

ENGINE PERFORMANCE

Engine Controls and Fuel - 6.2L (LT1) - Diagnostic Information and Procedures - Corvette

DIAGNOSTIC INFORMATION AND PROCEDURES

DTC P0010, P2088 OR P2089

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 P0010

Camshaft Position Actuator Solenoid Valve Control Circuit

DTC P2088

Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage

DTC P2089

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, P2088	P0010, P2089	P0010, P0011, P0016, P0106, P0107, P0690, P2089	P0011
Low Reference	-	P0010, P0011, P2089	-	P0011

Circuit/System Description

The camshaft position (CMP) actuator system enables the engine control module (ECM) to change the timing of the camshaft while the engine is operating. The ECM controls the camshaft position actuator magnet duty cycle by controlling the amount of On time. The magnet controls the amount of

engine oil flow to the CMP actuator by extending a pintle within the solenoid. The pintle acts against a spool valve in the CMP actuator mechanism which is attached to the front of the camshaft. As the spool valve is moved, oil is directed to the CMP actuator, which rotates the camshaft. The ECM can only command the camshaft position actuator to retard the valve timing from the camshaft park position or advance the valve timing back to the park position.

The ECM controls the camshaft position actuator magnet by supplying a 12 V pulse width modulated (PWM) signal. The ECM supplies a ground to the low reference circuit.

Conditions for Running the DTC

- The ignition switch is in the crank or run position.
- The system voltage is between 11-18 V.
- The CMP actuator is command On.
- The DTCs run continuously when the above conditions are met.

Conditions for Setting the DTC

The ECM detects that the commanded state of the driver and the actual state of the control circuit do not match for greater than 5 s.

Action Taken When the DTC Sets

- DTC P0010, P2088 and P2089 are Type B DTCs.
- The camshaft position actuator is commanded to the park position.

Conditions for Clearing the DTC

DTC P0010, P2088 and P2089 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information.

Circuit/System Verification

NOTE: If a crankshaft or camshaft position sensor DTC is set, the scan tool Camshaft Position Actuator output control will not function.

1. Ignition On. Verify that DTC P0335, P0336, P0340 or P0341 is not set.

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

If any of the DTCs are set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** for further diagnosis.

- **If none of the DTCs are set**

2. Verify the scan tool parameters listed below do not display Malfunction:

- Camshaft Position Actuator Solenoid Valve Control Circuit Open Test Status.
- Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage Test Status.
- Camshaft Position Actuator Solenoid Valve Control Circuit High Voltage Test Status.
- **If Malfunction is displayed**

Refer to Circuit/System Testing.

- **If Malfunction is not displayed**

3. Engine idling at normal operating temperature.

4. Verify the scan tool parameters listed below do not display Malfunction when commanding the scan tool Camshaft Position Actuator from 0-25° and back to 0° with a scan tool:

- Camshaft Position Actuator Solenoid Valve Control Circuit Open Test Status.
- Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage Test Status.
- Camshaft Position Actuator Solenoid Valve Control Circuit High Voltage Test Status.

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Refer to Circuit/System Testing.

- **If Malfunction is not displayed**

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

- **If the DTC sets**

Refer to Circuit/System Testing.

- **If the DTC does not set**

6. All OK.

Circuit/System Testing

1. Ignition Off and all vehicle systems Off, disconnect the harness connector at the Q6 Camshaft Position Actuator Solenoid Valve. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 5 ohms between the low reference circuit terminal 1 and ground.
 - **If 5 ohms or greater**
 1. Ignition Off, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for less than 2 ohms in the low reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.
 - **If less than 5 ohms**

NOTE: A test lamp must be used for this test. The control circuit is pulled-up to a low current voltage. The current is too low to illuminate a test lamp. A voltage on the control circuit is normal.

3. Ignition On.
4. Verify that a test lamp does not illuminate between the 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 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.
 - **If the test lamp does not illuminate**
5. Remove the test lamp.
6. Connect the DMM negative lead to the control circuit terminal 2. Connect the DMM positive lead to B+. Set the DMM on the diode setting. Command the Camshaft Position Actuator Solenoid On and Off with a scan tool. The DMM should transition from OL when commanded Off to less

than 1 V when commanded On.

- **If the parameter does not correspond to the specified values**

1. Ignition Off, disconnect the harness connector at the K20 Engine Control Module.
2. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance or short to ground in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.

- **If the parameter corresponds to the specified values**

7. Test or replace the Q6 Camshaft Position Actuator Solenoid Valve and magnet.

Component Testing

Static Test

1. Ignition Off, disconnect the harness connector at the appropriate Q6 Camshaft Position Actuator Solenoid Valve.
2. Test for 5-12 ohms between the control terminal 1 and the low reference terminal 2.
 - **If not between 5-12 ohms**

Replace the Q6 Camshaft Position Actuator Solenoid Valve.

- **If between 5-12 ohms**

3. Test for infinite resistance between each terminal and the Q6 Camshaft Position Actuator Solenoid Valve housing.
 - **If not infinite resistance**

Replace the Q6 Camshaft Position Actuator Solenoid Valve.

- **If infinite resistance**

4. Ignition Off, remove the camshaft position actuator magnet.
5. Test for 5.0-9.0 ohms between the solenoid control terminal 2 and the low reference terminal 1 at the camshaft position actuator magnet.
 - **If not within the specified range**

Replace the camshaft position actuator magnet

- **If within the specified range**

6. Test for infinite resistance between each terminal of the magnet and the magnet housing.
 - **If not within the specified value**

Replace the camshaft position actuator magnet

- **If within the specified value**

Dynamic Test

1. Remove the camshaft position actuator magnet.

NOTE:

- The camshaft position actuator magnet pintle should be facing downward for this test.
- Do not allow electrical current to flow through the camshaft position actuator magnet for greater than 1-2 s.

2. Install a 20 A fused jumper wire between the control circuit terminal 2 and 12 V. Momentarily install a jumper wire between the low reference terminal 1 and ground. The pintle should extend.

- If the function does not perform as specified

Replace the camshaft position actuator magnet

- If the function does perform as specified

3. All OK.

Repair Instructions

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

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- **Control Module References** for K20 Engine Control Module replacement, programming and setup

DTC P0011

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 P0011

Intake Camshaft Position System Performance

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
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Camshaft Position Actuator Solenoid High Control	P0010, P2088	P0010	P0010, P0011, P0016, P0106, P0107, P0690, P2089	P0011
Low Reference	-	P0010, P0011	-	P0011

Circuit/System Description

The camshaft position (CMP) actuator system enables the engine control module (ECM) to change the timing of the camshaft while the engine is operating. The ECM controls the camshaft position actuator magnet duty cycle by controlling the amount of On time. The magnet controls the amount of engine oil flow to the CMP actuator by extending a pintle within the solenoid. The pintle acts against a spool valve in the CMP actuator mechanism which is attached to the front of the camshaft. As the spool valve is moved, oil is directed to the CMP actuator, which rotates the camshaft. The ECM can only command the camshaft position actuator to retard the valve timing from the camshaft park position or advance the valve timing back to the park position.

The ECM controls the camshaft position actuator magnet by supplying a 12 V pulse width modulated (PWM) signal. The ECM supplies a ground to the low reference circuit.

Conditions for Running the DTC

- DTC P0010, P0016, P0335, P0336, P0340 and P0341 is not set.
- The engine is running.
- The system voltage is between 11-32 V.
- The CMP actuator is enabled and commanded greater than 0 degrees.
- The power take off (PTO) is not active - If equipped.
- The desired camshaft position does not vary greater than 7.5 degrees for 2 s.
- DTC P0011 runs continuously when 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 8 degrees for greater than 20 s

Action Taken When the DTC Sets

- DTC P0011 is a Type B DTC.
- The CMP actuator is commanded to the park position.

Conditions for Clearing the DTC

DTC P0011 is a Type B DTC.

Diagnostic Aids

- The engine oil condition has a major impact on the camshaft actuator system.
- A low oil level condition may set this DTC. 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 parameter. Advise the customer an oil change may be required.
- 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

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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

NOTE:

- The engine oil level and the oil pressure are critical to the correct

operation of the camshaft position (CMP) 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. Ignition On.
2. Verify the engine has the correct oil level and correct oil pressure. Refer to **Oil Pressure Diagnosis and Testing**.

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

Repair as necessary

- If the oil level and the oil pressure are correct

NOTE: If a crankshaft or camshaft position sensor DTC is set, the scan tool Camshaft Position Actuator output control will not function.

3. Verify that DTC P0010, P0016, P0335, P0336, P0340, P0341, P0345, P0346, P0365, P0366, P0390 or P0391, is not set.

- If any of the DTCs are set

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

- If none of the DTCs are set

4. Engine idling.
5. Verify the scan tool Desired Camshaft parameter and the Camshaft Position angle parameter match when commanding the Camshaft Position Actuator to 20 degrees with a scan tool.

- If the parameters do not match

Refer to Circuit/System Testing.

- If the parameters match

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.

- **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 Q6 Camshaft Position Actuator Solenoid Valve. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 5 ohms between the low reference circuit terminal 1 and ground.
 - **If 5 ohms or greater**
 1. Ignition Off, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for less than 2 ohms in the low reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.
 - **If less than 5 ohms**

NOTE: **A test lamp must be used for this test. The control circuit is pulled-up to a low current voltage. The current is too low to illuminate a test lamp. A voltage on the control circuit is normal.**

3. Ignition On.
4. Verify that a test lamp does not illuminate between the 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 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.
 - **If the test lamp does not illuminate**
5. Remove the test lamp.
6. Connect the DMM negative lead to the control circuit terminal 2. Connect the DMM positive lead to B+. Set the DMM on the diode setting. Command the Camshaft Position Actuator Solenoid On and Off with a scan tool. The DMM should transition from OL when commanded Off to less than 1 V when commanded On.
 - **If the parameter does not correspond to the specified values**
 1. Ignition Off, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance or short to ground in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.

- **If the parameter corresponds to the specified values**

7. Remove the camshaft position actuator magnet. Perform the . The camshaft position actuator magnet should pass the inspection.

- **If the inspection does not pass**

Replace the camshaft position actuator magnet

- **If the inspection does pass**

8. Perform the **Camshaft Position Actuator and Solenoid Valve Diagnosis and Testing** . The camshaft position actuator solenoid valve should pass the inspection.

- **If the test does not pass**

Replace the camshaft position actuator solenoid valve

- **If the test does pass**

9. Test or replace the Q6 Camshaft Position Actuator Solenoid Valve and magnet.

Component Testing

Static Test

1. Ignition Off, disconnect the harness connector at the appropriate Q6 Camshaft Position Actuator Solenoid Valve.
2. Test for 5-12 ohms between the control terminal 1 and the low reference terminal 2.

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

Replace the Q6 Camshaft Position Actuator Solenoid Valve.

- **If between 5-12 ohms**

3. Test for infinite resistance between each terminal and the Q6 Camshaft Position Actuator Solenoid Valve housing.

- **If not infinite resistance**

Replace the Q6 Camshaft Position Actuator Solenoid Valve.

- **If infinite resistance**

4. Ignition Off, remove the camshaft position actuator magnet.
5. Test for 5.0-9.0 ohms between the solenoid control terminal 2 and the low reference terminal 1 at the camshaft position actuator magnet.

- **If not within the specified range**

Replace the camshaft position actuator magnet

6. Test for infinite resistance between each terminal of the magnet and the magnet housing.

- **If not within the specified value**

Replace the camshaft position actuator magnet

- **If within the specified value**

7. All OK.

Dynamic Test

1. Remove the camshaft position actuator magnet.

NOTE:

- **The camshaft position actuator magnet pintle should be facing downward for this test.**
- **Do not allow electrical current to flow through the camshaft position actuator magnet for greater than 1-2 s.**

2. Install a 20 A fused jumper wire between the control circuit terminal 2 and 12 V. Momentarily install a jumper wire between the low reference terminal 1 and ground. The pintle should extend.

- **If the function does not perform as specified**

Replace the camshaft position actuator magnet

- **If the function does perform as specified**

3. All OK.

Repair Instructions

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

- **Camshaft Position Actuator Cleaning and Inspection**
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- **Control Module References** for K20 Engine Control Module replacement, programming and setup.

DTC P0016

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 P0016

Crankshaft Position - Camshaft Position Not Plausible

Circuit/System Description

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

Conditions for Running the DTC

- Crankshaft and camshaft position signals are synchronized.
- The engine is cranking or running.
- The camshaft position actuator solenoid valve is in the parked position.
- DTC P0335, P0336, P0340 or P0341 is not set.
- Time since last execution of the diagnostic is less than 1 s.

Conditions for Setting the DTC

The ECM detects that 2 camshaft position sensor pulses occur more than 11 crank degrees before or 11 crank degrees after the nominal position in 1 camshaft revolution during 2 out of 3 tests.

Action Taken When the DTC Sets

DTC P0016 is a Type B DTC.

Conditions for Clearing the DTC

DTC P0016 is a Type B DTC.

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

1. Ignition ON.
2. Verify DTC P0335, P0336, P0340 or P0341 is not set.
 - **If any of the DTCs are set**

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

- **If none of the DTCs are set**
3. Engine Running at normal operating temperature.
 4. Verify DTC P0016 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 (if equipped).
 - The correct installation of the Q6 Camshaft Position Actuator Solenoid Valve (if equipped).
 - The correct installation of the B23 Camshaft Position Sensor.
 - 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 or sprockets.
 - A timing chain that jumped teeth.
 - **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.

- **If the DTC does not set**
7. All OK.

Repair Instructions

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

- **Camshaft Position Actuator Cleaning and Inspection**
- **Camshaft Position Actuator Magnet Cleaning and Inspection**
- **Camshaft Position Actuator Solenoid Valve Inspection**
- **Camshaft Position Sensor Replacement**

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- **Camshaft Timing Chain and Sprocket Cleaning and Inspection**
 - **Crankshaft Position Sensor Replacement**

DTC P0030-P0032, P0036-P0038, P0050-P0054, P0056-P0060, P0135, P0141, P0155 OR P0161

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 P0030

HO2S Heater Control Circuit Bank 1 Sensor 1

DTC P0031

HO2S Heater Control Circuit Low Voltage Bank 1 Sensor 1

DTC P0032

HO2S Heater Control Circuit High Voltage Bank 1 Sensor 1

DTC P0036

HO2S Heater Control Circuit Bank 1 Sensor 2

DTC P0037

HO2S Heater Control Circuit Low Voltage Bank 1 Sensor 2

DTC P0038

HO2S Heater Control Circuit High Voltage Bank 1 Sensor 2

DTC P0050

HO2S Heater Control Circuit Bank 2 Sensor 1

DTC P0051

HO2S Heater Control Circuit Low Voltage Bank 2 Sensor 1

DTC P0052

HO2S Heater Control Circuit High Voltage Bank 2 Sensor 1

DTC P0053

HO2S Heater Resistance Bank 1 Sensor 1

DTC P0054

HO2S Heater Resistance Bank 1 Sensor 2

DTC P0056

HO2S Heater Control Circuit Bank 2 Sensor 2

DTC P0057

HO2S Heater Control Circuit Low Voltage Bank 2 Sensor 2

DTC P0058

HO2S Heater Control Circuit High Voltage Bank 2 Sensor 2

DTC P0059

HO2S Heater Resistance Bank 2 Sensor 1

DTC P0060

HO2S Heater Resistance Bank 2 Sensor 2

DTC P0135

HO2S Heater Performance Bank 1 Sensor 1

DTC P0141

HO2S Heater Performance Bank 1 Sensor 2

DTC P0155

HO2S Heater Performance Bank 2 Sensor 1

DTC P0161

HO2S Heater Performance Bank 2 Sensor 2

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
HO2S Heater Ignition Voltage	P0030, P0031, P0036, P0037, P0050, P0051, P0056, P0057, P0102, P0132, P0134, P0135, P0138, P0141, P0152, P0154, P0155, P0158, P0161, P0300, P0443, P0458, P06DA, P3401, P3403, P3425, P3441, P3443, P3449, P3451, *	P0030, P0031, P0036, P0037, P0050, P0051, P0056, P0057, P0132, P0134, P0135, P0138, P0140, P0141, P0152, P0154, P0155, P0157, P0158, P0160, P0161	P0690	P0135, P0141, P0155, P0161
HO2S Heater Control	P0030, P0031, P0036, P0037, P0050, P0051, P0053, P0054, P0056, P0057, P0059,	P0030, P0031, P0036, P0037, P0050, P0051, P0053, P0054, P0056, P0057, P0059, P0060, P0132, P0134, P0135, P0138, P0140, P0141, P0151, P0152,	P0030, P0032, P0036, P0038, P0050, P0052, P0056, P0058, P0132, P0134, P0135, P0138, P0140, P0141,	P0135, P0141, P0155, P0161

	P0135, P0141, P0155, P0161	P0158, P0160, P0161	P0154, P0155, P0157, P0158, P0160, P0161, P0506, P0690	
* Opens Fuse				

Typical Scan Tool Data

HO2S Heater Bank 1 or 2 Sensor 1 or 2

Circuit	Short to Ground	Open	Short to Voltage
Parameter Normal Range: 0.2-1.5 A			
Ignition Voltage	0 A	0 A	0.2-2 A
Low Control	0 A	0 A	0 A

Circuit/System Description

Heated oxygen sensors (HO2S) are used for fuel control and post catalyst monitoring. Each HO2S compares the oxygen content of the surrounding air with the oxygen content in the exhaust stream. The HO2S must reach operating temperature to provide an accurate voltage signal. A heating element inside the HO2S minimizes the time required for the sensors to reach operating temperature. Voltage is provided to the heater by an ignition voltage circuit through a fuse. With the engine running, ground is provided to the heater by the HO2S heater low control circuit through a low side driver within the engine control module (ECM). The ECM uses pulse width modulation (PWM) to control the HO2S heater operation to maintain a specific HO2S operating temperature range.

Conditions for Running the DTC

P0030-P0032, P0036-P0038, P0050-P0052 or P0056-P0058

- The ignition voltage is between 11-32 V.
- The engine speed is greater than 400 RPM.
- The DTCs run continuously when the above conditions are met.

P0053, P0054, P0059 or P0060

- DTCs P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0125, P0128 or P2610 are not set.
- The engine run time is less than 0.4 s.
- The ignition voltage is less than 32 V.
- The ignition is OFF for greater than 8 h.
- The engine coolant temperature (ECT) is between -30 to +45°C (-22 to +113°F) at engine start-

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- The ECT and the intake air temperature (IAT) are within 8°C (14°F) at engine start-up.
 - The DTCs run once per drive cycle when the above conditions are met.

P0135, P0141, P0155 or P0161

- DTCs P0116, P0117, P0118, P0125 or P0128 are not set.
- The ignition voltage is between 10-32 V.
- The HO2S is at operating temperature.
- The HO2S is commanded ON.
- The DTCs run once per drive cycle when the above conditions are met for 120 s.

Conditions for Setting the DTC

P0030, P0036, P0050 or P0056

The engine control module detects an open circuit in the heater output low side driver circuit of the heated oxygen sensor when the heater is commanded OFF for greater than 5 s.

P0031, P0037, P0051 or P0057

The engine control module detects a short to ground in the heater output low side driver circuit of the heated oxygen sensor when the heater is commanded OFF for greater than 5 s.

P0032, P0038, P0052 or P0058

The engine control module detects a short to voltage in the heater output low side driver circuit of the heated oxygen sensor when the heater is commanded ON for greater than 5 s.

P0053, P0054, P0059 or P0060

The engine control module detects the HO2S heater is not within a specified resistance range at engine start-up.

P0135 or P0155

The engine control module detects that the HO2S 1 heater current is greater than 3.1 amps or less than 0.3 amps for greater than 8 s.

P0141 or P0161

The engine control module detects that the HO2S 2 heater current is greater than 2.9 amps or less than 0.3 amps for greater than 8 s.

Action Taken When the DTC Sets

are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0030-P0032, P0036-P0038, P0050-P0054, P0056-P0060, P0135, P0141, P0155 and P0161 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the parameters listed below do not display Malfunction when commanding the HO2S Heater Bank 1 or 2 Sensor 1 or 2 ON and OFF with a scan tool:
 - HO2S Heater Control Circuit Low Voltage Test Status Bank 1 or 2 Sensor 1 or 2
 - HO2S Heater Control Circuit Open Test Status Bank 1 or 2 Sensor 1 or 2
 - HO2S Heater Control Circuit High Voltage Test Status Bank 1 or 2 Sensor 1 or 2
 - **If Malfunction is displayed**

Refer to Circuit/System Testing.
 - **If Malfunction is not displayed**

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

- **If the DTC sets**

Refer to Circuit/System Testing.

- **If the DTC does not set**

5. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the appropriate B52 Heated Oxygen Sensor. Ignition ON.
2. Verify that a test lamp illuminates between the ignition voltage circuit terminal 2 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF, remove the test lamp.
 2. Test for less than 2 ohms in the ignition circuit end to end.
 - 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 illuminate and the circuit fuse is open**
 1. Ignition OFF.
 2. Test for infinite resistance between the ignition circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, test all components connected to the fuse and replace as necessary.
 - **If the test lamp illuminates**
3. Verify that a test lamp does not illuminate between the ignition voltage circuit terminal 2 and the control 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.
 - **If the test lamp does not illuminate**
4. Remove the test lamp.
5. Verify the scan tool HO2S Heater Control Circuit High Voltage Test Status Bank 1 or 2 Sensor 1 or 2 parameter is OK when commanding the HO2S Heater ON with a scan tool.
 - **If the parameter is not OK**
 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.
 - **If the Parameter is OK**

NOTE:

- **Less than 10 ohms of additional resistance on the ignition voltage circuit or control circuit may set a DTC. If there is a resistance on a circuit, the driver will remain ON and the scan tool HO2S High Voltage Test Status parameter will display OK.**
- **Performing this test may set additional DTCs.**

6. Install a 10 A fused jumper wire between the control circuit terminal 1 and the ignition voltage circuit terminal 2.

NOTE:

This test may only be performed once per key cycle. If test is repeated, ignition OFF, allow the engine control module to shut down completely, then ignition ON.

7. Verify the scan tool HO2S Heater Control Circuit High Voltage Test Status Bank 1 or 2 Sensor 1 or 2 parameter is Malfunction when commanding the HO2S Heater ON with a scan tool.
 - **If the Parameter is not Malfunction**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.
 - **If the Parameter is Malfunction**
8. Test or replace the B52 Heated Oxygen Sensor.

Repair Instructions

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

- **Heated Oxygen Sensor Replacement - Bank 1 Sensor 1**
- **Heated Oxygen Sensor Replacement - Bank 1 Sensor 2**
- **Heated Oxygen Sensor Replacement - Bank 2 Sensor 1**
- **Heated Oxygen Sensor Replacement - Bank 2 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 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 air flow based on manifold absolute pressure (MAP) sensor and mass air flow (MAF).

Conditions for Running the DTC

DTC P0068

- The engine speed is greater than 800 RPM.
- The ignition voltage is greater than 6.5 V.
- The DTC runs continuously when the above conditions are met.

DTC P1101

- DTCs P001, P0102, P0103, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0128, P0335 or P0336 are not set
- The engine speed is between 450-5, 400 RPM
- The engine coolant temperature (ECT) is between -7 and +129°C (+19 and +264°F).
- The intake air temperature (IAT) sensor 1 is between -20 and +129°C (-4 to +264°F).
- The DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

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

Action Taken When the DTC Sets

- DTC P0068 is a type A DTC.

-
- DTC P1101 is a type B DTC.

Conditions for Clearing the DTC

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

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Throttle Actuator Control (TAC) System Description

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 or P06A3 is not set.
 - **If any of the DTCs are set**

Refer to **DTC P0641, P0651, P0697 or P06A3** for further diagnosis.

- **If none of the DTCs are set**

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

- **90 % or greater**

Refer to **Throttle Body Cleaning** .

- **If less than 90 %**

4. 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.

- **If Agree**

5. Determine the current vehicle testing altitude.

6. 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.

- **If the MAP Sensor parameter is in range**

7. 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** for further diagnosis.

- **The MAF Sensor parameter changes smoothly and gradually**

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

9. Verify the DTC does not set.

- **If the DTC sets**

- If the DTC does not set.

10. 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
 - 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
 - Improper operation of the crankcase ventilation system-Refer to **Crankcase Ventilation System Inspection/Diagnosis** for further diagnosis.
 - 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.

- 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.

- 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, P228C OR P228D

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 P228C

Fuel Pressure Regulator Control Performance - Low Pressure

DTC P228D

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 under the intake manifold 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 to 15 MPa (290 to 2,176 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 21.5 MPa (3,118 psi).

The fuel rail pressure sensor is a dual analog sensor that 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

- DTCs P0010, P0011, P0016, P0089, P0090, P0091, P0092, P0096, P0097, P0098, P0099, P00C8, P00C9, P00CA, P0117, P0118, P0178, P0179, P018B, P018C, P018D, P0191, P0192, P0193, P0231, P0232, P023F, P0335, P0336, P0340, P0341 or P1682 are not present.
- Fuel rail pressure is greater than 0.275 MPa (40 psi).
- Battery voltage is greater than 11 V.
- Fuel temperature is between -10°C (14°F) and 100°C (212°F).
- Intake air temperature is greater than -10°C (14°F).
- The engine has been running for greater than 2 m.
- Barometer pressure is greater than 70 kPa.
- Vehicle is not in a low fuel state.
- The DTCs run continuously when the above conditions are met.

Conditions for Setting the DTC

P0089

- The high pressure fuel pump has exceeded the control limits. This condition exists when the high pressure fuel pump actuator command is 0° or greater than 130°.
- The above condition exists for 750 out of 938 counts, approximately 30 seconds at idle or 7 seconds at 2, 700 RPM.

P228C

- The fuel rail pressure is greater than 3.00 MPa (435 psi) below the desired fuel rail pressure.
- The above condition exists for 750 out of 938 counts, approximately 30 seconds at idle or 7 seconds at 2, 700 RPM.

P228D

- The fuel rail pressure is greater than 3.00 MPa (435 psi) above the desired fuel rail pressure.
- The above condition exists for 750 out of 938 counts, approximately 30 seconds at idle or 7 seconds at 2, 700 RPM.

Action Taken When the DTC Sets

DTC P0089 is a Type B DTC.

DTCs P228C and P228D are Type A DTCs.

Conditions for Clearing the DTC

DTC P0089 is a Type B DTC.

DTCs P228C and P228D are Type A DTCs.

Diagnostic Aids

- A leak in the high pressure fuel system may set a DTC.
- 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 high pressure fuel pump and the fuel rail pressure sensor may set a DTC.
- 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 leaking or restricted fuel injector may set the DTC.
- As little as 2 ohms on either circuit of the high pressure fuel pump solenoid will cause a DTC to set. Test the circuits of the high pressure fuel pump solenoid for a high resistance if you suspect a condition.
- Vapor lock may set DTC P0089

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Fuel System Description

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify DTC P0010, P0011, P0016, P0090, P0091, P0092, P00C8, P00C9, P00CA, P018B, P018C, P018D, P0191, P0192, P0193, P0231, P0232, P023F, P0335, P0336, P0340, P0341, P127C, P127D or P163A are not set.

- **If the DTC is set**

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

- **If the DTC is not set**

3. Engine at idle.
 4. Verify the Fuel Rail Pressure Sensor parameter is between 1.9-6.0 MPa (276-870 psi).
- **If not between 1.9-6.0 MPa (276-870 psi)**

Refer to Circuit/System Testing.

- **If between 1.9-6.0 MPa (276-870 psi)**

5. Verify the scan tool Fuel Rail Pressure parameter increases or decreases while commanding an increase and decrease in Fuel Rail Pressure with a scan tool.

- **If the pressure does not increase or decrease with each command**

Refer to Circuit/System Testing.

- **If the pressure increases or decreases with each command**

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.

6. Verify the scan tool Fuel Pressure Sensor parameter does not drop off during acceleration, cruise or hard cornering.

- **If the pressure drops off**

Refer to **Fuel System Diagnosis** .

- **If the pressure does not drop off**

7. 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 5, 600 RPM. Repeat the test at least three times.
8. Verify DTC P0089, P228C or P228D is not set.

- **If the DTC is set**

Refer to Circuit/System Testing.

- **If the DTC is not set**

9. 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.
10. Verify DTC P0089, P228C or P228D is not set.

- **If the DTC is set**

Refer to Circuit/System Testing.

- **If the DTC is not set**

11. 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. Disconnect the harness connector at the G18 High Pressure Fuel Pump.
3. Test for less than 2 ohms between G18 High Pressure Fuel Pump connector terminal 2 and the K20 Engine Control Module high control circuit terminal 16.

- **If greater than 2 ohms**

Repair the high resistance in the circuit.

- **If 2 ohms or less**

4. Test for less than 2 ohms between the G18 High Pressure Fuel Pump connector terminal 1 and the K20 Engine Control Module high control circuit terminal 32.

- **If greater than 2 ohms**

Repair the high resistance in the circuit.

- **If 2 ohms or less**

5. Remove the G18 High Pressure Fuel Pump.
6. Verify the lobes on the camshaft does not have unusual wear or are worn.

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

Replace the Camshaft.

- **If the lobes do not have unusual wear or are not worn**

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

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 ohms in order to prevent misdiagnosis.

2. Test for 0.34 - 0.44 ohms at 20°C (68°F) between the low control circuit terminal 1 and the high control circuit terminal 2.

- If not within the specified range

Replace the G18 High Pressure Fuel Pump.

- If within the specified range

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.

- If infinite resistance

4. All OK.

Repair Instructions

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

- **Camshaft Replacement**
- **Fuel Pump Removal** for G18 High Pressure Fuel Pump replacement.

NOTE: Some vehicles do not support the Fuel Rail Pressure Relief Valve Reset procedure. Applications not supporting this procedure will return an error message stating "Parameter ID not supported. Check for proper vehicle selection."

- Perform the Fuel Rail Pressure Relief Valve Reset procedure.

DTC P0090-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 Open

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 Control	P0091, P00C9	P0090, P00C8	P0092, P00C9, P00CA, P0690	P0089. P226C. P226D
Low Control	P0091, P00C9	P0090, P00C8	P0092, P00C9, P00CA, P0690	P0089. P226C. P226D

Circuit/System Description

High pressure fuel is regulated by the high pressure fuel pump actuator solenoid valve, which is a part of the high pressure fuel pump. The engine control module (ECM) provides battery voltage on the solenoid high control circuit and ground on the solenoid low control circuit. Both circuits are controlled through output drivers within the ECM. When deactivated, both drivers are disabled. When activated, the high control circuit driver energizes the high pressure fuel pump solenoid and the low control circuit driver pulse-width modulates (PWM) the low control circuit to ground. The ECM monitors the voltage on the circuits to detect a failure.

Conditions for Running the DTC

- DTCs P0010, P0011, P0016, P0089, P0090, P0091, P0092, P0096, P0097, P0098, P0099, P00C8, P00C9, P00CA, P0117, P0118, P0178, P0179, P018B, P018C, P018D, P0192, P0193, P0231, P0232, P023F, P0335, P0336, P0340, P0341 or P1682 are not present.
- 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 engine control module 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 engine control module 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 engine control module 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 engine control module 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 engine control module 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 engine control module 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.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

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Fuel System Description

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify DTCs P0090, P0091, P0092, P00C8, P00C9 and P00CA is not set.
 - **If any of the DTCs are set**

Refer to Circuit/System Testing.

- **If none of the DTCs are set**

3. Engine at idle.
4. Verify the parameters listed below do not display Malfunction when commanding an increase and decrease in Fuel Rail Pressure with a scan tool:
 - Fuel Pressure Regulator Control Circuit Low Voltage Test Status
 - Fuel Pressure Regulator Control Circuit Open Test Status
 - Fuel Pressure Regulator Control Circuit High Voltage Test Status
 - Fuel Pressure Regulator High Control Circuit Low Voltage Test Status
 - Fuel Pressure Regulator High Control Circuit Open Test Status
 - Fuel Pressure Regulator High Control Circuit High Voltage Test Status
- **If Malfunction is displayed**

Refer to Circuit/System Testing.

- **If Malfunction is not displayed**

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.

- **If the DTC does not set**

7. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the G18 High Pressure Fuel Pump, ignition ON.
2. Verify that a test lamp does not illuminate between the high control circuit terminal 2 and ground.
 - **If the test lamp illuminates**
 1. Ignition OFF, remove the test lamp, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
 2. Test for less than 1 V between the high 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.
 - **If the test lamp does not illuminate**
3. Verify that a test lamp does not illuminate between the low control circuit terminal 1 and ground.

-
1. Ignition OFF, remove the test lamp, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
 2. Test for less than 1 V between the low 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.
 - **If the test lamp does not illuminate**
 4. Verify that a test lamp does not illuminate between the high control circuit terminal 2 and B+.
 - **If the test lamp illuminates**
 1. Ignition OFF, remove the test lamp, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the high 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.
 - **If the test lamp does not illuminate**
 5. Verify that a test lamp does not illuminate between the low control circuit terminal 1 and B+.
 - **If the test lamp illuminates**
 1. Ignition OFF, remove the test lamp, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the low 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.
 - **If the test lamp does not illuminate**
 6. Remove the test lamp, connect a 3 A fused jumper wire between the high control circuit terminal 2 and ground.
 7. Verify the Fuel Pressure Regulator High Control Circuit Low Voltage Test Status transitions from OK to Malfunction.
 - **If Malfunction is not displayed**
 1. Ignition OFF, remove the fused jumper, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for less than 2 ohms in the high control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.
 - **If Malfunction is displayed**
 8. Connect a 3 A fused jumper wire between the low control circuit terminal 1 and B+.
 9. Verify the Fuel Pressure Regulator Control Circuit High Voltage Test Status transitions from OK to Malfunction.
 - **If Malfunction is not displayed**
 1. Ignition OFF, remove the fused jumper, disconnect the harness connector at the K20 Engine Control Module.

2. Test for less than 2 ohms in the low control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.
 - **If Malfunction is displayed**

10. 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 ohms in order to prevent misdiagnosis.

2. Test for 0.34 - 0.44 ohms at 20°C (68°F) between the low control circuit terminal 1 and the high control circuit terminal 2.

- **If not within the specified range**

Replace the G18 High Pressure Fuel Pump.

- **If within the specified range**

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.

- **If infinite resistance**

4. All OK.

Repair Instructions

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

- **Fuel Pump Removal** for G18 High Pressure Fuel Pump replacement.
- **Control Module References** for K20 Engine Control Module replacement, programming and setup.

NOTE: Some vehicles do not support the Fuel Rail Pressure Relief Valve Reset procedure. Applications not supporting this procedure will return an error message stating "Parameter ID not supported. Check for proper vehicle selection."

- Perform the Fuel Rail Pressure Relief Valve Reset procedure.

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 Descriptors

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	P0113, P0114, P2199*	P0111, P2199
Low Reference	-	P0111, P0113, P0114, P2199, P2229, P2230	P0113, P0114, P2199, P2227, P2229*	-

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

IAT Sensor 2

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition Voltage	P0096, P0097, P00F4, P0102, P0178, P2199	P0096, P0097, P00F4, P0101, P0102, P2199, P2230	P0690	P0096, P0101, P0103
Signal	P0096, P0097, P00F5, P2199	P0096, P0097, P00F4, P2199	P0096, P0097, P00F4, P2199*	P0096

Ground	-	P00F4, P0102, P2199	-	P0096, P0102
*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	150°C (302°F)	-40°C (-40°F)	-40°C (-40°F)*
Low Reference	-	-40°C (-40°F)	-40°C (-40°F)*
*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			
Ignition Voltage	-40°C (-40°F) 10 Hz	-40°C (-40°F) 10 Hz	-
Signal	-40°C (-40°F) 10 Hz	-40°C (-40°F) 10 Hz	-40°C (-40°F)* 10 Hz
Ground	-	-40°C (-40°F) 10 Hz	-
*Internal ECM or sensor damage may occur if the circuit is shorted to B+.			

ECT Sensor

Circuit	Short to Ground	Open or High Resistance	Short to Voltage
Operating Conditions: Engine Running Parameter Normal Range: Varies with coolant temperature			
Signal	150°C (302°F)	-40°C (-40°F)	-40°C (-40°F)*
Low Reference	-	-40°C (-40°F)	-40°C (-40°F)*
*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

- MAF sensor
- BARO pressure sensor

The intake air temperature (IAT) sensor 1 is a variable resistor that changes the voltage on the engine control module (ECM) supplied 5 V signal circuit. The signal varies with inlet air temperature in the sensor bore and is displayed by the scan tool as °C (°F). The IAT sensor 2 and the humidity sensor share the same circuit. The IAT sensor 2 signal is displayed by the scan tool as Hertz (Hz) and °C (°F).

The sensors listed below share an ECM supplied 5 V reference circuit:

- IAT sensor 2
- Humidity sensor
- Barometric pressure (BARO) sensor

The sensors listed below share an ECM supplied low reference circuit:

- IAT sensor 1
- IAT sensor 2
- Humidity sensor
- Barometric pressure (BARO) 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	45 Hz	-40°C (-40°F)
Warm	302 Hz	104°C (219°F)

Conditions for Running the DTCs

P0096 and P0111

- DTCs P0097, P0098, P0112, P0113, P0117, P0118, P0119 or P1682 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 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°C (45°F).

AND

- The absolute difference between ECT start-up temperature and the IAT sensor 2 start-up temperature is greater than the absolute difference between ECT start-up temperature and the IAT sensor 1 start-up temperature.
- This DTC runs once per ignition cycle when the enabling conditions 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°C (45°F).

AND

- The absolute difference between ECT start-up temperature and the IAT sensor 1 start-up temperature is greater than the absolute difference between ECT start-up temperature and the IAT sensor 2 start-up temperature.
- This DTC runs once per ignition cycle when the enabling conditions are met.

Action Taken When the DTCs Set

DTCs P0096 and P0111 are Type B DTCs.

Conditions for Clearing the DTCs

DTCs P0096 and P0111 are Type B DTCs.

Diagnostic Aids

- With the ignition ON, when the engine is OFF and cold; properly functioning IAT sensors 1 and 2 will gradually increase the scan tool IAT Sensor 1 and 2 parameters. This is due to the heat that is generated by the multifunction intake air sensor internal 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 Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Throttle Actuator Control (TAC) System Description

Electrical Information Reference

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

Powertrain Component Views

Powertrain Component Views

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-38522-A Variable Signal Generator

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

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 25°C (45°F) of each other.
 - Start-Up IAT Sensor 1
 - Start-Up IAT Sensor 2
 - Start-Up ECT

Refer to Circuit/System Testing.

- **If within 25°C (45°F)**

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

- IAT Sensor 1
- IAT Sensor 2
- ECT Sensor

- **If not between: -38 and +149°C (-36 and +300°F)**

Refer to Circuit/System Testing.

- **If between: -38 and +149°C (-36 and +300°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 DTCs do not set.
 - **If any DTC sets**

Refer to Circuit/System Testing.

- **If no DTC sets**

6. All OK

Circuit/System Testing

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

1. Verify none of the following conditions exist:
 - 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.

- **If no condition exists**

2. Ignition OFF and all systems OFF, it may take up to for 2 minutes for all vehicle systems to

power down. Disconnect the harness connector at the B75C Multifunction Intake Air sensor.

3. Test for less than 2 ohms between the low reference circuit terminal 3 and ground.
 - **If 2 ohms or greater**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for less than 2 ohms in the low reference circuit end to end.
 - If 2 ohms or greater, repair the open or high resistance in the circuit.
 - If less than 2 ohms replace the K20 Engine Control Module.
 - **If less than 2 ohms**
4. Ignition OFF, all vehicle systems OFF, test for less than 2 ohms between the ground circuit terminal 7 and ground.
 - **If 2 ohms or greater**
 1. Ignition OFF. Disconnect the sensor chassis ground.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open or high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 2 ohms**
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 ohms in the ignition voltage circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, 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
 3. Test for greater than 2 ohms between the ignition voltage circuit terminal 5 and ground.
 - If less than 2 ohms, repair the short to ground on the circuit.
 - If greater than 2 ohms, test all the components connected to the circuit and repair or replace as necessary.
 - **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.

- If infinite resistance
- 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, 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.
- **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.
 - If infinite resistance
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.
 - **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.
 - If less than 1 V
 3. Ignition OFF.
 4. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.
 - **If warmer than 148°C (298°F).**

-
10. Ignition ON, test for 4.8-5.2 V between the intake air temperature signal 2 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.
 - If infinite resistance
3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, 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.

- **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.

- **If no DTCs set**

4. All OK.

- **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.

- **If between 28-32 Hz**
15. 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 table values.**

Replace the B75C Multifunction Intake Air sensor.

- **If within the table values.**

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 5%**

Replace the B75C Multifunction Intake Air sensor.

- **If within 5%**

2. 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 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

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition Voltage	P0096, P0097, P00F4, P0102, P0178, P2199	P0096, P0097, P00F4, P0101, P0102, P2199, P2230	P0690	P0096, P0101, P0103
Signal	P0096, P0097, P00F5, P2199	P0096, P0097, P00F4, P2199	P0096, P0097, P00F4, P2199*	P0096
Ground	-	P0096, P0097, P00F4, P0102, P2199, P2230	-	P0096, P0102

*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			
Ignition Voltage	-40°C (-40°F) 10 Hz	-40°C (-40°F) 10 Hz	-
Signal	-40°C (-40°F) 10 Hz	-40°C (-40°F) 10 Hz	-40°C (-40°F)* 10 Hz
Ground	-	-40°C (-40°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 mass air flow/multifunction intake air sensor:

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

The IAT sensor 2 and the humidity sensor share the same circuit. The IAT sensor 2 signal is displayed by the scan tool as Hertz (Hz) and °C (°F).

The sensors listed below share an ECM supplied 5 V reference circuit:

- IAT sensor 2
- Humidity sensor
- Barometric pressure (BARO) sensor

The sensors listed below share an ECM supplied low reference circuit:

- IAT sensor 1
- IAT sensor 2
- Humidity sensor
- Barometric pressure (BARO) 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	45 Hz	-40°C (-40°F)
Warm	302 Hz	104°C (219°F)

Conditions for Running the DTCs

P0097, P0098 and P0099

- The ignition is ON or the engine is running.
- The Ignition voltage is at least 11 V.
- 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°C (-40 and +302°F).

The ECM detects that the IAT sensor 2 signal is less than 13 Hz, colder than -60°C (-76°F), for greater than 5 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 5 s.

P0099

The ECM detects that the IAT sensor 2 signal is intermittent or has abruptly changed for longer than 5 s.

Action Taken When the DTC Sets

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

Conditions for Clearing the MIL/DTC

DTCs P0097, P0098 and P0099 are Type B DTCs.

Diagnostic Aids

- With the ignition ON, the engine OFF and 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 Schematics

Connector End View Reference

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

Powertrain Component Views

Powertrain Component Views

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-38522-A Variable Signal Generator

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

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 25°C (45°F) of each other.
 - Start-Up IAT Sensor 1
 - Start-Up IAT Sensor 2
 - Start-Up ECT
 - **If not within 25°C (45°F)**

Refer to Circuit/System Testing.

- **If within 25°C (45°F)**

3. Engine idling, verify the following scan tool parameters are between: between -38 and +149°C (-36 and +300°F).
 - IAT Sensor 1
 - IAT Sensor 2
 - ECT Sensor
 - **If not between: -38 and +149°C (-36 and +300°F)**

Refer to Circuit System Testing.

- **If between: -38 and +149°C (-36 and +300°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 DTCs do not set.
 - **If any DTC sets**

Refer to Circuit/System Testing.

- **If no DTC sets**

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 systems OFF, it may take up to for 2 minutes for all vehicle systems to power down. Disconnect the harness connector at the B75C Multifunction Intake Air sensor.
2. Ignition OFF, all vehicle systems OFF, test for less than 2 ohms between the ground circuit terminal 7 and ground.

-
- **If 2 ohms or greater**
 1. Ignition OFF. Disconnect the sensor chassis ground.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open or high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 2 ohms**
 - 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 ohms in the ignition voltage circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, 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
 3. Test for greater than 2 ohms between the ignition voltage circuit terminal 5 and ground.
 - If less than 2 ohms, repair the short to ground on the circuit.
 - If greater than 2 ohms, test all the components connected to the circuit and repair or replace as necessary.
 - **If a test lamp illuminates**
 - 4. 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.
 - If infinite resistance
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, 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.
 - **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.
 - **If no DTCs set**
 - 4. All OK.
 - **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 8 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
 - Duty Cycle switch to 50 % (Normal)
 - Frequency switch to 30 Hz
 8. Ignition ON, observe the scan tool IAT Sensor 2 parameter. The scan tool parameter should be between 28-32 Hz.
 - **If not between 28-32 Hz**

Replace the K20 Engine Control Module.
 - **If between 28-32 Hz**
 9. 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 readings with the scan tool IAT Sensor 2 parameter. The values should be within 5%.

- **If not within 5%**

Replace the B75C Multifunction Intake Air sensor.

- **If within 5%**

2. 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 P00C6

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 P00C6

Fuel Rail Pressure Low During Engine Cranking

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
High Pressure Fuel Pump Actuator High Control	P0091, P00C9	P0090, P00C8	P0092, P00C9, P00CA, P0690	-
High Pressure Fuel Pump Actuator Low Control	P0091, P00C9	P0090, P00C8	P0092, P00C9, P00CA, P0690	-

Circuit/System Description

High pressure fuel is regulated by the high pressure fuel pump actuator, which is a part of the high

module (ECM) provides battery voltage on the solenoid high control circuit and ground on the solenoid low control circuit. Both circuits are controlled through output drivers within the ECM. When deactivated, both drivers are disabled. When activated, the high control circuit driver energizes the high pressure fuel pump solenoid and the low control circuit driver pulse-width modulates (PWM) the low control circuit to ground. Before the engine is started the engine control module determines fuel rail pressure and engine coolant temperature (ECT) before the engine is cranked. If the fuel rail pressure is less than the target set point before the engine is cranked, the Pressure Rise Diagnostic is used. If the fuel rail pressure is greater than the target set point before the engine is cranked, the Pressure Fall Diagnostic is used. If the fuel rail pressure does not match the target set point in a calibrated time the DTC may set.

Conditions for Running the DTC

P00C6

- DTCs P0010, P0011, P0016, P0089, P0090, P0091, P0092, P0096, P0097, P0098, P0099, P00C8, P00C9, P00CA, P0117, P0118, P0178, P0179, P018B, P018C, P018D, P0191, P0192, P0193, P0231, P0232, P023F, P0335, P0336, P0340, P0341 or P1682 are not present.
- Run/Crank voltage is greater than 8 V.
- Engine coolant temperature is between -100°C (-148°F) and 65°C (149°F).
- Low side fuel pressure is greater than 0 kPa (0 psi).
- Engine is not running
- Vehicle is not in a low fuel condition
- Barometric pressure is greater than 70.0 kPa
- Intake air temperature is greater the -10°C (14°F)
- The DTC runs once for each engine start.

Conditions for Setting the DTC

Condition 1

- If the fuel rail pressure 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 pressure has not increased to the target set point within 10 seconds at -10°C (14°F) ECT or within 5 seconds if ECT is greater than 0°C (32°F).

Condition 2

- If the fuel rail pressure 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 has dropped below 2 MPa (290 psi) for 10 engine cycles if the ECT is less than -10°C (14°F) or 0.6 MPa (87 psi) for 10 engine cycle if the ECT is between -10°C (14°F) and 16°C (60°F) and 0.45 MPa (65 psi) for 10 cycles if ECT is greater than 16°C (60°F).

The above conditions must occur for two consecutive starts for the DTC to set.

Action Taken When the DTC Sets

DTC P00C6 is a Type B DTC

Conditions for Clearing the DTC

DTC P00C6 is a Type B DTC

Diagnostic Aids

- A restricted fuel feed pipe between the fuel feed pipe fuel pressure sensor and the high pressure fuel pump may set a DTC.
- A condition with the fuel tank fuel pump module or the fuel pump driver control module may set a DTC.
- A skewed fuel rail pressure sensor or an intermittent condition in the fuel rail pressure sensor circuits may set a DTC.
- A leaking or restricted fuel injector may set a DTC.
- A short to voltage in the crankshaft position signal circuit may set a DTC.
- A short to voltage in the camshaft position actuator solenoid valve control circuit may set a DTC.
- A stuck camshaft position actuator may cause the fuel pump synchronization logic to fail and set DTC P00C6.

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Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE: If vehicle is a no start, refer to **Engine Cranks But Does Not Run** .

1. Ignition ON.
2. Verify DTCs P0010, P0011, P0016, P0089, P0090, P0091, P0092, P0096, P0097, P0098, P0099, P00C8, P00C9, P00CA, P0117, P0118, P0178, P0179, P018B, P018C, P018D, P0191, P0192, P0193, P0231, P0232, P023F, P0335, P0336, P0340, P0341, P1682 are not present.

- If any of the DTCs are set

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

- If none of the DTCs are set

3. Verify the scan tool Fuel Pressure Sensor parameter is between 320-608 kPa (46-88 psi) while commanding the Fuel Pump Enable ON several times with a scan tool.

- If less than 320 kPa (46 psi)

Refer to **Fuel System Diagnosis**

- If greater than 690 kPa (100 psi)

Replace the G12 Fuel Pump.

- If between 320-608 kPa (46-88 psi)

NOTE: The fuel pressure may vary slightly when the fuel pump stops operating. After the fuel pump stops operating, the fuel pressure should stabilize and remain constant.

4. Verify that the fuel pressure decreases to 468-544 kPa (68-79 psi) after the fuel pump is turned off.

- If the fuel pressure does not decrease to 468-544 kPa (68-79 psi)

Replace the G12 Fuel Pump.

- If the fuel pressure decreases to 468-544 kPa (68-79 psi)

5. Verify DTC P00C6 is not set.

- **If the DTC is set**

Refer to Circuit/System Testing.

- **If the DTC is not set**

6. Engine at idle.

7. Verify the parameters listed below do not display Malfunction when commanding an increase and decrease in Fuel Rail Pressure with a scan tool:

- Fuel Pressure Regulator Control Circuit Low Voltage Test Status
- Fuel Pressure Regulator Control Circuit Open Test Status
- Fuel Pressure Regulator Control Circuit High Voltage Test Status
- Fuel Pressure Regulator High Control Circuit Low Voltage Test Status
- Fuel Pressure Regulator High Control Circuit Open Test Status
- Fuel Pressure Regulator High Control Circuit High Voltage Test Status

- **If Malfunction is displayed**

Refer to Circuit/System Testing.

- **If Malfunction is not displayed**

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

9. Verify the DTC does not set.

- **If the DTC sets**

Refer to Circuit/System Testing.

- **If the DTC does not set**

10. All OK.

Circuit/System Testing

1. Clear the DTCs.

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.

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

2. 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 6, 000 RPM. Repeat the test at least three times.

3. Verify the scan tool Fuel Rail Pressure Sensor parameter displays between 14-17 MPa (2, 031-2, 466 psi) while the engine speed is near 5, 600 RPM.

- **If not between 14-17 MPa (2, 031-2, 466 psi)**

Replace the G18 High Pressure Fuel Pump.

- **If between 14-17 MPa (2, 031-2, 466 psi)**

4. Ignition OFF, disconnect the harness connector at the G18 High Pressure Fuel Pump, ignition ON.

5. Verify that a test lamp does not illuminate between the high control circuit terminal 2 and ground.

- **If the test lamp illuminates**

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

2. Test for less than 1 V between the high 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.

- **If the test lamp does not illuminate**

6. Verify that a test lamp does not illuminate between the low control circuit terminal 1 and ground.

- **If the test lamp illuminates**

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

2. Test for less than 1 V between the low 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.

- **If the test lamp does not illuminate**

7. Verify that a test lamp does not illuminate between the high control circuit terminal 2 and B+.

- **If the test lamp illuminates**

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

2. Test for infinite resistance between the high 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.

- **If the test lamp does not illuminate**

8. Verify that a test lamp does not illuminate between the low control circuit terminal 1 and B+.

- **If the test lamp illuminates**

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

2. Test for infinite resistance between the low 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.
 - **If the test lamp does not illuminate**
9. Remove the test lamp, connect a 3 A fused jumper wire between the high control circuit terminal 2 and ground.
 10. Verify the Fuel Pressure Regulator High Control Circuit Low Voltage Test Status transitions from OK to Malfunction.
 - **If Malfunction is not displayed**
 1. Ignition OFF, remove the fused jumper, disconnect the harness connector X3 at the K20 Engine Control Module.
 2. Test for less than 2 ohms in the high control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.
 - **If Malfunction is displayed**
 11. Connect a 3 A fused jumper wire between the low control circuit terminal 2 and B+.
 12. Verify the Fuel Pressure Regulator Control Circuit High Voltage Test Status transitions from OK to Malfunction.
 - **If Malfunction is not displayed**
 1. Ignition OFF, remove the fused jumper, disconnect the harness connector X3 at the K20 Engine Control Module.
 2. Test for less than 2 ohms in the low control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.
 - **If Malfunction is displayed**
 13. Verify none of the conditions listed below exist:
 - Restricted fuel feed pipe
 - Restricted or plugged strainer
 - Poor connections at the high pressure fuel pump solenoid
 - **If a condition exist**

Repair as necessary.
 - **If a condition does not exist**
 14. 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 ohms in order to prevent

misdiagnosis.

2. Test for 0.34 - 0.44 ohms at 20°C (68°F) between the low control circuit terminal 1 and the high control circuit terminal 2.

- **If not within the specified range**

Replace the G18 High Pressure Fuel Pump.

- **If within the specified range**

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.

- **If infinite resistance**

4. All OK.

Repair Instructions

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

- **Fuel Feed Pipe Replacement**
- **Fuel Feed Intermediate Pipe Replacement - Position 1**
- **Fuel Feed Intermediate Pipe Replacement - Position 2**
- **Fuel Pump Removal** for G18 High Pressure Fuel Pump replacement.
- **Fuel Tank Fuel Pump Module Replacement** for G12 Fuel Pump replacement.
- **Control Module References** for K20 Engine Control Module replacement, programming and setup.

DTC P00F4-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

Intake Air Humidity Sensor Circuit High Voltage

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, P0102, P00F4, P0178, P2199	P0096, P0097, P0101, P0102, P00F4, P2199	P0690	P0096, P0101, P0103
Signal	P0096, P0097, P00F5, P2199	P0096, P0097, P00F4, P2199	P0096, P0097, P00F4, P2199*	P0096
Ground	-	P0096, P0097, P0102, P00F4, P2199, P2230	-	P0096, P0102

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

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	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 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 ECM applies 5 V to the circuit. The signal circuit is shared by the humidity sensor and the intake air temperature (IAT) sensor

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

Conditions for Running the DTCs

P00F4, P00F5 and P00F6

- DTC P1682 is not set.
- The ignition is ON.
- The ignition voltage is at least 11 V.
- 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 5 s.

P00F5

The ECM detects that the humidity sensor signal is greater than or equal to 95 % for greater than 5 s.

P00F6

The ECM detects that the humidity sensor signal is intermittent or has abruptly changed over a period of time greater than 5 s.

Action Taken When the DTC Sets

DTCs P00F4, P00F5, P00F6 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P00F4, P00F5, P00F6 are Type B DTCs.

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.
- 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.

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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 (Diagnostic 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 25°C (45°F) of each other.
 - Start-Up IAT Sensor 1
 - Start-Up IAT Sensor 2
 - Start-Up ECT
 - **If not within 25°C (45°F)**

Refer to Circuit/System Testing.

- **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.

- **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 DTCs do not set.
 - **If any DTC sets**

Refer to Circuit/System Testing.

- **If no DTCs set**
6. All OK

Circuit/System Testing

1. Ignition OFF and all systems OFF, it may take up to for 2 minutes for all vehicle systems to power down. Disconnect the harness connector at the B75C Multifunction Intake Air sensor.
2. Test for less than 2 ohms between the low reference circuit terminal 3 and ground.
 - **If 2 ohms or greater**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for less than 2 ohms in the low reference circuit end to end.
 - If 2 ohms or greater, repair the open or high resistance in the circuit.
 - If less than 2 ohms replace the K20 Engine Control Module.

-
- **If less than 2 ohms**
 - 3. Ignition OFF, all vehicle systems OFF, test for less than 2 ohms between the ground circuit terminal 7 and ground.
 - **If 2 ohms or greater**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open or high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 2 ohms**
 - 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 ohms in the ignition voltage circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, 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
 3. Test for greater than 2 ohms between the ignition voltage circuit terminal 5 and ground.
 - If less than 2 ohms, repair the short to ground on the circuit.
 - If greater than 2 ohms, test all the components connected to the circuit and repair or replace as necessary.
 - **If a test lamp illuminates**
 - 5. Ignition ON, test for 4.8-5.2 V between the humidity 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.
 - If infinite resistance
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, 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.
 - **If between 4.8-5.2 V**
6. 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.
 - **If no DTCs set**
 - **EL-38522-A, Variable Signal Generator; or equivalent is available**
4. All OK.
7. 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+
8. Set the **EL-38522-A** Variable Signal Generator to the following specifications.
 - Signal switch to 5 V
 - Frequency switch to 250 Hz
 - Duty Cycle switch to 50 % (Normal)
9. Ignition ON, observe the scan tool Intake Air Humidity parameter. The scan tool parameter should be between 45-55 %.
 - **If not between 45-55 %.**

Replace the K20 Engine Control Module.
 - **If between 45-55 %.**
10. Test or replace the B75C Multifunction Intake Air 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 5-95% or the parameter does not change.**

Replace the K20 Engine Control Module.

- **If within 5-95% and the parameter does change**

2. 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 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 Descriptor

DTC P0101

Mass Air Flow (MAF) Sensor Performance

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition Voltage	P0096, P0097, P00F4, P0102, P0178, P2199	P0096, P0097, P00F4, P0101, P0102, P2199	P0690	P0096, P0101, P0103
Signal	P0102	P0102	P0102*	P0101, P0103, P1101
Ground	-	P0096, P0097, P00F4, P0102, P2199	-	P0096, P0102

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

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

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 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

- DTCs P001, P0102, P0103, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0128, P0335 or P0336 are not set
- The engine speed is between 450 and 5, 400 RPM.
- The engine coolant temperature (ECT) is between -7 and +129°C (+19 and +264°F).
- The intake air temperature (IAT Sensor 1) is between -20 and +129°C (-4 and +264°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 air flow from the MAF, MAP and throttle position sensors is not within range of the calculated air flow 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 air flow 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.

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Control Module References for scan tool information

Special Tools

EL-38522-A Variable Signal Generator

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

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 **DTC P0641, P0651, P0697 or P06A3** for further diagnosis.

- **If none of the DTCs are set**

3. Verify the scan tool Throttle Body Idle Air Flow Compensation parameter is less than 90 %.
 - **90 % or greater**

Refer to **Throttle Body Cleaning** .

- **If less than 90 %**

4. 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.

- **If Agree**

5. Determine the current vehicle testing altitude.
6. 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.

- **If the MAP Sensor parameter is in range**

7. 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 the MAP Sensor parameter is not between 26-52 kPa (3.8-7.5 PSI) or does not change**

Refer to **DTC P0106** for further diagnosis.

- **If the MAP Sensor parameter is between 26-52 kPa (3.8-7.5 PSI) and changes**

8. 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.

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 for further diagnosis.

- **The MAF Sensor parameter changes smoothly and gradually**
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, for further diagnosis.

- **If the DTC does not set**
11. 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
 - 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.

-
- **If no condition is found**
 - 2. Ignition OFF. Disconnect the harness connector at the B75C Multifunction Intake Air sensor.
 - 3. Test for less than 2 ohms between the ground circuit terminal 7 and ground.
 - **If 2 ohms or greater**
 1. Ignition OFF. Disconnect the sensor chassis ground.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 2 ohms**
 - 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 ohms in the ignition voltage circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, 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
 3. Test for greater than 2 ohms between the ignition voltage circuit terminal 5 and ground.
 - If less than 2 ohms, repair the short to ground on the circuit.
 - If greater than 2 ohms, test all the components connected to the circuit and repair or replace as necessary.
 - **If a test lamp illuminates**
 - 5. Ignition ON, test for 4.8-5.2 V 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.
 - If infinite resistance
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, 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.

- **If between 4.8-5.2 V**

6. 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.

- **If no DTCs set**

4. All OK.

- **EL-38522-A, Variable Signal Generator; or equivalent is available**

7. 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+

8. 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)

9. 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.

- **If between 4, 950-5, 050 Hz.**

10. 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 ECM 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	Open/High Resistance	Short to Voltage	Signal Performance
Ignition Voltage	P0096, P0097, P00F4, P0102, P0178, P2199	P0096, P0097, P00F4, P0101, P0102, P2199	P0690	P0096, P0101, P0103
Signal	P0102	P0102	P0102*	P0101, P0103, P1101
Ground	-	P0096, P0097, P00F4, P0102, P2199	-	P0096, P0102

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

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	-

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

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 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 speed is greater than 300 RPM.
- The engine is running for greater than 1 s.
- The ignition signal is greater than 8 V.
- The above conditions are met for greater than 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 is less than 850 Hz (about 1.43 g/s) for greater than 10 s.

P0103

The ECM detects that the MAF Sensor Signal parameter is greater than 14, 500 Hz (about 1233 g/s) for greater than 10 s.

Action Taken When the DTC Sets

DTCs P0102 and P0103 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0102 and P0103 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Throttle Actuator Control (TAC) System Description

Electrical Information Reference

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

Powertrain Component Views

Powertrain Component Views

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-38522-A Variable Signal Generator

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

Circuit/System Verification

1. 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.

- **The MAF Sensor parameter changes smoothly and gradually**
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**

Refer to Circuit/System Testing.

- **If the DTC does not set.**
4. All OK

Circuit/System Testing

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

1. Ignition OFF and all systems OFF. Disconnect the harness connector at the B75C Multifunction Intake Air sensor.
2. Test for less than 2 ohms between the ground circuit terminal 7 and ground.
 - **If 2 ohms or greater**
 1. Ignition OFF. Disconnect the sensor chassis ground.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the chassis ground connection.
 - **If less than 2 ohms**
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**

-
2. Test for less than 2 ohms in the ignition voltage circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, 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
 3. Test for greater than 2 ohms between the ignition voltage circuit terminal 5 and ground.
 - If less than 2 ohms, repair the short to ground on the circuit.
 - If greater than 2 ohms, test all the components connected to the circuit and repair or replace as necessary.
 - If 2 ohms or greater, repair the open or high resistance in the circuit.
 - If the circuit tests normal and the fuse is open, test all the components connected to the circuit and repair or replace as necessary.
 - **If a test lamp illuminates**
 4. Ignition ON, test for 4.8-5.2 V 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.
 - If infinite resistance
 - 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, 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.
 - **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.

- **If no DTCs set**

4. All OK.

- **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.**

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

- **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 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

Circuits	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
5 V Reference	P0106, P0107, P0697	P0106, P0107	P0107	P0106, P0108, P0107, P0697	P0106
Signal	P0106, P0107, P0697	P0106, P0107	P0106, P0107	P0106, P0108*, P0697	P0106, P1101
Low Reference	-	P0106, P0108	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 operating in closed loop, idling and accessories OFF Parameter Normal Range: 12-103 kPa (1.7-14.9 PSI) (varies with altitude)			
5 V Reference	0 kPa (0 PSI)	0 kPa (0 PSI)	128 kPa (18.6 PSI)
Signal	0 kPa (0 PSI)	0 kPa (0 PSI)	128 kPa (18.6 PSI)*
Low Reference	-	80-128 kPa (11.6-18.6 PSI)	-

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

MAP Sensor, if equipped with Turbocharger

Circuits	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine running at various operating conditions Parameter Normal Range: 12-225 kPa (1.7-32.6 PSI) (varies with altitude)			
5 V Reference	0 kPa (0 PSI)	0 kPa (0 PSI)	255 kPa (36.9 PSI)
Signal	0 kPa (0 PSI)	0 kPa (0 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/System Description

The manifold absolute pressure (MAP) sensor measures the pressure inside the intake manifold.

barometric pressure (BARO) and if equipped, turbocharger output. A diaphragm 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.

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.

Under normal operation the greatest pressure that can exist in the intake manifold is at ignition ON, engine OFF, which is equal to the BARO. If equipped, a 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. The ECM monitors the MAP sensor signal for pressure outside of the normal range.

Conditions for Running the DTC

- DTCs P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0119, P0125, P0128, P0335, P0336, P0401 or P042E are not set
- The engine speed is between 450-5400 RPM.
- The engine coolant temperature (ECT) sensor is between -7-129°C (19-264°F).
- The intake air temperature (IAT) sensor is between -20-129°C (-4-264°F).
- This DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

The ECM determines if the MAP Sensor is stuck within the normal operating range. It accomplishes this by running 3 different models within the software to determine the values.

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

Schematic Reference

Engine Controls 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

GE-23738-A Vacuum Pump

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

Circuit/System Verification

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

Refer to **DTC P0641, P0651, P0697 or P06A3** for further diagnosis.
 - **If none of the DTCs are set**
2. If you were sent here from DTC P0068, P0101, P0121 or P1101; refer to Circuit/System Testing.
3. Ignition ON, verify the scan tool Throttle Body Idle Air Flow Compensation parameter is less than 90%.
 - **If 90% or greater**

Refer to **Throttle Body Cleaning** for this publication.
 - **If less than 90%**
4. 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.

- **If Agree**

5. Determine the current vehicle testing altitude.
6. 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.

- **If the MAP Sensor parameter is within range**

7. Engine idling, verify the scan tool MAP Sensor 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 Circuit/System Testing.

- **If between 26-52 kPa (3.8-7.5 PSI) and changes**

8. Verify the scan tool MAF Sensor parameter (g/s) 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.

- **If the MAF Sensor parameter changes smoothly and gradually**

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.

- **If the DTC does not set**

11. All OK.

Circuit/System Testing

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

- Improper operation of turbocharger wastegate actuator or bypass valve, if equipped
- Loose or improper installation of the turbocharger and the charge air cooler, including the flexible ductwork, if equipped
- An air flow restriction
- Any vacuum leak
- Improperly routed vacuum hoses
- In cold climates, inspect for any snow or ice buildup at the BARO port on the ECM, if equipped
- A restriction in the MAP Sensor port or the BARO port, if equipped
- Proper operation of the Positive Crankcase Ventilation (PCV) system
- Missing, restricted or leaking exhaust components. Refer to **Restricted 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.

- **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 B74 Manifold Absolute Pressure Sensor.
 3. Test for less than 2 ohms between the low reference circuit terminal 2 and ground.
 - **If 2 ohms or greater**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for less than 2 ohms in the low reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.
 - **If less than 2 ohms**
 4. Ignition ON, test for 4.8-5.2 V between the 5 V reference circuit terminal 1 and ground.
 - **If less than 4.8 V**
 1. Ignition OFF, disconnect the 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.
 - If infinite resistance
 3. Test for less than 2 ohms in the 5 V reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, 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 harness connector at 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.
- **If between 4.8-5.2 V**
- 5. Ignition ON, verify the scan tool MAP Sensor parameter is less than 0.5 V.
 - **If 0.5 V or greater**
 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 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.
 - **If less than 0.5 V**
- 6. Ignition OFF, install a 3 A fused jumper wire between the signal circuit terminal 3 and the 5 V reference circuit terminal 1.
- 7. Ignition ON, verify the scan tool MAP Sensor voltage parameter is greater than 4.5 V.
 - **If 4.5 V or less**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Remove the jumper wire, test for infinite resistance between the signal circuit terminal 3 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open or high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.
 - **If greater than 4.5 V**
- 8. Test or replace the B74 Manifold Absolute Pressure 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 B74 Manifold Absolute Pressure 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 B74 Manifold Absolute Pressure Sensor, with the . 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 B74 Manifold Absolute Pressure Sensor.

- **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 B74 Manifold Absolute Pressure 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 B74 Manifold Absolute Pressure Sensor.

- **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 B74 Manifold Absolute Pressure Sensor and disconnect the harness.
2. Install a 3 A fused jumper wire between the 5 V reference circuit terminal 1 of the sensor and the sensor harness.
3. Install a jumper wire between the low reference circuit terminal 2 of the sensor and ground.
4. Install a jumper wire to the signal circuit terminal 3 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 between 0-15 kPa (0-4.4 in Hg) of vacuum to the sensor with the **GE-23738-A**.
7. Verify the voltage changes, without any spikes or dropouts, between 0.2-4.9 V.
 - **If not between 0.2-4.9 V or has spikes or dropouts**

Replace the B74 Manifold Absolute Pressure Sensor.

- **If between 0.2-4.9 V and there are no spikes or dropouts**

8. All OK.

Repair Instructions

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

- **Manifold Absolute Pressure Sensor Replacement**.
- **Control Module References** for ECM replacement, programming and setup.

DTC P0107 OR P0108

- 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

Circuits	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
5 V Reference	P0107, P0697	P0106, P0107	P0107	P0107, P0108, P0697	P0106
Signal	P0106, P0107, P0697	P0106, P0107	P0106, P0107	P0106, P0108*, P0697	P0106
Low Reference	-	P0106, P0108	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 operating in closed loop, idling and accessories OFF. Parameter Normal Range: 26-52 kPa (3.8 to 7.6 PSI) (Varies with altitude)			
5 V Reference	0 kPa (0 PSI)	0 kPa (0 PSI)	127 kPa (18.4 PSI)
Signal	0 kPa (0 PSI)	0 kPa (0 PSI)	127 kPa (18.4 PSI) *
Low Reference	-	127 kPa (18.4 PSI)	-
* Internal ECM or sensor damage may occur if the circuit is shorted to B+.			

MAP Sensor, if equipped with Turbocharger

Circuits	Short to Ground	Open	Short to Voltage

Parameter Normal Range: 12-225 kPa (1.7 to 32.6 PSI) (Varies with altitude)			
5 V Reference	0 kPa (0 PSI)	0 kPa (0 PSI)	255 kPa (36.9 PSI)
Signal	0 kPa (0 PSI)	0 kPa (0 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/System 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 if equipped turbocharger output. A diaphragm 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.

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.

Under normal operation the greatest pressure that can exist in the intake manifold is at ignition ON, engine OFF, which is equal to the BARO. If equipped, a 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. The ECM monitors the MAP sensor signal for pressure outside of the normal range.

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.

Reference Information

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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 (Diagnostic Tools) .

Circuit/System Verification

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

Refer to DTC P0641, P0651, P0697 or P06A3 for further diagnosis.

-
- **If none of the DTCs are set**
 - 2. Determine the current vehicle testing altitude.
 - 3. 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 for further diagnosis.
 - **If the MAP Sensor parameter is within range**
 - 4. Verify the engine is equipped with a turbocharger.
 - **If not equipped with a turbocharger**

Refer to Step 6.
 - **If equipped with a turbocharger**
 - 5. Engine idling, verify the scan tool MAP Sensor voltage parameter is between 0.3-4.8 V and changes with accelerator pedal input.
 - **If not between 0.3-4.8 V or does not change**

Refer to Circuit/System Testing.
 - **If between 0.3-4.8 V and changes**

Refer to Step 7.
 - 6. Engine idling, verify the scan tool MAP Sensor voltage parameter is between 0.2-4.5 V and changes with accelerator pedal input.
 - **If not between 0.2-4.5 V or does not change**

Refer to Circuit/System Testing.
 - **If between 0.2-4.5 V and changes**
 - 7. 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.
 - 8. Verify the DTC does not set.
 - **If any DTC sets**

Refer to Circuit/System Testing.
 - **If no DTC sets**
 - 9. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the B74 Manifold Absolute Pressure Sensor.
2. Ignition OFF and all vehicle systems OFF. It may take up to 2 min for all vehicle systems to power down. Test for less than 2 ohms between the low reference circuit terminal 2 and ground.
 - **If 2 ohms or greater**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for less than 2 ohms in the low reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.
 - **If less than 2 ohms**
3. Ignition ON.
4. Test for 4.8-5.2 V between the 5 V reference circuit terminal 1 and ground.
 - **If less than 4.8 V**
 1. Ignition OFF, disconnect the 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.
 - If infinite resistance
 3. Test for less than 2 ohms in the 5 V reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, 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 harness connector at 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.
 - **If between 4.8-5.2 V**
5. Ignition ON, verify the scan tool MAP Sensor parameter is less than 0.5 V.
 - **If 0.5 V or greater**
 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 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.
 - **If less than 0.5 V**
 6. Ignition OFF, install a 3 A fused jumper wire between the signal circuit terminal 3 and the 5 V

reference circuit terminal 1.

7. Ignition ON, verify the scan tool MAP Sensor voltage parameter is greater than 4.5 V.
 - **If 4.5 V or less**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Remove the jumper wire, test for infinite resistance between the signal circuit terminal 3 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open or high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.
 - **If greater than 4.5 V**
8. Test or replace the B74 Manifold Absolute Pressure 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 B74 Manifold Absolute Pressure 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 B74 Manifold Absolute Pressure 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 B74 Manifold Absolute Pressure Sensor.

- **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 B74 Manifold Absolute Pressure 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 B74 Manifold Absolute Pressure Sensor.

- **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 B74 Manifold Absolute Pressure Sensor and disconnect the harness.
2. Install a 3 A fused jumper wire between the 5 V reference circuit terminal 1 of the sensor and the sensor harness.
3. Install a jumper wire between the low reference circuit terminal 2 of the sensor and ground.
4. Install a jumper wire to the signal circuit terminal 3 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 between 0-15 kPa (0-4.4 in Hg) of vacuum to the sensor with the **GE-23738-A**.
7. Verify the voltage changes, without any spikes or dropouts, between 0.2-4.9 V.
 - **If not between 0.2-4.9 V or has spikes or dropouts**

Replace the B74 Manifold Absolute Pressure Sensor.

- **If between 0.2-4.9 V and there are no spikes or dropouts**
8. All OK.

Repair Instructions

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

- **Manifold Absolute Pressure Sensor Replacement**
- **Control Module References** for ECM replacement, programming and setup

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	P0113, P0114, P2199*	P0111, P2199
Low Reference	-	P0111, P0113, P0114, P2199, P2227, P2228, P2229	P0113, P0114, P2199, P2227, P2229*	-

*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	Short to Voltage
Operating Conditions: Engine running			
Parameter Normal Range: Varies with ambient temperature			
Signal	150°C (302°F)	-40°C (-40°F)	-40°C (-40°F)*
Low Reference	-	-40°C (-40°F)	-40°C (-40°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 °C (°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 engine run time is greater than 0 s.
- The DTCs run continuously when the above conditions are met.

Conditions for Setting the DTCs

P0112

The ECM detects that the IAT sensor 1 signal is warmer than 149°C (300°F) for greater than 5 s.

P0113

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

The ECM detects that the IAT sensor 1 signal is colder than -60°C (-76°F) for greater than 5 s.

P0114

The ECM detects that the IAT sensor 1 signal is intermittent or has abruptly changed for greater than 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

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Connector End View Reference

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Powertrain Component Views

Powertrain Component Views

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Scan Tool Reference

Control Module References for scan tool information

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 25°C (45°F) of each other.
 - Start-Up IAT Sensor 1
 - Start-Up IAT Sensor 2
 - Start-Up ECT
 - **If not within 25°C (45°F)**

Refer to Circuit/System Testing.
 - **If within 25°C (45°F)**
3. Engine idling, verify the following scan tool parameters are between: -38 and +149°C (-36 and +300°F).
 - IAT Sensor 1

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

Refer to Circuit/System Testing.

- **If between: -38 and +149°C (-36 and +300°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.

- **If the DTC does not set.**
6. All OK

Circuit/System Testing

1. Ignition OFF and all systems OFF, it may take up to for 2 minutes for all vehicle systems to power down. Disconnect the harness connector at the B75C Multifunction Intake Air sensor.
2. Test for less than 2 ohms between the low reference circuit terminal 3 and ground.
 - **If 2 ohms or greater**
 1. Ignition OFF, disconnect the harness connector at the K20 engine control module.
 2. Test for less than 2 ohms in the low reference circuit end to end.
 - If 2 ohms or greater, repair the open or high resistance in the circuit.
 - If less than 2 ohms replace the K20 engine control module.
 - **If less than 2 ohms**
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.
 - If infinite resistance
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 engine control module.
 - **If greater than 5.2 V**

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.
 - **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.
 - If infinite resistance
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.
 - **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.
 - If less than 1 V
 3. Ignition OFF.
 4. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.
 - **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.

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 table values.**

Replace the B75C Multifunction Intake Air sensor.

- **If within the table values.**

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 P0116

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 P0116

Engine Coolant Temperature (ECT) Sensor Performance

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Signal	P0117	P0118	P0118	P0118	P0116, P0128
Low Reference	-	P0118	P0118	P0118	P0128

Typical Scan Tool Data

ECT Sensor Temperature

Circuit	Short to Ground	Open	Short to Voltage

Parameter Normal Range: -39 to +120°C (-38 to +248°F)

ECT Sensor	150°C (302°F)	-40°C (-40°F)	-40°C (-40°F)
Low Reference	-	-40°C (-40°F)	-40°C (-40°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 5V to the ECT sensor signal circuit and a ground for the low reference circuit.

The purpose of this diagnostic is to determine if the input from the ECT sensor is skewed warmer than normal. The internal clock of the ECM will record the amount of time the engine is OFF. If the required engine OFF time is met at start-up, the ECM will compare the temperature difference between the actual measured ECT and a calibrated ECT model. The information for this model is derived from the previous drive cycle and includes the accumulated mass air flow (MAF), the engine run time, the ambient air temperature and the ECT at the end of the drive cycle.

If the ECM detects that the temperature difference between the measured and modeled ECT is not within an acceptable operating range of each other, then the ECM will continue to run this diagnostic to determine if a block heater was active during the engine OFF time.

Conditions for Running the DTC

- DTCs P0111, P0112, P0113, P0114, P0117, P0118, P0128, P0502, P0503, P0601, P1621 or P2610 are not set.
- The vehicle has had a minimum ignition OFF time of 8 h.
- The engine is running.
- The start-up modeled ECT is colder than 50°C (+122°F).
- The previous accumulated MAF is greater than 6, 000 grams.
- The previous engine run time is greater than 600 s.

OR

- The vehicle has had a minimum ignition OFF time of 8 h.
- The engine is running.
- The previous ECT at engine shutdown is warmer than 75°C (+167°F).
- The previous accumulated MAF is greater than 6, 000 grams.
- The previous engine run time is greater than 600 s.
- This DTC runs once per ignition cycle within the enabling conditions.

Conditions for Setting the DTC**P0116**

The ECM detects a temperature difference at initial power-up that indicates that the actual measured ECT is 10°C (18°F) greater than the modeled ECT and an active block heater has not been detected.

Action Taken When the DTC Sets

DTC P0116 is a Type B DTC.

Conditions for Clearing the MIL/DTC

DTC P0116 is a Type B DTC.

Diagnostic Aids

- Engine coolant that is leaking through the sensor will create a high resistance short to ground. This condition results in less voltage on the ECT sensor signal circuit, which is interpreted by the ECM as a warmer ECT.
- The ECM memory which includes the ignition OFF timer is maintained by battery power. If the ECM or the battery are disconnected for less than 15 seconds the proper operation of the ECM memory and the timer can be disrupted. Always disconnect these components for greater than 30 s.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

1. Ignition ON.
2. Verify the scan tool ECT Sensor parameter is between -39 to + 120°C (-38 to +248°F) and changes with engine run time.

- **If not between -39 to + 120°C (-38 to +248°F) or does not change**

Refer to Circuit/System Testing.

- **If between -39 to + 120°C (-38 to +248°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**

Refer to Circuit/System Testing.

- **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 B34 Engine Coolant Temperature Sensor. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 5 ohms between the low reference terminal A and ground.
 - **If 5 ohms or greater**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for less than 2 ohms in the low reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.
 - **If less than 5 ohms**
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 harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the signal circuit terminal B and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K20 Engine Control Module.
 - **If colder than -39°C (-38°F)**
5. Install a 3 A fused jumper wire between the signal circuit terminal B and the low reference circuit terminal A.
6. Verify the scan tool ECT sensor parameter is warmer than 149°C (300°F).

- **If colder than the 149°C (300°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.
 - If less than 1 V
3. Ignition OFF
4. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.

- **If warmer than 149°C (300°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** 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.
 - **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.
 - **If infinite resistance**
4. All OK.

Repair Instructions

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

- **Engine Coolant Temperature Sensor Replacement**
- **Control Module References** for engine control module replacement, setup and programming.

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	High Resistance	Open	Short to Voltage	Signal Performance
Signal	P0117, P0119	P0118	P0118, P0119	P0118, P0119	P0119, P0128
Low Reference	-	P0118	P0118, P0119	-	P0116, P0128

Typical Scan Tool Data

ECT Sensor 1

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 air temperature, within a range of -39 to +139° C (-38 to +282°F)			
Signal	140°C (284°F)	-40°C (-40°F)	-40°C (-40°F)
Low Reference	-	-40°C (-40°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 and P0118

- The ignition is ON or the engine is running.
- The battery voltage is greater than 9 V.
- The engine run time is greater than 10 s.
- This DTC runs continuously when the above conditions are met.

P0119

- The ignition is ON or the engine is running.
- The battery voltage is greater than 9 V.
- DTC P0117 or P0118 are not set

Conditions for Setting the DTC

P0117

The ECM detects that the ECT sensor signal resistance is less than 34 ohms at 150°C (302°F).

P0118

The ECM detects that the ECT sensor signal resistance is greater than 140K ohms at 60°C (140°F).

P0119

The ECM detects that the ECT sensor signal has abruptly changed by a minimum of 5°C (9°F), warmer or colder for greater than 2 s.

Action Taken When the DTC Sets

- DTCs P0117, P0118 and P0119 are Type B DTCs
- The cooling fans will be commanded ON.
- The Engine Coolant Temperature Gauge is inoperative.
- The A/C compressor will be commanded OFF.

Conditions for Clearing the DTC

DTCs P0117, P0118 and P0119 are Type B DTCs

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 temperature should rise steadily, then stabilize after the thermostat opens.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

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Description and Operation

Cooling System Description and Operation

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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 the scan tool ECT Sensor parameter is between -39 to + 120°C (-38 to +248°F) and changes with engine run time.
 - **If not between -39 to + 120°C (-38 to +248°F) or does not change**

Refer to Circuit/System Testing.
 - **If between -39 to + 120°C (-38 to +248°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**

Refer to Circuit/System Testing.

- **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 and all vehicle systems OFF, disconnect the harness connector at the B34A Engine Coolant Temperature Sensor. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 ohms between the low reference circuit terminal A and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for less than 2 ohms in the low reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.
 - **If less than 10 ohms**
3. Ignition ON.
4. Verify the scan tool ECT Sensor parameter is at -40°C (-40°F).
 - **If warmer than -40°C (-40°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 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K20 Engine Control Module.
 - **If -40°C (-40°F)**
5. Install a 10 A fused jumper wire between the signal circuit terminal B and ground.
6. Verify the scan tool ECT Sensor parameter is at 150°C (302°F).
 - **If colder than 150°C (302°F).**
 1. Ignition OFF, remove the jumper, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit terminal B and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 3. Ignition OFF
 4. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.
 - **If warmer than 150°C (302°F)**

-
7. Test or replace the B34A 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** 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.
 - **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.
 - **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-P0123, P0222, P0223, P16A0-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*
Signal	P0122*, P0222*, P16A0	P0122*, P0222*, P16A1	P0123*, P0223*, P16A1**	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 signal and is used as voltages for throttle position sensor 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 between -7 to +126°C (19-259°F).
- The intake air temperature (IAT) is between -20 to +125°C (-4 to +257°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

- 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 in range for greater than 1 s.

P0122

The ECM detects the throttle position sensor 1 signal voltage is less than 0.32 V for greater than 1 s.

P0123

The ECM detects the throttle position sensor 1 signal voltage is greater than 4.7 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 4.6 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.

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

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Throttle Actuator Control (TAC) 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 that DTC P0601-P0606, P06A3 and P16F3 is not set.
 - **If any of the DTCs are set**

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

- **If none of the DTCs are set**
3. Verify the scan tool Throttle Body Idle Airflow Compensation parameter is less than 90 %.
 - **If 90 % or greater**

Refer to **Throttle Body Cleaning** .

- **If less than 90 %**
4. Verify the scan tool Throttle Position Sensor 1 and Throttle Position Sensor 2 voltage parameters are greater than 0.0 V.
 - **If 0.0 V**

Refer to Circuit/System Testing.

- **If greater 0.0 V**
5. Verify the Throttle Position Sensors 1 and 2 Agree/Disagree 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.

- **If Agree is displayed**

6. Verify DTC P0121, P0122, P0123, P0222, P0223, P16A0, P16A1, P16A2 and P2135 is not set.

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

Refer to Circuit/System Testing.

- **If none of the DTCs are 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**.

- **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**.

- **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**.

- **If the MAF Sensor parameter changes smoothly and gradually**

12. 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.

13. Verify the DTC does not set.

- **If the DTC sets**

Refer to Circuit/System Testing.

- **If the DTC does not set**

14. 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 minutes for all vehicle systems to power down.
2. Test for less than 5 ohms between the low reference circuit terminal 4 and ground.
 - **If 5 ohms or greater**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for less than 2 ohms in the low reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.
 - **If less than 5 ohms**
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.
 - If infinite resistance
 3. Test for less than 2 ohms in the 5 V reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, 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.
 - **If between 4.8-5.2 V**

- **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.
 - If infinite resistance
3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, 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.

- **If between 4.8-5.2 V**

6. 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 minutes for all vehicle systems to power down.
5. Ignition ON.
6. Verify the Throttle Position Sensors 1 and 2 Agree/Disagree 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.

- **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.

- 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
Signal	P0117, P0119	P0118, P0119	P0118*	P0116, P0128
Low Reference	-	P0118, P0119	-	P0128

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

Typical Scan Tool Data

ECT Sensor Temperature

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine running Parameter Normal Range: Varies with coolant temperature within a range of -39 to 139°C (-38 to 282°F)			
ECT Sensor Signal	150°C (302°F)	-40°C (-40°F)	-40°C (-40°F)
Low Reference	-	-40°C (-40°F)	-

Circuit/System Description

The purpose of this diagnostic is to analyze the performance of the thermostat by using the 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 P0068, P0071, P0072, P0073, P0074, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0116, P0117, P0118, P0119, P0121, P0122, P0123, P0223, P0502, P0503, P1516, P2101, P2135 are not set.
- The start-up IAT is warmer than -7°C (+19°F).
- The start-up ECT is colder than 70°C (158°F), when the IAT is above 10°C (50°F).

OR

- The start-up ECT is colder than 50°C (122°F), when the IAT is below 10°C (50°F).
- The engine OFF time is greater than 30 min.
- The engine run time is between 90 s and 22 min.
- The vehicle has traveled greater than 1.2 kilometers (1 miles) at greater than 8 km/h (5 mph).
- The accumulated airflow is between 20-75 g/s, with the minimum average airflow greater than 10 g/s.
- The fuel ethanol percentage is less than 87%.
- This DTC runs once per ignition cycle when the above conditions are met.

Conditions for Setting the DTC

- The ECM detects that the minimum ECT of 87°C (188°F) has not been met, when the IAT is greater than 10°C (50°F).

OR

- The ECM detects that the minimum ECT of 87°C (188°F) has not been met, when the IAT is less than 10°C (50°F).

Action Taken When the DTC Sets

DTC P0128 is a Type B DTC.

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.
- DTC P0128 occurring causes the Engine Coolant Temperature Gage to default to cold.

- Inspect the ECT sensor terminals and the ECT harness connector for corrosion. This condition results in a greater voltage on the ECT sensor signal circuit, which is interpreted by the ECM as a colder ECT.
- This diagnostic runs in a specific range. Measure and record the resistance of the ECT sensor at various ambient temperatures between -7 to +80°C (+19 to +176°F), then compare those measurements to the table.
- 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

Description and Operation

Cooling System Description and Operation

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify the cooling system is filled to the correct coolant level. Refer to Cooling System Leak Testing and Cooling System Draining and Filling (Static Fill) , Cooling System Draining and Filling (GE 47716) .

- If the coolant level is not correct

Repair as necessary

- If the coolant level is correct

NOTE: A critical analysis of the operation of the thermostat is necessary to properly diagnose this DTC.

2. Verify the proper heat range and the operation of the thermostat. Refer to Thermostat Diagnosis .

- If a condition is found

Replace the Thermostat.

- If a condition is not found

-
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 Step 1.

- **If the DTC does not set**

5. All OK.

Repair Instructions

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

-
- **Control Module References** for ECM replacement, setup and programming

DTC P0131, P0132, P0137, P0138, P0151, P0152, P0157 OR P0158

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 P0131

HO2S Circuit Low Voltage Bank 1 Sensor 1

DTC P0132

HO2S Circuit High Voltage Bank 1 Sensor 1

DTC P0137

HO2S Circuit Low Voltage Bank 1 Sensor 2

DTC P0138

HO2S Circuit High Voltage Bank 1 Sensor 2

DTC P0151

HO2S Circuit Low Voltage Bank 2 Sensor 1

DTC P0152

HO2S Circuit High Voltage Bank 2 Sensor 1

DTC P0157

HO2S Circuit Low Voltage Bank 2 Sensor 2

DTC P0158

HO2S Circuit High Voltage Bank 2 Sensor 2

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
HO2S High Signal	P0131, P0137, P0151, P0157, P0174	P0132, P0138, P0152, P0158	P0132, P0137, P0138, P0152, P0158, P0300	P0133, P013A, P013B, P013C, P013D, P013E, P013F, P014A, P014B, P0153, P015A, P015B, P015C, P015D, P2270, P2271, P2272, P2273
HO2S Low Signal	P0131, P0137, P0151, P0157	P0132, P0137, P0138, P0152, P0158, P0172, P0300, P0506	P0132, P0137, P0138, P0152, P0158	P0133, P013A, P013B, P013C, P013D, P013E, P013F, P014A, P014B, P0153, P015A, P015B, P015C, P015D, P2270, P2271, P2272, P2273

Typical Scan Tool Data

HO2S Bank 1 or 2 Sensor 1 or 2

Circuit	Short to Ground	Open	Short to Voltage
Parameter Normal Range: 200-800 mV			
HO2S High Signal	0.00 V	1.7-2.1 V	1.7-2.1 V
HO2S 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 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

P0131, P0137, P0151 or P0157

- 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.
- 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 2 s.

P0132, P0138, P0152 or P0158

- DTCs P0030, P0031, P0032, 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 oxygen sensor heater resistance has been learned.
- The fuel level is greater than 10%.
- Engine run time is greater than 5 s.
- The DTCs run continuously when the above conditions are met for 3 s.

Conditions for Setting the DTC

P0131, P0137, P0151 or P0157

- The engine control module detects that the heated oxygen sensor is shorted to ground if the HO2S voltage is less than 50 mV.
- The DTCs set within 6 s when the above condition is met.

P0132, P0138, P0152 or P0158

-
- The engine control module detects that the heated oxygen sensor has an open circuit or is shorted to voltage if the HO2S voltage is greater than 1, 050 mV.
 - The DTCs set within 13 s when the above condition is met.

Action Taken When the DTC Sets

DTCs P0131, P0132, P0137, P0138, P0151, P0152, P0157 and P0158 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0131, P0132, P0137, P0138, P0151, P0152, P0157 and P0158 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls 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 DTC P0030-P0032, P0036-P0038, P0050-P0054, P0056-P0060, P0135, P0141, P0155 or P0161.

- **If a DTC is not set.**

3. Engine running.
4. Verify the scan tool HO2S Bank 1 or 2 Sensor 1 or 2 parameters are between 50-1, 050 mV.
 - **If not between 50-1, 050 mV.**

Refer to Circuit/System Testing.

- **If between 50-1, 050 mV.**

5. Operate the vehicle within the Conditions for Running. 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.

- **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 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the high signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, 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 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.
 - **If between 1.7-3.0 V**
3. Verify the scan tool heated oxygen sensor Bank 1 or 2 Sensor 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.
 - If infinite resistance, replace the K20 Engine Control Module.

- **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 Bank 1 or 2 Sensor 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 ohms in the low signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms
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.

- **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
- **If any of the conditions exist**

Repair as necessary.

- **If none of the conditions exist**

7. Test or replace the B52 Heated Oxygen Sensor.

Repair Instructions

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

-
- **Heated Oxygen Sensor Replacement - Bank 1 Sensor 1**
 - **Heated Oxygen Sensor Replacement - Bank 1 Sensor 2**
 - **Heated Oxygen Sensor Replacement - Bank 2 Sensor 1**
 - **Heated Oxygen Sensor Replacement - Bank 2 Sensor 2**
 - Perform the scan tool Heated Oxygen Sensor Resistance Learn Reset after replacing a Heated Oxygen Sensor.
 - **Control Module References** for Engine Control Module replacement, programming and setup

DTC P0133, P013A-P013F, P014A, P014B, P0153, P015A-P015D OR P2270-P2273

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 P0133

HO2S Slow Response Bank 1 Sensor 1

DTC P013A

HO2S Slow Response Rich to Lean Bank 1 Sensor 2

DTC P013B

HO2S Slow Response Lean to Rich Bank 1 Sensor 2

DTC P013C

HO2S Slow Response Rich to Lean Bank 2 Sensor 2

DTC P013D

HO2S Slow Response Lean to Rich Bank 2 Sensor 2

DTC P013E

HO2S Delayed Response Rich to Lean Bank 1 Sensor 2

DTC P013F

HO2S Delayed Response Lean to Rich Bank 1 Sensor 2

DTC P014A

HO2S Delayed Response Rich to Lean Bank 2 Sensor 2

DTC P014B

HO2S Delayed Response Lean to Rich Bank 2 Sensor 2

DTC P0153

HO2S Slow Response Bank 2 Sensor 1

DTC P015A

HO2S Delayed Response Rich to Lean Bank 1 Sensor 1

DTC P015B

HO2S Delayed Response Lean to Rich Bank 1 Sensor 1

DTC P015C

HO2S Delayed Response Rich to Lean Bank 2 Sensor 1

DTC P015D

HO2S Delayed Response Lean to Rich Bank 2 Sensor 1

DTC P2270

HO2S Signal Stuck Lean Bank 1 Sensor 2

DTC P2271

HO2S Signal Stuck Rich Bank 1 Sensor 2

DTC P2272

HO2S Signal Stuck Lean Bank 2 Sensor 2

DTC P2273

HO2S Signal Stuck Rich Bank 2 Sensor 2

Diagnostic Fault Information

Circuit	Ground	Resistance	Voltage	Signal Performance
HO2S High Signal	P0131, P0137, P0151, P0157	P0132, P0138, P0152, P0158	P0132, P0138, P0152, P0158,	P0133, P013A, P013B, P013C, P013D, P013E, P013F, P014A, P014B, P0153, P015A, P015B, P015C, P015D, P2270, P2271, P2272, P2273
HO2S Low Signal	P0131, P0137, P0151, P0157	P0132, P0138, P0152, P0158	P0132, P0138, P0152, P0158	P0133, P013A, P013B, P013C, P013D, P013E, P013F, P014A, P014B, P0153, P015A, P015B, P015C, P015D, P2270, P2271, P2272, P2273

Typical Scan Tool Data

HO2S Bank 1 or 2 Sensor 1 or 2

Circuit	Short to Ground	Open	Short to Voltage
Parameter Normal Range: 200-800 mV			
HO2S High Signal	0.00 V	1.7-2.1 V	1.7-2.1 V
HO2S 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 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

P0133 or P0153

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0125, P0128, P0131, P0132, P0151, P0152, P0201- P0208, P0220, P0222, P0223, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0279, P0280, P0282, P0283, P0300 - P0308, P0411, P0442, P0443, P0446, P0449, P0452, P0453, P0455, P0458, P0459, P0496, P0498,

P0499, P1104, P1248, P1249, P124A - P124F, P1516, P16F3, P2100-P2103, P2119, P2135, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P216B, P216C, P216E, P216F, P2176, P217B, P217C, P217E, P217F, P2440, P2444 are not set.

- The ignition voltage is between 10-32 V.
- The intake air temperature (IAT) is warmer than -40°C (-40°F)
- The engine coolant temperature (ECT) is greater than 50°C (122°F).
- The fuel level is greater than 10%.
- The engine run time is greater than 30 s.
- The engine speed is between 1, 000-3, 000 RPM.
- The barometric (BARO) pressure is greater than 70 kPa.
- The mass airflow (MAF) is between 20-55 g/s.
- The fuel system is in Closed Loop.
- The fuel control state is not in power enrichment.
- Device controls not active.
- Fuel state is not in decel fuel cut-off mode.
- The DTCs run once per drive cycle when the above conditions are met for greater than 3.5 s.

P013A P013C, P013E or P014A

- 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, P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0111-P0114, P0116-P0118, P0120, P0121, P0122, P0123, P0125, P0128, P0131, P0132, P0133, P0134, P0135, P0137, P0138, P013A, P013B, P013E, P013F, P0140, P0141, P0171, P0172, P0201-P0208, P0220, P0222, P0223, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0279, P0280, P0282, P0283, P0300 - P0308, P0411, P0442, P0443, P0446, P0449, P0455, P0496, P0498, P0499, P1104, P1248, P1249, P124A - P124F, P1174, P1516, P16F3, P2100-P2103, P2119, P2135, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P216B, P216C, P216E, P216F, P2176, P217B, P217C, P217E, P217F, P2270, P2271, P2440, P2444 are not set.
- The ignition voltage is between 10-32 V.
- The learned heater resistance is valid.
- The fuel level is greater than 10%.
- The engine run time is equal to or greater than 5 min.
- The accelerator pedal is steady.
- The DTCs run once per ignition cycle, during decel fuel cut-off (DFCO), when the above conditions are met.

P013B P013D, P013F or P014B

- 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, P0202, P0203, P0204, P0220, P0222, P0223, P0300, P0442, P0443, P0446, P0449, P0455, P0496, P1133, P1174, P1516, P2101, P2119, P2135, P2176, P2270, P2271, P2A00 are not set.
- The ignition voltage is between 10-32 V.
- The learned heater resistance is valid.
- The fuel level is greater than 10%.
- The engine run time is equal to or greater than 5 min.
- The DTCs run once per ignition cycle when the above conditions are met.

P015A, P015B, P015C or P015D

- 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 intake air temperature (IAT) is warmer than -40°C (-40°F)
- The engine coolant temperature (ECT) is warmer than 50°C (122°F).
- The fuel level is greater than 10%.
- The engine run time is greater than 30 s.
- The engine speed is between 1, 000-2, 500 RPM.
- The vehicle speed is between 63-119 km/h (39-74 mph).
- The mass airflow (MAF) is between 4-20 g/s.
- The fuel system is in Closed Loop.
- Evap is not in control of purge.
- Device controls are not active.
- Oxygen sensor heater on for greater than 60 s.
- Calculated catalyst temperature is between 600-900°C (1, 122-1, 652°F).
- When all of the above conditions are met for 1 s, the fuel mixture is forced rich and the HO2S Bank 1 or 2 Sensor 1 is greater than 690 mV, then decel fuel cut-off (DFCO) is entered.
- The DTCs run once per drive cycle when the above conditions are met.

P2270 or P2272

- 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 ignition voltage is between 10-32 V.
- The fuel level is greater than 10%.
- The engine speed is between 1, 000-2, 500 RPM.
- The vehicle speed is between 63-119 km/h (39-74 mph).
- The engine airflow is between 4-20 g/s.
- The fuel state is in Closed Loop.
- The evaporative emission (EVAP) diagnostics are not in control of purge.
- The heated oxygen sensor heaters are ON for greater than 60 s.
- The predicted catalytic converter temperature is between 600-900°C (1, 112-1, 652°F).
- This DTC runs once per trip when all of the above conditions have been met for 1 s.

P2271 or P2273

- 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 ignition voltage is between 10-32 V.
- The fuel level is greater than 10%.
- The engine speed is between 1, 000-2, 500 RPM.
- The vehicle speed is between 63-119 km/h (39-74 mph).
- The engine airflow is between 4-20 g/s.
- The fueling state is in Closed Loop.
- The evaporative emission (EVAP) diagnostics are not in control of purge.
- Power take-off is not active.
- The heated oxygen sensor heaters have been ON for greater than 60 s.
- The predicted catalytic converter temperature is between 600-900°C (1, 112-1, 652°F).
- DTCs P013A, P013C, P013E, P014A, P2270 and P2272 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.

Conditions for Setting the DTC

P0133, P0153, P015A, P015B, P015C or P015D

-
- The ECM detects that the HO2S 1 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.

P013A or P013C

The ECM detects that the accumulated mass air flow monitored during rich-to-lean transitions between 450-150 mV is greater than calibrated value.

P013B or P013D

The ECM detects that the accumulated mass air flow monitored during lean-to-rich transitions between 350-650 mV is greater than calibrated value.

P013E or P014A

The ECM detects that the O2 sensor voltage has not decreased below 450 mV within a calibrated value of accumulated air flow.

P013F or P014B

The ECM detects that the O2 sensor voltage has not increased above 350 mV within a calibrated value of accumulated air flow.

P2270 or P2272

The ECM does not detect a HO2S voltage greater than 800 mV before accumulated mass air flow exceeds a calibrated value.

P2271 or P2273

The ECM does not detect an HO2S voltage less than 100 mV before accumulated mass air flow exceeds a calibrated value.

Action Taken When the DTC Sets

- DTCs P0133, P013E, P013F, P014A, P014B, P0153, P2270, P2271, P2272 and P2273 are Type B DTCs.
- DTCs P013A, P013B, P013C, P013D, P015A, P015B, P015C and P015D are Type A DTCs.

Conditions for Clearing the DTC

- DTCs P0133, P013E, P013F, P014A, P014B, P0153, P2270, P2271, P2272 and P2273 are Type B DTCs.
- DTCs P013A, P013B, P013C, P013D, P015A, P015B, P015C and P015D are Type A DTCs.

Diagnostic Aids

When DTCs P013E, P014A, P015A and P015C are all set at the same time, fuel saturation of the EVAP system is a possible cause.

Reference Information

Schematic Reference

Engine Controls 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 **DTC P0030-P0032, P0036-P0038, P0050-P0054, P0056-P0060, P0135, P0141, P0155 or P0161.**

- **If a DTC is not set**

3. Verify none of the conditions listed below exist:
 - Lean or rich fuel injectors-Refer to **Fuel Injector Diagnosis** .
 - Water intrusion in the HO2S harness connector
 - Low or high fuel system pressure-Refer to **Fuel System Diagnosis** .

- Fuel saturation of the evaporative emission (EVAP) canister
- Exhaust leaks-Refer to **Exhaust Leakage** .
- 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.

- **If none of the conditions exist**

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**

Test or replace the appropriate B52 Heated Oxygen Sensor.

- **If the DTC does not set**

6. All OK.

Repair Instructions

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

- **Heated Oxygen Sensor Replacement - Bank 1 Sensor 1**
- **Heated Oxygen Sensor Replacement - Bank 1 Sensor 2**
- **Heated Oxygen Sensor Replacement - Bank 2 Sensor 1**
- **Heated Oxygen Sensor Replacement - Bank 2 Sensor 2**
- Perform the scan tool Heated Oxygen Sensor Resistance Learn Reset after replacing a Heated Oxygen Sensor.
- **Control Module References** for Engine Control Module replacement, programming and setup

DTC P0171, P0172, P0174 OR P0175

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 Bank 1

DTC P0172

Fuel Trim System Rich Bank 1

DTC P0174

Fuel Trim System Lean Bank 2

DTC P0175

Fuel Trim System Rich Bank 2

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, P0050, P0053, P0059, P0101, P0102, P0103, P0106, P0107, P0108, P0131-P0135, P0151-P0155, P015A, P015B, P015C, P015D, P0178, P0179, P0201-P0208, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0279, P0280, P0282, P0283, P0300-P0308, P0506, P0507, P1248, P1249, P124A, P124B, P124C, P124D, P124E, P124F, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P216B, P216C, P216E, P216F, P217B, P217C, P217E, P217F, P2227, P2228, P2229, P2230 or P2269 are not set.
- The engine is in Closed Loop status.
- The catalyst monitor diagnostic intrusive test, post HO2S diagnostic intrusive test, device control and EVAP leak test are not active.
- The engine coolant temperature is between -40 and +150°C (-40 and +302°F).
- The intake air temperature is between -20 and +150°C (-4 and +302°F).
- The manifold absolute pressure is between 10-255 kPa (1.5-37 psi).
- The engine speed is between 375-7, 000 RPM.
- The mass air flow is between 1-510 g/s.

-
- The barometric pressure 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, P0172, P0174 and P0175 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0171, P0172, P0174 and P0175 are Type B DTCs.

Diagnostic Aids

- Allow the engine to reach operating temperature. With the engine running, observe the HO2S parameter with a scan tool. The HO2S value should vary from approximately 40 mV to approximately 900 mV and respond to fueling changes.
- 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.
- Inspect the air filter for being the correct one for this application. Make sure 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

Schematic Reference

Engine Controls 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 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.

- **If no other DTCs are set**
3. Verify DTC P0171, P0172, P0174 or P0175 is not set.
 - **If a DTC is set**

Refer to Circuit/System Testing.

- **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, P0172, P0174 or P0175 is not set.
 - **If any of the DTCs set**

Refer to Circuit/System Testing.

- **If none of the DTCs set**

6. All OK.

Circuit/System Testing

1. Ignition ON.
2. Verify the MAP sensor pressure parameter is within the range specified for your altitude. Refer to **Altitude Versus Barometric Pressure** .
 - **If not within the specified range**

Refer to **DTC P0106**.

- **If within the specified range**
3. Engine running at the operating temperature.
 4. Verify the Long Term Fuel Trim Bank 1 or 2 parameter is between -25.5 % and +34.5 % .
 - **If greater than +34.5 %:**
 1. Ignition OFF.
 2. Inspect for the conditions listed below:
 - Mass air flow 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**.
 - Contamination of the mass air flow sensor with oil or other foreign material.
 - 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** .
 - Vacuum hoses for splits, kinks and improper connections.
 - Insufficient fuel in the tank.
 - Partial blockage of the air filter element or other conditions that alter air flow to the mass air flow sensor.
 - 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.
 - The crankcase ventilation system for leaks-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** .

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**.
- Contamination of the mass air flow sensor with oil or other foreign material.
- 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 the engine oil as necessary.
 - 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 between -25.5 % and +34.5 %

5. All OK.

Repair Instructions

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

Reset the fuel trim after completing the repair.

DTC P0178 OR P0179

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 P0178

Fuel Composition Sensor Circuit Low Frequency

DTC P0179

Fuel Composition Sensor Circuit High Frequency

Circuit/System Description

Alcohol content information is supplied to the engine control module (ECM) from the fuel composition sensor. The fuel composition sensor has an ignition positive circuit, a signal circuit and a ground circuit. The fuel composition sensor uses a microprocessor inside the sensor to measure the ethanol percentage and changes the output signal accordingly. The signal circuit carries the ethanol percentage via the frequency signal. The ECM provides an internal pull up to 5 V on the signal circuit and the fuel composition sensor pulls the 5 V to ground in pulses. The normal range of operating frequency is between 50-150 Hz. The microprocessor inside the sensor is capable of a certain amount of self-diagnosis. An output frequency between 180 Hz and 190 Hz indicates that the fuel is contaminated.

Conditions for Running the DTC

- The ignition voltage is greater than 11 V.
- The DTC runs continuously when the above condition is met.

Conditions for Setting the DTC

P0178

The engine control module detects that the fuel composition sensor output frequency is less than 45 Hz for greater than 6 s.

P0179

The engine control module detects that the fuel composition sensor output frequency is between 155-185 Hz for greater than 6 s.

Action Taken When the DTC Sets

DTC P0178 and P0179 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTC P0178 and P0179 are Type B DTCs.

Diagnostic Aids

A momentary slug of water in the fuel system may set this DTC.

Reference Information

Engine Controls Schematics

Connector End View Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

- **J 38522-A** Variable Signal Generator
- **J 44175-A** Fuel Composition Tester

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

Circuit/System Verification

1. Engine running,
2. Verify the scan tool Fuel Composition Sensor parameter is between 50-150 Hz.
 - **If not between 50-150 Hz**

Refer to Circuit/System Testing.
 - **If between 50-150 Hz**
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.

Refer to Circuit/System Testing.

- **If the DTC does not set**

5. All OK.

Circuit/System Testing

1. Verify that there are no contaminants, water or too high of a concentration of ethanol in the fuel. Refer to **Alcohol/Contaminants-in-Fuel Diagnosis** and the **J44175-A** Instruction Manual.
2. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B198 Fuel Composition Sensor. It may take up to 2 min for all vehicle systems to power down.
3. Test for less than 5 ohms between the ground circuit terminal 2 and ground.
 - **If 5 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 5 ohms**
4. Ignition ON.
5. Verify that a test lamp illuminates between the ignition circuit terminal 1 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is OK**
 1. Ignition OFF, remove the test lamp.
 2. Test for less than 2 ohms in the ignition circuit end to end.
 - 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 illuminate and the circuit fuse is open**
 1. Ignition OFF, remove the test lamp.
 2. Test for infinite resistance between the ignition circuit and ground.
 - If less than infinite resistance, repair the short to ground in the circuit.
 - If infinite resistance, replace the B198 Fuel Composition Sensor.
 - **If the test lamp illuminates**
6. Remove the test lamp, ignition ON.
7. 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 X1 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 in the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the signal circuit end to end.

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

- **If greater than 5.2 V**

1. Ignition OFF, disconnect the harness connector X1 at the K20 Engine Control Module.
2. Ignition ON.
3. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.

- **If between 4.8-5.2 V**

8. Ignition OFF, connect the red lead of the **J 38522-A** Variable Signal Generator to the signal circuit terminal 3 at the B198 Fuel Composition Sensor harness connector.
9. Connect the battery voltage supply to B+ and the black lead to ground.
10. Set the **J 38522-A** Variable Signal Generator Signal to 5 V, the Frequency to 60 Hz and the Duty Cycle to Normal.
11. Ignition ON.
12. Verify the scan tool Fuel Composition Sensor parameter is at 60 Hz.
 - **If not at 60 Hz**

Replace the K20 Engine Control Module.

- **If at 60 Hz**

13. Test or replace the B198 Fuel Composition Sensor.

Component Testing

1. Test the fuel composition using the **J 44175-A** Fuel Composition Tester and the J 44175-A Instruction Manual. Record the frequency.
2. Compare the special tool test frequency and the scan tool Fuel Composition Sensor frequency parameter.
3. Verify the difference between the tool and the sensor is 12 Hz or less.
 - **If greater then 12 Hz**

Replace the B198 Fuel Composition Sensor.

- **If 12 Hz or less**

4. All OK.

Repair Instructions

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

- for B198 Fuel Composition Sensor replacement.

- **Control Module References** for K20 Engine Control Module replacement, programming and setup.

DTC P018B-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	P018C, P0192, P0532, P0641, P2228	P018C	P018D, P0193, P0523, P0641, P2227	P018B
Signal	P018C	P018C	P018D	P018B
Low Reference	-	P018D	P018D	P018B

Circuit/System Description

The fuel pressure sensor is located on the fuel pipe. The fuel pressure sensor provides a fuel pressure signal to the ECM, which is used to provide Closed Loop fuel pressure control.

Conditions for Running the DTC

DTC P018B

- DTCs P018C, P018D, P0231, P0232, P023F, P0641, P1255, P129D or P12A6 are not set.

-
- Engine is running
 - Fuel pressure is greater than 0 psi
 - The DTC runs continuously when the condition above is met.

DTC 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 change in the fuel pressure of at least 30 kPa (4.4 psi) when the fuel pump is operating. The fuel pressure sensor performance diagnostic detects a 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 0.14 V for 1 s.

P018D

The engine control module detects that the fuel pressure sensor voltage is greater than 4.86 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 Schematics

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- **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. Engine running.
2. 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.

- **If between 0.2-4.8 V**

3. 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.

- **If the parameter changes**

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

5. Verify the DTC does not set.

- **If the DTC sets**

Refer to Circuit/System Testing.

- **If the DTC does not set**

6. 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 min for all vehicle systems to power down.
2. Test for less than 5 ohms between the low reference circuit terminal 2 and ground.
 - **If 5 ohms or greater**
 1. Ignition OFF, disconnect the harness connector X1 at the K20 Engine Control Module.
 2. Test for less than 2 ohms in the low reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.
 - **If less than 5 ohms**
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 X1 at the K20 Engine Control Module.
 2. Test for infinite resistance between the 5 V reference circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the 5 V reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.
 - **If greater than 5.2 V**
 1. Ignition OFF, disconnect the harness connector X1 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.
 - **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 X1 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.
 - **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 4.8 V or greater.
 - **If less than 4.8 V**
 1. Ignition OFF, disconnect the harness connector X1 at the K20 Engine Control Module.
 2. Test for infinite resistance between the signal circuit terminal 1 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.
 - **If 4.8 V or greater**
8. Replace the B47 Fuel Pressure Sensor.

Repair Instructions

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

- **Fuel Pressure Sensor Replacement**
- **Control Module References** for K20 Engine Control Module replacement, programming and setup.

DTC P0191

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

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
	P0192, P0193,			

5 V Reference Voltage	P0345, P0365, P0390, P0506, P0641, P2227	P0192	P0641, P2227, P2229	P0191
Fuel Rail Pressure Sensor Signal 1	P0192	P0192, P0193	P0193	P0191
Fuel Rail Pressure Sensor Signal 2	P127C	P127C, P127D	P127D	P0191
Low Reference	-	P0193	P0193	P0191

Circuit/System Description

The fuel rail pressure sensor is a dual analog sensor that provides two fuel rail pressure signals to the engine control module (ECM). The ECM provides a 5 V reference voltage on the 5 V reference circuit and ground on the reference circuit. The ECM receives a varying signal voltage on both the fuel rail pressure sensor 1 and fuel rail pressure sensor 2 signal circuits. The ECM monitors the voltage on both of the fuel rail pressure sensor circuits and compares the values to determine if the sensors are accurate. If fuel rail pressure sensor 1 and fuel rail pressure sensor 2 voltage signals do not closely match DTC P0191 may set.

Conditions for Running the DTC

- Engine is running.
- DTCs P0192, P0193, P127C and P127D are not set.
- Commanded fuel pressure rate of change is greater than 0.70 MPa for greater than 1.25 seconds.
- Desired fuel pressure is greater than 0 psi.
- The DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

NOTE: Both Condition 1 and Condition 2 must be present to set DTC P0191.

Condition 1

The engine control module detects fuel rail pressure sensor 1 value is 1 MPa (145 psi) greater than or less than fuel rail pressure Sensor 2 value for greater than 1.5 s.

Condition 2

The engine control module detects the square root of (fuel rail pressure sensor 1 value divided by fuel rail pressure sensor 2 value) is greater than 1.22 or less than 0.86 for greater than 1.5 s.

Action Taken When the DTC Sets

-
- DTC P0191 is a Type A DTC.
 - A message center or an indicator may display Reduced Engine Power.

Conditions for Clearing the DTC

DTC P0191 is a Type A DTC.

Reference Information

Schematic Reference

Engine Controls 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. Engine running.
2. Verify the scan tool Fuel Pressure Sensor 2 parameter is between 0.25-4.75 V.
 - **If not between 0.25-4.75 V**

Refer to Circuit/System Testing.

- **If between 0.25-4.75 V**

3. Verify the scan tool Fuel Pressure Sensor 2 increases or decreases when commanding an increase and decrease in Fuel Pressure with a scan tool.

- **If the pressure does not increase or decrease with each command**

Refer to Circuit/System Testing.

- **If the pressure increases or decreases with each command**

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.

- **If the DTC does not set**

6. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the B47B Fuel Rail Pressure Sensor connector. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 5 ohms between the low reference circuit terminal 3 and ground.
 - **If 5 ohms or greater**
 1. Ignition OFF, disconnect the harness connector X2 at the K20 Engine Control Module.
 2. Test for less than 2 ohms in the low reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.
 - **If less than 5 ohms**
3. Ignition ON.
4. Test for 4.8-5.2 V between the 5 V reference circuit terminal 1 and ground.
 - **If less than 4.8 V**
 1. Ignition OFF, disconnect the harness connector X2 at the K20 Engine Control Module.
 2. Test for infinite resistance between the 5 V reference circuit and ground.
 - If less than infinite resistance, repair the short to ground in the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the 5 V reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.
 - **If greater than 5.2 V**
 1. Ignition OFF, disconnect the harness connector X2 at the K20 Engine Control Module,

-
2. Test for less than 1 V between the 5 V reference circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.
 - **If between 4.8-5.2 V**
 5. Verify the scan tool Fuel Rail Pressure Sensor 2 parameter is less than 0.25 V.
 - **If 0.25 V or greater**
 1. Ignition OFF, disconnect the harness connector X1 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.
 - **If less than 0.25 V**
 6. Install a 3 A fused jumper wire between the signal circuit terminal 2 and the 5 V reference circuit terminal 1.
 7. Verify the scan tool Fuel Rail Pressure Sensor 2 parameter is greater than 4.75 V.
 - **If 4.75 V or less**
 1. Ignition OFF, disconnect the harness connector X1 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.
 - If infinite resistance
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.
 - **If greater than 4.75 V**
 8. Verify the scan tool Fuel Rail Pressure Sensor 1 parameter is less than 0.25 V.
 - **If 0.25 V or greater**
 1. Ignition OFF, disconnect the harness connector X2 at the K20 Engine Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit terminal 4 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.
 - **If less than 0.25 V**
 9. Install a 3 A fused jumper wire between the signal circuit terminal 4 and the 5 V reference circuit terminal 1.
 10. Verify the scan tool Fuel Rail Pressure Sensor 1 parameter is greater than 4.75 V.
 - **If 4.75 V or less**
 1. Ignition OFF, disconnect the harness connector X2 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.
- If infinite resistance
- 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.
 - **If greater than 4.75 V**

11. Test or replace the B47B Fuel Rail Pressure Sensor.

Repair Instructions

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

- **Fuel Injection Fuel Rail Fuel Pressure Sensor Replacement** for B47B Fuel Rail Pressure Sensor replacement.
- **Control Module References** for K20 Engine Control Module replacement, programming and setup.

DTC P0192 OR P0193

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 P0192

Fuel Rail Pressure Sensor Circuit Low Voltage

DTC P0193

Fuel Rail Pressure Sensor Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference Voltage	P0192, P0193, P0340, P0345, P0365,	P0192	P0193, P0641, P2227, P2229	P0191

	P0506, P0641, P2227			
Fuel Rail Pressure Sensor Signal 1	P0192	P0192, P0193	P0193	P0191
Fuel Rail Pressure Sensor Signal 2	P127C	P127C, P127D	P127D	P0191
Low Reference	-	P0193	P0193	P0191

Circuit/System Description

The fuel rail pressure sensor is a dual analog sensor that provides two fuel rail pressure signals to the engine control module (ECM). The ECM provides a 5 V reference voltage on the 5 V reference circuit and ground on the reference circuit. The ECM receives a varying signal voltage on both the fuel rail pressure sensor 1 and fuel rail pressure sensor 2 signal circuits. The ECM monitors the voltage on both of the fuel rail pressure sensor circuits and compares the values to determine if the sensors are accurate.

Conditions for Running the DTC

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

Conditions for Setting the DTC

P0192

The engine control module detects that the fuel rail pressure sensor 1 signal voltage is less than 0.25 V for greater than 2.5 s.

P0193

The engine control module detects that the fuel rail pressure sensor 1 signal voltage is greater than 4.75 V for greater than 2.5 s.

Action Taken When the DTC Sets

- DTCs P0192 and P0193 are Type A DTCs.
- A message center or an indicator may display Reduced Engine Power.

Conditions for Clearing the DTC

DTCs P0192 and P0193 are Type A DTCs.

Reference Information

Schematic 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. Engine running.
2. Verify the scan tool Fuel Rail Pressure Sensor parameter is between 0.25-4.75 V.
 - **If not between 0.25-4.75 V**

Refer to Circuit/System Testing.

- **If between 0.25-4.75 V**

3. Verify the scan tool Fuel Rail Pressure Sensor parameter increases or decreases when commanding an increase and decrease in Fuel Pressure with a scan tool.
 - **If the pressure does not increase or decrease with each command**

Refer to Circuit/System Testing.

- **If the pressure increases or decreases with each command**

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.

- **If the DTC does not set**

6. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the B47B Fuel Rail Pressure Sensor connector. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 5 ohms between the low reference circuit terminal 3 and ground.
 - **If 5 ohms or greater**
 1. Ignition OFF, disconnect the harness connector X2 at the K20 Engine Control Module.
 2. Test for less than 2 ohms in the low reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.
 - **If less than 5 ohms**
3. Ignition ON.
4. Test for 4.8-5.2 V between the 5 V reference circuit terminal 1 and ground.
 - **If less than 4.8 V**
 1. Ignition OFF, disconnect the harness connector X2 at the K20 Engine Control Module.
 2. Test for infinite resistance between the 5 V reference circuit and ground.
 - If less than infinite resistance, repair the short to ground in the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the 5 V reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.
 - **If greater than 5.2 V**
 1. Ignition OFF, disconnect the harness connector X2 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.
 - **If between 4.8-5.2 V**
5. Verify the scan tool Fuel Rail Pressure Sensor 1 parameter is less than 0.25 V.
 - **If 0.25 V or greater**
 1. Ignition OFF, disconnect the harness connector X2 at the K20 Engine Control Module,

2. Test for less than 1 V between the signal circuit terminal 4 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.
 - **If less than 0.25 V**
6. Install a 3 A fused jumper wire between the signal circuit terminal 4 and the 5 V reference circuit terminal 1.
7. Verify the scan tool Fuel Rail Pressure Sensor 1 parameter is greater than 4.75 V.
 - **If 4.75 V or less**
 1. Ignition OFF, disconnect the harness connector X2 at the K20 Engine Control Module.
 2. Test for infinite resistance between the signal circuit terminal 4 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.
 - **If greater than 4.75 V**
8. Test or replace the B47B Fuel Rail Pressure Sensor.

Repair Instructions

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

- **Fuel Injection Fuel Rail Fuel Pressure Sensor Replacement** for B47B Fuel Rail Pressure Sensor replacement.
- **Control Module References** for K20 Engine Control Module replacement, programming and setup.

DTC P0197 OR P0198

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 P0197

Engine Oil Temperature (EOT) Sensor Circuit Low Voltage

DTC P0198

Engine Oil Temperature (EOT) Sensor Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage
EOT Sensor Signal	P0197	P0198	P0198	P0198
EOT Low Reference	-	P0198	P0198	-

Typical Scan Tool Data

Engine Oil Temperature Sensor

Circuit	Short to Ground	High Resistance	Short to Voltage
Operating Conditions: Engine running			
Parameter Normal Range: Varies with engine oil temperature			
EOT Sensor Signal	150°C (302°F)	-40°C (-40°F)	-40°C (-40°F)
Low Reference	-	-40°C (-40°F)	-40°C (-40°F)

Circuit/System Description

The engine oil temperature (EOT) sensor is a variable resistor that measures the temperature of the engine oil. The engine control module (ECM) supplies 5 volts on the EOT signal circuit and a ground to the low reference circuit.

Monitoring the engine oil temperature is necessary for optimal control of the cam phasers. The oil temperature is monitored from dual function oil level switch and temperature sensor located in the oil pan.

Conditions for Running the DTC

P0197

- The engine run time is greater than 20 seconds.

OR

- The ECT sensor is less than 150°C (302°F).
- The DTC runs continuously when the above enable conditions are met.

P0198

- The engine run time is greater than 20 seconds.

OR

-
- The ECT sensor is greater than -40°C (-40°F).
 - The DTC runs continuously when the above enable conditions are met.

Conditions for Setting the DTC

P0197

The EOT sensor is greater than 162°C (324°F) for greater than 25 seconds.

P0198

The EOT sensor is less than -60°C (-76°F) for greater than 25 seconds.

Action Taken When the DTC Sets

DTCs P0197 and P0198 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0197 and P0198 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

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

DTC Type Definitions

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE: Perform this verification procedure only if the ignition has been OFF for 10 hours or more.

1. Ignition ON, observe the scan tool IAT Sensor, Engine Oil temperature Sensor and ECT Sensor parameters. The readings should be within 15°C (27°F) of each other and also the ambient temperature.
2. Operate the vehicle within the Conditions for Running the DTC to verify that the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the EOT sensor.
2. Ignition OFF for 90 seconds, test for less than 5 ohms of resistance between the low reference circuit terminal C and ground.
 - If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the ECM.
3. Ignition ON, verify the scan tool Engine Oil temperature Sensor parameter is colder than -39°C (-38°F).
 - If greater than the specified range, test the signal circuit terminal B for a short to ground. If the circuit tests normal, replace the ECM.

NOTE: If the 3 A fuse in the jumper wire opens, the signal circuit is shorted to a voltage and the sensor may be damaged.

4. Install a 3 A fused jumper wire between the signal circuit terminal B and the low reference circuit terminal C. Verify the scan tool EOT Sensor parameter is warmer than 149°C (300°F).
 - If less than the specified range, test the signal circuit for a short to voltage or an open/high resistance, if the circuit tests normal, replace the ECM.
5. Ignition OFF, disconnect the harness connectors at the ECM.
6. Test for infinite resistance between the oil temperature sensor signal circuit terminal B and the oil level switch signal circuit terminal A.
 - If less than the specified range, repair the short circuit between the oil temperature sensor signal circuit and the oil level switch signal circuit.
7. If all circuits test normal, replace the engine oil level sensor and/or switch assembly.

Repair Instructions

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

- **Engine Oil Level Indicator Switch Replacement (Without Z52)**
- **Control Module References** for ECM replacement, setup and programming

DTC P0201-P0208, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0279, P0280, P0282 OR P0283

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 P0205

Cylinder 5 Injector Control Circuit

DTC P0206

Cylinder 6 Injector Control Circuit

DTC P0207

Cylinder 7 Injector Control Circuit

DTC P0208

Cylinder 8 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 P0273

Cylinder 5 Injector Control Circuit Low Voltage

DTC P0274

Cylinder 5 Injector Control Circuit High Voltage

DTC P0276

Cylinder 6 Injector Control Circuit Low Voltage

DTC P0277

Cylinder 6 Injector Control Circuit High Voltage

DTC P0279

DTC P0280

Cylinder 7 Injector Control Circuit High Voltage

DTC P0282

Cylinder 8 Injector Control Circuit Low Voltage

DTC P0283

Cylinder 8 Injector Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Short from Supply Circuit to Control Circuit
Direct Fuel Injector High Voltage Control Cylinder 1	P0261	P0201	P0262	P1248
Direct Fuel Injector High Voltage Supply Cylinder 1	P2147	P0201	P2148	P1248
Direct Fuel Injector High Voltage Control Cylinder 2	P0264	P0202	P0265	P1249
Direct Fuel Injector High Voltage Supply Cylinder 2	P2150	P0202	P2151	P1249
Direct Fuel Injector High Voltage Control Cylinder 3	P0267	P0203	P0268	P124A
Direct Fuel Injector High Voltage Supply Cylinder 3	P2153	P0203	P2154	P124A
Direct Fuel Injector High Voltage Control Cylinder 4	P0270	P0204	P0271	P124B
Direct Fuel Injector High Voltage Supply Cylinder 4	P2156	P0204	P2157	P124B
Direct Fuel Injector High Voltage Control Cylinder 5	P0273	P0205	P0274	P124C
Direct Fuel Injector High Voltage Supply Cylinder 5	P216B	P0205	P216C	P124C
Direct Fuel Injector High Voltage Control Cylinder 6	P0276	P0206	P0277	P124D
Direct Fuel Injector High Voltage Supply Cylinder 6	P216E	P0206	P216F	P124D
Direct Fuel Injector High Voltage Control Cylinder 7	P0279	P0207	P0280	P124E

Direct Fuel Injector High Voltage Supply Cylinder 7	P217B	P0207	P217C	P124E
Direct Fuel Injector High Voltage Control Cylinder 8	P0282	P0208	P0283	P124F
Direct Fuel Injector High Voltage Supply Cylinder 8	P217E	P0208	P217F	P124F
DTC P0300 may also be present for all fault conditions				

Circuit/System Description

The engine control module (ECM) supplies voltage to each fuel injector on the injector high voltage supply circuits. The ECM energizes each fuel injector by grounding the high voltage control circuit of the fuel injector. The ECM monitors the status of the fuel injector high voltage supply circuits and the fuel injector high voltage control 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
- Engine is running.
- Ignition voltage is greater than 11 V.
- The DTCs run continuously when the above conditions are met.

Conditions for Setting the DTC

DTC P0201, P0202, P0203, P0204, P0205, P0206, P0207 or P0208

The engine control module detects the fuel injector control circuit is open for greater than 2 s.

DTC P0261, P0264, P0267, P0270, P0273, P0276, P0279 or P0282

The engine control module detects the fuel injector control circuit is shorted to ground for greater than 2 s.

DTC P0262, P0265, P0268, P0271, P0274, P0277, P0280 or P0283

The engine control module 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, P0205, P0206, P0207, P0208, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P279, P280, P0282 and P0283 are Type A DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P279, P280, P0282 and P0283 are Type A DTCs.

Diagnostic Aids

- The MIL indicator flashes when there is an engine misfire.
- High resistance in the circuits of the fuel injectors may set a misfire DTC without setting a fuel injector DTC. Test the fuel injector circuits of the affected cylinder(s) for a high resistance if you suspect a condition.
- 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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- **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 P062B is not set
 - **If DTC P062B is set**

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

- **If DTC P062B is not set**

NOTE: **The engine must be running for the injector circuit status parameters to function.**

3. Engine idling.
4. Verify with a scan tool the Cylinder 1-8 Injector Control Circuit Status parameters display OK or Not Run.
 - **If OK or Not Run is not displayed**

Refer to Circuit/System Testing.

- **If OK or Not Run is displayed**

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 P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P279, P280, P0282 or P0283 does not set.
7. Verify the DTC does not set.
 - **If any of the DTCs set**

Refer to Circuit/System Testing.

- **If none of the DTCs set**

8. All OK.

Circuit/System Testing

1. Ignition OFF, all vehicle systems OFF, disconnect the harness connector X3 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 direct fuel injector high voltage supply circuit and ground.
 - **If less than infinite resistance**
 1. Disconnect the harness connector of the appropriate Q17 Fuel Injector.

high voltage supply circuit and ground.

- If infinite resistance

3. Test for infinite resistance between the appropriate Q17 Fuel Injector direct fuel injector high voltage control circuit and ground.

- If less than infinite, repair the short to ground in the circuit.
- If infinite, test or replace the appropriate Q17 Fuel Injector.

- **If infinite resistance**

3. Ignition ON

4. Test for less than 1 V between the appropriate Q17 Fuel Injector direct fuel injector high voltage supply circuit and ground.

- **If 1 V or greater**

1. Disconnect the harness connector of the appropriate Q17 Fuel Injector, ignition ON.
2. Test for less than 1 V between the appropriate Q17 Fuel Injector direct fuel injector high voltage supply 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 direct fuel injector high voltage control circuit.

- **If less than 1 V**

5. Ignition OFF.

6. Test for less than 10 ohms between the appropriate Q17 fuel injector direct fuel injector high voltage supply circuit and direct fuel injector high voltage control circuit.

- **If 10 ohms or greater**

1. Disconnect the harness connector of the appropriate Q17 Fuel Injector.
2. Test for less than 2 ohms on the appropriate high voltage supply circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms
3. Test for less than 2 ohms on the appropriate high voltage control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, test or replace the Q17 Fuel Injector.

- **If less than 10 ohms**

7. Test or replace the K20 Engine Control Module.

Component Testing

NOTE: The engine coolant temperature (ECT) sensor must be between 10-32°C (50-90°F) for an accurate measurement.

1. Ignition OFF, disconnect the harness connector at the appropriate Q17 Fuel Injector.
2. Test for 1.06 ohms $\pm$ 10% @ 20°C (68°F) between the terminals of the Q17 Fuel Injector.
 - **If not within the specified range**

Replace the Q17 Fuel Injector.

- **If within the specified range**

3. Test for infinite resistance between each terminal and the Q17 Fuel Injector housing/case.

- **If less than infinite resistance**

Replace the Q17 Fuel Injector.

- **If infinite resistance**

4. All OK.

Repair Instructions

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

- **Fuel Injector Replacement**
- **Control Module References** for K20 Engine Control Module replacement, programming and setup.

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

Fuel Pump Control Circuit High Voltage

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	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 seconds, 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 greater than 11 V.
- The engine is cranking or running.
- The fuel pump enable circuit is commanded ON.
- The fuel pump power module output current is less than 75 A.
- The DTC runs continuously when the conditions above are met.

P0232

- The ignition voltage is greater than 7 V.
- The fuel pump enable circuit is commanded ON.
- The DTC runs continuously when the conditions above are met.

P023F

- The ignition voltage is greater than 7 V.
- The commanded duty cycle is between 30-60 %.
- The DTC runs continuously when the conditions above are met.

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 output circuit voltage is greater than 4.0 V for 1 s when the voltage should be 0 V.

P023F

The fuel pump driver control module detects that the fuel pump current is less than 1 A and the fuel pump duty cycle is approximately 30-60 % for 1 s.

Action Taken When the DTC Sets

DTCs P0231, P0232 and P023F are Type A DTCs.

Conditions for Clearing the DTC

DTCs P0231, P0232 and P023F 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.

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.

Reference Information

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- **Wiring Repairs**

DTC Type Reference

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.

- **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.

- **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 G12 Fuel Pump. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 5 ohms between the low reference circuit terminal 2 and ground.
 - **If 5 ohms or greater**
 1. Ignition OFF, disconnect the harness connector at the K111 Fuel Pump Driver Control Module.
 2. Test for less than 2 ohms in the low reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, test or replace the K111 Fuel Pump Driver Control Module.
 - **If less than 5 ohms**
3. Ignition ON, connect a test lamp between the supply voltage circuit terminal 1 and the low reference circuit terminal 2.
4. 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 supply voltage circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
3. Test for less than 2 ohms in the supply voltage circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, 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 supply voltage 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.
 - **If the test lamp turns ON and OFF**
5. Replace the G12 Fuel Pump.

Component Testing

1. Ignition OFF, disconnect the harness connector at the K111 Fuel Pump Driver Control Module.
2. Connect a DMM, set on 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. Verify the DMM displays between 0.4-0.8 V.
 - **If not between 0.4-0.8 V**

Replace the K111 Fuel Pump Driver Control Module.

- **If between 0.4-0.8 V**
4. Connect a DMM, set on 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. Verify the DMM displays between OL.
 - **If not OL**

Replace the K111 Fuel Pump Driver Control Module.

- **If OL**
6. All OK.

Repair Instructions

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

- **Fuel Tank Fuel Pump Module Replacement** for G12 Fuel Pump replacement.

programming and setup.

DTC P0300-P0308

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

DTC P0305

Cylinder 5 Misfire Detected

DTC P0306

Cylinder 6 Misfire Detected

DTC P0307

Cylinder 7 Misfire Detected

DTC P0308

Circuit/System Description

The engine control module (ECM) uses information from the crankshaft position sensor and the camshaft position sensors in order to determine when an engine misfire is occurring. By monitoring variations in the crankshaft rotation speed for each cylinder, the ECM is able to detect individual misfire events. A misfire rate that is high enough can cause 3-way catalytic converter damage. The malfunction indicator lamp (MIL) will flash ON and OFF when the conditions for catalytic converter damage are present. DTCs P0301 through P0308 correspond to cylinders 1 through 8. If the ECM is able to determine that a specific cylinder is misfiring, the DTC for that cylinder will set and the corresponding fuel injector is disabled and/or add fuel. The ECM will re-enable the fuel injector after 3 crankshaft revolutions (6 for manual transmission vehicles) to determine if a misfire is still present and either disable for 3 crankshaft revolutions (6 for manual transmission vehicles) again or stay enabled, depending on whether the misfire is still present.

Conditions for Running the DTC

- DTC 0010, P0011, P0013, P0014, P0016, P0017, P0018, P0019, P0020, P0021, P0023, P0024, P0068, P0090, P0091, P0093, P00CA, 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, P0345, P0346, P0365, P0366, P0390, P0391, P0443, P0449, P0452, P0453, P0454, P0601, P0604, P0606, P0651, P0697, P2088, P2089, P2090, P2091, P2135, P2771, P3401, P3403, P3404, P3409, P3411, P3412 or P3417 is not set.

AND

- DTC P0806, P0807 or P0808 is not set; with manual transmission.
- The engine speed is greater than 1, 400 RPM.

OR

- The engine speed is greater than 1, 000 RPM and DTC P0315 is set.
- The engine coolant temperature (ECT) is between -7 and +130°C (19 and 266°F).
- If the ECT is colder than -7°C (+19°F) at start-up, this diagnostic will not run until the ECT is between 21°C and 125°C (69 and 257°F).
- The ignition voltage is between 9 and 32 V.
- The vehicle is not in a decel condition.
- 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 decel fuel cut-off mode.
- DTCs P0300 through P0308 run continuously when the above conditions exist.
- The Active Fuel Management System is not active.
- The EGR Intrusive test is not active.

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, P0304, P0305, P0306, P0307, P0308

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-P0308 are Type B DTCs.
- The ECM may disable up to two fuel injector's of the misfiring cylinder's when a catalyst damaging level of misfire is present. And will flash the malfunction indicator lamp (MIL).

Conditions for Clearing the DTC

DTCs P0300-P0308 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 following possible sources:
 - 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
 - Cracked Spark Plug Insulators
 - Broken or weak valve spring
 - A damaged or defective accessory drive component or belt; remove the belt and safely operate the engine to evaluate if misfire counts go away.
- Observe misfire counters after Active Fuel Management is commanded off for a sticking lifter.
- 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.

Reference Information

Schematic 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

Special Tools

J 26792 HEI Spark Tester

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

Circuit/System Verification

NOTE: **Before starting vehicle, review freeze frame data to determine if misfire sets during cold start or warmed up operation. If the vehicle has a cold start problem and the vehicle is started, the vehicle will require to be not started for many hours before next attempt to operate the vehicle within the fail conditions.**

1. Engine idling at the normal operating temperature.
2. Verify there is no abnormal engine noise.
 - **If there is an abnormal engine noise**

Refer to **Symptoms - Engine Mechanical** .

- **If there is no abnormal engine noise**
3. Verify no DTCs other than P0300-P0308 are set.

- **If any DTCs other than P0300-P0308 are set**

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

- **If only DTCs P0300-P0308 are set**

Refer to Circuit/System Testing.

- **If no DTCs are set**

4. Verify the scan tool Cylinder 1-8 Current Misfire Counter parameters are not incrementing.

- **If a Counter is incrementing**

Refer to Circuit/System Testing.

- **If a Counter is not incrementing**

5. Engine idling.

6. Verify the engine speed changes when performing the Cylinder Power Balance Test with a scan tool.

- **If engine speed does not change**

Refer to Circuit/System Testing.

- **If engine speed does change**

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 DTCs are not set.

- **If any of the DTCs set**

Refer to Circuit/System Testing.

- **If none of the DTCs set**

9. All OK.

Circuit/System Testing

1. Perform the **Crankshaft Position System Variation Learn** procedure. Verify the scan tool displays Learned Successful.

- **If the scan tool did not display Learned Successful**

Inspect for the following conditions and repair as necessary:

- Worn crankshaft main bearings
- A damaged or misaligned reluctor wheel

- Interference in the signal circuit of the crankshaft position sensor
- The ignition switch is in the ON position until there is insufficient system voltage.
- An ECM power disconnect with the ignition ON that may have erased the crankshaft position system variation values and set DTC P0315
- Debris between the crankshaft position sensor and the reluctor wheel
- If the engine control module is still unable to complete the learn procedure, replace the K20 Engine Control Module..
- **If the scan tool displays Learned Successful**

2. Verify that the following conditions do not exist:

- 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.

- **If no conditions exist**

3. Ignition OFF, remove the T8 Ignition Coil of the misfiring cylinder, but leave the electrical connector connected.

4. Verify none of the conditions listed below exist with the boot of the T8 Ignition Coil:

- Holes
- Tears
- Carbon tracking
- Oil contamination
- Water intrusion
- **If a condition exists**

Repair or replace as necessary.

- **If no conditions exist**

5. Install the **J 26792 (EL 26792)** HEI Spark Tester to the boot of the T8 Ignition Coil and ground.

NOTE: **An erratic or weak spark is considered a no spark condition.**

6. Verify the **J 26792 (EL 26792)** HEI Spark Tester sparks while cranking or starting the engine.

- **If there is no spark**

Refer to **Electronic Ignition System Diagnosis** for diagnosis of the ignition coil.

- **If there is spark**

7. Verify none of the conditions listed below exist with the spark plug:

- Holes
- Tears
- Carbon tracking
- Oil contamination
- Water intrusion

- **If a condition exists**

Repair or replace as necessary.

- **If no conditions exist**

- 8. Exchange the suspected spark plug with another cylinder that is operating correctly.
- 9. Engine idling.
- 10. Verify the scan tool Cylinder 1-8 Current Misfire Counter parameter does not increment on the spark plug coil it was removed from.

- **If the misfire does follow the spark plug exchange**

Replace the spark plug.

- **If the misfire does not follow the spark plug exchange**

11. If all conditions test normal, test or inspect for the conditions listed below:

- A lean or rich Q17 Fuel Injector-Refer to **Fuel Injector Balance Test** .
- 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 idling, verify the scan tool Cylinder 1-8 Current Misfire Counter parameters do not increment.
 - If the misfire counter parameters are incrementing, a misfire 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 or DTC P0430. Refer to **DTC P0420 or P0430**.

DTC P0315

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 P0315

Crankshaft Position System Variation Not Learned

Circuit/System Description

The crankshaft position system variation learn feature 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 engine control module (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 conditions.

The crankshaft position system variation compensating values are stored in ECM memory after a learn procedure has been performed and the ignition switch is turned to the OFF position for at least 30 s. If the actual variation is not within the crankshaft position system variation compensating values stored in the ECM, DTC P0300 may set.

If the crankshaft position system variation values are not stored in the ECM memory or a proper ECM power down does not occur after completing the Crankshaft Position Learn Procedure, DTC P0315 sets.

Conditions for Running the DTC

DTC P0315 runs continuously.

Conditions for Setting the DTC

The ECM detects that the crankshaft position system variation values are not stored in memory.

Action Taken When the DTC Sets

DTC P0315 is a Type A DTC.

Conditions for Clearing the MIL/DTC

DTC P0315 is a 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

Schematic Reference

Engine Controls Schematics

Connector End Views

COMPONENT CONNECTOR END VIEWS - INDEX

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

NOTE: **The Crankshaft Position System Variation Learn Procedure may have to be repeated up to 5 times before the procedure is successful.**

1. Perform the **Crankshaft Position System Variation Learn** procedure. The scan tool should display Learned Successful.
 - **If, after 5 Crankshaft Position System Variation Learn Procedure attempts, the scan tool did not display Learned Successful;** inspect for the following conditions:
 - Worn crankshaft main bearings
 - A damaged or misaligned reluctor wheel
 - Excessive crankshaft runout
 - A damaged crankshaft-Refer to **Crankshaft and Bearing Cleaning and Inspection** .
 - Interference in the signal circuit of the crankshaft position sensor

- The ignition switch is in the ON position until there is insufficient system voltage.
 - An ECM power disconnect with the ignition ON that may have erased the crankshaft position system variation values and set DTC P0315
 - Debris between the crankshaft position sensor and the reluctor wheel
 - **If a condition is found**
 - Repair or replace the affected component as necessary.
 - Perform the Crankshaft Position System Variation Learn Procedure.
 - **If no condition is found**
 - Replace the K20 engine control module.
 - Perform the Crankshaft Position System Variation Learn Procedure.
2. 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.
 3. Verify the DTC is not set.
 - **If any of DTC sets**

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

- **If none of the DTCs set**
4. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after using this diagnostic procedure.

Control Module References for engine control module replacement, programming and setup

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

Knock Sensor Performance Bank 1

DTC P0331

Knock Sensor Performance Bank 2

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 Signal	P0327	P0325	P0328	P0326
Knock Sensor 2 Signal	P0332	P0330	P0333	P0331
Knock Sensor 1 Low Reference	P0327	P0325, P06B6	P0328	P0326
Knock Sensor 2 Low Reference	P0332	P0330, P06B7	P0333	P0331

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 the two knock sensor signals through 2 isolated circuits. The ECM learns a minimum knock sensor noise level for all of the engine speed ranges. The ECM monitors for a normal knock sensor signal. The ECM monitors the two internal knock sensor processors by verifying a 20 KHz signal generated on the signal circuits is detected on the sensors' low reference circuits.

Conditions for Running the DTCs

P0324, P0326 and P0331-Condition 1

- Engine speed is between 400 and 8, 500 RPM.
- Engine is running for greater than 2 s.
- The engine coolant temperature (ECT) is warmer than -40°C (-40°F).
- The intake air temperature (IAT) sensor 1 is warmer than -40°C (-40°F).
- The DTCs run continuously when the above conditions are met.

-
- Engine speed is greater than 2, 200 RPM.
 - Engine is running for greater than 1 s.
 - The ECT is warmer than -40°C (-40°F).
 - The IAT sensor 1 is warmer than -40°C (-40°F).
 - The DTCs run continuously when the above conditions are met.

P06B6 and P06B7

- Engine speed is between 400 and 4, 000 RPM.
- Engine is running greater than 2 s.
- The DTCs run continuously when the above conditions are met.

Conditions for Setting the DTCs

P0324

The ECM detects that the knock sensor signal's performance is out of the normal expected range due to an excessive engine knock or abnormal noise or a flat signal; in at least a single cylinder.

P0326 and P0331

- The ECM detects that the knock sensor signal indicates the sensor harness is connected, but the sensor is not properly bolted to the engine.

OR

- The ECM detects that the knock sensor signal indicates an excessive engine knock is present.

P06B6 and P06B7

The ECM has detected an internal knock sensor processor fault.

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

Schematic Reference

Engine Controls 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. Engine running, observe the DTC information with a scan tool.
3. Verify DTC P0325, P0327, P0328, P0330, P0332, P0333, P06B6 and 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** for further diagnosis.

- **If only DTC P06B6 or P06B7 is set**

Verify that no external knock sensor circuit issues exist, then; replace the K20 Engine Control Module.

- **If none of the DTCs is set**

4. Vehicle OFF, inspect for the following:
 - The affected B68 Knock Sensor for physical damage. A sensor that is dropped or damaged may cause a DTC to set
 - The sensor for proper installation. A sensor that is loose or not at the correct torque may cause a DTC to set. Refer to **Fastener Tightening Specifications** .
 - The sensor mounting surface for burrs, casting flash and foreign material
 - The sensor must be clear of hoses, brackets and engine electrical wiring
 - Loose brackets

- Loose or broken accessory drive belts, brackets, components
- An engine mechanical condition-Refer to **Symptoms - Engine Mechanical**
- **If a condition is found**

Repair or replace component as appropriate.

- **If no condition is found**

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 any of the DTCs set**

Test or replace the B68 Knock Sensor.

- **If none of the DTCs set**

6. All OK.

Repair Instructions

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

- **Knock Sensor 1 Replacement**
- **Knock Sensor 2 Replacement**
- **Control Module References** for engine control module replacement, programming and setup.

DTC P0325, P0327, P0328, P0330, P0332 OR P0333

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 P0325

Knock Sensor Circuit Bank 1

DTC P0327

Knock Sensor Circuit Low Voltage Bank 1

DTC P0328

DTC P0330

Knock Sensor Circuit Bank 2

DTC P0332

Knock Sensor Circuit Low Voltage Bank 2

DTC P0333

Knock Sensor Circuit High Voltage Bank 2

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Knock Sensor 1 Signal	P0327	P0325	P0328	P0326
Knock Sensor 2 Signal	P0332	P0330	P0333	P0331
Knock Sensor 1 Low Reference	P0327	P0325, P06B6	P0328	P0326
Knock Sensor 2 Low Reference	P0332	P0330, P06B7	P0333	P0331

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 the two knock sensor signals through 2 isolated circuits. The ECM learns a minimum knock sensor noise level for all of the engine speed ranges. The ECM monitors for a normal knock sensor signal. The ECM monitors the two internal knock sensor processors by verifying a 20 KHz signal generated on the signal circuits is detected on the sensors' low reference circuits.

Conditions for Running the DTCs

P0325 and P0330

- Engine speed is between 500 and 8,500 RPM.
- Engine is running at least 2 s.
- The ECT is warmer than -40°C (-40°F).
- The IAT sensor 1 is warmer than -40°C (-40°F).
- The DTCs run continuously when the above conditions are met.

-
- Engine speed is less than 8, 500 RPM.
 - The DTCs run continuously when the above condition is met.

Conditions for Setting the DTCs

P0325 and P0330

The ECM detects that a knock sensor signal circuit is open for longer than 6 s.

P0327 and P0332

The ECM detects that a knock sensor signal circuit is shorted to ground for longer than 6 s.

P0328 and P0333

The ECM detects that a knock sensor signal circuit is shorted to voltage for longer than 6 s.

Action Taken When the DTCs Set

- DTCs P0325, P0327, P0328, P0330, P0332 and P0333 are Type B DTCs.
- The ignition timing is retarded to reduce the potential of engine damaging spark knock.

Conditions for Clearing the DTCs

DTCs P0325, P0327, P0328, P0330, P0332 and P0333 are Type B DTCs.

Diagnostic Aids

- Inspect the affected knock sensor for physical damage. A sensor that is dropped or damaged may cause a DTC to set.
- The sensor mounting surface must be free of burrs, casting flash and foreign material.
- The sensor must be clear of hoses, brackets and engine electrical wiring.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

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

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Engine running.
2. Verify that DTC P0325, P0327, P0328, P0330, P0332, P0333, P06B6 and P06B7 are not set.
 - **If any of the DTCs are set**

Refer to Circuit/System Testing
 - **If only DTC P06B6 or P06B7 is set**

Replace the K20 Engine Control Module.
 - **If none of the DTCs are set**
3. Verify the affected B68 Knock Sensor is properly tightened. Refer to **Fastener Tightening Specifications** .
4. Move the related harnesses and connectors on the affected knock sensor circuits while observing the scan tool parameters listed below. The parameters should display NO.
 - Cylinder 1 Knock Detected
 - Cylinder 2 Knock Detected
 - Cylinder 3 Knock Detected
 - Cylinder 4 Knock Detected
 - Cylinder 5 Knock Detected
 - Cylinder 6 Knock Detected
 - Cylinder 7 Knock Detected
 - Cylinder 8 Knock Detected
 - **If the parameters change**

Repair the wiring or the harness connectors.
 - **If none of the parameters changes**

within the conditions that you observed from the freeze frame/failure Records data.

6. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the B68 Knock Sensor, ignition ON.
2. Test for 1-2 V between the low reference circuit terminal 2 and ground.
 - **If 1 V or less**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the low reference circuit terminal 2 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance.
 3. Test for less than 2 ohms in the low reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.
 - **If greater than 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 low 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.
 - **If between 1-2 V**
3. Test for 2.5-3.5 V between the signal circuit terminal 1 and ground.
 - **If 2 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.
 - If infinite resistance.
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.
 - **If greater than 4 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.
 - **If between 2.5-3.5 V**
4. Test or replace the B68 Knock Sensor

Repair Instructions

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

- **Knock Sensor 1 Replacement**
- **Knock Sensor 2 Replacement**
- **Control Module References** for engine control module replacement, programming and setup.

DTC P0335 OR P0336

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 P0335

Crankshaft Position Sensor Circuit

DTC P0336

Crankshaft Position Sensor Performance

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P057C, P0651	P0335	P0651	P0336
Signal	P0335	P0335	P0335	P0336
Low Reference	-	P0335	-	P0336

Circuit/System Description

The crankshaft position sensor circuits consist of an engine control module (ECM) supplied 5 V reference circuit, low reference circuit and an output signal circuit. The crankshaft position sensor is an internally magnetic biased digital output integrated circuit sensing device. The sensor detects magnetic flux changes of the teeth and slots of a 58-tooth reluctor wheel on the crankshaft. Each tooth on the reluctor wheel is spaced at 60-tooth spacing, with 2 missing teeth for the reference gap. The crankshaft position sensor produces an ON/OFF DC voltage of varying frequency, with 58 output pulses per crankshaft revolution. The frequency of the crankshaft position sensor output depends on the velocity of the crankshaft. The crankshaft position sensor sends a digital signal, which represents an image of the crankshaft reluctor wheel. to the ECM as each tooth on the wheel rotates past the

crankshaft position sensor. The ECM uses each crankshaft position signal pulse to determine crankshaft speed and decodes the crankshaft reluctor wheel reference gap to identify crankshaft position. This information is then used to determine the optimum ignition and injection points of the engine. The ECM also uses crankshaft position sensor output information to determine the camshaft relative position to the crankshaft, to control camshaft phasing and to detect cylinder misfire.

Conditions for Running the DTC

P0335 Condition 1

- The starter is engaged and the engine control module detects camshaft position sensor pulses.

Or

- DTCs P0101, P0102 and P0103 are not set.

And

- The airflow into the engine is greater than 3 g/s.

Condition 2

- The engine is running.
- The starter is not engaged.

Condition 3

- The engine is running or the starter is engaged.
- DTCs P0340 and P0341 are not set.

P0336 Condition 1

- The airflow into the engine is greater than 3 g/s.
- Engine speed is greater than 450 RPM.
- DTCs P0335 is not set.

Condition 2

- The engine is running.
- The starter is not engaged.

Condition 3

- The starter is engaged and the engine control module detects camshaft position sensor pulses.

-
- DTCs P0101, P0102 and P0103 are not set.
 - The airflow into the engine is greater than 3 g/s.

Condition 4

- The engine is running or the starter is engaged.
- DTCs P0340 and P0341 are not set.

The DTCs run continuously once the above conditions are met.

Conditions for Setting the DTC

P0335 Condition 1

The ECM does not detect a crankshaft position sensor pulse for greater than 4 s.

Condition 2

The ECM does not detect a crankshaft position sensor pulse for greater than 0.3 s.

Condition 3

The ECM does not detect a crankshaft position sensor pulse for 2 out of 10 engine revolutions.

P0336 Condition 1

The ECM detects that 10 or more crankshaft resynchronization have occurred within 10.0 s.

Condition 2

The ECM does not detect the synchronization gap on the reluctor wheel for greater than 0.4 s.

Condition 3

The ECM does not detect the synchronization gap on the reluctor wheel for 1.5 s after the starter was engaged.

Condition 4

The ECM detects less than 51 or greater than 65 crankshaft position sensor pulses during 1 engine revolution for 8 out of 10 engine revolutions.

Action Taken When the DTC Sets

- DTCs P0335 and P0336 are Type B DTCs.
- The camshaft position sensor is used to determine engine position.

-
- The camshaft actuators are commanded to the parked position.

Conditions for Clearing the DTC

DTCs P0335 and P0336 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Electronic Ignition System Description

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify DTC P0651 is not set.
 - **If the DTC is set**

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

- **If the DTC is not set**
3. Engine Running.

4. Verify the scan tool Crankshaft Position Active Counter parameter increments.

- **If the counter does not increment**

Refer to Circuit/System Testing.

- **If the counter increments**

5. Verify the scan tool Crankshaft Position Resync Counter parameter displays 0 counts and the engine does not stumble or stall while moving the related harness/connectors of the B26 Crankshaft Position Sensor.

- **If greater than 0 counts and the engine stumbles or stalls**

Refer to Circuit/System Testing.

- **If 0 counts and the engine does not stumble or stall**

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.

- **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 B26 Crankshaft Position Sensor. It may take up to 2 minutes for all vehicle systems to power down.

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

- **If 5 ohms or greater**

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

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

- If 2 ohms or greater, repair the open/high resistance in the circuit.

- If 2 ohms or less, replace the K20 Engine Control Module.

- **If less than 5 ohms**

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 X3 harness connector at the K20 Engine Control Module.

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

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

- If infinite resistance
- 3. Test for less than 2 ohms in the 5 V reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.
- **If greater than 5.2 V**
- 1. Ignition OFF, disconnect the X3 harness connector at the K20 Engine Control Module, ignition ON.
- 2. Test for less than 1 V between the 5 V reference 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.
- **If between 4.8-5.2 V**
- 5. Test for 4.8-5.2 V between the signal circuit terminal 1 and ground.
 - **If less than 4.8 V**
 - 1. Ignition OFF, disconnect the X3 harness connector at the K20 Engine Control Module.
 - 2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance.
 - 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.
 - **If greater than 5.2 V**
 - 1. Ignition OFF, disconnect the X3 harness connector at the K20 Engine Control Module, 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.
 - **If between 4.8-5.2 V**
- 6. Ignition OFF, connect a 3 A fused jumper wire to the signal circuit terminal 1, ignition ON.

NOTE: Additional DTCs may set when performing this test.

- 7. Verify the scan tool Crankshaft Position Sensor Active Counter parameter increments while rapidly tapping the fused jumper wire end to ground.
 - **If the counter does not increment**
 - Replace the K20 Engine Control Module.
 - **If the counter increments**
- 8. Verify DTC P0336 is not set.

- **If the DTC is set**

Inspect for the conditions listed below:

- Excessive play or looseness of the B26 Crankshaft Position Sensor or the reluctor wheel
- Improper installation of the B26 Crankshaft Position Sensor
- Foreign material passing between the B26 Crankshaft Position Sensor and the reluctor wheel
- Damaged reluctor wheel
- Excessive air gap between the B26 Crankshaft Position Sensor and the reluctor wheel
- Engine oil for debris
- Timing chain, tensioner and sprockets for wear or damage
- If any of the conditions above are found, repair as necessary.
- If all components test normal, test or replace the B26 Crankshaft Position Sensor.
- **If the DTC is not set**

9. Test or replace the B26 Crankshaft Position Sensor.

Repair Instructions

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

- **Crankshaft Position Sensor Replacement**
- **Control Module References** for engine control module replacement, programming and setup