

2010 ENGINE PERFORMANCE

Engine Controls and Fuel - 2.8L, 3.0L, 3.2L, or 3.6L - Equinox & Terrain

DTC P0010, P0013, P0020, OR P0023 (LF1, LFW)

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 P0010

Intake Camshaft Position Actuator Solenoid Valve Control Circuit Bank 1

DTC P0013

Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit Bank 1

DTC P0020

Intake Camshaft Position Actuator Solenoid Valve Control Circuit Bank 2

DTC P0023

Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit Bank 2

CIRCUIT/SYSTEM DESCRIPTION

The camshaft position actuator system enables the Engine Control Module (ECM) to change the timing of the camshafts while the engine is operating. The Camshaft Position Actuator Solenoid Valve signal from the ECM is pulse width modulated (PWM). The ECM controls the Camshaft Position Actuator Solenoid Valve duty cycle by controlling the amount of solenoid valve ON time. The Camshaft Position Actuator Solenoid Valve controls the advance or the retard of each camshaft. The Camshaft Position Actuator Solenoid Valve controls the oil flow that applies the pressure to advance or retard the camshafts.

The ECM controls the Camshaft Position Actuator Solenoid Valve by supplying a 12 V pulse width modulated (PWM) signal. The ECM supplies a ground to the low reference circuit.

CONDITIONS FOR RUNNING THE DTC

- The ignition voltage is greater than 11 V.
- The ignition switch is in the Crank or Run position.

- The ECM commanded the Camshaft Position Actuator Solenoid Valve ON.
- DTCs P0010, P0013, P0020, and P0023 run continuously once the above conditions are met.

CONDITIONS FOR SETTING THE DTC

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

ACTION TAKEN WHEN THE DTC SETS

DTCs P0010, P0013, P0020, and P0023 are type B DTCs.

CONDITIONS FOR CLEARING THE DTC

DTCs P0010, P0013, P0020, and P0023 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 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 Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Camshaft Actuator 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

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

1. Ignition ON, observe the DTC information with a scan tool. Verify DTC P0335, P0336, P0340, P0341, P0345, P0346, P0365, P0366, P0390, and P0391 is not set.
 - If a DTC is set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** for further diagnosis.
2. Observe the appropriate control circuit status parameters listed below with a scan tool:
 - The Intake/Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage Test Status Bank 1 or 2
 - The Intake/Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit Open Test Status Bank 1 or 2
 - The Intake/Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit High Voltage Test Status Bank 1 or 2

Each parameter should display OK or Not Run

3. Engine idling, command the appropriate Camshaft Position Actuator from 0 degrees to 25 degrees and back to zero while observing the appropriate control circuit status parameters listed below with a scan tool:
 - The Intake/Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage Test Status Bank 1 or 2
 - The Intake/Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit Open Test Status Bank 1 or 2
 - The Intake/Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit High Voltage Test Status Bank 1 or 2

Each parameter should display OK or Not Run

4. The engine at the normal operating temperature, raise the engine speed to 2,000 RPM for 10 s. DTCs P0010, P0013, P0020, or P0023 should not set.
5. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the harness connector at the appropriate Q6 Camshaft Position Actuator Solenoid Valve.
2. Ignition OFF and all vehicle systems OFF. It may take up to 2 minutes for all vehicle systems to power

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

- If greater than the specified value, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the K20 ECM.

NOTE: **A test lamp must be used for this test. The control circuit is pulled-up to a low current voltage, 1.5-4.5 V on the control circuit is normal.**

3. Ignition ON, verify that a test lamp does not illuminate between the control circuit terminal 1 and ground.
 - If the test lamp illuminates, test the control circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.
4. Connect the DMM black lead to the control circuit terminal 1. Connect the DMM red lead to B+. Set the DMM on the diode setting. Command the CMP actuator solenoid ON and OFF with a scan tool. The DMM should transition from OL when commanded OFF to less than 1 V when commanded ON.
 - If the circuit voltage does not correspond to the specified values, test the control circuit for an open/high resistance or a short to ground. If the circuit tests normal, replace the K20 ECM.
5. If all circuits/connections test normal, test or replace the appropriate Q6 Camshaft Position Actuator Solenoid Valve.

COMPONENT TESTING

1. Ignition OFF, disconnect the harness connector at the appropriate Q6 Camshaft Position Actuator Solenoid Valve.
2. Test for 5-12 ohms between the control terminal 1 and the low reference circuit terminal 2 of the Q6 Camshaft Position Actuator Solenoid Valve.
 - If not within the specified range, replace the Q6 Camshaft Position Actuator Solenoid Valve.
3. Test for infinite resistance between each terminal and the Q6 Camshaft Position Actuator Solenoid Valve housing.
 - If not the specified value, replace the Q6 Camshaft Position Actuator Solenoid Valve.

REPAIR PROCEDURES

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

- **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right 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) Intake**
- **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Exhaust**
- **Control Module References** for Engine Control Module replacement, setup, and programming

DTC P0011, P0014, P0021, OR P0024 (LF1, LFW)

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 P0011

Intake Camshaft Position System Performance Bank 1

DTC P0014

Exhaust Camshaft Position System Performance Bank 1

DTC P0021

Intake Camshaft Position System Performance Bank 2

DTC P0024

Exhaust Camshaft Position System Performance Bank 2

CIRCUIT/SYSTEM DESCRIPTION

The camshaft position actuator system enables the Engine Control Module (ECM) to change the timing of the camshafts while the engine is operating. The camshaft position actuator solenoid signal from the ECM is pulse width modulated (PWM). The ECM controls the camshaft position actuator solenoid duty cycle by controlling the amount of solenoid ON time. The camshaft position actuator solenoid controls the advance or the retard of each camshaft. The camshaft position actuator solenoid controls the oil flow that applies the pressure to advance or retard the camshafts.

CONDITIONS FOR RUNNING THE DTC

- DTC P0010, P0013, P0020, P0023, P0016, P0017, P0018, P0019, P0335, P0336, P0340, P0341, P0345, P0346, P0365, P0366, P0390, and P0391 is not set.
- The ignition voltage is greater than 11 V.
- The engine is operating.
- The desired camshaft position is not changing greater than 4.5 degrees for at least 1 s.
- Both of the desired and actual camshaft position actuator values cannot be greater than 20 degrees or less than 5 degrees.
- DTCs P0011, P0014, P0021, and P0024 run continuously once the above conditions are met.

CONDITIONS FOR SETTING THE DTC

P0011 and P0021

The ECM detects the difference between the desired and actual camshaft position angle is greater than 5 degrees for greater 2.5 s.

P0014 and P0024

The ECM detects the difference between the desired and actual camshaft position angle is greater than 5 degrees for greater 10 s.

ACTION TAKEN WHEN THE DTC SETS

DTCs P0011, P0014, P0021, and P0024 are type B DTCs.

CONDITIONS FOR CLEARING THE DTC

DTCs P0011, P0014, P0021, and P0024 are type B DTCs.

DIAGNOSTIC AIDS

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

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Camshaft Actuator 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

NOTE:

- The engine oil level and the oil pressure are critical to the correct operation of the camshaft position actuator system. Verify that the engine has the correct oil level and the correct oil pressure before continuing with this diagnostic. Refer to Oil Pressure Diagnosis and Testing .
 - The engine oil condition has a major impact on the camshaft actuator system. Debris in the oil can interfere with the camshaft position actuator solenoid and the mechanical camshaft actuator operation. Inspect for dirty or degraded crankcase oil. The engine may require an oil change. Inquire with the customer when the last oil change was performed. You may also monitor the scan tool Engine Oil Life parameter. Advise the customer an oil change may be required.
 - If a crankshaft or camshaft position sensor DTC is set, the Camshaft Position Actuator output control will not function.
1. Ignition ON, observe the scan tool DTC information. Verify that DTC P0016, P0017, P0018, P0019, P0335, P0336, P0338, P0340, P0341, P0345, P0346, P0365, P0366, P0390, or P0391 is not set.
 - If a DTC is set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** for further diagnosis.
 2. Engine idling, command the appropriate Camshaft Position Actuator from 0 degrees to 20 degrees and back to zero while observing the appropriate scan tool Camshaft Position Variance parameters. The Camshaft Position Variance should be less than 2 degrees in each of the commanded states.
 3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the harness connector at the appropriate Q6 Camshaft Position Actuator Solenoid Valve.
2. Ignition OFF and all vehicle systems OFF. It may take up to 2 minutes for all vehicle systems to power down. Test for less than 5 ohms between the low reference circuit terminal 2 and ground.
 - If greater than the specified value, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the K20 ECM.

NOTE:

A test lamp must be used for this test. The control circuit is pulled-up to a low current voltage, 1.5-4.5 V on the control circuit is normal.

3. Ignition ON, verify that a test lamp does not illuminate between the control circuit terminal 1 and ground.

- If the test lamp illuminates, test the control circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.
- 4. Connect the DMM black lead to the control circuit terminal 1. Connect the DMM red lead to B+. Set the DMM on the diode setting. Command the CMP actuator solenoid ON and OFF with a scan tool. The DMM should transition from OL when commanded OFF to less than 1 V when commanded ON.
 - If the circuit voltage does not correspond to the specified values, test the control circuit for an open/high resistance or a short to ground. If the circuit tests normal, replace the K20 ECM.
- 5. Remove the Camshaft Position Actuator Solenoid Valve. Verify the following conditions do not exist with the Camshaft Position Actuator Solenoid Valve:
 - Torn, restricted, mis-positioned, or missing screens at the CMP actuator solenoid
 - Engine oil leak between the oil sealing lands of the CMP actuator solenoid. Inspect the lands of the CMP actuator solenoid for nicks.
 - Oil seepage at the CMP actuator solenoid connector
 - If a condition is found, replace Q6 Camshaft Position Actuator Solenoid Valve.
- 6. Ignition OFF, swap the appropriate Camshaft Position Actuator Solenoid Valve with a Camshaft Position Actuator Solenoid Valve that is operating correctly.
- 7. Engine idling. Command the appropriate Camshaft Position Actuator from 0 degrees to 20 degrees and back to zero while observing the appropriate scan tool Camshaft Position Variance parameters. The Camshaft Position Variance should be less than 2 degrees in each of the commanded states.
 - If greater than the specified value, replace the mechanical camshaft position actuator.
- 8. If all circuits/connections test normal, test or replace the Q6 Camshaft Position Actuator Solenoid Valve.

COMPONENT TESTING

1. Ignition OFF, disconnect the harness connector at the appropriate Q6 Camshaft Position Actuator Solenoid Valve.
2. Test for 5-12 ohms between the ignition circuit terminal 1 and the control circuit terminal 2 of the Q6 Camshaft Position Actuator Solenoid Valve.
 - If not within the specified range, replace the Q6 Camshaft Position Actuator Solenoid Valve.
3. Test for infinite resistance between each terminal and the Q6 Camshaft Position Actuator Solenoid Valve housing.
 - If not the specified value, replace the Q6 Camshaft Position Actuator Solenoid Valve.

REPAIR PROCEDURES

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

- **Camshaft Position Actuator Replacement - Bank 1 (LF1)**
- **Camshaft Position Actuator Replacement - Bank 2 (LF1)**
- **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right 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) Intake**

- **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Exhaust**
- **Control Module References** for ECM replacement, programming, and setup

DTC P0016, P0017, P0018, OR P0019 (LF1, LFW)

DIAGNOSTIC INSTRUCTIONS

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

DTC DESCRIPTORS

DTC P0016

Crankshaft Position - Intake Camshaft Position Not Plausible 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

The engine control module (ECM) uses the crankshaft position (CKP) sensor and the camshaft position (CMP) sensor pulses to monitor the correlation between the crankshaft and the camshaft position. An improper relative position can be caused by either engine timing or improper indexing of the camshaft drive chain.

CONDITIONS FOR RUNNING THE DTC

- DTC P0335, P0336, P0338, P0340, P0341, P0345, P0346, P0365, P0366, P0390, P0391, P0641, and P0651 are not set.
- The engine is operating.
- The crankshaft and camshaft position signals are synchronized.
- The camshaft position actuator is in the parked position.
- DTC P0016, P0017, P0018, and P0019 run continuously once the above conditions are met.

CONDITIONS FOR SETTING THE DTC

DTC P0016, P0017, P0018, or P0019

The ECM detects that one camshaft is mis-aligned with the crankshaft. The ECM detects one of the following conditions:

- Bank 1 intake camshaft is greater than 9 degrees retarded or 12 degrees advanced in relationship to the crankshaft.
- Bank 1 exhaust camshaft is greater than 10 degrees retarded or 13 degrees advanced in relationship to the crankshaft.
- Bank 2 intake camshaft is greater than 11 degrees retarded or 13 degrees advanced in relationship to the crankshaft.
- Bank 2 exhaust camshaft is greater than 9 degrees retarded or 13 degrees advanced in relationship to the crankshaft.

DTC P0016 and P0017

The ECM detects that both camshafts on bank 1 are mis-aligned with the crankshaft. The ECM detects the following conditions:

- Bank 1 intake camshaft is greater than 6 degrees retarded or 9 degrees advanced in relationship to the crankshaft.
- Bank 1 exhaust camshaft is greater than 6 degrees retarded or 9 degrees advanced in relationship to the crankshaft.

DTC P0018 and P0019

The ECM detects that both camshafts on bank 2 are mis-aligned with the crankshaft. The ECM detects the following conditions:

- Bank 2 intake camshaft is greater than 6 degrees retarded or 9 degrees advanced in relationship to the crankshaft.
- Bank 2 exhaust camshaft is greater than 7 degrees retarded or 9 degrees advanced in relationship to the crankshaft.

DTC P0016, P0017, P0018, and P0019

The ECM detects that all 4 camshafts are mis-aligned with the crankshaft. The ECM detects the following conditions:

- Bank 1 intake camshaft is greater than 6 degrees retarded or 9 degrees advanced in relationship to the crankshaft.
- Bank 1 exhaust camshaft is greater than 6 degrees retarded or 9 degrees advanced in relationship to the crankshaft.
- Bank 2 intake camshaft is greater than 6 degrees retarded or 8 degrees advanced in relationship to the crankshaft.
- Bank 2 exhaust camshaft is greater than 7 degrees retarded or 9 degrees advanced in relationship to the crankshaft.

crankshaft.

ACTION TAKEN WHEN THE DTC SETS

DTCs P0016, P0017, P0018, and P0019 are type B DTCs.

CONDITIONS FOR CLEARING THE DTC

DTCs P0016, P0017, P0018, and P0019 are type B DTCs.

DIAGNOSTIC AIDS

- Inspect the engine for any recent engine mechanical repairs. An incorrectly installed secondary timing chain can cause this DTC to set.
- This diagnostic algorithm is designed to detect an alignment condition between a primary intermediate sprocket and the secondary timing chain, or the alignment between a primary intermediate sprocket and the crankshaft. Either condition would cause the camshaft timing for both cams on one bank to be off an equal number of degrees.
- DTCs P0016, P0017, P0018, and P0019 set at the same time indicates a possible condition with the primary timing chain and the alignment between both intermediate sprockets and the crankshaft. Or, the crankshaft reluctor wheel has moved and is no longer referenced to top dead center (TDC).
- Observing the desired and actual camshaft angle parameters, with a scan tool before a DTC sets, may help to isolate whether a condition is specific to one camshaft, one bank, or caused by a condition with the primary crankshaft timing.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Camshaft Actuator System Description

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM TESTING

1. Ignition ON, observe the DTC information with a scan tool. Verify that none of the following DTCs are set. DTC P0010, P0013, P0020, P0023, P0335, P0336, P0340, P0341, P0345, P0346, P0365, P0366, P0390, or P0391.
 - If any of the DTCs listed are set refer to Diagnostic Trouble Code (DTC) List - Vehicle for further diagnosis.
2. Idle the engine at normal operating temperature. DTCs P0016, P0017, P0018, or P0019 should not set.
 - If a DTC sets, inspect for the following and repair as necessary:
 - The correct installation of the camshaft sensors
 - The correct installation of the crankshaft sensor
 - A timing chain tensioner condition
 - An incorrectly installed timing chain
 - Excessive play in the timing chain
 - A mechanical cam actuator that is stuck in the full advance or retard position.
 - A timing chain that jumped teeth
 - A crankshaft reluctor wheel that has moved in relationship to top dead center (TDC) on the crankshaft
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

REPAIR PROCEDURES

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Timing Chain Alignment Diagram
- Camshaft Timing Drive Components Cleaning and Inspection
- Crankshaft and Bearing Cleaning and Inspection

DTC P0030, P0036, P0050, P0053, P0054, P0056, P0059, P0060, P0135, P0141, P0155, OR P0161 (LF1)

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 P0036

HO2S Heater Control Circuit Bank 1 Sensor 2

DTC P0050

HO2S Heater Control Circuit 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 P0059

HO2S Heater Resistance Bank 2 Sensor 1

DTC P0060

HO2S Heater Resistance Bank 2 Sensor 2

DTC P0135

HO2S Heater Performance Bank 1 Sensor 1

DTC P0141

HO2S Heater Performance Bank 1 Sensor 2

DTC P0155

HO2S Heater Performance Bank 2 Sensor 1

DTC P0161

HO2S Heater Performance Bank 2 Sensor 2

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	High Resistance	Open	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	P0132, P0134, P0138, P0140, P0152, P0154, P0158, P0160	P0133, P013A, P013B, P013C, P013D, P013E, P013F, P014A, P014B, P0153, P1133, P1153, P2A00, P2A03
HO2S Low Signal	P0131, P0137, P0151, P0157	P0132, P0134, P0138, P0140, P0152, P0154, P0158, P0160	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, P1133, P1153, P2A00, P2A03
HO2S Heater Voltage Supply	P0030, P0036, P0050, P0056, P0132, P0135, P0138,	P0030, P0036, P0050, P0056, P0132, P0134, P0135, P0138, P0140,	P0030, P0036, P0050, P0056, P0132, P0134, P0135, P0138, P0140,	P0690	P0135, P0141, P0155, P0161

	P0141, P0152, P0155, P0158, P0161, *	P0141, P0152, P0154, P0155, P0158, P0160, P0161	P0141, P0152, P0154, P0155, P0158, P0160, P0161		
HO2S Heater Control	P0030, P0036, P0050, P0053, P0054, P0056, P0059, P0060, P0135, P0141, P0155, P0161	P0030, P0036, P0050, P0056, P0132, P0134, P0135, P0138, P0140, P0141, P0152, P0154, P0155, P0158, P0160, P0161	P0030, P0036, P0050, P0056, P0132, P0134, P0135, P0138, P0140, P0141, P0152, P0154, P0155, P0158, P0160, P0161	P0030, P0036, P0050, P0056, P0132, P0134, P0135, P0138, P0140, P0141, P0152, P0154, P0155, P0158, P0160, P0161	P0135, P0141, P0155, P0161
* 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	0.2-1.5 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, P0036, P0050, or P0056

- The ignition 1 voltage is between 11-18 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 P0112, P0113, P0117, P0118, or P2610 are not set.
- The engine run time is greater than 20 s.
- The ignition voltage is less than 18 V.
- The ignition is OFF for greater than 8 h.
- The engine coolant temperature (ECT) is between -30 to +45°C (-22 to +113°F) at engine start-up.
- 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 1 voltage is between 10-32 V.
- The HO2S is at operating temperature.
- The HO2S is commanded ON.
- The DTCs run once per drive cycle when the above conditions are met for 120 s.

CONDITIONS FOR SETTING THE DTC

P0030, P0036, P0050, or P0056

The 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.

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 amps, or less than 0.3 amps 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.

ACTION TAKEN WHEN THE DTC SETS

DTCs P0030, P0036, P0050, P0053, P0054, P0056, P0059, P0060, P0135, P0141, P0155, and P0161 are Type B DTCs.

CONDITIONS FOR CLEARING THE MIL/DTC

DTCs P0030, P0036, P0050, P0053, P0054, P0056, P0059, P0060, P0135, P0141, P0155, and P0161 are Type B DTCs.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. Engine idling, command the appropriate B52 HO2S heater ON and OFF with a scan tool while observing the B52 HO2S Heater Circuit Test Status parameter. The parameter should display OK or Not Run.
2. Engine idling at operating temperature, observe the scan tool B52 HO2S Heater parameter. The amperage should be within 0.2-1.5 A.
3. Engine idling at operating temperature, move the related wiring and connectors while observing the B52 HO2S Heater parameter with a scan tool. The parameter should not change with movement.
 - If movement affects the parameter, repair the appropriate harness or connector.

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

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the harness connector at the appropriate B52 HO2S.
2. Ignition ON, verify that a test lamp illuminates between the ignition voltage circuit terminal D and ground.
 - If the test lamp does not illuminate, test the ignition voltage circuit for a short to ground or an open/high resistance. If the circuit tests normal and the B52 HO2S heater circuit fuse is open, test all components connected to the fuse and replace as necessary.
3. Ignition ON, observe the appropriate scan tool HO2S Heater Control Open Circuit Test Status parameter. The parameter should display Malfunction.
 - If not the specified value, test the heater control circuit terminal E for a short to ground, or for a short to voltage. If the circuit tests normal, replace the K20 ECM.
4. Connect a 3 A fused jumper wire between the heater control circuit terminal E and ground. Observe the appropriate scan tool HO2S Heater Control Circuit Low Voltage Test Status parameter. The parameter should transition from OK to Malfunction.
 - If not the specified value, test the heater control circuit terminal E for an open/high resistance. If the circuit tests normal, replace the K20 ECM.

NOTE:

- **Less than 10 ohms of additional resistance on the ignition voltage circuit, or control circuit may set a DTC. If there is 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.**

5. Ignition OFF, connect a 10 A fused jumper wire between the control circuit terminal E and the ignition voltage circuit terminal D.
6. Engine idling, observe the appropriate HO2S Control Circuit High Voltage Test Status parameter. The parameter should transition from Not Run to Malfunction.
 - If not the specified value, test the control circuit and the ignition voltage circuit for high resistance. If the circuits test normal, replace the K20 ECM.
7. If all circuits test normal, test or replace the appropriate B52 HO2S.

REPAIR PROCEDURES

CAUTION: Refer to Heated Oxygen Sensor Resistance Learn Reset Caution .

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- **Heated Oxygen Sensor Replacement - Bank 1 Sensor 1 (LF1)**
- **Heated Oxygen Sensor Replacement - Bank 1 Sensor 2 (LF1)**
- **Heated Oxygen Sensor Replacement - Bank 2 Sensor 1 (LF1)**
- **Heated Oxygen Sensor Replacement - Bank 2 Sensor 2**
- **Control Module References** for ECM replacement, setup, and programming

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 Airflow Performance

DTC P1101

Intake Air Flow System Performance

CIRCUIT/SYSTEM DESCRIPTION

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

CONDITIONS FOR RUNNING THE DTC

DTC P0068

- The engine speed is greater than 800 RPM.
- The ignition voltage is greater than 6.0 V.
- The throttle actuator control system is not in reduced power mode.
- The DTC runs continuously when the above conditions are met.

DTC P1101

- DTCs P0102, P0103, P0107, P0108, P0112, P0113, P0117, P0118, P0335, P0336 are not set
- The engine speed is between 400-7,000 RPM
- The engine coolant temperature (ECT) is between 69-127°C (156-260°F).
- The intake air temperature (IAT) is between -20 to +125°C (-4 to +257°F).

- The DTC runs continuously when the above conditions are met.

CONDITIONS FOR SETTING THE DTC

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

ACTION TAKEN WHEN THE DTC SETS

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

CONDITIONS FOR CLEARING THE DTC

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

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM TESTING

1. Verify none of the following conditions exist:
 - The air intake duct system for loose clamps, cracks, or other damage

- The air intake duct system for being collapsed or restricted
 - The B75 mass airflow sensor is installed correctly.
 - Restricted air filter
 - Q38 throttle body for dirt, debris, and coking. Also, throttle body blade or shaft damage. Refer to **Throttle Body Inspection and Cleaning** for further diagnosis.
 - Splits, kinks, or improper connections at the vacuum hoses
 - Missing, restricted, or leaking exhaust components-Refer to **Symptoms - Engine Exhaust** .
 - Vacuum leaks at the intake manifold and Q38 throttle body.
 - If a condition exists, repair as necessary.
2. Ignition ON, observe the diagnostic trouble code (DTC) information with a scan tool. Verify that DTC P0641, P0651, P0697, or P06A3 is not set.
 - If any of the above DTCs are set, refer to **DTC P0641, P0651, P0697, or P06A3 (ECM)** for further diagnosis.
 3. Determine the current vehicle testing altitude. Compare the MAP Sensor pressure parameter to the reading in the **Altitude Versus Barometric Pressure** table. The MAP sensor pressure parameter should be within the specified range indicated in the table.
 - If the MAP sensor pressure is not within the range specified for your altitude, refer to **DTC P0106 (LF1)**.
 4. Engine idling, observe the MAP Sensor kPa parameter. The reading should be between 26-52 kPa (3.8-7.5 psi).
 - If not within the specified range, refer to **DTC P0106 (LF1)**.
 5. Use the scan tool snapshot function to take a snapshot of the engine data list 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 snapshot and review the data.
 4. Observe the MAF Sensor g/s parameter frame by frame with a scan tool. The MAF Sensor g/s parameter should change smoothly and gradually as the engine speed is increased and then returned to idle.
 - If the MAF Sensor g/s parameter does not change smoothly and gradually, refer to **DTC P0101** for further diagnosis.
 6. If all conditions test normal, test the engine for a mechanical condition. Refer to **Symptoms - Engine Mechanical** .

REPAIR PROCEDURES

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

- **Throttle Body Assembly Replacement (LF1)**
- **Air Cleaner Element Replacement (LE5)**

DTC P0089, P00C6, P228C, OR P228D

DIAGNOSTIC INSTRUCTIONS

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

DTC DESCRIPTORS

DTC P0089

Fuel Pressure Regulator Performance

DTC P00C6

Fuel Rail Pressure Low During Engine Cranking

DTC P228C

Fuel Pressure Regulator 1 Control Performance - Low Pressure

DTC P228D

Fuel Pressure Regulator 1 Control Performance - High Pressure

CIRCUIT/SYSTEM DESCRIPTION

The fuel rail pressure sensor detects fuel pressure within the fuel rail. The engine control module (ECM) provides a 5 V reference voltage on the 5 V reference circuit and ground on the low reference circuit. The ECM receives a varying signal voltage on the signal circuit.

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 ECM provides a 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 high pressure mechanical fuel pump is driven by three lobes on the camshaft. The ECM uses the camshaft and crankshaft position sensor inputs to synchronize the high pressure fuel pump actuator with the position of each of the camshaft lobes. The ECM regulates fuel pressure by adjusting the portion of each pump stroke that provides fuel to the rail.

The ECM monitors the fuel rail fuel pressure sensor and the high pressure fuel pump actuator to determine if the commanded and actual pressure are within a predetermined range, or if the amount of fuel pressure correction exceeds a calibrated pressure.

CONDITIONS FOR RUNNING THE DTC

P0089, P228C, or P228D

- DTC P0090, P0091, P0092, P0191, P0192, or P0193 is not set.
- The ignition voltage is less than 18 V.
- The deceleration fuel cut-off (DFCO) is inactive.
- The engine speed is greater than 25 RPM.
- The air bag is not deployed.
- The DTCs run continuously when the above conditions are met for 5 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, P0627, P0628, P0629 are not set.
- The ignition voltage is more than 8 V.
- The engine coolant temperature is between -100 and +65°C (-148 and +149°F).
- The low side fuel pressure is more than 0 kPa (0 psi).
- The engine is not running.
- The DTC runs once for each engine start.

CONDITIONS FOR SETTING THE DTC

P0089

The high pressure fuel pump actuator command necessary to maintain the desired fuel rail pressure is +/-2,500 kPa (363 psi) of the command expected by the controller. The condition exists for greater than 5 s.

P00C6

The ECM detects that the fuel pressure is not rising or has fallen beyond acceptable limits during engine cranking.

P228C

The actual fuel rail pressure is 1,500 kPa (218 psi) less than the desired fuel pressure. The condition exists for greater than 5 s.

P228D

The actual fuel rail pressure is 3,600 kPa (522 psi) greater than the desired fuel rail pressure. The condition exists for greater than 5 s.

ACTION TAKEN WHEN THE DTC SETS

- DTCs P0089 and P00C6 are Type B DTCs.
- DTCs P228C and P228D are Type A DTCs.

- A message center or an indicator displays Reduced Engine Power.

CONDITIONS FOR CLEARING THE DTC

- DTCs P0089 and P00C6 are Type B DTCs.
- DTCs P228C and P228D are Type A DTCs.

DIAGNOSTIC AIDS

- A restricted fuel feed pipe between the fuel feed pipe fuel pressure sensor and the high pressure fuel pump may set a DTC.
- A condition with the fuel tank fuel pump module or fuel pump flow control module may set these DTCs.
- A skewed fuel rail pressure sensor, or an intermittent condition in the fuel rail pressure sensor circuits may set these DTCs.
- A leaking or restricted fuel injector may set DTC P0089.
- A short to voltage in the crankshaft position signal circuit may set a DTC.
- A short to voltage in the camshaft position actuator solenoid valve control circuit may set a DTC.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Fuel System Description (LF1)

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. Observe the DTC information with a scan tool. DTC P0627, P0628, P0629, P069E, or U0109 should not set.
 - If a DTC is set refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. Attempt to start and idle the engine.
3. Observe the DTC information with a scan tool. DTCs P0089, P00C6, P228C, and P228D should not set.
4. Engine idling, observe the Fuel Rail Pressure Sensor parameter with a scan tool. The pressure should be approximately 1.9-2.1 Mpa (279-305 psi).
5. Command an increase and decrease in fuel rail pressure with a scan tool. Observe the scan tool Fuel Rail Pressure Sensor parameter. The Fuel Rail Pressure Sensor should increase or decrease with each commanded state.
6. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

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

1. Ignition ON, observe the scan tool fuel pump control module fuel line pressure sensor parameter. Command an increase in the fuel line pressure with a scan tool. Verify the fuel line pressure increases to greater than 414 kPa (60 psi) as commanded.
 - If less than the specified range, refer to **Fuel System Diagnosis** .

NOTE: **As little as 2 ohms on either circuit of the high pressure fuel pump actuator will cause these DTCs to set. Test the circuits of the high pressure fuel pump actuator for a high resistance if you suspect a condition.**

2. Remove the G18 high pressure fuel pump and visually inspect the lobes on the camshaft for unusual wear.
 - If the lobes appear normal, replace the G18 high pressure fuel pump.
 - If the lobes are worn, replace the camshaft.

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 ohms in order to prevent misdiagnosis.

2. Test for 10 ohms plus/minus 1 ohms at 25°C (77°F) between the low control circuit terminal 1 and the high control circuit terminal 2.
 - If not within the specified range, replace the G18 high pressure fuel pump.
3. Test for infinite resistance between each terminal and the G18 high pressure fuel pump housing.
 - If not the specified value, replace the G18 high pressure fuel pump.

REPAIR PROCEDURES

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

- **Camshaft Replacement - Right Side**
- **Fuel Pressure Sensor Replacement - Fuel Injection Fuel Rail (LF1)**
- **Fuel Pump Replacement**

DTC P0090-P0092, P00C8, P00C9, OR P00CA

DIAGNOSTIC INSTRUCTIONS

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

DTC DESCRIPTORS

DTC P0090

Fuel Pressure Regulator Control Circuit

DTC P0091

Fuel Pressure Regulator Control Circuit Low Voltage

DTC P0092

Fuel Pressure Regulator Control Circuit High Voltage

DTC P00C8

Fuel Pressure Regulator High Control Circuit

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, P00CA	-
High Pressure Fuel Pump Actuator Low Control	P0091, 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 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.

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

P0091

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

P0092

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

P00C8

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

P00C9

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

P00CA

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

ACTION TAKEN WHEN THE DTC SETS

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

CONDITIONS FOR CLEARING THE DTC

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

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Fuel System Description (LF1)

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. Observe the DTC information with a scan tool. DTC P0090, P0091, P0092, P00C8, P00C9, P00CA, P0685, or P1682 should not set.
 - If a DTC is set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. Ignition ON, command the Fuel Pressure Regulator ON and OFF with a scan tool while observing the following control circuit status parameters:
 - Fuel Pressure Regulator Control Circuit High Voltage Test Status
 - Fuel Pressure Regulator Control Circuit Open Test Status
 - Fuel Pressure Regulator Control Circuit Low Voltage Test Status
 - Fuel Pressure Regulator High Control Circuit High Voltage Test Status
 - Fuel Pressure Regulator High Control Circuit Open Test Status
 - Fuel Pressure Regulator High Control Circuit Low Voltage Test Status
 - Each parameter should toggle between OK and Not Run or Not Run and OK.
3. Engine idling, observe the Fuel Rail Pressure Sensor parameter with a scan tool. The pressure should be approximately 1.9-2.1 MPa (279-305 psi).
4. Command an increase and decrease in fuel rail pressure with a scan tool. Observe the scan tool Fuel Rail Pressure Sensor parameter. The Fuel Rail Pressure Sensor should increase or decrease with each command.
5. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the harness connector at the G18 high pressure fuel pump.
2. Ignition OFF, verify that a test lamp does not illuminate between B+ and the low control circuit terminal 1.
 - If the test lamp illuminates, test the low control circuit for a short to ground. If the circuit tests normal, replace the K20 ECM.
3. Ignition ON, verify that a test lamp does not illuminate between ground and the high control circuit terminal 2.
 - If the test lamp illuminates, test the high control circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.
4. Ignition ON, command the Fuel Pressure Regulator ON with a scan tool. Verify that the test lamp

illuminates.

- If the test lamp does not illuminate, test the high control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
- 5. Ignition OFF, connect a test lamp between the low control circuit terminal 1 and B+.
- 6. Ignition ON, command the Fuel Pressure Regulator ON with a scan tool. Verify that the test lamp illuminates.
 - If the test lamp does not illuminate, test the low control circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
- 7. If all circuits test normal, 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 ohms in order to prevent misdiagnosis.**

2. Test for 9-11 ohms at 25°C (77°F) between the low control circuit terminal 1 and the high control circuit terminal 2.
 - If not within the specified range, replace the G18 high pressure fuel pump.
3. Measure the resistance between each terminal and the high pressure fuel pump housing. The DMM should display OL.
 - If less than the specified value, replace the G18 high pressure fuel pump.

REPAIR PROCEDURES

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

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

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

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Ignition 1 Voltage	P0102	P0101	P0102	-	P0101, P0103
MAF Sensor Signal	P0102	P0102	P0102	P0102	P0101, P0103, P1101
Ground	-	P0102	P0102	-	P0102

TYPICAL SCAN TOOL DATA

MAF Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine running at various operating conditions Parameter Normal Range: 2,000-10,000 Hz			
Ignition 1 Voltage	0 Hz	0 Hz	-
MAF Sensor Signal	0 Hz	0 Hz	0 Hz
Ground	-	0 Hz	-

CIRCUIT DESCRIPTION

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

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

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

the appropriate DTC to fail. The following table illustrates the possible failure combinations and the resulting DTC or DTCs.

Scan Tool Diagnostic Test Results

MAF Performance Test	MAP Performance Test 1	MAP Performance Test 2	Throttle Position Sensors Performance Test	DTCs Passed	DTCs Failed
-	-	OK	OK	P0101, P0106, P0121, P1101	None
OK	OK	Malfunction	OK	P0101, P0106, P0121, P1101	None
Malfunction	OK	Malfunction	OK	P0106, P0121, P1101	P0101
OK	Malfunction	Malfunction	OK	P0101, P0121, P1101	P0106
Malfunction	Malfunction	Malfunction	OK	P0121, P1101	P0101, P0106
-	-	OK	Malfunction	P0101, P0106, P1101	P0121
OK	OK	Malfunction	Malfunction	P0101, P0106, P0121, P1101	None
Malfunction	OK	Malfunction	Malfunction	P0101, P0106, P0121	P1101
-	Malfunction	Malfunction	Malfunction	P0101, P0106, P0121	P1101
OK	OK	Malfunction	OK	-	P0102

CONDITIONS FOR RUNNING THE DTCS

- DTCs P0102, P0103, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0128, P0335 or P0336 are not set.
- The engine is running.
- The engine coolant is between 69-127°C (156-261°F).
- The intake air temperature is between -20 and +125°C (-4 and +257°F).
- The DTC runs continuously when the above conditions are met.

CONDITIONS FOR SETTING THE DTC

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

ACTION TAKEN WHEN THE DTC SETS

DTC P0101 is a Type B DTC.

CONDITIONS FOR CLEARING THE MIL/DTC

DTC P0101 is a Type B DTC.

DIAGNOSTIC AIDS

- A steady or intermittent high resistance of 15 ohms or greater on the ignition 1 voltage circuit will cause the MAF sensor signal to be increased by as much as 60 g/s.
- Any type of contamination on the MAF sensor heating elements will degrade the proper operation of the sensor. Certain types of contaminants act as a heat insulator, which will impair the response of the sensor to airflow changes. Water or snow can create the opposite effect, and cause the signal to increase rapidly.
- Depending on the current ambient temperature, and the vehicle operating conditions, a MAF sensor signal circuit that is shorted to the IAT signal circuit will cause the MAF sensor signal to be skewed or erratic. Additionally, it may cause a rapid fluctuation in the IAT Sensor parameter.
- A skewed or stuck engine coolant temperature (ECT) or IAT sensor will cause the calculated models to be inaccurate and may cause this DTC to run when it should not. Refer to **Temperature Versus Resistance - Engine Coolant Temperature Sensor** or **Temperature Versus Resistance - Intake Air Temperature Sensor** .

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End 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

- **J 38522:** Variable Signal Generator
- For equivalent regional tools, refer to **Special Tools** .

CIRCUIT/SYSTEM VERIFICATION

1. Verify that the following DTCs are not set:
 - 5 V reference circuits
 - Camshaft position system performance
 - Engine controls ignition relay circuits
 - Ignition circuits-Body control module (BCM)
 - If any of the DTCs are set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. Verify that restrictions do not exist in the exhaust system. Refer to **Restricted Exhaust** .
3. Engine idling, observe the scan tool MAF Sensor parameter. The reading should be between 2,000-3,900 Hz depending on the engine coolant temperature (ECT).
4. A wide open throttle (WOT) acceleration from a stop should cause the MAF Sensor parameter on the scan tool to increase rapidly. This increase should be from 2-8 g/s at idle to greater than 180 g/s at the time of the 1-2 shift.
5. Use the scan tool and compare the MAF Sensor parameter to a known good vehicle, under various operating conditions.
6. Verify the proper operation of the ECT and IAT sensors. A skewed or stuck ECT or IAT sensor will cause the calculated models to be inaccurate and may cause this DTC to run when it should not. Refer to **Temperature Versus Resistance - Intake Air Temperature Sensor** .
7. Verify the proper operation of the MAP sensor. A skewed MAP sensor will cause the BARO value to be inaccurate. Refer to **DTC P0106 (LF1)**.
8. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Verify the integrity of the entire air induction system by inspecting for the following conditions:
 - Any damaged components
 - Loose or improper installation
 - An air flow restriction
 - Any vacuum leaks
 - Water intrusion
 - In cold climates, inspect for any snow or ice buildup
 - Inspect the B75B MAF/IAT sensor element for contamination.
2. Ignition OFF, disconnect the harness connector at the B75B MAF/IAT sensor.
3. Ignition OFF, all vehicle systems OFF, this may take up to 2 min, test for less than 5 ohms between the ground circuit terminal B and ground.

- If greater than the specified range, test the ground circuit for an open/high resistance.
- 4. Ignition ON, verify that a test lamp illuminates between the ignition circuit terminal C and ground.
 - If the test lamp does not illuminate, test the ignition circuit for a short to ground or an open/high resistance.
- 5. Ignition ON, test for 4.8-5.2 V between the signal circuit terminal A and ground.
 - If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
 - If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.
- 6. Ignition OFF, connect the red lead of the **J 38522: Variable Signal Generator** to the signal circuit terminal A at the B75B MAF/IAT sensor harness connector. Connect the battery voltage supply to the B+, and the black lead to ground.
- 7. Set the **J 38522: Variable Signal Generator** signal switch to 5 V, the Frequency switch to 5K, and the Duty Cycle switch to Normal.
- 8. Engine idling, observe the scan tool MAF Sensor parameter. The scan tool MAF Sensor parameter should be between 4,950-5,050 Hz.
 - If the MAF Sensor parameter is not within the specified range, replace the K20 ECM.
- 9. If all other circuits test normal, test or replace the B75B MAF/IAT sensor.

REPAIR PROCEDURES

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

- **Engine Coolant Temperature Sensor Replacement (LF1)**
- **Mass Airflow Sensor with Intake Air Temperature Sensor Replacement**
- **Control Module References** for ECM replacement, setup, and programming

DTC P0102 OR P0103

DIAGNOSTIC INSTRUCTIONS

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

DTC DESCRIPTORS

DTC P0102

Mass Air Flow (MAF) Sensor Circuit Low Frequency

DTC P0103

Mass Air Flow (MAF) Sensor Circuit High Frequency

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Ignition 1 Voltage	P0102	P0101	P0102	P0690	P0101, P0103
MAF Sensor Signal	P0102	P0102	P0102	P0102	P0101, P0103, P1101
Ground	-	P0102	P0102	-	P0102

TYPICAL SCAN TOOL DATA

MAF Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine running at various operating conditions Parameter Normal Range: 2,000-10,000 Hz			
Ignition 1 Voltage	0 Hz	0 Hz	-
MAF Sensor Signal	0 Hz	0 Hz	0 Hz
Ground	-	0 Hz	-

CIRCUIT/SYSTEM DESCRIPTION

The mass air flow (MAF) sensor is integrated with the intake air temperature (IAT) sensor. The MAF sensor is an air flow meter that measures the amount of air entering the engine. 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 MAF/IAT sensor has the following circuits:

The ECM applies 5 V to the MAF sensor on the MAF sensor signal circuit. The sensor uses the voltage to produce a frequency based on the inlet air flow through the sensor bore. The frequency varies in a range of near 2,000 Hertz at idle to near 10,000 Hertz at maximum engine load.

CONDITIONS FOR RUNNING THE DTC

- The engine is running for greater than 1 s.
- The ignition 1 signal is greater than 8 V.
- The above conditions are met for greater than 1 s.
- The DTC runs continuously when the above conditions are met.

CONDITIONS FOR SETTING THE DTC

P0102

The ECM detects that the MAF Sensor Signal parameter is less than 500 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.

DIAGNOSTIC AIDS

- Verify the integrity of the air induction system by inspecting for the following conditions:
 - Loose or improper installation
 - Damaged components
 - Any water intrusion in the induction system
 - Any contamination or debris on the sensing elements of the MAF sensor
- A steady or intermittent high resistance of 15 ohms or greater on the ignition 1 voltage circuit will cause the MAF sensor signal to be increased by as much as 60 g/s.
- Depending on the current ambient temperature, and the vehicle operating conditions, a MAF sensor signal circuit that is shorted to the IAT signal circuit will cause the MAF sensor signal to be skewed or erratic. Additionally, it may cause a rapid fluctuation in the IAT Sensor parameter.
- Verify that any electrical aftermarket devices are properly connected and grounded. Refer to **Checking Aftermarket Accessories**

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End 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

- **J 38522:** Variable Signal Generator
- For equivalent regional tools, refer to **Special Tools** .

CIRCUIT/SYSTEM VERIFICATION

- Engine idling, observe the scan tool MAF Sensor parameter. The reading should be between 2,000-3,900 Hz depending on the engine coolant temperature (ECT).
- A wide open throttle (WOT) acceleration from a stop should cause the MAF Sensor parameter on the scan tool to increase rapidly. This increase should be from 2-8 g/s at idle to greater than 180 g/s at the time of the 1-2 shift.
- Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Verify that the following DTCs are not set: P0685, P0690 or B1380.
 - If any of the DTCs are set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. Ignition OFF, disconnect the harness connector at the B75B MAF/IAT sensor.
3. Ignition OFF, all vehicle systems OFF, this may take up to 2 minutes, test for less than 5 ohms between the ground circuit terminal B and ground.
 - If greater than the specified range, test the ground circuit for an open/high resistance.
4. Ignition ON, verify that a test lamp illuminates between the ignition circuit terminal C and ground.
 - If the test lamp does not illuminate, test the ignition circuit for a short to ground or an open/high resistance.
 - If the circuit tests normal and the fuse is open, test all the components connected to the circuit and repair or replace as necessary.
5. Ignition ON, test for 4.8-5.2 V between the signal circuit terminal A and ground.
 - If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
 - If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.
6. Ignition OFF, connect the red lead of the **J 38522:** Variable Signal Generator to the signal circuit terminal A at the B75B MAF/IAT sensor harness connector. Connect the battery voltage supply to B+, and the black lead to ground.
7. Set the **J 38522:** Variable Signal Generator signal to 5 V, the Frequency to 5K, and the Duty Cycle to

Normal.

8. Engine idling, observe the scan tool MAF Sensor parameter. The scan tool MAF Sensor parameter should be between 4,950-5,050 Hz.
 - If the MAF Sensor parameter is not within the specified range, replace the K20 ECM.
9. If all other circuits test normal, replace the B75B MAF/IAT sensor.

REPAIR PROCEDURES

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

- **Mass Airflow Sensor with Intake Air Temperature Sensor Replacement**
- **Control Module References** for ECM replacement, setup, and programming

DTC P0106 (LF1)

DIAGNOSTIC INSTRUCTIONS

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

DTC DESCRIPTOR

DTC P0106

Manifold Absolute Pressure (MAP) Sensor Performance

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
5 V Reference	P0107, P0641	P0106, P0697	P0107	P0106, P0697	P0106, P0107
MAP Sensor Signal	P0107	P0106, P0107	P0107	P0108	P0106, P0107, P1101
Low Reference	-	P0106, P0108	P0106, P0108	-	P0106, P0108

TYPICAL SCAN TOOL DATA

MAP Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine running, transmission in Park or Neutral Parameter Normal Range: 20-48 kPa (2.9-7 psi), varies with altitude			

5 V Reference	0 kPa (0 psi)	0 kPa (0 psi)	127 kPa (18.4 psi)
MAP Sensor Signal	0 kPa (0 psi)	0 kPa (0 psi)	127 kPa (18.4 psi)
Low Reference	-	127 kPa (18.4 psi)	-

CIRCUIT DESCRIPTION

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

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

The estimates of MAF and MAP obtained from this system of models and calculations are then compared to the actual measured values from the MAF, MAP, and the throttle position sensors and to each other to determine the appropriate DTC to fail. The following table illustrates the possible failure combinations and the resulting DTC or DTCs.

Scan Tool Diagnostic Test Results

MAF Performance Test	MAP Performance Test 1	MAP Performance Test 2	Throttle Position Performance Test	DTCs Passed	DTCs Failed
-	-	OK	OK	P0101, P0106, P0121, P1101	None
OK	OK	Malfunction	OK	P0101, P0106, P0121, P1101	None
Malfunction	OK	Malfunction	OK	P0106, P0121, P1101	P0101
OK	Malfunction	Malfunction	OK	P0101, P0121, P1101	P0106
Malfunction	Malfunction	Malfunction	OK	P0121, P1101	P0101, P0106

-	-	OK	Malfunction	P0101, P0106, P1101	P0121
OK	OK	Malfunction	Malfunction	P0101, P0106, P0121, P1101	None
Malfunction	OK	Malfunction	Malfunction	P0101, P0106, P0121	P1101
-	Malfunction	Malfunction	Malfunction	P0101, P0106, P0121	P1101

CONDITIONS FOR RUNNING THE DTC

- DTC P0102, P0103, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0128, P0335 or P0336 is not set.
- The engine speed is between 400-7,000 RPM.
- The IAT Sensor parameter is between -20° to +125°C (-4° to +257°F).
- The ECT Sensor parameter is between 69-127°C (156-260°F).
- This DTC runs continuously within the enabling conditions.

CONDITIONS FOR SETTING THE DTCS

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

ACTION TAKEN WHEN THE DTC SETS

DTC P0106 is a Type B DTC.

CONDITIONS FOR CLEARING THE MIL/DTC

DTC P0106 is a Type B DTC.

DIAGNOSTIC AIDS

- A wide open throttle (WOT) acceleration from a stop should cause the MAP sensor parameter on the scan tool to increase rapidly to near the BARO parameter at the time of the 1-2 shift.
- The BARO that is used by the ECM to calculate the air flow models is initially based on the MAP sensor at ignition ON. When the engine is running, the ECM will continually update the BARO value near WOT using the MAP sensor and a calculation. A skewed MAP sensor will cause the BARO value to be inaccurate.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End 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

- J 23738-A: Mityvac
- J 35555: Metal Mityvac
- For equivalent regional tools, refer to Special Tools .

CIRCUIT/SYSTEM VERIFICATION

1. Verify that DTC P0641, P0651, or P0697 is not set.
 - If any of the DTCs are set, refer to DTC P0641, P0651, P0697, or P06A3 (ECM) .
2. Verify that restrictions do not exist in the exhaust system. Refer to Restricted Exhaust .
3. Ignition OFF for 90 s, determine the current vehicle testing altitude.
4. Ignition ON, engine OFF, observe the scan tool BARO parameter. Compare the parameter to the Altitude Versus Barometric Pressure table. The BARO parameter should be within the specified range indicated in the table.
5. Use the scan tool and compare the MAP Sensor parameter to a known good vehicle, under various operating conditions. The reading should be within 5 kPa of the known good vehicle.
6. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Verify the integrity of the entire air induction system by inspecting for the following conditions:
 - Any damaged components
 - Loose or improper installation
 - An air flow restriction
 - Any vacuum leak
 - Improperly routed vacuum hoses
 - In cold climates, inspect for any snow or ice buildup
 - Verify that restrictions do not exist in the MAP sensor port or vacuum source.
2. Ignition OFF for 90 s, disconnect the harness connector at the B74 MAP sensor.
3. Ignition OFF, test for less than 5 ohms between the low reference circuit terminal 2 and ground.
 - If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the K20 ECM.
4. Ignition ON, test for 4.8-5.2 V between the 5 V reference circuit terminal 1 and ground.
 - If less than the specified range, test the 5 V reference circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
 - If greater than the specified range, test the 5 V reference circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.
5. Verify the scan tool MAP Sensor parameter is less than 1 kPa (0.2 psi).
 - If greater than the specified range, test the signal circuit terminal 3 for a short to voltage. If the circuit tests normal, replace the K20 ECM.
6. Install a 3 A fused jumper wire between the signal circuit terminal 3 and the 5 V reference circuit terminal 1. Verify the scan tool MAP Sensor parameter is greater than 127 kPa (18.4 psi).
 - If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
7. If the circuits test normal, test or replace the B74 MAP sensor.

COMPONENT TESTING

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

Skewed Signal Test

1. Using the following steps and referencing the table below will determine if the MAP sensor is skewed.
2. Ignition ON, engine OFF, observe the MAP Sensor scan tool parameter.
3. Use the observed MAP Sensor scan tool parameter that is closest to a value that is indicated in the first column.

THEN

4. Using the **J 23738-A**: Mityvac or the **J 35555**: Metal Mityvac to apply 5 in Hg of vacuum to the B74 MAP sensor, the parameter in the first column should decrease by 17 kPa (2.5 psi). The acceptable range

is indicated in the second column.

- Using the **J 23738-A: Mityvac** or the **J 35555: Metal Mityvac** to apply 10 in Hg of vacuum to the B74 MAP sensor, the parameter in the first column should decrease by 34 kPa (4.9 psi). The acceptable range is indicated in the third column.

Ignition ON, Engine OFF, MAP Sensor Parameter	MAP Sensor Parameter With 5 Inches of Vacuum Applied	MAP Sensor Parameter With 10 Inches of Vacuum Applied
100 kPa (14.5 psi)	79-87 kPa (11.5-12.6 psi)	62-70 kPa (9-10.2 psi)
95 kPa (13.8 psi)	74-82 kPa (10.7-11.9 psi)	57-65 kPa (8.3-9.4 psi)
90 kPa (13.1 psi)	69-77 kPa (10-11.2 psi)	52-60 kPa (7.5-8.7 psi)
80 kPa (11.6 psi)	59-67 kPa (8.6-9.7 psi)	42-50 kPa (6.1-7.3 psi)
70 kPa (10.2 psi)	49-57 kPa (7.1-8.3 psi)	32-40 kPa (4.7-5.8 psi)
60 kPa (8.7 psi)	39-47 kPa (5.7-6.8 psi)	22-30 kPa (3.2-4.4 psi)

Erratic Signal Test

- Ignition OFF, remove the B74 MAP sensor.
- Install a 3 A fused jumper wire between the 5 V reference circuit terminal 1 and the corresponding terminal of the B74 MAP sensor.
- Install a jumper wire between the low reference circuit terminal 2 of the B74 MAP sensor and ground.
- Install a jumper wire at terminal 3 of the B74 MAP sensor.
- Connect a DMM between the jumper wire from terminal 3 of the B74 MAP sensor and ground.
- Ignition ON, with the **J 23738-A: Mityvac** or **J 35555: Metal Mityvac**, slowly apply vacuum to the sensor while observing the voltage on the DMM. The voltage should vary between 0-5.2 V, without any spikes or dropouts.
 - If the voltage reading is erratic, replace the B74 MAP sensor.

REPAIR PROCEDURES

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

Control Module References for ECM replacement, setup, and programming

DTC P0107 OR P0108 (W/LF1)

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 DESCRIPTORS

DTC P0107

Manifold Absolute Pressure (MAP) Sensor Circuit Low Voltage

DTC P0108

Manifold Absolute Pressure (MAP) Sensor Circuit High Voltage

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
5 V Reference	P0106, P0107, P0108, P0697	P0106, P0107	P0107	P0106, P0108, P0697	P0106, P0107
MAP Sensor Signal	P0107	P0106, P0107	P0107	P0106, P0108	P0106, P0107, P1101
Low Reference	-	P0106, P0108	P0108	-	P0106, P0108

TYPICAL SCAN TOOL DATA

MAP Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine running, transmission in Park or Neutral Parameter Normal Range: 20-48 kPa (2.9-7.0 psi), varies with altitude			
5 V Reference	0 kPa (0 psi)	0 kPa (0 psi)	127 kPa (18.4 psi)
MAP Sensor Signal	0 kPa (0 psi)	0 kPa (0 psi)	127 kPa (18.4 psi)
Low Reference	-	127 kPa (18.4 psi)	-

CIRCUIT DESCRIPTION

The manifold absolute pressure (MAP) sensor has a 5 V reference circuit, a low reference circuit, and a signal circuit. The engine control module (ECM) supplies 5 V to the MAP sensor on the 5 V reference circuit, and provides a ground for the low reference circuit. The MAP sensor provides a voltage signal to the ECM on the signal circuit relative to the intake manifold pressure changes.

CONDITIONS FOR RUNNING THE DTC

- DTC P0697 is not set.
- The engine is running.
- This DTC runs continuously within the enabling conditions.

CONDITIONS FOR SETTING THE DTC

The ECM detects that the MAP sensor voltage is less than 0.20 V for more than 5 s.

P0108

The ECM detects that the MAP sensor voltage is more than 4.80 V for more than 5 s.

ACTION TAKEN WHEN THE DTC SETS

DTCs P0107 and P0108 are Type B DTCs.

CONDITIONS FOR CLEARING THE MIL/DTC

DTCs P0107 and P0108 are Type B DTCs.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End 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

- **J 23738-A:** Mityvac
- **J 35555:** Metal Mityvac
- For equivalent regional tools, refer to **Special Tools** .

CIRCUIT/SYSTEM VERIFICATION

1. Verify that DTC P0641, P0651, or P0697 is not set.
 - If any of the DTCs are set refer to **DTC P0641, P0651, P0697, or P06A3 (ECM)** .
2. Ignition ON, observe the scan tool MAP Sensor parameter. The reading should be between 0.20-4.80 V.
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Ignition OFF for 90 s, disconnect the harness connector at the B74 MAP sensor.
2. Test for less than 5 ohms between the low reference circuit terminal 2 and ground.
 - If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the K20 ECM.
3. Ignition ON, test for 4.8-5.2 V between the 5 V reference circuit terminal 1 and ground.
 - If less than the specified range, test the 5 V reference circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
 - If greater than the specified range, test the 5 V reference circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.
4. Verify the scan tool MAP Sensor parameter is less than 1 kPa (0.2 psi).
 - If greater than the specified range, test the signal circuit terminal 3 for a short to voltage. If the circuit tests normal, replace the K20 ECM.
5. Install a 3 A fused jumper wire between the signal circuit terminal 3 and the 5 V reference circuit terminal 1. Verify the scan tool MAP Sensor parameter is greater than 127 kPa (18.4 psi).
 - If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
6. If the circuits test normal, test or replace the B74 MAP sensor.

COMPONENT TESTING

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

Erratic Signal Test

1. Ignition OFF, remove the B74 MAP sensor.
2. Install a 3 A fused jumper wire between the 5 V reference circuit terminal 1 and the corresponding terminal of the B74 MAP sensor.
3. Install a jumper wire between the low reference circuit terminal 2 of the B74 MAP sensor and ground.
4. Install a jumper wire at terminal 3 of the B74 MAP sensor.
5. Connect a DMM between the jumper wire from terminal 3 of the B74 MAP sensor and ground.
6. Ignition ON, with the **J 23738-A: Mityvac** or the **J 35555: Metal Mityvac**, slowly apply vacuum to the sensor while observing the voltage on the DMM. The voltage should vary between 0-5 V without any

- spikes or dropouts.
- If the voltage reading is erratic, replace the B74 MAP sensor.

REPAIR PROCEDURES

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

Control Module References for ECM replacement, setup, and programming

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 Circuit Low Voltage

DTC P0113

Intake Air Temperature (IAT) Sensor Circuit High Voltage

DTC P0114

Intake Air Temperature (IAT) Sensor Circuit Intermittent

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
IAT Sensor Signal	P0112, P0114	P0113, P0114, P0112	P0113, P0114	P0114
Low Reference	-	P0113, P0114	P0113, P0114	P0114

TYPICAL SCAN TOOL DATA

IAT Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine running			
Parameter Normal Range: Varies with ambient temperature			

IAT Sensor Signal	150°C (302°F)	-40°C (-40°F)	-40°C (-40°F)*
Low Reference	-	-40°C (-40°F)	-40°C (-40°F)*
*Internal ECM or sensor damage may occur if the circuit is shorted to B+			

CIRCUIT/SYSTEM DESCRIPTION

The intake air temperature (IAT) sensor is a variable resistor. It is integrated into the mass air flow (MAF) sensor. The IAT sensor has a signal circuit and a low reference circuit. The IAT sensor measures the temperature of the air entering the engine. The engine control module (ECM) supplies 5 V to the IAT signal circuit, and a ground for the IAT low reference circuit.

CONDITIONS FOR RUNNING THE DTC

P0112

- The engine run time is greater than 1 s.
- The DTC runs continuously when the above conditions are met.

P0113

- The engine run time is greater than 1 s.
- The DTC runs 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 DTC

P0112

The ECM detects that the IAT sensor signal is warmer than 149°C (300°F) for greater than 7 s.

P0113

The ECM detects that the IAT sensor signal is colder than -60°C (-76°F) for greater than 7 s.

P0114

The ECM detects that the IAT sensor signal is intermittent or has abruptly changed for greater than 4 s.

ACTION TAKEN WHEN THE DTC SETS

DTCs P0112, P0113, and P0114 are Type B DTCs.

CONDITIONS FOR CLEARING THE DTC

- DTCs P0112, P0113, and P0114 are Type B DTCs.
- The ECM commands the cooling fans ON.

DIAGNOSTIC AIDS

- With the ignition ON, the engine OFF, if the engine is cold, a properly functioning IAT sensor will gradually increase the scan tool IAT Sensor parameter. This is due to the heat that is generated by the mass air flow (MAF) sensor heating elements
- Depending on the ambient temperature, an IAT sensor signal circuit or low reference circuit that is shorted to the MAF sensor signal circuit can cause a DTC P0113 and/or P0114 to set. This condition causes a rapid fluctuation in the IAT Sensor parameter.
- An IAT sensor signal circuit that is shorted to the MAF sensor ignition circuit can cause a DTC P0113 and/or P0114 to set.
- A MAF sensor ground circuit that is open will cause a DTC P0113 and/or a DTC P0114 to set.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End 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. Engine running, observe the scan tool IAT Sensor Signal parameter. The reading should be between -40

to +149°C (-40 to +300°F) depending on the current ambient temperature and the vehicle operating conditions.

2. Operate the vehicle within the Conditions for Running the DTC to verify that the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

NOTE: All electrical components and accessories must be turned OFF and allowed to power down.

1. Ignition OFF, disconnect the harness connector at the B75B MAF/IAT sensor.
2. Ignition OFF, all vehicle systems OFF, this may take up to 2 minutes, test for less than 5 ohms between the low reference circuit terminal D and ground.
 - If greater than the specified range, test the low reference circuit for an open/high resistance or for a short to voltage. If the circuit tests normal, replace the K20 ECM.
3. Ignition ON, verify the scan tool IAT Sensor Signal parameter is colder than -39°C (-38°F).
 - If warmer than the specified range, test the signal circuit terminal E for a short to ground. If the circuit tests normal, replace the K20 ECM.

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

4. Install a 3 A fused jumper wire between the signal circuit terminal E and ground. Verify the scan tool IAT parameter is warmer than 149°C (300°F).
 - If colder than the specified range, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
5. If all circuits test normal, test or replace the B75B MAF/IAT sensor.

COMPONENT TESTING

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** table.

REPAIR PROCEDURES

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

- **Mass Airflow Sensor with Intake Air Temperature Sensor Replacement**
- **Control Module References** for ECM replacement, setup, and programming

DTC P0116 (LF1)

DIAGNOSTIC INSTRUCTIONS

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

DTC DESCRIPTOR

DTC P0116

Engine Coolant Temperature (ECT) Sensor Performance

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
ECT Sensor Signal	P0117	P0118	P0118*	P0116*
Low Reference	-	P0118	P0118*	P0116*
*Internal ECM or ECT 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 operating in Closed Loop. Parameter Normal Range: -39 to +142°C (-38 to +288°F) Varies with coolant temperature.			
ECT Sensor Signal	143°C (289°F)	-40°C (-40°F)	-40°C (-40°F)*
Low Reference	-	-40°C (-40°F)	-40°C (-40°F)*
* Internal ECM or ECT sensor damage may occur if the circuit is shorted to B+			

CIRCUIT 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 signal circuit and supplies a ground to the low reference circuit. The ECM monitors the mutual performance of the ECT and the intake air temperature (IAT) signals. The ECM monitors the warm up and cool down behavior of the sensors, after a vehicle driven at operating temperature is shut down. If the ECM detects that the ECT is not with in a predetermined range of IAT after a long soak, or the ECT and IAT are not within a range of each other, as compared to a previous cold start, this DTC sets.

The following table illustrates the difference between temperature, resistance, and voltage:

ECT	ECT Resistance	ECT Signal Voltage
Cold	High	High
Warm	Low	Low

CONDITIONS FOR RUNNING THE DTC

Condition 1

- Before the ECM can report DTC P0116 failed, DTC P0101 must run and pass.
- DTC P0112, P0113, P0117, P0118 or P2610 is not set.
- The engine run time of the previous ignition cycle was greater than 10 min.
- The calculated engine cool down of the previous test was greater than 50°C (120°F).
- The ignition was OFF for greater than 330 min after the previous engine shut down.
- The accumulated air mass of the previous ignition cycle was greater than 6,000 grams.
- The DTC runs once an ignition cycle when the above conditions are met for greater than 35 s.

Condition 2

- Before the ECM can report DTC P0116 failed, DTC P0101 must run and pass.
- DTCs P0112, P0113, P0117, P0118 are not set.
- The ECT at the previous engine shut down is warmer than 82°C (180°F).
- The block heater is not detected.
- The ignition was OFF for greater than 330 min after the previous engine shut down.
- DTC runs once an ignition cycle when the above conditions are met.

CONDITIONS FOR SETTING THE DTC

- The ECM determines the difference between the ECT and IAT at ignition ON is not within 14°C (25°F) of the difference recorded during a previous ignition cycle, when the enable conditions were met.

OR

- The ECM determines the IAT at ignition ON is within a calibrated range of the ECT and IAT recorded during a previous ignition cycle, but the ECT is not within 14°C (25°F) of the calibrated range.

ACTION TAKEN WHEN THE DTC SETS

DTC P0116 is a Type A/B DTC.

CONDITIONS FOR CLEARING THE MIL/DTC

DTC P0116 is a Type A/B DTC.

DIAGNOSTIC AIDS

- Test the ECT and the IAT sensor at various temperature levels in order to evaluate the possibility of a skewed sensor. A skewed sensor can result in a DTC or a driveability condition. Refer to **Temperature Versus Resistance - Engine Coolant Temperature Sensor** and **Temperature Versus Resistance -**

Intake Air Temperature Sensor .

- If the vehicle has sat overnight, the IAT sensor and the ECT sensor values should display within 3°C (5°F).
- After starting a cold engine, the ECT sensor temperature should rise steadily, then stabilize after the thermostat opens.
- High resistance in the circuits of either the ECT or IAT sensor could set a DTC.
- A short to ground or voltage through a conductive material or fluid could set this DTC. Inspect the ECT sensor for evidence of engine coolant leaking into the connector body.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End 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. Verify that DTC P0117, P0118, or P0119 is not set.
 - If any of the DTCs are set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. Inspect the engine coolant level. Verify that the cooling system is operating correctly.
 - If you suspect a condition with engine cooling system, refer to **Loss of Coolant** .
3. Ignition ON, verify the P0116 Freeze Frame Start Up ECT and the Start Up IAT parameters are within 14°C (25°F).
4. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure

Records data.

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the harness connector at the B34 ECT sensor.

CAUTION: Do NOT use a test lamp to test the continuity of the circuit. Damage to the control module may occur due to excessive current draw.

NOTE: The control module or the sensor may be damaged if the circuit is shorted to battery positive voltage.

2. Test for less than 5 ohms between the low reference circuit terminal A and ground.
 - If greater than the specified range, test the low reference circuit for an open/high resistance, or for a short to voltage. If the circuit tests normal, replace the K20 ECM.
3. Ignition ON, verify that the scan tool ECT sensor parameter is at -40°C (-40°F).
 - If warmer than the specified value, test the signal circuit for a short to ground. If the circuit tests normal, replace the K20 ECM.

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

4. Ignition ON, install a 3 A fused jumper wire between the signal circuit terminal A and the low reference circuit terminal B. Verify the ECT sensor parameter is warmer than 142°C (288°F).
 - If colder than the specified value, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
5. If all circuits test normal, test or replace the B34 ECT sensor.

COMPONENT TESTING

1. Ignition OFF, disconnect the harness connector at the B34 engine coolant temperature (ECT) sensor.

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

2. Test the ECT sensor by varying the sensor temperature while monitoring the sensor resistance. Compare the readings with the Temperature Versus Resistance - Engine Coolant Temperature Sensor table and verify that the resistance is within 5 % of the specification.
 - If not within the specified range, replace the B34 ECT sensor.

REPAIR PROCEDURES

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Engine Coolant Temperature Sensor Replacement (LF1)

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

DTC P0117 OR P0118 (W/LF1)

DIAGNOSTIC INSTRUCTIONS

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

DTC DESCRIPTORS

DTC P0117

Engine Coolant Temperature (ECT) Sensor Circuit Low Voltage

DTC P0118

Engine Coolant Temperature (ECT) Sensor Circuit High Voltage

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
ECT Sensor Signal	P0117	P0118	P0118*	P0116
Low Reference	-	P0118	P0118*	P0116
* Sensor or ECM 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 operating in Closed Loop.			
Parameter Normal Range: -39 to 142°C (-38 to 288°F) Varies with coolant temperature.			
ECT Sensor Signal	150°C (302°F)	-40°C (-40°F)	-40°C (-40°F)*
Low Reference	-	-40°C (-40°F)	-40°C (-40°F)*
* Internal ECM or ECT sensor damage may occur if the circuit is shorted to B+			

CIRCUIT 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 signal circuit and supplies a ground to the low reference circuit.

The following table illustrates the difference between temperature, resistance, and voltage:

ECT	ECT Resistance	ECT Signal Voltage
Cold	High	High
Warm	Low	Low

CONDITIONS FOR RUNNING THE DTC

P0117

- The engine is operating.
- The start up intake air temperature (IAT) is less than 72°C (161°F).

OR

- The start up intake air temperature (IAT) is greater than 72°C (161°F).
- The engine run time is greater than 59 s.
- The DTC runs continuously once the above conditions are met.

P0118

- The ignition is ON or the engine is operating.
- The DTC runs continuously once the above condition is met.

CONDITIONS FOR SETTING THE DTC

P0117

The ECM detects that the ECT is greater than 140°C (284°F) for greater than 1 s or a cumulative of 10 s.

P0118

The ECM detects that the ECT is less than -39°C (-38°F) for greater than 1 s or a cumulative of 10 s.

ACTION TAKEN WHEN THE DTC SETS

DTC P0117 and P0118 are Type B DTCs.

The ECM may activate the Cooling Fans at high speed.

CONDITIONS FOR CLEARING THE MIL/DTC

DTC P0117 and P0118 are Type B DTCs.

DIAGNOSTIC AIDS

- Test the ECT sensor at various temperature levels in order to evaluate the possibility of a skewed sensor. A skewed sensor can result in a DTC or a driveability condition. Refer to **Temperature Versus**

Resistance - Engine Coolant Temperature Sensor

- If the vehicle has sat overnight, the IAT sensor and the ECT sensor values should display within 3°C (5°F).
- After starting a cold engine, the ECT sensor temperature should rise steadily, then stabilize after the thermostat opens.
- High resistance in the circuits of either the ECT or IAT sensor could set a DTC.
- DTC's must be cleared before Engine Cooling Fan's are Commanded Off.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End 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. Engine idling for 1 min. Observe the DTC information with a scan tool. DTCs P0117 and P0118 should not set.
2. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the harness connector at the B34 ECT sensor.

CAUTION: Do NOT use a test lamp to test the continuity of the circuit. Damage to the control module may occur due to excessive current draw.

NOTE: The control module or the sensor may be damaged if the circuit is shorted to battery positive voltage.

2. Ignition Off all vehicle systems Off, this may take up to 2 minutes. Test for less than 5 ohms between the low reference circuit terminal A and ground.
 - If greater than the specified range, test the low reference circuit for an open/high resistance, or for a short to voltage. If the circuit tests normal, replace the K20 ECM.
3. Ignition ON, verify that the scan tool ECT sensor parameter is at -40°C (-40°F).
 - If greater than the specified value, test the signal circuit terminal B for a short to ground. If the circuit tests normal, replace the K20 ECM.

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

4. Ignition ON, install a 3 A fused jumper wire between the signal circuit terminal A and the low reference circuit terminal B. Verify the ECT sensor parameter is greater than 142°C (288°F).
 - If less than the specified value, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
5. If all circuits test normal, test or replace the B34 ECT sensor.

COMPONENT TESTING

1. Ignition OFF, disconnect the harness connector at the B34 engine coolant temperature (ECT) sensor.

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

2. Test the ECT sensor by varying the sensor temperature while monitoring the sensor resistance. Compare the readings with the Temperature Versus Resistance - Engine Coolant Temperature Sensor table and verify that the resistance is within 5 % of the specification.
 - If not within the specified range, replace the B34 ECT sensor.

REPAIR PROCEDURES

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Engine Coolant Temperature Sensor Replacement (LF1)
- Control Module References for ECM replacement, setup, and programming

DTC P0121-P0123, P0222, P0223, OR P2135 (LF1, LFW)

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 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 P2135

Throttle Position Sensors 1-2 Not Plausible

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
5-Volt Reference	P06A3	-	P0122, P0222,	P06A3	P0121
TP Sensor 1 Signal	P0122	P2119, P2135, P2176	P0122	P0123, P2135	P0121, P2135
TP Sensor 2 Signal	P0222	P2135	P0223	P0223, P2135	P0121, P2135
Low Reference	-	-	P0122, P0223	-	-

TYPICAL SCAN TOOL DATA

TP Sensor 1

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: The engine is idling. Parameter Normal Range: TP Sensor 1 3.0-4.0 V			
5-Volt Reference	0.00 V	0.00 V	4-5 V
TP Sensor 1 Signal	0.00 V	0.00 V	5.00 V
Low Reference	-	4-5 V	-

TP Sensor 2

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: The engine is idling. Parameter Normal Range: TP Sensor 2 1.4-2.4 V			
5-Volt Reference	0-0.5 V	0-0.5 V	3-5 V
TP Sensor 2 Signal	0.00 V	5.00 V	5.00 V
Low Reference	-	5.00 V	-

CIRCUIT/SYSTEM DESCRIPTION

The throttle body assembly contains 2 throttle position (TP) sensors. The TP sensors are mounted to the throttle body assembly and are not serviceable. The TP sensors provide a signal voltage that changes relative to throttle blade angle. The engine control module (ECM) supplies the TP sensors with a common 5-volt reference circuit, a common low reference circuit, and 2 independent signal circuits.

The TP sensors have opposite functionality. TP sensor 1 signal voltage decreases and TP sensor 2 signal voltage increases as the accelerator pedal increases to wide open throttle (WOT).

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 400-7,000 RPM.
- The engine coolant temperature (ECT) is between 69-127°C (156-260°F).
- The intake air temperature (IAT) is between -20 to +125°C (-4 to +257°F).
- The DTC runs continuously when the above conditions are met.

P0122, P0123, P0222, P0223

- DTC P06A3 is not set.
- The ignition is ON, or the engine is running.
- The engine is not operating in reduced power mode.
- The ignition voltage is greater than 6 V.
- The DTCs runs continuously when the above condition are met.

P2135

- DTCs P0121, P0122, P0123, P0222, P0223, or P06A3 are not set.
- The ignition is ON, or the engine is running.
- The engine is not operating in reduced power mode.
- The ignition voltage is greater than 6 V.
- The DTCs runs continuously when the above conditions are met.

CONDITIONS FOR SETTING THE DTC

P0121

The ECM detects that the TP sensor 1 voltage is stuck in range for less than 1 s.

P0122

The ECM detects that the TP sensor 1 voltage is less than 0.3 V for less than 1 s.

P0123

The ECM detects that the TP sensor 1 voltage is greater than 4.8 V for less than 1 s.

P0222

The ECM detects that the TP sensor 2 voltage is less than 0.3 V for less than 1 s.

P0223

The ECM detects that the TP sensor 2 voltage is greater than 4.6 V for less than 1 s.

P2135

The ECM detects that TP sensor 1 and TP sensor 2 disagree greater than 7-10 percent for less than 1 s.

ACTION TAKEN WHEN THE DTC SETS

P0121

- DTC P0121 is a type B DTC
- The ECM commands the throttle actuator control (TAC) system to operate in a Reduced Engine Power mode.

P0122, P0123, P0222, P0223, or P2135

- DTC P0122, P0123, P0222, P0223, and P2135 are type A DTCs
- The ECM commands the throttle actuator control (TAC) system to operate in a Reduced Engine Power

mode.

CONDITIONS FOR CLEARING THE DTC

- DTC P0121 is a type B DTC.
- DTCs P0122, P0123, P0222, P0223 and P2135 is a type A DTC.

DIAGNOSTIC AIDS

A high resistance condition on the throttle position and throttle actuator control circuits could cause a DTC to set.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Throttle Actuator Control (TAC) System Description

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. Ignition ON, observe the DTC information with a scan tool. Verify DTC P06A3 is not set.
 - If the DTC is set, refer to **DTC P0641, P0651, P0697, or P06A3 (ECM)** .
2. Ignition ON, observe both TP Sensor voltage parameters with a scan tool. Verify the scan tool TP sensor

parameters are between 1.0-4.0 V.

3. Observe the scan tool TP Sensor 1 and 2 Agree/Disagree parameter while performing the following tests:
 - Rapidly depress the accelerator pedal from the rest position to the wide open throttle position (WOT) and release pedal. Repeat the procedure several times.
 - Slowly depress the accelerator pedal to WOT and then slowly return the pedal to closed throttle. Repeat the procedure several times.

The TP Sensor 1 and 2 Agree/Disagree parameter should display Agree.

4. Observe the DTC Information with a scan tool. DTCs P0121, P0122, P0123, P0222, P0223, and P2135 should not set.
5. Observe both TP Sensor percentage parameters while quickly pressing the accelerator pedal from a closed throttle to WOT. Both TP Sensor percentage parameters should change.
6. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the harness connector at the Q38 throttle body assembly.
2. Ignition OFF and all vehicle systems OFF. It may take up to 2 minutes for all vehicle systems to power down. Test for less than 5 ohms between the low reference circuit terminal C and ground.
 - If greater than the specified range, test the low reference circuit for a short to voltage, or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
3. Ignition ON, test for 4.8-5.2 V between the 5-volt reference circuit terminal E and ground.
 - If less than the specified range, test the 5-volt reference circuit for a short to ground or open/high resistance. If the circuit tests normal, replace the K20 ECM.
 - If greater than the specified range, test the 5-volt reference circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.
4. Test for less than 1 V between the TP sensor 1 signal circuit terminal D and ground.
 - If greater than specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.
5. Test for 4.8-5.2 V between the TP sensor 2 signal circuit terminal F and ground.
 - If less than specified range, test the signal circuit for a short to ground, or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
 - If greater than specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.
6. Install a 3 A fused jumper wire between TP sensor 1 signal circuit terminal D and the 5-volt reference circuit terminal E. Verify the scan tool TP sensor 1 voltage parameter is greater than 4.8 V.
 - If less than the specified range, test the signal circuit for a short to ground, or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
7. If all circuits test normal, test or replace the Q38 throttle body assembly.

REPAIR PROCEDURES

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

- **Throttle Body Assembly Replacement (LF1)**
- **Control Module References** for ECM replacement, setup, and programming

DTC P0128 (W/LF1)

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

CIRCUIT DESCRIPTION

The engine control module (ECM) monitors the temperature of the engine coolant for engine control and as an enabling criteria for some diagnostics. The amount of air flow into an engine is proportional to the amount of heat an engine generates. The ECM monitors the amount of air flow into the engine to calculate engine coolant temperature (ECT). The ECM uses the calculated temperature to determine if the engine has warmed up to the closed loop temperature or to the thermostat regulating temperature. If the coolant temperature does not increase normally or does not reach the closed loop temperature, diagnostics that use the ECT as enabling criteria, may not run when expected.

CONDITIONS FOR RUNNING THE DTC

- Before the ECM can report DTC P0128 failed, DTC P0117 and P0118 must run and pass.
- DTCs P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0114, P0116, P0117, P0118, P0121, P0122, P0123, P0502, or P0503 is not set.
- The Engine has not run for greater than 30 minutes.
- The Engine run time from a cold start is greater than 2 minutes.
- The ECT is colder than 50°C (122°F) at start up.
- The vehicle speed is greater than 8 km/h (5 mph) for more than 2.4 km/h (1.5 miles).
- The Ethanol content of the fuel is less than 87 percent.
- DTC P0128 runs continuously once the above conditions have been met for approximately 15 min.

OR

- DTCs P0116, P0117, or P0118 is not set.
- The block heater is not detected.
- DTC P0128 runs continuously once the above conditions have been met for approximately 8 min.

CONDITIONS FOR SETTING THE DTC

- The ECM detects that the actual engine coolant temperature is 11°C (20°F) colder than the calculated thermostat regulating temperature of 89°C (192°F), for greater than 4 s or for a cumulative of 30 s.

OR

- The ECM detects that the actual engine coolant temperature is 10°C (18°F) colder than the calculated ECT for greater than 1 s or a cumulative of 10 s.

ACTION TAKEN WHEN THE DTC SETS

DTC P0128 is a Type B DTC.

CONDITIONS FOR CLEARING THE MIL/DTC

DTC P0128 is a Type B DTC.

DIAGNOSTIC AIDS

An engine that soaks for about 8 h will help diagnosis the condition. After the cold soak, operate the vehicle at highway speeds for 20 min while monitoring the scan tool Calculated ECT - Thermostat parameter. If there is a condition, the calculated temperature will be 10°C (18°F) warmer than the actual engine coolant temperature.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End 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. Verify that the engine coolant level is correct.
 - If the engine coolant is not at the correct level, refer to **Loss of Coolant**.
2. Verify that the engine coolant temperature is at the normal operating temperature.
 - If the engine coolant temperature is colder than the normal operating temperature, refer to **Thermostat Diagnosis**.
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the harness connector at the B34 ECT sensor.

CAUTION: Do NOT use a test lamp to test the continuity of the circuit. Damage to the control module may occur due to excessive current draw.

NOTE: The control module or the sensor may be damaged if the circuit is shorted to battery positive voltage.

2. Test for less than 5 ohms between the low reference circuit terminal 2 and ground.
 - If greater than specified value, test the circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
3. Ignition ON, observe the scan tool the ECT sensor parameter. Verify that the ECT sensor parameter is at -40°C (-40°F).
 - If warmer than the specified value, test the signal circuit for a short to ground. If the circuit/connections test normal, replace the K20 ECM.

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

4. Install a 3 A fused jumper wire between the signal circuit terminal 1 and the low reference circuit terminal 2. Verify the scan tool ECT sensor parameter is warmer than 142°C (288°F).
 - If colder than the specified value, test the signal circuit for an open/high resistance or for a short to voltage. If the circuit/connections test normal, replace the K20 ECM.
5. If all circuits test normal, test or replace the B34 ECT sensor.

COMPONENT TESTING

1. Ignition OFF, disconnect the harness connector at the B34 ECT sensor.

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

2. Test the ECT sensor by varying the sensor temperature while monitoring the sensor resistance. Compare the readings with the **Temperature Versus Resistance - Engine Coolant Temperature Sensor** table and verify that the resistance is within 5 % of the specification.
 - If not within the specified range, replace the B34 ECT sensor.

REPAIR PROCEDURES

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

- **Engine Coolant Temperature Sensor Replacement (LF1)**
- **Control Module References** for ECM replacement, setup, and programming

DTC P0131, P0132, P0137, P0138, P0151, P0152, P0157, P0158, P2A00, P2A01, P2A03, OR P2A04 (LF1)

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

DTC P2A00

HO2S Circuit Closed Loop Performance Bank 1 Sensor 1

DTC P2A03

HO2S Circuit Closed Loop Performance Bank 2 Sensor 1

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	High Resistance	Open	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	P0132, P0134, P0138, P0140, P0152, P0154, P0158, P0160	P0133, P013A, P013B, P013C, P013D, P013E, P013F, P014A, P014B, P0153, P1133, P1153, P2A00, P2A03
HO2S Low Signal	P0131, P0137, P0151, P0157	P0132, P0134, P0138, P0140, P0152, P0154, P0158, P0160	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, P1133, P1153, P2A00, P2A03
	P0030,	P0030, P0036, P0050,	P0030, P0036, P0050,		

HO2S Heater Voltage Supply	P0036, P0050, P0056, P0132, P0135, P0138, P0141, P0152, P0155, P0158, P0161, *	P0056, P0132, P0134, P0135, P0138, P0140, P0141, P0152, P0154, P0155, P0158, P0160, P0161	P0056, P0132, P0134, P0135, P0138, P0140, P0141, P0152, P0154, P0155, P0158, P0160, P0161	P0690	P0135, P0141, P0155, P0161
HO2S Heater Control	P0030, P0036, P0050, P0053, P0054, P0056, P0059, P0060, P0135, P0141, P0155, P0161	P0030, P0036, P0050, P0132, P0134, P0135, P0138, P0140, P0141, P0152, P0154, P0155, P0158, P0160, P0161	P0030, P0036, P0050, P0056, P0132, P0134, P0135, P0138, P0140, P0141, P0152, P0154, P0155, P0158, P0160, P0161	P0030, P0036, P0050, P0056, P0132, P0134, P0135, P0138, P0140, P0141, P0152, P0154, P0155, P0158, P0160, P0161	P0135, P0141, P0155, P0161
* Opens Fuse					

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 1.27 V	Approximately 1.27 V
HO2S Low Signal	0.00 V	Approximately 1.27 V	Approximately 1.27 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 0-1,275 mV. Once sufficient HO2S voltage fluctuation is observed by the control module, Closed Loop is entered. The control module uses the HO2S voltage to determine the air-to-fuel ratio. An HO2S voltage that increases toward 1,000 mV indicates a rich fuel mixture. An HO2S voltage that decreases toward 0 mV indicates a lean fuel mixture.

The heating elements inside each HO2S heat the sensor to bring the sensor up to operating conditions faster. This allows the system to enter Closed Loop earlier and the control module to calculate the air-to-fuel ratio sooner.

CONDITIONS FOR RUNNING THE DTC

P0131, P0137, P0151, or P0157

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0128, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0220, P0222, P0223, P0442, P0443, P0446, P0449, P0455, P0496, P1516, P2101, P2119, P2135, P2176 are not set.
- The engine is operating in Closed Loop.
- The Ignition 1 voltage is between 10-32 V.
- The fuel level is greater than 10 %.
- The throttle position (TP) is between 3-70 %.
- The DTCs run continuously when the above conditions are met for 2 s.

P0132, P0138, P0152, or P0158

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0128, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0220, P0222, P0223, P0442, P0443, P0446, P0449, P0455, P0496, P1516, P2101, P2119, P2135, P2176 are not set.
- The engine is operating in Closed Loop.
- The Ignition 1 voltage is between 10-32 V.
- The fuel level is greater than 10 %.
- The throttle position (TP) is between 0-70 %.
- The DTCs run continuously when the above conditions are met for 3 s.

P2A00 or P2A03

- DTCs P0030, P0036, P0053, P0054, P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0128, P0131, P0132, P0133, P0134, P0135, P0137, P0138, P0140, P0141, P0171, P0172, P0174, P0175, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0220, P0222, P0223, P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307, P0308, P0442, P0443, P0446, P0449, P0455, P0496, P1133, P1516, P2101, P2119, P2135, P2176 are not set.
- The engine is running.

- The system voltage is between 10-32 V.
- The ECT Sensor parameter is more than 0°C (32°F).
- DTCs P2A00 and P2A03 run continuously when the above conditions are met.

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.

P2A00 or P2A03

- The ECM detects that the Fuel Control Loop Status parameter is open.
- DTCs P2A00 and P2A03 set within 30 s when the above condition is met.

ACTION TAKEN WHEN THE DTC SETS

DTCs P0131, P0132, P0137, P0138, P0151, P0152, P0158, P2A00 and P2A03 are Type B DTCs.

CONDITIONS FOR CLEARING THE MIL/DTC

DTCs P0131, P0132, P0137, P0138, P0151, P0152, P0158, P2A00 and P2A03 are Type B DTCs.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Heated Oxygen Sensor Wiring 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, observe the DTC information with a scan tool. Verify no B52 HO2S heater DTCs are set.
 - If a B52 HO2S heater DTC is set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. Engine running, observe the appropriate scan tool B52 HO2S voltage parameter. The reading should be within the range of 50-1,050 mV.
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the appropriate B52 HO2S harness connector.
2. Ignition ON, observe the appropriate scan tool HO2S voltage parameter. The parameter should display 1.27 V.
 - If less than the specified range, test the high and low signal circuits for a short to ground. If both signal circuit test normal, replace the K20 ECM.
3. Ignition ON, test for 2.5-3.0 V between the high signal circuit terminal B and ground.
 - If less than the specified range, test the high signal circuit for an open/high resistance. If the circuit tests normal, replace the K20 ECM.
 - If greater than the specified range, test the high signal circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.
4. Ignition OFF, connect a 3 A fused jumper wire between the high signal circuit terminal B and the low signal circuit terminal A.

NOTE: **The low signal circuit is tied to a pull-up circuit within the ECM. A voltage of 0.90-1.10 V on the low signal circuit is normal.**

5. Ignition ON, verify the scan tool HO2S parameter displays 0.0 V.
 - If greater than the specified range, test the low signal circuit for an open/high resistance or for a short to voltage. If the circuit tests normal, replace the K20 ECM.
6. If all circuits test normal, test or replace the appropriate B52 HO2S.

REPAIR PROCEDURES

CAUTION: Refer to Heated Oxygen Sensor Resistance Learn Reset Caution .

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

- **Heated Oxygen Sensor Replacement - Bank 1 Sensor 1 (LF1)**
- **Heated Oxygen Sensor Replacement - Bank 1 Sensor 2 (LF1)**
- **Heated Oxygen Sensor Replacement - Bank 2 Sensor 1 (LF1)**
- **Heated Oxygen Sensor Replacement - Bank 2 Sensor 2**
- **Control Module References** for ECM replacement, setup, and programming

DTC P0133, P013A-P013F, P014A, P014B, P0153, P1133, OR P1153 (LF1)

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 P1133

HO2S Insufficient Switching Bank 1 Sensor 1

DTC P1153

HO2S Insufficient Switching Bank 2 Sensor 1

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	High Resistance	Open	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	P0132, P0134, P0138, P0140, P0152, P0154, P0158, P0160	P0133, P013A, P013B, P013C, P013D, P013E, P013F, P014A, P014B, P0153, P1133, P1153, P2A00, P2A03
HO2S Low Signal	P0131, P0137, P0151, P0157	P0132, P0134, P0138, P0140, P0152, P0154, P0158, P0160	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, P1133, P1153, P2A00, P2A03
	P0030,	P0030, P0036, P0050,	P0030, P0036, P0050,		

HO2S Heater Voltage Supply	P0036, P0050, P0056, P0132, P0135, P0138, P0141, P0152, P0155, P0158, P0161, *	P0056, P0132, P0134, P0135, P0138, P0140, P0141, P0152, P0154, P0155, P0158, P0160, P0161	P0056, P0132, P0134, P0135, P0138, P0140, P0141, P0152, P0154, P0155, P0158, P0160, P0161	P0690	P0135, P0141, P0155, P0161
HO2S Heater Control	P0030, P0036, P0050, P0053, P0054, P0056, P0059, P0060, P0135, P0141, P0155, P0161	P0030, P0036, P0050, P0132, P0134, P0135, P0138, P0140, P0141, P0152, P0154, P0155, P0158, P0160, P0161	P0030, P0036, P0050, P0056, P0132, P0134, P0135, P0138, P0140, P0141, P0152, P0154, P0155, P0158, P0160, P0161	P0030, P0036, P0050, P0056, P0132, P0134, P0135, P0138, P0140, P0141, P0152, P0154, P0155, P0158, P0160, P0161	P0135, P0141, P0155, P0161
* Opens Fuse					

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 0-1,275 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, P0153, P1133, or P1153

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0128, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0220, P0222, P0223, P0442, P0443, P0446, P0449, P0455, P0496, P1516, P2101, P2119, P2135, P2176 are not set.
- The engine coolant temperature (ECT) is greater than 71°C (159°F).
- The intake air temperature (IAT) is warmer than -40°C (-40°F)
- The ignition 1 voltage is between 10-32 V.
- The fuel level is greater than 10 %.
- The engine run time is greater than 60 s.
- The engine speed is between 1,000-3,000 RPM.
- The barometric (BARO) pressure is greater than 70 kPa.
- The mass airflow (MAF) is between 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.

P013A P013C, P013E, or P014A

- Before the ECM can report DTC P013A, or P013C failed, DTCs P013E, P014A, P2270, and P2272 must run and pass.
- Before the ECM can report DTC P013E, or P014A failed, DTCs P2270 and P2272 must run and pass.
- DTCs P0030, P0036, P0053, P0054, P0101, P0102, P0103, P0106, P0107, P0108, P0120, P0121, P0122, P0123, P0131, P0132, P0133, P0134, P0135, P0137, P0138, P013A, P013B, P013E, P013F, P0140, P0141, P0171, P0172, P0201, P0202, P0203, P0204, P0220, P0222, P0223, P0300, P0442, P0443, P0446, P0449, P0455, P0496, P1133, P1174, P1516, P2101, P2119, P2135, P2176, P2270, P2271, P2A00 are not set.
- The ignition 1 voltage is between 10-32 V.
- The learned heater resistance is valid.
- The fuel level is greater than 10 %.
- The engine run time is equal to or greater than 5 min.
- The accelerator pedal (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 P0030, P0036, P0053, P0054, P0101, P0102, P0103, P0106, P0107, P0108, P0120, P0121, P0122, P0123, P0131, P0132, P0133, P0134, P0135, P0137, P0138, P013A, P013B, P013E, P013F, P0140, P0141, P0171, P0172, P0201, P0202, P0203, P0204, P0220, P0222, P0223, P0300, P0442, P0443, P0446, P0449, P0455, P0496, P1133, P1174, P1516, P2101, P2119, P2135, P2176, P2270, P2271, P2A00 are not set.
- The ignition 1 voltage is between 10-32 V.
- The learned heater resistance is valid.
- The fuel level is greater than 10 %.
- The engine run time is equal to or greater than 5 min.
- The DTCs run once per ignition cycle when the above conditions are met.

CONDITIONS FOR SETTING THE DTC

P0133 or P0153

- 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 O2 sensor voltage has not decreased below 450 mV within 42 grams of accumulated air flow.

P013F or P014B

The ECM detects that the O2 sensor voltage has not increased above 350 mV within 200 grams of accumulated air flow.

P1133 or P1153

- The ECM detects that the HO2S 1 rich-to-lean counts, or the lean-to-rich counts are less than a calibrated value.
- The DTCs set within 60 s when the above condition is met.

ACTION TAKEN WHEN THE DTC SETS

DTCs P0133, P013A, P013B, P013C, P013D, P013E, P013F, P014A, P014B, P0153, P1133, and P1153 are Type B DTCs.

CONDITIONS FOR CLEARING THE DTC

DTCs P0133, P013A, P013B, P013C, P013D, P013E, P013F, P014A, P014B, P0153, P1133, and P1153 are Type B DTCs.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**
- **Heated Oxygen Sensor 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, observe the DTC information with a scan tool. Verify no B52 HO2S heater DTCs are set.
 - If a B52 HO2S heater DTC is set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. Engine running, observe the appropriate scan tool B52 HO2S voltage parameter. The reading should be within the range of 50-1,050 mV.
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Verify none of the following conditions exist:
 - Lean or rich fuel injectors-Refer to **Fuel Injector Solenoid Coil Test** .
 - 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 near the B52 HO2S
 - Engine vacuum leaks
 - Engine oil consumption-Refer to **Oil Consumption Diagnosis** .
 - Engine coolant consumption-Refer to **Loss of Coolant** .
 - If you find any of the above conditions, repair as necessary.
2. If all conditions test normal, test or replace the appropriate B52 HO2S.

REPAIR PROCEDURES

CAUTION: Refer to **Heated Oxygen Sensor Resistance Learn Reset Caution** .

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

- **Heated Oxygen Sensor Replacement - Bank 1 Sensor 1 (LF1)**
- **Heated Oxygen Sensor Replacement - Bank 1 Sensor 2 (LF1)**
- **Heated Oxygen Sensor Replacement - Bank 2 Sensor 1 (LF1)**
- **Heated Oxygen Sensor Replacement - Bank 2 Sensor 2**
- **Control Module References** for ECM replacement, setup, and programming

DTC P0134, P0140, P0154, OR P0160 (LF1)

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 P0134

HO2S Circuit Insufficient Activity Bank 1 Sensor 1

DTC P0140

HO2S Circuit Insufficient Activity Bank 1 Sensor 2

DTC P0154

HO2S Circuit Insufficient Activity Bank 2 Sensor 1

DTC P0160

HO2S Circuit Insufficient Activity 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, P0134, P0138, P0140, P0152, P0154, P0158, P0160	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, P1133, P1153, P2A00, P2A03
HO2S Low Signal	P0131, P0137, P0151, P0157	P0132, P0134, P0138, P0140, P0152, P0154, P0158, P0160	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, P1133, P1153, P2A00, P2A03
HO2S Heater Voltage Supply	P0030, P0036, P0050, P0056, P0132, P0134, P0135, P0138, P0141, P0152, P0155, P0158, P0161, *	P0030, P0036, P0050, P0056, P0132, P0134, P0135, P0138, P0140, P0141, P0152, P0154, P0155, P0158, P0160,	P0030, P0036, P0050, P0056, P0132, P0134, P0135, P0138, P0140, P0141, P0152, P0154, P0155, P0158, P0160,	P0690	P0135, P0141, P0155, P0161

		P0161	P0161		
HO2S Heater Control	P0030, P0036, P0050, P0053, P0054, P0056, P0059, P0060, P0135, P0141, P0155, P0161	P0030, P0036, P0050, P0056, P0132, P0134, P0135, P0138, P0140, P0141, P0152, P0154, P0155, P0158, P0160, P0161	P0030, P0036, P0050, P0056, P0132, P0134, P0135, P0138, P0140, P0141, P0152, P0154, P0155, P0158, P0160, P0161	P0030, P0036, P0050, P0056, P0132, P0134, P0135, P0138, P0140, P0141, P0152, P0154, P0155, P0158, P0160, P0161	P0135, P0141, P0155, P0161

* Opens Fuse

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 mV	Approximately 1.27 V	Approximately 1.27 V
HO2S Low Signal	0.00 mV	Approximately 1.27 V	Approximately 1.27 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 0-1,275 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

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0128, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0220, P0222, P0223, P0442, P0443, P0446, P0449, P0455, P0496, P1516, P2101, P2119, P2135, P2176 are not set.
- The ignition 1 voltage is between 10-32 V.
- The engine run time is greater than 150 s.
- The fuel system is in Closed Loop.
- The DTCs run continuously when the above conditions are met.

CONDITIONS FOR SETTING THE DTC

P0134 or P0154

- The ECM detects that the HO2S 1 voltage is between 350-550 mV.
- The HO2S heater warm-up cycle is complete.
- The DTCs set within 15 s when the above conditions are met.

P0140 or P0160

- The ECM detects that the HO2S 2 voltage is not varying.
- The HO2S heater warm-up cycle is complete.
- The DTCs set within 15 s when the above conditions are met.

ACTION TAKEN WHEN THE DTC SETS

DTCs P0134, P0140, P0154, and P0160 are Type B DTCs.

CONDITIONS FOR CLEARING THE DTC

DTCs P0134, P0140, P0154, and P0160 are Type B DTCs.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

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

- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**
- **Heated Oxygen Sensor 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, observe the DTC information with a scan tool. Verify no B52 HO2S heater DTCs are set.
 - If a B52 HO2S heater DTC is set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. Engine running, observe the appropriate scan tool B52 HO2S voltage parameter. The reading should be within the range of 50-1,050 mV.
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

NOTE: **All modules must be powered down or misdiagnosis may result.**

1. Ignition OFF, disconnect the appropriate B52 HO2S harness connector.
2. Ignition ON, observe the appropriate scan tool HO2S voltage parameter. The parameter should display 1.27 V.
 - If less than the specified range, test the high and low signal circuits for a short to ground. If both signal circuits test normal, replace the K20 ECM.
3. Ignition ON, test for 2.5-3.0 V between the high signal circuit terminal B and ground.
 - If less than the specified range, test the high signal circuit for an open/high resistance. If the circuit tests normal, replace the K20 ECM.
 - If greater than the specified range, test the high signal circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.
4. Ignition OFF, connect a 3 A fused jumper wire between the high signal circuit terminal B and the low signal circuit terminal A.

NOTE: **The low signal circuit is tied to a pull-up circuit within the ECM. A voltage of 0.90-1.10 V on the low signal circuit is normal.**

5. Ignition ON, verify the scan tool HO2S parameter displays 0.0 V.

- If greater than the specified value, test the low signal circuit for an open/high resistance or for a short to voltage. If the circuit tests normal, replace the K20 ECM.
6. Verify none of the following conditions exist:
- 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 near the HO2S
 - Engine vacuum leaks
- If any of the above conditions exist, repair as necessary. If all circuits test normal, test or replace the appropriate B52 HO2S.

REPAIR PROCEDURES

CAUTION: Refer to **Heated Oxygen Sensor Resistance Learn Reset Caution** .

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

- **Heated Oxygen Sensor Replacement - Bank 1 Sensor 1 (LF1)**
- **Heated Oxygen Sensor Replacement - Bank 1 Sensor 2 (LF1)**
- **Heated Oxygen Sensor Replacement - Bank 2 Sensor 1 (LF1)**
- **Heated Oxygen Sensor Replacement - Bank 2 Sensor 2**
- **Control Module References** for ECM replacement, setup, and programming

DTC P0171, P0172, P0174, OR P0175 (LF1, LFW)

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 the air/fuel metering system in order to provide the best possible combination of driveability, fuel economy, and emission control. Fuel delivery is controlled differently during Open Loop and Closed Loop (CL). During Open Loop, the ECM determines fuel delivery based on sensor signals without heated oxygen sensor (HO2S) input. During CL, the ECM adds HO2S inputs and level of purge to calculate the short and long term fuel trim (FT) adjustments. If the HO2S indicates a lean condition, the fuel trim values will be above 0 %. If the HO2S indicates a rich condition, the FT values will be below 0 %. The short term FT values change rapidly in response to the HO2S voltage signals. The long term FT makes coarse adjustments in order to maintain an optimum air/fuel ratio. A block of cells contain information arranged in combinations of engine RPM and engine load for a full range of vehicle operating conditions. The long term FT diagnostic is based on an average of cells currently being used. The ECM selects the cells based on the engine speed and load. The FT diagnostic will conduct a test to determine if a rich failure actually exists or if excessive vapor from the evaporative emission (EVAP) canister is causing a rich condition.

If the ECM detects an excessively lean condition, DTC P0171 or P0174 sets. If the ECM detects an excessively rich condition, DTC P0172 or P0175 sets.

CONDITIONS FOR RUNNING THE DTC

- DTCs P0101, P0102, P0103, P0106, P0107, P0108, P0178, P0179, P0201-P0208, P0300, P0301-P0304, P0401, P0403-P0406, P0411, P042E, P0442, P0443, P0446, P0449, P0452, P0453, P0455, P0496, P0506, P0507, P2227-P2230, P2269, P2440, P2444 are not set.
- The engine is in Closed Loop status.
- The engine coolant temperature (ECT) is between -38 and +150°C (-36 and +302°F).
- The intake air temperature (IAT) is between -38 and +150°C (-36 and +302°F).
- The manifold absolute pressure (MAP) is between 5-255 kPa (1.45-37 psi).
- The vehicle speed is less than 134 km/h (83 mph).
- The engine speed is between 400-6,600 RPM.
- The mass air flow (MAF) is between 0.5-510 g/s.
- The barometric pressure (BARO) is more than 70 kPa (10.2 psi).
- The fuel level is more than 10 %.
- This diagnostic runs continuously when the above conditions have been met.

CONDITIONS FOR SETTING THE DTC

- The average long term FT weighted average value is more 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

The ECM records the operating conditions at the time the diagnostic fails. The first time the diagnostic fails, the ECM stores this information in the Failure Records. If the diagnostic reports a failure on the second ignition cycle the ECM records the operating conditions at the time of the failure. The ECM writes the operating conditions to the Freeze Frame and updates the Failure Records. The ECM illuminates the malfunction indicator lamp (MIL) when it detects the same fuel trim failure during 2 consecutive trips.

CONDITIONS FOR CLEARING THE MIL/DTC

- The ECM turns OFF the malfunction indicator lamp (MIL) at the beginning of the fourth ignition cycle, after 3 ignition cycles that the diagnostic runs and does not fail.
- A current DTC, Last Test Failed, clears when the diagnostic runs and passes.
- A history DTC and related Freeze Frame data clears after 40 warm-up cycles, if no failures are reported by this or any other emission related diagnostic.
- Clear the MIL and the DTC with a scan tool.

REFERENCE INFORMATION

Electrical Information Reference

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

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. Disregard any transmission symptoms, antilock brake system (ABS) indicators, and traction control system (TCS) indicators until any fuel trim faults are repaired. A fuel trim fault may cause default actions such as harsh shifts and illumination of the ABS/TCS indicators.
2. E85 compatible engine only-Over estimation of the ethanol content will result in a rich shift of fuel trim values, and under-estimation will result in a lean shift of fuel trim values. A fuel trim DTC may set if the learned alcohol content, Fuel Alcohol Content parameter on the scan tool, is different than the measured alcohol content in the vehicle such that fuel trim values exceed failure threshold values.
3. Verify that other DTCs are not set.
 - If any DTCs are set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle**.
4. 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.

NOTE: EVAP purge enablement may cause the FT to be momentarily outside the normal range.

5. The normal Short Term FT parameter should be between +10 % and -10 % with near 0 % the optimum, with the engine running at operating temperature.
6. The Long Term FT parameter should be between +10 % and -10 %, with near 0 % the optimum, with the engine running at operating temperature.
7. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

P0171 or P0174

Allow the engine to reach operating temperature. With the engine running, observe the affected Long Term FT parameter with a scan tool. The value should be less than approximately 20 % with the engine running at operating temperature.

- If the value is not less than 20 %, inspect for the following:
 - With the ignition ON and the engine OFF, observe the manifold absolute pressure (MAP) sensor parameter. The MAP sensor pressure should be within the range specified for your altitude. Refer to **Altitude Versus Barometric Pressure**.
 - Refer to **DTC P0106 (LF1)** if the MAP sensor does not indicate the correct barometric pressure.
 - With the engine idling, observe the mass air flow (MAF) sensor parameter. The MAF sensor parameter should be within 2-6 g/s at idle.
 - Refer to **DTC P0101** or **DTC P0102 or P0103** if the MAF sensor parameter is not within 2-6 g/s at idle.
- Vacuum hoses for splits, kinks, and improper connections
- Insufficient fuel in the tank
- Low fuel pressure-Refer to **Fuel System Diagnosis**.
- Fuel contamination-Refer to **Alcohol/Contaminants-in-Fuel Diagnosis** for gasoline or **Fuel Composition Diagnosis** for E85.
- Malfunctioning fuel injectors-Refer to **Fuel Injector Solenoid Coil Test**.
- Missing, loose, or leaking exhaust components from the HO2S forward-Refer to **Symptoms - Engine Exhaust**.
- Vacuum leaks at the intake manifold, the throttle body, and the injector O-rings
- The air induction system and the air intake ducts for leaks or for a missing air filter element
- A cracked EVAP canister

- Evaporative pipes obstructed or leaking
- The crankcase ventilation system for leaks
- The HO2S for improper installation and for electrical wires or connectors that may have contacted the exhaust system
- The HO2S signal circuit open, shorted to ground, or shorted to the low reference circuit
- Malfunctioning engine components-Refer to **Symptoms - Engine Mechanical** .

P0172 or P0175

Allow the engine to reach operating temperature. With the engine running, observe the affected Long Term FT parameter with a scan tool. The value should be more than approximately -20 % with the engine running at operating temperature.

- If the value is not more than -20 %, inspect for the following:
 - With the engine idling and the transmission in the Park or Neutral position, observe the manifold absolute pressure (MAP) sensor parameter. The MAP sensor parameter should be between 19-42 kPa.
 - Refer to **DTC P0106 (LF1)** if the MAP sensor parameter is not between 19-42 kPa.
 - With the engine idling, observe the mass air flow (MAF) sensor parameter. The MAF sensor parameter should be within 2-6 g/s at idle.
 - Refer to **DTC P0101** or **DTC P0102 or P0103** if the MAF sensor parameter is not within 2-6 g/s at idle.
 - Vacuum hoses for splits, kinks, and improper connections
 - The air intake duct for being collapsed or restricted
 - The air filter for being dirty or restricted
 - Objects blocking the throttle body
 - Excessive fuel in the crankcase due to leaking fuel injectors
 - The evaporative emissions control system for improper operation
 - Excessive fuel pressure-Refer to **Fuel System Diagnosis** .
 - Malfunctioning fuel injectors-Refer to **Fuel Injector Solenoid Coil Test** .
 - Fuel contamination-Refer to **Alcohol/Contaminants-in-Fuel Diagnosis** for gasoline or **Fuel Composition Diagnosis** for E85.
 - The HO2S for improper installation and for electrical wires or connectors that may have contacted the exhaust system
 - The HO2S signal circuit shorted to voltage

REPAIR PROCEDURES

- **Air Cleaner Element Replacement (LE5)**
- **Evaporative Emission Canister Replacement**
- **Evaporative Emission Canister Purge Solenoid Valve Replacement (LF1)**
- **Evaporative Emission Canister Vent Solenoid Valve Replacement**

- **Fuel System Cleaning**
- **Fuel Tank Draining**
- **Heated Oxygen Sensor Replacement - Bank 1 Sensor 1 (LF1)** , **Heated Oxygen Sensor Replacement - Bank 1 Sensor 2 (LF1)** , **Heated Oxygen Sensor Replacement - Bank 2 Sensor 1 (LF1)** , and **Heated Oxygen Sensor Replacement - Bank 2 Sensor 2**
- **Mass Airflow Sensor with Intake Air Temperature Sensor Replacement**
- **Throttle Body Assembly Replacement (LF1)**

REPAIR VERIFICATION

NOTE:

- After repairs, use the scan tool Fuel Trim Reset function in order to reset the Long Term Fuel Trim.
- To verify the performance of the catalytic converter has not been affected by the condition that set this DTC, perform the Repair Verification for DTC P0420 or P0430. Refer to **DTC P0420 or P0430** .

1. Install any components or connectors that have been removed or replaced during diagnosis.
2. Perform any adjustment, programming, or setup procedures that are required when a component or module is removed or replaced.
3. Turn ON the ignition, with the engine OFF.

NOTE: **DO NOT clear codes with the engine running. The codes may reset in the same ignition cycle.**

4. Clear the DTCs.
5. Turn OFF the ignition for 60 s.
6. Start the engine.
7. Duplicate the Conditions for Running the DTC and use the Freeze Frame/Failure Records, if applicable, in order to verify the DTC does not reset. If the DTC resets, or another DTC is present, refer to the **Diagnostic Trouble Code (DTC) List - Vehicle** and perform the appropriate diagnostic procedure.

DTC P018B-P018D

DIAGNOSTIC INSTRUCTIONS

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

DTC DESCRIPTORS

DTC P018B

Fuel Pressure Sensor Performance

DTC P018C

Fuel Pressure Sensor Circuit Low Voltage

DTC P018D

Fuel Pressure Sensor Circuit High Voltage

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P0641	P0641, P06A6	P0641	P06A6
Signal	P018C	P018B, P018C	P018D	P018B
Low Reference	-	P0641, P06A6	-	P06A6

CIRCUIT/SYSTEM DESCRIPTION

The fuel pressure sensor is located on the fuel line. The fuel pressure sensor monitors the fuel pressure in the fuel line. The fuel pump control module monitors the voltage signal from the fuel pressure sensor.

CONDITIONS FOR RUNNING THE DTC

- The engine is running.
- DTC P018C, P018D, P0231, P0232, P023F, P064A, P1255 or P06A6 are not active.
- DTC P0641 has not failed this ignition cycle.
- Fuel pump control is enabled and the fuel pump control state is normal.
- The engine has been running for at least 5 seconds.

CONDITIONS FOR SETTING THE DTC

The fuel pump control module does not detect a change in the fuel rail pressure of at least 30 kPa (4.4 psi) when the fuel pump is operating at its minimum or maximum voltage limits for over 5 seconds.

ACTION TAKEN WHEN THE DTC SETS

DTC P018B, P018C and P018D are Type A DTCs.

CONDITIONS FOR CLEARING THE DTC

DTC P018B, P018C and P018D are Type A DTCs.

DIAGNOSTIC AIDS

Using the Failure Records data may help locate an intermittent condition. If you cannot duplicate the DTC, the information in the Failure Records can help determine how many miles since the DTC set. The Fail Counter and Pass Counter can help determine how many ignition cycles that the diagnostic test reported a pass and/or a fail.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Fuel System Description (LF1)

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM TESTING

NOTE: Verify that the fuel tank is not empty. Only perform this diagnostic if there is at least 2 gallons of fuel in the fuel tank. Clear the DTC, and start and run the engine. Verify that the DTC P0118B resets before proceeding with the circuit system testing. If the DTC does not reset, refer to diagnostic aids.

1. Ignition OFF, disconnect the harness connector at the B47 fuel pressure sensor.
2. Ignition OFF, test for less than 1 ohms between the low reference circuit terminal 2 and ground.
 - If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the K27 fuel pump flow control module.
3. Ignition ON, test for 4.8-5.2 V between the B47 fuel pressure sensor 5 V reference circuit terminal 3 and

ground.

- If less than the specified range, test the 5 V reference circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K27 fuel pump flow control module.
 - If greater than the specified range, test the 5 V reference circuit for a short to voltage. If the circuit tests normal, replace the K27 fuel pump flow control module.
4. Verify the scan tool 5 V reference is less than 1 V.
- If greater than the specified range, test the signal circuit terminal 1 for a short to voltage. If the circuit tests normal, replace the K27 fuel pump flow control module.
5. Install a 3 A fused jumper wire between the signal circuit terminal 1 and the 5 V reference circuit terminal 3. Verify the scan tool 5 V reference is greater than 4.8 V.
- If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K27 fuel pump flow control module.
6. If all circuits test normal, replace the B47 fuel pressure sensor.

REPAIR PROCEDURES

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

Control Module References for fuel pump control module replacement, setup, and programming

DTC P0191

DIAGNOSTIC INSTRUCTIONS

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

DTC DESCRIPTOR

DTC P0191

Fuel Rail Pressure Sensor Performance

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference Voltage	P0192, P0193, P0340, P0345, P0365, P0390, P0506, P0641, P2227	P0192	P0193, P0641, P2227, P2229	P0191
Fuel Rail Pressure Sensor Signal	P0192	P0192, P0193	P0193	P0191

Low Reference	-	P0193	P0193	P0191
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CIRCUIT/SYSTEM DESCRIPTION

The fuel rail fuel pressure sensor detects fuel pressure within the fuel rail. The engine control module (ECM) provides a 5 V reference voltage on the 5 V reference circuit and ground on the low reference circuit. The ECM receives a varying signal voltage on the signal circuit. The ECM monitors the voltage on the fuel rail fuel pressure sensor circuits. When the fuel pressure is high, the signal voltage is high. When the fuel pressure is low, the signal voltage is low.

CONDITIONS FOR RUNNING THE DTC

Condition 1

- The engine speed is greater than 25 RPM for greater than 31 s.
- DTC P0191 runs once an ignition cycle at engine start up when the condition has been met.

Condition 2 and 3

- The engine speed is greater than 25 RPM for greater than 30 s.
- The engine coolant temperature (ECT) at the previous engine shut down was warmer than 72°C (162°F).
- The ECT at engine start is colder than 55°C (131°F).
- At engine start, if the ECT is warmer than the intake air temperature (IAT), then the IAT must be within 35°C (95°F) of the ECT.
- At engine start, if the IAT is warmer than the ECT, then the ECT must be within 10°C (50°F) of the IAT.
- The block heater, if equipped, is not active.
- The engine off time since the previous engine shut down is greater than 4.2 h.
- DTC P0191 runs once an ignition cycle at engine start up when the above conditions have been met.

CONDITIONS FOR SETTING THE DTC

Condition 1

DTC P0087, P2187, or P2188 is set, and the fuel pressure at ignition ON is less than 120 kPa (17.4 psi) for greater than 4 s or for a cumulative of 30 s.

Condition 2

DTC P0088, P2177, or P2187 is set, and the fuel pressure at ignition ON is greater than 1500 kPa (218 psi) for greater than 4 s or for a cumulative of 30 s.

Condition 3

The fuel pressure at ignition ON is greater than 1500 kPa (218 psi) and a fuel pressure increase of greater than 385 kPa (56 psi) occurs during the fuel pump prime. The condition exists for greater than 4 s or for a cumulative

of 30 s.

ACTION TAKEN WHEN THE DTC SETS

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

CONDITIONS FOR CLEARING THE DTC

DTC P0191 is a Type A DTC.

DIAGNOSTIC AIDS

A condition with the fuel tank fuel pump module or the fuel pump control module may set this DTC.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Fuel System Description (LF1)

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. Observe the scan tool DTC information, verify DTC P0627, P0628, P0629, P069E or U0109 is not set.
 - If any of the DTCs are set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle**.
2. Engine idling, observe the scan tool Fuel Rail Pressure Sensor parameter. The pressure should be approximately 1.9-2.1 Mpa (279-305 psi).
3. Engine idling, the scan tool Fuel Rail Pressure Sensor should be close to the scan tool Desired Fuel Rail Pressure. As the engine speed increases, the Desired Fuel Rail Pressure and the Fuel Rail Pressure Sensor should closely match each other.
4. Move related harnesses/connectors of the B47 fuel rail fuel pressure sensor and verify the engine does not stumble, stall, or change engine speed.
 - If the engine stumbles, stalls, or changes engine speed, test or repair the suspected harness or connection.
5. Observe the DTC information with a scan tool, DTC P0191 should not set.
6. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the multi-way harness connector X109 at the rear of the intake manifold.
2. Remove the fuse that supplies B+ to terminal 52-X1 of the K20 ECM.

NOTE: Testing for steps 3 through 7 is performed on the ECM side of the multi-way harness connector.

3. Ignition OFF, test for less than 5 ohms between the low reference circuit terminal 5 and ground.
 - If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the K20 ECM.
4. Install the fuse that supplies B+ to terminal 52-X1 of the K20 ECM.
5. Ignition ON, test for 4.8-5.2 V between the 5 V reference circuit terminal 11 and ground.
 - If less than the specified range, test the 5 V reference circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
 - If greater than the specified range, test the 5 V reference circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.
6. Ignition ON, verify the scan tool Fuel Rail Pressure Sensor voltage parameter is less than 0.02 V.
 - If greater than the specified value, test the signal circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.
7. Connect a 3 A fused jumper wire between the signal circuit terminal 12 and the 5 V reference circuit terminal 11. Verify the scan tool Fuel Rail Pressure Sensor Voltage parameter is greater than 4.96 V.
 - If less than the specified value, test the signal circuit for an open/high resistance or a short to ground. If the circuit tests normal, replace the K20 ECM.
8. Ignition OFF, remove the intake manifold.
9. Connect the multi-way harness connector X109.

NOTE: **Testing for steps 12 through 16 are performed at the fuel rail fuel pressure sensor connector.**

10. Disconnect the B47 fuel rail fuel pressure sensor connector.
11. Remove the fuse that supplies B+ to terminal 52-X1 of the K20 ECM.
12. Ignition OFF, test for less than 5 ohms between the low reference circuit terminal C and ground.
 - If greater than the specified range, test the low reference circuit for an open/high resistance.
13. Install the fuse that supplies B+ to terminal 52-X1 of the K20 ECM.
14. Ignition ON, test for 4.8-5.2 V between the 5 V reference circuit terminal A and ground.
 - If less than the specified range, test the 5 V reference circuit for a short to ground or an open/high resistance.
 - If greater than the specified range, test the 5 V reference circuit for a short to voltage.
15. Ignition ON, verify the scan tool Fuel Rail Pressure Sensor voltage parameter is less than 0.02 V.
 - If greater than the specified value, test the signal circuit for a short to voltage.
16. Connect a 3 A fused jumper wire between the signal circuit terminal B and the 5 V reference circuit terminal A. Verify the scan tool Fuel Rail Pressure Sensor voltage parameter is greater than 4.96 V.
 - If less than the specified value, test the signal circuit for an open/high resistance or a short to ground.
17. If all circuits test normal, replace the B47 fuel rail fuel pressure sensor.

REPAIR PROCEDURES

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

- **Fuel Pressure Sensor Replacement - Fuel Injection Fuel Rail (LF1)**
- **Control Module References** for ECM replacement, setup, and programming

DTC P0192 OR P0193

DIAGNOSTIC INSTRUCTIONS

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

DTC DESCRIPTORS

DTC P0192

Fuel Rail Pressure Sensor Circuit Low Voltage

DTC P0193

Fuel Rail Pressure Sensor Circuit High Voltage

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference Voltage	P0192, P0193, P0340, P0345, P0365, P0390, P0506, P0641, P2227, P2229	P0192	P0193, P0641, P2227, P2229	P0191
Fuel Rail Pressure Sensor Signal	P0192	P0192, P0193	P0193	P0191
Low Reference	-	P0193	P0193	P0191

CIRCUIT/SYSTEM DESCRIPTION

The fuel rail fuel pressure sensor detects fuel pressure within the fuel rail. The engine control module (ECM) provides a 5 V reference voltage on the 5 V reference circuit and ground on the reference ground circuit. The ECM receives a varying signal voltage on the signal circuit. The ECM monitors the voltage on the fuel rail fuel pressure sensor circuits. When the fuel pressure is high, the signal voltage is high. When the fuel pressure is low, the signal voltage is low.

CONDITIONS FOR RUNNING THE DTC

- The engine is running.
- The ignition voltage is between 11-18 V.
- The DTCs run continuously within the enabling conditions.

CONDITIONS FOR SETTING THE DTC

P0192

The ECM detects that the fuel rail fuel pressure sensor signal voltage is low.

P0193

The ECM detects that the fuel rail fuel pressure sensor signal voltage is high.

ACTION TAKEN WHEN THE DTC SETS

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

CONDITIONS FOR CLEARING THE DTC

DTCs P0192 and P0193 are Type A DTCs.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Fuel System Description (LF1)

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, observe the DTC information with a scan tool, DTC P0641 should not be set.
 - If a DTC is set, refer to **DTC P0641, P0651, P0697, or P06A3 (ECM)** .
2. Engine idling, observe the DTC information with a scan tool. DTC P0192 or P0193 should not set.
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the multi-way harness connector X109 at the rear of the intake manifold.
2. Remove the fuse that supplies B+ to terminal 52-X1 of the K20 ECM.

NOTE: **Testing for steps 3 through 7 is performed on the ECM side of the multi-way harness connector.**

3. Ignition OFF, test for less than 5 ohms between the low reference circuit terminal 5 and ground.
 - If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the K20 ECM.
4. Install the fuse that supplies B+ to terminal 52-X1 of the K20 ECM.
5. Ignition ON, test for 4.8-5.2 V between the 5 V reference circuit terminal 11 and ground.
 - If less than the specified range, test the 5 V reference circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
 - If greater than the specified range, test the 5 V reference circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.
6. Ignition ON, verify the scan tool Fuel Rail Pressure Sensor voltage parameter is less than 0.02 V.
 - If greater than the specified value, test the signal circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.
7. Connect a 3 A fused jumper wire between the signal circuit terminal 12 and the 5 V reference circuit terminal 11. Verify the scan tool Fuel Rail Pressure Sensor voltage parameter is greater than 4.96 V.
 - If less than the specified value, test the signal circuit for an open/high resistance or a short to ground. If the circuit tests normal, replace the K20 ECM.
8. Ignition OFF, remove the intake manifold.
9. Connect the multi-way harness connector X109.

NOTE: **Testing for steps 12 through 16 are performed at the fuel rail fuel pressure sensor connector.**

10. Disconnect the B47 fuel rail fuel pressure sensor connector.
11. Remove the fuse that supplies B+ to terminal 52-X1 of the K20 ECM.
12. Ignition OFF, test for less than 5 ohms between the low reference circuit terminal C and ground.
 - If greater than the specified range, test the low reference circuit for an open/high resistance.
13. Install the fuse that supplies B+ to terminal 52-X1 of the K20 ECM.
14. Ignition ON, test for 4.8-5.2 V between the 5 V reference circuit terminal A and ground.
 - If less than the specified range, test the 5 V reference circuit for a short to ground or an open/high resistance.
 - If greater than the specified range, test the 5 V reference circuit for a short to voltage.
15. Ignition ON, verify the scan tool Fuel Rail Pressure Sensor voltage parameter is less than 0.02 V.
 - If greater than the specified value, test the signal circuit for a short to voltage.
16. Connect a 3 A fused jumper wire between the signal circuit terminal B and the 5 V reference circuit terminal A. Verify the scan tool Fuel Rail Pressure Sensor voltage parameter is greater than 4.96 V.
 - If less than the specified value, test the signal circuit for an open/high resistance or a short to ground.
17. If all circuits test normal, replace the B47 fuel rail fuel pressure sensor.

REPAIR PROCEDURES

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

- **Fuel Pressure Sensor Replacement - Fuel Injection Fuel Rail (LF1)**
- **Control Module References** for ECM replacement, setup, and programming

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

				Short from Supply Circuit to Control
	Short to	Open/High	Short to	

Circuit	Ground	Resistance	Voltage	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	P2157	P124B
Direct Fuel Injector High Voltage Control Cylinder 4	P0270	P0204	P0271	P124B
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 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 ECM detects the injector high voltage supply circuit or the injector high voltage control circuit is open for

greater than 2 s.

P0261, P0264, P0267, P0270, P0273, or P0276

The ECM detects the injector high voltage control circuit is shorted to ground for greater than 2 s.

P0262, P0265, P0268, P0271, P0274, or P0277

The ECM detects the 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 Injector Control Circuit Status parameters. An Injector Control Circuit Status parameter will change from OK or Not Run to Fault if there is a condition with the circuit or a connection.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Fuel System Description (LF1)

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. Observe the DTC information with a scan tool. DTC P0685 or P1682 should not set.
 - If a DTC is set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. Engine operating, observe the DTC information with a scan tool. DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277 should not set.
3. Observe the scan tool Current Misfire Counter parameters. The Current Misfire Counters should not increment.
4. Ignition ON, observe the scan tool Cylinder 1-6 Injector Control Circuit Status parameters. Verify the Injector Control Circuit Status parameters display OK.
5. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the appropriate multi-way harness connector X108 or X109, at the rear of the intake manifold.
2. Ignition ON, observe the appropriate scan tool Cylinder 1-6 Injector Control Circuit Status. The parameter should display Open.
 - If not the specified value, test the appropriate high voltage supply circuit, ECM side, for a short to ground or the appropriate high voltage control circuit, ECM side, for a short to voltage. If the circuits test normal, replace the K20 ECM.
3. Ignition ON, connect a test lamp between the appropriate high voltage supply circuit and the high voltage control circuit. The Injector Control Circuit Status should transition from Open to OK.
 - If not the specified value, test for the following conditions in the ECM side of the harness:
 - An open/high resistance in the high voltage supply circuit
 - An open/high resistance in the high voltage control circuit
 - A short to ground in the high voltage control circuit
 - A short to voltage in the high voltage supply circuit
 - If the circuits test normal, replace the K20 ECM.

NOTE: **Testing for the following steps is performed on the fuel injector side of the multi-way harness connector. It may be necessary to remove the intake manifold to isolate the condition.**

4. Ignition OFF, measure the resistance between the appropriate high voltage supply circuit and ground. The DMM should display OL ohms.
 - If less than the specified range, test the high voltage supply circuit and the high voltage control circuit for a short to ground. If the circuits/connections test normal, test or replace the appropriate Q17 fuel injector(s).
5. Test for 2-3 ohms between the appropriate high voltage supply circuit and high voltage control circuit.
 - If less than the specified range, test for a short between the high voltage supply circuit and high voltage control circuit. If the circuits/connections test normal, test or replace the appropriate Q17 fuel injector(s).
 - If greater than the specified range, test the high voltage supply circuit and high voltage control circuit for an open/high resistance. If the circuits/connections test normal, test or replace the appropriate Q17 fuel injector.

COMPONENT TESTING

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

1. Remove the intake manifold and disconnect the appropriate Q17 fuel injector.
2. Test for 1.9-2.3 ohms at 20°C (68°F) between the high voltage supply circuit terminal 2 and the high voltage control circuit terminal 1 at the fuel injector.
 - If not within the specified range, replace the Q17 fuel injector.
3. Measure the resistance between each terminal at the Q17 fuel injector and the Q17 fuel injector housing/case. The DMM should display OL ohms.
 - If less than the specified value, replace the Q17 fuel injector.

REPAIR PROCEDURES

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

- **Fuel Injection Fuel Rail Assembly Replacement - Bank 1 (LF1)**
- **Fuel Injection Fuel Rail Assembly Replacement - Bank 2 (LF1)**
- **Control Module References** for ECM replacement, setup, and programming

DTC P0231, P0232, OR P023F

DIAGNOSTIC INSTRUCTIONS

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

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

DTC DESCRIPTORS

DTC P0231

Fuel Pump Control Circuit Low Voltage

DTC P0232

Fuel Pump Control Circuit High Voltage

DTC P023F

Fuel Pump Control Circuit

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open or 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 control module when the ECM detects that the ignition is on. The voltage from the ECM to the fuel pump control module remains active for 2 seconds, unless the engine is in crank or run. While this voltage is being received, the fuel pump control module supplies a varying voltage to the fuel tank pump module in order to maintain the desired fuel rail pressure.

CONDITIONS FOR RUNNING THE DTC

P0231, P023F

The ignition voltage is between 9-18 V.

P0232

The control enable voltage signal supplied for the ECM to fuel pump control module is inactive for 4 seconds after engine has been shut off.

CONDITIONS FOR SETTING THE DTC

The fuel pump control module detects a fault on the fuel pump voltage circuit that is less than 4 V or greater than 4.5 V.

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.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Fuel System Description (LF1)

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

Ignition ON, command the fuel pump ON and OFF using the scan tool ECM fuel pump output control. The fuel pump should turn ON and OFF.

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the harness connector at the G12 fuel pump.
2. Connect a test lamp between the control circuit terminal 1 and ground.
3. Ignition ON, command the G12 fuel pump ON and OFF with a scan tool. The test lamp should turn ON and OFF, as commanded.
 - If the test lamp is always ON, test the control circuit for a short to voltage. If the circuit tests normal, replace the K27 fuel pump control module.
 - If the test lamp is always OFF, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K27 fuel pump control module.
4. Ignition OFF, connect a test lamp between the control circuit terminal 1 and the low reference circuit terminal 2.
5. Ignition ON, command the G12 fuel pump ON with a scan tool. The test lamp should illuminate.
 - If the test lamp does not illuminate, test the low reference circuit terminal 2 for a short to voltage or an open/high resistance. If the circuit tests normal, replace the K27 fuel pump control module.
6. If all circuits test normal, replace the G12 fuel pump.

REPAIR PROCEDURES

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

- **Fuel Tank Fuel Pump Module Replacement**
- **Control Module References** for fuel pump control module replacement, setup, and programming