System Diagnosis**

    - **Go to next step: If between 370 and 450 kPa (54 and 65 PSI)**
5. Perform the following procedure/test: **Cylinder Power Balance Test**

   Verify the procedure/test passes.

    - **If the procedure/test does not pass**

      Replace the component that failed the test: Q17 Fuel Injector

    - **Go to next step: If the procedure/test passes**
6. 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

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- **Go to next step: If the value changes**

7. 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

   - **Go to next step: If the value changes**

8. Test or replace the component: G18 High Pressure Fuel Pump

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Fuel Injection Fuel Rail Assembly Replacement** - Q18B Fuel Pressure Regulator 2
- **Fuel Injection Pump Metering Valve Replacement** - Q18A Fuel Pressure Regulator 1
- **Fuel Injection Pump Replacement** - G18 High Pressure Fuel Pump
- For control module replacement, programming, and setup refer to **Control Module References**

DTC P2297 OR P2A00

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.
- **Diagnostic Procedure Instructions** provides 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.

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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, P0202, P0203, P0204, P020A, P020B, P020C, P020D, P0216, P0234, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0299, P02EE, P02EF, P02F0, P02F1, P0403, P0405, P0406, P042E, P042F, P0489, P0490, P049D, P0545, P0546, 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, P11B3, P11DB, P11DD, P1248, P1249, P124A, P124B, P126A, P1402, P1407, P140F, P1424, P2032, P2033, P2080, P2081, P2084, P2085, P2147, P2148, P2150, P2151, P2200, P2205, P2206, P2207, P2208, P2209, P220A, P2210, P2211, P2227, P2228, P2229, P2230, P2263, P228A, P228B, P2481, P2482, P2483, P2484, P242B, P242C, P242D, P242E, P2452 - P2456, P2628, P2627, or U029D 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 600-3, 000 RPM.
- The engine is operating under deceleration fuel cut-off.
- The exhaust gas recirculation (EGR) valve position is less than 5%.
- The NOx Sensor 1 Heater Operation parameter displays Allowed.

The DTC 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, P0202, P0203, P0204, P020A, P020B, P020C, P020D, P0216, P0234, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0299, P02EE, P02EF, P02F0, P02F1, P0403, P0405, P0406, P049D, P0545, P0546, 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, P11B3, P11DB, P11DD, P1248, P1249, P124A, P124B, P126A, P2032, P2033, P2080, P2081, P2084, P2085, P2147, P2148, P2150, P2151, P2200, P2205, P2206, P2207, P2208, P2209, P220A, P2210, P2211, P2227, P2228, P2229, P2230, P2263, P228A, P228B, P2481, P2482, P2483, P2484, P242B, P242C, P242D, P242E, P2452 - P2456, P2628, P2627, or U029D 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 1, 200-2, 000 RPM.
- The engine is operating under full load.
- The NOx Sensor 1 Heater Operation parameter displays Allowed.

The DTC 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

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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, P0202, P0203, P0204, P020A, P020B, P020C, P020D, P0216, P0234, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0299, P02EE, P02EF, P02F0, P02F1, P0403, P0405, P0406, P042E, P042F, P0489, P0490, P049D, P0545, P0546, 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, P11B3, P11DB, P11DD, P1248, P1249, P124A, P124B, P126A, P1402, P1407, P140F, P1424, P2032, P2033, P2080, P2081, P2084, P2085, P2147, P2148, P2150, P2151, P2200, P2205, P2206, P2207, P2208, P2209, P220A, P2210, P2211, P2227, P2228, P2229, P2230, P2263, P228A, P228B, P2481, P2482, P2483, P2484, P242B, P242C, P242D, P242E, P2452 - P2456, P2628, P2627, 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 none of the conditions listed below exist:
   - Leaking or restricted intake system/charge air hoses. Refer to **Charge Air Cooler Diagnosis (Induction System Smoke Test)**, or **Charge Air Cooler Diagnosis (Full System Air Leak Test)**
   - Leaking exhaust system/turbo charger. 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.

Nitrogen Oxides Sensor Replacement - Position 1

DTC P244A

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.
- **Diagnostic Procedure Instructions** provides 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

- DTCs related to the following system/component = Not Set
    - B17 Barometric Pressure Sensor
    - B65 Intake Manifold Pressure and Air Temperature Sensor
    - B75C Multifunction Intake Air Sensor
    - B131 Exhaust Temperature Sensor
    - B154 Diesel Particulate Filter Exhaust Differential Pressure Sensor
- Engine speed is greater than 1, 250 RPM
- Engine coolant temperature is warmer than 40B°C (104B°F)

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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.

Diagnostic Aids

- Certain weather conditions during prolonged drive trips may cause ice to form in the area of the component: B154 Diesel Particulate Filter Exhaust Differential Pressure Sensor
- If ice is found in the area of the component B154, clean and dry the component and retest to verify the issue has been corrected.
- The differential pressure sensor lines should slope downward continuously toward the exhaust to allow condensed water to drain.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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

EN 23738-A Mityvac

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Circuit/System Verification

1. Ignition ON.
2. Verify there are no DTCs set related to the following component/system:
    - B17 Barometric Pressure Sensor
    - B65 Intake Manifold Pressure and Air Temperature Sensor
    - B75C Multifunction Intake Air Sensor
    - B131 Exhaust Temperature Sensor
    - B154 Diesel Particulate Filter Exhaust Differential Pressure Sensor
    - **If a related DTC is set**

      Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** for further diagnosis.

    - **Go to next step: If a related DTC is not 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**

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Repair as necessary.

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

3. Connect the EN 23738 - A vacuum gauge to port two (rear of particulate filter) of the B154 Diesel Particulate Filter Exhaust Differential Pressure Sensor.
4. Ignition ON, using the EN 23738 - A vacuum gauge, slowly apply -10 kPa (3 in Hg) vacuum 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.

- **Exhaust Pressure Differential Sensor Replacement**
- **Exhaust Particulate Filter Replacement (LWN)**
- **Control Module References** for engine control module replacement, programming, and setup.

DTC P244C

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 P244C

Catalyst Low Temperature During Regeneration

Circuit/System Description

For an overview of the component/system, refer to **Exhaust Aftertreatment System Description**

Conditions for Running the DTC

Particulate Filter Regeneration = Active

Conditions for Setting the DTC

Exhaust Gas Temperature Sensor 4 = Not within a calibrated range

Actions 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

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Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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 there are no DTCs set related to the following component/system: B131D Exhaust Temperature Sensor 4
   - **If a related DTC is set**

     Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**

   - **Go to next step: If a related DTC is not set**
3. Verify a condition does not exist with the component:
   - B154 Diesel Particulate Filter Exhaust Differential Pressure Sensor - Hoses / Lines - Kinked/Leaking/Restricted
   - Exhaust System - Leaking/Loose Clamps/Visible Damage
   - Induction System - Leaking/Loose Clamps/Restricted/Visible Damage
   - Q67 Exhaust Aftertreatment Fuel Injector - Leaking/Restricted - Refer to **Exhaust Aftertreatment Fuel Injector Diagnosis**
   - **If a condition exists**

     Repair or replace as necessary

   - **Go to next step: If no condition exists**
4. Perform the scan tool function: **Diesel Particulate Filter (DPF) Service Regeneration**
5. Verify the procedure was successful.
   - **If the procedure was not successful**

     Replace the component: Exhaust Particulate Filter

   - **Go to next step: If the procedure was successful**
6. All OK.

Repair Instructions

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Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Exhaust Particulate Filter Replacement (LWN)**

DTC P2452-P2456

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.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P2452

Diesel Particulate Filter (DPF) Differential Pressure Sensor Circuit

DTC P2453

Diesel Particulate Filter (DPF) Differential Pressure Sensor Performance

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	P0641	P2454	P0641	P2453, P2456
Signal	P2454	P2454, P2452	P2455	P2453, P2456
Low Reference	-	P2454, P2452	-	P2453, P2456

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 600B°C (1, 112B°F) and the accumulated soot is oxidized or burned off into carbon dioxide (CO2).

Conditions for Running the DTC

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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.

P2453

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

P2454, P2455

- The ignition is ON or the engine is running.
- The engine is not cranking.
- The ignition voltage is greater than 11 V.

These 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 engine is not cranking.
- 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.

P2453

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

P2454

The ECM detects an 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, P2453, P2454, P2455 and P2456 are Type B DTCs.

Conditions for Clearing the DTC

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DTC P2452, P2453, P2454, P2455 and P2456 are Type B DTCs.

Diagnostic Aids

- A skewed or stuck exhaust differential pressure sensor will cause DTC P2453 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 DTC P2453 to set.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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. Engine idling.
2. Verify the scan tool DPF differential pressure parameter is within 0 - 10 kPa (0 - 1.5 PSI).
    - **If not within the specified range**

      Refer to Circuit/System Testing.

    - **Go to next step: If within the specified range**
3. Engine idling at operating temperature, verify that the DPF Differential Pressure parameter is between 0 - 3 kPa (0 - 0.44 PSI).
    - **If not within the specified range**

      Refer to Circuit/System Testing.

    - **Go to next step: If 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 from the Freeze Frame/Failure Records data.
5. Verify that the DTC is not set.
    - **If the DTC sets**

      Refer to Circuit/System Testing.

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

6. All OK.

Circuit/System Testing

1. Verify the following conditions do not exist with the DPF system:
   - 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. Ignition OFF, disconnect the harness connector at the B154 Diesel Particulate Filter Exhaust Differential Pressure Sensor.
3. 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**
4. Ignition ON, test for 4.8 - 5.2 V between the 5 V reference circuit terminal 3 and ground.
   - **If less than 4.8 V**
   1. Ignition OFF, disconnect the X3 harness 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 in the circuit.
      - Go to next step: 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 X3 harness connector at the K20 Engine Control Module.
   2. Test for less than 1 V in the 5 V reference circuit end to end.
      - If 1 V or greater, repair the short to voltage in 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 Diesel Particulate Filter Differential Pressure Sensor parameter is greater than 4.8 V.
   - **If 4.8 V or less**
   1. Ignition OFF, disconnect the X3 harness connector at the K20 Engine Control Module.
   2. 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 K20 Engine Control Module.
      - **Go to next step: If greater than 4.8 V**
6. Install a 3 A fused jumper wire between the signal circuit terminal 1 and ground. Verify the scan tool Diesel Particulate Filter differential pressure sensor parameter is less than 1 V.

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- **If greater than 1 V**

1. Ignition OFF, disconnect the X3 harness connector at the K20 Engine Control Module.
2. Test for less than 1 V in the signal circuit end to end.
    - If 1 V or greater, repair the short to voltage in the circuit.
    - Go to next step: If less than 1 V
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.

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

  Go to next step: Replace the B154 Diesel Particulate Filter Exhaust Differential Pressure Sensor.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Exhaust Pressure Differential Sensor Replacement**
- **Control Module References** for engine control module replacement, programming, and setup.

DTC P2457

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.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P2457

Exhaust Gas Recirculation (EGR) Cooling System Performance

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, P0101, P0102, P0103, 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 voltage is greater than 11 V.
- The EGR temperature sensor 1 is between 95-850B°C (203-1, 562B°F).
- The barometric pressure is greater than 70 kPa (10.2 psi).
- The outside air temperature is warmer than -7B°C (19.4B°F).
- The engine coolant temperature is between 70-130B°C (158 - 266B°F).
- The engine speed is between 560-3, 100 RPM.

The DTC runs once per ignition cycle.

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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

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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, P0101, P0102, P0103, 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

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- **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
      - Go to next step: 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.

Exhaust Gas Recirculation Cooler Replacement

DTC P2459

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.
- **Diagnostic Procedure Instructions** provides 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

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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

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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**

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1. Perform the Diesel Particulate Filter Service Regeneration.
2. Verify the regeneration completed.
    - If the regeneration did not complete, replace the Diesel Particulate Filter.
    - Go to next step: If the regeneration completed

      Go to next step: 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.

Exhaust Particulate Filter Replacement (LWN)

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

DTC P245A-P245D

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.
- **Diagnostic Procedure Instructions** provides 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 11V.
- These DTCs run when the above conditions are met.

Conditions for Setting the DTC

P245A

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The ECM detects an open circuit in the control 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

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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

EN-23738-A Mityvac

For equivalent regional tools, refer to **Special Tools ((Diagnosis Tools))** .

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).

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- **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.
        - Go to next step: 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.

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2. Test for infinite resistance between the ignition circuit and ground.
    - If less than infinite resistance, repair the short to ground on the circuit.
    - Go to next step: 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.

Control Module References for engine control module replacement, programming, and setup.

DTC P2463

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.
- **Diagnostic Procedure Instructions** provides 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.

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Conditions for Running the DTC

- DTC P00C7, P00E9, P00EA, P00EB, P00EC, P0101, P0102, P0103, P0106, P0107, P0108, P0116, P0117, P0118, P0119, P0128, P0201, P0202, P0203, P0204, P020A, P020B, P020C, P020D, P0216, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P02EE, P02EF, P02F0, P02F1, P0405, P0406, P049D, P062B, P062D, P113E, P1197, P1248, P1249, P124A, P124B, P126A, P2147, P2148, P2150, P2151, P2227, P2228, P2229, P2230, P2452 - P2456, P2470, P2471, or P2472 is not set
- Ambient temperature is warmer than -40B°C (-40B°F)
- Engine speed is greater than 800 RPM
- Engine coolant temperature is warmer than 40B°C (104B°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

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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**

      Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**

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

3. 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**
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 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 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 (Induction System Smoke Test)**, or **Charge Air Cooler Diagnosis (Full System Air Leak 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-P0103** .
   - 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.

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- Q67 Exhaust Aftertreatment Fuel Injector leaking or restricted - Refer to **Exhaust Aftertreatment Fuel Injector Diagnosis**.
- 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.

Exhaust Particulate Filter Replacement (LWN)

DTC P24A0 OR P24A1

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.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P24A0

Closed Loop Diesel Particulate Filter (DPF) Regeneration Control At Limit - Low Temperature

DTC P24A1

Closed Loop Diesel Particulate Filter (DPF) Regeneration Control At Limit - High Temperature

Circuit/System Description

The diesel exhaust aftertreatment system consists of an under hood pre-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 the exhaust aftertreatment fuel injector in order to increase the exhaust gas temperature. During this period, the DPF temperature is raised to approximately 600B°C (1 112B°F) and the accumulated soot is oxidized or burned off into carbon dioxide (CO2).

Conditions for Running the DTCs

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- DTC P00C7, P00E9, P00EA, P00EB, P00EC, P0101, P0102, P0103, P0106, P0107, P0108, P0116, P0117, P0118, P0119, P0128, P0201, P0202, P0203, P0204, P020A, P020B, P020C, P020D, P0216, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P02EE, P02EF, P02F0, P02F1, P0405, P0406, P049D, P0502, P0503, P062B, P062D, P0722, P0723, P111E, P113E, P1197, P1248, P1249, P124A, P124B, P126A, P2147, P2148, P2150, P2151, P2470, P2471, or P2472 is not set.
- Ignition voltage is greater than 11 V.
- Vehicle speed is greater than 3 km/h (2 mph).
- The ECM is commanding a DPF regeneration.

The DTCs run continuously when the above conditions are met.

Conditions for Setting the DTC

P24A0

The ECM detects insufficient exhaust temperature upstream of the DPF during a DPF regeneration.

P24A1

The ECM detects greater than desired exhaust temperature upstream of the DPF during a DPF regeneration.

Action Taken When the DTC Sets

DTCs P24A0 and P24A1 are Type B DTCs.

Conditions for Clearing the DTC

DTCs P24A0 and P24A1 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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

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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, P0202, P0203, P0204, P020A, P020B, P020C, P020D, P0216, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P02EE, P02EF, P02F0, P02F1, P0405, P0406, P049D, P0502, P0503, P062B, P062D, P0722, P0723, P111E, P113E, P1197, P1248, P1249, P124A, P124B, P126A, P2147, P2148, P2150, P2151, P2470, P2471, or P2472 is not set.
   - **If a DTC is set**

     Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

   - **Go to next step: If a DTC is not set**
3. Verify that the resistance of the B131 Exhaust Gas Temperature Sensor 3 and 4 is within the range specified in **Temperature Versus Resistance - Exhaust Gas Temperature Sensor**
   - **If not within the specified range**

     Replace the appropriate B131 Exhaust Gas Temperature Sensor

   - **Go to next step: If within the specified range**
4. Verify the following conditions do not exist:
   - Improperly operating exhaust aftertreatment fuel injector. Refer to **Exhaust Aftertreatment Fuel Injector Diagnosis**
   - Exhaust system leaks - Refer to **Exhaust Leakage** .
   - A loose or disconnected charge air cooler hose or pipe
   - Loose or missing induction or exhaust system components
   - **If a condition is found**

     Repair as necessary.

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

     Replace the exhaust particulate filter.

   - **Go to next step: If the regeneration completed**
7. 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.
8. Verify the DTC does not set.
   - **If a DTC sets**

     Replace the exhaust particulate filter.

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

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Exhaust Particulate Filter Replacement (LWN)

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

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DTC P24A4

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.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P24A4

Diesel Particulate Filter (DPF) Soot Accumulation Excessive

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, P00EB, P00EC, P0101, P0102, P0103, P0106, P0107, P0108, P0116, P0117, P0118, P0119, P0128, P0201, P0202, P0203, P0204, P020A, P020B, P020C, P020D, P0216, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P02EE, P02EF, P02F0, P02F1, P0405, P0406, P049D, P062B, P062D, P113E, P1197, P1248, P1249, P124A, P124B, P126A, P2147, P2148, P2150, P2151, P2227, P2228, P2229, P2230, P2452 - P2456, P2470, P2471, or P2472 is not set
- Ambient temperature is warmer than -40B°C (-40B°F)
- Engine speed is greater than 800 RPM
- Engine coolant temperature is warmer than 40B°C (104B°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.

Action Taken When the DTC Sets

DTC P24A4 is a Type A DTC.

Conditions for Clearing the DTC

DTC P24A4 is a Type A DTC.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **Component Connector End Views - Index**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**

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- **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 P00C7, P00E9, P00EA, P00EB, P00EC, P0101, P0102, P0103, P0106, P0107, P0108, P0116, P0117, P0118, P0119, P0128, P0201, P0202, P0203, P0204, P020A, P020B, P020C, P020D, P0216, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P02EE, P02EF, P02F0, P02F1, P0405, P0406, P049D, P062B, P062D, P113E, P1197, P1248, P1249, P124A, P124B, P126A, P2147, P2148, P2150, P2151, P2227, P2228, P2229, P2230, P2452 - P2456, P2470, P2471, or P2472 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 following conditions do not exist:
   - Exhaust system leaks - Refer to **Exhaust Leakage** .
   - Aftermarket engine calibration
   - **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 exhaust particulate filter.

   - **Go to next step: If the regeneration completed**
6. Verify DTC P24A4 is not set.
   - **If the DTC is set**

     Replace the Diesel Particulate Filter.

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

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Exhaust Particulate Filter Replacement (LWN)

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

DTC P24A5

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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.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P24A5

Exhaust Gas Recirculation (EGR) Cooler Bypass Control 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

- DTC P0071, P0072, P0073, P0074, P0101, P0102, P0103, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0119, P011E, P0128, P245A, P245C, or P245D is not set.
- Engine coolant temperature is warmer than 70B°C (158B°F).
- Ignition voltage is greater than 11 V.
- The outside air temperature is warmer than -23B°C (-9B°F).

The DTC runs 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 MIL/DTC

DTC P24A5 is a Type B DTC.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **Component Connector End Views - Index**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**

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

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition On.
2. Verify DTC P0071, P0072, P0073, P0074, P0101, P0102, P0103, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0119, P011E, P0128, 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

   - Go to next step: 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**

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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.

Exhaust Gas Recirculation Cooler Replacement

DTC P24B0-P24B6, P24C7, P24D0, OR P24D1

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 P24B0

Particulate Matter Sensor Circuit Low Voltage

DTC P24B1

Particulate Matter Sensor Circuit High Voltage

DTC P24B3

Particulate Matter Sensor Heater Control Circuit

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

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For an overview of the component/system, refer to **Exhaust Aftertreatment System Description**

Component	Description
B136 Exhaust Particulate Matter Sensor	The sensor measures the particulate matter in the form of soot in the exhaust.
K115 Reductant Control Module	The control module controls the heating and dosing of the reductant.

The actual sensor surface is only a few square millimeters in size. On the surface there are 2 microscopic comb-shaped electrodes with intertwined tines (electrical traces) to have the longest possible route of transitions from one to the other electrode. Soot is conductive, therefore when soot deposits between the electrodes, electrical current can flow from one electrode to the other. The more soot deposits between the electrodes, the lower the resistance. To measure the resistance, voltage is applied to the electrodes. The voltage also generates an electrical field that attracts the soot. If the sensor surface is saturated, the sensor is electrically heated to burn off the soot.

Conditions for Running the DTC

P24B0

- DTC P142C, P142D, P142E, P142F, P1474, P1475, P1476, P1477, P1478, P16D7, P16D8, P16D9, P24B0, P24B1, P24B3, P24B5, P24B6, P24D0, U02A3 = Not set
- Ignition On
- Ignition Voltage = Greater than 11 V
- Reductant Control Module Relay = ON
- Particulate Matter Sensor = 560 to 800B°C (1, 040 to 1, 472B°F)

Frequency the DTC runs = Continuously - After the running conditions are met

P24B1, P24B3, P24B5, P24B6, P24D0

- DTC P16D7, P16D8, P16D9, P24D0, U02A3 = Not set
- Ignition On
- Ignition Voltage = Greater than 11 V
- Reductant Control Module Relay = ON

Frequency the DTC runs = Continuously - After the running conditions are met

P24C7

- DTC P24B0, P24B1, P24D0, U02A3 = Not set
- Ambient Air Temperature = Warmer than -20B°C (-4B°F)
- Barometric Pressure = Greater than 55 kPa (7.9 PSI)
- Ignition On
- Ignition Voltage = Greater than 11 V
- Particulate Matter Sensor Operation = Allowed
- Reductant Control Module Relay = ON
- Time since diagnostic ran last = DPF Regeneration - Greater than 300 s

Frequency the DTC runs = Continuously - After the running conditions are met

P24D1

- DTC P16D7, P16D8, P16D9, P24D0, U02A3 = Not set

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- Ignition On
- Ignition Voltage = Greater than 11 V
- Reductant Control Module Relay = ON
- Particulate Matter Sensor Operation = Allowed
- Time since diagnostic ran last = DPF Regeneration - Greater than 150 s

Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

P24B0, P24B3, P24D1

The control module detects an open circuit or Internal Malfunction - Sensor

P24B1, P24B6

The control module detects a short to voltage.

P24B5

The control module detects a short to ground.

P24C7

Particulate Matter Sensor Temperature = Not within a calibrated range

P24D0

Control module K115 detects: = Supply Voltage Out of Range

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

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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

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Scan Tool Reference

Control Module References

Circuit/System Verification

1. Verify there are no DTCs set related to the following component/system:
    - B9 Ambient Air Temperature Sensor
    - B34 Engine Coolant Temperature Sensor
    - B74 Manifold Absolute Pressure Sensor
    - B75C Multifunction Intake Air Sensor
    - Q17 Fuel Injector
    - Q38 Throttle Body
    - Communication Interface Module
    - **If a related DTC is set**

      Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**

    - **Go to next step: If a related DTC is not set**
2. Verify DTC P24D0 is not set.
    - **If the DTC sets**

      Refer to: Circuit/System Testing

    - **Go to next step: If the DTC is not set**
3. Verify DTC P24B0, P24B1, P24B3, P24B5, P24B6, P24C7, P24D1 is not set.
    - **If the DTC sets**

      Replace the component: B136 Exhaust Particulate Matter Sensor

    - **Go to next step: If the DTC is not set**
4. All OK.

Circuit/System Testing

1. Ignition/Vehicle - Off
2. Disconnect the electrical connector: B136 Exhaust Particulate Matter Sensor
3. Connect a test lamp between the test points: Ignition circuit terminal 6 & Ground
4. Ignition - On / Vehicle - In Service Mode
5. Verify the test lamp turns On.
    - **If the test lamp does not turn On**
    1. Ignition/Vehicle - Off & Remove - Test lamp & Fuse
    2. Test for less than 2 ohms between the test points: Ignition circuit terminal 6 & The other end of the circuit
        - If 2 ohms or greater - Repair the open/high resistance in the circuit.
        - Go to next step: If less than 2 ohms
    3. Test for infinite resistance between the test points: Ignition circuit terminal 6 & Ground
    - If less than infinite resistance - Repair the short to ground on the circuit.
    - If infinite resistance - Replace the component: B136 Exhaust Particulate Matter Sensor
    - **Go to next step: If the test lamp turns On**
6. Test or replace the component: B136 Exhaust Particulate Matter Sensor

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Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Exhaust Particulate Matter Sensor Replacement**
- For control module replacement, programming, and setup refer to **Control Module References**

DTC P2564, P2565, OR U0656

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

DTC U0656

Lost Communication with Turbocharger/Supercharger Boost Control Position Sensor

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P0641**, U0656**	P2565*, U0656	P0641**, U0656**	-
Serial Data	U0656**	U0656	U0656**	-
Low Reference	-	P2564*, U0656	-	-
*This DTC sets when there is an internal component issue: M103 Turbocharger Vane Position Actuator **Additional DTCs may set.				

Typical Scan Tool Data

Turbocharger Vane Position Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: • Engine = Running • Accessories = Off **Parameter Normal Range:** 3 to 4 V			
5 V Reference	0.0 V	3.5 V	3.5 V
Serial Data	2.8 V	0.0 V	2.9 V
Low Reference	-	0.0 V	-

Circuit/System Description

For an overview of the component/system, refer to **Compressor Air Intake Turbocharger System Description**

Circuit	Description
5 V Reference	Regulated voltage supplied by the control module.
Serial Data	The control module input circuit has an internal resistance connected to 5 V. Digitally encoded information for communication between devices.
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.
M103 Turbocharger Vane Position Actuator	The assembly has several functions: • The valve is actuated by a 12 V DC motor. A spring is used to keep the valve in the open position. The valve actuator motor moves the valve in the closed direction. The more current flows through the motor, the more the valve closes. • The component M103 contains a contactless inductive position sensor. A fixed transmitter coil excites a movable rotor, which in turn induces a current in a fixed receiver coil. The current varies with the angle of the rotor. Electronics inside the sensor convert the current into digital data which is transmitted via a serial data circuit to the control module K20.

Conditions for Running the DTC

P2564, P2565

- DTC U0656 = Not set
- Engine Cranking
- Ignition = On or Engine = Running
- Ignition Voltage = Greater than 11 V

Frequency the DTC runs = Continuously - After the running conditions are met

U0656

Ignition = On or Engine = Running

Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

P2564

Turbocharger Vane Position Sensor = Less than 10% - For greater than 1 s

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P2565

Turbocharger Vane Position Sensor = Greater than 90% - For greater than 1 s

U0656

Serial Data circuit = Message Counter Incorrect/Too Many Pulses/Too Few Pulses - For greater than 1 s

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type A DTC

- Reduced Engine Power = Active
- P16 Instrument Cluster = Reduced Engine Power
- Warning Message = Service Emission System/Service Exhaust Fluid System

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 the DTC to set.
- A weak battery may cause this DTC to set.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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 DTC P0641, P0651, P0697, or P06A3 is not set.
    - **If any of the DTCs are set**

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

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

3. Verify DTC P2564, P2565, U0656 is not set.
    - **If only DTC P2564, P2565 is set**

      Replace the component: M103 Turbocharger Vane Position Actuator

    - **If DTC U0656 and one or more of the DTCs P2564, P2565 is set**

      Refer to: Circuit/System Testing

    - **Go to next step: If none of the DTCs are set**
4. Perform the scan tool control function: Turbocharger Vane Position - Increase & Decrease

   Verify the scan tool parameter: Turbocharger Vane Position Sensor = Desired Turbocharger Vane Position

    - **If not the specified state**

      Refer to: Circuit/System Testing

    - **Go to next step: If the specified state**
5. Verify the scan tool parameter: Turbocharger Vane Position Sensor = The value should not spike or drop out.

   Perform the action while monitoring the parameter:

    - Wiggle the harness and connector: M103 Turbocharger Vane Position Actuator
    - 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**
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.

   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:

- **Disconnecting the component electrical connector causes additional DTCs to set.**
- **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: M103 Turbocharger Vane Position Actuator
3. Test for less than 5 ohms between the test points: Low Reference circuit terminal 3 & Ground

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- **If 5 ohms or greater**

1. Disconnect the appropriate electrical connector: K20 Engine Control Module
2. Test for less than 2 ohms between the test points: Low 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

- **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 5 & Low Reference circuit terminal 3
    - **If less than 4.8 V**

    1. Ignition/Vehicle - Off
    2. Disconnect the appropriate electrical connector: K20 Engine Control Module
    3. Test for infinite resistance between the test points: 5 V Reference circuit terminal 5 @ Component harness & Ground
        - If less than infinite resistance - Repair the short to ground on the circuit.
        - Go to next step: If infinite resistance
    4. Test for less than 2 ohms between the test points: 5 V 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

    - **If greater than 5.2 V**

    1. Ignition/Vehicle - Off
    2. Disconnect the appropriate 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 5 @ 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. Test for 3.75 to 4.25 V between the test points: Serial Data circuit terminal 4 @ Component harness & Ground
    - **If less than 3.75 V**

    1. Ignition/Vehicle - Off
    2. Disconnect the appropriate electrical connector: K20 Engine Control Module
    3. Test for infinite resistance between the test points: Serial Data circuit terminal 4 @ Component harness & Ground
        - If less than infinite resistance - Repair the short to ground on the circuit.
        - Go to next step: If infinite resistance
    4. Test for less than 2 ohms between the test points: Serial Data circuit terminal 4 @ 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 4.25 V**

    1. Ignition/Vehicle - Off
    2. Disconnect the appropriate electrical connector: K20 Engine Control Module
    3. Ignition - On / Vehicle - In Service Mode

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4. Test for less than 1 V between the test points: Serial Data circuit terminal 4 @ Component harness & Ground
    - If 1 V or greater - Repair the short to voltage on the circuit.
    - Go to next step: If less than 1 V - Replace the component: K20 Engine Control Module
- **Go to next step: If between 3.75 and 4.25 V**

7. Test or replace the component: M103 Turbocharger Vane Position Actuator

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Compressor Air Intake Turbocharger Replacement** - M103 Turbocharger Vane Position Actuator
- For control module replacement, programming, and setup refer to **Control Module References**

Additional Procedures

BARO Sensor Reset - Perform only when the following component/system is replaced or serviced: K20 Engine Control Module

NOTE: **The DTC causing the Driver Information Center message/speed limitation to set must run and pass before the message/speed limitation will clear. This may require driving the vehicle.**

1. Ignition - On / Vehicle - In Service Mode
2. Verify that all scan tool Event Data parameters under the following data list displays No: Exhaust Gas Recirculation System Malfunction Warning Event Data
    - **If not the specified state**

      Operate the vehicle within the Conditions for Running the DTC for the Event Data parameter that displays Yes.

    - **Go to next step: If the specified state**
3. All OK.

DTC P25BD

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 P25BD

Unmetered Fuel - Forced Engine Shutdown

Circuit/System Description

This DTC sets when the control module detects the engine speed increased beyond the desired control limits when no fuel is being delivered.

Conditions for Running the DTC

Engine Speed = Greater than 1, 500 RPM

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Frequency the DTC runs = Continuously - After the running conditions are met - For greater than 10 s

Conditions for Setting the DTC

Engine Speed = Greater than 5, 200 RPM & Fuel Pressure Regulator = Off - For greater than 1 s

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type A DTC

- Q17 Fuel Injector - All = Commanded Off
- Q20 Intake Air Flow Valve = Closed

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type A DTC

Diagnostic Aids

The following conditions could cause the DTC to set:

- Aftermarket equipment/accessories: Exhaust System/Fuel System/Induction System
- Engine oil overfilled
- Engine oil sludge build-up.
- Starting fluid use or alternative fuel added to the engine such as ether.

Reference Information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References

Circuit/System Verification

NOTE: **After determining what caused the DTC, verify there's no engine mechanical condition.**

1. Ignition - On / Vehicle - In Service Mode
2. Verify there are no DTCs set related to the following component/system:
   - B23 Camshaft Position Sensor
   - B26 Crankshaft Position Sensor
   - Q17 Fuel Injector
   - Fuel System
   - **If a related DTC is set**

     Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**

   - **Go to next step: If a related DTC is not set**
3. Verify the condition does not exist: Engine Oil - Fill Level = Overfull
   - **If the condition exists**
   1. Ignition/Vehicle - Off
   2. Verify the following conditions do not exist:

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- Q17 Fuel Injector - Leaking
- Aftermarket equipment/accessories: Calibration/Software/Fuel System
- Engine Oil - Contaminated
- Fuel System - Modified
- If a condition exists - Repair or replace as necessary
- If no condition exists - Refer to: Diagnostic Aids

- **Go to next step: If no condition exists**

4. Verify the following conditions do not exist:
   - Positive Crankcase Ventilation Pipe or Positive Crankcase Ventilation Tube - Blocked/Ice/Kinked/Leaking/Restricted/Visible Damage
   - Positive Crankcase Ventilation Valve Orifice - Blocked/Restricted/Visible Damage
   - Positive Crankcase Ventilation Oil Separator - Blocked/Kinked/Leaking/Restricted/Visible Damage
   - **If a condition exists**

     Repair or replace as necessary

   - **Go to next step: If no condition exists**
5. Engine - Running
6. Verify there is no abnormal noise from the component: Engine
   - **If an abnormal noise is present**

     Refer to **Symptoms - Engine Mechanical**

   - **Go to next step: If no abnormal noise is present**
7. Verify the following conditions do not exist:
   - Excessive engine oil @ Charge Air Cooler
   - Excessive engine oilor Excessive Smoke @ Exhaust System
   - Excessive engine oil @ Induction System/Intake Runners
   - **If a condition exists**

     Replace the component: Turbocharger

   - **Go to next step: If no condition exists**
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.

   Verify the DTC does not set.

   - **If the DTC sets**

     Repeat the procedure starting at step 1

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

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

For control module replacement, programming, and setup refer to **Control Module References**

DTC P2627 OR P2628

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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.
- **Diagnostic Procedure Instructions** provides 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-P0204, P020A-P020D, P0216, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P02EE, P02EF, P02F0, P02F1, P0405, P0406, P049D, P0545, P0546, 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, P124B, P126A, P2032, P2033, P2081, P2085, P2200, P2205,

P2206, P2207, P2208, P2209, P2210, P220A, P2211, P2147, P2148, P2150, P2151, P2227, P2228, P2229, P2230, P242C, P242D, P242E, P2452-P2456, P2481, P2482, or P2484 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

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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 P00C7, P00E9, P00EA, P00EB, P00EC, P0101, P0102, P0103, P0106, P0107, P0108, P0116, P0117, P0118, P0119, P0128, P0201-P0204, P020A-P020D, P0216, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P02EE, P02EF, P02F0, P02F1, P0405, P0406, P049D, P0545, P0546, 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, P124B, P126A, P2032, P2033, P2081, P2085, P2200, P2205, P2206, P2207, P2208, P2209, P2210, P220A, P2211, P2147, P2148, P2150, P2151, P2227, P2228, P2229, P2230, P242C, P242D, P242E, P2452-P2456, P2481, P2482, or P2484 is not set.

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- **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.

Nitrogen Oxides Sensor Replacement - Position 1

Perform the scan tool **NOx Sensor 1 Reset** after replacing the Nitrogen Oxides Sensor Position 1 replacement.

DTC P2687-P2689

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 P2687

Fuel Heater Relay Control Circuit

DTC P2688

Fuel Heater Relay Control Circuit Low Voltage

DTC P2689

Fuel Heater Relay Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition - Relay Coil	P2688	P2687	-	-
B+ - Relay Switch	*	***	-	-

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Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Control - Component	*	***	**	-
Control - Relay Coil	P2688**	P2687***	P2689***	-
Ground - Component	-	***	***	-
*Opens the fuse that supplies voltage to the component. **Component = Always On ***Component = Always Off				

Typical Scan Tool Data

Fuel Heater Relay Control Circuit High Voltage Test Status

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition = On **Parameter Normal Range:** Not Run/OK			
Ignition - Relay Coil	Not Run/OK	Not Run/OK	Not Run/OK
Control - Relay Coil	Not Run/OK	Not Run/OK	Malfunction

Fuel Heater Relay Control Circuit Low Voltage Test Status

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition = On **Parameter Normal Range:** Not Run/OK			
Ignition - Relay Coil	Not Run/OK	Not Run/OK	Not Run/OK
Control - Relay Coil	Malfunction	Not Run/OK	Not Run/OK

Fuel Heater Relay Control Circuit Open Test Status

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition = On **Parameter Normal Range:** Not Run/OK			
Ignition - Relay Coil	Not Run/OK	Not Run/OK	Not Run/OK
Control - Relay Coil	Not Run/OK	Malfunction	Not Run/OK

Circuit/System Description

For an overview of the component/system, refer to **Fuel System Description**

Circuit	Description
Ignition - Relay Coil	Supplied from a relay.
B+ - Relay Switch	Supplied from a fuse.
Control - Component	The output circuit is switched to 12 V to activate the component.
Control - Relay Coil	The output circuit is switched to ground to activate the component.
Ground - Component	Chassis Ground

Component	Description
KR22 Fuel Heater Relay	A relay is a switch that is actuated by a solenoid.
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.

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Conditions for Running the DTC

- Battery Voltage = Greater than 11 V
- Ignition = On or Engine = Running

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 C DTC

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type C DTC

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **Component Connector End Views - Index**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Electrical Relay Replacement (Attached to Wire Harness)** , or **Electrical Relay Replacement (Within an Electrical Center)**
- **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. Perform the scan tool control function: Fuel Heater Relay - On and Off

   Verify the scan tool parameter:

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

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Refer to: Circuit/System Testing

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

3. Perform the scan tool control function: Fuel Heater Relay - On and Off

   Verify a click can be heard or felt at the following component(s) when the scan tool control function was commanded: KR22 Fuel Heater Relay

   - **If a click cannot be heard or felt**

     Refer to: Circuit/System Testing

   - **Go to next step: If a click can be heard or felt**

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.

   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**

5. All OK.

Circuit/System Testing

1. Ignition/Vehicle & All vehicle systems - Off
2. Remove the component: KR22 Fuel Heater Relay
3. Ignition - On / Vehicle - In Service Mode
4. Verify a test lamp turns On between the test points: Ignition circuit terminal 85 & Ground
   - **If the test lamp does not turn On**
   1. Ignition/Vehicle - Off & Remove - Test lamp
   2. Remove the component: KR75 Engine Controls Ignition Relay
   3. Test for less than 2 ohms between the test points: Ignition circuit terminal 85 @ KR22 Fuel Heater Relay - Relay Socket & Control circuit terminal 87 @ KR75 Engine Controls Ignition Relay - Relay Socket
      - If 2 ohms or greater - Repair the open/high resistance in the circuit.
      - If less than 2 ohms - Verify the fuse is OK and there is voltage at the fuse.
   - **Go to next step: If the test lamp turns On**
   1. Ignition/Vehicle - Off & Remove - Test lamp
   2. Test for infinite resistance between the test points: Ignition circuit terminal 85 & Ground
      - If less than infinite resistance - Repair the short to ground on the circuit.
      - If infinite resistance - Replace the component: KR22 Fuel Heater Relay
   - **Go to next step: If the test lamp turns On**
5. Verify a test lamp does not turn On between the test points: Control circuit terminal 86 & B+
   - **If the test lamp turns On**
   1. Ignition/Vehicle - Off & Remove - Test lamp
   2. Disconnect the electrical connector: X3 @ K20 Engine Control Module
   3. Test for infinite resistance between the test points: Control circuit terminal 86 @ Relay Socket & Ground
      - If less than infinite resistance - Repair the short to ground on the circuit.
      - If infinite resistance - Replace the component: K20 Engine Control Module

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- **Go to next step: If the test lamp does not turn On**

6. Remove - Test Lamp
7. Perform the scan tool control function: Fuel Heater Relay - On

   Verify the scan tool parameter: Fuel Heater Relay Control Circuit High Voltage Test Status = OK

   - **If not the specified state**
   1. Ignition/Vehicle - Off
   2. Disconnect the electrical connector: X3 @ 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 86 @ Relay Socket & 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**
8. Connect a 3 A fused jumper wire between the test points: Control circuit terminal 86 & Ignition circuit terminal 85
9. Perform the scan tool control function: Fuel Heater Relay - On

   Verify the scan tool parameter: Fuel Heater Relay 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: X3 @ K20 Engine Control Module
   3. Test for less than 2 ohms between the test points: Control circuit terminal 86 @ Relay Socket & Terminal 45 @ 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 specified state**
10. Verify a test lamp turns On between the test points: Ignition circuit terminal 87 & Ground
    - **If the test lamp does not turn On and the circuit fuse is OK**
    1. Ignition/Vehicle - Off & Remove - Test lamp
    2. Test for less than 2 ohms between the test points: Ignition circuit terminal 87 @ Relay Socket & Output terminal @ X50A Fuse Block - Underhood F44UA Fuse
       - If 2 ohms or greater - Repair the open/high resistance in the circuit.
       - If less than 2 ohms - Verify the fuse is OK and there is voltage at the fuse.
    - **If the test lamp does not turn On and the circuit fuse is open**
    1. Ignition/Vehicle - Off & Remove - Test lamp
    2. Test for infinite resistance between the test points: Ignition circuit terminal 87 & Ground
       - If less than infinite resistance - Repair the short to ground on the circuit.
       - Go to next step: If infinite resistance
    3. Disconnect the electrical connector: K20 Engine Control Module
    4. Test for infinite resistance between the test points: Control circuit terminal 30 @ Relay Socket & Ground
       - If less than infinite resistance - Repair the short to ground on the circuit.
       - Go to next step: If infinite resistance
    5. Replace the component: E11A Fuel Heater/Water in Fuel Sensor F44UA Fuse
    6. Install the component: KR22 Fuel Heater Relay

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7. Connect a test lamp between the test points: Control circuit terminal 4 & Ground circuit terminal 3
8. Ignition - On / Vehicle - In Service Mode
9. Perform the scan tool control function: Fuel Heater Relay - On and Off

   Verify the test lamp turns On and Off.

   - If the test lamp does not turn On and Off - Test or replace the component: KR22 Fuel Heater Relay
   - If the test lamp turns On and Off - Test or replace the component: E11A Fuel Heater/Water in Fuel Sensor

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

11. Ignition/Vehicle & All vehicle systems - Off
12. Install the component: KR22 Fuel Heater Relay
13. Disconnect the electrical connector: E11A Fuel Heater/Water in Fuel Sensor
14. Test for less than 10 ohms between the test points: Ground circuit terminal 3 & Ground
    - **If 10 ohms or greater**
    1. Disconnect the ground connection: G404
    2. Test for less than 2 ohms between the test points: Ground circuit terminal 3 @ Component harness & Terminal G404
       - If 2 ohms or greater - Repair the open/high resistance in the circuit.
       - If less than 2 ohms - Repair the open/high resistance in the ground connection.
    - **Go to next step: If less than 10 ohms**
15. Connect a test lamp between the test points: Control circuit terminal 4 & Ground circuit terminal 3
16. Ignition - On / Vehicle - In Service Mode
17. Perform the scan tool control function: Fuel Heater Relay - On and Off

    Verify the test lamp turns On and Off.

    - **If the test lamp is always Off**

      Repair the open/high resistance in the circuit: Control Circuit

    - **If the test lamp is always On**

      Repair the short to voltage on the circuit: Control Circuit

    - **Go to next step: If the test lamp turns On and Off**
18. Test or replace the component: E11A Fuel Heater/Water in Fuel Sensor

Component Testing

Relay Test

1. Ignition/Vehicle - Off
2. Remove the component: KR22 Fuel Heater Relay
3. Test for 70 to 110 ohms between the test points: Component terminal 85 & 86
   - **If not between 70 and 110 ohms**

     Replace the component: KR22 Fuel Heater Relay

   - **Go to next step: If between 70 and 110 ohms**
4. Test for infinite resistance between the test points:
   - Component terminal 30 & 85

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- Component terminal 30 & 86
- Component terminal 30 & 87
- Component terminal 85 & 87
- **If less than infinite resistance**

  Replace the component: KR22 Fuel Heater Relay

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

5. Connect a 3 A fused jumper wire between the test points: Component terminal 86 & 12 V

   Connect a jumper wire between the test points: Component terminal 85 & Ground

6. Test for less than 2 ohms between the test points: Component terminal 30 & 87
   - **If 2 ohms or greater**

     Replace the component: KR22 Fuel Heater Relay

   - **Go to next step: If less than 2 ohms**
7. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Fuel Filter Assembly Replacement** - E11A Fuel Heater/Water in Fuel Sensor
- **Electrical Relay Replacement (Attached to Wire Harness)** , or **Electrical Relay Replacement (Within an Electrical Center)**
- For control module replacement, programming, and setup refer to **Control Module References**

DTC P268C-P268F

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 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

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This diagnostic applies to microprocessor integrity conditions within the control module. This diagnostic also checks if the control module is not programmed, or is programmed incorrectly.

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

Actions 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

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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 P268C, P268D, P268E, P268F is not set.
    - **If the DTC sets**
    1. Perform the following learn procedure: **Fuel Injector Flow Rate Programming**
    2. Verify the DTC does not set.
        - If the DTC sets - Replace the component: K20 Engine Control Module
        - Go to next step: If the DTC does not set
    3. All OK.
    - **Go to next step: If the DTC is not set**
3. All OK.

Repair Instructions

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Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

For control module replacement, programming, and setup refer to **Control Module References**

DTC P2ADA-P2ADD

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 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

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P2ADB	P2ADC	P2ADC	P2ADD
Serial Data	P2ADB	P2ADC	P2ADC	P2ADA
Low Reference	-	P2ADC	P2ADC	P2ADD

Circuit/System Description

For an overview of the component/system, refer to **Exhaust Aftertreatment System Description**

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

Component	Description
B212 Reductant Sensor Module	The sensor sends measured values and state of health information via serial data to the ECM and the reductant control module.
K115 Reductant Control Module	The control module controls the heating and dosing of the reductant.

Conditions for Running the DTC

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P2ADA

- DTC P1015, P1016, P1017, P1018, P1019, P262B, P2ADB, P2ADC, P2ADD, U010E = Not set
- Ignition = On
- Ignition Voltage = Greater than 11 V
- Ignition = Off - For greater than 8 h

Frequency the DTC runs = Once - Per ignition cycle - After the running conditions are met

P2ADB, P2ADC

- DTC P1015, P1016, P1017, P1018, P1019, P101A, U010E = Not set
- Ignition = On
- Ignition Voltage = Greater than 11 V
- Reductant Control Module = Inactive

Frequency the DTC runs = Continuously - After the running conditions are met

P2ADD

- DTC P1015, P1016, P1017, P1018, P1019, P101A, P206C, P206D, U010E = Not set
- Ignition = On
- Ignition Voltage = Greater than 11 V
- Reductant Control Module = Inactive

Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

P2ADA, P2ADD

Not within a calibrated range - For greater than 1 s

P2ADB

Serial Data circuit = Short to Ground - For greater than 1 s

P2ADC

Serial Data circuit = Short to Voltage - For greater than 1 s

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type A DTC

- The control module uses default replacement values.
- Warning = Service Emission Systemor Service Exhaust Fluid System

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type A DTC

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

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Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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 the scan tool parameter: Reductant Quality Sensor Status = OK or Not Ready
   - **If not the specified state**

     Refer to: Circuit/System Testing

   - **Go to next step: If the specified state**
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/Vehicle & All vehicle systems - Off
2. Disconnect the electrical connector: B212 Reductant Sensor Module
3. Ignition - On / Vehicle - In Service Mode
4. Test for less than 20 ohms between the test points: Low Reference circuit terminal 3 & Ground
   - **If 20 ohms or greater**
   1. Ignition/Vehicle - Off
   2. Disconnect the electrical connector: X2 @ K115 Reductant Control Module
   3. Test for less than 2 ohms between the test points: Low Reference circuit terminal 3 @ Component harness & Terminal 6 X2 @ Control module harness
      - If 2 ohms or greater - Repair the open/high resistance in the circuit.
      - If less than 2 ohms - Replace the component: K115 Reductant Control Module
   - **Go to next step: If less than 20 ohms**

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5. Test for 4.8 to 5.2 V between the test points: 5 V Reference circuit terminal 1 & Low Reference circuit terminal 3
    - **If less than 4.8 V**
    1. Ignition/Vehicle - Off
    2. Disconnect the electrical connector: K115 Reductant Control Module
    3. Test for infinite resistance between the test points: 5 V Reference circuit terminal 1 @ Component harness & Ground
        - If less than infinite resistance - Repair the short to ground on the circuit.
        - Go to next step: If infinite resistance
    4. Test for less than 2 ohms between the test points: 5 V Reference circuit terminal 1 @ Component harness & Terminal 19 X2 @ Control module harness
        - If 2 ohms or greater - Repair the open/high resistance in the circuit.
        - If less than 2 ohms - Replace the component: K115 Reductant Control Module
    - **If greater than 5.2 V**
    1. Ignition/Vehicle - Off
    2. Disconnect the electrical connector: K115 Reductant 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 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: K115 Reductant Control Module
    - **Go to next step: If between 4.8 and 5.2 V**
6. Test for 4.4 to 4.8 V between the test points: Serial Data circuit terminal 2 & Ground
    - **If less than 4.4 V**
    1. Ignition/Vehicle - Off
    2. Disconnect the electrical connector: K115 Reductant Control Module
    3. Test for infinite resistance between the test points: Serial Data circuit terminal 2 @ Component harness & Ground
        - If less than infinite resistance - Repair the short to ground on the circuit.
        - Go to next step: If infinite resistance
    4. Test for less than 2 ohms between the test points: Serial Data circuit terminal 2 @ Component harness & Terminal 18 X2 @ Control module harness
        - If 2 ohms or greater - Repair the open/high resistance in the circuit.
        - If less than 2 ohms - Replace the component: K115 Reductant Control Module
    - **If greater than 4.8 V**
    1. Test for less than 1 V between the test points: Serial Data circuit terminal 2 @ Component harness & Ground
        - If 1 V or greater - Repair the short to voltage on the circuit.
        - If less than 1 V - Replace the component: K115 Reductant Control Module
    - **Go to next step: If between 4.4 and 4.8 V**
7. Test or replace the component: B212 Reductant Sensor Module

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Emission Reduction Fluid Tank Replacement** - B212 Reductant Sensor Module
- **Reductant Control Module Replacement** - K115 Reductant Control Module

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- For control module replacement, programming, and setup refer to **Control Module References**

DTC P2BAA

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.
- **Diagnostic Procedure Instructions** provides 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

DTC P2BAA

- The ignition voltage is greater than 11V.
- Engine running.
- The vehicle is not moving for greater than 100 s.
- The barometric pressure is greater than 70 kPa (10.2 psi).
- The ambient air temperature is warmer than -20B°C (-4B°F).
- The reductant tank is not frozen.
- Vehicle is not in a DPF regeneration.
- DTC P2BAA runs when the above conditions are met.

Conditions for Setting the DTC

The ECM detects that diesel exhaust fluid (DEF) delivery is lower than a calibrated amount.

Action Taken When the DTC Sets

DTC P2BAA is a Type A DTC.

Conditions for Clearing the DTC

DTC P2BAA is a Type A DTC.

Diagnostic Aids

- A leak in the reductant system can be located by inspecting for a build-up of crystallized diesel exhaust fluid (Reductant).
- Using the Reductant Injector Device Control, a ticking sound should be heard at the reductant injector.

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- The reductant injector may temporarily stick after the engine is off for a short period and cause DTC P20EE or P2BAA to set. The reductant injector may unstick after exposure to elevated exhaust temperatures after the engine is restarted.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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 P0070, P0071, P0072, P0073, P0074, P00C7, P00E9, P00EA, P00EB, P00EC, P0100, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0119, P0128, P0201, P0202, P0203, P0204, P020A, P020B, P020C, P020D, P0216, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P02EE, P02EF, P02F0, P02F1, P0405, P0406, P049D, P0502, P0503, P062B, P062D, P0722, P0723, P111E, P1248, P1249, P124A, P124B, P126A, P202E, P2147, P2148, P2150, P2151, P2227, P2228, P2229, or P2230 are 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 **Reductant System Tamper Warning Service Bay Test** after diagnosing other DTCs
        - If the test does not pass

          Refer to Circuit/System Testing.

        - Go to next step: If the test passes

          Go to next step: All OK.

    - **Go to next step: If no other DTCs are set**
2. Verify that DTC P2BAA is not set
    - **If the DTC is set**

      Refer to Circuit/System Testing

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

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3. All OK.

Circuit/System Testing

1. Ignition OFF. 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**
2. Ignition ON, command the Reductant System Leak Test on with the scan tool.
3. 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 the scan tool.
    2. Verify that the desired Reductant Pump Speed and actual Reductant Pump Speed parameters are equal.
        - If not equal

          Refer to **DTC P105A**

        - Go to next step: If equal
    - **Go to next step: If within the specified range**
4. 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**
5. Verify the **Reductant Fluid Injector Quantity Test** passes.
    - **If the test does not pass**

      Repair as instructed per the test.

    - **Go to next step: If the test passes**
6. Perform the **Reductant System Tamper Service Bay Test**.
    - **If the test does not pass**

      A condition with the system still exists. Refer to Circuit/System Testing.

    - **Go to next step: If the test passes**
7. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Emission Reduction Fluid Supply Pump Module Replacement**
- **Reductant Fluid Injector Replacement**
- **Control Module References** for engine control module replacement, programming, and setup.

Repair Verification

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

1. Perform the **Reductant System Tamper 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 P2D45

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 P2D45

Reductant Temperature Too Low

Circuit/System Description

For an overview of the component/system, refer to **Exhaust Aftertreatment System Description**

Circuit	Description
Control - Terminal 11	The output circuit is switched to 12 V to activate the component.
Control - Terminal 4	The output circuit is switched to ground to enable the component(s).

Conditions for Running the DTC

- DTCs related to the following system/component = Not Set
  - B214 Reductant Temperature Sensor
  - E53 Reductant Tank Heater
  - K115 Reductant Control Module
- Ambient Air Temperature & Reductant Temperature = Within 8B°C (14.4B°F) of each other - During engine startup
- Engine Run Time = Greater than 610 s
- Ignition = Off - For greater than 8 h
- Ignition Voltage = Greater than 11 V
- Reductant Heater 1 Command = ON - For greater than 600 s
- Reductant Temperature = Less than -15B°C (5B°F) - During engine startup

Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

Reductant Temperature = Not within a calibrated range

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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

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **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 there are no DTCs set related to the following component/system:
   - B214 Reductant Temperature Sensor
   - E53 Reductant Tank Heater
   - **If any of the DTCs are set**

     Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**

   - **Go to next step: If none of the DTC are set**
3. Verify the condition does not exist: Warning Message = Service Emission System/Service Exhaust Fluid System
   - **If the condition exists**

     Refer to **Contaminants-in-Diesel Exhaust Fluid Diagnosis**

   - **Go to next step: If no condition exists**
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**

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Replace the component: E53 Reductant Tank Heater

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

6. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Emission Reduction Fluid Supply Pump Module Replacement** - E53 Reductant Tank Heater
- For control module replacement, programming, and setup refer to **Control Module References**

Additional Procedures

NOTE: **Performing this procedure will clear the Driver Information message for the applicable system.**

Perform the scan tool control function: **Reductant System Tamper Service Bay Test** - Perform only when the following warning message is displayed: Service Emission System/Service Exhaust Fluid System

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.
- **Diagnostic Procedure Instructions** provides 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

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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

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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 with Intake Air Temperature 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 3B°C (5B°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 owners 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 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 module. 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. See **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.

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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.

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- 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.

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.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Description

Several states require that a vehicle pass on-board diagnostic (OBD) system tests and inspection/maintenance (I/M) emission inspections in order to renew license plates. This is accomplished by viewing the Inspection/Maintenance System Status or Data display on a scan tool. Using a scan tool, the technician can observe the I/M status in order to verify that the vehicle meets the criteria that complies with the local area requirements.

While testing in the I/M System Status mode, some DTCs may occur that are called I/M Test DTCs. An I/M Test DTC is defined as a fault code that is currently commanding the malfunction indicator lamp (MIL) ON, and is stored in non-volatile memory. The intended use of this data is to prevent vehicles from passing I/M inspection without proper repair to the vehicle. These fault codes are not erasable from any scan tool command or by disconnecting power to the controller. I/M Test DTCs are supported by all emissions related electronic control units, such as engine control modules (ECMs), transmission control modules (TCMs), fuel pump control modules, etc. An I/M Test DTC will not be stored or erased from the electronic control unit except at the end of trip processing which occurs 5 s after ignition OFF.

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 requires at least one, and sometimes several, diagnostic tests. The results of these tests are reported by a DTC. A system monitor is complete when either all of the DTCs comprising the monitor have Run and Passed, or any one of the DTCs comprising the monitor have illuminated the MIL. Once all of the tests are completed, the Inspection/Maintenance System Status or Data will indicate YES in the Completed or Value column.

For example, when the HO2S Heater Status indicates YES, either all of the oxygen sensor heater tests have passed or one of the tests has illuminated the MIL. If the vehicle has four heated oxygen sensors, either all four heater circuit tests have passed or one of the heater circuit tests has illuminated the MIL. The Inspection/Maintenance System Status or Data will indicate NO under the Completed or Value column when any of the required tests for that system have not run. The following is a list of conditions that would set the Inspection/Maintenance System or Data indicator to NO:

- The vehicle is new from the factory and has not yet been driven through the necessary drive conditions to complete the tests.
- 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.

Conditions for Clearing I/M Test DTCs

1. Only the OBD II System can erase I/M Test DTCs. The OBD II system must determine that the malfunction that caused the I/M Test DTC to be stored is no longer present and is not commanding the MIL. Each of the following represents ways to clear an I/M Test DTC:
    - If the MIL goes off due to 3 passing drive cycles, and the scan tool code clear is not used, the I/M Test DTC is erased at power down of the last drive cycle.
    - If a scan tool code clear is used to turn OFF the MIL, the I/M Test DTC is not erased, therefore the DTC must PASS and not FAIL during the drive cycle. The I/M Test DTC is erased at power down of the drive cycle.
    - If the controller is reflashed/reprogrammed, all I/M Test DTCs are erased.
2. For the OBD II System to run a single drive cycle for clearing an I/M Test DTC, all of the following conditions must occur:
    - Cumulative time of engine run time greater than 600 s.
    - Cumulative vehicle operation above 41 km/h (25 mph) over 300 s.
    - Continuous vehicle idle greater than 30 s.
    - Ignition OFF for 5 s to allow the code to clear.

Monitored Emission Control Systems

The OBD II system monitors all emission control systems that are on-board, but not all vehicles need every possible emission control system. For example, a vehicle may not be equipped with secondary air injection or exhaust gas recirculation (EGR). The OBD II regulations require monitoring of the following; if equipped:

- The air conditioning system
- The catalytic converter efficiency
- Comprehensive component monitoring - Emission related inputs and outputs
- The evaporative emission (EVAP) system
- The fuel delivery system
- Heated catalyst monitoring
- Misfire monitoring
- The oxygen sensor system (O2S or HO2S)
- The oxygen sensor heater system (HO2S heater)

For the specific DTCs required for each system, refer to **Inspection/Maintenance (I/M) System DTC Table**. Systems such as misfire and comprehensive components may not be listed in a system status list. These tests run continuously and do not require an I/M System Status indicator.

Diagnostic Aids

The Inspection/Maintenance System Status or Data display provides an indication of when the control module has completed the required tests. This does not necessarily mean that the test has passed, only that a decision was made. If the diagnostic fails, a DTC will indicate the failure. If a failure indication is present for a DTC associated with one of the I/M regulated systems, it may prevent other required tests from running. For example, a DTC for the control circuit of the EVAP purge solenoid may not be listed in the Inspection/Maintenance System DTC Table because it is a continuous test. If this DTC is set, the Active Tests for the EVAP system may not run.

The Inspection/Maintenance System Status or Data information may be useful for a technician to determine if diagnostics have run when verifying repairs.

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.

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- **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.

INSPECTION/MAINTENANCE (I/M) SYSTEM DTC TABLE

Description

Perform the following procedure to determine if the inspection/maintenance (I/M) status monitor parameters displays Complete: **Inspection/Maintenance System Check**

If the status monitor parameters did not update to Complete, refer to the applicable DTC listed below. Each DTC 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 from running. Reviewing and operating the vehicle within the conditions for running each DTC will allow the inspection/maintenance system status parameters to display Complete. Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**

Scan Tool Parameter	DTCs Required to Set I/M System Status Monitor to Complete
Boost System Monitor - Since Diagnostic Trouble Codes Cleared	P0234, P026A, P0299, P02CA, P02CB, P168A, P168B
Catalytic Converter Monitor - Since Diagnostic Trouble Codes Cleared	P0420, P0421, P0422, P0430, P2000, P20CE, P244C

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Scan Tool Parameter	DTCs Required to Set I/M System Status Monitor to Complete
Exhaust Aftertreatment Monitor - Since Diagnostic Trouble Codes Cleared	P2000, P20EE, P226D, P2BAA, P2BAD, P2C7A
Exhaust Gas Recirculation Valve/Camshaft Position Monitor - Since Diagnostic Trouble Codes Cleared	P0011, P0014, P0021, P0024, P0400, P0401, P0402, P0404, P0405, P0406, P040F, P042E, P049B, P05CC, P05CD, P05CE, P05CF, P110E, P110F, P131F, P140B, P140C, P140F, P1426, P1437, P14A5, P16D0, P16D1, P241F, P2457, P2646, P2647
Exhaust Gas Sensor Monitor - Since Diagnostic Trouble Codes Cleared	P0133, P0135, P013A, P013B, P0141, P014C, P014D, P019A, P019B, P049C, P1004, P11B3, P11CC, P11D3, P11D5, P1479, P147B, P1488, P14D9, P2209, P2297, P229F, P22A7, P22B6, P22B7, P22F9, P22FA, P22FB, P22FE, P232F, P23B5, P23B7, P23C1, P24AF, P24B4, P24B7, P24C7, P24D1, P24DA, P2627, P2628, P2A00, P2A01, P2A02, P2C62, P2C63, P2C64, P2C65
Fuel System Monitor - Since Diagnostic Trouble Codes Cleared	P01CB, P01CC, P01CD, P01CE, P01CF, P01D0, P01D1, P01D2, P01D2, P01D3, P01D4, P01D5, P01D6, P01D7, P01D8, P01D9, P01DA, P026B, P026C, P026D, P1174, P1175, P1488, P14D9, P219A, P219B, P219C, P219D, P219E, P219F, P21A0, P21A1, P21A2, P21A3, P228C, P228D, P229A, P229B
Oxygen Sensor Heater Monitor - Since Diagnostic Trouble Codes Cleared	P0053, P0054, P0059, P0060, P0141, P0155, P0161
Oxygen Sensor/Heated Oxygen Sensor Monitor - Since Diagnostic Trouble Codes Cleared	P0133, P0135, P0136, P013A, P013B, P013C, P013D, P013E, P013F, P0140, P0142, P014A, P014B, P0153, P0156, P015A, P015B, P015C, P015D, P0160, P1133, P1134, P1153, P1154, P2195, P2196, P2197, P2198, P2270, P2271, P2272, P2273, P2A01, P2A02, P2A04
Particulate Filter Monitor - Since Diagnostic Trouble Codes Cleared	P144B, P144C, P144E, P144F, P2002, P226D, P226E, P2459, P24A0, P24A1

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.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Description

The purpose of the Inspection/Maintenance (I/M) complete system set procedure is to satisfy the enable criteria necessary to execute all of the I/M readiness diagnostics and complete the trips for those particular diagnostics. When all I/M monitored diagnostic tests are completed, the I/M System Status indicators are set to YES. Perform the Inspection/Maintenance (I/M) Complete System Set Procedure if any I/M System Status indicators are set to NO.

Conditions for Meeting a Cold Start

- The ignition voltage between 10 and 15 V.
- The barometric pressure (BARO) is more than 75 kPa (10.9 PSI).

- The engine coolant temperature (ECT) at start-up is less than 42B°C (108B°F).
- The intake air temperature (IAT) is between 2 - 32B°C (36-90B°F).
- The engine is OFF for greater than 6 hours or the following conditions must be met:
  - The start-up IAT minus start-up ECT are within 12B°C (22B°F).
  - The start-up ECT minus start-up IAT are within 50B°C (90B°F).
- Fuel level is between 25 and 75%.

Circuit/System Verification

1. Verify that all I/M System Status 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.

Inspection/Maintenance (I/M) System Set Procedure

1. Ensure that the vehicle meets the conditions for a cold start listed above.
   - If the EVAP I/M System Status indicator displays NO, perform the **EVAP Service Bay Test** if applicable.
2. Turn OFF all accessories; HVAC system, other electrical loads, including aftermarket/add-on equipment, etc., and open the hood.
3. Set the vehicle parking brake and ensure the vehicle is in park for automatic transmission or neutral for manual transmission.
4. Start and idle the engine for 2 min.

   WARNING: **Refer to Road Test Warning .**

5. Close the hood, release the parking brake and Accelerate at part throttle to 72 - 80 km/h (45 - 50 MPH) with this speed maintained until the engine reaches operating temperature, 8 - 10 min.
6. Continue operation under these conditions for an additional 6 min.
7. Accelerate at part throttle to 90 km/h (55 MPH) with this speed maintained for 2 min.
8. Release the accelerator pedal for at least 10 s. This will allow the vehicle to enter the decel fuel cut off.

   NOTE: **Do NOT touch the accelerator pedal until told to do so. A change in throttle position or an increase in engine speed may invalidate this portion of the test.**

9. Safely stop the vehicle, with the engine in drive for automatic or neutral with the clutch pedal depressed and parking brake applied for manual. Allow the vehicle to idle for 2 min.
10. Shift the vehicle to park for automatic and neutral for manual. Turn OFF the ignition and exit the vehicle. Do NOT disturb the vehicle for 45 min.
11. Observe the Inspection/Maintenance (I/M) System Status with a scan tool. All of the I/M System Status indicators should display YES.
    - If the EVAP I/M System Status indicator displays NO, turn OFF the ignition, ensure that the vehicle meets the conditions for a cold start, and repeat steps 6 - 11 three more times, or until the EVAP I/M System Status indicator transitions to YES. If the indicator continues to display NO, refer to the **Inspection/Maintenance (I/M) System DTC Table** to identify the DTCs that did not run.
    - If any of the I/M System Status indicators display NO, refer to the **Inspection/Maintenance (I/M) System DTC Table** for the indicator which did not display YES. The I/M System DTC Table

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identifies the DTCs associated with each I/M System Status Indicator.

NOTE: **An I/M Test DTC will not be stored or erased from the ECU except at the end of trip processing, which occurs 5 s after ignition OFF.**

12. Observe the I/M Test DTC information with a scan tool. Verify there are no I/M Test DTCs present.
    - If an I/M Test DTC is set, diagnose the DTC using the **Diagnostic Trouble Code (DTC) List - Vehicle** , and refer to **Inspection/Maintenance System Check**.
13. Observe the engine DTC information with a scan tool. Verify no DTCs are present.
    - If a DTC is set, diagnose using the **Diagnostic Trouble Code (DTC) List - Vehicle** . After repairs, perform the **Inspection/Maintenance Complete System Set Procedure** to verify no further DTCs are set.

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.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Circuit/System Description

The water in fuel sensor has a ignition circuit, signal circuit, and a ground circuit. The Engine Control Module (ECM) monitors the signal circuit for a predetermined voltage. The ECM determines the amount of water in the fuel with a sensor located in the fuel filter assembly. When the water in the fuel is above an acceptable level, the ECM sends a request to the instrument panel cluster to illuminate the Water In Fuel lamp.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics Engine Controls Schematics

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **Component Connector End Views - Index**

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 contaminants are noticed in the fuel, a fuel system cleaning may be necessary. Refer to Contaminants-in-Fuel Diagnosis.**

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1. Verify that DTCs P2264, or P2269 are not set.
    - **If DTCs P2264, or P2269 are set**

      Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

    - **Go to next step: If DTCs P2264, or P2269 are not set**
2. Verify there is no water in the fuel.
    - **If water present in the fuel**

      Refer to **Water-in-Fuel Draining** .

    - **Go to next step: If no water present in the fuel**
3. Ignition ON.
4. Verify the Water In Fuel lamp turns ON and OFF when commanded with a scan tool.
    - **If the Water in Fuel lamp does not turn ON and OFF**

      Refer to **Symptoms - Displays and Gauges** .

    - **Go to next step: If the Water in Fuel lamp turns ON and OFF**
5. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

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.
- **Diagnostic Procedure Instructions** provides 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

Inspect for any of the following conditions:

- Insufficient fuel can cause a no start condition. Thoroughly inspect the fuel delivery system for sufficient fuel volume to the fuel injectors. Inspect the fuel supply components for partial blockage or restrictions.
- Fuel injectors with partially blocked and restricted nozzles, or a malfunctioning solenoid, can cause a no start condition. Refer to **Fuel System Diagnosis**.
- There may be fuel spray at the fuel injectors and the indicated fuel pressure may be correct, yet there may not be enough fuel to start the engine. If the fuel injectors and the injector circuit are OK, and fuel spray is detected, the fuel injector ON time may be inadequate. If the engine control module (ECM) receives incorrect inputs from the various information sensors, the fuel delivered by the fuel injectors may be inadequate to start the engine. Check all the engine data parameters with a scan tool and compare the values indicated with the expected values or the values from a known good vehicle.
- Check the crankshaft position sensor engine reference signal with a scan tool. Observe the Engine Speed parameter while cranking the engine. The scan tool should indicate a steady 200 - 300 RPM while

cranking. If erratic values, such as sudden spikes in the engine speed are displayed, the engine reference signal is not stable enough for the engine to start and run properly.

- Inspect the engine for good secure electrical grounds.
- Water or foreign material in the fuel can cause a no start or engine will not stay running condition. During freezing weather water can freeze inside the fuel system. The engine may start after 30 min in a heated repair shop. The malfunction may not recur until parked overnight in freezing temperatures. Extreme weather conditions can cause contaminated fuel to prevent the vehicle from starting.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **Component Connector End Views - Index**

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-34730-1A Fuel Pressure Gauge

For equivalent regional tools, refer to **Special Tools ((Diagnosis Tools))** .

Circuit/System Verification

NOTE: **This diagnostic assumes the following:**

- Verify the battery is completely charged. Refer to **Battery Inspection/Test** .
- Verify the engine cranking speed should be at least 100 RPM cold and 180 RPM hot. Refer to **Engine Cranks Slowly** .
- Verify there is adequate fuel in the fuel tank.

1. Engine cranking for 15 s, verify the DTC information with a scan tool. Verify that no DTC is set.
   - **If any DTC is set**

     Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

   - **Go to next step: If no DTC is set**
2. Visually inspect the fuel system from the high pressure pump to the fuel tank for leaks.
   - **If a fuel leak is present**

     Refer to **Fuel System Diagnosis**.

   - **Go to next step: If no fuel leaks are present**

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3. Engine cranking for 15 s, observe the scan tool Fuel Rail Pressure Sensor parameter. The reading should be greater than 13 MPa (1885 PSI)
    - **If the Fuel Rail Pressure Sensor parameter is less than 13 MPa (1885 PSI)**

      Refer to **Fuel System Diagnosis**

    - **Go to next step: If the Fuel Rail Pressure Sensor parameter is 13 MPa (1885 PSI) or greater**
4. Verify the following conditions do not exist:
    - Collapsed air intake duct to the throttle body
    - Restricted air filter element
    - A skewed engine coolant temperature (ECT) sensor. Verify sensor resistance against the **Temperature Versus Resistance - Engine Coolant Temperature Sensor** tables.
    - Exhaust system restricted. Refer to **Restricted Exhaust** .
    - Fuel contamination. Refer to **Contaminants-in-Fuel Diagnosis**.
    - Engine mechanical condition, for example, worn timing belt or low compression. Refer to **Symptoms - Engine Controls**, or **Engine Compression Test** .
    - **If any of the above listed conditions are exists**

      Repair as necessary.

    - **Go to next step: If no of the above listed conditions is exists**
5. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

REDUCTANT FLUID INJECTOR 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.
- **Diagnostic Procedure Instructions** provides 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

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- Diesel Exhaust Fluid (DEF) Warning Strategy (DEF Level), or Diesel Exhaust Fluid (DEF) Warning Strategy (Emission Control), or Diesel Exhaust Fluid (DEF) Warning Strategy (Anti-Tampering), or Diesel Exhaust Fluid (DEF) Warning Strategy (DEF Quality)
- Engine Controls Wiring Schematics

Connector End View Reference

Master Electrical Component List , or Inline Harness Connector End Views - Index or 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

Scan Tool Reference

Control Module References for scan tool information

Special Tools

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 less than -7B°C (19.5B°F).**
- **The Reductant Quantity Test may need to be run multiple times to dissolve crystallized reductant and to restore proper flow pattern.**
- **Once the injector begins cycling, the Reductant Quantity Test takes approximately 5 minutes to run and the ECM will end the test after approximately 325 s.**

1. Remove the Q61 Emission Reduction Fluid Injector from the exhaust leaving the harness connector and reductant line connected.

   NOTE: **It may take up to two minutes for the injector to begin cycling.**

2. Command the Reductant Injection Quantity Test On with a scan tool. While pointing the injector towards a shop towel or large container, observe the injector spray pattern. Three individual streams and

atomization or mist of reductant should be observed.

- **If the function does not perform as specified**

  Inspect the 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**

3. Position the injector nozzle towards one of the graduated scale container from the **J 45873** Fuel Return Volume Test Kit.
4. Command the Reductant Injection Quantity Test On with a scan tool. The injector should flow at least 50 ml.
   - **If not at least 50 ml**
   1. Disconnect the injector from the supply line.
   2. Position the injector supply line towards the graduated scale container.
   3. Command the Reductant Injection Quantity Test On with a scan tool. The supply line should flow greater than 30 ml.
   - If 30 ml or less, inspect the supply line for damage or restrictions.
   - If greater than 30 ml, replace the Q61 Emission Reduction Fluid Injector.
   - **Go to next step: If at least 50 ml**
5. Return to referring document.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Reductant Fluid Injector Replacement**
- **Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe Replacement**

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 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.

The scan tool Reductant Level and Reductant Level Sensor parameters should change when DEF is added to the reservoir. If the parameters do not change, the reductant level sensor may be stuck.

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.

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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

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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 (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 (NOx) 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

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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
- See 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
- See 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
- See 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
- See 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

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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
- See 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 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.

In order to clear the Service Exhaust Fluid System or Service Emission System message, the condition causing the message must be repaired, and the Reductant System Tamper Service Bay Test must be run. Refer to **Reductant System Tamper Service Bay Test**.

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
- See 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
- See 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
- See 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
- See 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
- See 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
- See 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

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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
- See 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
- See 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 (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.

In order to clear the Exhaust Fluid Quality Poor warning, the reductant tank must be drained and refilled with fresh reductant. Refer to **Contaminants-in-Diesel Exhaust Fluid Diagnosis**. The Reductant System Tamper Service Bay Test must be preformed to verify proper operation of the reductant system and clear the Exhaust

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Fluid Quality Poor warning after the condition causing the warning has been repaired. Refer to **Reductant System Malfunction Service Bay Test**.

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
- See 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
- See 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
- See 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
- See 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

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- See 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
- See 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
- See Owner's Manual Now
- Transitioning to 7 km (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:

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- Exhaust Fluid Quality Poor
- See Owner's Manual Now
- Speed Limited to 7 km (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).

CONTAMINANTS-IN-DIESEL EXHAUST FLUID DIAGNOSIS

Description

Maximum oxides of nitrogen (NOx) 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**

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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 20B°C (68B°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 scan tool function: Reductant System Malfunction Warning Service Bay Test
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.

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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 -7B°C (19B°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.

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 60-100B°C (140-212B°F).
- Barometric pressure is greater than 70 kPa (10.2 PSI).
- Ambient air temperature is greater than -30B°C (-22B°F).
- Reductant temperature is greater than -7B°C (19B°F) and not frozen.
- Reductant level must be greater than 33 %.
- Fuel temperature is less than 80B°C (176B°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 - 100B°C (140 - 212B°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

WARNING: **Tailpipe outlet exhaust temperature will be greater than 300B°C (572B°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.**

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 -7B°C (19B°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 -5B°C (+23B°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.

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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 Diesel Exhaust Fluid Quality 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 Diesel Exhaust Fluid Quality 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 60-100B°C (140-212B°F).
- Barometric pressure is greater than 70 kPa (10.2 PSI).
- Ambient air temperature is greater than -30B°C (-22B°F).
- Reductant temperature is greater than -20B°C (-4B°F) and not frozen.
- Reductant level must be greater than 33 %.
- Fuel temperature is less than 80B°C (176B°F).
- SCR catalyst temperature is less than 300B°C (572B°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.

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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 - 100B°C (140 - 212B°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 -7B°C (19B°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 -5B°C (+23B°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.
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. Cycle the Reductant Heaters On and Off with a scan tool.
   2. 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.

RELATIVE ENGINE COMPRESSION TEST

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

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Circuit/System Description

The Relative Engine Compression test monitors starter current draw to determine the relative compression of all cylinders. Each compression stroke causes mechanical resistance, increasing the current draw on the battery. Starter current and battery voltage are inversely proportionate.

Diagnostic Aids

- An engine with little to no compression variance between cylinders will have waveform valleys that are even.
- If the engine compression is equally low across all cylinders, the oscilloscope pattern will appear good.
- The total amplitude (range from highest to lowest point of the waveform) is NOT an indicator of good compression.

Reference Information

Component View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **Component Connector End Views - Index**

Special Tools

- <special tool><special tool-no>CH-51450-A</special tool-no><special tool-desc> Oscilloscope Diagnostic Kit</special tool-desc></special tool>
- <special tool><special tool-no>CH-51450-LEAD-A</special tool-no><special tool-desc> Oscilloscope Basic Lead Kit</special tool-desc></special tool>

Equivalent regional tools: **Special Tools ((Diagnosis Tools))**

Circuit/System Testing

1. Ignition/Vehicle - Off
2. Apply - Parking Brake
3. Install - <special tool><special tool-no>CH-51450-A</special tool-no><special tool-desc> Oscilloscope Diagnostic Kit</special tool-desc></special tool> & <special tool><special tool-no>CH-51450-LEAD-A</special tool-no><special tool-desc> Oscilloscope Basic Lead Kit</special tool-desc></special tool>
    1. Channel A Lead: Blue @ Oscilloscope
    2. Channel A Lead: Blue @ B+ & Ground

    NOTE: **Hover the mouse cursor over an icon button to display the button's description.**

4. Coupling - DC
5. Select: Connect Detect

    Verify the following information is correctly displayed: Connected Channels = Green

    - **If the information is not correctly displayed**

      Repair the poor connection & Repeat this step

    - **Go to next step: If the information is correctly displayed**
6. Setup - <special tool><special tool-no>CH-51450-A</special tool-no><special tool-desc> Oscilloscope Diagnostic Kit</special tool-desc></special tool> & <special tool><special tool-no>CH-51450-LEAD-A</special tool-no><special tool-desc> Oscilloscope Basic Lead Kit</special tool-desc></special tool>
    1. Select: Automotive

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2. Select: Charging and Starting
3. Select: Relative Compression
4. Select: Voltage

7. Remove the component: F20UA Fuse @ X50A Fuse Block - Underhood
8. Select: Start Capturing
9. Perform the following action:
    1. {Automatic Transmission} Apply & Hold - Brake Pedal

       {Manual Transmission} Apply & Hold - Clutch Pedal

    2. Engine - Cranking - For 5 - 10 s
    3. Select: Stop Capturing

       Verify the following information is correctly displayed: The waveform valleys are all even. Refer to **Oscilloscope Waveform Library**

    - **If the information is not correctly displayed**

      Verify the condition does not exist with the component and repair as necessary:

      NOTE: **The following are examples of what could cause compression issues. Inspect all mechanical components for the applicable cylinder. The list is not all encompassing. Refer to Symptoms - Engine Mechanical**

    - Camshaft Lobe(s) - Visible Damage/Worn
    - Exhaust Valve or Intake Valve - Stuck Open/Visible Damage
    - Exhaust Valve Seator Intake Valve Seat - Visible Damage
    - Piston - Cracked/Visible Damage
    - Piston Ring - Seized/Visible Damage/Worn
    - Valve Lifter - Visible Damage/Worn
    - Valve Spring - Visible Damage/Worn
    - Valve Rocker Arm - Visible Damage/Worn
    - **Go to next step: If the information is correctly displayed**
10. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

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.**

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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.

Water or other like contaminates in fuel will also create drivability 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 drivability 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 drivability concerns or component failure.

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, 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.
4. Remove the water-in-fuel sensor from the bottom of the fuel filter and inspect inside the filter for rust deposits, dirt, or other debris.

   NOTE: **The presence of water or gasoline in diesel fuel may also cause damage to other fuel system components.**

5. 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 (Cylinder #1, #2, #3)** , or **Fuel Injector Replacement (Cylinder #4)** , or **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**

EXHAUST AFTERTREATMENT FUEL INJECTOR DIAGNOSIS

Diagnostic Instructions

- Perform the Diagnostic System Check prior to using this diagnostic procedure: **Diagnostic System Check - Vehicle**

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- Review the description of Strategy Based Diagnosis: **Strategy Based Diagnosis**
- An overview of each diagnostic category can be found here: **Diagnostic Procedure Instructions**

Circuit/System Description

For an overview of the component/system, refer to **Exhaust Aftertreatment System Description**

Diagnostic Aids

The following conditions could cause DTC P0420, P2463 to set: Restrictions @ Q67 Exhaust Aftertreatment Fuel Injector - Fuel Feed Pipe

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **Component Connector End Views - Index**

Electrical Information Reference

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

Scan Tool Reference

Control Module References

Circuit/System Testing

NOTE: **This procedure requires a graduated cylinder to measure the amount of fluid injected.**

1. Ignition/Vehicle & All vehicle systems - Off
2. Remove the component: Q67 Exhaust Aftertreatment Fuel Injector - Nozzle @ Exhaust Pipe
3. Install suitable hose to the component: Q67 Exhaust Aftertreatment Fuel Injector - Nozzle - Place the other end of the hose into a suitable container.
4. Engine Running
5. Verify the condition does not exist: Q67 Exhaust Aftertreatment Fuel Injector - Leaking
   - **If the condition exists**

     Replace the component: Q67 Exhaust Aftertreatment Fuel Injector

   - **Go to next step: If no conditions exist**

NOTE:

- **Activating the device control On prior to taking a flow measurement may cause a faulty injector to test good.**
- **Each time the device control is activated, the quantity of fuel that flows into the container must be recorded even if little or no fuel flows.**

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6. Perform the scan tool control function: Exhaust Aftertreatment Fuel Injector Flow Test & Record the measurement. - Repeat2 times
7. Verify all measurements are between 30 and 40 mL (1.0 and 1.4 US fl oz)
    - **If there is no flow**
    1. Ignition/Vehicle - Off
    2. Disconnect the component: Fuel Feed Pipe @ Q67 Exhaust Aftertreatment Fuel Injector
    3. Install suitable hose to the component: Fuel Feed Pipe - Place the other end of the hose into a suitable container.
    4. Ignition - On / Vehicle - In Service Mode
    5. Verify there is fuel flow from the component: Fuel Feed Pipe
        - If there is no flow
        1. Verify the condition does not exist: Fuel Feed Pipe - Restricted
            - If a condition exists - Repair or replace as necessary
            - If no condition exists - Replace the component: G12 Fuel Pump
        - If there is flow - Replace the component: Q67 Exhaust Aftertreatment Fuel Injector
    - **If any measurement is less than 30 ml (1.0 US fl oz)**

      Replace the component: Q67 Exhaust Aftertreatment Fuel Injector
    - **If any measurement is greater than 40 ml (1.4 US fl oz)**

      Replace the component: G12 Fuel Pump
    - **Go to next step: If all measurements are between 30 and 40 mL (1.0 and 1.4 US fl oz)**
8. All OK. - Refer to: Diagnostic Aids

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Low Pressure Diesel Hydrocarbon Injector Replacement** - Q67 Exhaust Aftertreatment Fuel Injector
- **Fuel Tank Fuel Pump Module Replacement** - G12 Fuel Pump
- For control module replacement, programming, and setup refer to **Control Module References**

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.
- **Diagnostic Procedure Instructions** provides 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

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Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **Component Connector End Views - Index**

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. An audible click should be heard with each command.
   - **If a audible click is not heard**

     Refer to **DTC P2687-P2689**

   - **Go to next step: If a audible click is heard**
3. Verify with a scan tool that the Fuel Temperature Sensor parameter slowly starts to rise.
   - **If the Fuel Temperature Sensor Parameter does not start to rise**

     Refer to Circuit/System Testing

   - **Go to next step: If the Fuel Temperature Sensor Parameter rises**
4. All OK

NOTE: **Perform the fuel heater relay Component Testing before proceeding to Circuit/System Testing.**

Circuit/System Testing

1. Ignition OFF.
2. Disconnect the harness connector at the E11B Fuel Heater/Temperature Sensor.
3. Test for less than 10 Ω between the fuel heater ground circuit terminal 7 and ground.
   - **If 10 Ω or greater**

     Repair the open/high resistance in the circuit

   - **Go to next step: If less than 10 Ω**
4. Connect a test lamp between voltage supply circuit terminal 6 and ground.

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5. Ignition On.
6. Command the Fuel Heater Relay On and Off with a scan tool. The test lamp should turn On and Off when commanded.
    - **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.
        - Go to next step: If fuse is good and no voltage is present
    2. Ignition Off.
    3. Remove the KR22 Fuel Heater Relay from X50B Fuse Block-Underhood Auxiliary.
    4. Verify that a test lamp illuminates between the fuel heater voltage supply circuit terminal B1/87 and ground.
        - If the test lamp does not illuminate, repair the open/high resistance in the circuit.
        - Go to next step: If the test lamp illuminates
    5. Test for less than 2 ohms between the test points: Signal circuit terminal 6 @ Component harness & Terminal C3/30 @ KR22 Fuel Heater Relay
        - 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 X50B Fuse Block-Underhood Auxiliary.
    3. Ignition On.
    4. Test for less then 1 V between the fuel heater voltage supply circuit terminal 6 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**
7. Replace the E11B Fuel Heater/Temperature 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 85 and 86.
    - **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:
    - C3/30 and B3/86
    - C3/30 and B1/87
    - C3/30 and C1/85
    - C1/85 and B1/87
    - **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 B3/86 and 12 V.
6. Install a jumper wire between relay terminal C1/85 and ground.

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7. Test for less than 2 Ω between terminals C3/30 and B1/87.
    - **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.

- **Fuel Filter Assembly Replacement**
- **Electrical Relay Replacement (Attached to Wire Harness)** , or **Electrical Relay Replacement (Within an Electrical Center)**

CYLINDER POWER BALANCE TEST

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**

Circuit/System Description

This procedure allows the technician to turned off each fuel injector using a scan tool. The change in engine speed or sound, when an injector is turned off, is an indicator how much power that cylinder contributes. If a cylinder generates less power than the others, that indicates a problem with either the compression or the injector.

The scan tool control function can also be used to find the cause of a misfire, engine knock, excessive smoke or rough running condition when no relevant DTCs are set.

Reference Information

Special Tools

- <special tool><special tool-no>CH-51450-A</special tool-no><special tool-desc> Oscilloscope Diagnostic Kit</special tool-desc></special tool>
- <special tool><special tool-no>CH-51450-LEAD-A</special tool-no><special tool-desc> Oscilloscope Basic Lead Kit</special tool-desc></special tool>

Equivalent regional tools: **Special Tools ((Diagnosis Tools))**

Circuit/System Verification

1. Ignition - On / Vehicle - In Service Mode
2. Verify there are no DTCs set, except DTC P0300 - P0304, related to the following system/component: Q17 Fuel Injector
    - **If a related DTC is set**

      Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**

    - **Go to next step: If a related DTC is not set**
3. Engine - Idling

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4. Perform the scan tool control function: Cylinder Power Balance - Enable - Cylinder 1 - 4 Injector - One at a time

   Verify the sound of the engine changes the same way when turning off each individual injector.

   - **If the engine sound does not change the same way for one or more cylinders**

   {Tool Available: <special tool><special tool-no>CH-51450-A</special tool-no><special tool-desc> Oscilloscope Diagnostic Kit</special tool-desc></special tool> & <special tool><special tool-no>CH-51450-LEAD-A</special tool-no><special tool-desc> Oscilloscope Basic Lead Kit</special tool-desc></special tool>}

   1. Ignition/Vehicle - Off
   2. Perform the following procedure/test: **Relative Engine Compression Test**

      Verify the procedure/test passes.

      - If the procedure/test does not pass - Refer to **Symptoms - Engine Mechanical**
      - If the procedure/test passes - Replace the appropriate component: Q17 Fuel Injector

   {Tool Not Available: <special tool><special tool-no>CH-51450-A</special tool-no><special tool-desc> Oscilloscope Diagnostic Kit</special tool-desc></special tool> & <special tool><special tool-no>CH-51450-LEAD-A</special tool-no><special tool-desc> Oscilloscope Basic Lead Kit</special tool-desc></special tool>}

   1. Ignition/Vehicle - Off
   2. Perform the following procedure/test: **Engine Compression Test**

      Verify the procedure/test passes.

      - If the procedure/test does not pass - Refer to **Symptoms - Engine Mechanical**
      - If the procedure/test passes - Replace the appropriate component: Q17 Fuel Injector

   - **Go to next step: If the engine sound changes the same way for all cylinders**
5. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Fuel Injector Replacement (Cylinder #1, #2, #3)** , or **Fuel Injector Replacement (Cylinder #4)**
- For control module replacement, programming, and setup refer to **Control Module References**

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:

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- G18 High Pressure Fuel Pump
- Q17 Fuel Injector
- Fuel Line
- Fuel Rail
- {If equipped} Fuel Return Pipe

Reference Information

Special Tools

- <special tool><special tool-no>GE-28428-E</special tool-no><special tool-desc>High-Intensity Black Light Kit</special tool-desc></special tool>
- <special tool><special tool-no>GE-42220</special tool-no><special tool-desc>Universal 12 V Leak Detection Lamp</special tool-desc></special tool>

Circuit/System Verification

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: <special tool><special tool-no>GE-28428-E</special tool-no><special tool-desc>High-Intensity Black Light Kit</special tool-desc></special tool> or <special tool><special tool-no>GE-42220</special tool-no><special tool-desc>Universal 12 V Leak Detection Lamp</special tool-desc></special tool> - 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 **Fuel Return System Diagnosis**

   - **Go to next step: If no leak is present**
6. All OK.

FUEL PUMP ELECTRICAL CIRCUIT 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.

- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Circuit/System Description

The engine control module (ECM) provides ignition voltage to the coil side of the fuel pump relay whenever the engine is cranking or running. The ECM enables the fuel pump relay as long as the engine is cranking or running.

Diagnostic Aids

The following conditions may cause the fuel pump fuse to open:

- The fuse is faulty.
- There is an intermittent short to ground in the supply voltage circuit of the fuel pump.
- The fuel pump has an intermittent internal condition.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **Component Connector End Views - Index**

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

Special Tools

J-43244 Relay Puller Pliers

For equivalent regional tools, refer to **Special Tools ((Diagnosis Tools))** .

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool parameters listed below do not display Malfunction when commanding the Fuel Pump Relay ON and OFF.
    - Fuel Pump Relay Control Circuit Low Voltage Test Status
    - Fuel Pump Relay Control Circuit Open Test Status
    - Fuel Pump Relay Control Circuit High Voltage Test Status
    - **If Malfunction is displayed**

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Refer to Circuit/System Testing.

- **Go to next step: If Malfunction is not displayed**

3. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the KR23A Fuel Pump Relay. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 Ω between the ground circuit terminal 86 and ground.
   - **If 10 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/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. Ignition ON.
4. Verify a test lamp illuminates between the ignition circuit terminal 30 and ground.
   - **If the test lamp does not illuminate and the circuit fuse is OK**
   1. Ignition OFF, remove the test lamp.
   2. 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, verify the fuse is OK and there is voltage at the fuse.
   - **If the test lamp does not illuminate and the circuit fuse is open**
   1. Ignition OFF, remove the test lamp.
   2. Test for infinite resistance between the ignition circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - Go to next step: If infinite resistance
   3. Disconnect the harness connector at the G12 Fuel Pump.
   4. Test for infinite resistance between the output control circuit terminal 87 and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance, test or replace the G12 Fuel Pump.
   - **Go to next step: If the test lamp illuminates**
5. Verify that a test lamp does not illuminate between the control circuit terminal 85 and ground.
   - **If the test lamp illuminates**
   1. Ignition OFF, remove the test lamp, disconnect the 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, replace the K20 Engine Control Module.
   - **Go to next step: If the test lamp does not illuminate**
6. Remove the test lamp.
7. Verify the scan tool Fuel Pump Relay Control Circuit Low Voltage Test Status parameter is OK when commanding the Fuel Pump Relay ON.
   - **If OK is not displayed**
   1. Ignition OFF, disconnect the 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.

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- If infinite resistance, replace the K20 Engine Control Module.
- **Go to next step: If OK is displayed**

8. Install a 3 A fused jumper wire between the control circuit terminal 85 and the ground circuit terminal 86.
9. Verify the scan tool Fuel Pump Relay Control Circuit Low Voltage Test Status parameter is Malfunction when commanding the Fuel Pump Relay ON.
    - **If Malfunction is not displayed**
    1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the K20 Engine Control Module.
    2. 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 Malfunction is displayed**
10. Verify that a test lamp does not illuminate between the output control circuit terminal 87 and ground.
    - **If the test lamp illuminates**

      Repair the short to voltage on the control circuit

    - **Go to next step: If the test lamp does not illuminate**
11. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the G12 Fuel Pump. It may take up to 2 min for all vehicle systems to power down.
12. Test for less than 10 Ω between the G12 Fuel Pump ground circuit terminal 2 and ground.
    - **If 10 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/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**
13. Connect the harness connector at the G12 Fuel Pump.
14. Ignition ON, connect a 20 A fused jumper wire between the ignition circuit terminal 30 and the output control circuit terminal 87.
15. Verify the G12 Fuel Pump is activated.
    - **If the G12 Fuel Pump does not activate**
    1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the G12 Fuel Pump.
    2. Test for less than 2 Ω in the output 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 G12 Fuel Pump.
    - **Go to next step: If the G12 Fuel Pump activates**
16. Replace the KR23A Fuel Pump Relay.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Control Module References** for ECM replacement, programming, and setup
- **Fuel Tank Fuel Pump Module Replacement** for fuel pump replacement.
- **Electrical Relay Replacement (Attached to Wire Harness)** , or **Electrical Relay Replacement (Within an Electrical Center)**

FUEL RETURN SYSTEM DIAGNOSIS

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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**

Circuit/System Description

For an overview of the component/system, refer to **Fuel System Description**

Reference Information

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **Component Connector End Views - Index**

Special Tools

<special tool><special tool-no>GE-41415-60</special tool-no><special tool-desc>Engine Induction System Leak Test Adapter/Capless Fuel Fill Adapter</special tool-desc></special tool>

Equivalent regional tools: **Special Tools ((Diagnosis Tools))**

Circuit/System Testing

1. Disconnect the component: Fuel Return Hose @ Engine - Refer to **Metal Collar Quick Connect Fitting Service** , or **Plastic Collar Quick Connect Fitting Service**
2. Perform the following action:
   - {Cap Type Fuel Fill} Remove - Fuel Tank Filler Cap
   - {Capless Type Fuel Fill} Install - <special tool><special tool-no>GE-41415-60</special tool-no><special tool-desc>Engine Induction System Leak Test Adapter/Capless Fuel Fill Adapter</special tool-desc></special tool> @ Door @ Fuel Tank Filler Pipe
3. Apply - 6.9 kPa (1 PSI) - Compressed Air @ Fuel Return Hose

   Verify air flow can be detected at the component: Fuel Tank Filler Pipe

   - **If air flow is not detected**
   1. Disconnect the component: Fuel Return Hose @ Fuel Tank
   2. Apply - 6.9 kPa (1 PSI) - Compressed Air @ Fuel Return Hose

      Verify air flow can be detected at the component: Fuel Return Hose @ Fuel Tank

      - If air flow is detected - Replace the component: A7 Fuel Pump and Level Sensor Assembly
      - If air flow is not detected - Repair or replace the component(s) as necessary: Fuel Return Hose
   - **Go to next step: If air flow is detected**
4. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Fuel Pump Fuel Return Hose Replacement**
- **Fuel Return Front Pipe Replacement**
- **Fuel Return Pipe Replacement**

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- Fuel Return Rear Pipe Replacement
- Fuel Tank Fuel Pump Module Replacement

FUEL SPECIFIC GRAVITY TESTING

The fuel quality hydrometer provides a general indication of fuel quality and should not be considered scientifically accurate.

Diesel Fuel American Petroleum Institute (API) Gravity Requirements

Specification	No. 2 Diesel with up to 20% Bio-diesel	No. 2 Diesel	No. 1 Diesel
API Gravity	34 - 38	35 - 39	40 - 44

1. Fill a 1 liter (0.946 quart) container with a sample of fuel.
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. Submerse 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.
4. Refer to the Fuel Oil Specific Gravity Requirements table. If the correct fuel is being used in the conditions listed in Fuel Quality, refer to Fuel System Specifications , and meets fuel oil specific gravity requirements, the fuel is OK. If not, the fuel should be replaced.

FUEL SYSTEM 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

Circuit/System Description

For an overview of the component/system, refer to Fuel System Description

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

Master Electrical Component List , or Inline Harness Connector End Views - Index or Component Connector End Views - Index

Electrical Information Reference

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

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- Wiring Repairs

Scan Tool Reference

Control Module References

Circuit/System Verification

NOTE:

- **Verify the fuel tank is not empty before proceeding.**
- **Inspect the fuel system for damage or external leaks before proceeding.**

1. Verify DTC P018B, P018C, P018D, P0191, P0192, P0193, P127C, P127D is not set.
   - **If DTC P018B, P018C, P018D, P0191, P0192, P0193, P127C, P127D is set**

     Refer to Diagnostic Trouble Code (DTC) List - Vehicle
   - **Go to next step: If DTC P018B, P018C, P018D, P0191, P0192, P0193, P127c, P127D is not set**
2. Ignition - On / Vehicle - In Service Mode
3. Perform the scan tool control function: Fuel Pump Enable - Command the function On several times.

   Verify the scan tool parameter: Fuel Pressure Sensor = 370 to 450 kPa (54 to 65 PSI)
   - **If less than 370 kPa (54 PSI)**

     Refer to: Circuit/System Testing
   - **If greater than 450 kPa (65 PSI)**

     Refer to Fuel Return System Diagnosis
   - **Go to next step: If between 370 and 450 kPa (54 and 65 PSI)**
4. Engine - Cranking / Running - For 10 s

   Verify the scan tool parameter: Fuel Rail Pressure Sensor 1 = Greater than 13 MPa (1, 885 PSI)
   - **If 13 MPa (1, 885 PSI) or less**

     Refer to Fuel System Diagnosis - High Pressure Side
   - **Go to next step: If greater than 13 MPa (1, 885 PSI)**
5. Engine - Cranking

   Verify the function: Engine = Running
   - **If the function does not work**

     Refer to Fuel System Diagnosis - High Pressure Side
   - **Go to next step: If the function works**
6. Engine - Running

   Verify the following conditions do not exist:
   - Engine Stalled
   - Engine Idle Speed Not Stable
   - Engine Misfire

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- Exhaust - Smoke
- **If a condition exists**

  Refer to **Fuel System Diagnosis - High Pressure Side**

- **Go to next step: If no condition exists**

7. Refer to **Symptoms - Engine Controls**

Circuit/System Testing

1. Verify the following conditions do not exist:
   - Poor component electrical connections: Fuel Pump - Electrical Connector
   - Fuel Feed Pipe - Leaking / Restricted - Refer to **Fuel Leak Diagnosis**
   - Fuel Return Pipe - Leaking / Restricted - Refer to **Fuel Leak Diagnosis**
   - **If a condition exists**

     Repair or replace as necessary

   - **Go to next step: If no condition exists**
2. Verify the condition does not exist: Fuel Filter - Restricted
   - ***If the condition exists***

     Replace the component: Fuel Filter

   - **Go to next step: If no condition exists**
3. Test or replace the component: A7 Fuel Pump and Level Sensor Assembly

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Fuel Filter Replacement**
- **Fuel Tank Fuel Pump Module Replacement**

FUEL SYSTEM DIAGNOSIS - HIGH PRESSURE SIDE

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**

Circuit/System Description

For an overview of the component/system, refer to **Fuel System Description**

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

Master Electrical Component List , or **Inline Harness Connector End Views - Index** or **Component Connector End Views - Index**

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Component View Reference

Powertrain Component Views

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: **Do NOT perform this procedure unless directed here from the following diagnostic/test: Fuel System Diagnosis**

1. Engine - Cranking - For 10 s

   Verify the function: Engine = Running

   - **If the function does not work**

     Refer to: Circuit/System Testing - Test 1

   - **Go to next step: If the function works**
2. Ignition/Vehicle - Off
3. Verify the condition does not exist: Fuel - Contaminated/Poor Quality - Refer to **Contaminants-in-Fuel Diagnosis**
   - **If a condition exists**

     Repair or replace as necessary

   - **Go to next step: If no condition exists**
4. Engine - Running

   Verify the following conditions do not exist:

   - Engine - Misfire/Stalling
   - Engine Power - Low
   - Exhaust - Excessive Smoke
   - Idle Speed - Unstable
   - **If a condition exists**

     Refer to: Circuit/System Testing - Test 2

   - **Go to next step: If no condition exists**
5. Refer to **Symptoms - Engine Controls**

Circuit/System Testing

Test 1

1. Ignition/Vehicle & All vehicle systems - Off

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NOTE:

- **In order to perform step 2 - 5, the fuel temperature must be greater than 10B°C (50B°F) or misdiagnosis may occur.**
- **Leave the electrical connector connected.**

2. Disconnect the component: Fuel Return Hose @ Q18B Fuel Pressure Regulator 2 & Plug the fuel return hose(s) in order to prevent leakage.
3. Install suitable hose to the component: Outlet @ Q18B Fuel Pressure Regulator 2 & Place the other end of the hose into a suitable container.
4. Engine - Cranking - Until air is purged from the hose
5. Engine - Cranking - For 15 s

   Verify the container contains less than 15 mL (0.5 US fl oz)

   - **If 15 mL (0.5 US fl oz) or greater**

     Replace the component: Q18B Fuel Pressure Regulator 2

   - **Go to next step: If less than 15 mL (0.5 US fl oz)**
6. Ignition/Vehicle & All vehicle systems - Off
7. Install the component: Fuel Return Hose @ Q18B Fuel Pressure Regulator 2
8. Disconnect the electrical connector: Q17 Fuel Injector - All
9. Disconnect the component: Fuel Injection Fuel Return Pipe - Plug the fuel return hose(s) in order to prevent leakage. Refer to **Fuel Injection Fuel Return Pipe Replacement**
10. Engine - Cranking - For 15 s
11. Verify the condition does not exist: Leaking @ Fuel Injection Fuel Return Pipe
    - **If a condition exists**

      Replace the appropriate component: Q17 Fuel Injector

    - **Go to next step: If no condition exists**
12. Ignition/Vehicle & All vehicle systems - Off
13. Install the component: Fuel Injection Fuel Return Pipe
14. Perform the following steps:
    1. Disconnect the electrical connector: Q17 Fuel Injector - All
    2. Disconnect the electrical connector: E12 Glow Plug - All - Secure and insulate the connection using electrical tape.
    3. Remove the component: E12 Glow Plug - All
    4. Place and hold a clean shop towel over the component: Threaded Hole @ Cylinder Head - Glow Plug
    5. Engine - Cranking - For 6 s

       Verify the condition does not exist: Fuel On Shop Towel

       - **If a condition exists**

         Replace the appropriate component: Q17 Fuel Injector

       - **Go to next step: If no condition exists**
15. Test or replace the component: G18 High Pressure Fuel Pump

Test 2

1. Ignition/Vehicle & All vehicle systems - Off

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2. Perform the following procedure/test: **Cylinder Power Balance Test**

   Verify the procedure/test passes.

   - **If the procedure/test does not pass**

     Replace the component that failed the test: Q17 Fuel Injector

   - **Go to next step: If the procedure/test passes**
3. Engine - Idling

   NOTE: **Fuel Rail Pressure - Maximum @ At Idle Speed = 100 MPa (14, 504 PSI)**
4. Perform the scan tool control function: Fuel Rail Pressure - Increase & Decrease

   Verify the following parameters are within 690 kPa (100 PSI) of each other:

   - Desired Fuel Rail Pressure
   - Fuel Rail Pressure Sensor 1
   - **If not within 690 kPa (100 PSI) of each other**

     Replace the component: Q18A Fuel Pressure Regulator 1

   - **Go to next step: If within 690 kPa (100 PSI) of each other**
5. Ignition/Vehicle & All vehicle systems - Off

   NOTE:
   - **In order to perform step 6 - 9, the fuel temperature must be greater than 10B°C (50B°F) or misdiagnosis may occur.**
   - **Leave the electrical connector connected.**
6. Disconnect the component: Fuel Return Hose @ Q18B Fuel Pressure Regulator 2 & Plug the fuel return hose(s) in order to prevent leakage.
7. Install suitable hose to the component: Outlet @ Q18B Fuel Pressure Regulator 2 & Place the other end of the hose into a suitable container.
8. Engine - Idling - Until air is purged from the hose
9. Engine - Idling - For 15 s

   Verify the container contains less than 15 mL (0.5 US fl oz)

   - **If 15 mL (0.5 US fl oz) or greater**

     Replace the component: Q18B Fuel Pressure Regulator 2

   - **Go to next step: If less than 15 mL (0.5 US fl oz)**
10. Ignition/Vehicle & All vehicle systems - Off
11. Install the component: Fuel Return Hose @ Q18B Fuel Pressure Regulator 2
12. Disconnect the electrical connector: Q17 Fuel Injector - All
13. Disconnect the component: Fuel Injection Fuel Return Pipe - Plug the fuel return hose(s) in order to prevent leakage. Refer to **Fuel Injection Fuel Return Pipe Replacement**
14. Engine - Cranking - For 15 s
15. Verify the condition does not exist: Leaking @ Fuel Injection Fuel Return Pipe
    - **If a condition exists**

      Replace the appropriate component: Q17 Fuel Injector

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- **Go to next step: If no condition exists**

16. Ignition/Vehicle & All vehicle systems - Off
17. Install the component: Fuel Injection Fuel Return Pipe
18. Perform the following steps:
    1. Disconnect the electrical connector: Q17 Fuel Injector - All
    2. Disconnect the electrical connector: E12 Glow Plug - All - Secure and insulate the connection using electrical tape.
    3. Remove the component: E12 Glow Plug - All
    4. Place and hold a clean shop towel over the component: Threaded Hole @ Cylinder Head - Glow Plug
    5. Engine - Cranking - For 6 s

       Verify the condition does not exist: Fuel On Shop Towel

    - **If a condition exists**

      Replace the appropriate component: Q17 Fuel Injector

    - **Go to next step: If no condition exists**
19. Test or replace the component: G18 High Pressure Fuel Pump

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Fuel Injection Fuel Rail Assembly Replacement** - Q18B Fuel Pressure Regulator 2
- **Fuel Injection Fuel Return Pipe Replacement**
- **Fuel Injection Pump Metering Valve Replacement** - Q18A Fuel Pressure Regulator 1
- **Fuel Injector Replacement (Cylinder #1, #2, #3)** , or **Fuel Injector Replacement (Cylinder #4)**
- **Glow Plug Replacement**
- For control module replacement, programming, and setup refer to **Control Module References**

CHARGE AIR COOLER DIAGNOSIS (INDUCTION SYSTEM 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.
- **Diagnostic Procedure Instructions** provides 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-SPT** High Intensity White Light
- **GE 41413-311** Brass Cone Adapter
- **GE 41413-A** Evaporative Emission System Tester (EEST)

  For equivalent regional tools, refer to **Special Tools ((Diagnosis Tools))** .

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Smoke Test Application

1. Ignition Off, remove the Intake manifold cover, refer to **Intake Manifold Cover Replacement** .
2. Remove the intake manifold cover insulator, refer to **Intake Manifold Cover Insulator Replacement (Top of Engine)** , or **Intake Manifold Cover Insulator Replacement (Left Side)**
3. Place the air filter in a disposable plastic bag and secure it in the air cleaner housing to help prevent smoke leakage.
4. Remove a B193 Charge Air Cooler Temperature Sensor, refer to **Charge Air Cooler Air Temperature Sensor Replacement (Inlet Duct)** , or **Charge Air Cooler Air Temperature Sensor Replacement (Outlet Duct)** .
5. Connect the **GE 41413-A** hose to the **GE 41413-311** .

   NOTE: **Wrap the GE 41413-311 with a layer of electrical tape to protect the threads in the inlet/outlet duct.**

6. Insert the **GE 41413-311** into the Charge Air Cooler (CAC) temperature sensor mounting boss on the CAC inlet or outlet duct.
7. Apply smoke continuously with the **GE 41413-A** 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.**

8. Verify smoke is not visible at the components listed below:
   - Mass air flow sensor
   - Air cleaner outlet duct
   - Turbocharger air inlet adapter
   - Crankcase depression regulator valve
   - Intake manifold and gaskets
   - Charge Air Cooler Hoses/Pipes/Tubes
   - **If smoke is visible**

     Repair or replace the affected gasket, seal or component as necessary and repeat steps 7 and 8.

   - **Go to next step: If smoke is not visible**
9. Refer to **Charge Air Cooler Diagnosis (Induction System Smoke Test)** and perform the Charge Air Cooler Diagnosis (Induction System Air Leak Test).

CHARGE AIR COOLER DIAGNOSIS (FULL SYSTEM AIR 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.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Reference Information

Special Tools

- **EN 46091** Charge Air Cooler Tester
- **EN 46091-15** Engine Pressure Test Adapter
- **EN 47603** Compression Gauge Adapter
- **EN 47656-NA** Engine Pressure Test Adapter

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- **EN 47656-75** Quick Connect Air Fitting Kit

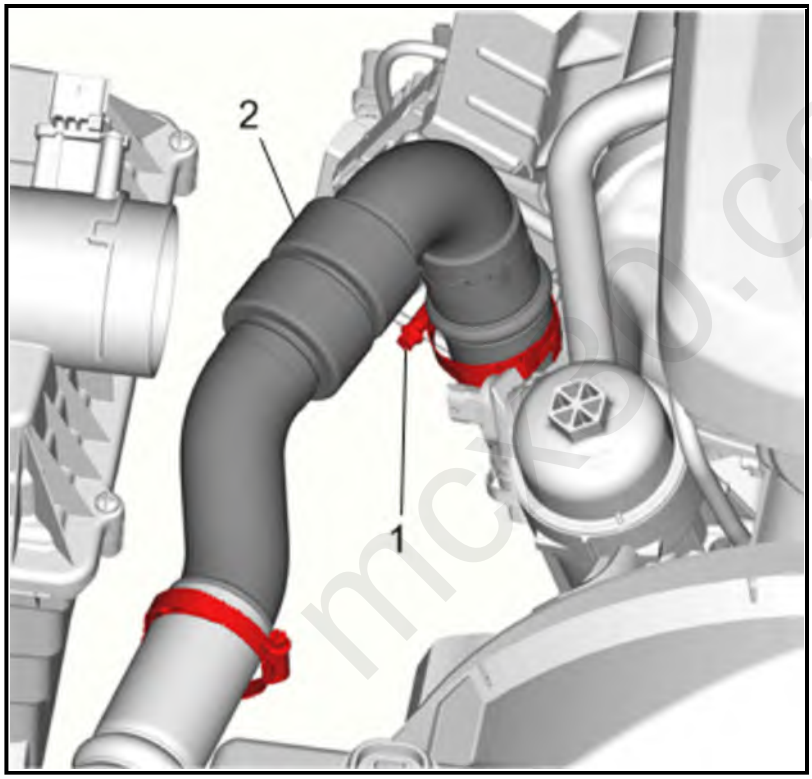
EN 46091-1 Pressure Regulator Adjustment

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** compression gauge adapter to the **EN 46091-1** gauge set outlet and connect shop air to the **EN 46091-1** air shutoff valve.
2. Open the shutoff valve, then slowly adjust the regulator on the **EN 46091-1** until the gauge reads 69 kPa (10 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.

Charge Air Cooler Inlet Connection (Engine Air Intake Hot Side)

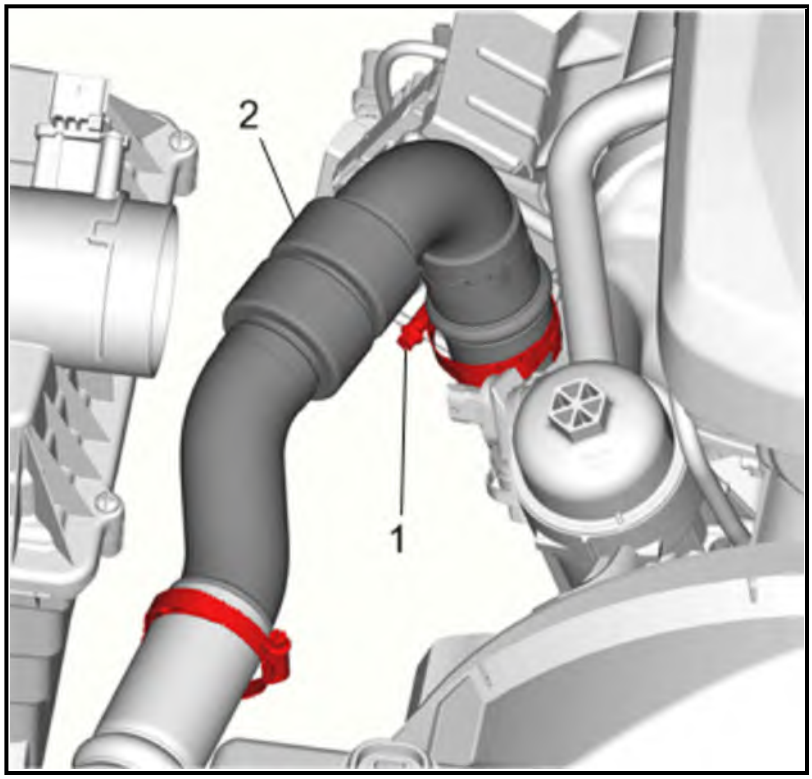
1. Loosen the clamp (1) that fastens the charge air cooler inlet duct connector hose (2) to the turbocharger.



NOTE:

- **Do not use a screwdriver or other tool to pry the hose loose. The hose can be torn or damaged. Loosen the hose by twisting.**
- **Do not disconnect charge air cooler inlet pipe at the charged air cooler**
- **After removing the charge air cooler connector hose at the turbocharger, protect the turbocharger opening to prevent entry of objects.**

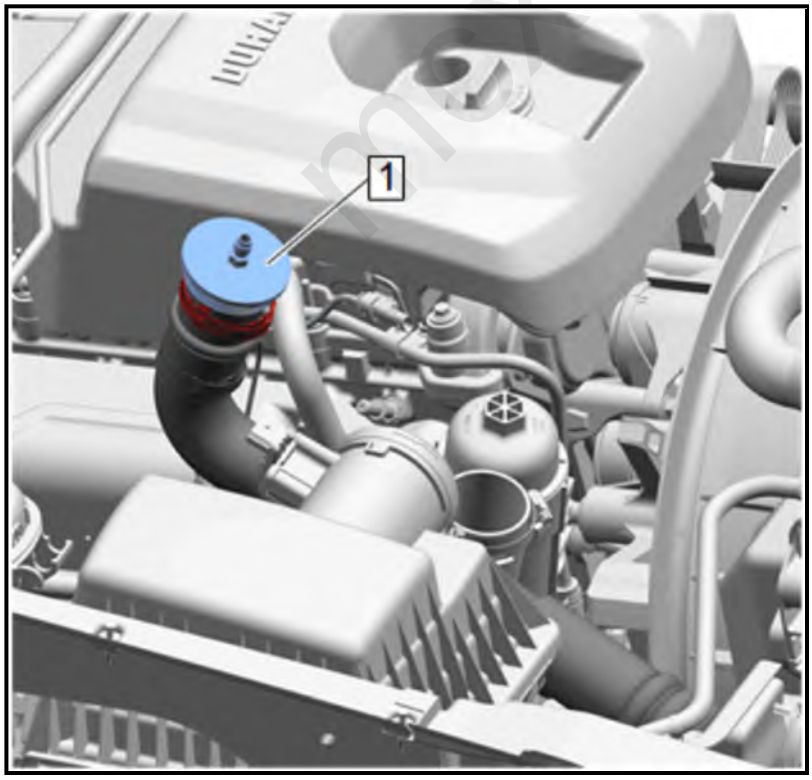
2. Remove the charge air cooler inlet connector hose (2) at the turbocharger, refer to **Charge Air Cooler Inlet Duct Replacement** .
3. Rotate the charge air cooler inlet hose/pipe assembly upward for access to the open end of the hose.
4. Carefully remove the existing clamp (1) from the CAC/turbocharger connector hose.



NOTE:

- **Ensure the EN 47656-75 has been installed on the EN 47656-NA**
- **Clean any oil residue from the inside of the hose and the EN 47656-NA before installing the EN 47656-NA .**
- **The special tool is to be installed in the charge air cooler inlet connector hose at the compressor outlet of the turbocharger.**

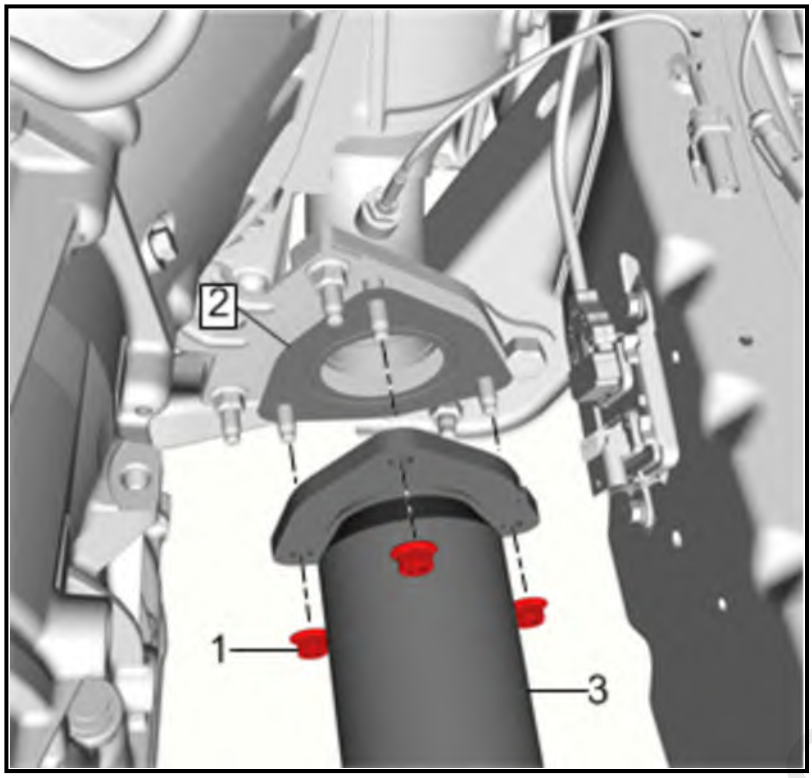
5. Install the **EN 47656-NA** Engine Pressure Test Adapter (1) to the CAC connector hose inlet using a suitable hose clamp.



Turbocharger Exhaust Pipe Connection

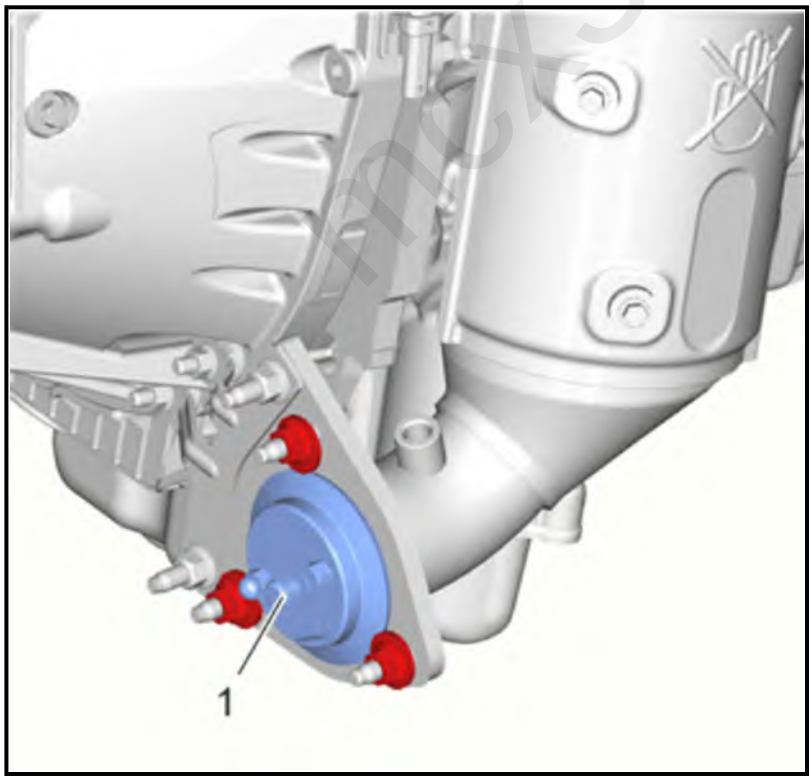
1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

2. Remove the 3 fasteners (1) at nitrogen oxides catalytic converter flange. Position the flange and pipe assembly aside.



NOTE: **An improperly seated EN 46091-15 will cause an excessive air leak and hissing noise.**

3. Install the **EN 46091-15** (1) to the catalytic converter pipe flange using 3 suitable flat washers and the 3 fasteners from the catalytic converter.



Air Pressure Application

WARNING: **Refer to Charge Air Cooler Warning .**

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1. Attach the **EN 46091-1** outlet hose to the quick disconnect fitting on **EN 47656-NA** .
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 69 kPa (10 psi) while listening for abnormal air leaks.

NOTE:

- **For accurate readings you must allow at least 30 s for the air pressure to stabilize.**
- **The engine will not hold pressure if the gauge valve is turned OFF.**
- **If an excessive air leak hissing sound at turbocharger outlet is present, rotate the crankshaft 90 degrees.**

4. Leave the air valve turned ON for the duration of the test.

Leak Test

NOTE: **An air leak that appears as small bubbles or foaming is normal.**

1. Turn **EN 46091-1** air valve ON and perform the following procedure:
    1. Inspect for air leaks by listening for excessive hissing sounds.
    2. Inspect for air leaks by using a pump spray bottle to apply a soapy solution, while observing for excessive soapy bubbles at all of the following engine locations:
        - Charge air cooler pipes/hoses connections
        - Charge air cooler core
        - EGR valve gaskets
        - EGR cooler bypass valve gaskets
        - EGR cooler gaskets
        - Exhaust manifold gaskets
        - Turbocharger gaskets, inlet and outlet connections
        - Intake manifold gaskets
        - Intake manifold runner control valve - if equipped
            - If any abnormal leaks are found, replace the affected gasket or component as necessary.
2. Retest the engine system for air leaks. There should be no abnormal air leaks.
3. If no other air leaks are found, assemble the vehicle. Remove the tester and adapters by performing the following procedure:
    1. Slowly bleed the air from the cooler by depressing the relief valve on the adapter.
    2. Remove the air hose, gauge/regulator assembly, and both adapters.
    3. Carefully remove the retainer clips (1) from the OEM clamp before install.

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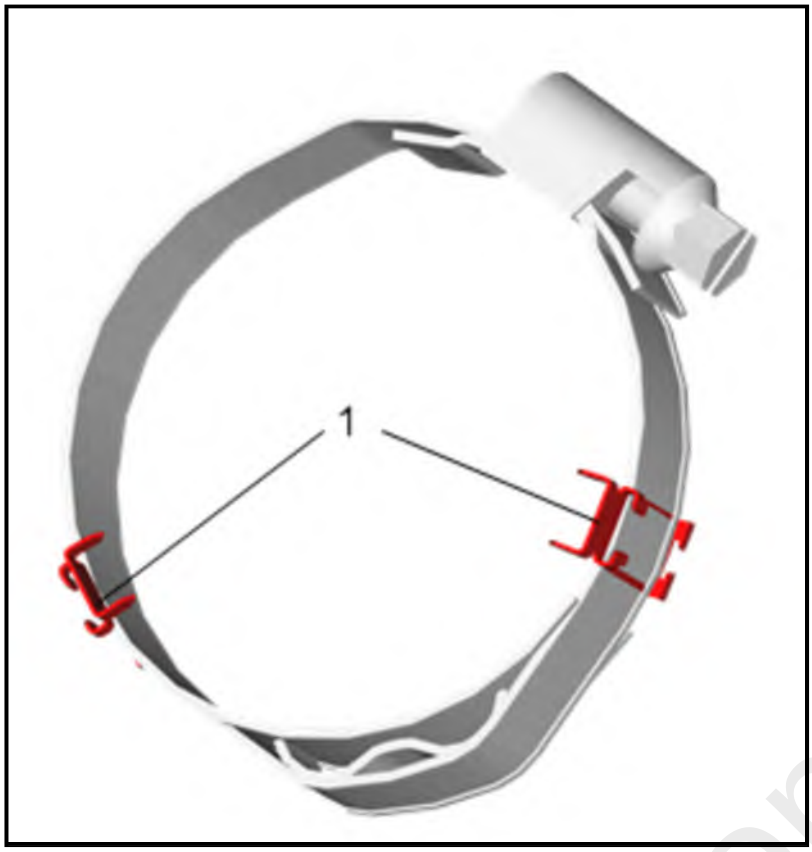

4. Connect the CAC inlet hose/pipe to the turbocharger with an OEM clamp and tighten, refer to **Charge Air Cooler Inlet Duct Replacement** .
5. Connect the nitrogen oxides catalytic converter flange, refer to **Nitrogen Oxides Catalytic Converter Replacement (LWN)** .
6. Clear all DTC information with a scan tool.

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