

2018 ENGINE PERFORMANCE

Engine Controls And Fuel - 3.6L (LFY) - Diagnostic Information And Procedures (P0010 - P2316) - Traverse

DIAGNOSTIC INFORMATION AND PROCEDURES

DTC P0010, P0011, P0013, P0014, P0020, P0021, P0023, P0024, P2088, P2089, P2090, P2091, P2092, P2092, P2093, P2094, OR P2095

Diagnostic Instructions

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

DTC Descriptor

DTC P0010

Intake Camshaft Position Actuator Solenoid Valve Control Circuit Bank 1

DTC P0011

Intake Camshaft Position System Performance Bank 1

DTC P0013

Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit Bank 1

DTC P0014

Exhaust Camshaft Position System Performance

DTC P0020

Intake Camshaft Position Actuator Solenoid Valve Control Circuit Bank 2

DTC P0021

Intake Camshaft Position System Performance Bank 2

DTC P0023

Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit Bank 2

DTC P0024

Exhaust Camshaft Position System Performance Bank 2

DTC P2088

Intake Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage Bank 1

DTC P2089

Intake Camshaft Position Actuator Solenoid Valve Control Circuit High Voltage Bank 1

DTC P2090

DTC P2091

Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit High Voltage Bank 1

DTC P2092

Intake Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage Bank 2

DTC P2093

Intake Camshaft Position Actuator Solenoid Valve Control Circuit High Voltage Bank 2

DTC P2094

Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage Bank 2

DTC P2095

Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit High Voltage Bank 2

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Control	P0010, P0013, P0020, P0023, P2088, P2090, P2092, P2094	P0010, P0013, P0020, P0023	P0010, P0013, P0020, P0023, P2089, P2091, P2093, P2095	P0011, P0014, P0021, P0024
Low Reference	-	P0010, P0013, P0020, P0023	-	P0011, P0014, P0021, P0024

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

Circuit	Description
Control	The output circuit is switched to 12 V to activate the component.
Low Reference	Grounded through the control module.

Component	Description
K20 Engine Control Module	The control module controls a series of actuators to ensure optimal engine performance. The control module does this by reading values from a variety of sensors, interprets the data and adjusts the engine actuators accordingly.
Q6 Camshaft Position Actuator Solenoid Valve	A solenoid valve is an electro-mechanically operated valve. The valve is controlled by an electric current through the solenoid.

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

Conditions for Running the DTC**P0010, P0013, P0020, P0023, P2088 - P2095**

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

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

P0011, P0014, P0021, P0024

- DTC P0010, P0013, P0020, P0023, P2088, P2089, P2090, P2091, P2092, P2093, P2094, P2095 = Not set
- Camshaft Position Actuator Solenoid Valve = On
- Desired Camshaft Position & Camshaft Position = 5 to 20°
- Desired Camshaft Position = Does not vary greater than 4.5° - For greater than 1 s
- Engine = Running
- Ignition Voltage = Greater than 11 V

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

Conditions for Setting the DTC

P0010, P0013, P0020, P0023, P2088 - P2095

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

P0011, P0014, P0021, P0024

Desired Camshaft Position & Camshaft Position = Not within 8° of each other - For greater than 30 s

Actions Taken When the DTC Sets

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

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

Conditions for Clearing the DTC

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

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

Diagnostic Aids

Inspect the engine for any recent mechanical repairs. An incorrectly installed camshaft, camshaft actuator, or timing belt/chain can cause this DTC to set.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

Powertrain Component Views

Electrical Information Reference

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

DTC Type Reference

Scan Tool Reference

Control Module References

Circuit/System Verification

NOTE:

- The engine oil level and the oil pressure are critical to the correct operation of the system.
- Engine oil condition has a major impact on the camshaft actuator system.
- If a crankshaft or camshaft position sensor DTC is set, the scan tool camshaft position actuator output control will be disabled.

1. Ignition - On / Vehicle - In Service Mode

2. Verify DTC P0335, P0336, P0340, P0341, P0365, P0366 is not set.

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

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

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

3. Verify the following conditions do not exist :

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

Repair as necessary

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

4. Engine - Idling

5. Perform the appropriate scan tool control function :

- Exhaust Camshaft Position Actuator - From 0 to 10° and back to 0°.
- Intake Camshaft Position Actuator - From 0 to 10° and back to 0°.
- Verify the appropriate scan tool parameter :
- Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage Test Status = OK or Not Run
- Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit Open Test Status = OK or Not Run
- Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit High Voltage Test Status = OK or Not Run
- Intake Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage Test Status = OK or Not Run
- Intake Camshaft Position Actuator Solenoid Valve Control Circuit Open Test Status = OK or Not Run
- Intake Camshaft Position Actuator Solenoid Valve Control Circuit High Voltage Test Status = OK or Not Run
- **If not the specified state**

Refer to : Circuit/System Testing

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

6. Perform the appropriate scan tool control function :

- Exhaust Camshaft Position Actuator - From 0 to 10° and back to 0°.
- Intake Camshaft Position Actuator - From 0 to 10° and back to 0°.

- Verify the appropriate scan tool parameter :
- Exhaust Camshaft Position Variance = Less than 2° - During each of the commanded states
- Intake Camshaft Position Variance = Less than 2° - During each of the commanded states
- **If 2° or greater**

Refer to : Circuit/System Testing

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

7. Perform the appropriate scan tool control function :

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

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

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

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

Verify the DTC does not set.

- **If the DTC sets**

Refer to : Circuit/System Testing

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

9. All OK.

Circuit/System Testing

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

1. Ignition/Vehicle & All vehicle systems - Off
2. Disconnect the appropriate electrical connector : Q6 Camshaft Position Actuator Solenoid Valve
3. Test for less than 10 ohms between the test points : Low Reference circuit terminal 2/B & Ground
 - **If 10 ohms or greater**
 1. Disconnect the appropriate electrical connector : K20 Engine Control Module
 2. Test for less than 2 ohms between the test points : Low Reference circuit terminal 2/B @ Component harness & The other end of the circuit @ Control module harness
 - If 2 ohms or greater - Repair the open/high resistance in the circuit.
 - If less than 2 ohms - Replace the component : K20 Engine Control Module
 - **Go to next step : If less than 10 ohms**
4. Connect a test lamp between the test points : Control circuit terminal 1/A & Low Reference circuit terminal 2/B
5. Engine - Running
6. Perform the appropriate scan tool control function :
 - Exhaust Camshaft Position Actuator Solenoid Valve - On and Off
 - Intake Camshaft Position Actuator Solenoid Valve - On and Off

Verify the test lamp turns On and Off.

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

1. Ignition/Vehicle - Off & Remove - Test lamp
2. Disconnect the appropriate electrical connector : K20 Engine Control Module
3. Test for infinite resistance between the test points : Control circuit terminal 1/A @ Component harness & Ground
 - If less than infinite resistance - Repair the short to ground on the circuit.
 - Go to next step : If infinite resistance
4. Test for less than 2 ohms between the test points : Control circuit terminal 1/A @ Component harness & The other end of the circuit @ Control module harness
 - If 2 ohms or greater - Repair the open/high resistance in the circuit.
 - If less than 2 ohms - Replace the component : K20 Engine Control Module

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

1. Ignition/Vehicle - Off & Remove - Test lamp
2. Disconnect the appropriate electrical connector : K20 Engine Control Module
3. Ignition - On / Vehicle - In Service Mode
4. Test for less than 1 V between the test points : Control circuit terminal 1/A @ Component harness & Ground
 - If 1 V or greater - Repair the short to voltage on the circuit.
 - If less than 1 V - Replace the component : K20 Engine Control Module

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

7. Verify DTC P0011, P0014, P0021, P0024 is not set.

- **If the DTC is set**

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

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

1. Swap the two components :
 - Q6E Camshaft Position Actuator Solenoid Valve - Exhaust
 - Q6F Camshaft Position Actuator Solenoid Valve - Intake
2. Engine - Running

NOTE:

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

3. Perform the scan tool control function :
 - Exhaust Camshaft Position Actuator - From 0 to 10° and back to 0°.
 - Intake Camshaft Position Actuator - From 0 to 10° and back to 0°.
 - Verify the scan tool parameter :
 - Exhaust Camshaft Position Variance = Less than 2° - During each of the commanded states

- Intake Camshaft Position Variance = Less than $2\hat{A}^{\circ}$ - During each of the commanded states
- If $2\hat{A}^{\circ}$ or greater - Replace the component : Camshaft Position Actuator
- If less than $2\hat{A}^{\circ}$ - Replace the component : Q6 Camshaft Position Actuator Solenoid Valve - The original component that set the DTC
- **Go to next step : If the DTC is not set**

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

Component Testing

Static Test

1. Ignition/Vehicle - Off
2. Disconnect the appropriate electrical connector : Q6 Camshaft Position Actuator Solenoid Valve
3. Test for 6 to 12 ohms between the test points : Control terminal 1/A & Low Reference terminal 2/B
 - **If not between 6 and 12 ohms**
Replace the component : Q6 Camshaft Position Actuator Solenoid Valve
 - **Go to next step : If between 6 and 12 ohms**
4. Test for infinite resistance between the test points : Each terminal of the component & The component's housing
 - **If less than infinite resistance**
Replace the component : Q6 Camshaft Position Actuator Solenoid Valve
 - **Go to next step : If infinite resistance**
5. All OK.

Dynamic Test

1. Ignition/Vehicle - Off
2. Disconnect the appropriate electrical connector : Q6 Camshaft Position Actuator Solenoid Valve
3. Connect a jumper wire between the test points : Low Reference terminal 2/B & Ground
4. Momentarily connect a 7.5 A fused jumper wire between the test points : Control terminal 1/A & B+

Verify the component produces a clicking sound : Q6 Camshaft Position Actuator Solenoid Valve

- **If the component does not produce a sound**
Replace the component : Q6 Camshaft Position Actuator Solenoid Valve
 - **Go to next step : If the component produces a sound**
5. All OK.

Repair Instructions

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

- [Camshaft Position Actuator Replacement - Bank 1](#)
- [Camshaft Position Actuator Replacement - Bank 2](#)
- [Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 \(Right Side\) Exhaust](#)
- [Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 \(Left Side\) Exhaust](#)
- [Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 \(Right Side\) Intake](#)

- [Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 \(Left Side\) Intake](#)
- For control module replacement, programming, and setup refer to : [Control Module References](#)

DTC P0016, P0017, P0018, OR P0019

Diagnostic Instructions

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

DTC Descriptor

DTC P0016

Crankshaft Position - Intake Camshaft Position Not Plausible Bank 1

DTC P0017

Crankshaft Position - Exhaust Camshaft Position Not Plausible Bank 1

DTC P0018

Crankshaft Position - Intake Camshaft Position Not Plausible Bank 2

DTC P0019

Crankshaft Position - Exhaust Camshaft Position Not Plausible Bank 2

Circuit/System Description

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

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

Conditions for Running the DTC

- DTC P0335, P0336, P0340, P0341, P0345, P0346, P0365, P0366, P0390, P0391, P0641, P0651 = Not set
- Engine = Cranking or Running
- Crankshaft Position Sensor & Camshaft Position Sensor = Synchronized
- Camshaft Position Actuator = Park position

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

Conditions for Setting the DTC

The deviation of the relative camshaft position is greater than -9° in one direction or greater than 9° in the other direction (measured in degrees of the crankshaft).

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type B DTC

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type B DTC

Reference Information

DTC Type Reference

Scan Tool Reference

Control Module References

Circuit/System Verification

NOTE: The engine oil level and condition is critical to the correct operation of the system. The engine oil condition has a major impact on the camshaft actuator system. Debris in the oil can interfere with the camshaft position actuator solenoid valve and the mechanical camshaft actuator operation. Inspect for dirty or degraded engine oil.

1. Ignition - On / Vehicle - In Service Mode
2. Verify DTC P0010, P0013, P0020, P0023, P0335, P0336, P0340, P0341, P0345, P0346, P0365, P0366, P0390, P0391, P2088, P2089, P2090, P2091, P2092, P2093, P2094, P2095 is not set.

- If any of the DTCs are set

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

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

3. Engine - Idling - At normal operating temperature.
4. Verify DTC P0016, P0017, P0018, or P0019 is not set.

- If the DTC is set

1. Ignition/Vehicle - Off

2. Verify the following conditions do not exist :

- B23 Camshaft Position Sensor - Incorrect installation
- B26 Crankshaft Position Sensor - Incorrect installation
- Q6 Camshaft Position Actuator Solenoid Valve - Incorrect installation/Stuck Closed/Stuck Open
- Reluctor Ring - Misaligned @ Crankshaft
- Timing Belt or Timing Chain - Excessive play
- Timing Belt Tensioner or Timing Chain Tensioner - Incorrect installation
- If a condition exists - Repair or replace as necessary
- If none of the conditions exists - Refer to step 2.

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

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

Verify the DTC does not set.

- If the DTC sets

One of the above conditions still exist.

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

6. All OK.

Repair Instructions

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

- **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Intake**
- **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Intake**

- [Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 \(Right Side\) Exhaust](#)
- [Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 \(Left Side\) Exhaust](#)
- [Camshaft Position Sensor Replacement - Bank 1 \(Right Side\) Intake](#)
- [Camshaft Position Sensor Replacement - Bank 2 \(Left Side\) Intake](#)
- [Camshaft Position Sensor Replacement - Bank 1 \(Right Side\) Exhaust](#)
- [Camshaft Position Sensor Replacement - Bank 2 \(Left Side\) Exhaust](#)
- [Crankshaft Position Sensor Replacement \(AWD\) Crankshaft Position Sensor Replacement \(FWD\)](#)
- [Timing Chain Alignment Diagram](#)
- [Camshaft Timing Drive Components Cleaning and Inspection](#)

DTC P0030, P0031, P0032, P0036, P0037, P0038, P0050, P0051, P0052, P0053, P0054, P0056, P0057, P0058, P0059, P0060, P0135, P0141, P0155, P0161, P103B, OR P103C

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

DTC P103B

HO2S Heater Supply Voltage Sensing Circuit Performance

DTC P103C

HO2S Heater Supply Voltage Sensing Circuit Low Voltage

Diagnostic Fault Information

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

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
HO2S Heater Voltage Supply	P0030, P0031, P0036, P0037, P0050, P0051, P0054, P0056, P0057, P0059, P0060, P0097, P00F4, P0102, P0132, P0135, P0138, P0141, P0152, P0155, P0158, P0161, P2199 *	P0030, P0031, P0036, P0037, P0050, P0051, P0054, P0056, P0057, P0059, P0060, P0132, P0134, P0135, P0138, P0140, P0141, P0152, P0154, P0155, P0158, P0160, P0161	P0690	P0135, P0141, P0155, P0161, P103B, P103C
HO2S Heater Control	P0030, P0031, P0036, P0037, P0050, P0051, P0053, P0054, P0056, P0057, P0059, P0060, P0135, P0141, P0155, P0161	P0030, P0036, P0050, P0056, P0132, P0134, P0135, P0137, P0138, P0140, P0141, P0152, P0154, P0155, P0158, P0160, P0161	P0030, P0032, P0036, P0038, P0050, P0052, P0056, P0058, P0132, P0134, P0135, P0138, P0140, P0141, P0152, P0154, P0155, P0158, P0160, P0161, P0690, P16B3	P0135, P0141, P0155, P0161, P103B, P103C

* Opens Fuse

Typical Scan Tool Data

HO2S Sensor 1 Current / HO2S Sensor 2 Current

Circuit	Short to Ground	Open	Short to Voltage
Parameter Normal Range: 0.2 - 1.5 A			
HO2S Heater Low Control	0 A	0 A	0 A
HO2S Heater Voltage Supply	0 A	0 A	0.2 - 2 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 greater than 11 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 P0116, P0117, P0118, P0119, P0128, P111E or P262B are not set.
- The engine run time is less than 0.06 s.
- The Ignition voltage is less than 32 V.
- The ignition is OFF for greater than 8 h.

- The engine coolant temperature (ECT) is greater than -30°C (-22°F).
- 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 greater than 10 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.

P103B and P103C

- The Ignition voltage is between 10 - 32 V.
- The engine is cranking or running.
- The heater supply circuit is within 2 V of the ignition voltage.
- The DTCs run continuously when the above conditions are met for greater than 3 s.

Conditions for Setting the DTC

P0030, P0036, P0050, or P0056

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.

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 13 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 13 s.

P0053, P0054, P0059, or P0060

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

P0135 or P0155

The ECM detects that the HO2S 1 heater current is greater than 3.1 A, or less than 0.3 A for greater than 8 s.

P0141 or P0161

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

P103B

The heater supply circuit is not within 2 V of the ignition voltage.. for greater than 3 s

P103C

The ECM detects the HO2S heater supply voltage is less than 6 V for greater than 3 s.

Action Taken When the DTC Sets

DTCs P0030-P0032, P0036-P0038, P0050-P0054, P0056-P0060, P0135, P0141, P0155, P0161, P103B, and P103C are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0030-P0032, P0036-P0038, P0050-P0054, P0056-P0060, P0135, P0141, P0155, P0161, P103B, and P103C are Type B DTCs.

Diagnostic Aids

- If the condition is intermittent, move the related harnesses and connectors, with the engine operating, while monitoring the scan tool circuit status parameters for the component. The circuit status parameters will change from OK or Not Run to Malfunction if there is a condition with the circuit or a connection.
- An open fuse in the heated oxygen sensor heater circuit may be caused by the heater element in one of the sensors. The condition may not be present until the sensor operates for a period of time. If no fault is present in the heater circuit, monitor the amperage of each heater with a scan tool to determine if one of the heater elements is the cause of the open fuse. Inspect the sensor pigtail or the harness for contacting the exhaust system.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Engine running.
2. Verify the parameters listed below do not display Malfunction :
 - 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.
 - **Go to next step : If Malfunction is not displayed**
3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
4. Verify the DTC does not set.
 - **If the DTC sets**

Refer to Circuit/System Testing.

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

5. All OK.

Circuit/System Testing

1. Ignition OFF, 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/Vehicle - Off & Remove - Test lamp
 2. Test for less than 2 Ω in the ignition circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition/Vehicle - Off & Remove - Test lamp
 2. Test for infinite resistance between the ignition circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, test all components connected to the fuse and replace as necessary.
 - **Go to next step : If the test lamp illuminates**
3. Verify DTC P103B, P103C is not set.
 - **If a related DTC is set**
 1. Ignition/Vehicle OFF
 2. Disconnect the electrical connector : X2 @ K20 Engine Control Module
 3. Disconnect the electrical connector : B52A Heated Oxygen Sensor-Bank 1 Sensor 1 or B52B Heated Oxygen Sensor - Bank 1 Sensor 2
 4. Test for less than 2 ohms between the test points : Ignition circuit terminal 2 @ B52D Heated Oxygen Sensor-Bank 1 Sensor 2 or B52F Heated Oxygen Sensor - Bank 2 Sensor 2. (harness side) & Terminal 28 X2 @ Control module harness
 - If 2 ohms or greater - Repair the open/high resistance in the circuit.
 - If less than 2 ohms - Test or replace the component : K20 Engine Control Module
 - **Go to next step : If a related DTC is not set**
4. 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.
 - **Go to next step : If the test lamp does not illuminate**
5. Remove the test lamp.
6. Verify the scan tool HO2S 1 or 2 Heater Control Circuit High Voltage Test Status parameter is OK when commanding the HO2S Heater Sensor 1 or 2 ON with a scan tool.
 - **If OK is not displayed**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
 2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.
 - **Go to next step : If OK is displayed**

NOTE:

- **Less than 10 Ω 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.

7. 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.

8. Verify the scan tool HO2S 1 or 2 Heater Control Circuit High Voltage Test Status parameter is Malfunction when commanding the HO2S Heater Sensor 1 or 2 ON with a scan tool.

- **If Malfunction is not displayed**

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

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

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

- **Go to next step : If Malfunction is displayed**

9. 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 \(AWD\). Heated Oxygen Sensor Replacement - Bank 1 Sensor 2 \(FWD\)](#)
- [Heated Oxygen Sensor Replacement - Bank 2 Sensor 1](#)
- [Heated Oxygen Sensor Replacement - Bank 2 Sensor 2 \(AWD\). Heated Oxygen Sensor Replacement - Bank 2 Sensor 2 \(FWD\)](#)
- 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 P0101, P0102, P0103, P0107, P0108 P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0128, P0335, or P0336 are not set
- The engine speed is between 500 - 6, 800 RPM
- The engine coolant temperature (ECT) is between -7 to +125Â°C (-4 to +257Â°F).
- The intake air temperature (IAT) sensor 1 is between -20 to +125Â°C (-4 to +257Â°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 Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

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Powertrain Component Views

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify that DTC 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.

- **Go to next step : 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 Inspection and Cleaning](#) .

- **Go to next step : 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.

- **Go to next step : 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.

- **Go to next step : 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.

- **Go to next step : 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**

Refer to Circuit/System Testing.

- **Go to next step : 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 conditions listed below exist :

- Any damaged, improperly installed, collapsed, or restricted components
- Improper operation of turbocharger wastegate actuator or bypass valve, where equipped

- Loose clamps, cracks, or other damage
- An air flow restriction
- Restricted air filter
- Splits, kinks, leaks, or improper connections at the vacuum hoses
- Vacuum leaks at the intake manifold, MAP sensor, and throttle body
- Water intrusion
- Any snow or ice buildup, in cold climates
- Contamination of the MAF sensor element
- Missing, restricted, or leaking exhaust components - Refer to [Symptoms - Engine Exhaust](#) for further diagnosis.
- **If a condition is found**

Repair or replace component as appropriate.

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

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

- **If a condition is found**

Repair or replace component as appropriate.

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

3. All OK.

Repair Instructions

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

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

DTC P0089, P00C6, P228C, P228D, OR P2C1E, P2C1F, OR P2C20

Diagnostic Instructions

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

DTC Descriptor

DTC P0089

Fuel Pressure Regulator Performance

DTC P00C6

Fuel Rail Pressure Low During Engine Cranking

DTC P228C

Fuel Pressure Regulator Control Performance - Low Pressure

DTC P228D

Fuel Pressure Regulator Control Performance - High Pressure

DTC P2C1E

Cold Start Fuel Pressure Regulator Performance

DTC P2C1F

Cold Start Fuel Pressure Regulator Control Performance - Low Pressure

DTC P2C20

Cold Start Fuel Pressure Regulator Control Performance - High Pressure

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Control - Terminal 2	P0091, P00C9	P0090, P00C8	P0092, P00C9, P00CA	P0089, P00C6, P228C, P228D, P2C1E, P2C1F, P2C20
Control - Terminal 1	P0091, P0092, P00C9	P0090, P00C8	P0092, P00CA	P0089, P00C6, P228C, P228D, P2C1E, P2C1F, P2C20

Circuit/System Description

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

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

Component	Description
Fuel Pressure Regulator - G18 High Pressure Fuel Pump	The fuel pressure regulator is a solenoid valve that restricts the flow of fuel to the high pressure fuel pump and thereby controls the pressure the pump can produce.
K20 Engine Control Module	The control module controls a series of actuators to ensure optimal engine performance. The control module does this by reading values from a variety of sensors, interprets the data and adjusts the engine actuators accordingly.

The fuel pressure regulator is a part of the high pressure fuel pump. The fuel pressure regulator is the solenoid valve that controls the pressure in the fuel rail.

Conditions for Running the DTC

P0089, P228C, P228D

- DTC P0016, P0017, P0018, P0019, P0090, P0091, P0092, P00C8, P00C9, P00CA, P0111, P0112, P0113, P0116, P0117, P0118, P0128, P0192, P0193, P0335, P0336, P0340, P0341, P0345, P0346, P0365, P0366, P0390, P0391, P0628 = Not set
- BARO = Greater than 70 kPa (10.2 PSI)
- Engine = Running
- Fuel Temperature = -10 to 132Â°C (14 to 270Â°F)
- IAT Sensor = Greater than -10Â°C (14Â°F)
- Ignition Voltage = Greater than 11 V
- Low Pressure Side of the Fuel System = Greater than 300 kPa (43 PSI)

Frequency the DTC runs = Continuously - After the running conditions are met - For greater than 10 s

P00C6

- DTC P0090, P0091, P0092, P00C8, P00C9, P00CA, P0116, P0117, P0118, P0128, P0192, P0193, P0335, P0336, P0340, P0341, P0345, P0346, P0365, P0366, P0390, P0391, P0628 = Not set
- BARO = Greater than 70 kPa (10.2 PSI)
- Engine = Not Running
- ECT Sensor = Less than 85°C (185°F)
- IAT Sensor = Greater than -10°C (14°F)
- Low Pressure Side of the Fuel System = Greater than 0 kPa (0 PSI)
- Run/Crank = Greater than 8 V

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

P2C1E, P2C1F, P2C20

- BARO = Greater than 70 kPa (10.2 PSI)
- Engine = Not Running
- Fuel Temperature = -10 to 132°C (14 to 270°F)
- IAT Sensor = Greater than -10°C (14°F)
- Ignition Voltage = Greater than 11 V
- Low Pressure Side of the Fuel System = Greater than 300 kPa (43 PSI)

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

Conditions for Setting the DTC

P0089

Q18 Fuel Pressure Regulator = Not Within 0 to 240°C - For greater than 10 s

P00C6

Desired Fuel Rail Pressure - Ignition/Vehicle = On & Engine = Off	Engine Run Time	Engine Coolant Temperature	Fuel Rail Pressure
Less than desired	11 s	-40°C (-40°F)	Actual pressure is not equal to the desired pressure
Less than desired	3 s	20 to 95°C (68 to 203°F)	Actual pressure is not equal to the desired pressure
Less than desired	5 s	Greater than 112°C (234°F)	Actual pressure is not equal to the desired pressure
Greater than desired	During the first 10 engine revolutions.	Less than -10°C (14°F)	Pressure drops greater than 2 MPa (290 PSI)
Greater than desired	During the first 10 engine revolutions.	0 to 8°C (32 to 46°F)	Pressure drops greater than 0.6 MPa (87 PSI)
Greater than desired	During the first 10 engine revolutions.	Greater than 8°C (46°F)	Pressure drops greater than 0.5 MPa (73 PSI)

P228C, P228D, P2C1E, P2C20

The following parameters are not within 3 MPa (435 PSI) of each other :

- Desired Fuel Rail Pressure
- Fuel Rail Pressure

The above condition(s) must occur for greater than 30 s. - At Idle Speed

P2C1E

G18 High Pressure Fuel Pump - Control = Greater than the maximum threshold

The above condition(s) must occur for greater than 10 s.

Actions Taken When the DTC Sets

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

DTC P0089, P00C6 = Type B DTC

{ P228C, P228D } Engine = Reduced Engine Power

Conditions for Clearing the DTC

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

DTC P0089, P00C6 = Type B DTC

Reference Information

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Engine Controls Wiring Schematics

Connector End View Reference

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- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References

Circuit/System Verification

1. Ignition - On / Vehicle - In Service Mode
2. Verify DTC P0016, P0017, P0018, P0019, P0090, P0091, P0092, P00C8, P00C9, P00CA, P0111, P0112, P0113, P0116, P0117, P0118, P0128, P0192, P0193, P0335, P0336, P0340, P0341, P0345, P0346, P0365, P0366, P0390, P0391, P0628 is not set.
 - **If any of the DTCs are set**

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

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

3. Engine - Idling

4. Verify the scan tool parameter : Fuel Rail Pressure Sensor 1 = 1.9 to 5.0 MPa (276 to 725 PSI)

- **If not between 1.9 and 5.0 MPa (276 and 725 PSI)**

Refer to : Circuit/System Testing

- **Go to next step : If between 1.9 and 5.0 MPa (276 and 725 PSI)**

5. Perform the scan tool control function : Fuel Rail Pressure - Increase & Decrease

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

- **If the value does not change**

Refer to : Circuit/System Testing

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

6. 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.

7. From a stop, accelerate to 7, 000 RPM with the throttle position greater than 95%.

Verify the scan tool parameter : Fuel Rail Pressure Sensor 1 = 14 to 17 MPa (2, 031 to 2, 466 PSI)

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

Refer to : Circuit/System Testing

- **Go to next step : If between 14 and 17 MPa (2, 031 and 2, 466 PSI)**

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

Verify the DTC does not set.

- **If the DTC sets**

Refer to : Circuit/System Testing

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

9. All OK.

Circuit/System Testing

1. Ignition/Vehicle - Off

2. Verify the following conditions do not exist :

- Q17 Fuel Injector - Leaking/Restricted
- Camshaft Position Actuator - Binding or Sticking/Stuck
- Direct Fuel Injection Fuel Rail - Leaking/Restricted
- Fuel - Contaminated/Poor Quality
- Fuel Feed Pipe - Leaking/Restricted
- Fuel Pressure Regulator - Binding or Sticking/Stuck
- **If a condition exists**

Repair or replace as necessary.

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

3. Remove the component : G18 High Pressure Fuel Pump

4. Inspect the component for wear or damage : Camshaft Lobe(s)

- **If worn**

Replace the component : Camshaft

- **Go to next step : If not worn**

5. Test or replace the component : G18 High Pressure Fuel Pump

Component Testing

NOTE: As little as 2 ohms of resistance in a circuit may cause a DTC to set.

1. Ignition/Vehicle - Off

2. Disconnect the electrical connector : G18 High Pressure Fuel Pump

3. Test for 9 to 11 ohms between the test points : Control terminal 1 & Control terminal 2

- **If not between 9 and 11 ohms**

Replace the component : G18 High Pressure Fuel Pump

- **Go to next step : If between 9 and 11 ohms**

4. Test for infinite resistance between the test points : Each terminal of the component & The component's housing

- **If less than infinite resistance**

Replace the component : G18 High Pressure Fuel Pump

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

5. All OK.

Repair Instructions

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

- [Camshaft Replacement - Left Side](#)
- [Fuel Pump Replacement](#) - G18 High Pressure Fuel Pump

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

Diagnostic Instructions

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

DTC Descriptors

DTC P0090

Fuel Pressure Regulator Control Circuit

DTC P0091

Fuel Pressure Regulator Control Circuit Low Voltage

DTC P0092

Fuel Pressure Regulator Control Circuit High Voltage

DTC P00C8

DTC P00C9

Fuel Pressure Regulator High Control Circuit Low Voltage

DTC P00CA

Fuel Pressure Regulator High Control Circuit High Voltage

Diagnostic Fault Information

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

Circuit/System Description

High pressure fuel is regulated by the high pressure fuel pump actuator, which is a part of the high pressure fuel pump. The high pressure fuel pump actuator is a solenoid valve. The engine control module (ECM) provides battery voltage on the actuator high control circuit and ground on the actuator 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 actuator 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.

The high fuel pressure necessary for direct injection is supplied by the high pressure fuel pump. The high pressure fuel pump is mounted on the rear of the engine and is driven by a three-lobe cam on the Bank 1 exhaust 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 ECM requests pressure ranging from 2 - 15 MPa (290 - 2, 176 PSI), depending on engine speed and load. Output drivers in the ECM provide the pump control circuit with a 12 V pulse-width modulated (PWM) signal, which regulates fuel pressure by closing and opening the control valve at specific times during pump strokes. This effectively regulates the portion of each pump stroke that is delivered to the fuel rail.

It is important to note that the high pressure fuel pump is a trailing-edge control system, meaning that if the control solenoid is NOT powered, the pump operates at maximum flow rate. In the event of pump control failure, the high pressure system is protected by a relief valve in the pump that prevents the pressure from exceeding 17.5 MPa (2, 538 PSI).

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

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

Conditions for Running the DTC

- The ignition voltage is between 11 - 18 V.
- 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 Wiring Schematics

Connector End View Reference

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Description and Operation

Fuel System Description

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

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify DTC P0685, or P1682 are not set.
 - **If any of the DTCs are set**

Refer to Diagnostic Trouble Code (DTC) List - Vehicle .
 - **Go to next step : If none of the DTCs are set**
3. Verify the parameters listed below do not display Malfunction when commanding the Fuel Pressure Regulator ON and OFF with a scan tool.
 - Fuel Pressure Regulator Control Circuit High Voltage Test Status
 - Fuel Pressure Regulator Control Circuit Open Test Status
 - Fuel Pressure Regulator Control Circuit Low Voltage Test Status
 - Fuel Pressure Regulator High Control Circuit High Voltage Test Status
 - Fuel Pressure Regulator High Control Circuit Open Test Status
 - Fuel Pressure Regulator High Control Circuit Low Voltage Test Status
 - **If Malfunction is displayed**

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

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

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, 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.
 - **Go to next step : 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.
 - **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 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.
 - **Go to next step : 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.
 - **Go to next step : 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.
 - **Go to next step : 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 1 and ground.

NOTE: For steps 7 - 9 it may be necessary to Start/Crank the engine to update the scan tool parameter.

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 Ω in the high control circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **Go to next step : If Malfunction is displayed**
8. Connect a 3 A fused jumper wire between the low control circuit terminal 2 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 Ω in the low control circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **Go to next step : If Malfunction is displayed**
10. Test or replace the G18 High Pressure Fuel Pump.

Component Testing

Static Test

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

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

prevent misdiagnosis.

2. Test for 9 - 11 Ω between low control circuit terminal 2 and high control circuit terminal 1.

- **If not within the specified range**

Replace the G18 High Pressure Fuel Pump.

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

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

- **If less than infinite resistance**

Replace the G18 High Pressure Fuel Pump.

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

4. All OK.

Repair Instructions

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

- [Fuel Pump Replacement](#) for 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 Descriptor

DTC P0096

Intake Air Temperature (IAT) Sensor 2 Performance

DTC P0111

Intake Air Temperature (IAT) Sensor 1 Performance

Diagnostic Fault Information

IAT Sensor 1

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P0112, P0113, P2199	P0113, P2199	P0112*, P2199	P0111*, P2199
Low Reference	-	P0113, P2199, P2227, P2229	P0113*, P0114	P0096, P0111*, P2199

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

IAT Sensor 2 and Intake Air Humidity

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Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition Voltage	P0096, P0097, P00F4, P0102, P2199	P0097, P00F4, P0102, P0103, P2199	-	P0096
Signal	P0097, P00F5, P2199	P0097, P00F4, P2199	P0097*, P00F4*, P2199*	P0096
Ground	-	P0096, P0097, P00F4, P0102, P2199	-	P0096
*Internal ECM or sensor damage may occur if the circuit is shorted to B+.				

Typical Scan Tool Data

IAT Sensor 1

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

IAT Sensor 2 and Intake Air Humidity Sensor

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

Circuit/System Description

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

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

- IAT sensor 2

- Humidity sensor
- MAF sensor

The multifunction intake air sensor houses the following :

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

IAT Sensor 1 - Temperature, Resistance, Voltage Table

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

IAT Sensor 2 - Temperature, Frequency Table

IAT Sensor 2	IAT Sensor 2 Frequency	IAT Sensor 2 Temperature
Cold	10 Hz	-40Â°C (-40Â°F)
Warm	302 Hz	104Â°C (219Â°F)

Conditions for Running the DTCs

P0096 and P0111

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

Conditions for Setting the DTCs

P0096

- The ECM determines the absolute difference between IAT sensor 1 start-up temperature and the IAT sensor 2 start-up temperature is greater than 10Â°C (18Â°F).

AND

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

P0111

- The ECM determines the absolute difference between IAT sensor 1 start-up temperature and the IAT sensor 2 start-up temperature is greater than 10Â°C (18Â°F).

AND

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

Action Taken When the DTC Sets

- DTC P0096 is a Type B DTC.

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

Conditions for Clearing the DTCs

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

Diagnostic Aids

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

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

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

Powertrain Component Views

Powertrain Component Views

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

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

Special Tools

EL-38522-A Variable Signal Generator

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

Circuit/System Verification

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

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

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

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

3. Ignition On.

4. Verify the following scan tool parameters are within 10Â°C (18Â°F) of each other.

- Start-Up IAT Sensor 1
- Start-Up IAT Sensor 2
- Start-Up ECT Sensor
- **If not within 10Â°C (18Â°F)**

Refer to Circuit/System Testing.

- **Go to next step : If within 10Â°C (18Â°F)**

5. Engine running.

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

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

Refer to Circuit/System Testing.

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

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

8. Verify the DTC does not set.

- **If the DTC sets**

Refer to Circuit/System Testing.

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

9. All OK

Circuit/System Testing

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

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

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

Repair or replace component as necessary.

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

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

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

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

- **If 5 Ω or greater**

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

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

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

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

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

NOTE:

The intake air temperature sensor 2 signal circuit is pulled up with low current voltage within the controller. Normally, a voltage can be

measured on the circuit with a DMM, but the current will not be high enough to illuminate a test lamp.

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

- **If 1% or greater**

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

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

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

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

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

16. Ignition On.

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

- **If 99% or less**

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

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

2. Ignition On.

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

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

4. Ignition Off.

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

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

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

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

Component Testing

Multifunction Intake Air Sensor

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

2. Connect a DMM between the IAT sensor 1 signal terminal 1 and the low reference terminal 3

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

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

- **If not within the specified range**

Replace the B75C Multifunction Intake Air Sensor.

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

4. All OK.

Multifunction Intake Air Sensor

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

- **If not within the specified range**

Replace the B75C Multifunction Intake Air Sensor.

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

2. All OK.

Testing with EL-38522-A

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

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

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

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

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

- Intake Air Humidity Sensor is between 48 - 52%
- **If a parameter is not within the specified range**

Replace the K20 Engine Control Module.

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

6. All OK.

Repair Instructions

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

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

DTC P0097, P0098, OR P0099

Diagnostic Instructions

- Perform the [Diagnostic System Check - Vehicle](#) prior to using this diagnostic procedure.

- Review [Strategy Based Diagnosis](#) for an overview of the diagnostic approach.
- [Diagnostic Procedure Instructions](#) provides an overview of each diagnostic category.

DTC Descriptors

DTC P0097

Intake Air Temperature (IAT) Sensor 2 Circuit Low Voltage

DTC P0098

Intake Air Temperature (IAT) Sensor 2 Circuit High Voltage

DTC P0099

Intake Air Temperature (IAT) Sensor 2 Circuit Intermittent

Diagnostic Fault Information

IAT Sensor 2 and Intake Air Humidity

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

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

Typical Scan Tool Data

IAT Sensor 2

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

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

Intake Air Humidity Sensor

Circuit	Short to Ground	Open or High Resistance	Short to Voltage
Operating Conditions: Engine Running Parameter Normal Range: Varies with ambient humidity, temperature, and engine bay conditions			
Ignition 1	0 %	0 %	-
Signal	100 %	0 %	0 %*
Ground	-	0 %	-

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

Circuit/System Description

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

- IAT sensor 2
- Humidity sensor
- MAF sensor

The multifunction intake air sensor houses the following :

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

IAT Sensor 2 - Temperature, Frequency Table

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

Conditions for Running the DTCs

P0097, P0098, and P0099

- DTCs P0685, P0686, P0687, P0689, P0690 or P1682 are not set.
- The ignition is ON, or the engine is running.
- The Ignition 1 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 $+150^{\circ}\text{C}$ (-40 and $+302^{\circ}\text{F}$).

The ECM detects that the IAT sensor 2 signal is less than 13 Hz, colder than -60°C (-76°F), for greater than 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 Vehicle in Service Mode, if the engine is cold, a properly functioning IAT sensor 2 will gradually increase the scan tool IAT Sensor 2 parameter. This is due to the heat that is generated by the MAF sensor heating elements.
- The humidity sensor and the IAT sensor 2 signals are sent to the ECM on the same circuit. If the IAT Sensor 2 parameter displays the values : 10 Hz; -40Â°C (-40Â°F), and there are also Humidity Sensor DTCs, check for a circuit problem.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

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

Powertrain Component Views

Powertrain Component Views

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-38522-A Variable Signal Generator

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

Circuit/System Verification

1. Ignition On.
2. Verify that DTC P00F4, P00F5, P00F6, P0102, P0103, P0641, P0651, P0697, or P06A3 is not set.
 - **If any of the DTCs are set**
 Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) for further diagnosis.
 - **Go to next step : If none of the DTCs are set**
3. Engine running.
4. Verify the following scan tool IAT Sensor 2 parameter is between -38 and +149Â°C (-36 and +300Â°F).
 - **If not between : -38 and +149Â°C (-36 and +300Â°F)**

Refer to Circuit System Testing.

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

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

Circuit/System Testing

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

1. Ignition Off, and all vehicle systems OFF, it may take up to 2 min. for all vehicle systems to power down. Disconnect the harness connector at the B75C Multifunction Intake Air sensor.
2. Test for less than 5 Ω between the low reference circuit terminal 3 and ground.
 - **If 5 Ω or greater**
 1. Disconnect the harness connector at the K20 Engine Control Module.
 2. Test for less than 2 Ω in the low reference circuit end to end.
 - If 2 Ω or greater, repair the open or high resistance in the circuit.
 - If less than 2 Ω replace the K20 Engine Control Module.
 - **Go to next step : If less than 5 Ω**
3. Test for less than 5 Ω between the ground circuit terminal 7 and ground.
 - **If 5 Ω or greater**
 1. Ignition Off.
 2. Test for less than 2 Ω in the ground circuit end to end.
 - If 2 Ω or greater, repair the open or high resistance in the circuit.
 - If less than 2 Ω , repair the open/high resistance in the ground connection.
 - **Go to next step : If less than 5 Ω**
4. Ignition On.
5. Verify that a test lamp illuminates between the ignition circuit terminal 5 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition Off, remove the test lamp and remove the fuse for the ignition voltage circuit.
 2. Test for less than 2 Ω in the ignition voltage circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**

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

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

NOTE: The intake air temperature sensor 2 signal circuit is pulled up with

low current voltage within the controller. Normally, a voltage can be measured on the circuit with a DMM, but the current will not be high enough to illuminate a test lamp.

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

- **If 1% or greater**

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

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

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

8. Ignition On.

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

- **If 99% or less**

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

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

2. Ignition On.

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

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

4. Ignition Off.

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

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

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

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

Component Testing

Multifunction Intake Air Sensor

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

- **If not within the specified range**

Replace the B75C Multifunction Intake Air Sensor.

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

2. All OK.

Testing with EL-38522-A

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

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

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

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

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

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

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

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

- Intake Air Humidity Sensor is between 48 - 52%
- If a parameter is not within the specified range

Replace the K20 Engine Control Module.

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

5. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.

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

DTC P00C7

Diagnostic Instructions

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

DTC Descriptor

DTC P00C7

Intake Air Pressure Measurement System - Multiple Sensors Not Plausible

Circuit/System Description

This system consists of the following components :

- B75C Multifunction Intake Air Sensor
- B74 Manifold Absolute Pressure Sensor

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

Conditions for Running the DTC

- DTC P0106, P0107, P0108, P2227, P2228, P2229, P2230, P1682 = Not set
- Engine = Not Running
- Time between current ignition cycle and the last time the engine was running = Greater than 7 min
- Manifold Absolute Pressure = 50 to 115 kPa (7.2 to 16.6 PSI)
- Barometric Pressure = 50 to 115 kPa (7.2 to 16.6 PSI)

DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

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

Actions Taken When the DTC Sets

DTC P00C7 is a Type B DTC.

Conditions for Clearing the DTC

DTC P00C7 is a Type B DTC.

Reference Information

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Engine Controls Wiring Schematics

Connector End View Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References

Circuit/System Verification

1. Ignition - On / Vehicle - In Service Mode
2. Verify DTC P0106, P0107, P0108, P2227, P2228, P2229, P2230 is not set.

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

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

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

3. Verify the following conditions do not exist :
 - Loose clamps, cracks, or other damages to the intake system.
 - Clogged air cleaner.
 - Clogged catalyst.
 - Vacuum hoses with kinks, leaks, or improper connections.
 - Leaking or restricted positive crankcase ventilation.

- Leaks at the intake manifold or throttle body.
- Leaking, missing, or damaged O-ring on the components listed below :
 - B75C Multifunction Intake Air Sensor
 - B74 Manifold Absolute Pressure Sensor
- **If a condition exists**

Repair or replace as necessary.

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

4. Verify the scan tool parameter :

- BARO Sensor = Altitude Versus Barometric Pressure - The value should be within the range listed in the table.
- MAP Sensor = Altitude Versus Barometric Pressure - The value should be within the range listed in the table.
- **If not in the specified range**
 - {BARO Sensor} Refer to : DTC P2227, P2228, P2229 or P2230 .
 - {MAP Sensor} Refer to : DTC P0106.
- **Go to next step : If in the specified range**

5. All OK.

DTC P00F4, P00F5 OR P00F6

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC P00F4

Intake Air Humidity Sensor Circuit Low Voltage

DTC P00F5

Intake Air Humidity Sensor Circuit High Voltage

DTC P00F6

Intake Air Humidity Sensor Circuit Erratic

Diagnostic Fault Information

Intake Air Humidity and IAT Sensor 2

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

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

Typical Scan Tool Data

Intake Air Humidity Sensor

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

IAT Sensor 2

Circuit	Short to Ground	Open or High Resistance	Short to Voltage
Operating Conditions: Engine Running Parameter Normal Range: Varies with ambient temperature			
Ignition 1	-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 Multifunction Intake Air sensor :

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

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

- IAT sensor 2
- Humidity sensor
- MAF sensor

Conditions for Running the DTCs**P00F4, P00F5, and P00F6**

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

Conditions for Setting the DTCs**P00F4**

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

P00F5

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

P00F6

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

Action Taken When the DTC Sets

- DTCs P00F4, P00F5, and P00F6 are Type B DTCs.

Conditions for Clearing the MIL/DTC

- DTCs P00F4, P00F5, and 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.
- When the ignition is On and the engine is cold, a properly functioning humidity sensor will gradually increase the scan tool Intake Air Humidity Signal parameter. This is due to the heat that is generated by the multifunction intake air sensor heating elements.
- The humidity sensor and the IAT sensor 2 signals are sent to the ECM on the same circuit. If the Intake Air Humidity parameter displays the value : 0% or 100%, and there are also IAT Sensor 2 DTCs, check for a circuit problem.
- When the ignition is On 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 multifunction intake air sensor heating elements.

Reference Information

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Engine Controls Wiring Schematics

Connector End View Reference

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Powertrain Component Views

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Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

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

Circuit/System Verification

1. Ignition On.
2. Verify that DTC P0102, P0103, P0641, P0651, P0697, or P06A3 is not set.
 - **If any of the DTCs are set**

Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) for further diagnosis.
 - **Go to next step : If none of the DTCs are set**
3. Engine running.
4. Verify the scan tool Intake Air Humidity Sensor parameter is between 5 and 90 %.
 - **If not between 5 and 90 %**

Refer to Circuit/System Testing.
 - **Go to next step : If between 5 and 90 %**
5. Operate the vehicle within the conditions for running the DTC. You may also operate the vehicle within the conditions that you observed from the freeze frame/failure records data.
6. Verify the DTC does not set.
 - **If the DTC sets**

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

Circuit/System Testing

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

1. Ignition Off, and all vehicle systems Off, it may take up to 2 min. for all vehicle systems to power down. Disconnect the harness connector at the B75C Multifunction Intake Air sensor.
2. Test for less than 5 Ω between the low reference circuit terminal 3 and ground.
 - **If 5 Ω or greater**
 1. Disconnect the harness connector at the K20 Engine Control Module.
 2. Test for less than 2 Ω in the low reference circuit end to end.
 - If 2 Ω or greater, repair the open or high resistance in the circuit.
 - If less than 2 Ω replace the K20 Engine Control Module.
 - **Go to next step : If less than 5 Ω**
3. Test for less than 5 Ω between the ground circuit terminal 7 and ground.
 - **If 5 Ω or greater**
 1. Ignition Off.
 2. Test for less than 2 Ω in the ground circuit end to end.
 - If 2 Ω or greater, repair the open or high resistance in the circuit.
 - If less than 2 Ω , repair the open/high resistance in the ground connection.
 - **Go to next step : If less than 5 Ω**
4. Ignition On.
5. Verify that a test lamp illuminates between the ignition circuit terminal 5 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition Off, remove the test lamp and remove the fuse for the ignition voltage circuit.

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

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

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

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

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

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

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

Component Testing

Multifunction Intake Air Sensor

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

- **If not within the specified range**

Replace the B75C Multifunction Intake Air Sensor.

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

2. All OK.

Testing with EL-38522-A

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

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

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

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

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

- Intake Air Humidity Sensor is between 48 - 52%
- **If a parameter is not within the specified range**

Replace the K20 Engine Control Module.

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

6. All OK.

Repair Instructions

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

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

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

Diagnostic Instructions

- Perform the [Diagnostic System Check - Vehicle](#) prior to using this diagnostic procedure.

- Review [Strategy Based Diagnosis](#) for an overview of the diagnostic approach.
- [Diagnostic Procedure Instructions](#) provides an overview of each of the diagnostic category.

DTC Descriptor

DTC P00FF

Body Control Module Requested MIL Illumination

DTC P069E

Fuel Pump Control Module Requested MIL Illumination

DTC P06EC

Fuel Injector Control Module Requested MIL Illumination

DTC P0700

Transmission Control Module Requested MIL Illumination

DTC P0800

Active Transfer Case Control Module Requested MIL Illumination

DTC P0AC4

Hybrid/EV Powertrain Control Module Requested MIL Illumination

DTC P1E00

Hybrid/EV Powertrain Control Module 2 Requested MIL Illumination

DTC P2561

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

DTC P25A2

Brake System Control Module Requested MIL Illumination

DTC P25AF

Coolant Temperature Control Module Requested MIL Illumination

DTC P25C9

Brake System Control Module 2 Requested MIL Illumination

DTC P26C8

Chassis Control Module Requested MIL Illumination

DTC P26C9

Auxiliary Chassis Control Module Requested MIL Illumination

Circuit/System Description

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

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

Conditions for Running the DTC

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

Conditions for Setting the DTC

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

Action Taken When the DTC Sets

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

Conditions for Clearing the MIL/DTC

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

Diagnostic Aids

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

Reference Information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE:

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

1. Vehicle in Service Mode.
2. Verify there are no engine control or communication DTCs set.
 - **If a DTC is set**

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

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

3. Verify there are no DTCs set in any other control module.
 - **If a DTC is set**

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

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

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

- If the DTC sets

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

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

6. All OK.

Repair Instructions

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

DTC P0101

Diagnostic Instructions

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

DTC 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	P0097, P00F4, P0102, P0103, P2199	P0097, P00F4, P0102, P0103, P2199	P0690	P0096, P0101, P0103
Signal	P0102	P0102	P0102*	P0101, P0103*, P1101
Ground	-	P0097, P00F4, P0102, P0103, 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: 1, 500 - 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 P0101, P0102, P0103, P0107, P0108 P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0128, P0335, or P0336 are not set
- The engine speed is between 425 and 6, 500 RPM.
- The engine coolant temperature (ECT) is between -7 to +150Â°C (+19 to +302Â°F).
- The intake air temperature (IAT Sensor 1) is between -20 to +125Â°C (-4 to +257Â°F).
- The DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

The engine control module (ECM) detects that the actual measured 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.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

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DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

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

Circuit/System Verification

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

Refer to [DTC P0641, P0651, P0697, or P06A3](#) for further diagnosis.
 - **Go to next step : 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 Inspection and Cleaning](#) .
 - **Go to next step : 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.
 - **Go to next step : 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.
 - **Go to next step : If the MAP Sensor parameter is in range**
7. Engine idling.
8. Verify the scan tool MAP Sensor 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.
 - **Go to next step : If the MAP Sensor parameter is between 26 - 52 kPa (3.8 - 7.5 PSI) and changes**
9. Verify the scan tool MAF Sensor g/s parameter changes smoothly and gradually as the engine speed is increased and decreased while performing the actions listed below.
 1. Engine idling
 2. Increase the engine speed slowly to 3, 000 RPM and then back to idle.
 3. Exit from the scan tool data list and review the stored data within the Stored Data function of the scan tool.
 4. Observe the MAF Sensor parameter frame by frame.
 - **The MAF Sensor parameter does not change smoothly and gradually**

Refer to Circuit/System Testing for further diagnosis.
 - **Go to next step : The MAF Sensor parameter changes smoothly and gradually**

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

11. Verify the DTC does not set.

- **If the DTC sets**

Refer to Circuit/System Testing, for further diagnosis.

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

12. All OK.

Circuit/System Testing

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

1. Verify the integrity of the entire air induction system by verifying that none of the conditions listed below 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.

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

2. Ignition OFF. Disconnect the harness connector at the B75C Multifunction Intake Air Sensor.

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

- **If 5 Ω or greater**

1. Disconnect the sensor chassis ground.

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

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

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

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

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

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

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

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

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

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

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

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

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

5. Ignition ON, test for 4.8 - 5.2 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.
- Go to next step : If infinite resistance

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

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

- **If greater than 5.2 V**

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

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

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

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

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

Component Testing

Testing with EL-38522-A

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

1. Ignition OFF, connect the leads of the **EL-38522-A** Variable Signal Generator as listed below :

- Red lead to the signal circuit terminal 6 at the harness connector
- Black leads to ground
- Battery voltage supply lead to B+

2. Set the **EL-38522-A** Variable Signal Generator to the specifications listed below :

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

3. Engine idling.

4. Verify the scan tool MAF Sensor parameter is between 4, 950 - 5, 050 Hz.

- **If not between 4, 950 - 5, 050 Hz.**

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

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

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

- **Go to next step : If between 4, 950 - 5, 050 Hz.**

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

Repair Instructions

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

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

DTC P0102 OR P0103

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0102

Mass Air Flow (MAF) Sensor Circuit Low Frequency

DTC P0103

Mass Air Flow (MAF) Sensor Circuit High Frequency

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition Voltage	P0097, P00F4, P0102, P0103, P2199	P0097, P00F4, P0102, P0103, P2199	P0690	P0096, P0101, P0103
Signal	P0102	P0102	P0102*	P0101, P0103*, P1101
Ground	-	P0097, P00F4, P0102, P0103, 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: 1, 500 - 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 DTCs

- The engine speed is greater than 300 RPM.
- The ignition signal is greater than 10 V.
- The DTC runs continuously when the above conditions are met for greater than 1 s.

Conditions for Setting the DTC

P0102

The ECM detects that the MAF Sensor Signal is less than or equal to 400 Hz for greater than 10 s.

P0103

The ECM detects that the MAF Sensor Signal parameter is greater than 14,500 Hz 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 Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

Powertrain Component Views

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-38522-A Variable Signal Generator

Circuit/System Verification

1. Engine running.
2. Verify the scan tool MAF Sensor Hz parameter is greater than 0 Hz.
 - **If 0 Hz**

Refer to Circuit/System Testing.
 - **Go to next step : If greater than 0 Hz**
3. 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. Increase the engine speed slowly to 3, 000 RPM and then back to idle.
 3. Exit from the scan tool data list and review the stored data within the Stored Data function of the scan tool.
 4. Observe the MAF Sensor parameter frame by frame.
 - **The MAF Sensor parameter does not change smoothly and gradually**

Refer to Circuit/System Testing.
 - **Go to next step : The MAF Sensor parameter changes smoothly and gradually**
4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
5. Verify the DTC does not set.
 - **If the DTC sets**

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

Circuit/System Testing

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

1. Ignition OFF, disconnect the harness connector at the B75C Multifunction Intake Air sensor.
2. Test for less than 5 Ω between the ground circuit terminal 7 and ground.
 - **If 5 Ω or greater**
 1. Ignition Off.
 2. Test for less than 2 Ω in the ground circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , repair the open/high resistance in the ground connection.
 - **Go to next step : If less than 5 Ω**
3. Ignition ON.
4. Verify that a test lamp illuminates between the ignition circuit terminal 5 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF, remove the test lamp and remove the fuse for the ignition voltage circuit.
 2. Test for less than 2 Ω in the ignition voltage circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF, remove the test lamp and remove the fuse for the ignition voltage circuit.

2. Test for infinite resistance between the ignition voltage circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, test all components connected to the ignition circuit, repair as necessary.
- **Go to next step : 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.
 - Go to next step : If infinite resistance
 3. Test for less than 2 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **If greater than 5.2 V**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.
 - **Go to next step : If between 4.8 - 5.2 V**
6. Test or replace the B75C Multifunction Intake Air sensor.

Component Testing

Testing with EL-38522-A

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

1. Ignition OFF, connect the leads of the **EL-38522-A** Variable Signal Generator as listed below :
 - Red lead to the signal circuit terminal 6 at the harness connector
 - Black leads to ground
 - Battery voltage supply lead to B+
2. Set the **EL-38522-A** Variable Signal Generator to the specifications listed below :
 - Signal switch to 5 V
 - Frequency switch to 5 kHz
 - Duty Cycle switch to 50 % (Normal)
3. Engine idling.
4. Verify the scan tool MAF Sensor parameter is between 4, 950 - 5, 050 Hz.
 - **If not between 4, 950 - 5, 050 Hz.**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for less than 2 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **Go to next step : If between 4, 950 - 5, 050 Hz.**
5. 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 prior to using this diagnostic procedure : [Diagnostic System Check - Vehicle](#)
- Review the description of Strategy Based Diagnosis : [Strategy Based Diagnosis](#)
- An overview of each diagnostic category can be found here : [Diagnostic Procedure Instructions](#)

DTC Descriptor

DTC P0106

Manifold Absolute Pressure (MAP) Sensor Performance

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P0106, P0107, P0641	P0107	P0106, P0108, P0641	P0106
Signal	P0106, P0107	P0106, P0108	P0106, P0108	P0106
Low Reference	-	P0106, P0108	-	P0106

Typical Scan Tool Data

MAP Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: • Engine - Idling - At normal operating temperature • Accessories = Off			
Parameter Normal Range: 26 to 52 kPa (3.8 to 7.6 PSI)			
5 V Reference	0 kPa (0.0 PSI)	0 kPa (0.0 PSI)	127 kPa (18.4 PSI)
Signal	0 kPa (0.0 PSI)	127 kPa (18.4 PSI)	127 kPa (18.4 PSI)
Low Reference	-	127 kPa (18.4 PSI)	-

Circuit/System Description

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

Component	Description
B74 Manifold Absolute Pressure Sensor	The sensor is a capacitive pressure transducer. Electronics in the sensor convert pressure into an analog voltage signal.
K20 Engine Control Module	The control module controls a series of actuators to ensure optimal engine performance. The control module does this by reading values from a variety of sensors, interprets the data and adjusts the engine actuators accordingly.

The sensor measures the pressure in the intake manifold. The signal is used to determine the engine load. When the engine is idling or decelerating, the sensor pressure should be low. When the engine is off or under wide-open throttle conditions the pressure should be the same or close to the barometric pressure.

Conditions for Running the DTC

- DTC P0102, P0103, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0119, P0128, P0335, P0336 = Not set
 - Intake Air Temperature = -20 to 125Â°C (-4 to 257Â°F)
 - Engine Coolant Temperature = -7 to 150Â°C (19 to 302Â°F)
 - Engine Speed. = 425 to 6, 500 RPM
- or
- DTC P0107, P0108, P2227, P2228, P2229, P2230, P2610 = Not set
 - Ignition On - Engine Off

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

Conditions for Setting the DTC

The difference between the manifold absolute pressure measured by the manifold absolute pressure sensor and a calculated value based on the throttle position exceeds the allowed range.

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type B

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type B

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Engine Control Module 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

Special Tools

Equivalent regional tools : [Special Tools](#)

Circuit/System Verification

1. Ignition - On / Vehicle - In Service Mode
2. Verify DTC P0641, P0651, P0697, P06A3 is not set.
 - **If any of the DTCs are set**
Refer to : [DTC P0641, P0651, P0697, or P06A3](#)
 - **Go to next step : If none of the DTCs are set**
3. If you were sent here from DTC P0101, P0121, P1101 - Refer to : Circuit/System Testing.
4. Verify the scan tool parameter : Throttle Body Idle Air Flow Compensation = Less than 90%
 - **If 90% or greater**

Refer to : [Throttle Body Inspection and Cleaning](#)

- **Go to next step : If less than 90%**
5. Perform the scan tool control function : Throttle Sweep - Start

Verify the scan tool parameter : Throttle Position Sensors 1 and 2 = Agree

- **If not the specified state**
Refer to : [DTC P0121-P0123, P0222, P0223, P16A0-P16A2, or P2135](#)
 - **Go to next step : If the specified state**
6. Determine the current vehicle testing altitude.
 7. Verify the scan tool parameter : MAP Sensor = The value should be within the range listed in the table : [Altitude Versus Barometric Pressure](#)

- **If not in the specified range**

Refer to : Circuit/System Testing

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

8. Engine - Idling - At normal operating temperature
9. Verify the scan tool parameter : MAP Sensor = 26 to 52 kPa (3.8 to 7.6 PSI) and changes
 - **If not between 26 and 52 kPa (3.8 and 7.6 PSI) or does not change**

Refer to : Circuit/System Testing

- **Go to next step : If between 26 and 52 kPa (3.8 and 7.6 PSI) and changes**

10. Observe the scan tool parameter : MAF Sensor & Engine Speed.
11. Increase the engine speed slowly to 3, 000 RPM and then back to idle.
12. Verify the scan tool parameter : MAF Sensor = The value should change smoothly and gradually as the engine speed is increased and decreased.
 - **If the value does not change smoothly and gradually**

Refer to : [DTC P0101](#)

- **Go to next step : If the value changes smoothly and gradually**

13. Verify the scan tool parameter : MAP Sensor = The value should not spike or drop out.

Perform the action while monitoring the parameter :

- Wiggle the harness and connector : B74 Manifold Absolute Pressure Sensor
- Wiggle the harness and connector : K20 Engine Control Module

- **If the value spikes or drops out**

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

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

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

15. Verify the DTC does not set.

- **If the DTC sets**

Refer to : Circuit/System Testing

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

16. All OK.

Circuit/System Testing

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

1. Ignition/Vehicle & All vehicle systems - Off

2. Verify the following conditions do not exist :

- Collapsed or restricted intake air duct.
- Leaking or restricted component : Exhaust System
- Leaking, missing, or damaged O-ring on the components listed below :
 - B74 Manifold Absolute Pressure Sensor
- Engine vacuum leaks.
- An engine mechanical condition. - Wear of timing chain, tensioner, or sprockets or If one or more cylinders indicate low compression

Refer to : [Symptoms - Engine Mechanical](#)

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

3. Disconnect the electrical connector : @ B74 Manifold Absolute Pressure Sensor

4. Test for less than 10 ohms between the test points : Low Reference circuit terminal 2 & Ground

- **If 10 ohms or greater**

1. Disconnect the electrical connector : K20 Engine Control Module

2. Test for less than 2 ohms between the test points : Low Reference circuit terminal 2 @ Component harness & Terminal 48 X2 @ Control module harness

- If 2 ohms or greater - Repair the open/high resistance in the circuit.
- If less than 2 ohms - Replace the component : K20 Engine Control Module

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

5. Ignition - On / Vehicle - In Service Mode

6. Test for 4.8 to 5.2 V between the test points : 5 V Reference circuit terminal 1 & Low Reference circuit terminal 2

- **If less than 4.8 V**

1. Ignition/Vehicle - Off

2. Disconnect the electrical connector : K20 Engine Control Module

3. Test for infinite resistance between the test points : 5 V Reference circuit terminal 1 @ Component harness & Ground

- If less than infinite resistance - Repair the short to ground on the circuit.
- **Go to next step : If infinite resistance**

4. Test for less than 2 ohms between the test points : 5 V Reference circuit terminal 1 @ Component harness & Terminal 47 X2 @ Control module harness
 - If 2 ohms or greater - Repair the open/high resistance in the circuit.
 - If less than 2 ohms - Replace the component : K20 Engine Control Module
- **If greater than 5.2 V**
 1. Ignition/Vehicle - Off
 2. Disconnect the electrical connector : K20 Engine Control Module
 3. Ignition - On / Vehicle - In Service Mode
 4. Test for less than 1 V between the test points : 5 V Reference circuit terminal 1 @ Component harness & Ground
 - If 1 V or greater - Repair the short to voltage on the circuit.
 - If less than 1 V - Replace the component : K20 Engine Control Module
- **Go to next step : If between 4.8 and 5.2 V**
7. Verify the scan tool parameter : MAP Sensor = Greater than 4.7 V
 - **If 4.7 V or less**
 1. Ignition/Vehicle - Off
 2. Disconnect the electrical connector : K20 Engine Control Module
 3. Test for infinite resistance between the test points : Signal circuit terminal 3 @ Component harness & Ground
 - If less than infinite resistance - Repair the short to ground on the circuit.
 - If infinite resistance - Replace the component : K20 Engine Control Module
 - **Go to next step : If greater than 4.7 V**
8. Connect a 3 A fused jumper wire between the test points : Signal circuit terminal 3 & Low Reference circuit terminal 2
9. Verify the scan tool parameter : MAP Sensor = Less than 0.2 V
 - **If 0.2 V or greater**
 1. Ignition/Vehicle - Off & Remove - Jumper wire(s)
 2. Disconnect the electrical connector : K20 Engine Control Module
 3. Ignition - On / Vehicle - In Service Mode
 4. Test for less than 1 V between the test points : Signal circuit terminal 3 @ Component harness & Ground
 - If 1 V or greater - Repair the short to voltage on the circuit.
 - Go to next step : If less than 1 V
 - 5. Ignition/Vehicle - Off
 - 6. Test for less than 2 ohms between the test points : Signal circuit terminal 3 @ Component harness & Terminal 67 X3 @ Control module harness
 - If 2 ohms or greater - Repair the open/high resistance in the circuit.
 - If less than 2 ohms - Replace the component : K20 Engine Control Module
- **Go to next step : If less than 0.2 V**
10. Test or replace the component : B74 Manifold Absolute Pressure Sensor

Component Testing

Dynamic Test - Using Vehicle Harness

1. Ignition/Vehicle - Off
2. Remove the component : B74 Manifold Absolute Pressure Sensor - Leave the electrical connector connected.
3. Install the special tool : **EN-23738-A** Vacuum Pump @ B74 Manifold Absolute Pressure Sensor
4. Ignition - On / Vehicle - In Service Mode
5. Use the tool to achieve a gauge reading between -13 and -21 kPa (-0.13 and -0.21 bar, -3.8 and -6.2 in Hg).

Verify the scan tool parameter : MAP Sensor = Decreases between 13 and 21 kPa (1.8 and 3.0 PSI)

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

Replace the component : B74 Manifold Absolute Pressure Sensor

- **Go to next step : If the parameter decreases between 13 and 21 kPa (1.8 and 3.0 PSI)**

6. Use the tool to achieve a gauge reading between -30 and -38 kPa (-0.3 and -0.38 bar, -8.8 and -11.2 in Hg).

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

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

Replace the component : B74 Manifold Absolute Pressure Sensor

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

7. All OK.

Dynamic Test - Using Jumper Wires

1. Ignition/Vehicle - Off
2. Remove the component : B74 Manifold Absolute Pressure Sensor
3. Connect a 3 A fused jumper wire between the test points : 5 V Reference terminal 1 & 5 V
4. Connect a jumper wire between the test points : Low Reference terminal 2 & Ground
5. Connect a DMM between the test points : Signal terminal 3 @ B74 Manifold Absolute Pressure Sensor & Ground
6. Install the special tool : EN-23738-A Vacuum Pump @ B74 Manifold Absolute Pressure Sensor
7. Use the tool to achieve a gauge reading between -55 and -47 kPa (-0.55 and -0.47 bar, -13.8 and -16.2 in Hg).

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

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

Replace the component : B74 Manifold Absolute Pressure Sensor

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

8. All OK.

Repair Instructions

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

- [Manifold Absolute Pressure Sensor Replacement](#)
- For control module replacement, programming, and setup refer to : [Control Module References](#)

DTC P0107 OR P0108

Diagnostic Instructions

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

DTC Descriptor

NOTE: This procedure may also diagnose malfunctions that are not detected by

DTC P0107

Manifold Absolute Pressure (MAP) Sensor Circuit Low Voltage

DTC P0108

Manifold Absolute Pressure (MAP) Sensor Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P0106, P0107, P0641	P0107	P0106, P0108, P0641	P0106
Signal	P0106, P0107	P0106, P0108	P0106, P0108	P0106
Low Reference	-	P0106, P0108	-	P0106

Typical Scan Tool Data**MAP Sensor**

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: - Engine - Idling - At normal operating temperature - All accessories Off.			
Parameter Normal Range: 26 to 52 kPa (3.8 to 7.6 PSI)			
5 V Reference	0 kPa (0.0 PSI)	0 kPa (0.0 PSI)	127 kPa (18.4 PSI)
Signal	0 kPa (0.0 PSI)	127 kPa (18.4 PSI)	127 kPa (18.4 PSI)
Low Reference	-	127 kPa (18.4 PSI)	-

Circuit/System Description

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

Component	Description
B74 Manifold Absolute Pressure Sensor	The sensor is a capacitive pressure transducer. Electronics in the sensor convert pressure into an analog voltage signal.
K20 Engine Control Module	The control module controls a series of actuators to ensure optimal engine performance. The control module does this by reading values from a variety of sensors, interprets the data and adjusts the engine actuators accordingly.

The sensor measures the pressure in the intake manifold. The signal is used to determine the engine load.

When the engine is idling or decelerating, the sensor pressure should be low. When the engine is off or under wide-open throttle conditions the pressure should be the same or close to the barometric pressure.

Conditions for Running the DTC

Ignition = On

DTCs run continuously when the above condition is met.

Conditions for Setting the DTC

P0107

MAP Sensor = Less than 0.2 V - For greater than 4 s

P0108

MAP Sensor = Greater than 3.4 V - For greater than 4 s

Actions Taken When the DTC Sets

DTCs P0107, P0108 are Type B DTCs.

Conditions for Clearing the DTC

DTCs P0107, P0108 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

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Circuit/System Verification

1. Ignition - On / Vehicle - In Service Mode
2. Verify DTC P0641, P0651, P0697, P06A3, P06D2 is not set.
 - **If any of the DTCs are set**

Refer to : [DTC P0641, P0651, P0697, or P06A3](#)
 - **Go to next step : If none of the DTCs are set**
3. Verify the scan tool parameter : MAP Sensor = The value should be within the range listed in the table : [Altitude Versus Barometric Pressure](#)
 - **If not in the specified range**

Refer to : Circuit/System Testing

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

4. Engine - Idling - At normal operating temperature All accessories Off.
5. Verify the scan tool parameter : MAP Sensor = 26 to 52 kPa (3.8 to 7.6 PSI)
 - **If not between 26 and 52 kPa (3.8 and 7.6 PSI)**

Refer to : Circuit/System Testing

- **Go to next step : If between 26 and 52 kPa (3.8 and 7.6 PSI)**

6. Verify the scan tool parameter : MAP Sensor = The value should not spike or drop out.

Perform the action while monitoring the parameter :

- Wiggle the harness and connector : B74 Manifold Absolute Pressure Sensor
- Wiggle the harness and connector : K20 Engine Control Module
- **If the value spikes or drops out**

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

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

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

Refer to : Circuit/System Testing

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

9. All OK.

Circuit/System Testing

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

1. Ignition/Vehicle & All vehicle systems - Off
2. Disconnect the electrical connector : B74 Manifold Absolute Pressure Sensor
3. Test for less than 10 ohms between the test points : Low Reference circuit terminal 2 & Ground
 - **If 10 ohms or greater**
 1. Disconnect the electrical connector : K20 Engine Control Module
 2. Test for less than 2 ohms between the test points : Low Reference circuit terminal 2 @ Component harness & Terminal 48 X2 @ Control module harness
 - If 2 ohms or greater - Repair the open/high resistance in the circuit.
 - If less than 2 ohms - Replace the component : K20 Engine Control Module
 - **Go to next step : If less than 10 ohms**
4. Ignition - On / Vehicle - In Service Mode
5. Test for 4.8 to 5.2 V between the test points : 5 V Reference circuit terminal 1 & Low Reference circuit terminal 2
 - **If less than 4.8 V**
 1. Ignition/Vehicle - Off
 2. Disconnect the electrical connector : K20 Engine Control Module
 3. Test for infinite resistance between the test points : 5 V Reference circuit terminal 1 @ Component harness & Ground
 - If less than infinite resistance - Repair the short to ground on the circuit.

- Go to next step : If infinite resistance
- 4. Test for less than 2 ohms between the test points : 5 V Reference circuit terminal 1 @ Component harness & Terminal 47 X2 @ Control module harness
 - If 2 ohms or greater - Repair the open/high resistance in the circuit.
 - If less than 2 ohms - Replace the component : K20 Engine Control Module
- **If greater than 5.2 V**
 1. Ignition/Vehicle - Off
 2. Disconnect the electrical connector : K20 Engine Control Module
 3. Ignition - On / Vehicle - In Service Mode
 4. Test for less than 1 V between the test points : 5 V Reference circuit terminal 1 @ Component harness & Ground
 - If 1 V or greater - Repair the short to voltage on the circuit.
 - If less than 1 V - Replace the component : K20 Engine Control Module
- **Go to next step : If between 4.8 and 5.2 V**
- 6. Verify the scan tool parameter : MAP Sensor = Greater than 4.7 V
 - **If 4.7 V or less**
 1. Ignition/Vehicle - Off
 2. Disconnect the electrical connector : K20 Engine Control Module
 3. Test for infinite resistance between the test points : Signal circuit terminal 3 @ Component harness & Ground
 - If less than infinite resistance - Repair the short to ground on the circuit.
 - If infinite resistance - Replace the component : K20 Engine Control Module
 - **Go to next step : If greater than 4.7 V**
- 7. Connect a 3 A fused jumper wire between the test points : Signal circuit terminal 3 & Low Reference circuit terminal 2
- 8. Verify the scan tool parameter : MAP Sensor = Less than 0.2 V
 - **If 0.2 V or greater**
 1. Ignition/Vehicle - Off & Remove - Jumper wire(s)
 2. Disconnect the electrical connector : K20 Engine Control Module
 3. Ignition - On / Vehicle - In Service Mode
 4. Test for less than 1 V between the test points : Signal circuit terminal 3 @ Component harness & Ground
 - If 1 V or greater - Repair the short to voltage on the circuit.
 - Go to next step : If less than 1 V
 - 5. Ignition/Vehicle - Off
 - 6. Test for less than 2 ohms between the test points : Signal circuit terminal 3 @ Component harness & Terminal 67 X3 @ Control module harness
 - If 2 ohms or greater - Repair the open/high resistance in the circuit.
 - If less than 2 ohms - Replace the component : K20 Engine Control Module
- **Go to next step : If less than 0.2 V**
- 9. Replace the component : B74 Manifold Absolute Pressure Sensor

Repair Instructions

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

- [Manifold Absolute Pressure Sensor Replacement](#)
- For control module replacement, programming, and setup refer to : [Control Module References](#)

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, P0113, P2199	P0113, P2199	P0112*, P2199	P0111*, P2199
Low Reference	-	P0113, P2199, P2227, P2229	P0113*, P0114	P0096, P0111*, P2199
*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	150Â°C (302Â°F)	-40Â°C (-40Â°F)	-40Â°C (-40Â°F)*
Low Reference	-	-40Â°C (-40Â°F)	-40Â°C (-40Â°F)*
*Internal ECM or sensor damage may occur if the circuit is shorted to B+			

Circuit/System Description

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

The multifunction intake air sensor houses the following :

- IAT sensor 1
- IAT sensor 2
- Humidity sensor
- Mass Air Flow (MAF) sensor
- BARO pressure sensor

IAT Sensor 1 - Temperature, Resistance, Voltage Table

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

Conditions for Running the DTCs

P0112 and P0113

- The engine run time is greater than 0 s.
- The DTCs run continuously when the above conditions are met.

P0114

- The ignition is ON or the engine is running.
- This DTC runs continuously within the enabling conditions.

Conditions for Setting the DTCs

P0112

The ECM detects that the IAT sensor 1 signal is warmer than 149Â°C (300Â°F) for greater than 4 s.

P0113

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

The ECM detects that the IAT sensor 1 signal is colder than -60Â°C (-76Â°F) for greater than 4 s.

P0114

- The ECM detects that the IAT sensor 1 signal has changed greater than 80Â°C (128Â°F) within 1 s.
- The condition exists for a cumulative of 4 s or greater.

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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Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Engine idling.
2. Verify the scan tool IAT Sensor 1 parameter is between -38 to +149°C (-36 to +300°F).
 - **If not between -38 to +149°C (-36 to +300°F)**

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

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

Circuit/System Testing

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

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

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

2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.
 - **Go to next step : If between 4.8 - 5.2 V**
5. Verify the scan tool IAT Sensor 1 parameter is colder than -39°C (-38°F).
 - **If warmer than -39°C (-38°F).**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the signal circuit terminal 1 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - Go to next step : If infinite resistance
 3. Test for less than $2\ \Omega$ in the signal circuit end to end.
 - If $2\ \Omega$ or greater, repair the open/high resistance in the circuit.
 - If less than $2\ \Omega$, replace the K20 Engine Control Module.
 - **Go to next step : If colder than -39°C (-38°F).**
6. Ignition OFF, install a 3 A fused jumper wire between the signal circuit terminal 1 and the low reference circuit terminal 3, ignition ON.
7. Verify the scan tool IAT Sensor 1 parameter is warmer than 149°C (300°F).
 - **If colder than 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.
 - Go to next step : If less than 1 V
 3. Ignition OFF.
 4. Test for less than $2\ \Omega$ in the signal circuit end to end.
 - If $2\ \Omega$ or greater, repair the open/high resistance in the circuit.
 - If less than $2\ \Omega$, replace the K20 Engine Control Module.
 - **Go to next step : If warmer than 149°C (300°F).**
8. 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 (Hitachi Sensor) Temperature Versus Resistance - Intake Air Temperature Sensor (Delco 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.

 - **Go to next step : 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](#) provide an overview of each diagnostic category.

DTC Descriptor

DTC P0116

Engine Coolant Temperature (ECT) Sensor Performance

Diagnostic Fault Information

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

Typical Scan Tool Data

ECT Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine Running			
Parameter Normal Range: -39 to 149Â°C (-38 to 300Â°F)			
ECT Sensor	150Â°C (302Â°F)	-40Â°C (-40Â°F)	-40Â°C (-40Â°F)
Low Reference	-	-40Â°C (-40Â°F)	-

Circuit/System Description

The engine coolant temperature (ECT) sensor is a variable resistor that measures the temperature of the engine coolant. The engine control module (ECM) supplies 5 V to the ECT sensor signal circuit and a ground for the low reference circuit.

The ECM uses this high side coolant rationality diagnostic 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 ignition is OFF. If the calibrated ignition OFF time is met at start-up, the ECM will compare the temperature difference between the ECT and the intake air temperature (IAT) to determine if the temperatures are within an acceptable operating range of each other.

Conditions for Running the DTC

- DTC P0111, P0112, P0113, P0114, P0117, P0118, P0119, P0128, P0502, P0503, P0601, or P262B is not set.
- The vehicle has had a minimum ignition OFF time of 8 h.
- The ignition is ON.
- The start-up IAT is warmer than -9Â°C (+15.8Â°F).
- The Fuel Level Sensor is greater than 2.5%.
- This DTC runs once per ignition cycle when the above conditions are met.

Conditions for Setting the DTC

The ECM detects a temperature difference at power-up that indicates that the ECT sensor is 15.8Â°C (28.4Â°F) warmer than the IAT sensor.

Action Taken When the DTC Sets

- DTC P0116 is a Type B DTC.
- The cooling fans will be commanded ON.
- The A/C compressor will be commanded OFF.

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.
- An IAT sensor that is skewed colder at various ambient temperatures due to greater resistance than is normal will increase the range between these two sensors. Measure and record the resistance of the IAT sensor at various ambient temperatures, then compare those measurements to the [Temperature Versus Resistance - Intake Air Temperature Sensor \(Hitachi Sensor\)](#), [Temperature Versus Resistance - Intake Air Temperature Sensor \(Delco Sensor\)](#) table.
- A slight to moderate resistance in the IAT sensor signal circuit or low reference circuit will increase the range between these two sensors. This condition results in a greater voltage on the IAT sensor signal circuit, which is interpreted by the ECM as a colder IAT.

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DTC Type Reference

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

Scan Tool Reference

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

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool ECT Sensor parameter is between - 40 and 150Â°C (- 40 and 302Â°F) and changes with engine run time.
 - **If not within the specified range or does not change**

Refer to Circuit/System Testing.

- **Go to next step : If within the specified range 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.
 - **Go to next step : If the DTC does not set**
 5. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF. Disconnect the harness connector at the 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 Ω between the low reference terminal A or 2 and ground.
 - **If 5 Ω or greater**
 1. Ignition OFF, disconnect the X3 harness connector at the K20 Engine Control Module.
 2. Test for less than 2 Ω in the low reference circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **Go to next step : If less than 5 Ω**
3. Ignition ON.
4. Verify the scan tool ECT Sensor parameter is colder than -39 $^{\circ}$ C (-38 $^{\circ}$ F).
 - **If warmer than -39 $^{\circ}$ C (-38 $^{\circ}$ F)**
 1. Ignition OFF, disconnect the X3 harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the signal circuit terminal B or 1 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K20 Engine Control Module.
 - **Go to next step : If colder than -39 $^{\circ}$ C (-38 $^{\circ}$ F)**
5. Install a 3 A fused jumper wire between the signal circuit terminal B or 1 and the low reference circuit terminal A or 2.
6. Verify the scan tool ECT sensor parameter is warmer than 149 $^{\circ}$ C (300 $^{\circ}$ F).
 - **If 149 $^{\circ}$ C (300 $^{\circ}$ F) or colder**
 1. Ignition OFF, 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.
 - Go to next step : If less than 1 V
 - 3. Ignition OFF
 - 4. Test for less than 2 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **Go to next step : If warmer than 149 $^{\circ}$ C (300 $^{\circ}$ F)**
7. Test or replace the B34 Engine Coolant Temperature Sensor.

Component Testing

1. Ignition OFF, disconnect the harness connector at the B34 Engine Coolant Temperature Sensor.
2. Test the ECT sensor by varying the sensor temperature while monitoring the sensor resistance.
3. Verify the readings are within the range specified in the **Temperature Versus Resistance - Engine Coolant Temperature Sensor** table.
 - **If not within the specified range**

Replace the B34 Engine Coolant Temperature Sensor.

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

4. Test for infinite resistance between each terminal and the sensor housing.

- **If less than infinite resistance**

Replace the B34 Engine Coolant Temperature Sensor.

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

5. All OK.

Repair Instructions

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

- [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 Descriptor

DTC P0117

Engine Coolant Temperature (ECT) Sensor Circuit Low Voltage

DTC P0118

Engine Coolant Temperature (ECT) Sensor Circuit High Voltage

DTC P0119

Engine Coolant Temperature (ECT) Sensor Circuit Intermittent

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P0117, P0119	P0118, P0119	P0118*, P0119	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

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine running at various operating conditions Parameter Normal Range: -39 to 149Â°C (-38 to 300Â°F)			
Signal	150Â°C (302Â°F)	-40Â°C (-40Â°F)	-40Â°C (-40Â°F)
Low Reference	-	-40Â°C (-40Â°F)	-

Circuit/System Description

The engine coolant temperature (ECT) sensor is a variable resistor that measures the temperature of the engine coolant. The engine control module (ECM) supplies 5 V to the ECT sensor signal circuit and a

ground for the low reference circuit. This diagnostic checks for an open, short to ground or an intermittent circuit condition between the ECM and ECT sensor.

Conditions for Running the DTC

P0117

- The ignition is ON.

OR

- The engine is running for greater than 10 s.
- This DTC runs continuously within the enabling conditions.

P0118

- The ignition is ON.

OR

- The engine is running for greater than 10 s.

OR

- The engine run time is less than 10 s when the IAT is warmer than -7°C (19°F).
- This DTC runs continuously within the enabling conditions.

P0119

- No active DTCs set.
- The ignition is ON.
- This DTC runs continuously within the enabling conditions.

Conditions for Setting the DTC

P0117

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

P0118

The ECM detects that the ECT is colder than -39°C (-38°F) for greater than 5 s.

P0119

The ECM detects that the ECT is intermittent or has abruptly changed for greater than 3 seconds.

Action Taken When the DTC Sets

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

Conditions for Clearing the DTC

DTC P0117, P0118 and P0119 are Type B DTCs.

Reference Information

Schematic Reference

[Engine Controls Wiring Schematics](#)

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- Wiring Repairs

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Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool ECT Sensor parameter is between - 40 and 150°C (- 40 and 302°F) and changes with engine run time.
 - **If not between the specified range or does not change**
Refer to Circuit/System Testing.
 - **Go to next step : If within the specified range 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.
 - **Go to next step : If the DTC does not set**
5. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF. Disconnect the B34 Engine Coolant Temperature Sensor. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 5 Ω between the low reference circuit terminal A or 2 and ground.
 - **If 5 Ω or greater**
 1. Ignition OFF, disconnect the X2 harness connector at the K20 Engine Control Module.
 2. Test for less than 2 Ω in the low reference circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **Go to next step : If less than 5 Ω**
3. Ignition ON.

4. Verify the scan tool ECT Sensor parameter is colder than -39°C (-38°F).
 - **If warmer than -39°C (-38°F)**
 1. Ignition OFF, disconnect the X3 harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the signal circuit terminal B or 1 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K20 Engine Control Module.
 - **Go to next step : If colder than -39°C (-38°F)**
5. Install a 3 A fused jumper wire between the signal circuit terminal B or 1 and the low reference circuit terminal A or 2.
6. Verify the scan tool ECT sensor parameter is warmer than 149°C (300°F).
 - **If 149°C (300°F) or colder**
 1. Ignition OFF, remove the jumper wire, disconnect the 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.
 - Go to next step : If less than 1 V
 3. Ignition OFF.
 4. Test for less than $2\ \Omega$ in the signal circuit end to end.
 - If $2\ \Omega$ or greater, repair the open/high resistance in the circuit.
 - If less than $2\ \Omega$, replace the K20 Engine Control Module.
 - **Go to next step : If warmer than 149°C (300°F)**
7. Test or replace the B34 Engine Coolant Temperature Sensor.

Component Testing

1. Ignition OFF, disconnect the B34 Engine Coolant Temperature Sensor.
2. Test the ECT sensor by varying the sensor temperature while monitoring the sensor resistance.
3. Verify the readings are within the range specified in [Temperature Versus Resistance - Engine Coolant Temperature Sensor](#) table.
 - **If not within the specified range**

Replace the B34 Engine Coolant Temperature Sensor.
 - **Go to next step : If within the specified range**
4. Test for infinite resistance between each terminal and the sensor housing.
 - **If less than infinite resistance**

Replace the B34 Engine Coolant Temperature Sensor.
 - **Go to next step : If infinite resistance**
5. All OK.

Repair Instructions

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

- [Engine Coolant Temperature Sensor Replacement](#)
- [Control Module References](#) for ECM replacement, programming, and setup.

DTC P0121, P0122, P0123, P0222, P0223, P16A0, P16A1, P16A2, OR P2135

Diagnostic Instructions

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

DTC Descriptors

DTC P0121

Throttle Position Sensor 1 Performance

DTC P0122

Throttle Position Sensor 1 Circuit Low Voltage

DTC P0123

Throttle Position Sensor 1 Circuit High Voltage

DTC P0222

Throttle Position Sensor 2 Circuit Low Voltage

DTC P0223

Throttle Position Sensor 2 Circuit High Voltage

DTC P16A0

Sensor Communication Circuit Low Voltage

DTC P16A1

Sensor Communication Circuit High Voltage

DTC P16A2

Sensor Communication Circuit Performance

DTC P2135

Throttle Position Sensors 1-2 Not Plausible

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P06A3	P0122*, P0222*, P16A0	P06A3	P0121*, P16A2, P2135*
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 into separate voltages which are displayed on a scan tool as the voltage inputs from TP sensors 1 and 2.

Conditions for Running the DTC

P0121

- DTCs P0102, P0103, P0107, P0108, P0112, P0113, P0117, P0118, P0335, or P0336 is not set.
- The engine speed is between 500 - 6, 800 RPM.
- The engine coolant temperature (ECT) is -7 to +126Â°C (19 - 259Â°F).
- The intake air temperature (IAT) is -20 to +125Â°C (-4 to +257Â°F).
- The DTC runs continuously when the above conditions are met.

P0122, P0123, P0222, P0223

- DTC P06A3 is not set.
- The run/crank or powertrain relay voltage is greater than 6.41 V and reduced power is not active.
- The DTCs run continuously when the above condition are met.

P16A0, P16A1, or P16A2

- DTC P06A3 is not set.
- The run/crank voltage is greater than 6.41 V.
- The DTCs run continuously once the above conditions are met.

P2135

- DTCs P0122, P0123, P0222, P0223, or P06A3 are not set.
- 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 4.75 V for greater than 1 s.

P0222

The ECM detects the throttle position sensor 2 signal voltage is less than 0.25 V for greater than 1 s.

P0223

The ECM detects the throttle position sensor 2 signal voltage is greater than 4.6 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 Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

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. If you were sent here from DTC P0068, P0101, P0106, or P1101 refer to Circuit/System Testing.
2. Ignition ON.
3. 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.
 - **Go to next step : If none of the DTCs are set**
4. Verify the scan tool Throttle Body Idle Air flow Compensation parameter is less than 90 %.
 - **If 90 % or greater**
Refer to [Throttle Body Inspection and Cleaning](#) .
 - **Go to next step : If less than 90 %**
5. Verify that DTC P0122, P0123, P0222, P0223, P16A0, P16A1, P16A2, or P2135 are not set.
 - **If DTC P0122, P0123, P0222, P0223, or P2135 are the only DTCs set**
Test or replace the Q38 Throttle Body Assembly.
 - **If DTC P16A0, P16A1, or P16A2 is set with any of the DTCs**
Refer to Circuit/System Testing.
 - **Go to next step : If none of the DTCs are set**
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.
 - **Go to next step : If Agree is displayed**
7. Verify DTC P0122, P0123, P0222, P0223, P16A0, P16A1, P16A2, and P2135 is not set.
 - **If a DTC is set**
Refer to Circuit/System Testing.
 - **Go to next step : If a DTC is not set**
8. Determine the current vehicle testing altitude.

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

- **The MAP Sensor pressure is not in range**

Refer to [DTC P0106](#).

- **Go to next step : The MAP Sensor pressure is within range**

10. Engine idling.

11. Verify the scan tool MAP Sensor pressure parameter is between 26 - 52 kPa (3.8 - 7.5 psi) and changes with accelerator pedal input.

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

Refer to [DTC P0106](#).

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

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

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

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

Refer to [DTC P0101](#).

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

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

14. Verify the DTC does not set.

- **If the DTC sets**

Refer to Circuit/System Testing.

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

15. All OK.

Circuit/System Testing

NOTE: 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 Ω between the low reference circuit terminal 4 and ground.

- **If 5 Ω or greater**

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

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

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

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

3. Ignition ON.

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

- **If less than 4.8 V**

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

2. Test for infinite resistance between the 5 V reference circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - Go to next step : If infinite resistance
3. Test for less than 2 Ω in the 5 V reference circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
- **If greater than 5.2 V**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
 2. Test for less than 1 V between the 5 V reference circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.
 - **Go to next step : If between 4.8 - 5.2 V**
5. Test for 4.8 - 5.2 V between the signal circuit terminal 3 and ground.
 - **If less than 4.8 V**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - Go to next step : If infinite resistance
 3. Test for less than 2 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **If greater than 5.2 V**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.
 - **Go to next step : If between 4.8 - 5.2 V**
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 displayed**

Test or replace the Q38 Throttle Body Assembly.
 - **Go to next step : If Agree is not displayed**

7. If the repair was related to a DTC, duplicate the Conditions for Running the DTC and use the Freeze Frame/Failure Records, if applicable, in order to verify the DTC does not set.

- If DTC sets

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

- Go to next step : If DTC does not set

8. All OK.

DTC P0128

Diagnostic Instructions

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

DTC Descriptor

DTC P0128

Engine Coolant Temperature (ECT) Below Thermostat Regulating Temperature

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
ECT Sensor Signal	P0117, P0119	P0118	P0118	P0116, P0119, P0128
Low Reference	-	P0118, P0119	-	P0119, P0128

Typical Scan Tool Data

ECT Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine Running at various operating conditions Parameter Normal Range: -39 to 149Â°C (-38 to 300Â°F)			
ECT Sensor Signal	150Â°C (302Â°F)	-40Â°C (-40Â°F)	-40Â°C (-40Â°F)
Low Reference	-	-40Â°C (-40Â°F)	-40Â°C (-40Â°F)

Circuit/System Description

The purpose of this diagnostic is to analyze the performance of the thermostat, by using the ECT sensor to determine if the engine coolant will increase at the correct rate, and also 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

- DTC P0068, P0071, P0072, P0073, P0074, P0101, P0102, P0103, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0119, P0121, P0122, P0123, P0222, P0223, P0502, P0503, P1101, P1516, P2101, or P2135 is not set.
- The start-up ECT is between -40Â° and 66Â°C (- 40Â° and 151Â°F).
- The engine OFF time is greater than 30 m.
- The engine run time is between 2 and 24 m.
- The vehicle has traveled greater than 2.4 km (1.5 mi).
- The Ethanol in the fuel is less than 87 %.
- This DTC runs once per ignition cycle when the above conditions are met.

Conditions for Setting the DTC

- The ECM determines that the ECT has not met its calibrated target of 71Â°C (160Â°F) when the start-up ambient temperature was between 10 and 52Â°C (50 and 126Â°F), for greater than 1 s.

OR

- The ECM determines that the ECT has not met its calibrated target of 55Â°C (131Â°F) when the start-up ambient temperature was between - 7 and 10Â°C (19 and 50Â°F), for greater than 1 s.

Action Taken When the DTC Sets

- DTC P0128 is a Type B DTC.
- The Engine Coolant Temperature Gauge defaults to cold.
- The A/C is commanded OFF and inoperative.
- The Cooling Fans are commanded ON.

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.
- Corrosion in the ECT sensor terminals or the ECT harness connector results in a greater voltage on the ECT sensor signal circuit, which is interpreted by the ECM as a colder ECT.
- A slight to moderate resistance in the ECT sensor signal circuit or low reference circuit will affect this diagnostic. This condition results in a greater voltage on the ECT sensor signal circuit, which is interpreted by the ECM as a colder ECT.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Cooling System Description and Operation

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.

2. Verify the scan tool ECT Sensor parameter is between - 40 and 150Â°C (- 40 and 302Â°F) and changes with engine run time.

- **If not between the specified range or does not change**

Refer to Circuit/System Testing.

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

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

5. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF. Disconnect the B34 Engine Coolant Temperature Sensor. It may take up to 2 minutes for all vehicle systems to power down.

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

- **If 5 Ω or greater**

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

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

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

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

3. Ignition ON.

4. Verify the scan tool ECT Sensor parameter is colder than -39Â° C (-38Â° F).

- **If warmer than -39Â° C (-38Â° F)**

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

2. Test for infinite resistance between the signal circuit terminal B or 1 and ground.

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

- **Go to next step : If colder than -39Â° C (-38Â° F)**

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

6. Verify the scan tool ECT sensor parameter is warmer than 149Â° C (300Â° F).

- **If 149Â° C (300Â° F) or colder**

1. Ignition OFF, remove the jumper wire, 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.
- Go to next step : If less than 1 V

3. Ignition OFF.

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

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

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

7. Test or replace the B34 Engine Coolant Temperature Sensor.

Component Testing

1. Ignition OFF, disconnect the B34 Engine Coolant Temperature Sensor.
2. Test the ECT sensor by varying the sensor temperature while monitoring the sensor resistance.
3. Verify the readings are within the range specified in [Temperature Versus Resistance - Engine Coolant Temperature Sensor](#) table.
 - **If not within the specified range**

Replace the B34 Engine Coolant Temperature Sensor.
 - **Go to next step : If within the specified range**
4. Test for infinite resistance between each terminal and the sensor housing.
 - **If less than infinite resistance**

Replace the B34 Engine Coolant Temperature Sensor.
 - **Go to next step : If infinite resistance**
5. All OK.

Repair Instructions

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

- [Engine Coolant Temperature Sensor Replacement](#)
- [Water Outlet Replacement \(LFY\)](#), for engine coolant thermostat replacement.
- [Control Module References](#) for engine control module replacement, programming and setup.

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	High Resistance	Open	Short to Voltage	Signal Performance
HO2S High Signal	P0131, P0137, P0151, P0157	P0132, P0138, P0152, P0158	P0132, P0138, P0152, P0158	P0132, P0138, P0152, P0158	P0133, P013A, P013B, P013C, P013D, P013E, P013F, P014A, P014B, P0153, P015A, P015B, P015C, P015D
HO2S Low Signal	P0131, P0137, P0151, P0157	P0132, P0138, P0152, P0158	P0132, P0138, P0152, P0158	P0132, P0138, P0152, P0158	P0133, P013A, P013B, P013C, P013D, P013E, P013F, P014A, P014B, P0153, P015A, P015B, P015C, P015D

Typical Scan Tool Data

HO2S Sensor 1 Voltage, HO2S Sensor 2 Voltage

Circuit	Short to Ground	Open	Short to Voltage
Parameter Normal Range: 200 - 800 mV			
HO2S High Signal	0.00 V	Approximately 1.9 V	Approximately 1.9 V
HO2S Low Signal	0.00 V	Approximately 1.9 V	Approximately 1.9 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, P0122, P0123, P0178, P0179, P0201, P0202, P0203, P0204, P0205, P0206, P0222, P0223, P0261, P0262, P0263, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0411, P0442, P0443, P0455, P0446, P0452, P0453, P0458, P0459, P0496, P0449, P0498, P0499, P16F3, P16A0, P16A2, P1104, P1248, P1249, P124A, P124B, P124C, P124D, P2100, P2101, P2102, P22103, P2135, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P216B, P216C, P216D, P216E, P216F, P2269, P2440, or P2444 are not set.
- The engine is operating in Closed Loop.
- The ignition voltage is greater than 10 V.
- The fuel level is greater than 10 percent.
- The throttle position (TP) is between 3 - 70 percent.
- The DTCs run continuously when the above conditions are met for 5 s.

P0132, P0138, P0152, or P0158

- DTCs P0068, P0122, P0123, P0178, P0179, P0201, P0202, P0203, P0204, P0205, P0206, P0222, P0223, P0261, P0262, P0263, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0411, P0442, P0446, P0452, P0453, P0455, P0458, P0496, P16F3, P16A0, P16A2, P1104, P1248, P1249, P124A, P124B, P124C, P124D, P2100, P2101, P2102, P22103, P2135, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P216B, P216C, P216D, P216E, P216F, P2269, P2440, or P2444 are not set.
- The engine is operating in Closed Loop.
- The Ignition voltage is between 10 - 32 V.
- The fuel level is greater than 10 percent.
- The throttle position (TP) is between 0 - 70 percent.
- The DTCs run continuously when the above conditions are met for 3 s.

Conditions for Setting the DTC

P0131, P0137, P0151, or P0157

- The ECM detects that the HO2S voltage is less than 50 mV.
- The DTCs set within 50 s when the above condition is met.

P0132, P0138, P0152, or P0158

- The ECM detects that the HO2S voltage is greater than 1,050 mV.
- The DTCs set within 50 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

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Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.

2. Verify no HO2S heater DTCs are set

- **If a DTC is set**

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

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

3. Engine running.

4. Verify the scan tool HO2S 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.

- **Go to next step : If between 50 - 1,050 mV**

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

6. Verify the DTC does not set.

- **If the DTC sets**

Refer to Circuit/System Testing.

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

7. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the appropriate B52 Heated Oxygen Sensor harness connector. It may take up to 2 minutes for all vehicle systems to power down. Ignition ON.

2. Test for 1.5 - 3.0 V between the high signal circuit terminal 4 and ground.

- **If less than 1.5 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.
- Go to next step : If infinite resistance

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

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

- **If greater than 3.0 V**

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

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

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

- **Go to next step : If between 1.5 - 3.0 V**

3. Verify the scan tool heated oxygen sensor Bank 1 or 2 Sensor 1 or 2 parameter is between 1.5 - 2.1 V

- **If less than 1.5 V**

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

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

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

- **Go to next step : If between 1.5 - 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 Ω in the low signal circuit end to end.

- If 2 Ω or greater, repair the open/high resistance in the circuit.
- Go to next step : If less than 2 Ω

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

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

- **Go to next step : If 0.0 V**

6. Verify none of the following conditions exist :

- Water intrusion in the B52 HO2S 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.

- **Go to next step : 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 \(AWD\)](#). [Heated Oxygen Sensor Replacement - Bank 1 Sensor 2 \(FWD\)](#).
- [Heated Oxygen Sensor Replacement - Bank 2 Sensor 1](#)
- [Heated Oxygen Sensor Replacement - Bank 2 Sensor 2 \(AWD\)](#). [Heated Oxygen Sensor Replacement - Bank 2 Sensor 2 \(FWD\)](#).
- Perform the scan tool Heated Oxygen Sensor Resistance Learn Reset after replacing an HO2S.
- [Control Module References](#) for ECM replacement, programming and setup

DTC P0133, P013A, P013B, P013C, P013D, P013E, P013F, P014A, P014B, P0153, P015A, P015B, P015C, P015D, P2270, P2271, P2272, 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

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
HO2S High Signal	P0131, P0137, P0151, P0157	P0132, P0134, P0138, P0140, P0152, P0154, P0158, P0160	P0132, P0134, P0138, P0140, P0152, P0154, P0158, P0160	P0133, P013A, P013B, P013C, P013D, P013E, P013F, P014A, P014B, P0153, P015A, P015B, P015C, P015D
HO2S Low Signal	P0131, P0137, P0151, P0157	P0132, P0134, P0138, P0140, P0152, P0154, P0158, P0160	P0132, P0134, P0138, P0140, P0152, P0154, P0158, P0160	P0133, P013A, P013B, P013C, P013D, P013E, P013F, P014A, P014B, P0153, P015A, P015B, P015C, P015D

Typical Scan Tool Data**HO2S Sensor 1 Voltage, HO2S Sensor 2 Voltage**

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, P010B, P010C, P010D, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0119, P0122, P0123, P0128, P0178, P0179, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0222, P0223, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0279, P0280, P0282, P0283, P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307, P0308, P0411, P0442, P0443, P0446, P0449, P0452, P0453, P0455, P0458, P0459, P0496, P0498, P0499, P1104, P111E, P1248, P1249, P124A, P124B, P124C, P124D, P124E, P124F, P16A0, P16A1, P16A2, P16F3, P2100, P2101, P2102, P2103, P2135, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P216B, P216C, P216E, P216F, P217B, P217C, P217E, P217F, P2227, P2228, P2229, P2230, P2269, P2440, or P2444 are not set.
- The engine coolant temperature (ECT) is greater than 50°C (122°F).
- The intake air temperature (IAT) is warmer than -40°C (-40°F)
- The Ignition voltage is greater than 10 V.

- 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 device controls are not active.
- The barometric (BARO) pressure is greater than 70 kPa.
- The mass airflow (MAF) is between 15 - 55 g/s.
- The fuel system is in Closed Loop.
- The throttle position (TP) is greater than 5%.
- The DTCs run once per drive cycle when the above conditions are met for 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 P0068, P0101, P0102, P0103, P0106, P0107, P0108, P010B, P010C, P010D, P0112, P0113, P0116, P0117, P0118, P0119, P0122, P0123, P0128, P0171, P0172, P0174, P0175, P0178, P0179, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0222, P0223, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0279, P0280, P0282, P0283, P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307, P0308, P0411, P1104, P111E, P11E9, P11EA, P11EB, P11EC, P1248, P1249, P124A, P124B, P124C, P124D, P124E, P124F, P16F3, P16A0, P16A1, P16A2, P2100, P2101, P2102, P2103, P2135, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P216B, P216C, P216E, P216F, P2178, P2179, P217B, P217C, P217E, 4 P217F, P2269, P2440, or P2444 are not set.
- The Ignition voltage is greater than 10 V.
- The learned heater resistance is valid.
- The fuel level is greater than 10%.
- The accelerator pedal (APP) is steady.
- The torque converter clutch (TCC) is applied.
- 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 P0068, P0101, P0102, P0103, P0106, P0107, P0108, P010B, P010C, P010D, P0112, P0113, P0116, P0117, P0118, P0119, P0122, P0123, P0128, P0171, P0172, P0174, P0175, P0178, P0179, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0222, P0223, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0279, P0280, P0282, P0283, P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307, P0308, P0411, P111E, P11E9, P11EA, P11EB, P11EC, P1248, P1249, P124A, P124B, P124C, P124D, P124E, P124F, P16F3, P16A0, P16A1, P16A2, P1104, P2100, P2101, P2102, P2103, P2135, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P216B, P216C, P216E, P216F, P2178, P2179, P217B, P217C, P217E, P217F, P2269, P2440, or P2444 are not set.
- The Ignition voltage is greater than 10 V.
- The learned heater resistance is valid.
- The fuel level is greater than 10%.
- The DTCs run once per ignition cycle when the above conditions are met.

P015A, P015B, P015C or P015D

- DTCs P0068, P0101, P0102, P0103, P010B, P010C, P010D, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0119, P0122, P0123, P0128, P0171, P0172, P0174, P0175, P0178, P0179, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0222, P0223, P0261, P0262, P0264, P0265, P0267, P0268 P0270, P0271, P0273, P0274, P0276, P0277, P0279, P0280, P0282, P0283, P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307, P0308, P0411, P0442, P0443, P0446, P0449, P0452, P0453, P0455, P0458, P0459, P0496, P0498, P0499, P111E, P11E9, P11EA, P11EB, P11EC, P1248, P1249, P124A, P124B, P124C, P124D, P124E, P124F, P16F3, P16A0, P16A1, P16A2, P1104, P2100, P2101, P2102, P2103, P2135, P2147, P2148, P2150, P2153, P2156, P2151, P2154, P2157, P216B, P216C, P216E, P216F, P217B, P217C, P217E, P217F, P2178, P2179, P2227, P2228, P2229, P2230, P2269, P2440, or P2444 are not set.
- The engine coolant temperature (ECT) is warmer than 62Â°C (143.6Â°F).
- The intake air temperature (IAT) is warmer than -40Â°C (-40Â°F)
- The Ignition voltage is greater than 10 V.
- The fuel level is greater than 10%.
- The engine run time is greater than 30 s.
- The engine speed is between 950 - 2, 950 RPM to enable and 900 - 3, 050 RPM to keep enabled.
- The vehicle speed is between 68 - 129 km/h (42 - 80 mph) to enable and 62 - 132 km/h (39 - 82 mph) to keep enabled
- The mass airflow (MAF) is between 4 - 11.5 g/s.
- The fuel system is in Closed Loop.
- The DTCs run once per drive cycle when the above conditions are met.

P2270 or P2272

- DTCs P0068, P0101, P0102, P0103, P010B, P010C, P010D, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0119, P0122, P0123, P0128, P0171, P0172, P0174, P0175, P0178, P0179, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0222, P0223, P0261, P0262, P0264, P0265, P0267, P0268 P0270, P0271, P0273, P0274, P0276, P0277, P0279, P0280, P0282, P0283, P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307, P0308, P0411, P0442, P0443, P0446, P0449, P0452, P0453, P0455, P0458, P0459, P0496, P0498, P0499, P111E, P11E9, P11EA, P11EB, P11EC, P1248, P1249, P124A, P124B, P124C, P124D, P124E, P124F, P16F3, P16A0, P16A1, P16A2, P1104, P2100, P2101, P2102, P2103, P2135, P2147, P2148, P2150, P2153, P2156, P2151, P2154, P2157, P216B, P216C, P216E, P216F, P217B, P217C, P217E, P217F, P2178, P2179, P2227, P2228, P2229, P2230, P2269, P2440, or P2444 are not set.
- The system voltage is between 10 - 32 V.
- The fuel level is greater than 10%.
- The engine speed is between 850 - 2, 500 RPM to enable and 800 - 2, 550 RPM to keep enabled.
- The engine airflow is between 4 - 11.5 g/s.
- The vehicle speed is between 68 - 129 km/h (42 - 80 mph) to enable and 62 - 132 km/h (39 - 82 mph) to keep enabled.
- The engine is in Closed Loop.
- The HO2S heaters are on for more than 60 s.
- The evaporative emission (EVAP) diagnostics are not in control of purge.
- The heated oxygen sensor heaters are ON for more than 60 s.
- The predicted catalytic converter temperature is between 575 - 980Â°C (1, 067 - 1, 796Â°F).
- This DTC runs once per trip when all of the above conditions have been met for 2 s.

P2271 or P2273

- DTCs P0068, P0101, P0102, P0103, P010B, P010C, P010D, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0119, P0122, P0123, P0128, P0171, P0172, P0174, P0175, P0178, P0179, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0222, P0223, P0261, P0262, P0264, P0265, P0267, P0268 P0270, P0271, P0273, P0274, P0276, P0277, P0279, P0280, P0282, P0283, P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307, P0308, P0411,

P0442, P0443, P0446, P0449, P0452, P0453, P0455, P0458, P0459, P0496, P0498, P0499, P111E, P11E9, P11EA, P11EB, P11EC, P1248, P1249, P124A, P124B, P124C, P124D, P124E, P124F, P16F3, P16A0, P16A1, P16A2, P1104, P2100, P2101, P2102, P2103, P2135, P2147, P2148, P2150, P2153, P2156, P2151, P2154, P2157, P216B, P216C, P216E, P216F, P217B, P217C, P217E, P217F, P2178, P2179, P2227, P2228, P2229, P2230, P2269, P2440, or P24441 are not set.

- The system voltage is greater than 10 V.
- The fuel level is greater than 10%.
- The engine is in Closed Loop.
- Decel fuel cut off is active.
- Power take-off is not active.
- The accelerator pedal position (APP) is stable
- DTCs P013A, P013E, and P2270 have run and passed.
- The 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 75 grams.

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 75 grams.

P013E or P014A

The ECM detects that the HO2S voltage has not decreased below 450 mV within a calibrated value of accumulated air flow.

P013F or P014B

The ECM detects that the HO2S 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.

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DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

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

Circuit/System Verification

1. Ignition ON.
2. Verify no HO2S heater DTCs are set.
 - **If a heater DTC is set**
Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) .
 - **Go to next step : If no heater DTCs are set**
3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
4. Verify none of the DTCs set.
 - **If any of the DTCs set**
Refer to Circuit/System Testing
 - **Go to next step : If none of the DTCs set**
5. 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 1.5 - 3.0 V between the high signal circuit terminal 4 and ground.
 - **If less than 1.5 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.
 - Go to next step : If infinite resistance
 3. Test for less than 2 Ω in the high signal circuit end to end.

- If 2 Ω or greater, repair the open/high resistance in the circuit.
- If less than 2 Ω , replace the K20 Engine Control Module.
- **If greater than 3.0 V**
 1. Ignition Off, disconnect the harness connector at the K20 Engine Control Module. Ignition On.
 2. Test for less than 1 V between the high signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.
- **Go to next step : If between 1.5 - 3.0 V**
- 3. Verify the scan tool HO2S Heater Bank 1 or 2 Sensor 2 parameter is between 1.5 - 2.1 V
 - **If less than 1.5 V**
 1. Ignition Off, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the low signal circuit terminal 3 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - Go to next step : If infinite resistance, replace the K20 Engine Control Module.
 - **Go to next step : If between 1.5 - 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 2 parameter displays 0.0 V.
 - **If greater than 0.0 V**
 1. Ignition Off, disconnect the harness connector at the K20 Engine Control Module. Ignition On.
 2. Test for less than 2 Ω in the low signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - Go to next step : If less than 2 Ω
 3. Test for less than 1 V between the low signal circuit terminal 3 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.
 - **Go to next step : If 0.0 V**
6. Verify none of the conditions listed below exist :
 - Lean or rich fuel injectors - Refer to [Fuel Injector Solenoid Coil Test](#) .
 - Water intrusion in the HO2S 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 - 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.

 - **Go to next step : If none of the conditions exist**
7. Test or replace the B52 Heated Oxygen Sensor

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 \(AWD\)](#), [Heated Oxygen Sensor Replacement - Bank 1 Sensor 2 \(FWD\)](#)
- [Heated Oxygen Sensor Replacement - Bank 2 Sensor 1](#)
- [Heated Oxygen Sensor Replacement - Bank 2 Sensor 2 \(AWD\)](#), [Heated Oxygen Sensor Replacement - Bank 2 Sensor 2 \(FWD\)](#)
- Perform the scan tool Heated Oxygen Sensor Resistance Learn Reset after replacing an HO2S.
- [Control Module References](#) for ECM replacement, programming and setup

DTC P0171, 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, P0053, P0101, P0102, P0103, P0106, P0107, P0108, P010B, P010C, P010D, P0112, P0113, P0178, P0179, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0236, P0237, P0238, P0261, P0264, P0267, P0270, P0273, P0276, P0279, P0282, P0262, P0265, P0268, P0271, P0274, P0277, P0280, P0283, P0300-P0304, P0305, P0306, P0307, P0308, P0131, P0132, P0133, P0134, P0135, P0401, P0404, P0411, P042E, P0442, P0455, P0458, P0496, P015A, P015B, P1133, P2147, P2148, P1249, P124A, P124B, P124C, P124D, P124E, P124F, P2150, P2151, P2153, P2154, P2156, P2157, P216B, P216C, P216E, P216F, P217B, P217C, P217E, P217F, P2227, P2228, P2229, P2230, P2269, P2440, P2444, or P2A00 are not set.
- The engine is in Closed Loop status.

- The catalyst monitor diagnostic intrusive test, post HO2S diagnostic intrusive test, device control, and evaporative emissions leak test are not active.
- The engine coolant temperature is less than 150°C (302°F).
- The intake air temperature is between -20 and +150°C (-4 and +302°F).
- The manifold absolute pressure is between 5 - 255 kPa (0.7 - 37 PSI).
- The engine speed is between 400 - 6,600 RPM.
- The mass air flow is between 0.5 - 510 g/s.
- The barometric pressure is greater than 70 kPa (10.2 PSI).
- The fuel level is greater than 10% and no fuel level sensor fault is present.
- 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.
- With the engine running at operating temperature, the normal Short Term Fuel Trim and Long Term Fuel Trim parameters should be between +10 and -10% with 0% the optimum.
- Any un-metered air into the engine causes this DTC to set. Thoroughly inspect all areas of the engine for vacuum leaks. An un-metered air leak in the induction system or a small vacuum leak may cause the ECM to learn an incorrect Throttle Body Idle Airflow Compensation value over time. The incorrectly learned value may cause various symptoms to occur such as rough or unstable idle speeds, and/or engine stall. If this condition is detected and repaired it will be necessary to perform the scan tool Idle Learn procedure to ensure any symptoms are corrected.
- A MAF sensor condition can cause this DTC without setting a MAF DTC. If there is a MAF sensor condition, the MAF sensor parameters will appear to be within range.
- Verify the air filter is the correct one for this application, the engine oil fill cap is in place and is tight, and 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

Electrical Information Reference

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

DTC Type Reference

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

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

Circuit/System Verification

1. Ignition ON.
2. Verify no other DTCs are set.
 - **If any other DTCs are set**
Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) for further diagnosis.
 - **Go to next step : If no other DTCs are set**
3. Verify DTC P0171, P0172, P0174, or P0175 is not set.
 - **If a DTC is set**
Refer to Circuit/System Testing.
 - **Go to next step : If no DTC is set**
4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed in the Freeze Frame/Failure Records data.
5. Verify DTC P0171, P0172, P0174, or P0175 is not set.
 - **If any of the DTCs set**
Refer to Circuit/System Testing.
 - **Go to next step : If none of the DTCs set**
6. All OK.

Circuit/System Testing

1. Ignition ON.
2. Verify no other DTCs are set.
 - **If any other DTCs are set**
Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) .
 - **Go to next step : If no other DTCs are set**
3. Verify the 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](#).
 - **Go to next step : If within the specified range**

NOTE: Fuel vapor introduced into the intake manifold during evaporative emission system purge can temporarily cause fuel trim parameter readings to be outside the normal range.

4. Engine running at the operating temperature, EVAP Purge Solenoid Valve Command 0%.
5. Verify the Long Term Fuel Trim Bank 1 or 2 parameter is between -10 % and +10 % .
 - **If greater than +10 % :**
 1. Ignition OFF.
 2. Verify the conditions listed below do not exist :
 - Mass air flow sensor signal skewed. If the Short Term Fuel Trim or Long Term Fuel Trim parameters for both banks changes greater than 20% when the MAF sensor is disconnected, refer to [DTC P0101](#).
 - Fuel contamination. Refer to [Alcohol/Contaminants-in-Fuel Diagnosis](#) .

- Missing, restricted, or leaking exhaust components. Refer to [Symptoms - Engine Exhaust](#) .
- Malfunctioning fuel injectors. Refer to [Fuel Injector Solenoid Coil Test](#) .
- Split, kinked, or improperly connected vacuum hoses.
- Insufficient fuel in the tank.
- Low fuel pressure. Refer to [Fuel System Diagnosis](#) .
- Vacuum leaks at the intake manifold, the throttle body, and the injector O-rings.
- Leaks in the air induction system and the air intake ducts, including mechanical sound enhancer, if equipped.
- Missing air filter element.
- Cracked evaporative emissions canister.
- Evaporative pipes obstructed or leaking.
- Leaks in the crankcase ventilation system. Refer to [Crankcase Ventilation System Inspection/Diagnosis](#) .
 - If a condition is found, repair as necessary.
 - If no condition is found, test the engine for a mechanical condition. Refer to [Symptoms - Engine Mechanical](#) .
- **If less than -10 %**
 1. Ignition OFF.
 2. Verify the conditions listed below do not exist :
 - Mass air flow (MAF) sensor signal skewed. If the Short Term Fuel Trim or Long Term Fuel Trim parameters for both banks changes greater than 20% when the MAF sensor is disconnected, refer to [DTC P0101](#).
 - Fuel contamination. Refer to [Alcohol/Contaminants-in-Fuel Diagnosis](#) .
 - Missing, restricted, or leaking exhaust components. Refer to [Symptoms - Engine Exhaust](#) .
 - Malfunctioning fuel injectors. Refer to [Fuel Injector Solenoid Coil Test](#) .
 - 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, test the engine for a mechanical condition. Refer to [Symptoms - Engine Mechanical](#) .
 - **Go to next step : If between -10 % and +10 %**
- 6. 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.
- 7. Verify DTC P0171, P0172, P0174, or P0175 is not set.
 - **If any of the DTCs set**

Refer to conditions listed above.
 - **Go to next step : If none of the DTCs set**
- 8. All OK.

Repair Instructions

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

Perform the scan tool Fuel Trim Reset after completing the repair.

DTC P0182, P0183, P0187, P0188, P0191, P0192, P111F, P126E, P126F, P127C, P128A, P128B, P16E4, OR P16E5 (LFY)

Diagnostic Instructions

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

DTC Descriptor

NOTE: This procedure may also diagnose malfunctions that are not detected by a DTC.

DTC P0182

Fuel Temperature Sensor Circuit Low Voltage

DTC P0183

Fuel Temperature Sensor Circuit High Voltage

DTC P0187

Fuel Rail Temperature Sensor Circuit Low Voltage

DTC P0188

Fuel Rail Temperature Sensor Circuit High Voltage

DTC P0191

Fuel Rail Pressure Sensor Performance

DTC P0192

Fuel Rail Pressure Sensor Circuit Low Voltage

DTC P111F

Fuel Temperature Sensor 1 - Fuel Temperature Sensor 2 Not Plausible

DTC P126E

Fuel Rail Temperature Sensor 1 Performance

DTC P126F

Fuel Rail Temperature Sensor 2 Performance

DTC P127C

Fuel Rail Pressure Sensor 2 Circuit Low Voltage

DTC P128A

Fuel Rail Pressure Sensor 1 Internal Performance

DTC P128B

Fuel Rail Pressure Sensor 2 Internal Performance

DTC P16E4

DTC P16E5

Sensor Communication Circuit 3 High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P0182*, P0187*, P0641**	P128C**, P128D**, P128F**, P16E4, P16E5	P0641**, P16E5	P111F, P126E, P126F
Signal	P16E4	P16E5	P16E5	P111F, P126E, P126F
Low Reference	-	P16E5	-	P111F, P126E, P126F
*This DTC sets when there is an internal component issue:B310 Fuel Pressure/Temperature Sensor **Additional DTCs may set.				

Typical Scan Tool Data**Fuel Rail Pressure Sensor 1 & Fuel Rail Pressure Sensor 2**

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine at Idle Parameter Normal Range: 3.9 to 4.2 MPa (565 to 609 PSI)			
5 V Reference	655.4 MPa (95058 PSI)	655.4 MPa (95058 PSI)	655.4 MPa (95058 PSI)
Signal	655.4 MPa (95058 PSI)	655.4 MPa (95058 PSI)	655.4 MPa (95058 PSI)
Low Reference	-	655.4 MPa (95058 PSI)	-

Fuel Rail Temperature Sensor 1 & Fuel Rail Temperature Sensor 2

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine at Idle Parameter Normal Range: -40 to 115Â°C (-40 to 240Â°F)			
5 V Reference	-40	-40	-40
Signal	-40	-40	-40
Low Reference	-	-40	-

Circuit/System Description

Circuit	Description
5 V Reference	Regulated voltage supplied by the control module.
Signal	Digitally encoded information for communication between devices.
Low Reference	Grounded through the control module.

Component	Description
B310 Fuel Pressure/Temperature Sensor	The sensor measures fuel rail pressure and fuel rail temperature.
K20 Engine Control Module	The control module controls a series of actuators to ensure optimal engine performance. The control module does this by reading values from a variety of sensors, interprets the data and adjusts the engine actuators accordingly.

The control module uses the fuel rail pressure sensor to constantly adjust the high pressure fuel pump's feed rate so that the ideal pressure is permanently maintained in the high pressure section (between the high pressure fuel pump and the injectors) by means of a closed loop control. The fuel rail pressure sensor transmits fuel pressure and temperature information via serial data to the control module K20. The sensor's internal microprocessor allows 4 separate sensor outputs from one 3 wire sensor.

Conditions for Running the DTC

P0182, P0183

- DTC P126E, P128C, P16E4, P16E5 = Not set
- DTC P126E, P128C = Not pending
- Ignition = On

DTC runs continuously when the above conditions are met.

P0187, P0188

- DTC P126E, P128C, P16E4, P16E5 = Not set
- DTC P126F, P128D = Not pending
- Ignition = On

DTC runs continuously when the above conditions are met.

P0191, P0192

- DTC P126E, P128C, P16E4, P16E5 = Not set
- DTC P126F, P128D = Not pending
- Ignition = On

DTC runs continuously when the above conditions are met.

P111F

- DTC P0182, P0183, P0187, P0188, P126E, P126F, P128C, P128D, P16E4, P16E5 = Not set
- DTC P128C, P128D, P16E4, P16E5 = Not pending
- Ignition = On

DTC runs continuously when the above conditions are met.

P126E, P126F

- DTC P128C, P16E4, P16E5 = Not set
- DTC P128C = Not pending
- Ignition = On

DTC runs continuously when the above conditions are met.

P127C

- DTC P126E, P128C, P16E4, P16E5 = Not set
- DTC P126F, P128D = Not pending
- Ignition = On

DTC runs continuously when the above conditions are met.

P128A, P128B

- DTC P128F, P16E4, P16E5 = Not set
- Ignition On

DTC runs continuously when the above conditions are met.

P16E4, P16E5

- DTC P0641, P0651, P0697, P06A3 = Not set
- Ignition On

DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

P0182

Fuel Rail Temperature Sensor 1 = Less than a predefined threshold - For greater than 4 s

P0183

Fuel Rail Temperature Sensor 1 = Greater than a predefined threshold - For greater than 4 s

P0187

Fuel Rail Temperature Sensor 2 = Less than a predefined threshold - For greater than 4 s

P0188

Fuel Rail Temperature Sensor 2 = Greater than a predefined threshold - For greater than 4 s

P0191

Fuel Rail Pressure Sensor 2 = Greater than a predefined threshold - For greater than 2.6 s

P0192

Fuel Rail Pressure Sensor 2 = Greater than a predefined threshold - For greater than 2.6 s

P111F

The following parameters are not within 10Â°C (50Â°F) of each other :

- Fuel Rail Temperature Sensor 1
- Fuel Rail Temperature Sensor 2

The above condition(s) must occur for greater than 8 s.

P126E

Fuel Rail Temperature Sensor 1 = Greater than the maximum threshold - For greater than 4 s

P126F

Fuel Rail Temperature Sensor 2 = Greater than the maximum threshold - For greater than 4 s

P127C

Fuel Rail Pressure Sensor 2 = Greater than a predefined threshold - For greater than 2.6 s

P128A

Fuel Rail Pressure Sensor 1 = Greater than a predefined threshold - For greater than 2.6 s

P128B

Fuel Rail Pressure Sensor 2 = Greater than a predefined threshold - For greater than 2.6 s

P16E4

Fuel Rail Pressure Sensor Signal = Less than a predefined threshold - For greater than 3.25 s

P16E5

Fuel Rail Pressure Sensor Signal = Greater than a predefined threshold - For greater than 3.25 s

Actions Taken When the DTC Sets

- DTC P0191, P0192, P127C, P128A, P128B, P16E4, P16E5 is a Type A DTC.
- DTCs P0182, P0183, P0187, P0188, P111F, P126E, P126F are Type B DTCs.

Conditions for Clearing the DTC

- DTC P0191, P0192, P127C, P128A, P128B, P16E4, P16E5 is a Type A DTC.
- DTCs P0182, P0183, P0187, P0188, P111F, P126E, P126F are Type B DTCs.

Reference Information

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Engine Controls Wiring Schematics

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DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References

Circuit/System Verification

1. Ignition - On / Vehicle - In Service Mode
2. Verify the scan tool parameter : Fuel Rail Temperature Sensor 1 = -39 to 115°C (-39 to 240°F)
 - **If not between -39 and 115°C (-39 and 240°F)**

Refer to : Circuit/System Testing

- **Go to next step : If between -39 and 115°C (-39 and 240°F)**

3. Verify the scan tool parameter : Fuel Rail Temperature Sensor 1 & Fuel Rail Temperature Sensor 2 = Within 10°C (50°F) of each other

- **If not within 10°C (50°F) of each other**

Refer to : Circuit/System Testing

- **Go to next step : If within 10Å°C (50Å°F) of each other**

4. Verify the scan tool parameter : Fuel Rail Temperature Sensor 1 = The value should not spike or drop out.

Perform the action while monitoring the parameter :

- Wiggle the harness and connector : B310 Fuel Pressure/Temperature Sensor
- Wiggle the harness and connector : K20 Engine Control Module
- **If the value spikes or drops out**

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

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

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

6. Verify the DTC does not set.

- **If the DTC sets**

Refer to : Circuit/System Testing

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

7. All OK.

Circuit/System Testing

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

1. Ignition/Vehicle & All vehicle systems - Off

2. Disconnect the electrical connector : B310 Fuel Pressure/Temperature Sensor

3. Test for less than 10 ohms between the test points : Low Reference circuit terminal 1 & Ground

- **If 10 ohms or greater**

1. Disconnect the electrical connector : X3 @ K20 Engine Control Module

2. Test for less than 2 ohms between the test points : Low Reference circuit terminal 1 @ Component harness & Terminal 41 @ Control module harness

- If 2 ohms or greater - Repair the open/high resistance in the circuit.
- If less than 2 ohms - Replace the component : K20 Engine Control Module

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

4. Ignition - On / Vehicle - In Service Mode

5. Test for 4.8 to 5.2 V between the test points : 5 V Reference circuit terminal 3 & Low Reference circuit terminal 1

- **If less than 4.8 V**

1. Ignition/Vehicle - Off

2. Disconnect the electrical connector : X3 @ K20 Engine Control Module

3. Test for infinite resistance between the test points : 5 V Reference circuit terminal 3 @ Component harness & Ground

- If less than infinite resistance - Repair the short to ground on the circuit.
- Go to next step : If infinite resistance

4. Test for less than 2 ohms between the test points : 5 V Reference circuit terminal 3 @ Component harness & Terminal 40 @ Control module harness

- If 2 ohms or greater - Repair the open/high resistance in the circuit.
- If less than 2 ohms - Replace the component : K20 Engine Control Module

- **If greater than 5.2 V**

1. Ignition/Vehicle - Off

2. Disconnect the electrical connector : X3 @ K20 Engine Control Module
3. Ignition - On / Vehicle - In Service Mode
4. Test for less than 1 V between the test points : 5 V Reference circuit terminal 3 @ Component harness & Ground
 - If 1 V or greater - Repair the short to voltage on the circuit.
 - If less than 1 V - Replace the component : K20 Engine Control Module
- **Go to next step : If between 4.8 and 5.2 V**
6. Test for 4.8 to 5.2 V between the test points : Signal circuit terminal 2 & Low Reference circuit terminal 1
 - **If less than 4.8 V**
 1. Ignition/Vehicle - Off
 2. Disconnect the electrical connector : X3 @ K20 Engine Control Module
 3. Test for infinite resistance between the test points : Signal circuit terminal 2 @ Component harness & Ground
 - If less than infinite resistance - Repair the short to ground on the circuit.
 - Go to next step : If infinite resistance
 4. Test for less than 2 ohms between the test points : Signal circuit terminal 2 @ Component harness & Terminal 60 @ Control module harness
 - If 2 ohms or greater - Repair the open/high resistance in the circuit.
 - If less than 2 ohms - Replace the component : K20 Engine Control Module
 - **If greater than 5.2 V**
 1. Ignition/Vehicle - Off
 2. Disconnect the electrical connector : X3 @ K20 Engine Control Module
 3. Ignition - On / Vehicle - In Service Mode
 4. Test for less than 1 V between the test points : Signal circuit terminal 2 @ Component harness & Ground
 - If 1 V or greater - Repair the short to voltage on the circuit.
 - If less than 1 V - Replace the component : K20 Engine Control Module
 - **Go to next step : If between 4.8 and 5.2 V**
7. Test or replace the component : B310 Fuel Pressure/Temperature Sensor

Component Testing

1. Connect a 3 A fused jumper wire between the test points : 5 V Reference terminal 3 & 5 V
2. Connect a jumper wire between the test points : Low Reference terminal 1 & Ground
3. Test for 2.5 to 4.0 V between the test points : Signal terminal 2 & Low Reference terminal 1
 - **If not between 2.5 and 4.0 V**

Replace the component : B310 Fuel Pressure/Temperature Sensor
 - **Go to next step : If between 2.5 and 4.0 V**
4. All OK.

Repair Instructions

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

- [Fuel Injection Fuel Rail Fuel Pressure Sensor Replacement](#) - B310 Fuel Pressure/Temperature Sensor
- For control module replacement, programming, and setup refer to : [Control Module References](#)

DTC P018B, P018C, 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, P0641, P06A6	P018C	P018D	P06A6
Signal	P018C	P018C	P018D	P018B
Low Reference	-	P018D	-	P06A6

Circuit/System Description

The fuel pressure sensor is located on the chassis 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 conditions above are 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 B DTCs.

Conditions for Clearing the DTC

DTC P018B, P018C and P018D are Type B 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

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Scan Tool Reference

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

Circuit/System Verification

1. Ignition ON.
2. Verify DTC U18A2 is not set or stored in history.
 - **If DTC U18A2 is set or stored in history**
Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) .
 - **Go to next step : If DTC U18A2 is not set or stored in history**
3. Engine running.
4. Verify the scan tool Fuel Pressure Sensor parameter is between 0.2 - 4.8 V.
 - **If not between 0.2 - 4.8 V**
Refer to Circuit/System Testing.
 - **Go to next step : If between 0.2 - 4.8 V**
5. Verify the scan tool Fuel Pressure Sensor increases or decreases when commanding an increase and decrease in Fuel Pressure with a scan tool.
 - **If the parameter does not change**

Refer to Circuit/System Testing.

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

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

7. Verify the DTC does not set.

- **If the DTC sets**

Refer to Circuit/System Testing.

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

8. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B47 Fuel Pressure Sensor. It may take up to 2 min for all vehicle systems to power down.

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

- **If 5 Ω or greater**

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

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

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

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

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

3. Ignition ON.

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

- **If less than 4.8 V**

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

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

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

- Go to next step : If infinite resistance

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

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

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

- **If greater than 5.2 V**

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

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

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

- If less than 1 V, replace the K20 Engine Control Module.

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

5. Verify the scan tool Fuel Pressure Sensor parameter is less than 1 V.

- **If 1 V or greater**

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

2. 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.

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

6. Install a 3 A fused jumper wire between the signal circuit terminal 3 and the 5 V reference circuit terminal 3, wait 15 s.

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 X1 harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the signal circuit terminal 3 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - Go to next step : If infinite resistance
 3. Test for less than 2 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
- **Go to next step : If 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 - Fuel Feed Pipe (AWD)**, **Fuel Pressure Sensor Replacement - Fuel Feed Pipe (FWD)**.
- **Control Module References** for K20 Engine Control Module replacement, programming, and setup

DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, OR P0277

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 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

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 Supply Cylinder 1	P2147	P0201	P2148	P1248
Direct Fuel Injector High Voltage Control Cylinder 1	P0261	P0201	P0262	P1248
Direct Fuel Injector High Voltage Supply Cylinder 2	P2150	P0202	P2151	P1249
Direct Fuel Injector High Voltage Control Cylinder 2	P0264	P0202	P0265	P1249
Direct Fuel Injector High Voltage Supply Cylinder 3	P2153	P0203	P2154	P124A
Direct Fuel Injector High Voltage Control Cylinder 3	P0267	P0203	P0268	P124A
Direct Fuel Injector High Voltage Supply Cylinder 4	P2156	P0204	P0270, P2157	P124B
Direct Fuel Injector High Voltage Control Cylinder 4	P0270, P2156	P0204	P0271, P2157	P124B

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Short from Supply Circuit to Control Circuit
Direct Fuel Injector High Voltage Supply Cylinder 5	P216B	P0205	P216C	P124C
Direct Fuel Injector High Voltage Control Cylinder 5	P0273	P0205	P0274	P124C
Direct Fuel Injector High Voltage Supply Cylinder 6	P216E	P0206	P216F	P124D
Direct Fuel Injector High Voltage Control Cylinder 6	P0276	P0206	P0277	P124D

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

- The engine is running.
- The ignition voltage is between 11 - 18 V.
- The DTCs run continuously once the above conditions are met.

Conditions for Setting the DTC

P0201, P0202, P0203, P0204, P0205, or P0206

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

P0261, P0264, P0267, P0270, P0273, or P0276

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

P0262, P0265, P0268, P0271, P0274, or P0277

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

Action Taken When the DTC Sets

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

Conditions for Clearing the DTC

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

Diagnostic Aids

- Performing the fuel injector coil test may help isolate an intermittent condition. Refer to **Fuel Injector Solenoid Coil Test**.
- If the condition is intermittent, move the related harnesses and connectors, with the engine operating, while monitoring the scan tool Cylinder 1 - 6 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

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Fuel System Description

Electrical Information Reference

- [Circuit Testing](#)
- [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 P0685 or P1682 is not set.
 - **If DTC P0685 or P1682 is set**
Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) .
 - **Go to next step : If DTC P0685 or P1682 is not set**
3. Engine idling.
4. Verify the scan tool Cylinder 1 - 6 Injector Control Circuit Status parameters display OK.
 - **If any parameters do not display OK**
Refer to Circuit/System Testing.
 - **Go to next step : If all parameters display OK**
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 DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277 does not set.
 - **If any DTC sets**
Refer to Circuit/System Testing.
 - **Go to next step : If no DTC sets**
7. All OK.

Circuit/System Testing

1. Ignition/Vehicle - Off
2. Disconnect the appropriate electrical connector : Q17 Fuel Injector
3. Ignition - On / Vehicle - In Service Mode

4. Verify the appropriate scan tool parameter Cylinder 1 - 6 Injector Control Circuit Status = Open

- **If the parameter displays the following : High Control Circuit High Voltage**

1. Ignition/Vehicle - Off
2. Disconnect the electrical connector : K20 Engine Control Module
3. Ignition - On / Vehicle - In Service Mode
4. Test for less than 1 V between the test points : Control circuit terminal 2 @ Component harness & Ground
 - If 1 V or greater - Repair the short to voltage on the circuit.
 - If less than 1 V - Replace the component : K20 Engine Control Module

- **If the parameter displays the following : High Control Circuit Low Voltage**

1. Ignition/Vehicle - Off
2. Disconnect the electrical connector : K20 Engine Control Module
3. Test for infinite resistance between the test points : Control circuit terminal 2 @ Component harness & Ground
 - If less than infinite resistance - Repair the short to ground on the circuit.
 - If infinite resistance - Replace the component : K20 Engine Control Module

- **Go to next step : If the parameter displays the following : Open**

5. Connect a 3 A fused jumper wire between the test points : Control circuit terminal 2 @ Component harness & Ground

6. Verify the appropriate scan tool parameter Cylinder 1 - 6 Injector Control Circuit Status = High Control Circuit Low Voltage

- **If not the specified state**

1. Ignition/Vehicle - Off
2. Disconnect the electrical connector : K20 Engine Control Module
3. Test for less than 2 ohms between the test points : Control circuit terminal 2 @ Component harness &
 - {Q17A Fuel Injector 1} Terminal 69 @ Control module harness
 - {Q17B Fuel Injector 2} Terminal 68 @ Control module harness
 - {Q17C Fuel Injector 3} Terminal 72 @ Control module harness
 - {Q17D Fuel Injector 4} Terminal 70 @ Control module harness
 - {Q17E Fuel Injector 5} Terminal 67 @ Control module harness
 - {Q17F Fuel Injector 6} Terminal 71 @ Control module harness
 - If 2 ohms or greater - Repair the open/high resistance in the circuit.
 - If less than 2 ohms - Replace the component : K20 Engine Control Module

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

7. Connect a 3 A fused jumper wire between the test points : Control circuit terminal 2 & Control circuit terminal 1 @ Component harness

8. Verify the appropriate scan tool parameter Cylinder 1 - 6 Injector Control Circuit Status = OK

- **If the parameter displays the following : High Control Circuit High Voltage**

1. Ignition/Vehicle - Off
2. Disconnect the electrical connector : K20 Engine Control Module
3. Ignition - On / Vehicle - In Service Mode
4. Test for less than 1 V between the test points : Control circuit terminal 1 @ Component harness & Ground
 - If 1 V or greater - Repair the short to voltage on the circuit.
 - If less than 1 V - Replace the component : K20 Engine Control Module

- **If the parameter displays the following : High Control Circuit Low Voltage**

1. Ignition/Vehicle - Off
2. Disconnect the electrical connector : K20 Engine Control Module

3. Test for infinite resistance between the test points : Control circuit terminal 1 @ Component harness & Ground
 - If less than infinite resistance - Repair the short to ground on the circuit.
 - If infinite resistance - Replace the component : K20 Engine Control Module
- **If the parameter displays the following : Open**
 1. Ignition/Vehicle - Off
 2. Disconnect the electrical connector : K20 Engine Control Module
 3. Test for less than 2 ohms between the test points : Control circuit terminal 1 @ Component harness &
 - {Q17A Fuel Injector 1} Terminal 49 @ Control module harness
 - {Q17B Fuel Injector 2} Terminal 48 @ Control module harness
 - {Q17C Fuel Injector 3} Terminal 52 @ Control module harness
 - {Q17D Fuel Injector 4} Terminal 50 @ Control module harness
 - {Q17E Fuel Injector 5} Terminal 47 @ Control module harness
 - {Q17F Fuel Injector 6} Terminal 51 @ Control module harness
 - If 2 ohms or greater - Repair the open/high resistance in the circuit.
 - If less than 2 ohms - Replace the component : K20 Engine Control Module
- **Go to next step : If the parameter displays the following : OK**
 9. Test or replace the component : Q17 Fuel Injector

Component Testing

- [Fuel Injector Solenoid Coil Test](#)
- [Fuel Injector Balance Test](#)

Repair Instructions

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

- [Fuel Injection Fuel Rail Assembly Replacement - Bank 1](#)
- [Fuel Injection Fuel Rail Assembly Replacement - Bank 2](#)
- [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	P0231	P023F	P0232	P023F, P2635
Low Reference	-	P023F	-	P023F, P2635

Circuit/System Description

The engine control module (ECM) supplies voltage to the fuel pump power control module when the ECM detects that the ignition is on. The voltage from the ECM to the fuel pump power control module remains active for 2 seconds, unless the engine is in crank or run. While this voltage is being received, the fuel pump power 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 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 power control module detects that the fuel pump current is greater than 14.48 A for 1 s.

P0232

The fuel pump power 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 power 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

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the fuel pump turns ON and OFF when commanding the Fuel Pump Enable On and Off with a scan tool.
 - **If the fuel pump does not turn ON and OFF**
Refer to Circuit/System Testing.
 - **Go to next step : If the fuel pump turns ON and OFF**
3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
4. Verify the DTC does not set.
 - **If the DTC sets**
Refer to Circuit/System Testing.
 - **Go to next step : If the DTC does not set**
5. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the G12 Fuel Pump and at the K111 Fuel Pump Power Control Module.
2. Test for less than 2 Ω in the low reference circuit end to end between the following terminals.
 - G12 Fuel Pump terminal 2

- K111 Fuel Pump Power Control Module terminal 16
- **If 2 Ω or greater**

Repair the open/high resistance in the circuit.

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

3. Connect the harness connector at the K111 Fuel Pump Power Control Module.
4. Ignition ON, connect a test lamp between the supply voltage circuit terminal 1 and the low reference circuit terminal 2 of the harness connector at the G12 Fuel Pump.
5. Verify the test lamp turns ON and OFF when commanding the Fuel Pump Enable On and Off with a scan tool.
 - **If the test lamp is always OFF**
 1. Ignition OFF, disconnect the harness connector at the K111 Fuel Pump Power 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.
 - Go to next step : If infinite resistance
 3. Test for less than 2 Ω in the supply voltage circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , test or replace the K111 Fuel Pump Power 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 Power 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 Power Control Module.
 - **Go to next step : If the test lamp turns ON and OFF**
6. Replace the G12 Fuel Pump.

Component Testing

Static Test

1. Ignition OFF, disconnect the harness connector at the K111 Fuel Pump Power Control Module.
2. Connect a DMM, set on the diode setting, with the positive lead at terminal 16 and the negative lead at terminal 9 of the K111 Fuel Pump Power Control Module
3. Test for 0.4 - 0.8 V between terminal 16 and terminal 9.
 - **If not between 0.4 - 0.8 V**

Replace the K111 Fuel Pump Power Control Module.
 - **Go to next step : If between 0.4 - 0.8 V**
4. Connect a DMM, set on the diode setting, with the positive lead at terminal 9 and the negative lead at terminal 16 of the K111 Fuel Pump Power Control Module
5. Test for OL between terminal 9 and terminal 16.
 - **If not OL**

Replace the K111 Fuel Pump Power Control Module.
 - **Go to next step : If OL**
6. All OK

Repair Instructions

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

- [Fuel Pump Power Control Module Replacement \(AWD\), Fuel Pump Power Control Module Replacement \(FWD\)](#)
- [Fuel Tank Fuel Pump Module Replacement \(FWD\), Fuel Tank Fuel Pump Module Replacement \(AWD\)](#) for G12 Fuel Pump replacement

DTC P0300, P0301, P0302, P0303, P0304, P0305 OR P0306

Diagnostic Instructions

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

DTC Descriptor

DTC P0300

Engine Misfire Detected

DTC P0301

Cylinder 1 Misfire Detected

DTC P0302

Cylinder 2 Misfire Detected

DTC P0303

Cylinder 3 Misfire Detected

DTC P0304

Cylinder 4 Misfire Detected

DTC P0305

Cylinder 5 Misfire Detected

DTC P0306

Cylinder 6 Misfire Detected

Circuit/System Description

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

- [Electronic Ignition System Description](#)
- [Fuel System Description](#)

A misfiring cylinder causes slight variations in the rotational speed of the crankshaft. The ECM is able to detect these variations by closely monitoring the crankshaft position sensor signal. The signals of the camshaft position sensors are used to determine which cylinder is misfiring. If the ECM detects a misfire rate sufficient to cause emission levels to exceed mandated standards, DTC P0300 sets. Under certain driving conditions, a misfire rate can be high enough to cause the catalytic converter to overheat, possibly damaging the converter. The malfunction indicator lamp (MIL) flashes when converter overheating, damaging conditions are present and DTC P0300 is set.

Conditions for Running the DTC

- DTC P0010, P0011, P0013, P0014, P0016, P0017, P0018, P0019, P0020, P0021, P0023, P0024, P0068, P00C8, P00C9, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0117, P0118, P0119, P0122, P0123, P0191, P0192, P0193, P0222, P0223, P0335, P0336,

P0340, P0341, P0345, P0346, P0365, P0366, P0390, P0391, P0601, P0604, P0606, P0651, P16A0, P16A1, P16A2, P16F3, P2101, P2135, P2227, P2228, P2229, P2230 = Not set

- Crankshaft/Camshaft Sensors = Synchronized
- Engine Coolant Temperature = -7 to 127Â°C (19.4 to 261Â°F)
- Engine Load = 0%
- Engine Speed = Greater than 1, 500 RPM
- Engine Speed = Less than 1, 000 RPM - DTC P0315 is set.
- Fuel Cut-Off System = Inactive
- Fuel level = Greater than 11%
- Rough Road Signal = Not Detected
- System Voltage = 9 to 32 V

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

Conditions for Setting the DTC

P0300

The control module K20 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

The control module K20 detects a crankshaft rotation speed variation indicating a single cylinder misfire rate sufficient to cause emissions levels to exceed mandated standards.

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type B DTC

Malfunction Indicator Lamp (MIL) = Flashing - During catalyst damaging misfire.

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type B DTC

Diagnostic Aids

Verify the following conditions do not exist :

- Accessory drive bracket - Defective/Loose/Visible Damage
- Belt Driven Device - Defective/Loose/Visible Damage
- Brake Rotor - Excessive runout
- Drive Belt - Defective/Loose/Visible Damage
- Drive Shaft - Excessive runout
- During certain road conditions : Rough
- Tire and wheel assemblies which exhibit excessive runout can produce vibrations even if the assemblies are balanced.
- Incorrect operation of the component : Transmission
- Command the Cylinder Deactivation system On with a scan tool, then observe the misfire counters when commanding the system Off. If the misfire counters are incrementing, inspect for a sticking valve lifter. - If equipped
- High resistance in the circuits of the component may set DTC P0300 - P0306 without setting the DTC for the component : Q17 Fuel Injector
- If the condition is intermittent, wiggle the related wiring harnesses and connectors, with the ignition/vehicle on or engine running, while monitoring the scan tool circuit status parameters for the component. The parameters will display if there is a condition with the circuit or a connection.

- DTC P0300 may set when there is a condition with the component circuits : B52 Heated Oxygen Sensor

Reference Information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References

Special Tools

J-26792 Ignition Spark Tester

Equivalent regional tools : **Special Tools**

Circuit/System Verification

1. Engine - Running
2. Verify there is no abnormal noise from the component : Engine
 - **If an abnormal noise is present**
Refer to : **Symptoms - Engine Mechanical**
 - **Go to next step : If no abnormal noise is present**
3. Perform the scan tool learn/reset function : **Crankshaft Position Variation Learn**
4. Verify there are no DTCs set related to the following system/component :
 - B23 Camshaft Position Sensor
 - B26 Crankshaft Position Sensor
 - B52 Heated Oxygen Sensor
 - Fuel System
 - Ignition System
 - Mechanical Condition
 - **If other DTCs are set**
Refer to : **Diagnostic Trouble Code (DTC) List - Vehicle**
 - **Go to next step : If no other DTCs are set**
5. Verify the scan tool parameter : Cylinder 1 - 6 Current Misfire Counter = Does not Increment
 - **If the parameter value increments**
Refer to : Circuit/System Testing
 - **Go to next step : If the parameter value does not increment**
6. Perform the scan tool control function : Cylinder Power Balance - Enable

Verify the sound of the engine changes the same way when turning off each individual injector.
 - **If the engine sound does not change the same way for one or more cylinders**
Refer to : Circuit/System Testing
 - **Go to next step : If the engine sound changes the same way for all cylinders**
7. Verify the scan tool parameter : Cylinder 1 - 6 Current Misfire Counter = Does not Increment

Perform the action while monitoring the parameter :

- Wiggle the harness and connector : K20 Engine Control Module
- Wiggle the harness and connector : Q17 Fuel Injector
- Wiggle the harness and connector : T8 Ignition Coil
- Wiggle the component : Vacuum Hoses
- **If the parameter value does not increment**

Repair or replace as necessary.

- **Go to next step : If the parameter value increments**

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

Verify the DTC does not set.

- **If the DTC sets**

Refer to : Circuit/System Testing

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

9. All OK.

Circuit/System Testing

1. Verify the following conditions do not exist :

- Engine - Vacuum leak
- Exhaust System - Leaking/Missing components/Restricted - Refer to : [Symptoms - Engine Exhaust](#)
- Fuel - Contaminated/Dirty/Fill Level = Low - Refer to : [Alcohol/Contaminants-in-Fuel Diagnosis](#)
- Fuel Pressure - High/Low - Refer to : [Fuel System Diagnosis](#)
- Positive Crankcase Ventilation System - Leaking/Incorrect connection/Restricted
- Spark Plug Boot - Carbon Tracking/ Fluid intrusion/Visible Damage
- Spark Plug - Carbon Tracking/Fouled/Visible Damage
- Vacuum Hoses - Kinked/Leaking/Incorrect connection/Restricted
- **If a condition exists**

Repair or replace as necessary.

- **Go to next step : If no conditions exist**

2. Ignition/Vehicle - Off

3. Remove the appropriate component : T8 Ignition Coil - Leave the electrical connector connected.

4. Install the special tool : J-26792 Ignition Spark Tester @ T8 Ignition Coil & Ground

5. Engine - Running

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

6. Verify there is spark at the tool.

- **If there is no spark**

Refer to : [Electronic Ignition System Diagnosis](#)

- **Go to next step : If there is spark**

7. Ignition/Vehicle - Off

8. Verify the component specifications are correct : Spark Plug - Gap / Heat Range /Torque

- **If not correct**

Repair or replace as necessary.

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

9. Swap the two components : Spark Plug - The original component that set the DTC & Another known good component from the vehicle
10. Engine - Running
11. Verify the scan tool parameter : Cylinder 1 - 6 Current Misfire Counter = Increments - At the original component location the DTC set.

- **If the parameter value does not increment**

Replace the component : Spark Plug - The original component that set the DTC

- **Go to next step : If the parameter value increments**

12. Perform the following procedure/test : Fuel Injector Balance - Refer to : [Fuel Injector Circuit Diagnosis](#)

Verify the procedure/test passes.

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

Replace the component that failed the test : Q17 Fuel Injector

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

13. Verify the condition does not exist : An engine mechanical condition. - Refer to : [Symptoms - Engine Mechanical](#)

- **If a condition exists**

Repair or replace as necessary.

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

14. All OK.

Repair Instructions

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

After any repair, perform DTC P0420 Circuit/System Verification, to verify the performance of the component : Catalytic Converter - Refer to : [DTC P0420 or P0430](#)

- [Crankshaft Position Variation Learn](#)
- [Ignition Coil Replacement - Bank 1](#)
- [Ignition Coil Replacement - Bank 2](#)
- [Spark Plug Replacement \(Bank 1\), Spark Plug Replacement \(Bank 2\)](#)

DTC P0315

Diagnostic Instructions

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

DTC Descriptor

DTC P0315

Crankshaft Position System Variation Not Learned

Circuit/System Description

The crankshaft position sensor variation or reluctor ring learn is used to calculate reference period errors caused by slight tolerance variations in the crankshaft and the crankshaft position sensor. The calculated

error allows the ECM to accurately compensate for reference period variations. This enhances the ability of the ECM to detect misfire events over a wider range of engine speed and load. The compensation values are stored in ECM memory after a learn procedure has been performed.

Conditions for Running the DTC

Engine = Running

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

Conditions for Setting the DTC

Crankshaft Position Variation Learn = Not Learned

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type A DTC

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type A DTC

Diagnostic Aids

This test procedure requires that the vehicle battery has passed a load test and is completely charged. Refer to : [Battery Inspection/Test](#)

Reference Information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References

Circuit/System Verification

1. Ignition - On / Vehicle - In Service Mode
2. Perform the scan tool learn/reset function : [Crankshaft Position Variation Learn](#)
3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Verify the DTC does not set.

- **If the DTC sets**

Replace the component : K20 Engine Control Module

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

4. All OK.

Repair Instructions

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

For control module replacement, programming, and setup refer to : [Control Module References](#)

DTC P0324, P0325, P0326, P0327, P0328, P0330, P0331, P0332, P0333, P06B6, OR P06B7

Diagnostic Instructions

- Perform the Diagnostic System Check prior to using this diagnostic procedure : [Diagnostic System Check - Vehicle](#)

- Review the description of Strategy Based Diagnosis : [Strategy Based Diagnosis](#)
- An overview of each diagnostic category can be found here : [Diagnostic Procedure Instructions](#)

DTC Descriptor

DTC P0324

Knock Sensor System Performance

DTC P0325

Knock Sensor 1 Circuit

DTC P0326

Knock Sensor 1 Performance

DTC P0327

Knock Sensor 1 Circuit Low Voltage

DTC P0328

Knock Sensor 1 Circuit High Voltage

DTC P0330

Knock Sensor 2 Circuit

DTC P0331

Knock Sensor 2 Performance

DTC P0332

Knock Sensor 2 Circuit Low Voltage

DTC P0333

Knock Sensor 2 Circuit High Voltage

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 - Terminal 1/A	P0327, P06B6	P0325	P0328	P0324*, P0326**
Knock Sensor 1 Signal - Terminal 2/B	P0327	P0325	P0328	P0324*, P0326**
Knock Sensor 2 Signal - Terminal 1/A	P0332, P06B7	P0330	P0333	P0324*, P0331**
Knock Sensor 2 Signal - Terminal 2/B	P0332	P0330	P0333	P0324*, P0331**
*Signal Performance = High **Signal Performance = Low				

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

Circuit	Description
Signal - Terminal 1/A	The control module input circuit has an internal resistance connected to 5 V.
Signal - Terminal 2/B	The control module input circuit has an internal resistance connected to 1.33 V.

Component	Description
B68 Knock Sensor	The sensor uses piezo-electric crystal technology that produces an AC voltage signal of varying amplitude and frequency based on the engine vibration or noise level. The amplitude and frequency depend upon the level of knock that the knock sensor detects.
K20 Engine Control Module	The control module controls a series of actuators to ensure optimal engine performance. The control module does this by reading values from a variety of sensors, interprets the data and adjusts the engine actuators accordingly.

The knock sensor measures vibrations of the engine block. To some extent it is comparable to a microphone. The sensor produces an AC voltage that is proportional in frequency and amplitude to the vibrations. The ECM can deduce from the signal if and which cylinder is knocking. This enables the ECM to adjust the spark timing so that the best fuel efficiency is gained. The ECM learns a minimum knock sensor noise level at idle and uses calibrated values for the rest of the engine speed range.

Conditions for Running the DTC

P0324

- Engine = Running - For greater than 2 s
- Engine Coolant Temperature = Warmer than -40Â°C (-40Â°F)
- Engine Speed = 400 to 8500 RPM
- Intake Air Temperature = Warmer than -40Â°C (-40Â°F)
- Mass Air Flow Per Cylinder = Less than 2, 000 mg

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

P0326, P0331

- Engine = Running - For greater than 2 s
- Engine Coolant Temperature = Warmer than -40Â°C (-40Â°F)
- Engine Speed = 2250 to 8500 RPM - Cumulative = Greater than 167 engine revolutions
- Intake Air Temperature = Warmer than -40Â°C (-40Â°F)
- Mass Air Flow Per Cylinder = Less than 2, 000 mg

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

P0325, P0330

- Engine = Running - Greater than 200 engine revolutionsFor greater than 2 s
- Engine Speed = 400 to 5, 500 RPM - Greater than 75 engine revolutions
- Engine Coolant Temperature = Warmer than -40Â°C (-40Â°F)
- Mass Air Flow Per Cylinder = 20 to 2, 000 mg
- Intake Air Temperature = Warmer than -40Â°C (-40Â°F)

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

P0327, P0328, P0332, P0333

Engine Speed = Less than 8, 500 RPM

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

P06B6, P06B7

- Engine = Running - For greater than 2 s
- Engine Speed = 400 to 5, 500 RPM - Greater than 75 engine revolutions
- Mass Air Flow Per Cylinder = 20 to 2, 000 mg

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

Conditions for Setting the DTC

P0324

Knock Sensor Signal = Excessive engine knocking

P0325, P0330

Signal circuit = Open - For greater than 5 s

P0326, P0331

Signal Performance = Low Frequency

P0327, P0332

Signal circuit = Short to Ground - For greater than 5 s

P0328, P0333

Signal circuit = Short to Voltage - For greater than 5 s

P06B6, P06B7

A fault of the processor that evaluates the knock sensor signal was detected.

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type B DTC

The ignition timing is retarded to reduce potentially engine-damaging knocking.

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type B DTC

Diagnostic Aids

- Inspect the knock sensor for physical damage. A damaged sensor may cause a DTC to set.
- The knock sensor mounting surface should be free of burrs, casting flash, and foreign material.
- Tightening the retaining bolt too much or simply dropping the knock sensor on the ground can damage it.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References

Circuit/System Verification

1. Engine - Running
2. Verify DTC P0325, P0327, P0328, P0330, P0332, P0333, P06B6, P06B7 is not set.

- **If only DTC P0325, P0327, P0328, P0330, P0332, P0333 is set**

Refer to : Circuit/System Testing

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

Replace the component : K20 Engine Control Module

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

3. Verify the scan tool parameter : Cylinder 1 - 6 Knock Detected = No

Perform the action while monitoring the parameter :

- Wiggle the harness and connector : B68 Knock Sensor
- Wiggle the harness and connector : K20 Engine Control Module
- **If not the specified state**

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

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

4. Verify DTC P0324, P0326, P0331 is not set.

- **If the DTC is set**

1. Verify a condition does not exist with the component : B68 Knock Sensor

- Incorrect installation - Refer to : [Fastener Specifications](#)
- Interference with other components - Bracket/Engine Wiring Harness/Hoses / Lines
- Visible Damage
- If a condition exists - Repair or replace as necessary
- Go to next step : If no condition exists

2. Verify the condition did not cause the DTC to set :

- Accessory drive bracket - Loose/Visible Damage
- Drive Belt & Belt Driven Device - Loose/Visible Damage
- Engine - Mechanical Condition - Refer to : [Symptoms - Engine Mechanical](#)
- Fuel - Contaminated/Poor Quality
- If a condition exists - Repair or replace as necessary
- If all conditions test normal - Test or replace the component : B68 Knock Sensor

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

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

Verify the DTC does not set.

- **If the DTC sets**

Refer to : Circuit/System Testing

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

6. All OK.

Circuit/System Testing

1. Ignition/Vehicle - Off
2. Disconnect the appropriate electrical connector : B68 Knock Sensor
3. Ignition - On / Vehicle - In Service Mode
4. Test for 1 to 2 V between the test points : Signal circuit terminal 2/B & Ground
 - **If less than 1 V**
 1. Ignition/Vehicle - Off
 2. Disconnect the appropriate electrical connector : K20 Engine Control Module
 3. Test for infinite resistance between the test points : Signal circuit terminal 2/B @ Component harness & Ground
 - If less than infinite resistance - Repair the short to ground on the circuit.
 - Go to next step : If infinite resistance
 4. Test for less than 2 ohms between the test points : Signal circuit terminal 2/B @ Component harness & The other end of the circuit @ Control module harness
 - If 2 ohms or greater - Repair the open/high resistance in the circuit.
 - If less than 2 ohms - Replace the component : K20 Engine Control Module
 - **If greater than 2 V**
 1. Ignition/Vehicle - Off
 2. Disconnect the appropriate electrical connector : K20 Engine Control Module
 3. Ignition - On / Vehicle - In Service Mode
 4. Test for less than 1 V between the test points : Signal circuit terminal 2/B @ Component harness & Ground
 - If 1 V or greater - Repair the short to voltage on the circuit.
 - If less than 1 V - Replace the component : K20 Engine Control Module
 - **Go to next step : If between 1 and 2 V**
5. Test for 2 to 4 V between the test points : Signal circuit terminal 1/A & Ground
 - **If less than 2 V**
 1. Ignition/Vehicle - Off
 2. Disconnect the appropriate electrical connector : K20 Engine Control Module
 3. Test for infinite resistance between the test points : Signal circuit terminal 1/A @ Component harness & Ground
 - If less than infinite resistance - Repair the short to ground on the circuit.
 - Go to next step : If infinite resistance
 4. Test for less than 2 ohms between the test points : Signal circuit terminal 1/A @ Component harness & The other end of the circuit @ Control module harness
 - If 2 ohms or greater - Repair the open/high resistance in the circuit.
 - If less than 2 ohms - Replace the component : K20 Engine Control Module
 - **If greater than 4 V**
 1. Ignition/Vehicle - Off
 2. Disconnect the appropriate electrical connector : K20 Engine Control Module

3. Ignition - On / Vehicle - In Service Mode

4. Test for less than 1 V between the test points : Signal circuit terminal 1/A @ Component harness & Ground

- If 1 V or greater - Repair the short to voltage on the circuit.
- If less than 1 V - Replace the component : K20 Engine Control Module

• **Go to next step : If between 2 and 4 V**

6. Test or replace the component : B68 Knock Sensor

Repair Instructions

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

- [Knock Sensor Replacement - Bank 1 \(AWD\)](#), [Knock Sensor Replacement - Bank 1 \(FWD\)](#)
- [Knock Sensor Replacement - Bank 2 \(AWD\)](#), [Knock Sensor Replacement - Bank 2 \(FWD\)](#)
- For control module replacement, programming, and setup refer to : [Control Module References](#)

DTC P0335 OR P0336

Diagnostic Instructions

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

DTC Descriptor

DTC P0335

Crankshaft Position Sensor Circuit

DTC P0336

Crankshaft Position Sensor Performance

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P0335, P0557, P057C, P0651, P118C	P0335	P0557, P0558, P0651, P118C	P0336
Signal	P0335, P0506	P0335, P0506	P0335	P0336
Low Reference	-	P0335, P0506	-	P0336

Circuit/System Description

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

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

Component	Description

Component	Description
B26 Crankshaft Position Sensor	The sensor contains a hall-effect sensor and additional electronics that processes the signal. It detects the change of strength of the magnetic field caused by the reluctor ring. When the strength changes, the sensor changes the amount of current it consumes. This results in a square wave signal of the current, while the voltage stays constant. The control module detects the frequency in which the current changes, which is proportional to the rotational speed.
K20 Engine Control Module	The control module controls a series of actuators to ensure optimal engine performance. The control module does this by reading values from a variety of sensors, interprets the data and adjusts the engine actuators accordingly.
Reluctor Ring	There are 58 teeth or invisible magnetic segments on the edge of the crankshaft position reluctor ring mounted on the crankshaft. Each tooth or magnetic segment on the ring is spaced at a 60 segment spacing with 2 missing segments for a reference gap.

The ECM uses information from the crankshaft position sensor and the camshaft position sensor(s) for sequencing and timing of the spark events.

Conditions for Running the DTC

P0335 Condition 1

- DTC P0101, P0102, P0103 = Not set
- MAF Sensor = Greater than 1.5 g/s

Condition 2

- Camshaft Position Sensor = Signal received
- Starter = Active

Condition 3

- Engine = Running

Condition 4

- DTC P0365, P0366 = Not set
- Engine = Running

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

P0336 Condition 1

- DTC P0335 = Not set
- Engine Speed = Greater than 100 RPM
- MAF Sensor = Greater than 1.5 g/s

Condition 2

- Engine = Running

Condition 3

- DTC P0101, P0102, P0103 = Not set
- MAF Sensor = Greater than 1.5 g/s

Condition 4

- Camshaft Position Sensor = Signal received
- Starter = Active

Condition 5

- DTC P0365, P0366 = Not set
- Engine = Running

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

Conditions for Setting the DTC

P0335

Crankshaft Position Sensor = No Signal - For greater than 4 s

P0336

Crankshaft Position Sensor = Signal synchronization lost 10 times within 10 s.

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type B DTC

- Camshaft Position Actuator = Park position
- Camshaft Position Sensor = Used for engine position

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type B DTC

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

Powertrain Component Views

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References

Circuit/System Verification

1. Ignition - On / Vehicle - In Service Mode

2. Verify DTC P0641, P0651 is not set.

- **If the DTC is set**

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

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

3. Engine - Running

4. Verify DTC P0336 is not set.

- **If the DTC is set**

Refer to : Circuit/System Testing

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

5. Verify the scan tool parameter : Crankshaft Position Active Counter = Increments

- **If the parameter value does not increment**

Refer to : Circuit/System Testing

- **Go to next step : If the parameter value increments**

6. Verify the scan tool parameter : Crankshaft Position Resync Counter = 0 Counts - The engine should not stumble/stall.

- Perform the action while monitoring the parameter :

- Wiggle the harness and connector : B26 Crankshaft Position Sensor
- Wiggle the harness and connector : K20 Engine Control Module
- **If greater than 0 counts**

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

- **Go to next step : If 0 counts**

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

Verify the DTC does not set.

- **If the DTC sets**

Refer to : Circuit/System Testing

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

8. All OK.

Circuit/System Testing

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

1. Ignition/Vehicle & All vehicle systems - Off

2. Disconnect the electrical connector : B26 Crankshaft Position Sensor

3. Test for less than 10 ohms between the test points : Low Reference circuit terminal 2 & Ground

- **If 10 ohms or greater**

1. Disconnect the appropriate electrical connector : K20 Engine Control Module

2. Test for less than 2 ohms between the test points : Low Reference circuit terminal 2 @ Component harness & The other end of the circuit @ Control module harness

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

- If less than 2 ohms - Replace the component : K20 Engine Control Module
 - **Go to next step : If less than 10 ohms**
4. Ignition - On / Vehicle - In Service Mode
5. Test for 4.8 to 5.2 V between the test points : 5 V Reference circuit terminal 1 & Ground
- **If less than 4.8 V**
 1. Ignition/Vehicle - Off
 2. Disconnect the appropriate electrical connector : K20 Engine Control Module
 3. Test for infinite resistance between the test points : 5 V Reference circuit terminal 1 @ Component harness & Ground
 - If less than infinite resistance - Repair the short to ground on the circuit.
 - Go to next step : If infinite resistance
 4. Test for less than 2 ohms between the test points : 5 V Reference circuit terminal 1 @ Component harness & The other end of the circuit @ Control module harness
 - If 2 ohms or greater - Repair the open/high resistance in the circuit.
 - If less than 2 ohms - Replace the component : K20 Engine Control Module
 - **If greater than 5.2 V**
 1. Ignition/Vehicle - Off
 2. Disconnect the appropriate electrical connector : K20 Engine Control Module
 3. Ignition - On / Vehicle - In Service Mode
 4. Test for less than 1 V between the test points : 5 V Reference circuit terminal 1 @ Component harness & Ground
 - If 1 V or greater - Repair the short to voltage on the circuit.
 - If less than 1 V - Replace the component : K20 Engine Control Module
 - **Go to next step : If between 4.8 and 5.2 V**
6. Rapidly tap a 3 A fused jumper wire between the test points : Signal circuit terminal 3 & Ground

Verify the scan tool parameter : Crankshaft Position Active Counter = Increments

- **If the parameter value does not increment**
 1. Ignition/Vehicle - Off
 2. Disconnect the appropriate electrical connector : K20 Engine Control Module
 3. Ignition - On / Vehicle - In Service Mode
 4. Test for less than 1 V between the test points : Signal circuit terminal 3 @ Component harness & Ground
 - If 1 V or greater - Repair the short to voltage on the circuit.
 - Go to next step : If less than 1 V
 - 1. Ignition/Vehicle - Off
 - 2. Test for infinite resistance between the test points : Signal circuit terminal 3 @ Component harness & Ground
 - If less than infinite resistance - Repair the short to ground on the circuit.
 - Go to next step : If infinite resistance
 - 3. Test for less than 2 ohms between the test points : Signal circuit terminal 3 @ Component harness & The other end of the circuit @ Control module harness
 - If 2 ohms or greater - Repair the open/high resistance in the circuit.
 - If less than 2 ohms - Replace the component : K20 Engine Control Module
 - **Go to next step : If the parameter value increments**
7. Verify DTC P0336 is not set.
- **If the DTC is set**

Verify the following conditions do not exist :

- B26 Crankshaft Position Sensor & Reluctor Ring - Excessive play/Foreign material passing between the components/Incorrect air gap /Incorrect installation/Loose/Visible Damage
- Camshaft Sprocket - Visible Damage /Worn
- Crankshaft Sprocket - Visible Damage /Worn
- Engine Oil - Contaminated/Dirty
- Timing Chain or Timing Belt - Visible Damage /Worn
- Timing Chain Tensioner or Timing Belt Tensioner - Visible Damage /Worn
 - If a condition exists - Repair or replace as necessary
 - If no condition exists - Test or replace the component : B26 Crankshaft Position Sensor
- **Go to next step : If the DTC is not set**

8. Test or replace the component : B26 Crankshaft Position Sensor

Repair Instructions

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

- [Crankshaft Position Sensor Replacement \(AWD\)](#), [Crankshaft Position Sensor Replacement \(FWD\)](#).
- For control module replacement, programming, and setup refer to : [Control Module References](#)

DTC P0340, P0341, P0345, P0346, P0365, P0366, P0390, OR P0391

Diagnostic Instructions

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

DTC Descriptor

DTC P0340

Intake Camshaft Position Sensor Circuit Bank 1

DTC P0341

Intake Camshaft Position Sensor Performance Bank 1

DTC P0345

Intake Camshaft Position Sensor Circuit Bank 2

DTC P0346

Intake Camshaft Position Sensor Performance Bank 2

DTC P0365

Exhaust Camshaft Position Sensor Circuit Bank 1

DTC P0366

Exhaust Camshaft Position Sensor Performance Bank 1

DTC P0390

Exhaust Camshaft Position Sensor Circuit Bank 2

DTC P0391

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P0340, P0345, P0365, P0390, P0641*	P0340, P0345, P0365, P0390	P0345, P0641*	-
Signal	P0340, P0345, P0365, P0390	P0340, P0345, P0365, P0390	P0340, P0345, P0365, P0390	P0341, P0346, P0366, P0391
Low Reference	-	P0340, P0345, P0365, P0390	-	-
*Additional DTCs may set.				

Circuit/System Description

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

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

Component	Description
B23 Camshaft Position Sensor	The sensor contains a hall-effect sensor and additional electronics that processes the signal. It detects the change of strength of the magnetic field caused by the reluctor ring. When the strength changes, the sensor changes the amount of current it consumes. This results in a square wave signal of the current, while the voltage stays constant. The control module detects the frequency in which the current changes, which is proportional to the rotational speed.
K20 Engine Control Module	The control module controls a series of actuators to ensure optimal engine performance. The control module does this by reading values from a variety of sensors, interprets the data and adjusts the engine actuators accordingly.
Reluctor Ring	There are 4 equally spaced teeth on the edge of the camshaft position reluctor ring mounted on the camshaft.

The ECM uses information from the crankshaft position sensor and the camshaft position sensor(s) for sequencing and timing of the spark events.

Conditions for Running the DTC**P0340, P0345, P0365, P0390 Condition 1**

- DTC P0101, P0102, P0103 = Not set
- MAF Sensor = Greater than 1.5 g/s

Condition 2

- Camshaft Position Sensor = Signal received
- M64 Starter Motor = Active

Condition 3

- Engine = Running
- M64 Starter Motor = Inactive

Condition 4

- DTC P0335, P0336, P0641, P0651 = Not set
- Crankshaft = Synchronized
- M64 Starter Motor = Active

Condition 5

- DTC P0335, P0336, P0641, P0651 = Not set
- Crankshaft = Synchronized

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

P0341, P0346, P0366, P0391 Condition 1

- DTC P0335, P0336, P0641, P0651 = Not set
- Crankshaft = Synchronized
- M64 Starter Motor = Active

Condition 2

- DTC P0335, P0336, P0641, P0651 = Not set
- Crankshaft = Synchronized

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

Conditions for Setting the DTC

P0340, P0345, P0365, P0390 Condition 1

Camshaft Position Sensor = No Signal - For greater than 5.5 s

Condition 2

Camshaft Position Sensor = No Signal - For greater than 4 s - Starter is engaged.

Condition 3

Camshaft Position Sensor = Less than 4 pulses - For greater than 3 s

Condition 4

Camshaft Position Sensor = No Signal - During the first 1 engine revolutions.

Condition 5

Camshaft Position Sensor = No Signal - During 100 engine revolutions.

P0341, P0346, P0366, P0391 Condition 1

Camshaft Position Sensor = Less than 4 pulses - During 2 engine revolutions.

Condition 2

Camshaft Position Sensor = Greater than 6 pulses - During 2 engine revolutions.

Condition 3

Camshaft Position Sensor = Less than 398 pulses - Greater than 402 pulses - During 100 engine revolutions.

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type B DTC

- Control module command = Reduced Engine Power
- Camshaft Position Actuator = Park position

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type B DTC

Diagnostic Aids

The cranking period may take longer.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

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Component View Reference

Powertrain Component Views

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References

Circuit/System Verification

1. Ignition - On / Vehicle - In Service Mode
2. Verify DTC P0641, P0651 is not set.

- **If the DTC is set**

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

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

3. Engine - Running
4. Verify DTC P0341, P0366 is not set.

- **If the DTC is set**

Refer to : Circuit/System Testing

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

5. Verify the scan tool parameter :

- Exhaust Camshaft Position Active Counter = Increments

- Intake Camshaft Position Active Counter = Increments
- **If the parameter value does not increment**

Refer to : Circuit/System Testing

- **Go to next step : If the parameter value increments**

6. Verify the scan tool parameter : Exhaust Camshaft Position Active Counter or Intake Camshaft Position Active Counter = Increments

Perform the action while monitoring the parameter :

- Wiggle the harness and connector : B23 Camshaft Position Sensor
- Wiggle the harness and connector : K20 Engine Control Module
- **If the parameter value does not increment**

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

- **Go to next step : If the parameter value increments**

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

Verify the DTC does not set.

- **If the DTC sets**

Refer to : Circuit/System Testing

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

8. All OK.

Circuit/System Testing

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

1. Ignition/Vehicle & All vehicle systems - Off
2. Disconnect the appropriate electrical connector : B23 Camshaft Position Sensor
3. Test for less than 10 ohms between the test points : Low Reference circuit terminal 1 & Ground
 - **If 10 ohms or greater**
 1. Disconnect the appropriate electrical connector : K20 Engine Control Module
 2. Test for less than 2 ohms between the test points : Low Reference circuit terminal 1 @ Component harness & The other end of the circuit @ Control module harness
 - If 2 ohms or greater - Repair the open/high resistance in the circuit.
 - If less than 2 ohms - Replace the component : K20 Engine Control Module
 - **Go to next step : If less than 10 ohms**
4. Ignition - On / Vehicle - In Service Mode
5. Test for 4.8 to 5.2 V between the test points : 5 V Reference circuit terminal 3 & Ground
 - **If less than 4.8 V**
 1. Ignition/Vehicle - Off
 2. Disconnect the appropriate electrical connector : K20 Engine Control Module
 3. Test for infinite resistance between the test points : 5 V Reference circuit terminal 3 @ Component harness & Ground
 - If less than infinite resistance - Repair the short to ground on the circuit.
 - Go to next step : If infinite resistance
 4. Test for less than 2 ohms between the test points : 5 V Reference circuit terminal 3 @ Component harness & The other end of the circuit @ Control module harness

- If 2 ohms or greater - Repair the open/high resistance in the circuit.
- If less than 2 ohms - Replace the component : K20 Engine Control Module
- **If greater than 5.2 V**
 1. Ignition/Vehicle - Off
 2. Disconnect the appropriate electrical connector : K20 Engine Control Module
 3. Ignition - On / Vehicle - In Service Mode
 4. Test for less than 1 V between the test points : 5 V Reference circuit terminal 3 @ Component harness & Ground
 - If 1 V or greater - Repair the short to voltage on the circuit.
 - If less than 1 V - Replace the component : K20 Engine Control Module
- **Go to next step : If between 4.8 and 5.2 V**
- 6. Test for 4.8 to 5.2 V between the test points : Signal circuit terminal 2 & Ground
 - **If less than 4.8 V**
 1. Ignition/Vehicle - Off
 2. Disconnect the appropriate electrical connector : K20 Engine Control Module
 3. Test for infinite resistance between the test points : Signal circuit terminal 2 @ Component harness & Ground
 - If less than infinite resistance - Repair the short to ground on the circuit.
 - Go to next step : If infinite resistance
 4. Test for less than 2 ohms between the test points : Signal circuit terminal 2 @ Component harness & The other end of the circuit @ Control module harness
 - If 2 ohms or greater - Repair the open/high resistance in the circuit.
 - If less than 2 ohms - Replace the component : K20 Engine Control Module
 - **If greater than 5.2 V**
 1. Ignition/Vehicle - Off
 2. Disconnect the appropriate electrical connector : K20 Engine Control Module
 3. Ignition - On / Vehicle - In Service Mode
 4. Test for less than 1 V between the test points : Signal circuit terminal 2 @ Component harness & Ground
 - If 1 V or greater - Repair the short to voltage on the circuit.
 - If less than 1 V - Replace the component : K20 Engine Control Module
 - **Go to next step : If between 4.8 and 5.2 V**
- 7. Verify DTC P0341, P0366 is not set.
 - **If the DTC is set**

Verify the following conditions do not exist :

 - B23 Camshaft Position Sensor & Reluctor Ring - Excessive play/Foreign material passing between the components/Incorrect air gap /Incorrect installation/Loose/Visible Damage
 - Engine Oil - Contaminated/Dirty
 - Timing Chain or Timing Belt - Visible Damage /Worn
 - Timing Chain Tensioner or Timing Belt Tensioner - Visible Damage /Worn
 - If a condition exists - Repair or replace as necessary
 - If no condition exists - Test or replace the component : B23 Camshaft Position Sensor
 - **Go to next step : If the DTC is not set**
- 8. Test or replace the component : B23 Camshaft Position Sensor

Repair Instructions

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

- **Camshaft Position Sensor Replacement - Bank 1 (Right Side) Exhaust**

- [Camshaft Position Sensor Replacement - Bank 2 \(Left Side\) Exhaust](#)
- [Camshaft Position Sensor Replacement - Bank 1 \(Right Side\) Intake](#)
- [Camshaft Position Sensor Replacement - Bank 2 \(Left Side\) Intake](#)
- For control module replacement, programming, and setup refer to : [Control Module References](#)

DTC P034A OR P034B

Diagnostic Instructions

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

DTC Descriptor

DTC P034A

Crankshaft Position Sensor - Engine Start Position Incorrect

DTC P034B

Crankshaft Position Sensor - Crankshaft Direction Incorrect

Circuit/System Description

The engine control module monitors the speed and the direction of rotation of the crankshaft during an autostop event and memorizes the crankshaft angle at which the engine stopped to be able to start the engine quicker.

Conditions for Running the DTC

P034A

- DTC P0335, P0336, P0651 = Not set
- Crankshaft position is being verified.
- Engine = Running - After an autostop event.

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

P034B

- DTC P0335, P0336, P0651 = Not set
- Crankshaft Position Sensor = Signal received
- Engine Speed = 400 to 2,000 RPM
- MAF Sensor = Greater than 1.5 g/s

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

Conditions for Setting the DTC

P034A

Condition 1

The difference between the memorized and actual crankshaft position was greater than 2 reluctor ring teeth during 2 autostart events in one ignition cycle.

Condition 2

The difference between the memorized and actual crankshaft position was greater than 1 reluctor ring teeth during 4 autostart events in one ignition cycle.

P034B

The direction of rotation of the crankshaft has changed more than 3 times within 10 s.

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type B DTC

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type B DTC

Diagnostic Aids

A DTC may set depending on certain driving conditions and would not require a component replacement. The Circuit/System Verification must be performed.

Reference Information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References

Circuit/System Verification

1. Ignition - On / Vehicle - In Service Mode
2. Verify DTC P0335, P0336, P0651 is not set.

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

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

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

3. Verify the following conditions do not exist :

- Foreign objects between the crankshaft position sensor and the reluctor ring.
- Gap between the crankshaft position sensor and the reluctor ring is out of tolerance.
- Mechanical damage to the crankshaft position sensor or the reluctor ring.
- **If a condition exists**

Repair as necessary

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

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

Verify the DTC does not set.

- **If the DTC sets**

Test or replace the component : B26 Crankshaft Position Sensor

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

5. All OK.

Repair Instructions

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

- [Crankshaft Position Sensor Replacement \(AWD\)](#), [Crankshaft Position Sensor Replacement \(FWD\)](#).

Diagnostic Instructions

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

DTC Descriptor

DTC P0351

Ignition Coil 1 Control Circuit

DTC P0352

Ignition Coil 2 Control Circuit

DTC P0353

Ignition Coil 3 Control Circuit

DTC P0354

Ignition Coil 4 Control Circuit

DTC P0355

Ignition Coil 5 Control Circuit

DTC P0356

Ignition Coil 6 Control Circuit

DTC P2300

Ignition Coil 1 Control Circuit Low Voltage

DTC P2301

Ignition Coil 1 Control Circuit High Voltage

DTC P2303

Ignition Coil 2 Control Circuit Low Voltage

DTC P2304

Ignition Coil 2 Control Circuit High Voltage

DTC P2306

Ignition Coil 3 Control Circuit Low Voltage

DTC P2307

Ignition Coil 3 Control Circuit High Voltage

DTC P2309

Ignition Coil 4 Control Circuit Low Voltage

DTC P2310

DTC P2312

Ignition Coil 5 Control Circuit Low Voltage

DTC P2313

Ignition Coil 5 Control Circuit High Voltage

DTC P2315

Ignition Coil 6 Control Circuit Low Voltage

DTC P2316

Ignition Coil 6 Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Control - Terminal 3/C @ T8A Ignition Coil 1	P0300, P2300	P0300, P0351	P0300, P2301	P0300, P0351
Control - Terminal 3/C @ T8B Ignition Coil 2	P0300, P2303	P0300, P0352	P0300, P2304	P0300, P0352
Control - Terminal 3/C @ T8C Ignition Coil 3	P0300, P2306	P0300, P0353	P0300, P2307	P0300, P0353
Control - Terminal 3/C @ T8D Ignition Coil 4	P0300, P2309	P0300, P0354	P0300, P2310	P0300, P0354
Control - Terminal 3/C @ T8E Ignition Coil 5	P0300, P2312	P0300, P0355	P0300, P2313	P0300, P0355
Control - Terminal 3/C @ T8F Ignition Coil 6	P0300, P2315	P0300, P0356	P0300, P2316	P0300, P0356
Ground - Terminal 1/A @ T8A Ignition Coil 1	-	P0300, P0351	-	P0300, P0351
Ground - Terminal 1/A @ T8B Ignition Coil 2	-	P0300, P0352	-	P0300, P0352
Ground - Terminal 1/A @ T8C Ignition Coil 3	-	P0300, P0353	-	P0300, P0353
Ground - Terminal 1/A @ T8D Ignition Coil 4	-	P0300, P0354	-	P0300, P0354
Ground - Terminal 1/A @ T8E Ignition Coil 5	-	P0300, P0355	-	P0300, P0355
Ground - Terminal 1/A @ T8F Ignition Coil 6	-	P0300, P0356	-	P0300, P0356

Circuit/System Description

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

Circuit	Description
Control	The output circuit is switched to ground to activate the component.
Ground	Chassis Ground

Component	Description

Component	Description
K20 Engine Control Module	The control module controls a series of actuators to ensure optimal engine performance. The control module does this by reading values from a variety of sensors, interprets the data and adjusts the engine actuators accordingly.
T8 Ignition Coil	The ignition system on this engine uses ignition coils with integrated power transistors.

The ECM controls the spark event for each cylinder through individual ignition coil control circuits. When the ECM commands the ignition control circuit On, electrical current flows through the primary winding of the ignition coil, creating a magnetic field. When a spark event is requested, the ECM commands the ignition control circuit Off, interrupting current flow through the primary winding. The collapsing magnetic field created by the primary winding induces a high voltage in the secondary winding, which is connected to the spark plugs.

Conditions for Running the DTC

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

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

Conditions for Setting the DTC

Control Circuit = Commanded state does not match the actual state

Actions Taken When the DTC Sets

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

DTC P0355, P0356, P2312, P2313, P2315, P2316 = Type B DTC

Conditions for Clearing the DTC

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

DTC P0355, P0356, P2312, P2313, P2315, P2316 = Type B DTC

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

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- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Control Module References

Special Tools

J-26792 Ignition Spark Tester

Equivalent regional tools : **Special Tools**

Circuit/System Verification

1. Engine - Running

2. Verify the scan tool parameter :

- Ignition Coil 1 - 6 Control Circuit High Voltage Test Status = OK or Not Run
- Ignition Coil 1 - 6 Control Circuit Low Voltage Test Status = OK or Not Run
- Ignition Coil 1 - 6 Control Circuit Open Test Status = OK or Not Run
- **If not the specified state**

Refer to : Circuit/System Testing

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

3. Verify the scan tool parameter :

- Ignition Coil 1 - 6 Control Circuit High Voltage Test Status = OK or Not Run
- Ignition Coil 1 - 6 Control Circuit Low Voltage Test Status = OK or Not Run
- Ignition Coil 1 - 6 Control Circuit Open Test Status = OK or Not Run
- Perform the action while monitoring the parameter :
- Wiggle the harness and connector : T8 Ignition Coil
- Wiggle the harness and connector : K20 Engine Control Module
- **If not the specified state**

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

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

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

Verify the DTC does not set.

- **If the DTC sets**

Refer to : Circuit/System Testing

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

5. All OK.

Circuit/System Testing

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

1. Ignition/Vehicle & All vehicle systems - Off

2. Disconnect the appropriate electrical connector : T8 Ignition Coil

3. Test for less than 10 ohms between the test points : Ground circuit terminal 1/A & Ground

- **If 10 ohms or greater**

1. Disconnect the ground connection : Ground terminal

2. Test for less than 2 ohms between the test points : Ground circuit terminal 1/A @ Component harness & The other end of the circuit @ Ground terminal
 - If 2 ohms or greater - Repair the open/high resistance in the circuit.
 - If less than 2 ohms - Repair the open/high resistance in the ground connection.
- **Go to next step : If less than 10 ohms**
4. Ignition - On / Vehicle - In Service Mode
5. Verify a test lamp does not turn On between the test points : Control circuit terminal 3/C & B+
 - **If the test lamp turns On**
 1. Ignition/Vehicle - Off & Remove - Test lamp
 2. Disconnect the electrical connector : K20 Engine Control Module
 3. Test for infinite resistance between the test points : Control circuit terminal 3/C @ Component harness & Ground
 - If less than infinite resistance - Repair the short to ground on the circuit.
 - If infinite resistance - Replace the component : K20 Engine Control Module
 - **Go to next step : If the test lamp does not turn On**
6. Remove - Test Lamp
7. Engine - Running
8. Verify the scan tool parameter : Ignition Coil 1 - 6 Control Circuit High Voltage Test Status = OK or Not Run
 - **If not the specified state**
 1. Ignition/Vehicle - Off
 2. Disconnect the electrical connector : K20 Engine Control Module
 3. Test for less than 1 V between the test points : Control circuit terminal 3/C @ Component harness & Ground
 - If 1 V or greater - Repair the short to voltage on the circuit.
 - If less than 1 V - Replace the component : K20 Engine Control Module
 - **Go to next step : If the specified state**
9. Ignition/Vehicle - Off
10. Connect a 3 A fused jumper wire between the test points : Control circuit terminal 3/C & Ignition circuit terminal 4/D
11. Engine - Running
12. Verify the scan tool parameter : Ignition Coil 1 - 6 Control Circuit High Voltage Test Status = OK or Not Run
 - **If the specified state**
 1. Ignition/Vehicle - Off & Remove - Jumper wire(s)
 2. Disconnect the electrical connector : K20 Engine Control Module
 3. Test for less than 2 ohms between the test points : Control circuit terminal 3/C @ Component harness & The other end of the circuit @ Control module harness
 - If 2 ohms or greater - Repair the open/high resistance in the circuit.
 - If less than 2 ohms - Replace the component : K20 Engine Control Module
 - **Go to next step : If not the specified state**
13. Test or replace the component : T8 Ignition Coil

Component Testing

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

1. Ignition/Vehicle - Off
2. Remove the appropriate component : T8 Ignition Coil - Leave the electrical connector connected.
3. Install the special tool : J-26792 Ignition Spark Tester
4. Engine - Running

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

5. Verify there is spark at the tool.

- **If there is no spark**

Replace the component : T8 Ignition Coil

- **Go to next step : If there is spark**

6. All OK.

Repair Instructions

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

- [Ignition Coil Replacement - Bank 1](#)
 - [Ignition Coil Replacement - Bank 2](#)
 - For control module replacement, programming, and setup refer to : [Control Module References](#)
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