

2018 ENGINE PERFORMANCE

Engine Controls And Fuel - 2.0L (LTG) - Diagnostic Information And Procedures (P0010 - P06B7) - Traverse

DIAGNOSTIC INFORMATION AND PROCEDURES

DTC P0010, P0013, OR P2088, P2089, P2090, OR P2091

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 P0010

Intake Camshaft Position Actuator Solenoid Valve Control Circuit

DTC P0013

Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit

DTC P2088

Intake Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage

DTC P2089

Intake Camshaft Position Actuator Solenoid Valve Control Circuit High Voltage

DTC P2090

Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage

DTC P2091

Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Control	P0010, P0013, P2088, P2090	P0010, P0013, P2089, P2091	P0010, P0013, P2089, P2091 *	P0011, P0014 *
Low Reference	-	P0010, P0013, P2089, P2091	-	P0011, P0014 *
*Additional DTCs may set.				

Circuit/System Description

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

Circuit	Description

Circuit	Description
Control	The output circuit is switched to 12 V to activate the component.
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.
Q6 Camshaft Position Actuator Solenoid Valve	A solenoid valve is an electro-mechanically operated valve. The valve is controlled by an electric current through the solenoid.

The solenoid valve controls the flow of engine oil to the hydraulic actuator that adjusts the angle of the camshaft relative to the position of the crankshaft.

Conditions for Running the DTC

P0010, P0013, P2088, P2089, P2090, P2091

- Camshaft Position Actuator Solenoid Valve = On
- Ignition Switch Position = Run/Crank
- Ignition Voltage = Greater than 11 V

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

Conditions for Setting the DTC

P0010, P0013, P2088, P2089, P2090, P2091

Control Circuit = Commanded state does not match the actual state - For greater than 5 s

Actions Taken When the DTC Sets

{With Turbocharger} DTCs listed in the DTC Descriptor Category = Type A DTC

{Without Turbocharger} DTCs listed in the DTC Descriptor Category = Type B DTC - Exceptions listed below

Conditions for Clearing the DTC

{With Turbocharger} DTCs listed in the DTC Descriptor Category = Type A DTC

{Without Turbocharger} DTCs listed in the DTC Descriptor Category = Type B DTC - Exceptions listed below

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

Powertrain Component Views

Electrical Information Reference

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

DTC Type Reference

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

Scan Tool Reference

[Control Module References](#)

[Circuit/System Verification](#)

NOTE:

- The engine oil level and the oil pressure are critical to the correct operation of the system. Verify the engine has the correct oil level and the correct oil pressure before continuing with this diagnostic.
- The engine oil condition has a major impact on the camshaft actuator system. Debris in the oil can interfere with the camshaft position actuator solenoid valve and the mechanical camshaft actuator operation. Inspect for dirty or degraded engine oil.
- If a crankshaft or camshaft position sensor DTC is set, the scan tool camshaft position actuator output control will be disabled.

1. Ignition - On/Vehicle - In Service Mode

2. Verify DTC P0335, P0336, P0340, P0341, P0365, P0366 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:

- Engine Oil - Contaminated/Dirty/Fill Level = Low
- Engine Oil Pressure - Low - Refer to: [Oil Pressure Diagnosis and Testing](#)
- **If a condition exists**

Repair as necessary

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

4. Engine - Idling

5. Perform the appropriate scan tool control function:

- Exhaust Camshaft Position Actuator - From 0 to 20° and back to 0°.
- Intake Camshaft Position Actuator - From 0 to 20° and back to 0°.
- Verify the scan tool parameter:
- Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage Test Status = OK or Not Run
- Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit Open Test Status = OK or Not Run
- Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit High Voltage Test Status = OK or Not Run
- Intake Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage Test Status = OK or Not Run
- Intake Camshaft Position Actuator Solenoid Valve Control Circuit Open Test Status = OK or Not Run

- Intake Camshaft Position Actuator Solenoid Valve Control Circuit High Voltage Test Status = OK or Not Run

- **If not the specified state**

Refer to: Circuit/System Testing

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

6. Perform the scan tool control function:

- Exhaust Camshaft Position Actuator - From 0 to 20° and back to 0°.
- Intake Camshaft Position Actuator - From 0 to 20° and back to 0°.
- Verify the scan tool parameter:
- Exhaust Camshaft Position Variance = Less than 2° - During each of the commanded states
- Intake Camshaft Position Variance = Less than 2° - During each of the commanded states
- **If 2° or greater**

Refer to: Circuit/System Testing

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

7. Verify the scan tool parameter:

- Intake Camshaft Position Variance = Less than 2°
- Exhaust Camshaft Position Variance = Less than 2°
- Perform the action while monitoring the parameter:
- Wiggle the harness and connector: Q6 Camshaft Position Actuator Solenoid Valve
- Wiggle the harness and connector: K20 Engine Control Module
- **If 2° or greater**

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

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

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 appropriate electrical connector: Q6 Camshaft Position Actuator Solenoid Valve
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. Perform the scan tool control function:

- Exhaust Camshaft Position Actuator Solenoid Valve - Off
- Intake Camshaft Position Actuator Solenoid Valve - Off

Verify a test lamp does not turn On between the test points: Control circuit terminal 1/A & Ground

- **If the test lamp turns On**

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 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 does not turn On**

6. Remove - Test Lamp

7. Perform the scan tool control function:

- Exhaust Camshaft Position Actuator Solenoid Valve - On
- Intake Camshaft Position Actuator Solenoid Valve - On
- Verify the scan tool parameter:
- Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage Test Status = OK or Not Run
- Intake Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage Test Status = OK or Not Run

- **If not the specified state**

1. Ignition/Vehicle - Off
2. Disconnect the appropriate electrical connector: 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.
 - 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 1/A & Ground

9. Perform the scan tool control function:

- Exhaust Camshaft Position Actuator Solenoid Valve - On
- Intake Camshaft Position Actuator Solenoid Valve - On
- Verify the scan tool parameter:
- Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage Test Status = Malfunction
- Intake Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage Test Status = Malfunction

- **If not the specified state**

1. Ignition/Vehicle - Off & Remove - Jumper wire(s)
2. Disconnect the appropriate electrical connector: K20 Engine Control Module
3. 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

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

10. Verify DTC P0011, P0014 is not set.

- **If the DTC is set**

1. Ignition/Vehicle - Off
2. Remove the component: Q6 Camshaft Position Actuator Solenoid Valve
3. Verify a condition does not exist with the component: Q6 Camshaft Position Actuator Solenoid Valve
 - Engine Oil - Leaking @ Harness Connector
 - Screen - Misaligned/Missing/Restricted/Torn
 - Valve - Scored/Visible Damage
 - If a condition exists - Replace the component: Q6 Camshaft Position Actuator Solenoid Valve
 - Go to next step: If no condition exists

NOTE: It may be necessary to use jumper wires if the connector indexing is different between the connectors.

4. Swap the two components:

- Q6E Camshaft Position Actuator Solenoid Valve - Exhaust
- Q6F Camshaft Position Actuator Solenoid Valve - Intake

5. Engine - Running

NOTE:

- **This step is testing the mechanical camshaft position actuator for the camshaft that set the DTC.**
- **Perform this test at the original location that set the DTC.**

6. Perform the scan tool control function:

- Exhaust Camshaft Position Actuator - From 0 to 20° and back to 0°.
- Intake Camshaft Position Actuator - From 0 to 20° and back to 0°.
- Verify the scan tool parameter:
- Exhaust Camshaft Position Variance = Less than 2° - During each of the commanded states
- Intake Camshaft Position Variance = Less than 2° - During each of the commanded states
- If 2° or greater - Replace the component: Camshaft Position Actuator
- If less than 2° - Replace the component: Q6 Camshaft Position Actuator Solenoid Valve - The original component that set the DTC

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

11. Test or replace the component: Q6 Camshaft Position Actuator Solenoid Valve

Component Testing

Static Test

1. Ignition/Vehicle - Off
2. Disconnect the appropriate electrical connector: Q6 Camshaft Position Actuator Solenoid Valve
3. Test for 5 to 12 ohms between the test points: Control terminal 1/A & Low Reference terminal 2/B

- **If not between 5 and 12 ohms**

Replace the component: Q6 Camshaft Position Actuator Solenoid Valve

- **Go to next step: If between 5 and 12 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: Q6 Camshaft Position Actuator Solenoid Valve

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

5. All OK.

Dynamic Test

1. Ignition/Vehicle - Off

2. Disconnect the appropriate electrical connector: Q6 Camshaft Position Actuator Solenoid Valve

3. Connect a jumper wire between the test points: Low Reference terminal 2/B & Ground

4. Momentarily connect a 7.5 A fused jumper wire between the test points: Control terminal 1/A & B+

Verify the component turns On and Off when connecting and disconnecting the jumper wire: Q6 Camshaft Position Actuator Solenoid Valve

- **If the component does not turn On and Off**

Replace the component: Q6 Camshaft Position Actuator Solenoid Valve

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

5. All OK.

Repair Instructions

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

- [Camshaft Position Actuator and Camshaft Replacement - Exhaust](#)
- [Camshaft Position Actuator and Camshaft Replacement - Intake](#)
- [Camshaft Position Actuator Exhaust Solenoid Valve Replacement](#)
- [Camshaft Position Actuator Intake Solenoid Valve Replacement](#)
- For control module replacement, programming, and setup refer to: [Control Module References](#)

DTC P0011 OR P0014

Diagnostic Instructions

- Perform the [Diagnostic System Check Instructions](#) 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 P0011

Intake Camshaft Position System Performance

DTC P0014

Exhaust Camshaft Position System Performance

Diagnostic Fault Information

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

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Control	P0010, P0013, P2088, P2090	P0010, P0013	P0010, P0013, P055B	P0010, P0013, P2089, P2091	P0011, P0014
Low Reference	-	P0010, P0013	P0010, P0013	-	-

Circuit/System Description

The camshaft position actuator system enables the engine control module (ECM) to change the timing of the camshafts while the engine is operating. The camshaft position actuator solenoid valves are each supplied a dedicated pulse width modulated (PWM) control circuit and low reference circuit from the ECM. The ECM operates each camshaft position actuator solenoid valve by controlling the amount of solenoid valve signal duty cycle to control the oil flow that applies the pressure to advance or retard the camshafts.

Conditions for Running the DTC

- DTC P0010, P0013, P0016, P0017, P0335, P0336, P0340, P0341, P0365, or P0366 is not set.
- The ignition voltage is greater than 11 V.
- The engine is operating.
- The desired camshaft position is not changing greater than 3.0 degrees for at least 3 s.
- Both of the desired and actual camshaft position actuator values cannot be greater than 29 degrees or less than 6 degrees.

The DTCs run continuously once the above conditions are met.

Conditions for Setting the DTC

The ECM detects the difference between the desired camshaft position angle and the actual camshaft position angle is greater than 6 degrees for greater 13.5 s.

Action Taken When the DTC Sets

- DTCs listed in the DTC Descriptor Category = Type B DTC - Exceptions listed below
If equipped with a turbocharger = Type A DTC
- The Auto Stop and Auto Start function of the hybrid system is disabled.

Conditions for Clearing the DTC

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

If equipped with a turbocharger = Type A DTC

Diagnostic Aids

- A low oil level or condition may set this DTC.
- Inspect the engine for any recent engine mechanical repairs. An incorrectly installed camshaft, camshaft actuator, or timing chain can cause this DTC to set.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Powertrain Component Views

Description and Operation

Camshaft Actuator System Description

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

NOTE:

- The engine oil level and the oil pressure are critical to the correct operation of the camshaft position actuator system. Verify that the engine has the correct oil level and the correct oil pressure before continuing with this diagnostic.
- The engine oil condition has a major impact on the camshaft actuator system. Debris in the oil can interfere with the camshaft position actuator solenoid and the mechanical camshaft actuator operation. Inspect for dirty or degraded crankcase oil. The engine may require an oil change. Inquire with the customer when the last oil change was performed. You may also monitor the scan tool Engine Oil Life Remaining parameter. Advise the customer an oil change may be required.

1. Verify the engine has the proper oil condition, level, and pressure. Refer to Oil Pressure Diagnosis and Testing.

- If the oil condition, level, and oil pressure are not correct

Repair as necessary.

- Go to next step: If the oil condition, level, and oil pressure are correct

2. Verify DTC P0010, P0011, P0013, P0014, P0016, P0017, P0335, P0336, P0340, P0341, P0365, P0366, P2088, P2089, P2090 or P2091 is not set.

- If any DTCs other than P0011 or P0014 are set

Refer to Diagnostic Trouble Code (DTC) List - Vehicle for further diagnosis.

- If only DTC P0011 or P0014 is set

1. 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.

2. Verify the DTC does not set.

- If the DTC sets, refer to Circuit/System Testing.
- If the DTC does not set, all OK.

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

3. All OK.

Circuit/System Testing

NOTE:

You must complete the Circuit/System Verification before proceeding with Circuit/System Testing.

1. Ignition OFF, disconnect the harness connector at the appropriate Q6 Camshaft Position Actuator Solenoid Valve, ignition ON.

2. Verify a test lamp illuminates between the control circuit terminal 1 or A and ground when commanding the appropriate Camshaft Position Actuator Solenoid Valve On with a scan tool.
 - **If the test lamp does not illuminate**
 1. Ignition OFF, 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 or short to ground in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **Go to next step: If the test lamp illuminates**
 3. Ignition OFF.
 4. Remove the appropriate Q6 Camshaft Position Actuator Solenoid Valve. Inspect the Camshaft Position Actuator Solenoid Valve and mounting area for the following conditions:
 - For a torn, restricted, incorrect positioned, or missing screens at the Q6 Camshaft Position Actuator Solenoid Valve
 - For engine oil leaks between the oil sealing lands of the Q6 Camshaft Position Actuator Solenoid Valve
 - For oil seepage at the Q6 Camshaft Position Actuator Solenoid Valve connector
 - **If a condition is found**

Replace the Q6 Camshaft Position Actuator Solenoid Valve.
 - **Go to next step: If a condition is not found**
- NOTE:** This step is testing the mechanical operation of the camshaft position actuator solenoid valve that set the DTC.
5. Exchange the suspected Q6 Camshaft Position Actuator Solenoid Valve with a Q6 Camshaft Position Actuator Solenoid Valve that is operating correctly.
 6. Engine Running.
 7. Command the appropriate camshaft position actuator from 0 degrees to 20 degrees and back to zero while observing the appropriate scan tool Intake/Exhaust Camshaft Position Variance parameters. The Intake/Exhaust Camshaft Position Variance should be less than 2 degrees in each of the commanded states.
 - **If the Camshaft Position Variance parameter is greater than 2 degrees**

Replace or repair the mechanical camshaft position actuator.
 - **Go to next step: If the Camshaft Position Variance parameter is less than 2 degrees**
 8. Test or replace the Q6 Camshaft Position Actuator Solenoid Valve.

Component Testing

1. Ignition OFF, disconnect the harness connector at the appropriate Q6 Camshaft Position Actuator Solenoid Valve.
2. Test for 7 - 12 Ω between the control terminal 1 or A and the low reference circuit terminal 2 or B.
 - **If not between 7 - 12 Ω**

Replace the Q6 Camshaft Position Actuator Solenoid Valve.
 - **Go to next step: If between 7 - 12 Ω**
3. Test for infinite resistance between each terminal and the Q6 Camshaft Position Actuator Solenoid Valve housing.
 - **If less than infinite resistance**

Replace the Q6 Camshaft Position Actuator Solenoid Valve.
 - **Go to next step: If infinite resistance**
4. All OK

Repair Instructions

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

- [Camshaft Position Actuator Intake Solenoid Valve Replacement](#)
- [Camshaft Position Actuator Exhaust Solenoid Valve Replacement](#)
- [Control Module References](#) for engine control module replacement, programming, and setup

DTC P0016 OR P0017

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 P0016

Crankshaft Position - Intake Camshaft Position Not Plausible

DTC P0017

Crankshaft Position - Exhaust Camshaft Position Not Plausible

Circuit/System Description

The engine control module (ECM) uses the crankshaft position sensor, intake camshaft position sensor, and exhaust camshaft position sensor information to monitor the correlation between the crankshaft, intake camshaft, and exhaust camshaft position.

Conditions for Running the DTC

- DTC P0335, P0336, P0340, P0341, P0365, P0366, P0641, and P0651 are not set.
- The engine is cranking or running.
- The crankshaft and camshaft position signals are synchronized.
- The camshaft position actuator solenoid valves are in the parked position.

The DTCs run continuously once the above conditions are met.

Conditions for Setting the DTC

The ECM detects a camshaft that is greater than 8 degrees advanced or 9 degrees retarded in relationship to the crankshaft.

Action Taken When the DTC Sets

DTCs P0016 and P0017 are Type B DTCs.

Conditions for Clearing the DTC

DTCs P0016 and P0017 are Type B DTCs.

Diagnostic Aids

- Inspect the engine for any recent engine mechanical repairs. An incorrectly installed timing chain can cause this DTC to set.
- A camshaft position actuator solenoid valve that is in the full advance or retard position can cause this DTC to set.

Reference Information

Description and Operation

Camshaft Actuator System Description

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 P0010, P0013, P0335, P0336, P0340, P0341, P0365, or P0366 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 at normal operating temperature.
4. Verify DTC P0016 or P0017 is not set.
 - **If the DTC is set**

Inspect for the following and repair as necessary:
 - A Q6 Camshaft Position Actuator Solenoid Valve that is stuck in the full advance or retard position.
 - The correct installation of the Q6 Camshaft Position Actuator Solenoid Valves.
 - The correct installation of the B23 Camshaft Position Sensors.
 - The correct installation of the B26 Crankshaft Position Sensor.
 - A timing chain tensioner condition.
 - An incorrectly installed timing chain.
 - Excessive play in the timing chain.
 - A timing chain that jumped teeth.
 - A crankshaft reluctor wheel that has moved in relationship to top dead center (TDC) on the crankshaft.
 - **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.
6. Verify the DTC does not set.
 - **If the DTC sets**

A mechanical condition listed above still exists.
 - **Go to next step: If the DTC does not set**
7. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.

- Camshaft Position Actuator Exhaust Solenoid Valve Replacement
- Camshaft Position Actuator Intake Solenoid Valve Replacement
- Camshaft Position Sensor Replacement - Exhaust
- Camshaft Position Sensor Replacement - Intake
- Crankshaft Position Sensor Replacement
- Timing Chain Tensioner Replacement

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 P0030**

HO2S Heater Control Circuit Sensor 1

DTC P0031

HO2S Heater Control Circuit Low Voltage Sensor 1

DTC P0032

HO2S Heater Control Circuit High Voltage Sensor 1

DTC P0036

HO2S Heater Control Circuit Sensor 2

DTC P0037

HO2S Heater Control Circuit Low Voltage Sensor 2

DTC P0038

HO2S Heater Control Circuit High Voltage Sensor 2

DTC P0054

HO2S Heater Resistance Sensor 2

DTC P0135

HO2S Heater Performance Sensor 1

DTC P0141

HO2S Heater Performance Sensor 2

DTC P103B

HO2S Heater Supply Voltage Sensing Circuit Performance

DTC P103C

HO2S Heater Supply Voltage Sensing Circuit Low Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition	P0030, P0031, P0036, P0037, P0132, P0135, P0138, P0141, P103B, P103C	P0030, P0031, P0036, P0037, P0132, P0135, P0138, P0141, P103B, P103C	-	P0135, P0141

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Control	P0030, P0031, P0036, P0037, P0132, P0135, P0138, P0141	P0030, P0031, P0036, P0037, P0132, P0135, P0138, P0141	P0030, P0032, P0036, P0038, P0132, P0135, P0138, P0141, P0690	P0135, P0141

Circuit/System Description

Circuit	Description
Ignition	Supplied from a fuse.
Control	The output circuit is switched to ground to activate the component.

Component	Description
B52 Heated Oxygen Sensor	In addition to the hot exhaust gas, heated oxygen sensors have a resistor heating element to minimize the time required for the sensor to reach operating temperature. The ECM monitors the temperature and turns the heater on as necessary.
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

P0030, P0031, P0032, P0036, P0037, P0038

- Engine Speed = Greater than 400 RPM
- Ignition Voltage = 11 to 32 V

Frequency the DTC runs = Continuously - After the running conditions are met - For greater than 5 s

P0053

- DTCs related to the following system/component = Not Set
 - B34 Engine Coolant Temperature Sensor
 - B111B Turbocharger Boost/Intake Air Temperature Sensor
- ECT Sensor & IAT Sensor = Within 8Â°C (14Â°F) of each other
- ECT Sensor = 30 to 255Â°C (86 to 491Â°F)
- Engine = Running
- Ignition Voltage = Less than 32 V

Frequency the DTC runs = Once - Per cold start-up - After the running conditions are met

P0135, P0141

- DTC P0116, P0117, P0118, P0119, P0128, P111E = Not set
- HO2S Heater = Device controls are not active.
- HO2S 1, 2 Heater Command = Greater than 0% Duty Cycle
- Ignition Voltage = 10 to 32 V

Frequency the DTC runs = 2 times - Per drive cycle - After the running conditions are met - For greater than 120 s

P103B, P103C

- Engine = Cranking or Running
- Ignition Voltage = 10 to 32 V

Frequency the DTC runs = Continuously - After the running conditions are met - For greater than 3 s

Conditions for Setting the DTC

P0030, P0031, P0032, P0036, P0037, P0038

Control Circuit = Commanded state does not match the actual state - For greater than 5 s

P0053, P0054

HO2S Heater Resistance = Resistance Out Of Range - During engine startup

P0135, P0141

HO2S 1, 2 Heater 0.3 to 2.5 A - For greater than 10 s

P103B

HO2S Heater Supply Voltage & Ignition Voltage = Not within 2 V of each other - For greater than 3 s

P103C

HO2S Heater Supply Voltage = Less than 6 V - For greater than 3 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

High resistance in the circuits of the component may set DTC P103B, P103C without setting the DTC for the component: B52 Heated Oxygen Sensor

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References

1. Engine - Idling - At normal operating temperature

NOTE: This step only applies to the following component DTCs: HO2S Heater

2. Verify DTC P103B, P103C is not set and no other DTCs are set.

- **If DTC P103B, P103C is set and other DTCs are set**

Refer to: Circuit/System Testing - Test 1

- **If DTC P103B, P103C is not set and other DTCs are set**

Refer to: Circuit/System Testing - Test 1

- **If DTC P103B, P103C 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. Verify the scan tool parameter:

- HO2S 1, 2 Heater Control Circuit High Voltage Test Status = OK or Not Run
- HO2S 1, 2 Heater Control Circuit Low Voltage Test Status = OK or Not Run
- HO2S 1, 2 Heater Control Circuit Open Test Status = OK or Not Run
- **If not the specified state**

Refer to: Circuit/System Testing - Test 1

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

4. Verify the scan tool parameter:

HO2S 1, 2 Heater = 0.3 to 2.4 A

- **If not between 0.3 and 2.4 A**

Refer to: Circuit/System Testing - Test 1

- **Go to next step: If between 0.3 and 2.4 A**

5. Verify the scan tool parameter: HO2S 1, 2 Heater = The value should not spike or drop out.

Perform the action while monitoring the parameter:

- Wiggle the harness and connector: B52 Heated Oxygen 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 step 2

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

7. All OK.

Test 1

1. Ignition/Vehicle & All vehicle systems - Off
2. Disconnect the appropriate electrical connector: B52 Heated Oxygen Sensor
3. Ignition - On/Vehicle - In Service Mode
4. Verify a test lamp turns On between the test points:

- {B52A Heated Oxygen Sensor 1} Ignition circuit terminal 5 & Ground
- {B52B Heated Oxygen Sensor 2} Ignition circuit terminal 2 & 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:

- {B52A Heated Oxygen Sensor 1} Ignition circuit terminal 5 & Output terminal @ Fuse
- {B52B Heated Oxygen Sensor 2} Ignition circuit terminal 2 & 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. Connect the electrical connector: B52 Heated Oxygen Sensor

3. Ignition - On/Vehicle - In Service Mode

4. Replace the component: Fuse

5. Verify the fuse does not open.

- If the fuse opens and there are components connected to the circuit - Disconnect a component and repeat step 4.4
- 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 with all components connected.

NOTE:

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

6. 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.

7. All OK.

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

5. Verify a test lamp does not turn On between the test points:

- {B52A Heated Oxygen Sensor 1} Ignition circuit terminal 5 & Control circuit terminal 6
- {B52B Heated Oxygen Sensor 2} Ignition circuit terminal 2 & Control circuit terminal 1
- **If the test lamp turns 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:

- {B52A Heated Oxygen Sensor 1} Control circuit terminal 6 @ Component harness & Ground
 - {B52B Heated Oxygen Sensor 2} 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**
6. Remove - Test Lamp
7. Engine - Running
8. Verify the scan tool parameter: HO2S 1, 2 Heater Control Circuit Open Test Status = Malfunction
- **If not the specified state**
 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:
 - {B52A Heated Oxygen Sensor 1} Control circuit terminal 6 @ Component harness & Ground
 - {B52B Heated Oxygen Sensor 2} Control circuit terminal 1 @ Component harness & Ground
 - If 1 V or greater - Repair the short to voltage on the circuit.
 - If less than 1 V - Replace the component: K20 Engine Control Module
 - **Go to next step: If the specified value**

NOTE:

- **As little as 10 ohms of resistance in a circuit may cause a DTC to set.**
- **Performing this test may set additional DTCs.**

9. Connect a 3 A fused jumper wire between the test points:
- {B52A Heated Oxygen Sensor 1} Ignition circuit terminal 5 & Control circuit terminal 6
 - {B52B Heated Oxygen Sensor 2} Ignition circuit terminal 2 & Control circuit terminal 1
10. Engine - Running
11. Verify the scan tool parameter: HO2S 1, 2 Heater Control Circuit High Voltage Test Status = Malfunction
- **If not the specified state**
 1. Ignition/Vehicle - Off & Remove - Jumper wire(s)
 2. Disconnect the appropriate electrical connector: K20 Engine Control Module
 3. Test for less than 2 ohms between the test points:
 - {B52A Heated Oxygen Sensor 1} Control circuit terminal 6 @ Component harness & The other end of the circuit @ Control module harness
 - {B52B Heated Oxygen Sensor 2} 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
 - **Go to next step: If the specified state**
12. Test or replace the component: B52 Heated Oxygen Sensor

Test 2

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: Output terminal @ Fuse & 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**

4. Replace the component: K20 Engine Control Module

Repair Instructions

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

- [Heated Oxygen Sensor Replacement - Sensor 1](#)
- [Heated Oxygen Sensor Replacement - Sensor 2](#)
- For control module replacement, programming, and setup refer to: [Control Module References](#)

DTC P0033, P0034, OR P0035

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 P0033

Turbocharger Bypass Solenoid Valve Control Circuit

DTC P0034

Turbocharger Bypass Solenoid Valve Control Circuit Low Voltage

DTC P0035

Turbocharger Bypass Solenoid Valve Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Ignition Voltage Circuit	P0033, P0034, P0243, P0245, P0443, P06DA, P06DB*	P0033	P0033	-	-
Turbocharger Bypass Valve Solenoid Control Circuit	P0034	P0033	P0033	P0035, P0690	P0033
* Ignition fuse opens. Message center or an indicator may display ENGINE POWER IS REDUCED. Engine may experience NO Crank - NO Start condition.					

Circuit/System Description

The dual-scroll turbocharger incorporates a wastegate that is controlled by the engine control module (ECM) by means of a pulse width modulation (PWM) solenoid, to regulate the pressure ratio of the compressor. An ECM controlled compressor bypass valve is integrated into the unit to prevent compressor surging and damage from vibrations by opening during abrupt closed throttle conditions. The bypass valve is open during closed throttle deceleration conditions to allow air to recirculate in the turbocharger and maintain compressor speed.

As engine load and RPM increase, the turbocharger bypass valve is commanded closed by the ECM. As soon as the throttle closes, the valve is commanded open to allow the turbocharger air to recirculate to prevent compressor surging.

Conditions for Running the DTCs

- Ignition is On or the engine is running.
- Battery voltage is between 11 - 32 V.
- The DTCs run continuously when the above conditions are met.

Conditions for Setting the DTCs

The ECM detects an open, a short to ground, or a short to voltage on the turbocharger bypass solenoid valve control circuit for greater than 10 s.

Action Taken When the DTCs Set

- DTCs P0033, P0034, and P0035 are Type A DTCs with emission package RPOs NT7, NU5, and NQL.
- DTCs P0033, P0034, and P0035 are Type C DTCs with emission package RPOs NE4 and NE9.

Conditions for Clearing the MIL/DTCs

- DTCs P0033, P0034, and P0035 are Type A DTCs with emission package RPOs NT7, NU5, and NQL.
- DTCs P0033, P0034, and P0035 are Type C DTCs with emission package RPOs NE4 and NE9.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Turbocharger System Description

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

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

Circuit/System Verification

1. Ignition On
2. Verify a click is heard or felt from the Q40 Turbocharger Bypass Solenoid Valve when commanding the Turbocharger Bypass Solenoid Valve between Active and Inactive with a scan tool.
 - **If a click is not heard or felt**

Refer to Circuit/System Testing

- **Go to next step: If a click is heard or felt**

3. Verify the circuit status parameters listed below do not display Malfunction when commanding the Turbocharger Bypass Solenoid Valve between Inactive and Active with a scan tool:

- Turbocharger Bypass Solenoid Valve Control Circuit High Voltage Test Status
- Turbocharger Bypass Solenoid Valve Control Circuit Open Test Status
- Turbocharger Bypass Solenoid Valve Control Circuit Low Voltage Test Status
- **If Malfunction is displayed**

Refer to Circuit/System Testing

- **Go to next step: If Malfunction is not displayed**

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 a DTC does 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 harness connector at the Q40 Turbocharger Bypass Solenoid Valve, Ignition On.

2. Verify a test lamp illuminates between the ignition circuit terminal 1 and ground.

- **If the test lamp does not illuminate and the circuit fuse is good**

1. Ignition Off.

2. Test for less than 2 Ω in the ignition 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, remove the test lamp.

NOTE:

An short circuit in any component supplied by the fuse may cause the fuse to open and set a DTC when the component is activated.

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, test all components supplied by the fuse and replace as necessary.

- **Go to next step: If the test lamp illuminates**

3. Verify that a test lamp does not illuminate between the control circuit terminal 2 and the ignition circuit terminal 1.

- **If the test lamp illuminates**

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.
- If infinite resistance, replace the K20 Engine Control Module.

- **Go to next step: If the test lamp does not illuminate**

4. Remove the test lamp.

5. Verify the scan tool Turbocharger Bypass Solenoid Valve Control Circuit High Voltage Test Status parameter is OK when commanding the Turbocharger Bypass Solenoid Valve Active with a scan tool.
 - **If OK is not displayed**
 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.
 - If less than 1 V, replace the K20 Engine Control Module.
 - **Go to next step: If OK is displayed**
6. Install a 3 A fused jumper wire between the control circuit terminal 2 and the ignition circuit terminal 1.
7. Verify the scan tool Turbocharger Bypass Solenoid Valve Control Circuit High Voltage Test Status parameter is Malfunction when commanding the Turbocharger Bypass Solenoid Valve Active with a scan tool.
 - **If Malfunction is not displayed**
 1. Ignition Off, 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**
8. Test or replace the Q40 Turbocharger Bypass Solenoid Valve.

Component Testing

Static Test

1. Ignition Off, disconnect the harness connector at the Q40 Turbocharger Bypass Solenoid Valve.
2. Test for 10 - 14 Ω between the control terminal 2 and the Ignition terminal 1 of the Q40 Turbocharger Bypass Solenoid Valve.
 - **If not between 10 - 14 Ω**

Replace the Q40 Turbocharger Bypass Solenoid Valve.
 - **Go to next step: If between 10 - 14 Ω**
3. All OK

Dynamic Test

1. Install a 10 A fused jumper wire between the ignition terminal 1 of the Q40 Turbocharger Bypass Solenoid Valve and 12 V. Install a jumper wire between the control terminal 2 and ground.
2. Verify the Q40 Turbocharger Bypass Solenoid Valve plunger retracts.
 - **If the plunger does not retract.**

Replace the Q40 Turbocharger Bypass Solenoid Valve.
 - **Go to next step: If the plunger retracts.**
3. All OK

Repair Instructions

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

- [Turbocharger Bypass Valve Solenoid Replacement](#)
- [Control Module References](#) for ECM replacement, programming, and setup

DTC P0068 OR P1101

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 P0068

Throttle Body Air Flow Performance

DTC P1101

Intake Air Flow System Performance

Circuit/System Description

The engine control module (ECM) compares actual air flow based on throttle position (TP) to a calculated airflow based on manifold absolute pressure (MAP) sensor, and mass air flow (MAF).

Conditions for Running the DTC

DTC P0068

- The engine speed is at least 800 RPM.
- The ignition voltage is at least 6.4 V.
- The DTC runs continuously when the above conditions are met.

DTC P1101

- DTC P0101, P0102, P0103, P0107, P0108, P0111, P0112, P0113, P0116, P0117, P0118, P0128, P0335, or P0336 is not set
- The engine speed is between 575 - 6600 RPM
- The engine coolant temperature (ECT) is between -7 to +129Â°C (+19 to +264Â°F).
- The intake air temperature (IAT) is between -20 to +125Â°C (-4 to +257Â°F).
- The DTC runs continuously when the above conditions are met.

Conditions for Setting the DTCs

The ECM detects that the actual airflow rate is greater than the calculated airflow.

Action Taken When the DTCs Set

- DTC P0068 is a type A DTC.
- DTC P1101 is a type B DTC.

Conditions for Clearing the DTCs

- DTC P0068 is a type A DTC.
- DTC P1101 is a type B DTC.

Reference Information

Schematic Reference

[Engine Controls Wiring Schematics](#)

Connector End View Reference

[COMPONENT CONNECTOR END VIEWS - INDEX](#)

Electrical Information Reference

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

Powertrain Component Views

[Powertrain Component Views](#)

DTC Type Reference

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

Scan Tool Reference

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

[Circuit/System Verification](#)

1. Ignition ON.
2. Verify that DTC P0641, P0651, P0697, P06A3 or P06D2 is not set.
 - **If any of the DTCs are set**
 Refer to [DTC P0641, P0651, P0697, P06A3, or P06D2](#) for further diagnosis.
 - **Go to next step: If none of the DTCs are set**
3. If you were sent here from DTC P0068, P0106, P0121, P0236, or P1101; refer to Circuit/System Testing.
4. Ignition ON, verify the scan tool Throttle Body Idle Air Flow Compensation parameter is less than 90%.
 - **90% or greater**
 Refer to [Throttle Body Cleaning](#).
 - **Go to next step: If less than 90%**
5. Verify the scan tool Throttle Position Sensors 1 and 2 Agree/Disagree parameter displays Agree while performing the Throttle Sweep Test with a scan tool.
 - **If Disagree**
 Refer to [DTC P0121-P0123, P0222, P0223, P16A0-P16A2, or P2135](#) for further diagnosis.
 - **Go to next step: If Agree**
6. Determine the current vehicle testing altitude.
7. Verify the scan tool MAP Sensor pressure parameter is within the range specified in the [Altitude Versus Barometric Pressure](#) table.
 - **If the MAP Sensor parameter is not in range**
 Refer to [DTC P0106](#) for further diagnosis.
 - **Go to next step: If the MAP Sensor parameter is within range**
8. Verify the engine is equipped with a turbocharger.
 - **If not equipped with a turbocharger**
 Refer to Step 10.
 - **Go to next step: If equipped with a turbocharger**
9. Verify the scan tool Boost Pressure Sensor parameter is within the range specified in the [Altitude Versus Barometric Pressure](#) table.

- **If the Boost Pressure Sensor parameter is not in range**

Refer to [DTC P0236](#) for further diagnosis.

- **Go to next step: If the Boost Pressure Sensor parameter is within range**

10. Verify the scan tool Boost Pressure Sensor parameter decreases after starting the engine.

- **If the Boost Pressure Sensor parameter does not decrease**

Refer to [DTC P0236](#) for further diagnosis.

- **Go to next step: If the Boost Pressure Sensor parameter does decrease**

11. Engine idling, verify the scan tool MAP Sensor pressure parameter is between 26 - 52 kPa (3.8 - 7.5 PSI) and changes with accelerator pedal input.

- **If not between 26 - 52 kPa (3.8 - 7.5 PSI) or does not change**

Refer to [DTC P0106](#) for further diagnosis.

- **Go to next step: If between 26 - 52 kPa (3.8 - 7.5 PSI) and changes**

12. Verify the scan tool MAF Sensor g/s parameter changes smoothly and gradually as the engine speed is increased and decreased while performing the actions listed below.

1. Engine idling
2. Perform the scan tool snapshot function.
3. Increase the engine speed slowly to 3000 RPM and then back to idle.
4. Exit from the scan tool snapshot and review the data.
5. Observe the MAF Sensor parameter frame by frame with a scan tool.

- **If the MAF Sensor parameter does not change smoothly and gradually**

Refer to [DTC P0101](#) for further diagnosis.

- **Go to next step: If the MAF Sensor parameter changes smoothly and gradually**

13. 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.

14. 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**

15. All OK

Circuit/System Testing

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

1. Verify the integrity of the entire air induction system by verifying that none of the following conditions exist:

- Any damaged, improperly installed, collapsed, or restricted components
- Improper operation of turbocharger wastegate actuator or bypass valve, where equipped
- Loose clamps, cracks, or other damage
- An air flow restriction
- Restricted air filter
- Splits, kinks, leaks, or improper connections at the vacuum hoses
- Vacuum leaks at the intake manifold, MAP sensor, and throttle body
- Water intrusion
- Any snow or ice buildup, in cold climates

- Contamination of the MAF sensor element
- Missing, restricted, or leaking exhaust components - Refer to [Symptoms - Engine Exhaust](#) for further diagnosis.
- **If a condition is found**

Repair or replace component as appropriate.

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

2. Test the engine for a mechanical condition. Refer to [Symptoms - Engine Mechanical](#) for diagnosis.

- **If a condition is found**

Repair or replace component as appropriate.

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

3. 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 P0089, P00C6, P228C, P228D, OR P2C1E, P2C1F, OR P2C20

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 P0089

Fuel Pressure Regulator Performance

DTC P00C6

Fuel Rail Pressure Low During Engine Cranking

DTC P228C

Fuel Pressure Regulator Control Performance - Low Pressure

DTC P228D

Fuel Pressure Regulator Control Performance - High Pressure

DTC P2C1E

Cold Start Fuel Pressure Regulator Performance

DTC P2C1F

Cold Start Fuel Pressure Regulator Control Performance - Low Pressure

DTC P2C20

Cold Start Fuel Pressure Regulator Control Performance - High Pressure

Circuit/System Description

The high fuel pressure necessary for direct injection is supplied by the high pressure fuel pump. The high pressure fuel pump is mounted on the rear of the engine and is driven by a four-lobe cam on the camshaft. This high pressure fuel pump also regulates the fuel pressure using an actuator in the form of an internal solenoid-controlled valve. In order to keep the engine running efficiently under all operating conditions, the engine control module (ECM) requests pressure ranging from 2 to 15 MPa (290 to 2176 PSI), depending on engine speed and load. Output drivers in the ECM provide the high pressure fuel pump control circuit with a 12 V pulse-width modulated (PWM) signal, which regulates fuel pressure by opening and closing the control valve at specific times during pump strokes. This effectively regulates the portion of each pump stroke that is delivered to the fuel rail. The high pressure fuel pump is normally closed and will not deliver an increase in fuel pressure when the control solenoid is NOT powered. In the event of pump control failure, the high pressure system is protected by a relief valve in the pump that prevents the pressure from exceeding 24 MPa (3481 PSI).

The fuel rail pressure sensor provides the feedback necessary to the ECM to control the high pressure fuel pump and the fuel injectors. The sensor is diagnosed separately from the fuel pressure control system.

The ECM monitors the fuel rail pressure sensor and the high pressure fuel pump solenoid to determine if the commanded and actual pressures are within a predetermined range during engine cranking and at all times while the engine is running. The ECM also monitors the high pressure fuel pump solenoid to make sure it is operating within expected limits.

Conditions for Running the DTC

P0089, P228C, or P228D

- DTC P0016, P0017, P0090, P0091, P0092, P00C8, P00C9, P00CA, P0111, P0112, P0113, P0114, P0117, P0118, P0119, P0128, P0192, P0193, P0335, P0336, P0340, P0341, P0365, P0366, P0627, P0628, P0629, or P1682 are not present.
- Battery voltage is greater than 8 V.
- The engine has been running for greater than or equal to 10 s.
- Low side fuel pressure is greater than 300 kPa (44 PSI).
- Barometric (BARO) pressure is greater than or equal to 70 kPa.
- Intake air temperature (IAT) is warmer than or equal to -10°C (14°F).
- Fuel temperature is between -10°C and +132°C (14°F and 270°F).
- Vehicle is not in a low fuel condition
- The DTCs run continuously when the above conditions are met.

P00C6

- DTC P0016, P0017, P0090, P0091, P0092, P00C8, P00C9, P00CA, P0111, P0112, P0113, P0114, P0117, P0118, P0119, P0128, P0192, P0193, P0335, P0336, P0340, P0341, P0365, P0366, P0627, P0628, P0629, or P1682 are not present.
- Ignition voltage is greater than 8 V.
- Engine coolant temperature is less than 65°C (149°F).
- Low side fuel pressure is greater than 300 kPa (44 PSI).
- Vehicle is not in a low fuel condition
- The diagnostic runs once for each engine start.

P2C1E, P2C1F or P2C20

- DTC P0016, P0017, P0090, P0091, P0092, P00C9, P00CA, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0119, P0128, P0192, P0335, P0336, P0340, P0341, P0345, P0346, P0365, P0366, P0390, P0391, P0627, P0628, P0629, P111E, P127C, P128A, P128B, P128F, P1682, P16E4, or P16E5 are not present
- Battery voltage is greater than 11 V.
- Low side fuel pressure is greater than 300 kPa (44 PSI).
- Barometric (BARO) pressure is greater than or equal to 70 kPa.

- Intake air temperature (IAT) is warmer than or equal to -10°C (14°F).
- Fuel temperature is between -10°C and $+132^{\circ}\text{C}$ (14°F and 270°F).
- Catalyst Warm up enabled

Conditions for Setting the DTC

P0089

- The high pressure fuel pump has exceeded the control limits. This condition exists when the Fuel Rail Pressure Regulator Command is 0° or greater than 92° for 12.5 s.

P00C6 Condition 1

- If the Fuel Rail Pressure Sensor is less than the target set point before the engine is cranked, the pressure rise diagnostic is used.
- The pressure rise diagnostic will fail if the Fuel Rail Pressure Sensor has not increased to the target set point within 9 s at -16°C (3.2°F) ECT or within 4 s if ECT is greater than 0°C (32°F).

P00C6 Condition 2

- If the Fuel Rail Pressure Sensor is greater than the target set point before the engine is cranked, the pressure fall diagnostic is used.
- The pressure fall diagnostic will fail if the Fuel Rail Pressure Sensor has dropped below 2 MPa (290 PSI) if the ECT is less than -16°C (3.2°F) or 0.6 MPa (87 PSI) if the ECT is greater than -16°C (3.2°F).

P228C, P2C1F

- The Fuel Rail Pressure Sensor is less than the Desired Fuel Rail Pressure by a predetermined value.
- The above condition exists for 10.00 s failures out of 12.50 s samples.

P228D, P2C20

- The Fuel Rail Pressure Sensor is greater than the Desired Fuel Rail Pressure by a predetermined value.
- The above condition exists for 10.00 s failures out of 12.50 s samples.

P2C1E

- This DTC determines when the high pressure pump control has reached to its max or min authority during Catalyst Warm up.
- The above condition exists for 10.00 seconds failures out of 12.50 Seconds samples.

Action Taken When the DTC Sets

- DTCs P0089 and P00C6 are Type B DTCs.
- DTCs P228C, P228D, P2C1E, P2C1F and P2C20 are Type A DTCs.
- A message center or an indicator displays Reduced Engine Power.
- Scan tool control of the high pressure fuel pump is inhibited.

Conditions for Clearing the DTC

- DTCs P0089 and P00C6 are Type B DTCs.
- DTCs P228C, P228D, P2C1E, P2C1F and P2C20 are Type A DTCs.

Diagnostic Aids

- Any problem with the camshaft may set fuel pressure DTCs due to the location and design of the high pressure fuel pump. If camshaft position control DTCs are current or in history, a cam control

issue may be the root cause.

- A faulty valve, plunger, or solenoid in the high pressure fuel pump may set a DTC. High pressure fuel pump damage will most likely be undetectable upon visual inspection.
- A restricted fuel feed pipe between the fuel feed pipe fuel pressure sensor and the high pressure fuel pump may set a DTC.
- A leaking or restricted fuel injector may set a DTC.
- A leak in the high pressure fuel system may set a DTC.
- Vapor lock may set DTC P0089
- For DTC P00C6, P2C1E, P2C1F, and P2C20, park the vehicle outdoors overnight and perform a start in the morning.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

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- [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. Attempt to start and idle the engine.
2. Observe the DTC information with a scan tool. DTCs P0089, P00C6, P228C, P2C1E, P2C1F, P228D and P2C20 should 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**
3. Engine idling.
4. Verify the scan tool Fuel Rail Pressure Sensor parameter is approximately 1.9 - 5.0 MPa (276 - 725 PSI).
 - **If not between 1.9 - 5.0 MPa (276 - 725 PSI)**

Refer to Circuit/System Testing.
 - **Go to next step: If between 1.9 - 5.0 MPa (276 - 725 PSI)**

WARNING: Road test a vehicle under safe conditions and while obeying all

traffic laws. Do not attempt any maneuvers that could jeopardize vehicle control. Failure to adhere to these precautions could lead to serious personal injury and vehicle damage.

5. Road test the vehicle and perform a wide open acceleration from a stop until the transmission shifts into second gear. On manual transmission applications, shift to second gear or stop the test near 2, 500 RPM. Repeat the test at least three times.
6. Verify DTCs P0089, P00C6, P228C, P2C1F, P228D and P2C20 do not set.

- **If any of the DTCs set**

Refer to Circuit/System Testing.

- **Go to next step: If none of the DTCs 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.
8. 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

NOTE: Circuit/System Verification must be performed first or misdiagnosis may result.

1. Remove the G18 High Pressure Fuel Pump.
2. Verify the lobes on the camshaft do not have unusual wear or are worn.

- **If the lobes have unusual wear or are worn**

Replace the Camshaft.

- **Go to next step: If the lobes are OK**

3. Test or replace the G18 High Pressure Fuel Pump.

Component Testing

1. Ignition OFF, disconnect the harness connector at the G18 High Pressure Fuel Pump.

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

2. Test for 1.09 - 1.21 Ω at 20 $^{\circ}$ C (68 $^{\circ}$ F) between the high control circuit terminal 2 and the low control circuit terminal 1.

- **If not between 1.09 - 1.21 Ω**

Replace the G18 High Pressure Fuel Pump.

- **Go to next step: If between 1.09 - 1.21 Ω**

3. Test for infinite resistance between each terminal and the G18 High Pressure Fuel Pump housing.

- **If less than infinite resistance**

Replace the G18 High Pressure Fuel Pump.

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

4. All OK

Repair Instructions

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

- [Fuel Pump Replacement](#) for the G18 High Pressure Fuel Pump replacement.
- [Intake and Exhaust Camshaft, Bearing Cap, and Lash Adjuster Removal](#)
- Perform the Fuel Rail Pressure Relief Valve Reset procedure, if supported on the scan tool.

DTC P0090, P0091, P0092, P00C8, P00C9, OR P00CA

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 P0090

Fuel Pressure Regulator Control Circuit

DTC P0091

Fuel Pressure Regulator Control Circuit Low Voltage

DTC P0092

Fuel Pressure Regulator Control Circuit High Voltage

DTC P00C8

Fuel Pressure Regulator High Control Circuit

DTC P00C9

Fuel Pressure Regulator High Control Circuit Low Voltage

DTC P00CA

Fuel Pressure Regulator High Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
High Pressure Fuel Pump Actuator High Control	P0091, P0092, P00C9	P0090, P00C8	P0092, P00CA	-
High Pressure Fuel Pump Actuator Low Control	P0091, P00C9	P0090, P00C8	P0092, P00C9, P00CA	-

Circuit/System Description

The high fuel pressure necessary for direct injection is supplied by the high pressure fuel pump. The high pressure fuel pump is mounted on the rear of the engine and is driven by a three-lobe cam on the camshaft. This high pressure fuel pump also regulates the fuel pressure using an actuator in the form of an internal solenoid-controlled valve. In order to keep the engine running efficiently under all operating conditions, the engine control module (ECM) requests pressure ranging from 2 - 15 MPa (290 - 2176 psi), depending on engine speed and load. Output drivers in the ECM provide the pump control circuit with a 12 V pulse-width modulated (PWM) signal, which regulates fuel pressure by closing and opening the control valve at specific times during pump strokes. This effectively regulates the portion of each pump stroke that is delivered to the fuel rail.

It is important to note that the high pressure fuel pump is a trailing-edge control system, meaning that if the control solenoid is NOT powered, the pump operates at maximum flow rate. In the event of pump control failure, the high pressure system is protected by a relief valve in the pump that prevents the pressure from exceeding 17.5 MPa (2538 psi).

NOTE: **The fuel rail pressure sensor is diagnosed separately from the fuel pressure control system and should not be replaced for any codes referenced in this document.**

The fuel rail fuel pressure sensor operates on a 5 V reference circuit and it provides the feedback necessary to the ECM to control the high pressure fuel pump and the fuel injectors.

Conditions for Running the DTC

- The ignition voltage is greater than 11 V.
- The engine speed is greater than 50 RPM.
- The DTCs run continuously within the enabling conditions.

Conditions for Setting the DTC

P0090

- The ECM detects an open circuit in the high pressure fuel pump actuator low control circuit.
- The DTC sets when the above condition is present for 4 s.

P0091

- The ECM detects a short to ground in the high pressure fuel pump actuator low control circuit.
- The DTC sets when the above condition is present for 4 s.

P0092

- The ECM detects a short to voltage in the high pressure fuel pump actuator low control circuit.
- The DTC sets when the above condition is present for 4 s.

P00C8

- The ECM detects an open circuit in the high pressure fuel pump actuator high control circuit.
- The DTC sets when the above condition is present for 4 s.

P00C9

- The ECM detects a short to ground in the high pressure fuel pump actuator high control circuit.
- The DTC sets when the above condition is present for 4 s.

P00CA

- The ECM detects a short to voltage in the high pressure fuel pump actuator high control circuit.
- The DTC sets when the above condition is present for 4 s.

Action Taken When the DTC Sets

- DTCs P0090, P0091, P0092, P00C8, P00C9, and P00CA are Type A DTCs.
- A message center or an indicator displays Reduced Engine Power.

Conditions for Clearing the DTC

DTCs P0090, P0091, P0092, P00C8, P00C9, and P00CA are Type A DTCs.

Diagnostic Aids

- Before performing any circuit testing, ensure that the harness connector for the G18 High Pressure Fuel Pump is properly seated.
- Before performing any circuit testing, visually inspect the harness connector and the G18 High Pressure Fuel Pump connector for damage or bent pins.
- Circuit faults in the high pressure fuel control system may result in performance diagnostic failures, such as P0089, P00C6, P163A, P228C, or P228D. If any of the circuit DTCs referenced in this document are active, they take priority over any fuel system performance diagnostic. Always attempt to diagnose and repair circuit faults first, before reviewing other system DTCs.

Reference Information

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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 DTC P0685 or P1682 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. Command the Fuel Pressure Regulator ON and OFF with a scan tool while observing the following control circuit status parameters:

- Fuel Pressure Regulator Control Circuit High Voltage Test Status
- Fuel Pressure Regulator Control Circuit Open Test Status
- Fuel Pressure Regulator Control Circuit Low Voltage Test Status
- Fuel Pressure Regulator High Control Circuit High Voltage Test Status
- Fuel Pressure Regulator High Control Circuit Open Test Status
- Fuel Pressure Regulator High Control Circuit Low Voltage Test Status
- **If Malfunction is displayed**

Refer to Circuit/System Testing.

- **Go to next step: If OK or Not Run is displayed**

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

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

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the G18 High Pressure Fuel Pump.
2. Ignition ON, verify that a test lamp does not illuminate between the high control circuit terminal 1 and ground and the low control circuit terminal 2 and ground.
 - **If the test lamp illuminates**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
 2. Test for less than 1 V between the appropriate 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**
3. Verify that a test lamp does not illuminate between the high control circuit terminal 1 and B+ and the low control circuit terminal 2 and B+.
 - **If the test lamp illuminates**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the appropriate control 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 control circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **Go to next step: If the test lamp does not illuminate**
4. Connect a 3 A fused jumper wire between the high control circuit terminal 1 and ground.
5. Verify the Fuel Pressure Regulator High Control Circuit Open Test Status transitions from Malfunction to OK and the Fuel Pressure Regulator High Control Circuit Low Voltage Test Status transitions from OK to Malfunction.
 - **The parameters do not change**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for less than 2 Ω in the high 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: The parameters change**
6. Connect a 3 A fused jumper wire between the low control circuit terminal 2 and B+.
7. Verify the Fuel Pressure Regulator Control Circuit Open Test Status transitions from Malfunction to OK and the Fuel Pressure Regulator Control Circuit High Voltage Test Status transitions from OK to Malfunction.
 - **The parameters do not change**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for less than 2 Ω in the low 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: The parameters change**

8. Test or replace the G18 High Pressure Fuel Pump.

Component Testing

1. Ignition OFF, disconnect the harness connector at the G18 High Pressure Fuel Pump.

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

2. Test for 0.3 - 0.7 Ω at 20 $^{\circ}$ C (68 $^{\circ}$ F) between the high control circuit terminal 1 and the low control circuit terminal 2.

- **If not between 0.3 - 0.7 Ω**

Replace the G18 High Pressure Fuel Pump.

- **Go to next step: If between 0.3 - 0.7 Ω**

3. Test for infinite resistance between each terminal and the G18 High Pressure Fuel Pump housing.

- **If less than infinite resistance**

Replace the G18 High Pressure Fuel Pump.

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

4. All OK

Repair Instructions

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

- [Fuel Pump Replacement](#)
- [Control Module References](#) for K20 Engine Control Module replacement, setup, and programming
- Perform the Fuel Rail Pressure Relief Valve Reset procedure, if supported on the scan tool.

DTC P0096 OR P0111

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 P0096

Intake Air Temperature (IAT) Sensor 2 Performance

DTC P0111

Intake Air Temperature (IAT) Sensor 1 Performance

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	P0111*, P0113*, P0114, P2199	P0111*, P2199

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Low Reference	-	P0113, P2199, P2227, P2229	P0113*, P0114	-
*Internal ECM or sensor damage may occur if the circuit is shorted to B+.				

IAT Sensor 2 and Intake Air Humidity

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

Typical Scan Tool Data

IAT Sensor 1

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

IAT Sensor 2 and Intake Air Humidity Sensor

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

Circuit/System Description

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

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

- IAT sensor 2
- Humidity sensor
- MAF sensor

The multifunction intake air sensor houses the following:

- IAT sensor 1
- IAT sensor 2
- Humidity sensor
- MAF sensor
- BARO pressure sensor

IAT Sensor 1 - Temperature, Resistance, Voltage Table

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

IAT Sensor 2 - Temperature, Frequency Table

IAT Sensor 2	IAT Sensor 2 Frequency	IAT Sensor 2 Temperature
Cold	10 Hz	$-40\hat{\text{A}}^{\circ}\text{C}$ ($-40\hat{\text{A}}^{\circ}\text{F}$)
Warm	302 Hz	$104\hat{\text{A}}^{\circ}\text{C}$ ($219\hat{\text{A}}^{\circ}\text{F}$)

Conditions for Running the DTCs

P0096 and P0111

- DTCs P0097, P0098, P0099, P0112, P0113, P0114, P0117, P00F4, P00F5, P00F6, P0118, P0119, P16A7, P16BC, or P1682 are not set.
- The vehicle has been OFF at least 8 hours.
- Ignition voltage is at least 11 V for greater than 1 s.
- The DTCs run once per ignition cycle when the conditions above are met.

Conditions for Setting the DTCs

P0096

- The ECM determines the absolute difference between IAT sensor 1 start-up temperature and the IAT sensor 2 start-up temperature is greater than $25\hat{\text{A}}^{\circ}\text{C}$ ($45\hat{\text{A}}^{\circ}\text{F}$).

AND

- The absolute difference between ECT start-up temperature and the IAT sensor 2 start-up temperature is greater or equal to the absolute difference between ECT start-up temperature and the IAT sensor 1 start-up temperature.
- The DTCs run once per ignition cycle when the conditions above are met.

P0111

- The ECM determines the absolute difference between IAT sensor 1 start-up temperature and the IAT sensor 2 start-up temperature is greater than $25\hat{\text{A}}^{\circ}\text{C}$ ($45\hat{\text{A}}^{\circ}\text{F}$).

AND

- The absolute difference between ECT start-up temperature and the IAT sensor 1 start-up temperature is greater or equal to the absolute difference between ECT start-up temperature and the IAT 2 start-up temperature.
- The DTCs run once per ignition cycle when the conditions above are met.

Action Taken When the DTC Sets

- P0096 is a Type B DTC.
- P0111 is a Type B DTC.
- The ECM commands the cooling fans ON.

Conditions for Clearing the DTCs

- P0096 is a Type B DTC.
- P0111 is a Type B DTC.

Diagnostic Aids

The humidity sensor and the IAT sensor 2 signals are sent to the ECM on the same circuit. If the IAT Sensor 2 parameter displays the values: 10 Hz; -40Â°C (-40Â°F), and there are also Humidity Sensor DTCs, check for a circuit problem.

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Engine Controls Wiring Schematics

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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 .

Circuit/System Verification

1. Ignition On.
2. Verify that DTC DTC P0097, P0098, P0099, P00F4, P00F5, P00F6, P0102, P0103, P0112, P0113, P0114, P0641, P0651, P0697, P06A3, or P06D2 is not set.
 - **If any of the DTCs are set**

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

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

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

3. Ignition On.

4. Verify the following scan tool parameters are within 25Â°C (45Â°F) of each other.

- Start-Up IAT Sensor 1
- Start-Up IAT Sensor 2
- **If not within 25Â°C (45Â°F)**

Refer to Circuit/System Testing.

- **Go to next step: If within 25Â°C (45Â°F)**

5. Engine running.

6. Verify the following scan tool parameters are between: -38 and +149Â°C (-36 and +300Â°F).

- IAT Sensor 1
- IAT Sensor 2
- **If not between: -38 and +149Â°C (-36 and +300Â°F)**

Refer to Circuit/System Testing.

- **Go to next step: If between: -38 and +149Â°C (-36 and +300Â°F)**

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**

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 integrity of the entire air induction system and verify that none of the following conditions exist:

- A restricted or collapsed air intake duct
- An intake manifold leak
- A misaligned or damaged air intake duct
- Any water intrusion in the induction system
- **If a condition exists**

Repair or replace component as necessary.

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

2. Ignition Off, and all vehicle systems Off, it may take up to 2 min. for all vehicle systems to power down.

3. Disconnect the harness connector at the B75C Multifunction Intake Air sensor.

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

- **If 5 Ω or greater**

1. Disconnect the harness connector at the K20 Engine Control Module.
2. Test for less than $2\ \Omega$ in the low reference circuit end to end.
 - If $2\ \Omega$ or greater, repair the open or high resistance in the circuit.
 - If less than $2\ \Omega$ replace the K20 Engine Control Module.
- **Go to next step: If less than $5\ \Omega$**
5. Test for less than $5\ \Omega$ between the ground circuit terminal 7 and ground.
 - **If $5\ \Omega$ or greater**
 1. Ignition Off.
 2. Test for less than $2\ \Omega$ in the ground circuit end to end.
 - If $2\ \Omega$ or greater, repair the open or high resistance in the circuit.
 - If less than $2\ \Omega$, repair the open/high resistance in the ground connection.
 - **Go to next step: If less than $5\ \Omega$**
6. Ignition On
7. Verify that a test lamp illuminates between the ignition circuit terminal 5 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition Off, remove the test lamp and remove the fuse for the ignition voltage circuit.
 2. Test for less than $2\ \Omega$ in the ignition voltage circuit end to end.
 - If $2\ \Omega$ or greater, repair the open/high resistance in the circuit.
 - If less than $2\ \Omega$, 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, remove the test lamp, the fuse for the ignition voltage circuit, and disconnect all components on the circuit.
 2. Test for infinite resistance between the ignition voltage circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, test all components connected to the ignition circuit, replace as necessary.
 - **Go to next step: If a test lamp illuminates**
8. Ignition On.
9. Verify the scan tool Intake Air Temperature Sensor 1 parameter is colder than -39°C (-38°F).
 - **If warmer than -39°C (-38°F).**
 1. Ignition Off, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the signal circuit terminal 1 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K20 Engine Control Module.
 - **Go to next step: If colder than -39°C (-38°F).**
10. Ignition Off, install a 3 A fused jumper wire between the IAT 1 signal circuit terminal 1 and the low reference circuit terminal 3.
11. Ignition On.
12. Verify the scan tool Intake Air Temperature Sensor 1 parameter is warmer than 148°C (298°F).
 - **If colder than 148°C (298°F).**
 1. Ignition Off, remove the jumper wire, disconnect the harness connector at the K20 Engine Control Module.
 2. Ignition On.
 3. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - Go to next step: If less than 1 V
 4. Ignition Off.
 5. Test for less than $2\ \Omega$ in the signal circuit end to end.
 - If $2\ \Omega$ or greater, repair the open/high resistance in the circuit.

- If less than 2 Ω , replace the K20 Engine Control Module.

- **Go to next step: If warmer than 148 $^{\circ}$ C (298 $^{\circ}$ F).**

13. Ignition On.

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

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

- **If 1% or greater**

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

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

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

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

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

16. Ignition On.

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

- **If 99% or less**

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

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

2. Ignition On.

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

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

4. Ignition Off.

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

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

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

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

Component Testing

Multifunction Intake Air Sensor

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

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

3. Test the IAT sensor 1 by varying the sensor temperature while monitoring the sensor resistance. Compare the readings with the [Temperature Versus Resistance - Intake Air Temperature Sensor](#) table for Hitachi Sensors. The resistance values should be in range of the table values.

- **If not within the specified range**

Replace the B75C Multifunction Intake Air Sensor.

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

4. All OK.

Multifunction Intake Air Sensor

1. Test the IAT Sensor 2 by varying the sensor temperature while monitoring the air temperature with a thermometer. Compare the thermometer readings with the scan tool IAT Sensor 2 parameter. The values should be within 5%.

- **If not within the specified range**

Replace the B75C Multifunction Intake Air Sensor.

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

2. All OK.

Testing with EL-38522-A

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

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

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

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

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

- Intake Air Humidity Sensor is between 48 - 52%
 - **If a parameter is not within the specified range**
6. Test for less than 2 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **Go to next step: If all the parameters are within the specified range**
 7. All OK.

Repair Instructions

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

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

DTC P0097, P0098, OR P0099

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 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

Diagnostic Fault Information

IAT Sensor 2 and Intake Air Humidity

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition Voltage	P0096, P0097, P00F4, P0102, P2199	P0096, P0097, P00F4, P0102, P2199	-	P0096
Signal	P0097, P00F4, P2199	P0097, P00F4, P2199	P0097*, P00F4*, P2199*	P0096
Ground	-	P0096, P0097, P00F4, P0102, P2199	-	P0096

*Internal ECM or sensor damage may occur if the circuit is shorted to B+.

Typical Scan Tool Data

IAT Sensor 2

Circuit	Short to Ground	Open or High Resistance	Short to Voltage
Operating Conditions: Engine Running Parameter Normal Range: Varies with ambient temperature			
Ignition Voltage	-40Â°C (-40Â°F) 10 Hz	-40Â°C (-40Â°F) 10 Hz	-
Signal	-40Â°C (-40Â°F) 10 Hz	-40Â°C (-40Â°F) 10 Hz	-40Â°C (-40Â°F)* 10 Hz
Ground	-	-40Â°C (-40Â°F) 10 Hz	-

*Internal ECM or sensor damage may occur if the circuit is shorted to B+

Intake Air Humidity Sensor

Circuit	Short to Ground	Open or High Resistance	Short to Voltage
Operating Conditions: Engine Running Parameter Normal Range: Varies with ambient humidity, temperature, and engine bay conditions			

Circuit	Short to Ground	Open or High Resistance	Short to Voltage
Ignition 1	0 %	0 %	-
Signal	100 %	0 %	0 %*
Ground	-	0 %	-
*Internal ECM or sensor damage may occur if the circuit is shorted to B+			

Circuit/System Description

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

- IAT sensor 2
- Humidity sensor
- MAF sensor

The multifunction intake air sensor houses the following:

- IAT sensor 1
- IAT sensor 2
- Humidity sensor
- MAF sensor
- BARO pressure sensor

IAT Sensor 2 - Temperature, Frequency Table

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

Conditions for Running the DTCs

P0097, P0098, and P0099

- DTCs P0685, P0686, P0687, P0689, P0690, P16A7, P16BC, or P1682 are not set.
- The ignition is ON, or the engine is running.
- The Ignition voltage is greater than 11 V for greater than 900 ms.
- The DTCs run continuously within the enabling conditions.

Conditions for Setting the DTCs

P0097

NOTE: The scan tool display range is between -40 and $+150^{\circ}\text{C}$ (-40 and $+302^{\circ}\text{F}$).

The ECM detects that the IAT sensor 2 signal is less than 13 Hz, colder than -60°C (-76°F), for greater than 4 s.

P0098

The ECM detects that the IAT sensor 2 signal is greater than 390 Hz, warmer than 150°C (302°F), for greater than 4 s.

P0099

The ECM monitors the IAT sensor 2 signal every 100 ms to determine if the signal has changed greater than 80%. The DTC sets when the condition exists for greater than 4 s.

Action Taken When the DTC Sets

- P0097, P0098, and P0099 are Type B DTCs.
- The ECM commands the cooling fans ON.

Conditions for Clearing the MIL/DTC

- P0097, P0098, and P0099 are Type B DTCs.

Diagnostic Aids

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

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

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- [Wiring Repairs](#)

Powertrain Component Views

Powertrain Component Views

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-38522-A Variable Signal Generator

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

Circuit/System Verification

1. Ignition On.
2. Verify that DTC P00F4, P00F5, P00F6, P0102, P0103, P0641, P0651, P0697, P06A3, or P06D2 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. Engine running.

4. Verify the following scan tool IAT Sensor 2 parameter is between -38 and $+149^{\circ}\text{C}$ (-36 and $+300^{\circ}\text{F}$).

- **If not between: -38 and $+149^{\circ}\text{C}$ (-36 and $+300^{\circ}\text{F}$)**

Refer to Circuit System Testing.

- **Go to next step: If between: -38 and $+149^{\circ}\text{C}$ (-36 and $+300^{\circ}\text{F}$)**

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

6. Verify the DTC does not set.

- **If the DTC sets**

Refer to Circuit/System Testing.

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

7. All OK

Circuit/System Testing

NOTE: You must perform the Circuit/System Verification before proceeding with 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 B75C Multifunction Intake Air sensor.

2. Test for less than $5\ \Omega$ between the low reference circuit terminal 3 and ground.

- **If $5\ \Omega$ or greater**

1. Disconnect the harness connector at the K20 Engine Control Module.

2. Test for less than $2\ \Omega$ in the low reference circuit end to end.

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

- **Go to next step: If less than $5\ \Omega$**

3. Test for less than $5\ \Omega$ between the ground circuit terminal 7 and ground.

- **If $5\ \Omega$ or greater**

1. Ignition Off.

2. Test for less than $2\ \Omega$ in the ground circuit end to end.

- If $2\ \Omega$ or greater, repair the open or high resistance in the circuit.
- If less than $2\ \Omega$, repair the open/high resistance in the ground connection.

- **Go to next step: If less than $5\ \Omega$**

4. Ignition On.

5. Verify that a test lamp illuminates between the ignition circuit terminal 5 and ground.

- **If the test lamp does not illuminate and the circuit fuse is good**

1. Ignition Off, remove the test lamp and remove the fuse for the ignition voltage circuit.

2. Test for less than $2\ \Omega$ in the ignition voltage circuit end to end.

- If $2\ \Omega$ or greater, repair the open/high resistance in the circuit.
- If less than $2\ \Omega$, 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**

NOTE: The ignition circuit may supply voltage to other components. Make sure to test all circuits and components for a short to ground that share the ignition circuit.

1. Ignition Off, remove the test lamp, the fuse for the ignition voltage circuit, and disconnect all components on the circuit.
2. Test for infinite resistance between the ignition voltage circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, test all components connected to the ignition circuit, replace as necessary.
- **Go to next step: If a test lamp illuminates**

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

6. Verify the scan tool Intake Air Humidity Sensor parameter is less than 1%.
 - **If 1% or greater**
 1. Ignition Off, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the IAT 2 signal circuit terminal 8 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K20 Engine Control Module.
 - **Go to next step: If less than 1%**
7. Ignition Off, install a 3 A fused jumper wire between the IAT 2 signal circuit terminal 8 and the low reference circuit terminal 3.
8. Ignition On.
9. Verify the scan tool Intake Air Humidity Sensor parameter is greater than 99%.
 - **If 99% or less**

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

1. Ignition Off, remove the jumper wire and disconnect the harness connector at the K20 Engine Control Module.
2. Ignition On.
3. Test for less than 1 V between the IAT 2 signal circuit terminal 8 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - **Go to next step: If less than 1 V.**
4. Ignition Off.
5. Test for less than 2 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
- **Go to next step: If greater than 99%**
10. Test or replace the B75C Multifunction Intake Air sensor.

Component Testing

Multifunction Intake Air Sensor

1. Test the IAT Sensor 2 by varying the sensor temperature while monitoring the air temperature with a thermometer. Compare the thermometer readings with the scan tool IAT Sensor 2 parameter. The values should be within 5%.
 - **If not within the specified range**

Replace the B75C Multifunction Intake Air Sensor.
 - **Go to next step: If within the specified range**
2. All OK.

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

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

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

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

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

- Intake Air Humidity Sensor is between 48 - 52%
 - **If a parameter is not within the specified range**
 1. Ignition Off, remove the **EL-38522-A** and disconnect the harness connector at the K20 Engine Control Module.
 2. Test for less than 2 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **Go to next step: If all the parameters are within the specified range**
5. All OK.

Repair Instructions

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

- **Mass Airflow Sensor with Intake Air Temperature Sensor Replacement** for B75C Multifunction Intake Air Sensor replacement
- **Control Module References** for engine control module replacement, programming, and setup.

DTC P00C7

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 P00C7

Circuit/System Description

The Intake Air Pressure Measurement System consists of 3 sensors, the barometric pressure (BARO) sensor, the manifold absolute pressure (MAP) sensor, and the turbocharger boost sensor.

Conditions for Running the DTC

- DTCs P0106, P0107, P0108, P0237, P0238, P2227, P2228, P2229, or P2230 are not set.
- The engine is not running.
- Time between current ignition cycle and the last time the engine was running is greater than 10 s.
- Manifold pressure between 50 - 115 kPa (7.25 - 16.68 PSI).
- BARO pressure between 50 - 115 kPa (7.25 - 16.68 PSI).
- Turbocharger boost pressure between 50 - 115 kPa (7.25 - 16.68 PSI).
- This DTC runs continuously within the enabling conditions.

Conditions for Setting the DTC

The ECM detects an inconsistency between pressure sensors in the induction system in which a particular sensor cannot be identified as the failed sensor. The difference is greater than 10 kPa (1.5 PSI).

Action Taken When the DTC Sets

DTC P00C7 is a Type B DTC.

Conditions for Clearing the DTC

DTC P00C7 is a Type B DTC.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

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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 P0106, P0107, P0108, P2122, P2123, P2127, P2128, P2138 or P2610 are not set.
 - **If a DTC is set**

If a DTC is set, refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) for further diagnosis.

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

3. Ignition ON.

4. Verify the following scan tool parameters are within range of the Altitude vs. Barometric Pressure table. Refer to: [Altitude Versus Barometric Pressure](#) table.

- BARO Sensor
- MAP Sensor
- Turbo Boost Sensor
- **If a sensor parameter is not within range**

Refer to the appropriate diagnostic below for further diagnosis.

- Barometric Pressure (BARO) Sensor. Refer to [DTC P2227-P2230](#).
- Manifold Absolute Pressure (MAP) Sensor. Refer to [DTC P0106](#).
- Turbocharger Boost Pressure Sensor. Refer to [DTC P0236](#).
- **Go to next step: If all sensor parameters are within range**

5. All OK

Repair Instructions

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

[Control Module References](#) for ECM replacement, programming and setup

DTC P00E9

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 P00E9

Intake Air Temperature (IAT) Sensor 3 Circuit Performance

Diagnostic Fault Information

IAT Sensor 3

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P00EA, P00EB	P00E9, P00EB, P00EC	P00EB, P00EC*	P00E9
Low Reference	-	P00E9, P00EB, P00EC	P00EB, P00EC*	-

*Internal ECM or sensor damage may occur if the circuit is shorted to B+.

Typical Scan Tool Data

IAT Sensor 3

Circuit	Short to Ground	Open or High Resistance	Short to Voltage
Operating Conditions: Engine Running Parameter Normal Range: Varies with ambient temperature; and engine bay conditions			
Signal	150Â°C (302Â°F)	-40Â°C (-40Â°F)	-40Â°C (-40Â°F)*

Circuit	Short to Ground	Open or High Resistance	Short to Voltage
Low Reference	-	-40Â°C (-40Â°F)	-40Â°C (-40Â°F)*
*Internal ECM or sensor damage may occur if the circuit is shorted to B+			

Circuit/System Description

The intake air temperature (IAT) sensor 3 is a variable resistor that changes an engine control module (ECM) supplied 5 V signal. The signal varies with inlet air temperature and is displayed by the scan tool as Â°C (Â°F). The IAT sensor 3 is integrated with the B111B Turbocharger Boost/Intake Air Temperature sensor. The ECM provides a ground for the IAT sensor 3 low reference circuit.

IAT Sensor 3 - Temperature, Resistance, Voltage Table

IAT Sensor 3	IAT Sensor 3 Resistance	IAT Sensor 3 Signal Voltage
Cold	High	High
Warm	Low	Low

Conditions for Running the DTC

P00E9

- DTCs P0097, P0098, P0112, P0113, P0117, P0118, P0119, P00EA, or P00EB are not set.
- The vehicle has been OFF at least 8 hours.
- Ignition voltage is at least 11 V.
- These DTCs run once per ignition cycle when the enabling conditions are met.

Conditions for Setting the DTC

P00E9 - Condition 1

- The ECM determines the absolute difference between IAT sensor 1 start-up temperature and the IAT sensor 2 start-up temperature is less or equal to 30Â°C (54Â°F).

AND

- The ECM determines the absolute difference between IAT sensor 3 start-up temperature and the IAT sensor 1 start-up temperature is greater than 25Â°C (77Â°F).

AND

- The ECM determines the absolute difference between IAT sensor 3 start-up temperature and the IAT sensor 2 start-up temperature is greater than 25Â°C (77Â°F).

P00E9 - Condition 2

- The ECM determines the IAT sensor 1 start-up temperature is between the IAT sensor 3 start-up temperature and the IAT sensor 2 start-up temperature

AND

- The ECM determines the absolute difference between IAT sensor 3 start-up temperature and the IAT sensor 2 start-up temperature is greater than 25Â°C (77Â°F).

AND

- The absolute difference between IAT sensor 3 start-up temperature and the IAT sensor 1 start-up temperature is greater than the absolute difference between IAT sensor 2 start-up temperature and the IAT sensor 1 start-up temperature.

P00E9 - Condition 3

- The ECM determines the IAT sensor 2 start-up temperature is between the IAT sensor 3 start-up temperature and the IAT sensor 1 start-up temperature

AND

- The ECM determines the absolute difference between IAT sensor 3 start-up temperature and the IAT sensor 1 start-up temperature is greater than 25Â°C (77Â°F).

AND

- The absolute difference between IAT sensor 3 start-up temperature and the IAT sensor 2 start-up temperature is greater than the absolute difference between IAT sensor 2 start-up temperature and the IAT sensor 1 start-up temperature.

Action Taken When the DTC Sets

DTC P00E9 is a Type B DTC.

Conditions for Clearing the DTCs

DTC P00E9 is a Type B DTC.

Reference Information

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Engine Controls Wiring Schematics

Connector End View Reference

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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** .

Circuit/System Verification

1. Ignition ON.
2. Verify that DTC P0641, P0651, P0697, or P06A3 is not set.
 - **If any of the DTCs are set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** for further diagnosis.

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

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

3. Ignition ON.

4. Verify the following scan tool parameters are within 30°C (54°F) of each other.

- Start-Up IAT Sensor 1
- IAT Sensor 2
- IAT Sensor 3
- **If not within 30°C (54°F)**

Refer to Circuit/System Testing.

- **Go to next step: If within 30°C (54°F)**

5. Engine idling, verify the following scan tool parameters are between: -38 and +149°C (-36 and +300°F).

- IAT Sensor 1
- IAT Sensor 2
- IAT Sensor 3
- **If not between: -38 and +149°C (-36 and +300°F)**

Refer to Circuit System Testing.

- **Go to next step: If between: -38 and +149°C (-36 and +300°F)**

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

7. Verify the DTC does not set.

- **If the DTC sets**

Refer to Circuit/System Testing.

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

8. All OK

Circuit/System Testing

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

1. Check the integrity of the entire air induction system and verify that none of the following conditions exist:

- A loose or disconnected charge air cooler hose or pipe; where equipped
- A blocked or obstructed charge air cooler, including: after-market grill covers; where equipped
- Any snow or ice build-up at the charge air cooler in cold climates; where equipped
- Any mud or dirt build-up at the charge air cooler; where equipped
- A restricted or collapsed air intake duct
- An intake manifold leak
- A MAP sensor seal that is leaking, missing, or damaged
- A restricted or collapsed air intake duct
- A misaligned or damaged air intake duct
- Any water intrusion in the induction system
- An Intake Manifold Resonator with a leaking seal, or a cracked or broken housing

- **If a condition exists**

Repair or replace component as appropriate.

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

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

3. Test for less than 2 Ω between the low reference circuit terminal 3 and ground.

- **If 2 Ω or greater**

1. Ignition OFF, disconnect the 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 or high resistance in the circuit.
- If less than 2 Ω replace the K20 Engine Control Module.

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

4. Ignition OFF, all vehicle systems OFF, test for less than 2 Ω between the ground circuit terminal 7 and ground.

- **If 2 Ω or greater**

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

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

- If 2 Ω or greater, repair the open or high resistance in the circuit.
- If less than 2 Ω , repair the open/high resistance in the ground connection.

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

5. Ignition ON, verify that a test lamp illuminates between the ignition circuit terminal 5 and ground.

- **If the test lamp does not illuminate and the circuit fuse is good**

1. Ignition OFF, remove the test lamp and remove the fuse for the ignition voltage circuit.

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

- If 2 Ω or greater, repair the open/high resistance in the circuit.
- If less than 2 Ω , verify the fuse is not open and there is voltage at the fuse.

- **If the test lamp does not illuminate and the circuit fuse is open**

1. Ignition OFF, remove the test lamp and remove the fuse for the ignition voltage circuit.

2. Test for infinite resistance between the ignition voltage circuit and ground.

- If less than infinite resistance, repair the short to ground on the circuit.
- If infinite resistance, test all components connected to the ignition circuit, replace as necessary.

- **Go to next step: If a test lamp illuminates**

6. Ignition ON, test for 4.8 - 5.2 V between the intake air temperature signal 1 circuit terminal 1 and ground.

- **If less than 4.8 V**

1. Ignition OFF, disconnect the 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.
- Go to next step: If infinite resistance

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

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

- **If greater than 5.2 V**

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

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

2. Ignition ON, test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.
- **Go to next step: If between 4.8 - 5.2 V**
7. Ignition ON, verify the scan tool IAT Sensor 1 parameter is colder than -39°C (-38°F).
 - **If warmer than -39°C (-38°F).**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the signal circuit terminal 1 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - Go to next step: If infinite resistance
 3. Test for less than $2\ \Omega$ in the signal circuit end to end.
 - If $2\ \Omega$ or greater, repair the open/high resistance in the circuit.
 - If less than $2\ \Omega$, replace the K20 Engine Control Module.
 - **Go to next step: If colder than -39°C (-38°F).**
8. Ignition OFF, install a 3 A fused jumper wire between the signal circuit terminal 1 and the low reference circuit terminal 3.
9. Verify the scan tool IAT Sensor 1 parameter is warmer than 148°C (298°F).
 - **If colder than 148°C (298°F).**
 1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - Go to next step: If less than 1 V
 3. Ignition OFF.
 4. Test for less than $2\ \Omega$ in the signal circuit end to end.
 - If $2\ \Omega$ or greater, repair the open/high resistance in the circuit.
 - If less than $2\ \Omega$, replace the K20 Engine Control Module.
 - **Go to next step: If warmer than 148°C (298°F).**
10. Ignition ON, test for 4.8 - 5.2 V between the intake air temperature sensor 2 signal circuit terminal 8 and ground.
 - **If less than 4.8 V**
 1. Ignition OFF, disconnect the 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.
 - Go to next step: If infinite resistance
 3. Test for less than $2\ \Omega$ in the signal circuit end to end.
 - If $2\ \Omega$ or greater, repair the open/high resistance in the circuit.
 - If less than $2\ \Omega$, replace the K20 Engine Control Module.
 - **If greater than 5.2 V**

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

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
2. Ignition ON, test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.
- **Go to next step: If between 4.8 - 5.2 V**
11. Determine if **EL-38522-A** Variable Signal Generator or equivalent is available.
 - **EL-38522-A, Variable Signal Generator; or equivalent is not available**

1. Test or replace the B75C Multifunction Intake Air sensor.
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 the DTC does not set.

- **If the DTC sets**

Replace the K20 Engine Control Module.

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

4. All OK.

- **Go to next step: EL-38522-A, Variable Signal Generator; or equivalent is available**

12. Ignition OFF, connect the leads of the **EL-38522-A** Variable Signal Generator as follows:

- Red lead to the signal circuit terminal 8 at the harness connector
- Black leads to ground
- Battery voltage supply lead to B+

13. Set the **EL-38522-A** Variable Signal Generator to the following specifications.

- Signal switch to 5 V
- Duty Cycle switch to 50% (Normal)
- Frequency switch to 30 Hz

14. Ignition ON, verify the scan tool IAT Sensor 2 parameter is between 28 - 32 Hz.

- **If not between 28 - 32 Hz**

Replace the K20 Engine Control Module.

- **Go to next step: If between 28 - 32 Hz**

15. 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 B111B Turbocharger Boost/Intake Air Temperature sensor.

16. Test for less than 2 Ω between the low reference circuit terminal 1 and ground.

- **If 2 Ω or greater**

1. Ignition OFF, disconnect the 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 or high resistance in the circuit.
- If less than 2 Ω replace the K20 Engine Control Module.

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

17. Ignition ON, test for 4.8 - 5.2 V between the intake air temperature signal 3 signal circuit terminal 2 and ground.

- **If less than 4.8 V**

1. Ignition OFF, disconnect the 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.
- Go to next step: If infinite resistance

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

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

- **If greater than 5.2 V**

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

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

2. Ignition ON, test for less than 1 V between the signal circuit and ground.

- If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.
 - **Go to next step: If between 4.8 - 5.2 V**
18. Ignition ON, verify the scan tool IAT Sensor 3 parameter is colder than -39°C (-38°F).
- **If warmer than -39°C (-38°F).**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the signal circuit terminal 2 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 $2\ \Omega$ in the signal circuit end to end.
 - If $2\ \Omega$ or greater, repair the open/high resistance in the circuit.
 - If less than $2\ \Omega$, replace the K20 Engine Control Module.
 - **Go to next step: If colder than -39°C (-38°F).**
19. Ignition OFF, install a 3 A fused jumper wire between the signal circuit terminal 2 and the low reference circuit terminal 1.
20. Verify the scan tool IAT Sensor 3 parameter is warmer than 148°C (298°F).
- **If colder than 148°C (298°F).**
 1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - Go to next step: If less than 1 V
 3. Ignition OFF.
 4. Test for less than $2\ \Omega$ in the signal circuit end to end.
 - If $2\ \Omega$ or greater, repair the open/high resistance in the circuit.
 - If less than $2\ \Omega$, replace the K20 Engine Control Module.
 - **Go to next step: If warmer than 148°C (298°F).**
21. Test or replace the appropriate sensor.

Component Testing

Multifunction Intake Air Sensor

1. Ignition OFF, disconnect the harness connector at the B75C Multifunction Intake Air Sensor.

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

2. Test the IAT sensor 1 by varying the sensor temperature while monitoring the sensor resistance. Compare the readings with the [Temperature Versus Resistance - Intake Air Temperature Sensor](#) table for Hitachi Sensors. The resistance values should be in range of the table values.

- **If not within the specified range**

Replace the B75C Multifunction Intake Air Sensor.

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

3. All OK.

Multifunction Intake Air Sensor

1. Test the IAT Sensor 2 by varying the sensor temperature while monitoring the air temperature with a thermometer. Compare the readings with the scan tool IAT Sensor 2 parameter. The values should be within 5%.

- **If not within the specified range**

Replace the B75C Multifunction Intake Air Sensor.

- Go to next step: If within the specified range

2. All OK.

Turbocharger Boost/Intake Air Temperature sensor

1. Ignition OFF, disconnect the harness connector at the B111B Turbocharger Boost/Intake Air Temperature sensor.

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

2. Test the IAT sensor 3 by varying the sensor temperature while monitoring the sensor resistance. Compare the readings with the [Temperature Versus Resistance - Intake Air Temperature Sensor](#) table for Delco Sensors. The resistance values should be in range of the table values.

- If not within the specified range

Replace the B111B Turbocharger Boost/Intake Air Temperature sensor.

- Go to next step: If within the specified range

3. All OK.

Repair Instructions

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

- [Intake Air Pressure and Temperature Sensor Replacement](#) for turbocharger boost/intake air temperature sensor replacement
- [Mass Airflow Sensor with Intake Air Temperature Sensor Replacement](#) for multifunction intake air sensor replacement
- [Control Module References](#) for engine control module replacement, programming, and setup

DTC P00EA, P00EB, OR P00EC

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 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

IAT Sensor 3

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P00EA, P00EB	P00E9, P00EB, P00EC	P00EB, P00EC*	P00E9
Low Reference	-	P00E9, P00EB, P00EC	P00EB, P00EC*	-

*Internal ECM or sensor damage may occur if the circuit is shorted to B+.

IAT Sensor 3

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

Circuit/System Description

The intake air temperature (IAT) sensor 3 is a variable resistor that changes an engine control module (ECM) supplied 5 V signal. The signal varies with inlet air temperature and is displayed by the scan tool as Â°C (Â°F). The IAT sensor 3 is integrated with the B111B Turbocharger Boost/Intake Air Temperature sensor. The ECM provides a ground for the IAT sensor 3 low reference circuit.

IAT Sensor 3 - Temperature, Resistance, Voltage Table

IAT Sensor 3	IAT Sensor 3 Resistance	IAT Sensor 3 Signal Voltage
Cold	High	High
Warm	Low	Low

Conditions for Running the DTCs**P00EA, P00EB, and P00EC**

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

Conditions for Setting the DTC**P00EA**

The ECM detects that the IAT sensor 3 signal is warmer than 149Â°C (300Â°F) for at least 5 s.

P00EB

The ECM detects that the IAT sensor 3 signal is colder than -60Â°C (-76Â°F) for at least 5 s.

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

P00EC

The ECM detects that the IAT sensor 3 signal is intermittent or has abruptly changed for at least 5 s.

Action Taken When the DTCs Set

- DTCs P00EA, P00EB, and P00EC are Type B DTCs.
- The ECM commands the cooling fans ON.

Conditions for Clearing the DTCs

DTCs P00EA, P00EB, and P00EC are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

COMPONENT CONNECTOR END VIEWS - INDEX

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

Powertrain Component Views

Powertrain Component Views

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify that DTC P0641, P0651, P0697, or P06A3 is not set.

- If any of the DTCs are set

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

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

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

3. Ignition ON.
4. Verify the following scan tool parameters are within 30Â°C (54Â°F) of each other.
 - Start-Up IAT Sensor 1
 - IAT Sensor 2
 - IAT Sensor 3
 - If not within 30Â°C (54Â°F)

Refer to Circuit/System Testing.

 - Go to next step: If within 30Â°C (54Â°F)
5. Engine idling, verify the following scan tool parameters are between: -38 and +149Â°C (-36 and +300Â°F).
 - IAT Sensor 1
 - IAT Sensor 2
 - IAT Sensor 3
 - If not between: -38 and +149Â°C (-36 and +300Â°F)

Refer to Circuit System Testing.

- Go to next step: If between: -38 and +149Â°C (-36 and +300Â°F)

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

7. Verify the DTC does not set.

- **If the DTC sets**

Refer to Circuit/System Testing.

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

8. All OK

Circuit/System Testing

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

1. 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 B111B Turbocharger Boost/Intake Air Temperature sensor.
2. Test for less than 2 Ω between the intake air temperature sensor 3 low reference circuit terminal 1 and ground.
 - **If 2 Ω or greater**
 1. Ignition OFF, disconnect the 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 or high resistance in the circuit.
 - If less than 2 Ω replace the K20 Engine Control Module.
 - **Go to next step: If less than 2 Ω**
3. Ignition ON, test for 4.8 - 5.2 V between the intake air temperature signal 3 signal circuit terminal 2 and ground.
 - **If less than 4.8 V**
 1. Ignition OFF, disconnect the 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.
 - Go to next step: If infinite resistance
 3. Test for less than 2 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **If greater than 5.2 V**

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

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
2. Ignition ON, test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.
- **Go to next step: If between 4.8 - 5.2 V**
4. Ignition ON, verify the scan tool IAT Sensor 3 parameter is colder than -39 $^{\circ}$ C (-38 $^{\circ}$ F).
 - **If warmer than -39 $^{\circ}$ C (-38 $^{\circ}$ F).**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the signal circuit terminal 2 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 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 colder than -39Â°C (-38Â°F).**
- 5. Ignition OFF, install a 3 A fused jumper wire between the signal circuit terminal 2 and the low reference circuit terminal 1.
- 6. Verify the scan tool IAT Sensor 3 parameter is warmer than 148Â°C (298Â°F).
 - **If colder than 148Â°C (298Â°F).**
 1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - Go to next step: If less than 1 V
 3. Ignition OFF.
 4. Test for less than 2 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω, replace the K20 Engine Control Module.
 - **Go to next step: If warmer than 148Â°C (298Â°F).**
- 7. Test or replace the B111B Turbocharger Boost/Intake Air Temperature sensor.

Component Testing

Turbocharger Boost/Intake Air Temperature sensor

1. Ignition OFF, disconnect the harness connector at the B111B Turbocharger Boost/Intake Air Temperature sensor.

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

2. Test the IAT sensor 3 by varying the sensor temperature while monitoring the sensor resistance. Compare the readings with the [Temperature Versus Resistance - Intake Air Temperature Sensor](#) table for Delco sensors. The resistance values should be in range of the table values.
 - **If not within the specified range.**

Replace the B111B Turbocharger Boost/Intake Air Temperature sensor.

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

3. All OK

Repair Instructions

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

- [Intake Air Pressure and Temperature Sensor Replacement](#) for B111B Turbocharger Boost/Intake Air Temperature sensor replacement
- [Control Module References](#) for control module replacement, programming, and setup.

DTC P00F4, P00F5, OR P00F6

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 P00F4

Intake Air Humidity Sensor Circuit Low Voltage

DTC P00F5

DTC P00F6

Intake Air Humidity Sensor Circuit Erratic

Diagnostic Fault Information**Intake Air Humidity**

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

IAT Sensor 2

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

Typical Scan Tool Data**Intake Air Humidity**

Circuit	Short to Ground	Open or High Resistance	Short to Voltage
Operating Conditions: Engine Running Parameter Normal Range: Varies with ambient humidity and temperature; and engine bay conditions			
Ignition 1	0 %	0 %	-
Signal	100 %	0 %	0 %*
Ground	-	0 %	-
*Internal ECM or sensor damage may occur if the circuit is shorted to B+			

IAT Sensor 2

Circuit	Short to Ground	Open or High Resistance	Short to Voltage
Operating Conditions: Engine Running Parameter Normal Range: Varies with ambient temperature			

Circuit	Short to Ground	Open or High Resistance	Short to Voltage
Ignition 1	-40Â°C (-40Â°F) 10 Hz	-40Â°C (-40Â°F) 10 Hz	-
Signal	-40Â°C (-40Â°F) 10 Hz	-40Â°C (-40Â°F) 10 Hz	-40Â°C (-40Â°F) 10 Hz*
Ground	-	-40Â°C (-40Â°F) 10 Hz	-
*Internal ECM or sensor damage may occur if the circuit is shorted to B+			

Circuit/System Description

The sensors listed below are integrated within the Multifunction Intake Air sensor:

- IAT sensor 1
- IAT sensor 2
- Humidity sensor
- MAF sensor
- BARO pressure sensor

The humidity sensor measures the ambient humidity of the air in the sensor bore. The signal varies with intake air humidity and is displayed by the scan tool as duty cycle %. The humidity sensor and the intake air temperature (IAT) sensor 2 share the same signal circuit. The ECM applies 5 V to the circuit.

Ignition voltage and ground circuits are supplied to the multifunction intake air sensor's internal circuits for these sensors:

- IAT sensor 2
- Humidity sensor
- MAF sensor

Conditions for Running the DTCs

P00F4, P00F5, and P00F6

- DTC P1682 is not active.
- The ignition is ON.
- The Ignition 1 voltage is at least 11 V for longer than 0.9 s.
- These DTCs run continuously within the enabling conditions.

Conditions for Setting the DTCs

P00F4

The ECM detects that the humidity sensor signal is less than or equal to 5% for greater than 4 s.

P00F5

The ECM detects that the humidity sensor signal is greater than or equal to 95% for greater than 4 s.

P00F6

The ECM monitors the humidity sensor signal every 0.1 s, to determine if the signal has changed more than 80%. The DTC fails when the condition exists for longer than 4 s.

Action Taken When the DTC Sets

- DTCs P00F4, P00F5, and P00F6 are Type B DTCs - North America and Korea.
- DTCs P00F4, P00F5, and P00F6 are Type C DTCs - Except North America and Korea.

Conditions for Clearing the MIL/DTC

- DTCs P00F4, P00F5, and P00F6 are Type B DTCs - North America and Korea.
- DTCs P00F4, P00F5, and P00F6 are Type C DTCs - Except North America and Korea.

Diagnostic Aids

- The Intake Air Humidity Signal parameter displays the measured humidity within the air intake system and may differ from atmospheric humidity measured outside the air intake system.
- With the ignition ON, the engine OFF, if the engine is cold, a properly functioning humidity sensor will gradually increase the scan tool Intake Air Humidity Signal parameter. This is due to the heat that is generated by the multifunction intake air sensor heating elements.
- The humidity sensor and the IAT sensor 2 signals are sent to the ECM on the same circuit. If the Intake Air Humidity parameter displays the value: 0% or 100%, and there are also IAT Sensor 2 DTCs, check for a circuit problem.
- With the ignition ON, the engine OFF, if the engine is cold, a properly functioning IAT sensor 2 will gradually increase the scan tool IAT Sensor 2 parameter. This is due to the heat that is generated by the multifunction intake air sensor heating elements.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

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Powertrain Component Views

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-38522-A Variable Signal Generator

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

Circuit/System Verification

NOTE: To minimize the effects of residual engine heat and sensor internal heating elements, perform Steps 1 and 2 of this verification procedure only if the ignition has been OFF for 8 hours or more.

1. Ignition ON.
2. Verify the following scan tool parameters are within 25Â°C (45Â°F) of each other.

- Start-Up IAT Sensor 1
- Start-Up IAT Sensor 2
- Start-Up IAT Sensor 3; where equipped
- **If not within 25°C (45°F)**

Refer to Circuit/System Testing.

- **Go to next step: If within 25°C (45°F)**

3. Engine idling, verify the scan tool Intake Air Humidity parameter is between 5 and 90%.

- **If not between 5 and 90%**

Refer to Circuit/System Testing.

- **Go to next step: If between 5 and 90%**

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

5. Verify the DTC does not set.

- **If the DTC sets**

Refer to Circuit/System Testing.

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

6. All OK

Circuit/System Testing

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

1. Ignition OFF, disconnect the harness connector at the B75C Multifunction Intake Air sensor (Humidity Sensor).

2. Test for less than 5 Ω between the ground circuit terminal 7 and ground.

- **If 5 Ω or greater**

1. Ignition OFF, disconnect the 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 or high resistance in the circuit.
- If less than 2 Ω replace the K20 Engine Control Module.

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

3. Ignition ON, verify that a test lamp illuminates between the ignition circuit terminal 5 and ground.

- **If the test lamp does not illuminate and the circuit fuse is good**

1. Ignition OFF, remove the test lamp and remove the fuse for the ignition voltage circuit.

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

- If 2 Ω or greater, repair the open/high resistance in the circuit.
- If less than 2 Ω , verify the fuse is not open and there is voltage at the fuse.

- **If the test lamp does not illuminate and the circuit fuse is open**

1. Ignition OFF, remove the test lamp and remove the fuse for the ignition voltage circuit.

2. Test for infinite resistance between the ignition voltage circuit and ground.

- If less than infinite resistance, repair the short to ground on the circuit.
- If infinite resistance, test all components connected to the ignition circuit, replace as necessary.

- **Go to next step: If a test lamp illuminates**

NOTE:

- The IAT 2 parameter and the Intake Air Humidity Sensor parameter share the same signal circuit.

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

4. Ignition On/Vehicle in Service Mode, verify the scan tool Intake Air Humidity Sensor parameter is less than 1%.

- **If 1% or greater**

1. Vehicle OFF, disconnect the harness connector at the K20 Engine Control Module.
2. Test for infinite resistance between the IAT 2 signal circuit terminal 8 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K20 Engine Control Module.

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

5. Vehicle OFF, install a 3 A fused jumper wire between the IAT 2 signal circuit terminal 8 and the low reference circuit terminal 3, Ignition On/Vehicle in Service Mode.

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

- **If 99% or less**

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

1. Vehicle OFF, remove the jumper wire and disconnect the harness connector at the K20 Engine Control Module, Ignition On/Vehicle in Service Mode.

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

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

3. Vehicle OFF.

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

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

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

7. Test or replace the B75C Multifunction Intake Air sensor (IAT 2 Humidity Sensor).

Component Testing

Multifunction Intake Air Sensor

1. Test the Intake Air Humidity Sensor by varying the air humidity in the intake duct near the sensor, while observing the scan tool Intake Air Humidity Sensor parameter. The parameter should change and be within 5 - 95%.

- **If not within the specified range**

Replace the B75C Multifunction Intake Air Sensor.

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

2. All OK.

IAT 2 Circuit Testing with EL-38522-A

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

1. Perform the following test using a **EL-38522-A** Variable Signal Generator or equivalent, if available.

2. Vehicle Off, connect the leads of the **EL-38522-A** Variable Signal Generator as follows:

1. Red lead to the signal circuit terminal 8 at the harness connector

2. Black leads to ground
3. Battery voltage supply lead to B+
3. Set the **EL-38522-A** Variable Signal Generator to the following specifications.
 - Signal switch to 5 V
 - Duty Cycle switch to 50% (Normal)
 - Frequency switch to 250 Hz
4. Ignition On/Vehicle in Service Mode.
5. Verify the scan tool IAT Sensor 2 parameters listed below are within the ranges listed below:
 - IAT Sensor 2 is between 248 - 252 Hz

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

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

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

- Intake Air Humidity Sensor is between 48 - 52%
- **If a parameter is not within the specified range**
 1. Vehicle Off, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for less than 2 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω, replace the K20 Engine Control Module.
 - **Go to next step: If all the parameters are within the specified range**

6. All OK.

Repair Instructions

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

- **Mass Airflow Sensor with Intake Air Temperature Sensor Replacement** for multifunction intake air sensor replacement
- **Control Module References** for Engine Control Module replacement, programming, and setup.

DTC P00FF, P069E, P06EC, P0700, P0800, P0AC4, P1700, P1E00, P2561, P25A2, P25AF, P25C9, P26C8, OR P26C9

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 of the diagnostic category.

DTC Descriptor

DTC P00FF

Body Control Module Requested MIL Illumination

DTC P069E

Fuel Pump Control Module Requested MIL Illumination

DTC P06EC

Fuel Injector Control Module Requested MIL Illumination

DTC P0700

DTC P0800

Active Transfer Case Control Module Requested MIL Illumination

DTC P0AC4

Hybrid/EV Powertrain Control Module Requested MIL Illumination

DTC P1E00

Hybrid/EV Powertrain Control Module 2 Requested MIL Illumination

DTC P2561

Air Conditioning (A/C) Control Module Requested MIL Illumination

DTC P25A2

Brake System Control Module Requested MIL Illumination

DTC P25AF

Coolant Temperature Control Module Requested MIL Illumination

DTC P25C9

Brake System Control Module 2 Requested MIL Illumination

DTC P26C8

Chassis Control Module Requested MIL Illumination

DTC P26C9

Auxiliary Chassis Control Module Requested MIL Illumination

Circuit/System Description

Control modules constantly monitor the vehicle for any condition which may adversely affect vehicle performance. If a condition is detected, the module sets a DTC and sends a serial data message to the engine control module (ECM). The ECM sets a DTC to inform the technician that the module has set a DTC. The serial data message sent by the module also contains a request for the ECM to illuminate the malfunction indicator lamp (MIL).

The technician can observe the DTC that was set by the module by reviewing the ECM Freeze Frame records on the scan tool. The ECM Freeze Frame records also contain the engine operating conditions present when the DTC set.

Conditions for Running the DTC

- The ignition is ON or the engine is running.
- These DTCs run continuously.

Conditions for Setting the DTC

The ECM receives a serial data message from a specific module indicating that DTC has set in the module.

Action Taken When the DTC Sets

DTCs P00FF, P069E, P06EC, P0700, P0800, P0AC4, P1E00, P2561, P25A2, P25AF, P25C9, P26C8, and P26C9 are Type A DTCs.

Conditions for Clearing the MIL/DTC

DTCs P00FF, P069E, P06EC, P0700, P0800, P0AC4, P1E00, P2561, P25A2, P25AF, P25C9, P26C8, and P26C9 are Type A DTCs.

Diagnostic Aids

Communication codes, U-codes, and P-codes that set in a module can request a DTC to be set in the ECM.

Reference Information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

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

Circuit/System Verification

NOTE:

- Do not replace the engine control module for these informational DTCs.
- Correct any engine control and communication DTCs before diagnosing these DTCs.

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

Repair Instructions

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

DTC P0101

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 P0101

Mass Air Flow (MAF) Sensor Performance

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Ignition Voltage	P0102	P0101	P0102	-	P0101, P0103
Signal	P0102	P0102	P0102	P0102	P0101, P0103, P1101
Ground	-	P0102	P0102	-	P0102

Typical Scan Tool Data

MAF Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine running at various operating conditions Parameter Normal Range: 2, 000 - 10, 000 Hz			
Ignition Voltage	0 Hz	0 Hz	-
Signal	0 Hz	0 Hz	0 Hz
Ground	-	0 Hz	-

Circuit Description

The intake flow rationality diagnostic provides the within-range rationality check for the mass air flow (MAF), manifold absolute pressure (MAP), and the throttle position sensors. This is an explicit model-based diagnostic containing 4 separate models for the intake system.

- The throttle model describes the flow through the throttle body and is used to estimate the MAF through the throttle body as a function of barometric pressure (BARO), throttle position sensors, intake air temperature (IAT), and estimated MAP. The information from this model is displayed on the scan tool as the MAF Performance Test parameter.
- The first intake manifold model describes the intake manifold and is used to estimate MAP as a function of the MAF into the manifold from the throttle body and the MAF out of the manifold caused by engine pumping. The flow into the manifold from the throttle uses the MAF estimate calculated from the above throttle model. The information from this model is displayed on the scan tool as the MAP Performance Test 1 parameter.
- The second intake manifold model is identical to the first intake manifold model except that the MAF sensor measurement is used instead of the throttle model estimate for the throttle air input. The information from this model is displayed on the scan tool as the MAP Performance Test 2 parameter.
- The fourth model is created from the combination and additional calculations of the throttle model and the first intake manifold model. The information from this model is displayed on the scan tool as the Throttle Position Performance Test parameter.

The estimates of MAF and MAP obtained from this system of models and calculations are then compared to the actual measured values from the MAF, MAP, and the throttle position sensors and to each other to determine the appropriate DTC to fail.

Conditions for Running the DTCs

- DTC P0102, P0103, P0107, P0108, P0111, P0112, P0113, P0114, P0117, P0118, P0128, P0335, or P0336 is not set.
- The engine speed is between 400 - 6, 000 RPM
- The engine coolant temperature (ECT) is between -7 and +130Â°C (+19 and +266Â°F).
- The intake air temperature (IAT) is between -20 and +125Â°C (-4 and +257Â°F).
- The DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

The engine control module (ECM) detects that the actual measured airflow from the MAF, MAP, and throttle position sensors is not within range of the calculated airflow that is derived from the system of models for greater than 2 s.

Action Taken When the DTC Sets

DTC P0101 is a Type B DTC.

Conditions for Clearing the MIL/DTC

DTC P0101 is a Type B DTC.

Diagnostic Aids

- Any type of contamination on the MAF sensor heating elements will degrade the proper operation of the sensor. Certain types of contaminants act as a heat insulator, which will impair the response of the sensor to airflow changes. Water or snow can create the opposite effect, and cause the signal to increase rapidly.
- Certain aftermarket air filters may cause this DTC to set.
- Certain aftermarket air induction systems may cause this DTC to set.
- Modifications to the air induction system may cause this DTC to set.
- Driveability concerns and erratic transmission shifting may be caused by an excessively oiled aftermarket air cleaner that is contaminating the MAF sensor.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

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

Special Tools

EL-38522 Variable Signal Generator

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

Circuit/System Verification

1. Ignition ON.
2. Verify that DTC P0641, P0651, P0697, P06A3 or P06D2 is not set.
 - **If any of the DTCs are set**

Refer to [DTC P0641, P0651, P0697, P06A3, or P06D2](#) for further diagnosis.

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

3. If you were sent here from DTC P0068, P0106, P0121, or P1101; refer to Circuit/System Testing.

4. Ignition ON.

5. Verify the scan tool Throttle Body Idle Air Flow Compensation parameter is less than 90%.

- **If 90% or greater**

Refer to [Throttle Body Cleaning](#) .

- **Go to next step: If less than 90%**

6. Verify the scan tool Throttle Position Sensors 1 and 2 Agree/Disagree parameter displays Agree while performing the Throttle Sweep Test with a scan tool.

- **If Disagree**

Refer to [DTC P0121-P0123, P0222, P0223, P16A0-P16A2, or P2135](#) for further diagnosis.

- **Go to next step: If Agree**

7. Determine the current vehicle testing altitude.

8. Verify the scan tool MAP Sensor pressure parameter is within the range specified in the [Altitude Versus Barometric Pressure](#) table.

- **If the MAP Sensor parameter is not in range**

Refer to [DTC P0106](#) for further diagnosis.

- **Go to next step: If the MAP Sensor parameter is within range**

9. Verify the scan tool MAF Sensor g/s parameter changes smoothly and gradually as the engine speed is increased and decreased while performing the actions listed below.

1. Engine idling
2. Perform the scan tool snapshot function.
3. Increase the engine speed slowly to 3, 000 RPM and then back to idle.
4. Exit from the scan tool snapshot and review the data.
5. Observe the MAF Sensor parameter frame by frame with a scan tool.

- **If the MAF Sensor parameter does not change smoothly and gradually**

Refer to Circuit/System Testing.

- **Go to next step: If the MAF Sensor parameter changes smoothly and gradually**

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.

11. Verify a DTC does not set.

- **If any DTC sets**

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

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

12. All OK

Circuit/System Testing

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

1. Verify the integrity of the entire air induction system by verifying that none of the following conditions exist:

- Any damaged components

- Improperly installed components
- Collapsed, restricted, or damaged components
- Loose clamps, cracks, or other damage
- An air flow restriction
- Improper operation of the positive crankcase ventilation system
- Restricted air filter
- Splits, kinks, leaks, or improper connections at the vacuum hoses
- Vacuum leaks at the intake manifold, MAP sensor, and throttle body
- Water intrusion
- Any snow or ice buildup, in cold climates
- Contamination of the Multifunction Intake Air sensor element
- **If a condition is found**

Repair or replace component as appropriate.

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

2. Ignition OFF, disconnect the harness connector at the B75C Multifunction Intake Air sensor.
3. Ignition OFF and all systems OFF. It may take up to for 2 minutes for all vehicle systems to power down. Test for less than 5 Ω between the ground circuit terminal 7 and ground.

- **If 5 Ω or greater**

1. Ignition OFF.
2. Test for less than 2 Ω in the ground circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , repair the open/high resistance in the ground connection.

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

4. Ignition ON, verify that a test lamp illuminates between the ignition circuit terminal 5 and ground.

- **If the test lamp does not illuminate and the circuit fuse is good**

1. Ignition OFF, remove the test lamp and remove the fuse for the ignition voltage circuit.
2. Test for less than 2 Ω in the ignition voltage circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , verify the fuse is not open and there is voltage at the fuse.

- **If the test lamp does not illuminate and the circuit fuse is open**

1. Ignition OFF, remove the test lamp and remove the fuse for the ignition voltage circuit.
2. Test for infinite resistance between the ignition voltage circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, test all components connected to the ignition circuit, replace as necessary.

- **Go to next step: If a test lamp illuminates**

5. Ignition ON, test for 4.8 - 5.2 volts between the signal circuit terminal 6 and ground.

- **If less than 4.8 V**

1. Ignition OFF, disconnect the 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.
 - Go to next step: If infinite resistance
3. Test for less than 2 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.

- **If greater than 5.2 V**

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
2. Ignition ON, test for less than 1 V between the signal circuit and ground.

- If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.
 - **Go to next step: If between 4.8 - 5.2 V**
6. Ignition OFF, connect the leads of the **EL-38522** Variable Signal Generator as follows:
 - Red lead to the signal circuit terminal 6 at the harness connector
 - Black leads to ground
 - Battery voltage supply lead to B+
 7. Set the **EL-38522** Variable Signal Generator to the following specifications.
 - Signal switch to 5 V
 - Frequency switch to 5 kHz
 - Duty Cycle switch to 50% (Normal)
 8. Engine idling, observe the scan tool MAF Sensor parameter. The scan tool MAF Sensor parameter should be between 4, 950 - 5, 050 Hz.
 - **If not between 4, 950 - 5, 050 Hz.**

If not between 4, 950 - 5, 050 Hz, replace the K20 Engine Control Module.

 - **Go to next step: If between 4, 950 - 5, 050 Hz.**
 9. Test or replace the B75C Multifunction Intake Air sensor.

Repair Instructions

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

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

DTC P0102 OR P0103

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 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	High Resistance	Open	Short to Voltage	Signal Performance
Ignition Voltage	P0096, P0097, P00F4, P0102, P2199**	P0096, P0097, P00F4, P0102, P2199**	P0102	P0096	P0101, P0103
Signal	P0102	P0102	P0102	P0102	P0101, P0103, P1101

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Ground	-	P0096, P0097, P00F4, P0102, P2199**	P0102	-	P0102
**Where used.					

Typical Scan Tool Data

MAF Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine running at various operating conditions			
Parameter Normal Range: 2, 000 - 10, 000 Hz			
Ignition Voltage	0 Hz	0 Hz	-
Signal	0 Hz	0 Hz	0 Hz
Ground	-	0 Hz	-

Circuit/System Description

The mass air flow (MAF) sensor is integrated with the multifunction intake air sensor. The MAF sensor is an air flow meter that measures the amount of air in the sensor bore. The engine control module (ECM) uses the MAF sensor signal to provide the correct fuel delivery for all engine speeds and loads. A small quantity of air entering the engine indicates a deceleration or idle condition. A large quantity of air entering the engine indicates an acceleration or high load condition.

The ECM applies 5 V to the MAF sensor on the MAF sensor signal circuit. The sensor uses the voltage to produce a variable frequency signal based on the inlet air flow through the sensor bore. The signal varies with engine load and is displayed by the scan tool as Hertz (Hz) and grams per second (g/s). Ignition voltage and ground circuits are also supplied to the multifunction intake air sensor's internal circuits for these sensors:

- Intake Air Temperature (IAT) sensor 2
- Humidity sensor
- MAF sensor

The multifunction intake air sensor houses the following:

- IAT sensor 1
- IAT sensor 2
- Humidity sensor
- MAF sensor
- BARO pressure sensor

Conditions for Running the DTC

- The engine is running for at least 1 s.
- The engine speed is at least 300 RPM.
- The ignition signal is at least 11 V.
- The above conditions are met for at least 1 s.
- The DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

P0102

The ECM detects that the MAF Sensor signal parameter is less than 500 Hz (about 0.25 g/s) for at least 250 cylinder firing events.

P0103

The ECM detects that the MAF Sensor signal parameter is at least 11, 000 Hz (about 328 g/s) for at least 250 cylinder firing events.

Action Taken When the DTCs Set

DTCs P0102 and P0103 are Type B DTCs.

Conditions for Clearing the MIL/DTCs

DTCs P0102 and P0103 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

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

Powertrain Component Views

Powertrain Component Views

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

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

Special Tools

EL-38522-A Variable Signal Generator

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

Circuit/System Verification

1. Engine idling, observe the scan tool MAF Sensor parameter. The reading should be between 2.5 - 5.5 g/s.
 - **If not between 2.5 - 5.5 g/s**
Refer to Circuit/System Testing.
 - **Go to next step: If between 2.5 - 5.5 g/s**
2. Verify the scan tool MAF Sensor g/s parameter changes smoothly and gradually as the engine speed is increased and decreased while performing the actions listed below.
 1. Engine idling
 2. Perform the scan tool snapshot function.
 3. Increase the engine speed slowly to 3, 000 RPM and then back to idle.
 4. Exit from the scan tool snapshot and review the data.
 5. Observe the MAF Sensor parameter frame by frame with a scan tool.

- **The MAF Sensor parameter does not change smoothly and gradually**

Refer to Circuit/System Testing.

- **Go to next step: The MAF Sensor parameter changes smoothly and gradually**

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

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

1. Ignition OFF, disconnect the harness connector at the B75C Multifunction Intake Air sensor.

2. Test for less than 2 Ω between the ground circuit terminal 7 and ground.

- **If 2 Ω or greater**

1. Ignition OFF. Disconnect the sensor chassis ground.

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 chassis ground connection.

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

3. Ignition ON, verify that a test lamp illuminates between the ignition circuit terminal 5 and ground.

- **If the test lamp does not illuminate and the circuit fuse is good**

1. Ignition OFF, remove the test lamp and remove the fuse for the ignition voltage circuit.

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

- If 2 Ω or greater, repair the open/high resistance in the circuit.
- If less than 2 Ω , verify the fuse is not open and there is voltage at the fuse.

- **If the test lamp does not illuminate and the circuit fuse is open**

1. Ignition OFF, remove the test lamp and remove the fuse for the ignition voltage circuit.

2. Test for infinite resistance between the ignition voltage circuit and ground.

- If less than infinite resistance, repair the short to ground on the circuit.
- If infinite resistance, test all components connected to the ignition circuit, replace as necessary.

- **Go to next step: If a test lamp illuminates**

4. Ignition ON, test for 4.8 - 5.2 volts between the signal circuit terminal 6 and ground.

- **If less than 4.8 V**

1. Ignition OFF, disconnect the 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.
- Go to next step: If infinite resistance

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

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

- **If greater than 5.2 V**

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

2. Ignition ON, test for less than 1 V between the signal circuit and ground.

- If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.
 - **Go to next step: If between 4.8 - 5.2 V**
5. Determine if **EL-38522-A** Variable Signal Generator or equivalent is available.
- **EL-38522-A, Variable Signal Generator; or equivalent is not available**
 1. Test or replace the B75C Multifunction Intake Air sensor.
 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 the DTC does not set.
 - **If the DTC sets**

Replace the K20 Engine Control Module.
 - **Go to next step: If no DTCs set**
4. All OK.
- **Go to next step: EL-38522-A, Variable Signal Generator; or equivalent is available**
6. Ignition OFF, connect the leads of the **EL-38522-A** Variable Signal Generator as follows:
- Red lead to the signal circuit terminal 6 at the harness connector
 - Black leads to ground
 - Battery voltage supply lead to B+
7. Set the **EL-38522-A** Variable Signal Generator to the following specifications.
- Signal switch to 5 V
 - Frequency switch to 5 kHz
 - Duty Cycle switch to 50% (Normal)
8. Engine idling, verify the scan tool MAF Sensor parameter is between 4, 950 - 5, 050 Hz.
- **If not between 4, 950 - 5, 050 Hz.**

Replace the K20 Engine Control Module.

 - **Go to next step: If between 4, 950 - 5, 050 Hz.**
9. Test or replace the B75C Multifunction Intake Air sensor.

Repair Instructions

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

- [Mass Airflow Sensor with Intake Air Temperature Sensor Replacement](#) for multifunction intake air sensor replacement
- [Control Module References](#) for engine control module replacement, programming, and setup

DTC P0106

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 P0106

Manifold Absolute Pressure (MAP) Sensor Performance

Diagnostic Fault Information

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Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P0106, P0107, P018C, P0532, P0641	P0106, P0107	P0106, P018C, P0533, P0641	P0106
Signal	P0106, P0107	P0106, P0108	P0106, P0108*	P0106
Low Reference	-	P0106, P0108	-	P0106
* Internal ECM or sensor damage may occur if the circuit is shorted to B+.				

Typical Scan Tool Data

MAP Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine idling at normal operating temperature Parameter Normal Range: 26 - 52 kPa (3.8 - 7.6 PSI)			
5 V Reference	0 kPa (0 PSI)	0 kPa (0 PSI)	255 kPa (36.9 PSI)
Signal	0 kPa (0 PSI)	255 kPa (36.9 PSI)*	255 kPa (36.9 PSI)*
Low Reference	-	255 kPa (36.9 PSI)	-
* Internal ECM or sensor damage may occur if the circuit is shorted to B+.			

Circuit Description

The manifold absolute pressure (MAP) sensor measures the pressure inside the intake manifold. Pressure in the intake manifold is affected by engine speed, throttle opening, air temperature, barometric pressure (BARO); and turbocharger output. A silicone chip within the MAP sensor is displaced by the pressure changes that occur from the varying load and operating conditions of the engine. The sensor translates this action into electrical resistance. Integrated within this sensor is also an intake air temperature (IAT) sensor.

The MAP sensor wiring includes 3 circuits. The engine control module (ECM) supplies a regulated 5 volts to the sensor on a 5 V reference circuit. The ECM supplies a ground on a low reference circuit. The MAP sensor provides a signal voltage to the ECM, relative to the pressure changes, on the MAP sensor signal circuit. The ECM converts the signal voltage input to a pressure value.

Integrated within the MAP sensor is a 4th circuit for the IAT. A signal voltage is supplied to the ECM relative to intake air temperature. The low reference is shared with the MAP sensor low reference. The IAT is diagnosed within it's own DTC.

Under normal operation the greatest pressure that can exist in the intake manifold is at ignition ON, engine OFF, which is equal to the barometric pressure (BARO). The turbocharger can increase the pressure above BARO, when the vehicle is operated at wide-open throttle (WOT). The lowest manifold pressure occurs when the vehicle is idling or decelerating.

Conditions for Running the DTC

- DTCs P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0119, P0128, P0335, P0336 are not set.
- The engine speed is between 400 - 6500 RPM.
- The engine coolant temperature (ECT) sensor is between -7 to +125Â°C (19.4 and 257Â°F).
- The intake air temperature (IAT) sensor is between -20 to +125Â°C (-4 and +257Â°F).
- This DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

The ECM detects that the MAP Sensor pressure is not within range of the calculated pressure that is derived from a system of models for more than 0.5 s.

Action Taken When the DTC Sets

DTC P0106 is a Type B DTC.

Conditions for Clearing the DTC

DTC P0106 is a Type B DTC.

Reference Information

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- [Wiring Repairs](#)

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

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

Special Tools

GE-23738-A Vacuum Pump

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

Circuit/System Verification

1. Ignition ON.
2. Verify that DTC P0641, P0651, P0697, P06A3, P06D2 or P06D6 is not set.
 - **If any of the DTCs are set**

Refer to [DTC P0641, P0651, P0697, P06A3, or P06D2](#) for further diagnosis.
 - **Go to next step: If none of the DTC are set**
3. If you were sent here from DTC P0068, P0101, P0121, P0236, or P1101; refer to Circuit/System Testing.
4. Ignition ON.
5. Verify the scan tool Throttle Body Idle Airflow Compensation parameter is less than 90%.

- **If 90% or greater**

Refer to [Throttle Body Cleaning](#) .

- **Go to next step: If less than 90%**

6. Verify the scan tool Throttle Position Sensors 1 and 2 Agree/Disagree parameter displays Agree while performing the Throttle Sweep Test with a scan tool.

- **If Disagree**

Refer to [DTC P0121-P0123, P0222, P0223, P16A0-P16A2, or P2135](#) for further diagnosis.

- **Go to next step: If Agree**

7. Determine the current vehicle testing altitude.

8. Verify the scan tool MAP Sensor parameter is within the range specified in the [Altitude Versus Barometric Pressure](#) table.

- **If the MAP Sensor parameter is not in range**

Refer to Circuit/System Testing.

- **Go to next step: If the MAP Sensor parameter is in range**

9. Verify the scan tool Boost Pressure Sensor parameter is within the range specified in the [Altitude Versus Barometric Pressure](#) table.

- **If the Boost Pressure Sensor parameter is not in range**

Refer to [DTC P0236](#) for further diagnosis.

- **Go to next step: If the Boost Pressure Sensor parameter is in range**

10. Verify the scan tool Boost Pressure Sensor parameter decreases after starting the engine.

- **If the Boost Pressure Sensor parameter does not decrease**

Refer to [DTC P0236](#) for further diagnosis.

- **Go to next step: If the Boost Pressure Sensor parameter is within range**

11. Engine idling, verify the scan tool MAP Sensor pressure parameter is between 24 - 52 kPa (3.4 - 7.5 PSI) and changes with accelerator pedal input.

- **If not between 24 - 52 kPa (3.4 - 7.5 PSI) or does not change**

Refer to Circuit/System Testing.

- **Go to next step: If between 24 - 52 kPa (3.4 - 7.5 PSI) and changes**

12. Observe and compare the scan tool MAF Sensor and Engine Speed parameters.

13. Increase the engine speed slowly to 3, 000 RPM and then back to idle.

14. Verify the scan tool MAF Sensor g/s parameter changes smoothly and gradually as the engine speed is increased and decreased.

- **If the MAF Sensor parameter does not change smoothly and gradually**

Refer to [DTC P0101](#).

- **Go to next step: If the MAF Sensor parameter does change smoothly and gradually**

15. 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.

16. Verify a DTC does not set.

- **If the DTC sets**

Refer to Circuit/System Testing.

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

Circuit/System Testing

1. Check the integrity of the entire air induction system and verify that none of the following conditions exist:

- Any damaged components
- Improper operation of turbocharger wastegate actuator or bypass valve
- Loose or improper installation of the turbocharger and the charge air cooler, including the flexible ductwork
- An air flow restriction
- Any vacuum leak
- Improperly routed vacuum hoses
- A restriction in the MAP Sensor port or the BARO port
- Proper operation of the positive crankcase ventilation system
- Missing, restricted or leaking exhaust components. Refer to [Symptoms - Engine Exhaust](#).
- Engine mechanical condition; for example: low compression or incorrect timing chain installation. Refer to [Symptoms - Engine Mechanical](#).
- **If a condition is found**

Repair or replace the component as appropriate.

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

2. Ignition OFF, and all vehicle systems OFF, it may take up to 2 min. for all vehicle systems to power down. Disconnect the harness connector at the B65 Intake Manifold Pressure and Air Temperature Sensor.

3. Test for less than 2 Ω between the low reference circuit terminal 3 or A and ground.

- **If 2 Ω or greater**

1. Ignition OFF, disconnect 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 2 Ω**

4. Ignition ON.

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

- **If less than 4.8 V**

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

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

- **If greater than 5.2 V**

1. Ignition OFF, disconnect the K20 Engine Control Module.
2. Ignition ON, test for less than 1 V between the 5 V reference circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.

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

6. Ignition ON, verify the scan tool MAP Sensor parameter is greater than 4.7 V.

- **If 4.7 V or less**

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
2. Ignition ON, test for infinite resistance between the signal circuit terminal 4 or D and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K20 Engine Control Module.

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

7. Ignition OFF, install a 3 A fused jumper wire between the signal circuit terminal 4 or D and the low reference circuit terminal 3 or A.

8. Ignition ON, verify the scan tool MAP Sensor voltage parameter is less than 0.2 V.

- **If 0.2 V or greater**

1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the K20 Engine Control Module, Ignition ON.
2. test for less than 1 V between the signal circuit terminal 4 or D 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 signal circuit end to end.
 - If 2 Ω or greater, repair the open or high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.

- **Go to next step: If less than 0.2 V**

9. Test or replace the B65 Intake Manifold Pressure and Air Temperature Sensor.

Component Testing

NOTE: You must perform the Circuit/System Testing in order to Check the integrity of the MAP Sensor circuits before proceeding with the Component Testing.

Skewed Sensor Test

1. Ignition OFF, remove the B65 Intake Manifold Pressure and Air Temperature Sensor from the engine. Connect the harness to the sensor, if disconnected.
2. Ignition ON, apply -17 kPa (5.0 in Hg) of vacuum to the B65 Intake Manifold Pressure and Air Temperature Sensor, with the **GE-23738-A**. Verify the scan tool MAP Sensor pressure parameter decreases between 13 - 21 kPa (1.8 - 3.0 PSI).

- **If the parameter does not decrease between 13 - 21 kPa (1.8 - 3.0 PSI).**

Replace the B65 Intake Manifold Pressure and Air Temperature Sensor.

- **Go to next step: If the parameter does decrease between 13 - 21 kPa (1.8 - 3.0 PSI).**

3. Apply -34 kPa (10.0 in Hg) of vacuum to the B65 Intake Manifold Pressure and Air Temperature Sensor, with the **GE-23738-A**. Verify the scan tool MAP Sensor pressure parameter decreases between 30 - 38 kPa (4.4 - 5.5 PSI).

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

Replace the B65 Intake Manifold Pressure and Air Temperature Sensor.

- **Go to next step: If the parameter does decrease between 30 - 38 kPa (4.4 - 5.5 PSI).**

4. All OK.

Erratic Signal Test

1. Ignition OFF, remove the B65 Intake Manifold Pressure and Air Temperature Sensor. and disconnect the harness.

2. Install a 3 A fused jumper wire between the 5 V reference circuit terminal 2 or C of the sensor and the sensor harness.
3. Install a jumper wire between the low reference circuit terminal 3 or A of the sensor and ground.
4. Install a jumper wire to the signal circuit terminal 4 or D of the sensor.
5. Connect a DMM between the jumper wire and ground.
6. Ignition ON, observe the DC voltage on the DMM. Slowly apply -15 kPa (4.4 in Hg) of vacuum to the sensor with the **GE-23738-A**. Verify the voltage changes, without any spikes or dropouts, between 1.3 - 0.9 V.

- **If not between 1.3 - 0.9 V or has spikes or dropouts**

Replace the B65 Intake Manifold Pressure and Air Temperature Sensor.

- **Go to next step: If between 1.3 - 0.9 V and there are no spikes or dropouts**

7. All OK.

Repair Instructions

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

- [Control Module References](#) for ECM replacement, programming and setup
- [Intake Air Pressure and Temperature Sensor Replacement](#)

DTC P0107 OR P0108

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 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	P0106, P0107, P018C, P0532, P0641	P0106, P0107	P0106, P018C, P0533, P0641	P0106
Signal	P0106, P0107	P0106, P0108	P0106, P0108*	P0106
Low Reference	-	P0106, P0108	-	P0106
* Internal ECM or sensor damage may occur if the circuit is shorted to B+.				

Typical Scan Tool Data

MAP Sensor

Circuits	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine idling at normal operating temperature Parameter Normal Range: 26 - 52 kPa (3.8 - 7.6 PSI)			
5 V Reference	0 kPa (0 PSI)	0 kPa (0 PSI)	255 kPa (36.9 PSI)

Circuits	Short to Ground	Open	Short to Voltage
Signal	0 kPa (0 PSI)	255 kPa (36.9 PSI)*	255 kPa (36.9 PSI)*
Low Reference	-	255 kPa (36.9 PSI)	-
* Internal ECM or sensor damage may occur if the circuit is shorted to B+.			

Circuit Description

The manifold absolute pressure (MAP) sensor measures the pressure inside the intake manifold. Pressure in the intake manifold is affected by engine speed, throttle opening, air temperature, barometric pressure (BARO); and turbocharger output. A silicone chip within the MAP sensor is displaced by the pressure changes that occur from the varying load and operating conditions of the engine. The sensor translates this action into electrical resistance. Integrated within this sensor is also an intake air temperature (IAT) sensor.

The MAP sensor wiring includes 3 circuits. The engine control module (ECM) supplies a regulated 5 volts to the sensor on a 5 V reference circuit. The ECM supplies a ground on a low reference circuit. The MAP sensor provides a signal voltage to the ECM, relative to the pressure changes, on the MAP sensor signal circuit. The ECM converts the signal voltage input to a pressure value.

Integrated within the MAP sensor is a 4th circuit for the IAT. A signal voltage is supplied to the ECM relative to intake air temperature. The low reference is shared with the MAP sensor low reference. The IAT is diagnosed within it's own DTC.

Under normal operation the greatest pressure that can exist in the intake manifold is at ignition ON, engine OFF, which is equal to the barometric pressure (BARO). The turbocharger can increase the pressure above BARO, when the vehicle is operated at wide-open throttle (WOT). The lowest manifold pressure occurs when the vehicle is idling or decelerating.

Conditions for Running the DTC

P0107

This DTC runs continuously.

P0108

This DTC runs continuously.

Conditions for Setting the DTC

P0107

The ECM detects that the MAP Sensor voltage is less than 0.15 V for greater than 13 ms.

P0108

The ECM detects that the MAP Sensor voltage is more than 4.50 V for greater than 13 ms.

Action Taken When the DTC Sets

DTCs P0107 and P0108 are Type B DTCs.

Conditions for Clearing the DTC

DTCs P0107 and P0108 are Type B DTCs.

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DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

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

Special Tools

GE-23738-A Vacuum Pump

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

Circuit/System Verification

1. Ignition ON, verify that DTC DTC P0641, P0651, P0697, P06A3, P06D2 or P06D6 is not set.

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

Refer to [DTC P0641, P0651, P0697, P06A3, or P06D2](#) for further diagnosis.

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

2. Determine the current vehicle testing altitude.

3. Verify the scan tool MAP Sensor pressure parameter is within the range specified in the [Altitude Versus Barometric Pressure](#) table.

- **If the MAP Sensor parameter is not in range**

Refer to Circuit/System Testing for further diagnosis.

- **Go to next step: If the MAP Sensor parameter is within range**

4. Engine idling, verify the scan tool MAP Sensor pressure parameter is between 24 - 52 kPa (3.4 - 7.5 PSI) and changes with accelerator pedal input.

- **If not between 24 - 52 kPa (3.4 - 7.5 PSI) or does not change**

Refer to Circuit/System Testing.

- **Go to next step: If between 24 - 52 kPa (3.4 - 7.5 PSI) and changes**

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 a DTC does not set.

- **If any DTC sets**

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

7. 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 B65 Intake Manifold Pressure and Air Temperature Sensor.

2. Test for less than 2 Ω between the low reference circuit terminal 3 or A and ground.

- **If 2 Ω or greater**

1. Ignition OFF, disconnect 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 2 Ω**

3. Ignition ON, test for 4.8 - 5.2 V between the 5 V reference circuit terminal 2 or C and ground.

- **If less than 4.8 V**

1. Ignition OFF, disconnect the K20 Engine Control Module.

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

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

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

•

- **If greater than 5.2 V**

1. Ignition OFF, disconnect the K20 Engine Control Module.

2. Ignition ON, test for less than 1 V between the 5 V reference circuit and ground.

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

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

4. Ignition ON, verify the scan tool MAP Sensor parameter is greater than 4.7 V.

- **If 4.7 V or less**

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

2. Ignition ON, test for infinite resistance between the signal circuit terminal 4 or D and ground.

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

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

5. Ignition OFF, install a 3 A fused jumper wire between the signal circuit terminal 4 or D and the low reference circuit terminal 3 or A.

6. Ignition ON, verify the scan tool MAP Sensor voltage parameter is less than 0.2 V.

- **If 0.2 V or greater**

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

2. test for less than 1 V between the signal circuit terminal 4 or D 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 signal circuit end to end.
 - If 2 Ω or greater, repair the open or high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **Go to next step: If less than 0.2 V**
 7. Test or replace the B65 Intake Manifold Pressure and Air Temperature Sensor.

Component Testing

NOTE: You must perform the Circuit/System Testing in order to verify the integrity of the MAP Sensor circuits before proceeding with the Component Testing.

Skewed Sensor Test

1. Ignition OFF, remove the B65 Intake Manifold Pressure and Air Temperature Sensor from the engine. Connect the harness to the sensor, if disconnected.
2. Ignition ON, apply -17 kPa (5.0 in Hg) of vacuum to the B65 Intake Manifold Pressure and Air Temperature Sensor, with the **GE-23738-A**. Verify the scan tool MAP Sensor pressure parameter decreases between 13 - 21 kPa (1.8 - 3.0 PSI).
 - **If the parameter does not decrease between 13 - 21 kPa (1.8 - 3.0 PSI).**

Replace the B65 Intake Manifold Pressure and Air Temperature Sensor.

 - **Go to next step: If the parameter does decrease between 13 - 21 kPa (1.8 - 3.0 PSI).**
3. Apply -34 kPa (10.0 in Hg) of vacuum to the B65 Intake Manifold Pressure and Air Temperature Sensor, with the **GE-23738-A**. Verify the scan tool MAP Sensor pressure parameter decreases between 30 - 38 kPa (4.4 - 5.5 PSI).
 - **If the parameter does not decrease between 30 - 38 kPa (4.4 - 5.5 PSI).**

Replace the B65 Intake Manifold Pressure and Air Temperature Sensor.

 - **Go to next step: If the parameter does decrease between 30 - 38 kPa (4.4 - 5.5 PSI).**
4. All OK.

Erratic Signal Test

1. Ignition OFF, remove the B65 Intake Manifold Pressure and Air Temperature Sensor and disconnect the harness.
2. Install a 3 A fused jumper wire between the 5 V reference circuit terminal 2 or C of the sensor and the sensor harness.
3. Install a jumper wire between the low reference circuit terminal 3 or A of the sensor and ground.
4. Install a jumper wire to the signal circuit terminal 4 or D of the sensor.
5. Connect a DMM between the jumper wire and ground.
6. Ignition ON, observe the DC voltage on the DMM. Slowly apply -15 kPa (4.4 in Hg) of vacuum to the sensor with the **GE-23738-A**. Verify the voltage changes, without any spikes or dropouts and is between 1.3 - 0.9 V.
 - **If not between 1.3 - 0.9 V or has spikes or dropouts**

Replace the B65 Intake Manifold Pressure and Air Temperature Sensor.

 - **Go to next step: If between 1.3 - 0.9 V and there are no spikes or dropouts**
7. All OK.

Repair Instructions

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

- [Control Module References](#) for ECM replacement, programming and setup
- [Intake Air Pressure and Temperature Sensor Replacement](#)

DTC P0112, P0113, OR P0114

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 P0112

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

IAT Sensor 1

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P0112, P0114, P2199**	P0111, P0113, P0114, P2199**	P0097*, P0113, P0114, P11C2, P2199**	P0111, P2199**
Low Reference	-	P0111, P0113, P0114, P2199**	P0113*, P0114	-
*Internal ECM or sensor damage may occur if the circuit is shorted to B+.				
**Where used.				

Typical Scan Tool Data

IAT Sensor 1

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

Circuit/System Description

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

The multifunction intake air sensor houses the following:

- IAT sensor 1
- IAT sensor 2
- Humidity sensor
- Mass Air Flow (MAF) sensor
- BARO pressure sensor

IAT Sensor 1 - Temperature, Resistance, Voltage Table

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

Conditions for Running the DTCs

P0112, P0113, and P0114

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

Conditions for Setting the DTC

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

P0112

The ECM detects that the IAT sensor signal is warmer than 149Â°C (300Â°F) for at least 5 s.

P0113

The ECM detects that the IAT sensor signal is colder than -60Â°C (-76Â°F) for at least 5 s.

P0114

Where this DTC is used, the ECM detects that the IAT sensor signal is intermittent or has abruptly changed for at least 5 s.

Action Taken When the DTCs Set

- DTCs P0112, P0113, and P0114 are Type B DTCs.
- The ECM commands the cooling fans ON.

Conditions for Clearing the DTCs

DTCs P0112, P0113, and P0114 are Type B DTCs.

Diagnostic Aids

With the ignition ON, the engine OFF, if the engine is cold, a properly functioning IAT sensor 1 will gradually increase the scan tool IAT Sensor 1 parameter. This is due to the heat that is generated by the MAF sensor heating elements.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

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NOTE: To minimize the effects of residual engine heat and sensor internal heating elements, perform Steps 1 and 2 of this verification procedure only if the ignition has been OFF for 8 hours or more.

1. Ignition ON.
2. Verify the following scan tool parameters are within 30Â°C (54Â°F) of each other.
 - Start-Up IAT Sensor 1
 - IAT Sensor 2
 - IAT Sensor 3; where equipped
 - **If not within 30Â°C (54Â°F)**
Refer to Circuit/System Testing.
 - **Go to next step: If within 30Â°C (54Â°F)**
3. Engine idling, verify the following scan tool parameters are between: -38 and +149Â°C (-36 and +300Â°F).
 - IAT Sensor 1
 - IAT Sensor 2
 - IAT Sensor 3; where equipped
 - **If not between: -38 and +149Â°C (-36 and +300Â°F)**
Refer to Circuit/System Testing.
 - **Go to next step: If between: -38 and +149Â°C (-36 and +300Â°F)**
4. Operate the vehicle within the conditions for running the DTC. You may also operate the vehicle within the conditions that you observed from the freeze frame/failure records data.
5. Verify the DTC does not set.
 - **If the DTC sets**
Refer to Circuit/System Testing.
 - **Go to next step: If the DTC does not set**
6. All OK

[Circuit/System Testing](#)

NOTE: You must perform the Circuit/System Verification before proceeding with 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 B75C Multifunction Intake Air sensor.
2. Test for less than 5 Ω between the low reference circuit terminal 3 and ground.
 - **If 5 Ω or greater**
 1. Ignition OFF, disconnect the harness connector at the K20 engine control module.
 2. Test for less than 2 Ω in the low reference circuit end to end.
 - If 2 Ω or greater, repair the open or high resistance in the circuit.
 - If less than 2 Ω replace the K20 engine control module.

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

3. Ignition ON, test for 4.8 - 5.2 V between the intake air temperature sensor 1 signal circuit terminal 1 and ground.
 - **If less than 4.8 V**
 1. Ignition OFF, disconnect the 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.
 - Go to next step: If infinite resistance
 3. Test for less than 2 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 engine control module.
 - **If greater than 5.2 V**

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

1. Ignition OFF, disconnect the harness connector at the K20 engine control module.
2. Ignition ON, test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 engine control module.
- **Go to next step: If between 4.8 - 5.2 V**
4. Ignition ON, verify the scan tool IAT Sensor 1 parameter is colder than -39°C (-38°F).
 - **If warmer than -39°C (-38°F).**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the signal circuit terminal 1 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - Go to next step: If infinite resistance
 3. Test for less than 2 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **Go to next step: If colder than -39°C (-38°F).**
5. Ignition OFF, install a 3 A fused jumper wire between the signal circuit terminal 1 and the low reference circuit terminal 3.
6. Verify the scan tool IAT Sensor 1 parameter is warmer than 148°C (298°F).
 - **If colder than 148°C (298°F).**
 1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - Go to next step: If less than 1 V
 3. Ignition OFF.
 4. Test for less than 2 Ω in the signal circuit end to end.

- If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **Go to next step: If warmer than 148°C (298°F).**
7. Test or replace the B75C Multifunction Intake Air sensor.

Component Testing

Multifunction Intake Air Sensor

1. Ignition OFF, disconnect the harness connector at the B75C Multifunction Intake Air Sensor.

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

2. Test the IAT sensor 1 by varying the sensor temperature while monitoring the sensor resistance. Compare the readings with the [Temperature Versus Resistance - Intake Air Temperature Sensor](#) table for Hitachi Sensors. The resistance values should be in range of the table values.

- **If not within the specified range**

Replace the B75C Multifunction Intake Air Sensor.

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

3. All OK.

Repair Instructions

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

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

DTC P0117, P0118, OR P0119

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 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	P0118*, P0119	P0116, P0128
Low Reference	-	P0113, P0118, P2199, P2227, P2229	-	P0128

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
*ECM or sensor damage may occur if the circuit is shorted to B+.				

Typical Scan Tool Data

ECT Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine running at various operating conditions			
Parameter Normal Range: Varies with coolant temperature			
Signal	150Â°C (302Â°F)	-40Â°C (-40Â°F)	-40Â°C (-40Â°F)
Low Reference	-	-40Â°C (-40Â°F)	-

Circuit/System Description

The engine coolant temperature (ECT) sensor is a variable resistor that measures the temperature of the engine coolant. The engine control module (ECM) supplies 5 V to the ECT sensor signal circuit and a ground for the low reference circuit. This diagnostic checks for an open, short to ground or an intermittent circuit condition between the ECM and ECT sensor.

Conditions for Running the DTC

P0117

- The ignition is ON.

OR

- The engine is running.
- This DTC runs continuously within the enabling conditions.

P0118

- The ignition is ON.

OR

- The engine is running for greater than 10 s.

OR

- The engine run time is less than 10 s when the IAT is warmer than -7Â°C (19Â°F).
- This DTC runs continuously within the enabling conditions.

P0119

- No active DTCs set.
- The ignition is ON.
- This DTC runs continuously within the enabling conditions.

Conditions for Setting the DTC

P0117

The ECM detects that the ECT is warmer than 149Â°C (300Â°F) for greater than 5 s.

P0118

The ECM detects that the ECT is colder than -39Â°C (-38Â°F) for greater than 5 s.

P0119

The ECM detects that the ECT is intermittent or has abruptly changed for greater than 3 seconds.

Action Taken When the DTC Sets

- DTC P0117, P0118 or P0119 are a Type B DTC.
- The cooling fans will be commanded ON.
- The Engine Coolant Temperature Gauge is inoperative.
- The AC compressor will be commanded OFF.

Conditions for Clearing the DTC

DTC P0117, P0118 or P0119 are a Type B DTC.

Diagnostic Aids

- The engine coolant temperature gauge will display full cold when an ECT DTC set's.
- After starting the engine, the engine coolant temperature (ECT) sensor 1 temperature should rise steadily, then stabilize after the thermostat opens.

Reference Information

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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 the scan tool ECT Sensor parameter is warmer than -40°C (-40°F) and colder than 150°C (302°F) and changes with engine run time.
 - **If colder than -39°C (-38°F) or warmer than 149°C (300°F) or does not change**
Refer to Circuit/System Testing.
 - **Go to next step: If warmer than -40°C (-40°F) and colder than 150°C (302°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.
4. Verify the DTC does not set.
 - **If the DTC sets**

- **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 B34 Engine Coolant Temperature sensor harness connector at the sensor. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 5 Ω between the low reference circuit terminal A or 2 and ground.
 - **If 5 Ω or greater**
 1. Ignition OFF, disconnect the 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 5 Ω**
3. Ignition ON.
4. Verify the scan tool ECT Sensor parameter is colder than -39 $^{\circ}$ C (-38 $^{\circ}$ F).
 - **If warmer than -39 $^{\circ}$ C (-38 $^{\circ}$ F)**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the signal circuit terminal B or 1 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K20 Engine Control Module.
 - **Go to next step: If colder than -39 $^{\circ}$ C (-38 $^{\circ}$ F)**
5. Install a 3 A fused jumper wire between the signal circuit terminal B or 1 and the low reference circuit terminal A or 2.
6. Verify the scan tool ECT sensor parameter is warmer than 149 $^{\circ}$ C (300 $^{\circ}$ F).
 - **If 149 $^{\circ}$ C (300 $^{\circ}$ F) or colder**
 1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - Go to next step: If less than 1 V
 - 3. Ignition OFF.
 - 4. Test for less than 2 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **Go to next step: If warmer than 149 $^{\circ}$ C (300 $^{\circ}$ F)**
7. Test or replace the B34 Engine Coolant Temperature Sensor.

Component Testing

1. Ignition OFF, disconnect the harness connector at the B34 Engine Coolant Temperature Sensor.
2. Test the ECT sensor by varying the sensor temperature while monitoring the sensor resistance. Compare the readings with the [Temperature Versus Resistance - Engine Coolant Temperature Sensor](#) table. The resistance values should be in range of the table values.
 - **If not within the specified range**

Replace the B34 Engine Coolant Temperature Sensor.
 - **Go to next step: If within the specified range**
3. Test for infinite resistance between each terminal and the sensor housing.
 - **If less than infinite resistance**

Replace the B34 Engine Coolant Temperature Sensor.

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

4. All OK.

Repair Instructions

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

- [Engine Coolant Temperature Sensor Replacement](#)
- [Control Module References](#) for ECM replacement, programming, and setup.

DTC P0121, P0122, P0123, P0222, P0223, P16A0, P16A1, P16A2, OR P2135

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 P0121

Throttle Position Sensor 1 Performance

DTC P0122

Throttle Position Sensor 1 Circuit Low Voltage

DTC P0123

Throttle Position Sensor 1 Circuit High Voltage

DTC P0222

Throttle Position Sensor 2 Circuit Low Voltage

DTC P0223

Throttle Position Sensor 2 Circuit High Voltage

DTC P16A0

Sensor Communication Circuit Low Voltage

DTC P16A1

Sensor Communication Circuit High Voltage

DTC P16A2

Sensor Communication Circuit Performance

DTC P2135

Throttle Position Sensors 1-2 Not Plausible

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P06A3	P0122*, P0222*, P16A0	P06A3	P0121, P16A2, P2135*

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P0122*, P0222*, P16A0	P0122*, P0222*, P16A1	P0123*, P0223*, P16A0**, P16A1**, P16A2**	P0121, P16A2, P2135*
Low Reference	-	P0123*, P0223*, P16A1	-	P0121, P16A2, P2135*

* This DTC set indicates an internal throttle body condition.

** A short to voltage causes P16A1 to set. If DTC P16A0, P16A1, and P16A2 set at the same time, an intermittent circuit condition exists.

Typical Scan Tool Data

Throttle Position Sensor 1

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: The engine is operating with the throttle closed. All accessories OFF. Parameter Normal Range: Throttle Position Sensor 1 3.75 - 4.75 V			
5 V Reference	5.0 V	5.0 V	5.0 V
Signal	5.0 V	0.0 V	0.0 V
Low Reference	-	0.0 V	-

Throttle Position Sensor 2

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: The engine is operating with the throttle closed. All accessories OFF. Parameter Normal Range: Throttle Position Sensor 2 0.45 - 0.90 V			
5 V Reference	0.0 V	0.0 V	0.0 V
Signal	0.0 V	5.0 V	5.0 V
Low Reference	-	5.0 V	-

Circuit/System Description

The throttle body assembly contains a contact-less inductive throttle position sensing element that is managed by a customized integrated circuit. The throttle position sensor is mounted within the throttle body assembly and is not serviceable. The engine control module (ECM) supplies the throttle body with a 5 V reference circuit, a low reference circuit, an H-bridge motor directional control circuit, and an asynchronous signal/serial data circuit. The asynchronous signal means communication is only going from the throttle body to the ECM. The throttle body cannot receive data from the ECM over the signal/serial data circuit. The throttle position sensor provides a signal voltage that changes relative to throttle blade angle. The customized integrated circuit translates the voltage based position information into serial data using the Society of Automotive Engineers (SAE) J2716 Single Edge Nibble Transmission (SENT) protocol. The throttle position sensor information is transmitted between the throttle body and the ECM on the signal/serial data circuit. The ECM decodes the serial data into a representation of voltage signals that are occurring in the throttle body. The information is then displayed on a scan tool as the voltage inputs from TP sensors 1 and 2.

Conditions for Running the DTC

P0121

- DTCs P0102, P0103, P0107, P0108, P0112, P0113, P0117, P0118, P0335, or P0336 is not set.
- The engine speed is between 500 - 6, 800 RPM.
- The engine coolant temperature (ECT) is -7 to +125Â°C (19 - 257Â°F).
- The intake air temperature (IAT) is -20 to +126Â°C (-4 to +259Â°F).
- The DTC runs continuously when the above conditions are met.

P0122, P0123, P0222, P0223

- DTC P06A3 is not set.
- The ignition is ON or the engine is running.
- The run/crank or powertrain relay voltage is greater than 6.41 V and reduced power is not active.
- The DTCs run continuously when the above condition are met.

P16A0, P16A1, or P16A2

- DTC P06A3 is not set.
- The ignition is ON or the engine is operating.
- The run/crank voltage is greater than 6.41 V.
- The DTCs run continuously once the above conditions are met for greater than 1 s.

P2135

- DTCs P0122, P0123, P0222, P0223, or P06A3 are not set.
- The ignition is ON or the engine is running.
- The run/crank or powertrain relay voltage is greater than 6.41 V and reduced power is not active.
- The DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

P0121

The ECM detects that the throttle position sensor 1 voltage is stuck within normal operating range for greater than 1 s.

P0122

The ECM detects the throttle position sensor 1 signal voltage is less than 0.33 V for greater than 1 s.

P0123

The ECM detects the throttle position sensor 1 signal voltage is greater than 4.75 V for greater than 1 s.

P0222

The ECM detects the throttle position sensor 2 signal voltage is less than 0.25 V for greater than 1 s.

P0223

The ECM detects the throttle position sensor 2 signal voltage is greater than 4.59 V for greater than 1 s.

P16A0

The ECM detects a low voltage circuit condition on the throttle position sensor signal circuit for greater than 1 s.

P16A1

The ECM detects a high voltage circuit condition on the throttle position sensor signal circuit for greater than 1 s.

P16A2

The ECM detects an incorrect message was received over the throttle position sensor signal circuit for greater than 1 s.

P2135

- The ECM detects that throttle position sensors 1 and 2 disagree greater than 7 - 10 percent for greater than 1 s.

OR

- The ECM detects that the TP sensor 1 and 2 learned minimum throttle position is greater than 5 percent of the 5 volt reference voltage.

Action Taken When the DTC Sets

- DTCs P0121 is a Type B DTC.
- DTCs P0122, P0123, P0222, P0223, P16A0, P16A1, P16A2, and P2135 are Type A DTCs.
- The ECM commands the throttle actuator control (TAC) system to operate in a Reduced Engine Power mode.
- A message center or an indicator displays Reduced Engine Power.
- Under certain conditions, the ECM commands the engine OFF.

Conditions for Clearing the DTC

- DTCs P0121 is a Type B DTC.
- DTCs P0122, P0123, P0222, P0223, P16A0, P16A1, P16A2, and P2135 are Type A DTCs.

Diagnostic Aids

- A high resistance condition on the throttle position and throttle actuator control circuits could cause a DTC to set.
- If the accelerator pedal is pressed to the wide open throttle position, the throttle blade angle or Throttle Position angle is limited to less than 40 percent.

Reference Information

Schematic Reference

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Connector End View Reference

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Description and Operation

Throttle Actuator Control (TAC) System Description

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- **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 P0601-P0606, P06A3, and P16F3 is not set.
 - **If a DTC is set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** for further diagnosis.

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

3. Verify the scan tool Throttle Body Idle Air flow Compensation parameter is less than 90%.

- **If 90% or greater**

Refer to [Throttle Body Cleaning](#) .

- **Go to next step: If less than 90%**

4. Verify that DTC P0122, P0123, P0222, P0223, P16A0, P16A1, P16A2, or P2135 are not set.

- **If DTC P0122, P0123, P0222, P0223, or P2135 are the only DTCs set**

Replace the Q38 Throttle Body.

- **If DTC P16A0, P16A1, or P16A2 is set with any of the DTCs**

Refer to Circuit/System Testing

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

5. Verify the Throttle Position Sensors 1 and 2 parameter displays Agree while performing the Throttle Sweep Test with a scan tool.

- **If Agree is not displayed**

Test or replace the Q38 Throttle Body Assembly.

- **Go to next step: If Agree is displayed**

6. Verify DTC P0122, P0123, P0222, P0223, P16A0, P16A1, P16A2, and P2135 is not set.

- **If a DTC is set**

Refer to Circuit/System Testing.

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

7. Determine the current vehicle testing altitude.

8. Verify the scan tool MAP Sensor pressure parameter is within range specified in the [Altitude Versus Barometric Pressure](#) table.

- **If the MAP Sensor pressure is not in range**

Refer to [DTC P0106](#).

- **Go to next step: If the MAP Sensor pressure is within range**

9. Engine idling.

10. Verify the scan tool MAP Sensor pressure parameter is between 26 - 52 kPa (3.8 - 7.5 psi) and changes with accelerator pedal input.

- **If not between 26 - 52 kPa (3.8 - 7.5 psi) or does not change**

Refer to [DTC P0106](#).

- **Go to next step: If between 26 - 52 kPa (3.8 - 7.5 psi) and changes**

11. Verify the scan tool MAF Sensor g/s parameter changes smoothly and gradually as the engine speed is increased and decreased while performing the actions listed below.

1. Engine idling

2. Perform the scan tool snapshot function.

3. Increase the engine speed slowly to 3,000 RPM and then back to idle.

4. Exit from the scan tool snapshot and review the data.

5. Observe the MAF Sensor parameter frame by frame with a scan tool.

- **If the MAF Sensor parameter does not change smoothly and gradually**

Refer to [DTC P0101](#).

- **Go to next step: If the MAF Sensor parameter changes smoothly and gradually**

12. Verify the scan tool Boost Pressure Sensor pressure and BARO parameters are within 3 kPa (0.4 psi) with engine at idle.

- **If the parameters are not within 3 kPa (0.4 psi)**

Refer to [DTC P0236](#).

- **Go to next step: If the parameters are within 3 kPa (0.4 psi)**

13. Verify the scan tool MAP Sensor parameter and the Boost Pressure Sensor parameter are within 20 kPa (2.9 psi) during a WOT acceleration at the time of the 1 - 2 shift.

- **If the parameters are not within 20 kPa (2.9 psi)**

Refer to [DTC P0236](#)

- **Go to next step: If the parameters are within 20 kPa (2.9 psi)**

14. 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.

15. 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**

16. All OK.

Circuit/System Testing

NOTE: **Disconnecting the throttle body harness connector causes additional DTCs to set.**

1. Ignition OFF, and all vehicle systems OFF, disconnect the harness connector at Q38 Throttle Body Assembly. It may take up to 2 min for all vehicle systems to power down.

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

- **If 5 Ω or greater**

1. Ignition OFF, disconnect the 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 5 Ω**

3. Ignition ON.

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

- **If less than 4.8 V**

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

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

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

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

5. Ignition ON.

6. Test for 4.8 - 5.2 V between the signal circuit terminal 3 and ground.

- **If less than 4.8 V**

1. Ignition OFF, disconnect the 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.
- Go to next step: If infinite resistance

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

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

- **If greater than 5.2 V**

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

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

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

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

7. Test or replace the Q38 Throttle Body Assembly.

Repair Instructions

- [Throttle Body Assembly Replacement](#)
- [Control Module References](#) for engine control module replacement, programming, and setup

Repair Verification

1. Install any components that have been removed or replaced during diagnosis.
2. Perform any adjustments, programming or setup procedures that are required when a component is removed or replaced.
3. Clear the DTCs with a scan tool.
4. Ignition OFF and all vehicle systems OFF. It may take up to 2 min for all vehicle systems to power down.
5. Ignition ON.
6. Verify the Throttle Position Sensors 1 and 2 parameter displays Agree while performing the Throttle Sweep Test with a scan tool.

- **If Agree is not displayed**

Test or replace the Q38 Throttle Body Assembly.

- **Go to next step: If Agree is displayed**

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, in order to verify the DTC does not set.

- **If DTC sets**

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

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

8. All OK.

DTC P0128

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 P0128

Engine Coolant Temperature (ECT) Below Thermostat Regulating Temperature

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
ECT Sensor Signal	P0117, P0119	P0118	P0118	P0116, P0119, P0128
Low Reference	-	P0118, P0119	-	P0119, P0128

Typical Scan Tool Data

ECT Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: The ignition is ON, or the engine is running Parameter Normal Range: Varies with ambient temperature, within a range of -39 to 149Â°C (-38 to 300Â°F)			
ECT Sensor Signal	150Â°C (302Â°F)	-40Â°C (-40Â°F)	-40Â°C (-40Â°F)
Low Reference	-	-40Â°C (-40Â°F)	-40Â°C (-40Â°F)

Circuit/System Description

The purpose of this diagnostic is to analyze the performance of the thermostat by using the engine coolant temperature (ECT) sensor to determine if the engine coolant will increase at the correct rate, and also to meet the calibrated target temperatures under various operating conditions.

The ECM uses the start-up ECT and the start-up intake air temperature (IAT) to begin the diagnostic calculation. The air flow into the engine is accumulated, and vehicle speed, distance, and engine run time are also factored in to determine if the ECT does increase normally and reach the calibrated target temperatures.

Conditions for Running the DTC

- DTCs P00B3, P00B6, P0101, P0102, P0103, P0111, P0112, P0113, P0116, P0117 or P0118 are not set.
- The engine OFF time is greater than 30 m.
- The start-up ECT sensor is between -40Â° to 66Â°C (-40Â° to 151Â°F).
- Engine run time between 30 s and 30 m.
- The Ethanol in the fuel is less than 87%.
- The vehicle has traveled greater than 0.8 kilometers (0.5 miles).
- The DTC runs once per ignition cycle when the above conditions are met.

Conditions for Setting the DTC

- The ECM determines that the ECT has not met its calibrated target of 71Â°C (160Â°F) when the start-up ambient temperature was between 10 and 52Â°C (50 and 126Â°F), for greater than 1 s.

OR

- The ECM determines that the ECT has not met its calibrated target of 55Â°C (131Â°F) when the start-up ambient temperature was between - 7 and 10Â°C (19 and 50Â°F), for greater than 1 s.

Action Taken When the DTC Sets

- DTC P0128 is a Type B DTC.

- The cooling fans will be commanded ON.
- The AC compressor will be commanded OFF.

Conditions for Clearing the MIL/DTC

DTC P0128 is a Type B DTC.

Diagnostic Aids

- DTC P0128 occurring with insufficient vehicle interior heating is an indication of improper thermostat operation.
- A slight to moderate resistance in the ECT sensor signal circuit or low reference circuit will affect this diagnostic. This condition results in a greater voltage on the ECT sensor signal circuit, which is interpreted by the ECM as a colder ECT.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Cooling System Description and Operation

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, verify that DTC P00B3, P00B6, P0101, P0102, P0103, P0111, P0112, P0113, P0116, P0117 or P0118 is not set.

- If DTC P00B3, P00B6, P0101, P0102, P0103, P0111, P0112, P0113, P0116, P0117 or P0118 is set

Refer to Diagnostic Trouble Code (DTC) List - Vehicle

- Go to next step: If DTC P00B3, P00B6, P0101, P0102, P0103, P0111, P0112, P0113, P0116, P0117 or P0118 is not set

2. Verify the cooling system is filled to the correct coolant level. Refer to Cooling System Draining and Filling (GE 47716), Cooling System Draining and Filling (Static Fill), and Loss of Coolant.

- If the coolant level is not correct

Repair as necessary

- Go to next step: If the coolant level is correct

3. Engine running for 15 min with the A/C OFF, increase the engine speed to 3,000 RPM.
4. Verify the scan tool ECT Sensor parameter is greater than 80°C (176°F).
 - **If less than 80°C (176°F)**
 Replace the Engine Coolant Thermostat.
 - **Go to next step: If greater than 80°C (176°F)**
5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
6. Verify the DTC does not set.
 - **If the DTC sets**
 Refer to Circuit/System Testing.
 - **Go to next step: If the DTC does not set**
7. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the B34 Engine Coolant Temperature sensor harness connector at the sensor. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 5 Ω between the low reference circuit terminal A or 2 and ground.
 - **If 5 Ω or greater**
 1. Ignition OFF, disconnect the X2 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 5 Ω**
3. Ignition ON.
4. Verify the scan tool ECT Sensor parameter is colder than -39°C (-38°F).
 - **If warmer than -39°C (-38°F)**
 1. Ignition OFF, disconnect the X2 harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the signal circuit terminal B or 1 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K20 Engine Control Module.
 - **Go to next step: If colder than -39°C (-38°F)**
5. Install a 3 A fused jumper wire between the signal circuit terminal B or 1 and the low reference circuit terminal A or 2.
6. Verify the scan tool ECT sensor parameter is warmer than 149°C (300°F).
 - **If 149°C (300°F) or colder**
 1. Ignition OFF, remove the jumper wire, disconnect the X2 harness connector at the K20 Engine Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - Go to next step: If less than 1 V
 - **Go to next step: If warmer than 149°C (300°F)**
7. Test the B34 Engine Coolant Temperature Sensor.

Refer to Component Testing.

Component Testing

1. Ignition OFF, disconnect the harness connector at the B34 Engine Coolant Temperature Sensor.
2. Test the ECT sensor by varying the sensor temperature while monitoring the sensor resistance. Compare the readings with the [Temperature Versus Resistance - Engine Coolant Temperature Sensor](#) table. The resistance values should be in range of the table values.
 - **If not within the specified range**

Replace the B34 Engine Coolant Temperature Sensor.
 - **Go to next step: If within the specified range**
3. Test for infinite resistance between each terminal and the sensor housing.
 - **If less than infinite resistance**

Replace the B34 Engine Coolant Temperature Sensor.
 - **Go to next step: If infinite resistance**
4. Refer to [Thermostat Diagnosis](#).

Repair Instructions

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

- [Engine Coolant Temperature Sensor Replacement](#)
- [Engine Coolant Thermostat Housing Replacement \(LTG\)](#)
- [Control Module References](#) for ECM replacement, setup and programming

DTC P0131, P0132, P015A, P015B, P223C, OR P223E

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 Descriptors

DTC P0131

HO2S Circuit Low Voltage Sensor 1

DTC P0132

HO2S Circuit High Voltage Sensor 1

DTC P015A

HO2S Delayed Response Rich to Lean Sensor 1

DTC P015B

HO2S Delayed Response Lean to Rich Sensor 1

DTC P223C

HO2S Pump Current Control Performance Bank 1 Sensor 1

DTC P223E

HO2S Reference Resistance Out of Range Bank 1 Sensor 1

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal - Terminal 2	P0131	P223E	P0132	P015A, P015B, P223C
Signal - Terminal 3	P0131	P223C	P0132	P015A, P015B, P223C
Signal - Terminal 7	P223C	P223C	P0132	P015A, P015B, P223C
Low Reference - Terminal 1	-	P223C, P223E	P0132	P015A, P015B, P223C

Typical Scan Tool Data

HO2S 1

Circuit	Short to Ground	Open/High Resistance	Short to Voltage
Operating Conditions: Engine = Running			
Parameter Normal Range: Between Lambda 0.8 and 1.1			
Signal - Terminal 2	Lambda 2	Between Lambda 0.67 and 1	Lambda 1
Signal - Terminal 3	Lambda 1	Lambda 1	Lambda 1
Signal - Terminal 7	Lambda 2	Lambda 1	Lambda 1
Low Reference - Terminal 1	Lambda 1	Lambda 1	Lambda 1

Circuit/System Description

The wide band heated oxygen sensor (HO2S) measures the amount of oxygen in the exhaust system and provides more information than the switching style HO2S. The wide band sensor consists of an oxygen sensing cell, an oxygen pumping cell, and a heater. The exhaust gas sample passes through a diffusion gap between the sensing cell and the pumping cell. The engine control module (ECM) supplies a voltage to the HO2S and uses this voltage as a reference to the amount of oxygen in the exhaust system. An electronic circuit within the ECM controls the pump current through the oxygen pumping cell in order to maintain a constant voltage in the oxygen sensing cell. The ECM monitors the voltage variation in the sensing cell and attempts to keep the voltage constant by increasing or decreasing the amount of current flow, or oxygen ion flow, to the pumping cell. By measuring the amount of current required to maintain the voltage in the sensing cell, the ECM can determine the concentration of oxygen in the exhaust. The HO2S voltage is displayed as a lambda value. A lambda value of 1 is equal to a stoichiometric air fuel ratio of 14.7:1. Under normal operating conditions, the lambda value will remain around 1. When the fuel system is lean, the oxygen level will be high and the lambda signal will be high or more than 1. When the fuel system is rich, the oxygen level will be low, and the lambda signal will be low or less than 1. The ECM uses this information to maintain the correct air/fuel ratio. If the ECM detects that the HO2S signal voltage is low, this DTC sets.

The heating elements inside each HO2S heat the sensor to bring the sensor up to operating conditions faster. This allows the system to enter Closed Loop earlier and the control module to calculate the air-to-fuel ratio sooner.

Conditions for Running the DTC

P0131, P0132

- DTC P0030, P0031, P0032, P0135 = Not set
- Ignition Voltage = 10 to 32 V
- Engine Running
- DTCs run continuously when the above conditions are met for greater than 4 s.

P015A, P015B

- DTC P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0128, P0131, P013A, P013B, P013E, P013F, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0220, P0222, P0223, P0442, P0443, P0446, P0449, P0455, P0496, P1516, P2101, P2119, P2135, P2176, P2270, P2271 = Not set
- P015A has run and passed for P015B to run.
- Ignition Voltage = 10 to 32 V
- Engine Coolant Temperature = Warmer than 62°C (144°F)
- Intake Air Temperature = Warmer than -40°C (-40°F)
- Fuel Level Sensor = Greater than 10%
- Engine Run Time = Greater than 120 s
- Engine Speed = 950 to 2950 RPM
- Vehicle Speed = 66 to 124 km/h (41 to 77 MPH)
- Mass Air Flow = 2 to 15 g/s
- Barometric Pressure = Greater than 70 kPa (10 PSI)
- Fuel Control Loop Status = Closed Loop Fuel Control
- Device controls are not active.
- The evaporative emission (EVAP) diagnostics are not in control of purge.
- HO2S 1 Heater Command = On For greater than 20 s
- After the above conditions are met for 2 s the fuel mixture is forced rich.
- At the end of the forced rich fuel state, decel fuel cut-off is active, without driver initiated accelerator pedal input.
- DTCs run once per drive cycle when the above conditions are met.

P223C

- DTC P0030, P0031, P0032, P0135 = Not set
- Ignition Voltage = 10 to 32 V
- Engine Running
- The DTC runs when time in decel fuel cut-off is greater than 5 s and less than 12 s, when the above conditions are met for 7 s.

P223E

- DTC P0030, P0031, P0032, P0135 = Not set
- Ignition Voltage = 10 to 32 V
- Engine Running
- DTC runs continuously when the above conditions are met for greater than 30 s.

Conditions for Setting the DTC

P0131

The engine control module detects that the heated oxygen sensor pump current or reference voltage circuit is shorted to ground for greater than 4 s.

P0132

The engine control module detects that the heated oxygen sensor pump current, reference voltage, or reference ground circuit is shorted to voltage for greater than 4 s.

P015A or P015B

- The engine control module detects that the heated oxygen sensor rich-to-lean or lean-to-rich average response time is greater than a calibrated value.
- The DTCs set within 60 s when the above condition is met.

P223C

The engine control module detects an open circuit fault to the pump current, reference voltage, reference ground, or trim circuit or a trim circuit short to ground, by detecting that the pump current is less than 0.10 mA or greater than 4.18 mA for greater than 7 s.

P223E

The engine control module detects that the heated oxygen sensor reference cell is colder than 700Å°C (1292Å°F) or warmer than 1000Å°C (1832Å°F) for greater than 4 s.

Actions Taken When the DTC Sets

- DTCs P0131, P0132, P223C, P223E are Type B DTCs.
- DTCs P015A, P015B are Type A DTCs.

Conditions for Clearing the DTC

- DTCs P0131, P0132, P223C, P223E are Type B DTCs.
- DTCs P015A, P015B are Type A DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References

Circuit/System Verification

1. Ignition - On/Vehicle - In Service Mode
2. Verify 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. Engine running.
4. Fuel Control Loop Status = Closed Loop
5. Verify the scan tool parameter: HO2S 1 = Between Lambda 0.8 and 1.1
 - **If not between Lambda 0.8 and 1.1**

Refer to: Circuit/System Testing

- **Go to next step: If between Lambda 0.8 and 1.1**

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: B52 Heated Oxygen 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: Low Reference circuit terminal 1 @ Component harness & Terminal X3 38 @ Control module harness
 - **If 2 ohms or greater - Repair the open/high resistance in the circuit.**
 - **If less than 2 ohms - Test or replace the component: K20 Engine Control Module**
 - **Go to next step: If less than 10 ohms**
4. Disconnect the electrical connector: K20 Engine Control Module
5. 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**
6. Ignition - On/Vehicle - In Service Mode
7. 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**
8. Ignition/Vehicle - Off
9. Test for less than 2 ohms between the test points: Signal circuit terminal 2 @ Component harness & Terminal X3 36 @ 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**
10. 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**
11. Ignition - On/Vehicle - In Service Mode

12. 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**

13. Ignition/Vehicle - Off

14. Test for less than 2 ohms between the test points: Signal circuit terminal 3 @ Component harness & Terminal X3 37 @ 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**

15. Test for infinite resistance between the test points: Signal 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**

16. Ignition - On/Vehicle - In Service Mode

17. Test for less than 1 V between the test points: Signal 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**

18. Ignition/Vehicle - Off

19. Test for less than 2 ohms between the test points: Signal circuit terminal 7 @ Component harness & Terminal X3 35 @ 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**

20. Verify none of the conditions listed below exist:

- Water intrusion in the following components or their wiring harnesses: B52 Heated Oxygen Sensor
- Fuel pressure low or high. Refer to: [Fuel System Diagnosis](#)
- Contaminated or poor quality fuel. Refer to: [Alcohol/Contaminants-in-Fuel Diagnosis](#)
- Fuel saturation of the evaporative emission (EVAP) canister
- Exhaust leaks
- Engine vacuum leaks.
- Oil consumption. Refer to: [Oil Consumption Diagnosis](#)
- Coolant consumption. Refer to: [Loss of Coolant](#)
- **If a condition exists**

Repair as necessary

- **Go to next step: If no conditions exist**

21. Test or replace the component: B52A Heated Oxygen Sensor 1

22. Perform the scan tool configuration/reset function: HO2S Heater Resistance Reset

23. 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**

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

24. All OK.

Repair Instructions

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

- [Heated Oxygen Sensor Replacement - Sensor 1](#)
- [Control Module References](#) for ECM replacement, programming and setup

DTC P0137, P0138, P013A, P013B, P013E, P013F, P2270, OR P2271

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 P0137

HO2S Circuit Low Voltage Sensor 2

DTC P0138

HO2S Circuit High Voltage Sensor 2

DTC P013A

HO2S Slow Response Rich to Lean Sensor 2

DTC P013B

HO2S Slow Response Lean to Rich Sensor 2

DTC P013E

HO2S Delayed Response Rich to Lean Sensor 2

DTC P013F

HO2S Delayed Response Lean to Rich Sensor 2

DTC P2270

HO2S Signal Stuck Lean Sensor 2

DTC P2271

HO2S Signal Stuck Rich Sensor 2

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
High Signal	P0131, P0137	P0132, P0138	P0132, P0138	P0133, P013A, P013B, P013E, P013F, P015A, P015B, P2270, P2271

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Low Signal	P0131, P0137, P0171	P0132, P0138	P0132, P0138	P0133, P013A, P013B, P013E, P013F, P015A, P015B, P2270, P2271

Typical Scan Tool Data

HO2S Sensor 2

Circuit	Short to Ground	Open	Short to Voltage
Parameter Normal Range: 200 - 800 mV			
High Signal	0.00 V	1.7 - 2.1 V	1.7 - 2.1 V
Low Signal	0.00 V	1.7 - 2.1 V	1.7 - 2.1 V

Circuit/System Description

The heated oxygen sensors (HO2S) are used for fuel control and catalyst monitoring. Each HO2S 2 compares the oxygen content of the surrounding air with the oxygen content of the exhaust stream. When the engine is started, the control module operates in an Open Loop mode, ignoring the HO2S signal voltage while calculating the air-to-fuel ratio. While the engine runs, the HO2S heats up and begins to generate a voltage within a range of 0 - 1, 000 mV. Once sufficient HO2S voltage fluctuation is observed by the control module, Closed Loop is entered. The control module uses the HO2S voltage to determine the air-to-fuel ratio. An HO2S voltage that increases toward 1, 000 mV indicates a rich fuel mixture. An HO2S voltage that decreases toward 0 mV indicates a lean fuel mixture.

The heating elements inside each HO2S heat the sensor to bring the sensor up to operating conditions faster. This allows the system to enter Closed Loop earlier and the control module to calculate the air-to-fuel ratio sooner.

Conditions for Running the DTC

P0137

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0128, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0220, P0222, P0223, P0442, P0443, P0446, P0449, P0455, P0496, P1516, P2101, P2119, P2135, P2176 are not set.
- The Ignition voltage is between 10 - 32 V.
- The fuel system is operating in Closed Loop.
- Device controls are not active.
- The fuel level is greater than 10%.
- Ethanol content is less than 87%.
- Decel fuel cut-off is not active.
- The DTCs run continuously when the above conditions are met for 5 s.

P0138

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0128, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0220, P0222, P0223, P0442, P0443, P0446, P0449, P0455, P0496, P1516, P2101, P2119, P2135, P2176 are not set.
- The Ignition voltage is between 10 - 32 V.
- Ignition is OFF for greater than 8 h.
- The fuel system is operating in Closed Loop.
- Ethanol content is less than 87%.
- The fuel level is greater than 10%.

- The engine run time is greater than 30 s.
- The engine is not in Power Enrichment.
- The DTCs run continuously after an initial delay of 3 min when the above conditions are met for 5 s.

P013A or P013E

- Before the ECM can report DTC P013A, or P013C failed, DTCs P013E, P014A, P2270, and P2272 must run and pass.
- Before the ECM can report DTC P013E, or P014A failed, DTCs P2270 and P2272 must run and pass.
- DTCs P0030, P0036, P0053, P0054, P0101, P0102, P0103, P0106, P0107, P0108, P0120, P0121, P0122, P0123, P0131, P0132, P0133, P0134, P0135, P0137, P0138, P013A, P013B, P013E, P013F, P0140, P0141, P0171, P0172, P0201-P0208, P0220, P0222, P0223, P0300-P0308, P0442, P0443, P0446, P0449, P0455, P0496, P1174, P1516, P2101, P2119, P2135, P2176, P2270, P2271 are not set.
- The Ignition voltage is between 10 - 32 V.
- The engine is OFF for greater 8 h.
- The learned heater resistance is valid.
- The fuel level is greater than 10%.
- After the above conditions are met decel fuel cut-off continues without driver initiated pedal input.
- The DTCs run once per ignition cycle, during decel fuel cut-off (DFCO), when the above conditions are met.

P013B or P013F

- Before the ECM can report DTC P013B, or P013D failed, DTCs P013A, P013C, P013E, P013F, P014A, P014B, P2270, P2271, P2272, and P2273 must run and pass.
- Before the ECM can report DTC P013F, or P014B failed, DTCs P013A, P013C, P013E, P014A, P2270, P2271, P2272, and P2273 must run and pass.
- DTCs P0030, P0036, P0053, P0054, P0101, P0102, P0103, P0106, P0107, P0108, P0120, P0121, P0122, P0123, P0131, P0132, P0133, P0134, P0135, P0137, P0138, P013A, P013B, P013E, P013F, P0140, P0141, P0171, P0172, P0201-P0208, P0220, P0222, P0223, P0300-P0308, P0442, P0443, P0446, P0449, P0455, P0496, P1174, P1516, P2101, P2119, P2135, P2176, P2270, P2271 are not set.
- The Ignition voltage is between 10 - 32 V.
- The engine is OFF for greater 8 h.
- The learned heater resistance is valid.
- The fuel level is greater than 10%.
- After the above conditions are met, fuel enrich mode is continued.
- The DTCs run once per ignition cycle when the above conditions are met.

P2270

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0128, P013A, P013B, P013E, P013F, P0171, P0172, P0201, P0202, P0203, P0204, P0220, P0222, P0223, P0300, P0411, P0412, P0418, P1174, P1516, P2101, P2119, P2135, P2176, P2270, P2271 are not set.
- The system voltage is between 10 - 32 V.
- The engine is OFF for greater 8 h.
- The fuel level is greater than 10%.
- The pedal position is less than 4%.
- The engine speed is between 950 - 2, 950 RPM.
- The engine airflow is between 3 - 12 g/s.
- The vehicle speed is between 66 - 124 km/h (41 - 77 mph).

- The fuel state is in Closed Loop.
- The evaporative emission (EVAP) diagnostics are not in control of purge.
- The HO2S heaters are ON for more than 80 s.
- The predicted catalytic converter temperature is between 500 - 850°C (932 - 1,562°F).
- This DTC runs once per trip when all of the above conditions have been met for 1 s.

P2271

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0128, P013A, P013B, P013E, P013F, P0171, P0172, P0201, P0202, P0203, P0204, P0220, P0222, P0223, P0300, P0411, P0412, P0418, P1174, P1516, P2101, P2119, P2135, P2176, P2270 are not set.
- The system voltage is between 10 - 32 V.
- The engine is OFF for greater 8 h.
- The fuel level is greater than 10%.
- The fueling state is in Closed Loop.
- DTCs P013A, P013E, and P2270 have run and passed.

THEN

- Decel fuel cut-off is active.
- The accelerator pedal position is stable.
- This DTC runs once per trip when the above conditions are met for 3 s.

Conditions for Setting the DTC

P0137

The engine control module detects that the heated oxygen sensor voltage is less than 50 mV and the circuit is shorted to ground for greater than 50 s.

P0138

The engine control module detects that the heated oxygen sensor voltage is greater than 1,050 mV and the circuit is shorted to voltage for greater than 13 s.

P013A

The engine control module detects that the accumulated mass air flow monitored during rich-to-lean transitions between 450 - 150 mV is greater than 36 grams.

P013B

The engine control module detects that the accumulated mass air flow monitored during lean-to-rich transitions between 300 - 600 mV is greater than 88 grams.

P013E

The engine control module detects an initial delayed response to a change from rich to lean such that the heated oxygen sensor voltage has not decreased to 450 mV within a calibrated value of accumulated air flow.

P013F

The engine control module detects an initial delayed response to a change from lean to rich such that the heated oxygen sensor voltage has not increased above 350 mV within a calibrated value of accumulated air flow.

P2270

The engine control module does not detect a heated oxygen sensor voltage greater than 825 mV before accumulated mass air flow exceeds a calibrated value.

P2271

The engine control module does not detect an heated oxygen sensor voltage less than 100 mV before accumulated mass air flow exceeds a calibrated value.

Action Taken When the DTC Sets

- DTCs P0137, P0138, P013E, P013F, P2270, and P2271 are Type B DTCs.
- DTCs P013A and P013B are Type A DTCs.

Conditions for Clearing the MIL/DTC

- DTCs P0137, P0138, P013E, P013F, P2270, and P2271 are Type B DTCs.
- DTCs P013A and P013B are Type A DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

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

Circuit/System Verification

1. Ignition ON.
2. Verify no HO2S heater DTCs are 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. Engine running.
4. Verify the scan tool HO2S 1 or 2 parameters are between 50 - 1,050 mV.
 - **If not between 50 - 1,050 mV.**

Refer to Circuit/System Testing.

- **Go to next step: If between 50 - 1,050 mV.**
5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
 6. Verify the DTC does not set.

- **If the DTC sets.**

Refer to Circuit/System Testing.

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

7. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the appropriate B52 Heated Oxygen Sensor harness connector. It may take up to 2 minutes for all vehicle systems to power down. Ignition ON.
2. Test for 1.7 - 3.0 V between the high signal circuit terminal 4 and ground.
 - **If less than 1.7 V**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the high signal circuit terminal 4 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 high signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **If greater than 3.0 V**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
 2. Test for less than 1 V between the high signal circuit terminal 4 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.
 - **Go to next step: If between 1.7 - 3.0 V**
3. Verify the scan tool HO2S 1 or 2 parameter is between 1.7 - 2.1 V.
 - **If less than 1.7 V**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the low signal circuit terminal 3 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - Go to next step: If infinite resistance, replace the K20 Engine Control Module.
 - **Go to next step: If between 1.7 - 2.1 V**
4. Connect a 3 A fused jumper wire between the high signal circuit terminal 4 and the low signal circuit terminal 3.

NOTE: The low signal circuit is tied to a pull-up circuit within the engine control module. A voltage of 0.0 - 1.10 V on the low signal circuit is normal.

5. Verify the scan tool HO2S 1 or 2 parameter displays 0.0 V.
 - **If greater than 0.0 V**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
 2. Test for less than 2 Ω in the low signal 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 less than 1 V between the low signal circuit terminal 3 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 0.0 V**

6. Verify none of the conditions listed below exist:

- Water intrusion in the B52 Heated Oxygen Sensor harness connector
- Low or high fuel system pressure - Refer to [Fuel System Diagnosis](#) .
- Fuel that is contaminated - Refer to [Alcohol/Contaminants-in-Fuel Diagnosis](#) .
- Fuel saturation of the evaporative emission (EVAP) canister
- Exhaust leaks
- Engine vacuum leaks
- Engine oil consumption - Refer to [Oil Consumption Diagnosis](#) .
- Engine coolant consumption - Refer to [Loss of Coolant](#) .
- **If any of the conditions exist**

Repair as necessary.

- **Go to next step: If none of the conditions exist**

Go to next step: Test or replace the B52 Heated Oxygen Sensor.

Repair Instructions

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

- [Heated Oxygen Sensor Replacement - Sensor 1](#)
- [Heated Oxygen Sensor Replacement - Sensor 2](#)
- Perform the scan tool Heated Oxygen Sensor Resistance Learn Reset after replacing an HO2S.
- [Control Module References](#) for ECM replacement, programming and setup

DTC P0171 OR P0172

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 P0171

Fuel Trim System Lean

DTC P0172

Fuel Trim System Rich

Circuit/System Description

The engine control module (ECM) controls a Closed Loop air/fuel metering system in order to provide the best possible combination of driveability, fuel economy, and emission control. The ECM monitors the heated oxygen sensor (HO2S) signal voltage, and adjusts the fuel delivery based on the signal voltage while in Closed Loop. A change made to the fuel delivery changes the long and short term fuel trim values. The short term fuel trim values change rapidly in response to the HO2S signal voltages. These changes fine tune the engine fueling. The long term fuel trim values change in response to trends in the short term fuel trim. The long term fuel trim makes coarse adjustments to fueling in order to re-center and restore control to short term fuel trim. The ideal fuel trim values are around 0%. A positive fuel trim value indicates that the ECM is adding fuel in order to compensate for a lean condition. A negative fuel trim value indicates that the ECM is reducing the amount of fuel in order to compensate for a rich condition.

Conditions for Running the DTC

- DTCs P0030, P0053, P0101, P0102, P0103, P0106, P0107, P0108, P0131-P0135, P015A, P015B, P0178, P0179, P0201-P0204, P0236, P0237, P0238, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0300-P0304, P0411, P0442, P0455, P0458, P0496, P0506, P0507, P1248, P1249, P124A, P124B, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P2227, P2228, P2229, P2230, P2269, P2440, P2444, or P2A00 are not set.
- The engine is in Closed Loop status.
- The catalyst monitor diagnostic intrusive test, post 02 diagnostic intrusive test, device control, and evaporative emission leak test are not active.
- The engine coolant temperature (ECT) is between -20 and +130Â°C (-4 and +266Â°F).
- The intake air temperature (IAT) is between -20 and +150Â°C (-4 and +302Â°F).
- The manifold absolute pressure (MAP) is between 15 - 255 kPa (2.2 - 37 psi).
- The engine speed is between 400 - 6, 600 RPM.
- The mass air flow (MAF) is between 1 - 512 g/s.
- The barometric pressure (BARO) is greater than 70 kPa (10.2 psi).
- The fuel level is greater than 10%.
- This diagnostic runs continuously when the above conditions have been met.

Conditions for Setting the DTC

- The average long term fuel trim weighted average value is greater or less than a calibrated value.
- The above condition is present for approximately 3 min after the Conditions for Running the DTC have been met.

Action Taken When the DTC Sets

DTCs P0171 and P0172 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0171 and P0172 are Type B DTCs.

Diagnostic Aids

- The normal Short Term Fuel Trim and Long Term Fuel Trim parameters should be between +10 and -10% with 0% the optimum, with the engine running at operating temperature.
- Any un-metered air into the engine causes this DTC to set. Thoroughly inspect all areas of the engine for vacuum leaks.
- A MAF sensor condition can cause this DTC without setting a MAF DTC. If there is a MAF sensor condition, the MAF sensor parameters will appear to be within range.
- Verify that the air filter is the correct one for this application. Verify that the engine oil fill cap is in place and that it is tight. Verify that the engine oil dip stick is fully seated.
- Certain aftermarket air filters may cause a DTC to set.
- Certain aftermarket air induction systems or modifications to the air induction system may cause a DTC to set.
- Certain aftermarket exhaust system components may cause a DTC to set.

Reference Information

Component View Reference

Powertrain Component Views

Electrical Information Reference

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

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify no other DTCs are set.
 - **If any other DTCs are set**
Refer to Diagnostic Trouble Code (DTC) List - Vehicle for further diagnosis.
 - **Go to next step: If no other DTCs are set**
3. Verify DTC P0171 or P0172 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 in the Freeze Frame/Failure Records data.
5. Verify DTC P0171 or P0172 is not set.
 - **If any of the DTCs set**
Refer to Circuit/System Testing.
 - **Go to next step: If none of the DTCs set**
6. All OK.

Circuit/System Testing

1. Ignition ON.
2. Verify the manifold absolute pressure sensor is within the range specified for your altitude. Refer to Altitude Versus Barometric Pressure.
 - **If not within the specified range**
Refer to DTC P0106.
 - **Go to next step: If within the specified range**
3. Engine running at the operating temperature.
4. Verify the Long Term Fuel Trim parameter is between -10% and +10%.
 - **If greater than +10%**
 1. Ignition OFF.
 2. Inspect for the conditions listed below:
 - Mass air flow (MAF) sensor signal skewed. If the Short Term Fuel Trim parameter changes greater than 20% when the MAF sensor is disconnected, refer to DTC P0101.
 - Fuel contamination. Refer to Alcohol/Contaminants-in-Fuel Diagnosis.
 - Missing, restricted, or leaking exhaust components. Refer to Symptoms - Engine Exhaust.
 - Malfunctioning fuel injectors. Refer to Fuel Injector Diagnosis.
 - Split, kinked or improperly connected vacuum hoses.
 - Insufficient fuel in the tank
 - Low fuel pressure. Refer to Fuel System Diagnosis.

- Vacuum leaks at the intake manifold, the throttle body, and the injector O-rings.
- Leaks in the air induction system and the air intake ducts
- Missing air filter element
- Cracked EVAP canister
- Evaporative pipes obstructed or leaking
- Leaks in the crankcase ventilation system. Refer to [Crankcase Ventilation System Inspection/Diagnosis](#) .
 - If a condition is found, repair as necessary.
 - If no condition is found, inspect the engine for a mechanical condition. Refer to [Symptoms - Engine Mechanical](#) .
- **If less than -10%**
 1. Ignition OFF.
 2. Inspect for the conditions listed below:
 - Mass air flow (MAF) sensor signal skewed. If the Short Term Fuel Trim parameters for both banks changes greater than 20% when the MAF sensor is disconnected, refer to [DTC P0101](#).
 - Fuel contamination - Refer to [Alcohol/Contaminants-in-Fuel Diagnosis](#) .
 - Missing, restricted, or leaking exhaust components - Refer to [Symptoms - Engine Exhaust](#) .
 - Malfunctioning fuel injectors - Refer to [Fuel Injector Diagnosis](#)
 - Collapsed or restricted air intake duct
 - Excessive fuel pressure - Refer to [Fuel System Diagnosis](#)
 - Dirty or restricted air filter
 - Objects blocking the throttle body
 - Improper operation of the evaporative emissions control system
 - Excessive fuel in the crankcase - Change engine oil as necessary and inspect for the following:

G18 High Pressure Fuel Pump = Leaking

Q17 Fuel Injector = Leaking - Refer to [Fuel Injector Diagnosis](#)
 - If a condition is found, repair as necessary.
 - If no condition is found, inspect the engine for a mechanical condition. Refer to [Symptoms - Engine Mechanical](#) .
 - **Go to next step: If between -10% and +10%**
- 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 DTC P0171 or P0172 is not set.
 - **If any of the DTCs set**

Refer to conditions listed above.
 - **Go to next step: If none of the DTCs set**
- 7. All OK.

Repair Instructions

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

Perform the scan tool Fuel Trim Reset after completing the repair.

DTC P018B, P018C, OR P018D

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 P018B

Fuel Pressure Sensor Performance

DTC P018C

Fuel Pressure Sensor Circuit Low Voltage

DTC P018D

Fuel Pressure Sensor Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P0106, P0107, P018C, P0192, P0340, P0365, P0452, P0522, P0532, P055C, P0641, P2227, P2228	P018C	P018D, P0193, P0453, P0523, P0533, P055D, P0641, P2227	P018B
Signal	P018C	P018C	P018D	P018B
Low Reference	-	P0073, P018D, P0453, P0463, P0533, P0558	P018D	P018B

Circuit/System Description

The fuel pressure sensor is located on the fuel pipe. The fuel pressure sensor monitors the fuel pressure in the fuel line. The engine control module (ECM) monitors the voltage signal from the fuel pressure sensor. The sensor provides a fuel pressure signal to the ECM, which is used to provide Closed Loop fuel pressure control.

Conditions for Running the DTC

P018B

- DTC P018C, P018D, P0231, P0232, P023F, P0606, P0641, or P1255 is not set.
- The engine is running for greater than 5 s.
- The fuel pump enable circuit is commanded ON.
- Low fuel level warning not present.
- The DTC runs continuously when the conditions above are met.

P018C or P018D

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

Conditions for Setting the DTC

P018B

The engine control module does not detect a normal fuel pressure change when the fuel pump is operating. The fuel pressure sensor performance diagnostic provides a means to detect fuel pressure

sensor output that is stuck within the normal operating range of the sensor.

P018C

The engine control module detects that the fuel pressure sensor voltage is less than 0.2 V for 1 s.

P018D

The engine control module detects that the fuel pressure sensor voltage is greater than 4.8 V for 1 s.

Action Taken When the DTC Sets

DTC P018B, P018C and P018D are Type A DTCs.

Conditions for Clearing the DTC

DTC P018B, P018C and P018D are Type A DTCs.

Diagnostic Aids

Using the Failure Records data may help locate an intermittent condition. If you cannot duplicate the DTC, the information in the Failure Records can help determine how many miles since the DTC set. The Fail Counter and Pass Counter can help determine how many ignition cycles that the diagnostic test reported a pass and/or a fail.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Fuel System Description

Electrical Information Reference

- **Circuit Testing**
- **Testing for Intermittent Conditions and Poor Connections**
- **Connector Repairs**
- **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 U0074 or U18A2 is not set or stored in history.
 - **If DTC U0074 or U18A2 is set or stored in history**

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

- **Go to next step: If DTC U0074 or U18A2 is not set or stored in history**
3. Engine running.

4. Verify the scan tool Fuel Pressure Sensor parameter is between 0.2 - 4.8 V.

- **If not between 0.2 - 4.8 V**

Refer to Circuit/System Testing.

- **Go to next step: If between 0.2 - 4.8 V**

5. Verify the scan tool Fuel Pressure Sensor increases or decreases when commanding an increase and decrease in Fuel Pressure with a scan tool.

- **If the parameter does not change**

Refer to Circuit/System Testing.

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

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

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B47 Fuel Pressure Sensor. It may take up to 2 minutes for all vehicle systems to power down.

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

- **If 5 Ω or greater**

1. Ignition OFF, disconnect the 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 5 Ω**

3. Ignition ON.

4. 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 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 on 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 harness connector at the K20 Engine Control Module, ignition ON.

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

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

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

5. Verify the scan tool Fuel Pressure Sensor parameter is less than 1 V.

- **If 1 V or greater**

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
2. Test for less than 1 V between the signal 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 less than 1 V**
6. Install a 3 A fused jumper wire between the signal circuit terminal 1 and the 5 V reference circuit terminal 3, wait 15 seconds.
7. Verify the scan tool Fuel Pressure Sensor parameter is greater than 4.8 V.
 - **If 4.8 V or less**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the signal circuit terminal 1 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - Go to next step: If infinite resistance
 3. Test for less than 2 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **Go to next step: If greater than 4.8 V**
8. Replace the B47 Fuel Pressure Sensor.

Repair Instructions

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

- [Fuel Pressure Sensor Replacement - Fuel Feed Pipe](#)
- [Control Module References](#) for control module replacement, programming and setup.

DTC P0191 OR P0192

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 P0191

Fuel Rail Pressure Sensor Performance

DTC P0192

Fuel Rail Pressure Sensor Circuit Low Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P018C, P0192, P0340, P0365, P0452, P0506, P0522, P0532, P055C, P0641, P2227, P2228	P0192	P018D, P0453, P0523, P0533, P055D, P0641, P2227	P0191
Signal	P0192, P0506	P0192	-	P0191
Low Reference	-	P0506	-	P0191

The fuel rail pressure sensor transmits fuel pressure and temperature information by serial data using the Society of Automotive Engineers (SAE) J2716 Single Edge Nibble Transmission (SENT) protocol. The fuel rail pressure sensor internal microprocessor allows 4 separate sensor outputs from one 3 wire sensor. The engine control module (ECM) supplies the fuel rail pressure sensor with a 5 V reference circuit, a low reference circuit, and an asynchronous signal/serial data circuit. The asynchronous signal means communication is only going from the fuel rail pressure sensor to the ECM.

Conditions for Running the DTC**P0191 - Condition 1**

- The engine is not cranking.
- The ignition voltage is greater than 11 V.
- The vehicle speed is less than or equal to 1 km/h (0.62 MPH).
- The low side fuel pressure is greater than or equal to 250 kPa (36 PSI).
- The Accelerator Pedal Position is 0% for 2.5 s.
- The engine is running for greater than 30 s.

P0191 - Condition 2 and 3

- The engine is not cranking.
- The ignition voltage is greater than 11 V.
- The engine speed is between 1, 000 - 3, 000 RPM.
- The vehicle speed is greater than or equal to 35 km/h (22 MPH).
- The low side fuel pressure is greater than or equal to 250 kPa (36 PSI).
- The Desired Fuel Rail Pressure is between 4 - 6 MPa (580 - 870 PSI).
- The Accelerator Pedal Position is greater than or equal to 10%.
- The engine is running for greater than 30 s.

P0191 - Condition 4

- DTC P0016, P0017, P0090, P0091, P0092, P00C8, P00C9, P00CA, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0119, P0122, P0123, P0128, P0192, P0193, P0201, P0202, P0203, P0204, P0222, P0223, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0300, P0301, P0302, P0303, P0304, P0335, P0336, P0340, P0341, P0351-P0354, P0365, P0366, P0506, P0507, P0628, P0697, P06A3, P0722, P0723, P1248, P1249, P124A, P124B, P1682, P2122, P2123, P2127, P2128, P2135, P2138, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157 is not set.
- The engine is not cranking.
- The vehicle speed is greater than or equal to 30 km/h (18.64 MPH).
- The engine speed is greater than or equal to 2, 000 RPM.
- The barometric (BARO) pressure is greater than 70 kPa.
- The intake air temperature (IAT) is warmer than -20°C (-4°F).

P0192

- The engine is running.
- The ignition voltage is greater than 11 V.
- The DTCs run continuously within the enabling conditions.

Conditions for Setting the DTC**P0191 - Condition 1**

The difference between the low side fuel pressure and the high side fuel pressure is less than or equal to -1 MPa (-145 PSI) or greater than or equal to 1 MPa (145 PSI) with the high pressure fuel pump actuator

commanded OFF. The condition exists for greater than 3 s.

P0191 - Condition 2

The difference between the relief pressure and the measured high pressure is less than or equal to -1.6 MPa (-232 PSI) with the high pressure fuel pump actuator commanded ON. The condition exists for greater than 2 s.

P0191 - Condition 3

The difference between the commanded high pressure and the measured high pressure is greater than or equal to 3 MPa (435 PSI) and the modeled injection pressure is greater than or equal to 1.6 MPa (232 PSI) with the high pressure fuel pump actuator commanded ON. The condition exists for greater than 3 s.

P0191 - Condition 4

The difference between the measured maximum high pressure and the measured minimum high pressure is less than or equal to 0.1 MPa (14.5 PSI) with the high pressure fuel pump actuator commanded ON. The condition exists for greater than 30 s with the engine running or greater than 10 s with the engine cranking.

P0192

The ECM detects that the fuel rail fuel pressure sensor signal voltage is low for greater than 5 s.

Action Taken When the DTC Sets

- DTCs P0191, P0192, are Type A DTCs.
- A message center or an indicator may display Reduced Engine Power.

Conditions for Clearing the DTC

DTCs P0191, P0192 are Type A DTCs.

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- **Testing for Intermittent Conditions and Poor Connections**
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DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Control Module References for scan tool information

Circuit/System Verification

1. Ignition On.
2. Verify DTC P0641 is not set.
 - **If the DTC is set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** for further diagnosis.
 - **Go to next step: If the DTC is not set**
3. Engine idling.
4. Verify DTC P0191 or P0192 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. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
6. Verify the DTC does not set.
 - **If the DTC sets**

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

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the fuel injector multi-way harness connector X160. It may take up to 2 mins for all vehicle systems to power down.

NOTE: **Testing for steps 2 through 7 is performed on the ECM side of the multi-way harness connector.**

2. Test for less than 5 Ω between the low reference circuit terminal 5 and ground.
 - **If 5 Ω or greater**
 1. Ignition OFF, disconnect the 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 5 Ω**
3. Ignition On.
4. Test for 4.8 - 5.2 V between the 5 V reference circuit terminal 11 and ground.
 - **If less than 4.8 V**
 1. Ignition OFF, disconnect the 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 on 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 harness connector at the K20 Engine Control Module, ignition On.
 2. Test for less than 1 V between the 5 V reference circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.
 - **Go to next step: If between 4.8 - 5.2 V**
- 5. Verify the scan tool Fuel Rail Pressure Sensor voltage parameter is less than 0.02 V.
 - **If 0.02 V or greater**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition On.
 2. Test for less than 1 V between the signal circuit terminal 12 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 less than 0.02 V**
- 6. Install a 3 A fused jumper wire between the signal circuit terminal 12 and the 5 V reference circuit terminal 11.
- 7. Verify the scan tool Fuel Rail Pressure Sensor voltage parameter is greater than 4.96 V.
 - **If 4.96 V or less**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the signal circuit terminal 12 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 signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **Go to next step: If greater than 4.96 V**
- 8. Connect the fuel injector multi-way harness connector X160.
- 9. Disconnect the B47B Fuel Rail Pressure Sensor connector.

NOTE: **Testing for steps 11 through 17 is performed at the fuel rail fuel pressure sensor connector.**

10. Test for less than 5 Ω between the low reference circuit terminal 1 and ground.
 - **If 5 Ω or greater**
 1. Ignition OFF, disconnect the 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 5 Ω**
11. Ignition On.
12. 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 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 on 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 harness connector at the K20 Engine Control Module, ignition On.
2. Test for less than 1 V between the 5 V reference circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.
- **Go to next step: If between 4.8 - 5.2 V**

13. Ignition On.

14. Verify the scan tool Fuel Rail Pressure Sensor voltage parameter is less than 0.02 V.

- **If 0.02 V or greater**

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition On.
2. Test for less than 1 V between the signal circuit terminal 2 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.
- **Go to next step: If less than 0.02 V**

15. Install a 3 A fused jumper wire between the signal circuit terminal 2 and the 5 V reference circuit terminal 3.

16. Verify the scan tool Fuel Rail Pressure Sensor voltage parameter is greater than 4.96 V.

- **If 4.96 V or less**

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
2. Test for infinite resistance between the signal circuit terminal 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 signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
- **Go to next step: If greater than 4.96 V**

17. Replace the B47B Fuel Rail Pressure Sensor.

Repair Instructions

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

- [Fuel Injection Fuel Rail Fuel Pressure Sensor Replacement](#)
- [Control Module References](#) for ECM replacement, setup, and programming

DTC P0201, P0202, P02023, P0204, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P1248, P1249, P124A, P124B, P2147, P2148, P2150, P2151, P2153, P2154, P2156, OR P2157

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 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

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

Cylinder 1 Injector High Control Circuit Low Voltage

DTC P2148

Cylinder 1 Injector High Control Circuit High Voltage

DTC P2150

DTC P2151

Cylinder 2 Injector High Control Circuit High Voltage

DTC P2153

Cylinder 3 Injector High Control Circuit Low Voltage

DTC P2154

Cylinder 3 Injector High Control Circuit High Voltage

DTC P2156

Cylinder 4 Injector High Control Circuit Low Voltage

DTC P2157

Cylinder 4 Injector High Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Short from Supply Circuit to Control Circuit
Fuel Injector 1 Control +	P0300, P2147	P0201, P0300	P0300, P2148	P1248
Fuel Injector 1 Control -	P0261, P0300	P0201, P0300	P0262, P0300, P2148	P0300, P1248
Fuel Injector 2 Control +	P0300, P2150	P0202, P0300	P0300, P2151	P1249
Fuel Injector 2 Control -	P0264, P0300	P0202, P0300	P0265, P0300, P2151	P0300, P1249
Fuel Injector 3 Control +	P0300, P2153	P0203, P0300	P0300, P2154	P124A
Fuel Injector 3 Control -	P0267, P0300	P0203, P0300	P0268, P0300, P2154	P0300, P124A
Fuel Injector 4 Control +	P0300, P2156	P0204, P0300	P0300, P2157	P124B
Fuel Injector 4 Control -	P0270, P0300	P0204, P0300	P0271, P0300, P2157	P0300, P124B

Circuit/System Description

The engine control module (ECM) supplies voltage to each fuel injector on the high control circuits. The ECM energizes each fuel injector by grounding the low control circuit of the fuel injector. The ECM monitors the status of the fuel injector circuits. When a fuel injector circuit condition is detected by the ECM, the affected fuel injector(s) is disabled.

Conditions for Running the DTC

- DTC P062B is not set.
- The engine is running for greater than 5 s.
- The ignition voltage is greater than 11 V.
- The DTCs run continuously once the above conditions are met.

Conditions for Setting the DTC**P0201, P0202, P0203, or P0204**

The ECM detects the fuel injector control circuit is open for greater than 2 s.

P0261, P0264, P0267, or P0270

The ECM detects the fuel injector control - circuit is shorted to ground for greater than 2 s.

P0262, P0265, P0268, or P0271

The ECM detects the fuel injector control + circuit is shorted to voltage for greater than 2 s.

P1248, P1249, P124A, or P124B

The ECM detects the fuel injector control + circuit is shorted to the fuel injector control - circuit for greater than 2 s.

P2147, P2150, P2153, or P2156

The ECM detects the fuel injector control + circuit is shorted to ground for greater than 2 s.

P2148, P2151, P2154, or P2157

The ECM detects the fuel injector control + circuit is shorted to voltage for greater than 2 s.

Action Taken When the DTC Sets

DTCs P0201, P0202, P0203, P0204, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P1248, P1249, P124A, P124B, P2147, P2148, P2150, P2151, P2153, P2154, P2156, and P2157 are Type A DTCs.

Conditions for Clearing the DTC

DTCs P0201, P0202, P0203, P0204, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P1248, P1249, P124A, P124B, P2147, P2148, P2150, P2151, P2153, P2154, P2156, and P2157 are Type A DTCs.

Diagnostic Aids

- Performing the fuel injector coil test may help isolate an intermittent condition. Refer to [Fuel Injector Diagnosis](#).
- If the condition is intermittent, move the related harnesses and connectors, with the engine operating, while monitoring the scan tool Injector Control Circuit Status parameters. An Injector Control Circuit Status parameter will change from OK or Not Run to Malfunction if there is a condition with the circuit or a connection.

Reference Information

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Engine Controls Wiring Schematics

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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 P0685 or P1682 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: **The engine must be running for the scan tool Cylinder 1 - 4 Injector Control Circuit Status parameters to function.**

3. Engine idling.
4. Verify with a scan tool the parameters listed below do not increment.

- Cylinder 1 Current Misfire Counter
- Cylinder 2 Current Misfire Counter
- Cylinder 3 Current Misfire Counter
- Cylinder 4 Current Misfire Counter
- **If a parameter increments**

Refer to Circuit/System Testing.

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

5. Verify with a scan tool the parameters listed below display OK or Not Run.

- Cylinder 1 Injector Control Circuit Status
- Cylinder 2 Injector Control Circuit Status
- Cylinder 3 Injector Control Circuit Status
- Cylinder 4 Injector Control Circuit Status
- **If OK or Not Run is not displayed**

Refer to Circuit/System Testing.

- **Go to next step: If OK or Not Run is displayed**

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

1. Ignition OFF, all vehicle systems OFF, disconnect the harness connector at the K20 Engine Control Module. It may take up to 2 min for all vehicle systems to power down.
2. Test for infinite resistance between the appropriate Q17 Fuel Injector control + circuit and ground.
 - **If less than infinite resistance**

1. Disconnect the harness connector of the Q17 Fuel Injector.
2. Test for infinite resistance between the Q17 Fuel Injector control + circuit and ground.
 - If less than infinite, repair the short to ground in the circuit.
 - Go to next step: If infinite resistance
3. Test for infinite resistance between the Q17 Fuel Injector control - circuit and ground.
 - If less than infinite, repair the short to ground in the circuit.
 - If infinite, replace the Q17 Fuel Injector.
 - **Go to next step: If infinite resistance**
3. Ignition ON.
4. Test for less than 1 V between the Q17 Fuel Injector control + circuit and ground.
 - **If 1 V or greater**
 1. Disconnect the harness connector of the Q17 Fuel Injector, ignition ON.
 2. Test for less than 1 V between the Q17 Fuel Injector control + circuit and 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 control - circuit.
 - **Go to next step: If less than 1 V**
5. Ignition OFF.
6. Test for less than 3 Ω between the Q17 Fuel Injector control + circuit and control - circuit.
 - **If 3 Ω or greater**
 1. Disconnect the harness connector of the Q17 Fuel Injector.
 2. Test for less than 2 Ω on the control + 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 less than 2 Ω on 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 Q17 Fuel Injector.
 - **Go to next step: If less than 3 Ω**
7. Replace the K20 Engine Control Module.

Component Testing

Fuel Injector Diagnosis

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Fuel Injector Replacement
- Control Module References for control module replacement, setup, and programming

DTC P0231, P0232, OR P023F

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 P0231

Fuel Pump Control Circuit Low Voltage

DTC P0232

DTC P023F

Fuel Pump Control Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Control	P0171, P0232, P023F	P0171, P0232, P023F	P0171, P0232, P023F, P2635	P023F, P2635
Low Reference	-	P0232, P023F, P0506	P0232, P023F, P0506	P023F, P2635

Circuit/System Description

The engine control module (ECM) supplies voltage to the fuel pump driver control module when the ECM detects that the ignition is on. The voltage from the ECM to the fuel pump driver control module remains active for 2 s, unless the engine is in crank or run. While this voltage is being received, the fuel pump driver control module supplies a varying voltage to the fuel tank fuel pump module in order to maintain the desired fuel line pressure.

Conditions for Running the DTC**P0231**

- The ignition voltage is between 9 - 32 V.
- The fuel pump enable circuit is commanded ON.
- The fuel pump current is less than 100 A.

P0232

- The ignition voltage is between 9 - 32 V.
- The fuel pump enable circuit is commanded OFF.
- The above conditions are met for 4 s.
- The DTC runs once per trip.

P023F

- The ignition voltage is between 9 - 32 V.
- The fuel pump enable circuit is commanded ON.

Conditions for Setting the DTC**P0231**

The fuel pump driver control module detects that the fuel pump current is greater than 14.48 A for 1 s.

P0232

The fuel pump driver control module detects that the fuel pump control circuit voltage is greater than 3.86 V for 0.5 s when the voltage should be 0 V.

P023F

The fuel pump driver control module detects that the fuel pump current is less than 0.5 A and the fuel pump duty cycle is greater than 20 percent for 1 s.

Action Taken When the DTC Sets

- DTCs P0231 and P023F are Type A DTCs.

- DTC P0232 is a Type B DTC.

Conditions for Clearing the DTC

- DTCs P0231 and P023F are Type A DTCs.
- DTC P0232 is a Type B DTC.

Diagnostic Aids

Using the Failure Records data may help locate an intermittent condition. If you cannot duplicate the DTC, the information in the Failure Records can help determine how many miles since the DTC set. The Fail Counter and Pass Counter can help determine how many ignition cycles that the diagnostic test reported a pass and/or a fail.

On vehicles equipped with a high pressure mechanical pump on Direct Fuel Injection engines, the vehicle may continue to run even though the pump in the fuel tank is not operating.

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Engine Controls Wiring Schematics

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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 the fuel pump turns ON and OFF when commanding the Fuel Pump Enable On and Off with a scan tool.
 - **If the fuel pump does not turn ON and OFF**
Refer to Circuit/System Testing.
 - **Go to next step: If the fuel pump turns ON and OFF**
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 the K111 Fuel Pump Driver Control Module and the X350 inline harness connector.
2. Test for less than 2 Ω in the low reference circuit end to end between the appropriate terminal at the body side of connector X350 and at the K111 Fuel Pump Driver Control Module.
 - **If 2 Ω or greater**

Repair the open/high resistance in the circuit.
 - **Go to next step: If less than 2 Ω**
3. Connect the harness connector at the K111 Fuel Pump Driver Control Module.
4. Ignition ON, connect a test lamp between the fuel pump control circuit terminal and the low reference circuit terminal at the body side of connector X350.
5. Verify the test lamp turns ON and OFF when commanding the Fuel Pump Enable On and Off with a scan tool.
 - **If the test lamp is always OFF**
 1. Ignition OFF, disconnect the harness connector at the K111 Fuel Pump Driver Control Module.
 2. Test for infinite resistance between the fuel pump control 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 fuel pump control circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , test or replace the K111 Fuel Pump Driver Control Module.
 - **If the test lamp is always ON**
 1. Ignition OFF, remove the test lamp, disconnect the harness connector at the K111 Fuel Pump Driver Control Module, ignition ON.
 2. Test for less than 1 V between the fuel pump control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, test or replace the K111 Fuel Pump Driver Control Module.
 - **Go to next step: If the test lamp turns ON and OFF**
6. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the K111 Fuel Pump Driver Control Module and at the G12 Fuel Pump. It may take up to 2 minutes for all vehicle systems to power down.
7. Test for infinite resistance between the low reference circuit and ground.
 - **If less than infinite resistance**

Repair the short to ground on the circuit.
 - **Go to next step: If infinite resistance**
8. 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.
 - **Go to next step: If less than 2 Ω**
9. Test for infinite resistance between the fuel pump control circuit and ground.
 - **If less than infinite resistance**

Repair the short to ground on the circuit.
 - **Go to next step: If infinite resistance**

10. Test for less than 2 Ω in the fuel pump control 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**

11. Replace the G12 Fuel Pump.

Component Testing

Static Test

1. Ignition OFF, disconnect the harness connector at the K111 Fuel Pump Driver Control Module.
2. Connect a DMM, set on the diode setting, with the positive lead at terminal 16 and the negative lead at terminal 9 of the K111 Fuel Pump Driver Control Module
3. Test for 0.4 - 0.8 V between terminal 16 and terminal 9.

- **If not between 0.4 - 0.8 V**

Replace the K111 Fuel Pump Driver Control Module.

- **Go to next step: If between 0.4 - 0.8 V**

4. Connect a DMM, set on the diode setting, with the positive lead at terminal 9 and the negative lead at terminal 16 of the K111 Fuel Pump Driver Control Module
5. Test for OL between terminal 9 and terminal 16.

- **If not OL**

Replace the K111 Fuel Pump Driver Control Module.

- **Go to next step: If OL**

6. All OK.

Repair Instructions

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

- **Fuel Pump Power Control Module Replacement** for K111 Fuel Pump Driver Control Module replacement
- **Fuel Tank Fuel Pump Module Replacement** for G12 Fuel Pump replacement

DTC P0234 OR P0299

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 P0234

Engine Overboost

DTC P0299

Engine Underboost

Circuit Description

The boost pressure sensor is integrated with the intake air temperature (IAT) sensor 3. The boost pressure sensor measures the range of pressures between the turbocharger and the throttle body. The sensor used on this engine is a three atmosphere sensor. Pressure in this portion of the induction system

is affected by engine speed, throttle opening, turbocharger boost pressure, IAT, barometric pressure (BARO), and the efficiency of the charge air cooler.

The sensor provides a signal voltage to the engine control module (ECM), relative to the pressure changes, on the boost pressure signal circuit. Under normal operation the greatest pressure that can exist in this portion of the induction system at ignition On, engine Off is equal to the BARO. When the vehicle is operated at wide-open throttle (WOT) the turbocharger can increase the pressure to near 240 kPa (34.8 psi). The lowest pressure that occurs is when the vehicle is idling or decelerating, and it is equal to BARO.

Conditions for Running the DTCs

- DTC P0010, P0011, P0013, P0014, P0016, P0017, P0033, P0034, P0035, P0068, P00C8, P00C9, P0111, P0112, P0113, P0114, P0116, P0122, P0123, P0128, P0222, P0223, P0236, P0237, P0238, P0243, P0245, P0246, P0601, P0604, P0606, P1682, P16A0, P16A1, P16F3, P2101, P2176, P2227, P2228, P2229, P2230 or P2261 is not set.
- The driver requested boost pressure level exceeds the level of the base boost pressure.
- The engine speed is between 1, 600 - 6, 000 RPM.
- The desired boost pressure is between 140 - 300 kPa (20.3 - 43.5 psi)
- The Barometric Pressure (BARO) is between 60 - 120 kPa (8.7 - 17.4 psi).
- The Engine Coolant Temperature (ECT) is between -40 to +120Â°C (-40 to +248Â°F).
- The Intake Air Temperature (IAT) is between -40 to +80Â°C (-40 to +176Â°F)
- The turbocharger wastegate is not under output device control.
- The turbocharger bypass valve is not under output device control.
- The DTCs run continuously when the above conditions have been met.

Conditions for Setting the DTC

P0234

The ECM detects that the actual boost pressure is greater than the desired boost pressure by a calibrated amount for greater than 3 s.

P0299

The ECM detects that the actual boost pressure is less than the desired boost pressure by a calibrated amount for greater than 3 s.

Action Taken When the DTC Sets

- P0234 and P0299 are Type A DTCs with emission package RPOs NT7, NU5, and NQL.
- P0234 and P0299 are Type C DTCs with emission package RPOs NE4 and NE9.
- The ECM will disable boost control and limit the system to mechanical boost only, resulting in a substantial decrease in engine power.

Conditions For Clearing the MIL/DTC

- P0234 and P0299 are Type A DTCs with emission package RPOs NT7, NU5, and NQL.
- P0234 and P0299 are Type C DTCs with emission package RPOs NE4 and NE9.

Diagnostic Aids

- The charge air cooler is connected to the turbocharger and to the throttle body by flexible duct work that requires the use of special high torque fastening clamps. These clamps cannot be substituted. In order to prevent any type of air leak when servicing the ductwork, the tightening specifications and proper positioning of the clamps is critical, and must be strictly adhered to.
- Use a solution of dish soap and water in a spray bottle to pinpoint any air leaks.

Reference Information

Schematic Reference

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[Turbocharger System Description](#)

- [Circuit Testing](#)
- [Connector Repairs](#)
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- [Wiring Repairs](#)

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

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

GE-23738-A Vacuum Pump

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

[Circuit/System Verification](#)

1. Ignition On.
2. Verify DTC P0106, P0107, P0108, P0236, P0237, P0238, P0243, P0245, P0246, P2227, P2228, P2229, or 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**
3. Verify the scan tool BARO Sensor parameter is within the range specified in the [Altitude Versus Barometric Pressure](#) table for the current testing altitude.
 - **If not within the range.**
Refer to [DTC P2227-P2230](#) .
 - **Go to next step: If within the range.**
4. Verify the scan tool MAP Sensor and BARO Sensor parameters are within 3 kPa (0.4 psi).
 - **If not within 3 kPa (0.4 psi).**
Refer to [DTC P0106](#).
 - **Go to next step: If within 3 kPa (0.4 psi).**
5. Verify the scan tool Boost Pressure Sensor and BARO Sensor parameters are within 3 kPa (0.4 psi).
 - **If not within 3 kPa (0.4 psi).**
Refer to [DTC P0236](#).
 - **Go to next step: If within 3 kPa (0.4 psi).**

6. Verify a click is heard or felt from the Q40 Turbocharger Bypass Solenoid Valve when commanding the Turbocharger Bypass Solenoid Valve between Active and Inactive with a scan tool.

- **If a click is not heard or felt**

Refer to [DTC P0033-P0035](#).

- **Go to next step: If a click is heard or felt**

7. Verify the parameters listed below do not display Malfunction when commanding the Turbocharger Bypass Solenoid Valve between Active and Inactive with a scan tool.

- Turbocharger Bypass Solenoid Valve Control Circuit High Voltage Test Status
- Turbocharger Bypass Solenoid Valve Control Circuit Open Test Status
- Turbocharger Bypass Solenoid Valve Control Circuit Low Voltage Test Status
- **If Malfunction is displayed**

Refer to [DTC P0033-P0035](#).

- **Go to next step: If Malfunction is not displayed**

8. Verify a series of clicks, which increase in frequency, are heard or felt from the Q42 Turbocharger Wastegate Solenoid Valve when commanding the Turbocharger Wastegate Solenoid Valve between 15 - 100% with a scan tool.

- **If a series of clicks in increasing frequency are not heard or felt**

Refer to [DTC P0243, P0245, or P0246](#).

- **Go to next step: If a series of clicks in increasing frequency is heard or felt**

9. Verify the parameters listed below do not display Malfunction when commanding the Turbocharger Wastegate Solenoid Valve between 15 - 100% with a scan tool.

- Turbocharger Wastegate Solenoid Valve Control Circuit High Voltage Test Status
- Turbocharger Wastegate Solenoid Valve Control Circuit Open Test Status
- Turbocharger Wastegate Solenoid Valve Control Circuit Low Voltage Test Status
- **If Malfunction is displayed**

Refer to [DTC P0243, P0245, or P0246](#).

- **Go to next step: If Malfunction is not displayed**

10. Verify the scan tool MAP Sensor parameter and the Boost Pressure Sensor parameter are within 20 kPa (2.9 psi) during a WOT acceleration at the time of the 1-2 shift.

- **If not within 20 kPa (2.9 psi)**

Refer to Circuit/System Testing.

- **Go to next step: If within 20 kPa (2.9 psi)**

11. 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.

12. Verify a DTC does not set.

- **If a DTC sets**

Refer to Circuit/System Testing

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

13. All OK

Circuit/System Testing

1. Verify the conditions listed below do not exist:

- Loose clamps, cracks or other damage in the air intake duct system
- Collapsed or restricted intake duct system

- Restricted air filter
- Any air flow restriction
- Any air leak between the turbocharger and the throttle body, including the charge air cooler assembly
- Splits, kinks or improper connections at the vacuum hoses
- Any vacuum leak
- Restricted, leaking or incorrect routing of hoses going to the components listed below:
 - Q42 Turbocharger Wastegate Solenoid Valve
 - Turbocharger wastegate actuator
 - Turbocharger
- Missing, restricted or leaking exhaust components. Refer to [Symptoms - Engine Exhaust](#).
- Exhaust leak between the turbocharger and the exhaust manifold
- Restricted or leaking turbocharger oil supply line
- Loose or incorrect installation of any components
- **If a condition exists**

Repair or replace the affected component as necessary.

- **Go to next step: If none of the conditions exist**
2. Ignition Off, disconnect the turbocharger wastegate solenoid valve supply hose at the turbocharger and apply 51 kPa (15 inches Hg) of vacuum to the hose with the **GE 23738-A**, ignition On.
 3. Verify the pressure decreases to 0 kPa (0 inches Hg) when commanding the Turbocharger Wastegate Solenoid Valve to 15% with a scan tool.
 - **The pressure does not decrease to 0 kPa (0 inches Hg)**

Replace the Q42 Turbocharger Wastegate Solenoid Valve

- **Go to next step: The pressure decreases to 0 kPa (0 inches Hg)**
4. Connect the turbocharger wastegate solenoid valve supply hose to the turbocharger.
 5. Disconnect the hose from the turbocharger wastegate actuator and connect the exhaust/pressure port of the **GE 23738-A**, or a suitable hand pressure pump, to the actuator.
 6. Verify the wastegate actuator rod moves when applying pressure to the actuator.
 - **If the actuator does not move**
 1. Disconnect the wastegate actuator arm from the wastegate.
 2. Verify the wastegate actuator rod moves when applying pressure to the actuator.
 - If the actuator does not move, replace the turbocharger wastegate actuator.
 - If the actuator moves, replace the turbocharger.
 - **Go to next step: If the actuator moves**

NOTE: Leave harness connector connected or re-connect it after removing valve.

7. Ignition Off, remove the Q40 Turbocharger Bypass Solenoid Valve from the turbocharger, ignition On.
8. Verify the Q40 Turbocharger Bypass Solenoid Valve plunger retracts and extends when commanding the Turbocharger Bypass Solenoid Valve between Active and Inactive with a scan tool.
 - **The valve plunger does not retract and extend**

Replace the Q40 Turbocharger Bypass Solenoid Valve

 - **Go to next step: The valve plunger retracts and extends**
9. Verify the conditions listed below do not exist with the turbocharger assembly. Refer to [Camshaft Cover and Compressor Air Intake Turbocharger Cleaning and Inspection](#)

- Cracked, damaged or worn turbine blades
- Restricted wastegate, turbine, ports or passages
- Foreign material
- **A condition exists**

Repair or replace the turbocharger as necessary

- **Go to next step: None of the conditions exist**

10. Replace the turbocharger.

Repair Instructions

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

- [Turbocharger Replacement](#)
- [Turbocharger Bypass Valve Solenoid Replacement](#)
- [Turbocharger Wastegate Actuator Replacement](#)
- [Turbocharger Wastegate Regulator Solenoid Valve Replacement](#)
- [Control Module References](#) for ECM replacement, programming, and setup

DTC P0236

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 P0236

Turbocharger Boost Sensor Performance

Circuit Description

The boost pressure sensor is integrated with the turbocharger boost/intake air temperature sensor. The boost pressure sensor measures the range of pressures between the turbocharger and the throttle body. The sensor used on this engine is a three atmosphere sensor. Pressure in this portion of the induction system is affected by engine speed, throttle opening, turbocharger boost pressure, Intake air temperature (IAT), barometric pressure (BARO), and the efficiency of the charge air cooler.

The sensor provides a signal voltage to the engine control module (ECM), relative to the pressure changes. Under normal operation the greatest pressure that can exist in this portion of the induction system at ignition ON, engine OFF is equal to the BARO. When the engine is operated at wide-open throttle (WOT) the turbocharger can increase the pressure to near 240 kPa (34.8 psi). The pressure is equal to the BARO when the engine is idling or decelerating.

Conditions for Running the DTC

- DTC P0106, P0107, P0108, P0237, P0238, P2227, P2228, P2229, or P2230 is not set.
- DTC P0106, P0107, P0108, P0237, or P0238 is not pending.
- Ignition is ON.
- Engine is OFF.
- The time between current ignition cycle and the last time the engine was running is greater than 10 s.
- The DTC runs continuously when the above conditions have been met.

OR

- DTC P0102, P0103, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0128, P0237, P0238, P0335, P0336, P2227, P2228, P2229 or P2230 is not set.
- DTC P0112, P0113, P0117, or P0118 is not pending.
- Engine speed is between 400 - 6,000 RPM.
- Engine Coolant Temperature (ECT) is between -7 to +125°C (19.4 - 257°F).
- Intake Air Temperature (IAT) is between -20 to +125°C (-4 to +257°F).
- The DTC runs continuously when the above conditions have been met.

Conditions for Setting the DTC

- The ECM detects that the boost pressure sensor signal is not within range of a model derived from engine speed, the BARO sensor, the MAF sensor, the MAP sensor, the throttle position sensor and the turbocharger boost pressure sensor when the engine is running.

OR

- The ECM detects that the boost pressure sensor signal is less than 50 kPa (7.3 psi) or greater than 115 kPa (16.7 psi) when the ignition is ON and the engine is NOT rotating.

OR

- The ECM detects that the difference between MAP and BARO is less than or equal to 10 kPa and the difference between turbocharger boost pressure and MAP is greater than 10 kPa and the difference between turbocharger boost pressure and BARO is greater than 10 kPa when the ignition is ON and the engine is NOT rotating.

Action Taken When the DTC Sets

DTC P0236 is a Type B DTC.

Conditions for Clearing the MIL/DTC

DTC P0236 is a Type B DTC.

Diagnostic Aids

- The charge air cooler is connected to the turbocharger and to the throttle body by flexible duct work that requires the use of special high torque fastening clamps. These clamps cannot be substituted. In order to prevent any type of air leak when servicing the duct work, the tightening specifications and proper positioning of the clamps is critical, and must be strictly adhered to.
- Use a smoke generating device or a solution of dish soap and water in a spray bottle to pinpoint any suspected air leaks in the induction system and in the charge air cooler assembly.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Turbocharger System Description

Electrical Information Reference

- Circuit Testing
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- [Wiring Repairs](#)

DTC Type Reference

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

Scan Tool Reference

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

[Circuit/System Verification](#)

1. Verify that DTC P0641, P0651, P0697, P06A3, P06D2, P0237, or P0238 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. If you were sent here from DTC P0068, P0101, P0106, P0121, or P1101 refer to Circuit/System Testing.
3. Ignition ON.
4. Verify the scan tool Throttle Body Idle Airflow Compensation parameter is less than 90%.
 - **If 90% or greater**
Refer to [Throttle Body Cleaning](#) .
 - **Go to next step: If less than 90%**
5. Verify the scan tool Throttle Position Sensors 1 and 2 Agree/Disagree parameter displays Agree while performing the Throttle Sweep Test with a scan tool.
 - **If Disagree**
Refer to [DTC P0121-P0123, P0222, P0223, P16A0-P16A2, or P2135](#).
 - **Go to next step: If Agree**
6. Verify the scan tool BARO parameter is within the range specified in the [Altitude Versus Barometric Pressure](#) table, for the current vehicle testing altitude.
 - **BARO is not in range**
Refer to [DTC P2227-P2230](#) .
 - **Go to next step: BARO is within range**
7. Verify the scan tool MAP Sensor pressure and BARO parameters are within 3 kPa (0.4 psi).
 - **The parameters are not within 3 kPa (0.4 psi).**
Refer to [DTC P0106](#).
 - **Go to next step: The parameters are within 3 kPa (0.4 psi).**
8. Engine idling.
9. Verify the scan tool MAP Sensor pressure parameter is between 26 - 52 kPa (3.8 - 7.5 psi) and changes with accelerator pedal input.
 - **If not between 26 - 52 kPa (3.8 - 7.5 psi) or does not change**
Refer to [DTC P0106](#).
 - **Go to next step: If between 26 - 52 kPa (3.8 - 7.5 psi) and changes**
10. Verify the scan tool MAF Sensor g/s parameter changes smoothly and gradually as the engine speed is increased and decreased while performing the actions listed below.
 1. Engine idling
 2. Perform the scan tool snapshot function.

3. Increase the engine speed slowly to 3,000 RPM and then back to idle.

4. Exit from the scan tool snapshot and review the data.

5. Observe the MAF Sensor parameter frame by frame with a scan tool.

- **The MAF Sensor parameter does not change smoothly and gradually**

Refer to [DTC P0101](#).

- **Go to next step: The MAF Sensor parameter changes smoothly and gradually**

11. Verify the scan tool Boost Pressure Sensor pressure and BARO parameters are within 3 kPa (0.4 psi).

- **The parameters are not within 3 kPa (0.4 psi).**

Refer to Circuit/System Testing

- **Go to next step: The parameters are within 3 kPa (0.4 psi).**

12. Verify the scan tool MAP Sensor parameter and the Boost Pressure Sensor parameter are within 20 kPa (2.9 psi) during a WOT acceleration at the time of the 1-2 shift.

- **The parameters are not within 20 kPa (2.9 psi)**

Refer to Circuit/System Testing.

- **Go to next step: The parameters are within 20 kPa (2.9 psi)**

13. 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.

14. Verify a DTC does not set.

- **If the DTC sets**

Refer to Circuit/System Testing.

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

15. All OK.

Circuit/System Testing

1. Verify that DTC P0237 or P0238 is not set.

- **If a DTC is set**

Refer to [DTC P0237 or P0238](#).

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

2. Verify the conditions listed below do not exist:

- Loose clamps, cracks, or other damage in the air intake duct system
- Collapsed or restricted air intake duct system
- Restricted air filter
- Splits, kinks or improper connections at the vacuum hoses
- Missing, restricted or leaking exhaust components - Refer to [Symptoms - Engine Exhaust](#)
- Vacuum leaks at the intake manifold and throttle body
- **If a condition exists**

Repair as necessary.

- **Go to next step: If none of the conditions exist**

3. Replace the B111B turbocharger boost/intake air temperature sensor.

Repair Instructions

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

- [Intake Air Pressure and Temperature Sensor Replacement](#) for turbocharger boost/intake air temperature sensor replacement.
- [Control Module References](#) for engine control module replacement, programming, and setup

DTC P0237 OR P0238

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 P0237

Turbocharger Boost Sensor Circuit Low Voltage

DTC P0238

Turbocharger Boost Sensor Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P018C, P0192, P0236, P0237, P0340, P0365, P0452, P0532, P0641, P2227*	P0236, P0237	P018D, P0193, P0236, P0237, P0453, P0523, P0641, P2227*	P0236
Intake Air Pressure Signal	P0236, P0237, P2227	P0236, P0237	P0193, P0236, P0238, P0641, P2227*	P0236
Low Reference	-	P00EB, P0236, P0238, P2227	-	-
* A message center or an indicator may display ENGINE POWER IS REDUCED. Engine may experience Crank - NO Start condition.				

Typical Scan Tool Data

Boost Pressure Sensor

Circuit	Short to Ground	Open	Short to Voltage
Parameter Normal Range: BARO to 240 kPa (34.8 psi)			
Operating Conditions: Engine running under various operating conditions			
5 V Reference	0 kPa (0 psi)	0 kPa (0 psi)	0 kPa (0 psi)
Boost Pressure Sensor	0 kPa (0 psi)	0 kPa (0 psi)	392 kPa (56.9 psi)
Low Reference	-	387 kPa (56.1 psi)	-

Circuit Description

The boost pressure sensor is integrated with the turbocharger boost/intake air temperature sensor. The boost pressure sensor measures the range of pressures between the turbocharger and the throttle body. The sensor used on this engine is a three atmosphere sensor. Pressure in this portion of the induction system is affected by engine speed, throttle opening, turbocharger boost pressure, Intake air temperature (IAT), barometric pressure (BARO), and the efficiency of the charge air cooler.

The sensor provides a signal voltage to the engine control module (ECM), relative to the pressure changes. Under normal operation the greatest pressure that can exist in this portion of the induction system at ignition ON, engine OFF is equal to the BARO. When the engine is operated at wide-open

throttle (WOT) the turbocharger can increase the pressure to near 240 kPa (34.8 psi). The pressure is equal to the BARO when the engine is idling or decelerating.

Conditions for Running the DTC

- Ignition is ON or the engine is running.
- The DTCs run continuously when the above conditions have been met.

Conditions for Setting the DTC

P0237

The ECM detects that the boost pressure sensor voltage is less than 0.9 V for greater than 5 s.

P0238

The ECM detects that the boost pressure sensor voltage is greater than 3.9 V for greater than 5 s.

Action Taken When the DTC Sets

- DTCs P0237 and P0238 are Type B DTCs.
- The ECM will disable boost control and limit the system to mechanical boost only, resulting in a substantial decrease in engine power.

Conditions for Clearing the MIL/DTC

DTCs P0237 and P0238 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

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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. Verify that DTC P0641 is not set.

- **If the DTC is set**

Refer to [DTC P0641, P0651, P0697, P06A3, or P06D2](#) .

- **Go to next step: If the DTC is not set**
- 2. Verify the scan tool BARO parameter is within the range specified in the [Altitude Versus Barometric Pressure](#) table, for the current vehicle testing altitude.
 - **BARO is not in range**
Refer to [DTC P2227-P2230](#).
 - **Go to next step: BARO is within range**
- 3. Verify the scan tool Boost Pressure Sensor pressure and BARO parameters are within 3 kPa (0.4 psi).
 - **The parameters are not within 3 kPa (0.4 psi).**
Refer to Circuit/System Testing
 - **Go to next step: The parameters are within 3 kPa (0.4 psi).**
- 4. Verify the scan tool MAP Sensor parameter and the Boost Pressure Sensor parameter are within 20 kPa (2.9 psi) during a WOT acceleration at the time of the 1-2 shift.
 - **The parameters are not within 20 kPa (2.9 psi)**
Refer to Circuit/System Testing.
 - **Go to next step: The parameters are within 20 kPa (2.9 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.
- 6. Verify a 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

1. Ignition OFF, and all vehicle systems OFF, disconnect the harness connector at the B111B turbocharger boost/intake air temperature sensor. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 5 Ω between the low reference circuit terminal 1 and ground.
 - **If 5 Ω or greater**
 1. Ignition OFF, disconnect the 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 5 Ω**
3. Ignition ON.
4. 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 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 on 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.

NOTE:

If the signal circuit is shorted to a voltage the engine control

module or the sensor may be damaged.

-
- **If greater than 5.2 V**
 1. Ignition OFF, disconnect the harness connector at the K20 engine control module, ignition ON.
 2. Test for less than 1 V between the 5 V reference circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 engine control module.
 - **Go to next step: If between 4.8 - 5.2 V**
- 5. Verify the scan tool Boost Pressure Sensor voltage parameter is greater than 4.7 V.
 - **If 4.7 V or less**
 1. Ignition OFF, disconnect the harness connector at the K20 engine control module, ignition ON.
 2. Test for infinite resistance between the signal circuit terminal 4 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K20 Engine Control Module.
 - **Go to next step: If greater than 4.7 V**
- 6. Install a 3 A fused jumper wire between the signal circuit terminal 4 and the low reference circuit terminal 1.
- 7. Verify the scan tool Boost Pressure Sensor voltage parameter is less than 0.2 V.
 - **If 0.2 V or greater**
 1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the K20 engine control module, Ignition ON.
 2. Test for less than 1 V between the signal circuit terminal 4 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - 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 or high resistance in the circuit.
 - If less than 2 Ω , replace the K20 engine control module.
 - **Go to next step: If less than 0.2 V**
- 8. Test or replace the B111B turbocharger boost/intake air temperature sensor.

Repair Instructions

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

- [Intake Air Pressure and Temperature Sensor Replacement](#) for turbocharger boost/intake air temperature sensor replacement
- [Control Module References](#) for ECM replacement, programming, and setup

DTC P0243, P0245, OR P0246

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 P0243

Turbocharger Wastegate Solenoid Valve Control Circuit

DTC P0245

DTC P0246

Turbocharger Wastegate Solenoid Valve Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Ignition Voltage	P0033, P0034, P0243, P0245, P0443, P06DA, P06DB*	P0243	P0243	-	-
Turbocharger Wastegate Solenoid Control	P0245	P0243	P0243	P0246	P0243
* Ignition fuse opens. A message center or an indicator may display ENGINE POWER IS REDUCED. Engine may experience NO Crank - NO Start condition.					

Circuit/System Description

The dual-scroll turbocharger incorporates a wastegate that is controlled by the engine control module (ECM) by means of a pulse width modulation (PWM) solenoid, to regulate the pressure ratio of the compressor. An ECM controlled compressor bypass valve is integrated into the unit to prevent compressor surging and damage from vibrations by opening during abrupt closed throttle conditions. The bypass valve is open during closed throttle deceleration conditions to allow air to recirculate in the turbocharger and maintain compressor speed.

As engine load and speed increase, the turbocharger bypass valve is commanded closed by the ECM. As soon as the throttle closes, the valve is commanded open to allow the turbocharger air to recirculate to prevent compressor surging.

Conditions for Running the DTCs

- Ignition is On or the engine is running.
- Battery voltage is between 11 - 32 V.
- The DTCs run continuously when the above conditions are met.

Conditions for Setting the DTCs**P0243**

The ECM detects an open circuit on the turbocharger wastegate solenoid control circuit for greater than 2 s.

P0245

The ECM detects a short to ground on the turbocharger wastegate solenoid control circuit for greater than 2 s.

P0246

The ECM detects a short to voltage on the turbocharger wastegate solenoid control circuit for greater than 2 s.

Action Taken When the DTCs Set

- P0243, P0245, and P0246 are Type A DTCs with emission package RPOs NT7, NU5, and NQL.
- P0243, P0245, and P0246 are Type C DTCs with emission package RPOs NE4 and NE9.

- The ECM will disable boost control and limit the system to mechanical boost only, resulting in a substantial decrease in engine power.

Conditions for Clearing the MIL/DTCs

- P0243, P0245, and P0246 are Type A DTCs with emission package RPOs NT7, NU5, and NQL.
- P0243, P0245, and P0246 are Type C DTCs with emission package RPOs NE4 and NE9.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Turbocharger System Description

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition On
2. Verify a series of clicks, which increase in frequency, are heard or felt from the Q42 Turbocharger Wastegate Solenoid Valve when commanding the Turbocharger Wastegate Solenoid Valve between 15 - 100% with a scan tool.
 - **If a series of clicks in increasing frequency are not heard or felt**
Refer to Circuit/System Testing.
 - **Go to next step: If a series of clicks in increasing frequency is heard or felt**
3. Verify the parameters listed below do not display Malfunction when commanding the Turbocharger Wastegate Solenoid Valve between 15 - 100% with a scan tool.
 - Turbocharger Wastegate Solenoid Valve Control Circuit High Voltage Test Status
 - Turbocharger Wastegate Solenoid Valve Control Circuit Open Test Status
 - Turbocharger Wastegate Solenoid Valve Control Circuit Low Voltage Test Status
 - **If Malfunction is displayed**
Refer to Circuit/System Testing.
 - **Go to next step: If Malfunction is not displayed**
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 a DTC does 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 harness connector at the Q42 Turbocharger Wastegate Solenoid Valve, ignition On.

2. Verify a test lamp illuminates between the ignition circuit terminal 1 and ground.

- **If the test lamp does not illuminate and the circuit fuse is good**

1. Ignition Off.

2. Test for less than 2 Ω in the ignition 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, remove the test lamp.

NOTE:

A short circuit in any component supplied by the fuse may cause the fuse to open and set a DTC when the component is activated.

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, test all components supplied by the fuse and replace as necessary.

- **Go to next step: If the test lamp illuminates**

3. Verify that a test lamp does not illuminate between the control circuit terminal 2 and the ignition circuit terminal 1.

- **If the test lamp illuminates**

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.
- If infinite resistance, replace the K20 Engine Control Module.

- **Go to next step: If the test lamp does not illuminate**

4. Remove the test lamp.

5. Verify the scan tool Turbocharger Wastegate Solenoid Valve Control Circuit High Voltage Test Status parameter is OK when commanding the Turbocharger Wastegate Solenoid Valve between 15 - 100% with a scan tool.

- **If OK is not displayed**

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.
- If less than 1 V, replace the K20 Engine Control Module.

- **Go to next step: If OK is displayed**

6. Install a 3 A fused jumper wire between the control circuit terminal 2 and the ignition circuit terminal 1.

7. Verify the scan tool Turbocharger Wastegate Solenoid Valve Control Circuit High Voltage Test Status parameter is Malfunction when commanding the Turbocharger Wastegate Solenoid Valve between 15 - 100% with a scan tool.

- **If Malfunction is not displayed**

1. Ignition Off, 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**
8. Test or replace the Q42 Turbocharger Wastegate Solenoid Valve.

Repair Instructions

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

- [Turbocharger Wastegate Regulator Solenoid Valve Replacement](#)
- [Control Module References](#) for ECM replacement, programming and setup

DTC P0300, P0301, P0302, P0303, OR P0304

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 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

The engine control module (ECM) uses information from the crankshaft position sensor and the camshaft position sensor to determine when a engine cylinder misfire is occurring. By monitoring variations in the crankshaft rotation speed for each cylinder, the ECM can detect individual cylinder misfire events.

Extreme cylinder misfire events can cause catalytic converter damage. The malfunction indicator lamp (MIL) will flash when the conditions for catalytic converter damage are present. DTCs P0301 through P0304 correspond to cylinders 1 through 4. When the ECM detects that one or more specific cylinders are misfiring, the DTC for the respective misfiring cylinder will set and up to 2 of the corresponding fuel injectors are disabled for a minimum of 30 s. The ECM will then re-enable the fuel injector and, after approximately 200 engine revolutions, will determine if the misfire is still present. If the misfire is still present, the ECM will disable the fuel injector again repeating the process. If the misfire is not present, the fuel injector will remain enabled by the ECM. In Spark Ignition Direct Injection (SIDI) system applications, if a fuel injector fault DTC is set during a misfire event, the ECM will not re-enable the injector.

Conditions for Running the DTC

- DTC P0010, P0011, P0013, P0014, P0016, P0017, P0068, P00C8, P00C9, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0117, P0118, P0119, P0122, P0123, P0191, P0192, P0193, P0222, P0223, P0335, P0336, P0340, P0341, P0365, P0366, P0601, P0604, P0606, P0651, P16A0, P16A1, P16A2, P16F3, P2101, P2135, P2227, P2228, P2229, or P2230 is not set.
- The engine speed is less than 1,000 RPM and DTC P0315 is set.
- The engine speed is greater than 1,050 RPM.
- The crankshaft position and camshaft position sensors are synchronized.
- The engine coolant temperature (ECT) is between -12 and 127°C (10 - 261°F).
- If the ECT is colder than -12°C (10°F) at start-up, this diagnostic will not run until the ECT is between 21 - 127°C (70 - 261°F).
- The battery voltage is between 9 - 32 V.
- The ECM is not detecting a rough road signal.
- The fuel level is at least 11%.
- The ECM is not in fuel cut-off or deceleration fuel cut-off mode.

The DTCs run continuously when the above conditions are met.

Conditions for Setting the DTC

P0300

The ECM detects a crankshaft rotation speed variation indicating a misfire rate sufficient to cause emissions levels to exceed a predetermined value or a misfire rate high enough to cause catalyst damage.

P0301, P0302, P0303, or P0304

The ECM detects a crankshaft rotation speed variation indicating a single cylinder misfire rate sufficient to cause emissions levels to exceed mandated standards.

Action Taken When the DTC Sets

- DTCs P0300-P0304 are Type B DTCs.
- The ECM will flash the malfunction indicator lamp (MIL) when a catalyst damaging level of misfire is present.
- If a hybrid application, engine idle speed will increase to between 1750-2500 RPM.

Conditions for Clearing the DTC

DTCs P0300-P0304 are Type B DTCs.

Diagnostic Aids

- A misfire DTC could be caused by an excessive vibration from sources other than the engine. Inspect for the conditions listed below:
 - A tire or wheel that is out of round or out of balance
 - Variable thickness brake rotors
 - An unbalanced drive shaft
 - Certain rough road conditions
 - Transmission operation
 - A damaged or defective accessory drive component or belt
- High resistance in the circuits of the injectors may set a misfire DTC without setting an injector DTC. Test the injector circuits of the affected cylinder(s) for a high resistance if you suspect a condition.
- If the condition is intermittent, observing the scan tool IC Circuit Test and Fuel Injector Circuit Test Status parameters may help isolate the condition. The circuit test status parameters will change from OK or Not Run to Fault/Malfunction if a condition exists.
- A condition in the heated O2 sensor (HO2S) heater control circuits may set a DTC P0300.

Description and Operation

- [Electronic Ignition System Description](#)
- [Fuel System Description](#)

DTC Type Reference

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

Scan Tool Reference

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

Special Tools

EL26792 Spark Tester

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

Circuit/System Verification

NOTE:

Before starting the engine, review the freeze frame failure records data to determine if the misfire sets during a cold start or at operating temperature. If there is a cold start condition and the engine is started, the engine will need to be cooled down before the next attempt to start the engine within the fail conditions.

If this a hybrid application and the hybrid battery is fully charged, the engine runs at a very low load since the hybrid battery cannot accept any additional charge. At this very low engine load, engine misfire may not be detected. It may be necessary to drive the vehicle in battery only propulsion mode in order to discharge the hybrid battery before diagnosis can be performed.

1. If this is a hybrid application, skip to step 4.
2. Engine Running at normal operating temperature.
3. Verify there is no abnormal engine noise.
 - **If abnormal engine noise is present**

Refer to [Symptoms - Engine Mechanical](#) .
 - **Go to next step: If abnormal engine noise is not present**
4. Perform the scan tool [Crankshaft Position Variation Learn](#) procedure.
5. Verify no DTCs are set.
 - **If any DTCs other than P0300-P0304 are set**

Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) .
 - **If DTC P0300-P0304 is set**

Refer to Circuit/System Testing.
 - **Go to next step: If no DTCs are set**
6. Verify the scan tool Cylinder 1 - 4 Current Misfire Counter parameters do not increment.
 - **If increments**

Refer to Circuit/System Testing.
 - **Go to next step: If does not increment**

7. Engine Running, perform the Cylinder Power Balance Test with a scan tool.

8. Verify the engine speed changes when each injector is disabled and then enabled.

- **If engine speed does not change**

Refer to Circuit/System Testing.

- **Go to next step: If engine speed does change**

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.

10. 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**

11. All OK.

Circuit/System Testing

1. Verify none of the following conditions listed below exist:

- Damage, carbon tracking, or fluid intrusion of the spark plug boots and/or spark plugs
- Vacuum hose splits, kinks, and incorrect connections
- Engine vacuum leaks
- Crankcase ventilation system for vacuum leaks
- Fuel pressure that is too low or too high. Refer to [Fuel System Diagnosis](#) .
- Contaminated fuel. Refer to [Alcohol/Contaminants-in-Fuel Diagnosis](#) .
- Exhaust system restrictions

- **If a condition exists**

Repair or replace as necessary.

- **Go to next step: If no conditions exist**

NOTE: An erratic or weak spark is considered a no spark condition.

2. Ignition OFF, remove the appropriate T8 Ignition Coil from the spark plug and connect the **EL 26792** HEI Spark Tester to the spark plug boot, engine Cranking.

3. Verify the spark output.

- **If no output or the output is weak**

Refer to [Electronic Ignition System Diagnosis](#) .

- **Go to next step: If the output is good**

4. Ignition OFF.

5. Verify the conditions listed below. Refer to [Ignition System Specifications](#) .

- The correct spark plug type
- The correct spark plug gap
- The correct spark plug torque
- **If a condition exists**

Repair or replace as necessary.

- **Go to next step: If no conditions exist**

6. Exchange the suspect spark plug with another cylinder that is operating correctly.

7. Engine Running.

8. Verify the scan tool Cylinder 1 - 4 Current Misfire Counter does not increment for the cylinder where the suspect spark plug was installed.

- **If increments**

Replace the spark plug.

- **Go to next step: If does not increment**

9. Test or inspect for the conditions listed below:

- A lean or rich Q17 Fuel Injector - Refer to [Fuel Injector Diagnosis](#) .
- An engine mechanical condition - Refer to [Symptoms - Engine Mechanical](#) .

Repair Instructions

- [Ignition Coil Replacement](#)
- [Spark Plug Replacement](#)

Repair Verification

1. Install any components or connectors that have been removed or replaced during diagnosis.
2. Perform any adjustment, programming or setup procedures that are required when a component or module is removed or replaced.
3. Clear the DTCs.
4. Turn OFF the ignition for 60 s.
5. If the repair was related to a DTC, duplicate the Conditions for Running the DTC and use the Freeze Frame/Failure Records, if applicable, in order to verify the DTC does not reset. If the DTC resets or another DTC is present, refer to the [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) and perform the appropriate diagnostic procedure.
6. Engine Running, verify the scan tool Cylinder 1 - 4 Current Misfire Counter parameters do not increment.
 - If the misfire counter parameters increment, a misfire condition still exists.
7. To verify that the performance of the catalytic converter has not been affected by the condition that set this DTC, perform the Repair Verification for DTC P0420. Refer to [DTC P0420](#) .

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

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 P0324, P0326, P0331, P06B6, OR P06B7

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 P0324

Knock Sensor System Performance

DTC P0326

DTC P0331

Knock Sensor 2 Performance

DTC P06B6

Control Module Knock Sensor Processor 1 Performance

DTC P06B7

Control Module Knock Sensor Processor 2 Performance

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Knock Sensor 1 High Signal	P0327, P06B6	P0325	P0328	P0324*, P0326**
Knock Sensor 2 High Signal	P0332, P06B7	P0330	P0333	P0324*, P0331**
Knock Sensor 1 Low Signal	P0327	P0325	P0328	P0324*, P0326**
Knock Sensor 2 Low Signal	P0332	P0330	P0333	P0324*, P0331**
* Signal Performance High ** Signal Performance Low				

Circuit/System Description

The knock sensors enable the engine control module (ECM) to control the ignition timing for the best possible performance while protecting the engine from potentially damaging levels of detonation. The knock sensors produce an alternating current (AC) voltage signal that varies depending on the vibration level during engine operation. The ECM adjusts the spark timing based on the amplitude and the frequency of the two knock sensor signals. The ECM receives each knock sensor signal through a dedicated circuit. The ECM learns a minimum knock sensor noise level for all of the engine speed ranges and monitors the normal knock sensor signal. The ECM monitors the internal knock sensor processor test circuits which perform the open circuit diagnostic.

Conditions for Running the DTCs**P0324**

- Engine is running for 2 s or greater.
- Engine speed is 8, 500 RPM or less.
- Engine air flow is between 0 - 2000 mg per cylinder.
- The engine coolant temperature (ECT) is -40Â°C (-40Â°F) or warmer.
- The intake air temperature (IAT) sensor is -40Â°C (-40Â°F) or warmer.

AND

- Engine speed is 550 RPM or greater for 300 or more cumulative revolutions.

OR

- Engine speed is 8500 RPM or greater for 400 or more cumulative revolutions.

P0326 and P0331

- Engine is running for 2 s or greater.
- Engine speed is 8, 500 RPM or less.
- Engine air flow is between 20 - 2000 mg per cylinder.

- The engine coolant temperature (ECT) is -40°C (-40°F) or warmer.
- The intake air temperature (IAT) sensor is -40°C (-40°F) or warmer.

AND

- Engine speed is 500 RPM or greater for 200 or more cumulative revolutions.

OR

- Engine speed is 2000 RPM or greater for 200 or more cumulative revolutions.

OR

- Engine speed is 8500 RPM or greater for 200 or more cumulative revolutions.

P06B6 and P06B7

- Engine is running for 2 s or greater.
- Engine speed is between 400 - 8, 500 RPM for 150 or more cumulative revolutions.
- Engine air flow is between 20 - 2000 mg per cylinder.

The DTCs run continuously when the above conditions are met.

Conditions for Setting the DTCs

P0324

The ECM detects that either knock sensor signal performance is out of the normal calibrated range due to excessive engine knock on a per cylinder basis.

P0326

The ECM detects that the knock sensor 1 signal performance is out of the normal calibrated range due to a low signal level.

P0331

The ECM detects that the knock sensor 2 signal performance is out of the normal calibrated range due to a low signal level.

P06B6 and P06B7

The ECM has detected a fault in the knock sensor processor open circuit diagnostic internal test circuit.

Action Taken When the DTCs Set

- DTCs P0324, P0326, P0331, P06B6, and P06B7 are Type B DTCs.
- The ignition timing is retarded to reduce the potential of engine damaging spark knock.

Conditions for Clearing the DTCs

DTCs P0324, P0326, P0331, P06B6, and P06B7 are Type B DTCs.

Reference Information

Description and Operation

Electronic Ignition System Description

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Circuit/System Verification

1. Engine Running.
2. Verify DTC P0325, P0327, P0328, P0330, P0332, P0333, P06B6, or P06B7 is not set.
 - **If DTC P0325, P0327, P0328, P0330, P0332, or P0333 is set with P06B6 or P06B7**

Refer to [DTC P0325, P0327, P0328, P0330, P0332, or P0333](#) .
 - **If only DTC P06B6 or P06B7 is set**

Replace the K20 Engine Control Module.
 - **Go to next step: If none of the DTCs are set**
3. Ignition OFF.
4. Verify none of the conditions listed below exist:
 - B68 Knock Sensor or wiring harness damage.
 - Incorrect B68 Knock Sensor installation. Refer to [Fastener Specifications](#) .
 - B68 Knock Sensor and engine mounting surface burrs, casting flash, and foreign material.
 - Close proximity of hoses, brackets, and engine wiring.
 - Loose brackets.
 - Loose or broken accessory drive belts, brackets, components.
 - An engine mechanical condition. Refer to [Symptoms - Engine Mechanical](#) .
 - Contaminated or poor quality fuel.
 - **If a condition exists**

Repair or replace as necessary.
 - **Go to next step: If no conditions exist**
5. Operate the vehicle within the conditions for running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
 - **If the DTC sets**

Test or replace the appropriate B68 Knock Sensor.
 - **Go to next step: If the DTC does not set**
6. All OK.

Repair Instructions

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

- [Knock Sensor Replacement \(Sensor 1\)](#) [Knock Sensor Replacement \(Sensor 2\)](#)
 - [Control Module References](#) for engine control module replacement, programming, and setup.
-