

2010 ENGINE PERFORMANCE

Engine Controls and Fuel - 2.2L or 2.4L - Equinox & Terrain

DTC P0010 OR P0013

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

DTC P0013

Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit

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 between 10-18 V.
- The ECM has commanded the Camshaft Position Actuator Solenoid Valve ON.
- DTCs P0010 and P0013 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 and P0013 are type B DTCs.

CONDITIONS FOR CLEARING THE DTC

DTCs P0010 and P0013 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, and P0341 is not set.
 - If any of the DTCs are 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 Exhaust/Intake Camshaft Position Actuator Solenoid Valve Control Circuit Open test status
 - The Exhaust/Intake Camshaft Position Actuator Solenoid Valve Control Circuit High Voltage test status
 - The Exhaust/Intake Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage test status

Each parameter should display OK or Not Run

3. Engine idling, command the Camshaft Position Actuator to 20 degrees while observing the following control circuit status parameters with a scan tool:
 - The Exhaust/Intake Camshaft Position Actuator Solenoid Valve Control Circuit Open test status
 - The Exhaust/Intake Camshaft Position Actuator Solenoid Valve Control Circuit High Voltage test status
 - The Exhaust/Intake Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage test status

Each parameter should display OK or Not Run

4. Engine at normal operating temperature, raise the engine speed to 2,000 RPM for 10 s. DTC P0010 or P0013 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.

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.**

2. Ignition ON, verify that a test lamp does not illuminate between the control circuit terminal A 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.
3. 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 B 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.

4. Ignition ON, connect the DMM black lead to the control circuit terminal A. 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 8-13 ohms between the control terminal A and the low reference circuit terminal B 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 Replacement**
- **Control Module References** for Engine Control Module replacement, setup, and programming

DTC P0011 OR P0014

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

DTC P0014

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, P0016, P0017, P0335, P0336, P0340, P0341, P0365, or P0366 is not set.
- The ignition voltage is between 11-18 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 25 degrees or less than 5 degrees.
- DTCs P0011 and P0014 run continuously once the above conditions are met.

CONDITIONS FOR SETTING THE DTC

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

ACTION TAKEN WHEN THE DTC SETS

DTCs P0011 and P0014 are type B DTCs.

CONDITIONS FOR CLEARING THE DTC

DTCs P0011 and P0014 are type B DTCs.

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

DIAGNOSTIC AIDS

- The engine oil condition has a major impact on the camshaft actuator system.
- A low oil level condition may set this DTC. The engine may require an oil change. Inquire with the customer when the last oil change was performed. You may also monitor the scan tool Engine Oil Life Remaining parameter. Advise the customer an oil change may be required.
- Inspect the engine for any recent engine mechanical repairs. An incorrectly installed camshaft, camshaft actuator, or timing chain can cause this DTC to set.

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 Remaining 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, P0335, P0336,

P0340, P0341, P0365, or P0366 is not set.

- If any of the DTCs are set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** 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 B 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 A 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 A. 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 Q6 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 Q6 Camshaft Position Actuator Solenoid Valve with a Q6 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 8-13 ohms between the control terminal A and the low reference circuit terminal B 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 Replacement
- Camshaft Position Intake Actuator Replacement
- Camshaft Position Exhaust Actuator Replacement
- Control Module References for Engine Control Module replacement, setup, and programming

DTC P0016 OR P0017

DIAGNOSTIC INSTRUCTIONS

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

DTC DESCRIPTORS

DTC P0016

Crankshaft Position - Intake Camshaft Position Not Plausible

DTC P0017

Crankshaft Position - Exhaust Camshaft Position Not Plausible

CIRCUIT/SYSTEM DESCRIPTION

The engine control module (ECM) uses the crankshaft position (CKP) sensor and the intake and exhaust

camshaft position (CMP) sensor information to monitor the correlation between the crankshaft, intake, and exhaust camshaft position.

CONDITIONS FOR RUNNING THE DTC

- DTC P0335, P0336, P0340, P0341, P0365, P0366, P0641, and P0651 are not set.
- The engine is cranking or running.
- The crankshaft and camshaft position signals are synchronized.
- The camshaft position actuator is in the parked position.
- DTC P0016 and P0017 run continuously once the above conditions are met.

CONDITIONS FOR SETTING THE DTC

The ECM detects a camshaft that is greater than 10 degrees advanced, or 10 degrees retarded, in relationship to the crankshaft.

ACTION TAKEN WHEN THE DTC SETS

DTCs P0016 and P0017 are type B DTCs.

CONDITIONS FOR CLEARING THE DTC

DTCs P0016 and P0017 are type B DTCs.

DIAGNOSTIC AIDS

- Inspect the engine for any recent engine mechanical repairs. An incorrectly installed timing chain can cause this DTC to set.
- 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, P0335, P0336, P0340, P0341, P0365, or P0366.
 - 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 or P0017 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
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.

- **Camshaft Timing Chain and Sprocket Cleaning and Inspection**
- **Camshaft Timing Chain, Sprocket, and Tensioner Replacement**

DTC P0030, P0036, P0053, P0054, P0135, OR P0141

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 Sensor 1

DTC P0036

HO2S Heater Control Circuit Sensor 2

DTC P0053

HO2S Heater Resistance Sensor 1

DTC P0054

HO2S Heater Resistance Sensor 2

DTC P0135

HO2S Heater Performance Sensor 1

DTC P0141

HO2S Heater Performance Sensor 2

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
HO2S High Signal	P0131, P0137	P0132, P0134, P0138, P0140	P0132, P0134, P0138, P0140	P0132, P0134, P0138, P0140	P0133, P013A, P013B, P013E, P013F, P1133, P2A00
HO2S Low Signal	P0131, P0137	P0132, P0134, P0138,	P0132, P0134, P0138,	P0132, P0134, P0138,	P0133, P013A, P013B, P013E,

		P0140	P0140	P0140	P013F, P1133, P2A00
HO2S Heater Voltage Supply	P0030, P0036, P0132, P0135, P0138, P0141, *	P0030, P0036, P0132, P0134, P0135, P0138, P0140, P0141	P0030, P0036, P0132, P0134, P0135, P0138, P0140, P0141	P0690	P0135, P0141
HO2S Heater Control	P0030, P0036, P0053, P0054, P0135, P0141	P0030, P0036, P0132, P0134, P0135, P0138, P0140, P0141	P0030, P0036, P0132, P0134, P0135, P0138, P0140, P0141	P0030, P0036, P0132, P0134, P0135, P0138, P0140, P0141	P0135, P0141
* Opens fuse					

CIRCUIT DESCRIPTION

The heated oxygen sensor (HO2S) heater reduces the time required for the oxygen sensor to reach operating temperature and maintains the operating temperature during extended idle periods. When the ignition is turned to the ON position, ignition voltage is supplied directly to the sensor heater. The engine control module (ECM) controls the heater operation by first modulating the control circuit to ground when the sensors are cold. This prevents the possibility of thermal shock to the sensor, from condensation build-up on the sensor, by controlling the sensors rate of heating. After a predetermined amount of time, the ECM commands the heaters ON continuously. Once the sensor reaches operating temperature, the ECM may modulate the heater control circuit to ground, to maintain a desired temperature.

The ECM controls the heater by grounding the control circuit with a solid state device called a driver. The driver is equipped with a feedback circuit that is pulled-up to voltage. The ECM can determine if the control circuit is open, shorted to ground, or shorted to a voltage by monitoring the feedback voltage.

CONDITIONS FOR RUNNING THE DTC

P0030 or P0036

- The ignition voltage is between 11-32 V.
- The engine speed is greater than 400 RPM.
- The DTCs run continuously once the above conditions are met for 10 s.

P0053 or P0054

- DTCs P0112, P0113, P0117, P0118, P0128, P2610 are not set.

- The engine is running.
- Ignition voltage is less than 32 V.
- The ignition is OFF for more than 8 h.
- The Engine Coolant Temperature (ECT) Sensor parameter is between -30 to +45°C (-22 to +113°F) at engine start-up.
- DTCs P0053 and P0054 run once per drive cycle when the above conditions are met.

P0135

- DTCs P0116, P0117, P0118, P0128 are not set.
- The ECT Sensor parameter is more than 70°C (158°F).
- The Ignition 1 Signal parameter is between 10-32 V.
- DTC P0135 runs twice per drive cycle when the above conditions are met for 2 min.

P0141

- DTCs P0116, P0117, P0128 are not set.
- The ECT Sensor parameter is more than 70°C (158°F).
- The Ignition 1 Signal parameter is between 10-32 V.
- DTC P0141 runs twice per drive cycle when the above conditions are met for 2 min.

CONDITIONS FOR SETTING THE DTC

P0030 or P0036

- The ECM detects that the affected HO2S heater low control circuit voltage is not within a specified range.
- DTCs P0030 and P0036 set within 3 s when the above condition is met.

P0053 or P0054

- The ECM detects that the affected HO2S heater low control circuit resistance is not within a specified range at engine start-up.
- DTCs P0053 and P0054 set within 1 s when the above condition is met.

P0135

- The ECM detects that the affected HO2S 1 heater current parameter is more than 2.5 A or less than 0.3 A.
- DTC P0135 sets within 60 s when the above condition is met.

P0141

- The ECM detects that the affected HO2S 2 heater current parameter is more than 2.5 A or less than 0.3 A.
- DTC P0141 sets within 60 s when the above condition is met.

ACTION TAKEN WHEN THE DTC SETS

DTCs P0030, P0036, P0053, P0054, P0135, and P0141 are Type B DTCs.

CONDITIONS FOR CLEARING THE MIL/DTC

DTCs P0030, P0036, P0053, P0054, P0135, and P0141 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 test status parameters for the component. The circuit test status parameters change from OK or Not Run to Malfunction if there is a condition with the circuit or a connection.
- An open fuse in the HO2S heater circuit may be caused by the heater element in one of the sensors. The condition may not be present until the sensor operates for a period of time. If no fault is present in the heater circuit, monitor the amperage of each heater using the DMM to determine if one of the heater elements is the cause of the open fuse. Inspect the sensor pigtail or the harness for contacting the exhaust system.

REFERENCE INFORMATION

Schematic Reference

Engine Controls 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, 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

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

- **Heated Oxygen Sensor Replacement - Sensor 1 (LE5)**
- **Heated Oxygen Sensor Replacement - Sensor 2 (LE5)**
- **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
 - The Q38 throttle body for dirt, debris, and coking. Also, throttle body blade or shaft damage. Refer to **Throttle Body Cleaning** for further diagnosis.
 - A damaged Q38 throttle body blade or shaft
 - 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**.
 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**.
 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** for further diagnosis.

REPAIR PROCEDURES

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

- **Air Cleaner Element Replacement**
- **Throttle Body Assembly Replacement**

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 P0016, P0017, P0090, P0091, P0092, P00C8, P00C9, P00CA, P0112, P0113, P0116, P0117, P0118, P0128, P0192, P0193, P0335, P0336, P0340, P0341, P0365, P0366, P0627, P0628, P0629 or P1682 is not set.
- The ignition voltage is more than 11 V.
- The engine is running.
- The low side fuel pressure is more than 275 kPa (40 psi).
- The DTC runs continuously when the above conditions are met for 60 s.

P00C6

- DTC P0016, P0017, P0090, P0091, P0092, P00C8, P00C9, P00CA, P0112, P0113, P0116, P0117, P0118, P0128, P0192, P0193, P0335, P0336, P0340, P0341, P0365, P0366, P0627, P0628, P0629 or P1682 is not set.
- The ignition voltage is more than 8 V.
- The engine coolant temperature is between -100 and +80°C (-148 and +176°F).
- The low side fuel pressure is more than 300 kPa (43.5 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 is greater than or equal to 240 ° or less than or equal to 0 °. 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 3 MPa (435 psi) less than the desired fuel pressure. The condition exists for greater than 5 s.

P228D

The actual fuel rail pressure is 3 MPa (435 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 the fuel pump flow control module may set a DTC.
- A skewed fuel rail pressure sensor, or an intermittent condition in the fuel rail pressure sensor circuits may set a DTC.
- A leaking or restricted fuel injector may set a DTC.
- A short to voltage in the crankshaft position signal circuit may set a DTC.
- A short to voltage in the camshaft position actuator solenoid valve control circuit may set a DTC.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Fuel System Description

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. 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.

- **Fuel Injection Fuel Rail Fuel Pressure Sensor Replacement (LAF)**
- **Fuel Pump Replacement**
- **Intake Camshaft and Valve Lifter 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, P0690	-
High Pressure Fuel Pump Actuator Low Control	P0091, P00C9	P0090, P00C8	P0092, P00CA, P0690	-

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

CONDITIONS FOR SETTING THE DTC

P0090

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

P0091

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

P0092

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

P00C8

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

P00C9

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

P00CA

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

ACTION TAKEN WHEN THE DTC SETS

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

CONDITIONS FOR CLEARING THE DTC

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

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Fuel System Description

Electrical Information Reference

- **Circuit Testing**

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. 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** for further diagnosis.
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. 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 ON, verify that a test lamp does not illuminate between the high control circuit terminal 2 and ground and the low control circuit terminal 1 and ground.
 - If the test lamp illuminates, test the appropriate control circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.
3. Verify that a test lamp does not illuminate between the high control circuit terminal 2 and B+ and the low control circuit terminal 1 and B+.
 - If the test lamp illuminates, test the appropriate control circuit for a short to ground. If the circuit tests normal, replace the K20 ECM.

4. Connect a 3 A fused jumper wire between the high control circuit terminal 2 and ground. The Fuel Pressure Regulator High Control Circuit Open Test Status should transition from Malfunction to OK and the Fuel Pressure Regulator High Control Circuit Low Voltage Test Status should transition from OK to Malfunction.
 - If not the specified value, test the high control circuit for an open/high resistance.
5. Connect a 3 A fused jumper wire between the low control circuit terminal 1 and B+. The Fuel Pressure Regulator Control Circuit Open Test Status should transition from Malfunction to OK and the Fuel Pressure Regulator Control Circuit High Voltage Test Status should transition from OK to Malfunction.
 - If not the specified value, test the low control circuit for an open/high resistance.
6. 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 at the G18 high pressure fuel pump.
 - 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

Mass Air Flow (MAF) Sensor Performance

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Ignition Voltage	P0102	P0101	P0102	-	P0101, P0103
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 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 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
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 temperature (ECT) is between 70-125°C (158-261°F).
- The intake air temperature (IAT) 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 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.

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

EN-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 operating at idle, observe the scan tool MAF Sensor parameter. The reading should be between 2,000-3,800 Hz depending on the 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 2-6 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** .
7. Verify the proper operation of the MAP sensor. A skewed MAP sensor will cause the BARO value to be inaccurate. Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** DTC P0106 for further diagnosis.
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 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.
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 **EN-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 **EN-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**
- **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 Voltage	P0030, P0036, P0102, P0135, P0141, P0443	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 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 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 signal is greater than 11 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 300 Hz for greater than 10 s.

P0103

The ECM detects that the MAF Sensor signal parameter is greater than 11,000 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

- A steady or intermittent high resistance of 15 ohms or greater on the ignition 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.

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

EN-38522: Variable Signal Generator

For equivalent regional tools, refer to **Special Tools** .

CIRCUIT/SYSTEM VERIFICATION

1. Verify that DTCs P0685, P0690 or B1380 are not set.
 - If any of the DTCs are set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. Engine running, observe the scan tool MAF Sensor parameter. The reading should be between 1,700-3,800 Hz depending on the engine coolant temperature (ECT).
3. 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 2-6 g/s at idle to greater than 180 g/s at the time of the 1-2 shift.
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. Verify that DTCs P0685, P0690 or B1380 are not set.
 - If any of the DTCs are set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. Verify the integrity of the air induction system by inspecting for the following conditions:
 - Loose or improper installation
 - Water intrusion
3. Ignition OFF, disconnect the harness connector at the B75B MAF/IAT sensor.
4. 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.
5. 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.
6. 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.
7. Ignition OFF, connect the red lead of the **EN-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.
8. Set the **EN-38522: Variable Signal Generator** signal to 5 V, the Frequency to 5K, and the Duty Cycle to Normal.

9. Engine idling, observe the scan tool MAF Sensor parameter. The scan tool MAF Sensor parameter should be between 4,950-5,050 Hz.
 - If the MAF Sensor parameter is not within the specified range, replace the K20 ECM.
10. 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

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, P0452, P0532, P0641	P0106, P0107	P0107	P0108, P0533, P0641	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, varies with altitude			
5 V Reference	0 kPa	0 kPa	127 kPa
MAP Sensor Signal	0 kPa	0 kPa	127 kPa
Low Reference	-	127 kPa	-

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	Fault	OK	P0101, P0106, P0121, P1101	None
Fault	OK	Fault	OK	P0106, P0121, P1101	P0101
OK	Fault	Fault	OK	P0101, P0121, P1101	P0106

Fault	Fault	Fault	OK	P0121, P1101	P0101, P0106
-	-	OK	Fault	P0101, P0106, P1101	P0121
OK	OK	Fault	Fault	P0101, P0106, P0121, P1101	None
Fault	OK	Fault	Fault	P0101, P0106, P0121	P1101
-	Fault	Fault	Fault	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 400-8,192 RPM.
- The IAT Sensor parameter is between -7° to +125°C (+19° to +257°F).
- The ECT Sensor parameter is between 70-125°C (158-257°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

GE 23738-A: Mityvac

For equivalent regional tools, refer to Special Tools .

CIRCUIT/SYSTEM VERIFICATION

1. Verify that DTC P0697 is not set.
 - If the DTC is 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.
 - 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.
 - 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 **GE 23738-A: Mityvac** to apply 5 in Hg of vacuum to the B74 MAP sensor, the parameter in the first column should decrease by 17 kPa. The acceptable range is indicated in the second column.
5. Using the **GE 23738-A: Mityvac** to apply 10 in Hg of vacuum to the B74 MAP sensor, the parameter in

the first column should decrease by 34 kPa. 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	79-87 kPa	62-70 kPa
95 kPa	74-82 kPa	57-65 kPa
90 kPa	69-77 kPa	52-60 kPa
80 kPa	59-67 kPa	42-50 kPa
70 kPa	49-57 kPa	32-40 kPa
60 kPa	39-47 kPa	22-30 kPa

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 **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.
 - o 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

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	P0107, P0452, P0532, P0641	P0106, P0107	P0107	P0108, P0533, P0641	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, varies with altitude			
5 V Reference	0 kPa	0 kPa	127 kPa
MAP Sensor Signal	0 kPa	0 kPa	127 kPa
Low Reference	-	127 kPa	-

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

P0107

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 P0697 is not set.
 - If the DTC is 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.
 - 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.
 - 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	P0113	P0113	P0114
Low Reference	-	P0113	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.
- The ECM commands the cooling fans ON.

CONDITIONS FOR CLEARING THE DTC

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

DIAGNOSTIC AIDS

- 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 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 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 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 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 of the B75B MAF/IAT sensor, at various ambient temperatures, then compare those measurements to the **Temperature Versus Resistance** 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

DIAGNOSTIC INSTRUCTIONS

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

DTC DESCRIPTOR

DTC P0116

Engine Coolant Temperature (ECT) Sensor Performance

DIAGNOSTIC FAULT INFORMATION

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

TYPICAL SCAN TOOL DATA

ECT Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine running at various operating conditions			
Parameter Normal Range: Varies with coolant temperature			
ECT Sensor	150°C (302°F)	-40°C (-40°F)	-40°C (-40°F)
Low Reference	-	-40°C (-40°F)	-40°C (-40°F)

CIRCUIT/SYSTEM DESCRIPTION

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

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

CONDITIONS FOR RUNNING THE DTC

- DTC P0112, P0113, P0117, P0118, P0128, P0502, P0503, P0601, P1621, or P2610 is not set.
- The vehicle has had a minimum ignition OFF time of 8 h.
- The ignition is ON.
- The start-up IAT is warmer than -7°C (+19°F).
- The Fuel Level Sensor parameter is greater than 2.5%.
- This DTC runs once per ignition cycle within the enabling conditions.

CONDITIONS FOR SETTING THE DTC

- The ECM detects a temperature difference at power-up that indicates that the ECT sensor is 30°C (54°F) warmer than the IAT sensor.

OR

- The ECM detects a temperature difference at power-up that indicates that the ECT sensor is 16°C (29°F) warmer than the IAT sensor, and the time spent cranking the engine is greater than 30 s when the fuel level is greater than 2.5%.

OR

- The ECM detects a temperature difference at power-up that indicates that the ECT sensor is 16°C (29°F) warmer than the IAT sensor. Then the vehicle must be driven for greater than 6 min and 40 s at greater than 24 km/h (15 mph). If the IAT sensor then decreases greater than 5°C (9°F), an engine block heater was detected and the test is aborted. If the IAT sensor does not decrease, an engine block heater was not detected and DTC P0116 will set.

ACTION TAKEN WHEN THE DTC SETS

DTC P0116 is a Type B DTC.

CONDITIONS FOR CLEARING THE MIL/DTC

DTC P0116 is a Type B DTC.

DIAGNOSTIC AIDS

- Engine coolant that is leaking through the sensor will create a high resistance short to ground. This condition results in less voltage on the ECT sensor signal circuit, which is interpreted by the ECM as a warmer ECT.
- An IAT sensor that is skewed colder at various ambient temperatures due to greater resistance than is normal will increase the range between these two sensors. Measure and record the resistance of the IAT sensor at various ambient temperatures, then compare those measurements to the **Temperature Versus Resistance** table.
- A slight to moderate resistance in the IAT sensor signal circuit or low reference circuit will increase the range between these two sensors. This condition results in a greater voltage on the IAT sensor signal circuit, which is interpreted by the ECM as a colder IAT.

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. Ignition OFF, inspect the cooling system surge tank for the proper coolant level. Refer to **Cooling System Leak Testing** and **Cooling System Draining and Filling (Static)** or **Cooling System Draining and Filling (GE 47716)**.
2. Ignition OFF for 8 h or greater.
3. Ignition ON, observe the scan tool ECT Sensor and IAT Sensor parameters. The ECT, IAT, and ambient temperature should be within 15°C (27°F) of each other.
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 for 90 s, disconnect the harness connector at the B34 ECT sensor.
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. If the circuit tests normal, replace the K20 ECM.
3. Ignition ON, verify the scan tool ECT Sensor parameter is colder than -39°C (-38°F).
 - If warmer than the specified range, test the signal circuit terminal B for a short to ground. If the circuit tests normal, replace the K20 ECM.
4. Install a 3 A fused jumper wire between the signal circuit terminal B and the low reference circuit terminal A. Verify the scan tool ECT Sensor 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 the circuits test normal, test or replace the B34 ECT sensor.

COMPONENT TESTING

Measure and record the resistance of the ECT sensor at various ambient temperatures, then compare those measurements to the **Temperature Versus Resistance** table.

REPAIR PROCEDURES

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

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

DTC P0117 OR P0118

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

TYPICAL SCAN TOOL DATA

ECT Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine running at various operating conditions			
Parameter Normal Range: Varies with coolant temperature			
ECT Sensor	150°C (302°F)	-40°C (-40°F)	-40°C (-40°F)
Low Reference	-	-40°C (-40°F)	-40°C (-40°F)

CIRCUIT/SYSTEM DESCRIPTION

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

low reference circuit.

CONDITIONS FOR RUNNING THE DTC

P0117

- The ignition is ON.

OR

- The engine is running for greater than 10 s.

OR

- The engine run time is less than 10 s when the intake air temperature (IAT) is colder than 50°C (122°F).
- This DTC runs continuously within the enabling conditions.

P0118

- The ignition is ON.

OR

- The engine is running for greater than 10 s.

OR

- The engine run time is less than 10 s when the IAT is warmer than 0°C (32°F).
- This DTC runs continuously within the enabling conditions.

CONDITIONS FOR SETTING THE DTC

P0117

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

P0118

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

ACTION TAKEN WHEN THE DTC SETS

DTCs P0117 and P0118 are Type B DTCs.

CONDITIONS FOR CLEARING THE MIL/DTC

DTCs P0117 and P0118 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

CIRCUIT/SYSTEM VERIFICATION

1. Ignition ON, observe the ECT Sensor parameter. The reading should be between -39 to +120°C (-38 to +248°F).
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 for 90 s, disconnect the harness connector at the ECT sensor.
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. If the circuit tests normal, replace the K20 ECM.
3. Ignition ON, verify the scan tool ECT Sensor parameter is colder than -39°C (-38°F).
 - If warmer than the specified range, test the signal circuit terminal B for a short to ground. If the circuit tests normal, replace the K20 ECM.
4. Install a 3 A fused jumper wire between the signal circuit terminal B and the low reference circuit terminal A. Verify the scan tool ECT Sensor 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 the circuits test normal, test or replace the B34 ECT sensor.

COMPONENT TESTING

Measure and record the resistance of the ECT sensor at various ambient temperatures, then compare those measurements to the **Temperature Versus Resistance** table.

REPAIR PROCEDURES

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

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

DTC P0121-P0123, P0222, P0223, OR P2135

DIAGNOSTIC INSTRUCTIONS

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

DTC DESCRIPTORS

DTC P0121

Throttle Position Sensor 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 V 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	-	-	P0123, 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 V 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 V Reference	0.02 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 V 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 V reference circuit terminal E and ground.
 - If less than the specified range, test the 5 V 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 V 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 V 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**
- **Control Module References** for ECM replacement, programming, and setup

DTC P0128

DIAGNOSTIC INSTRUCTIONS

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

DTC DESCRIPTOR

DTC P0128

Engine Coolant Temperature (ECT) Below Thermostat Regulating Temperature

DIAGNOSTIC FAULT INFORMATION

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

TYPICAL SCAN TOOL DATA

ECT Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: The ignition is ON, or the engine is running Parameter Normal Range: Varies with ambient temperature, within a range of -39 to +120°C (-38 to +248°F)			
ECT Sensor Signal	140°C (284°F)	-40°C (-40°F)	-40°C (-40°F)
Low Reference	-	-40°C (-40°F)	-40°C (-40°F)

CIRCUIT/SYSTEM DESCRIPTION

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

The purpose of this diagnostic is to analyze the performance of the thermostat by comparing the measured ECT to a modeled ECT using information from the following inputs:

- ECT
- Engine load
- Intake air temperature (IAT)
- Mass air flow (MAF)
- Vehicle speed (VS)

The ECM uses the start-up ECT and the start-up intake air temperature (IAT) to begin the diagnostic calculation. The air flow into the engine is accumulated, and vehicle speed, distance, engine load, and engine run time are also factored in to determine if the ECT does increase normally and then maintains that temperature within a calibrated range of the modeled ECT.

CONDITIONS FOR RUNNING THE DTC

- DTC P0102, P0103, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0119, P0121, P0122, P0123, P0221, P0222, P0223, P0335, P0336, or P0501 is not set.
- The decrease in ECT after engine start is within a calibrated range.
- The decrease in IAT after engine start is within a calibrated range.
- The engine idle time is less than 40 %.
- The engine run time is greater than 8 s.
- The engine run time at minimum load is less than 50 %.
- The engine run time at maximum load is less than 90 %.
- The ignition voltage is greater than 10 V.
- The start-up ECT is between -10 and +75°C (14-167°F).
- The start-up IAT is warmer than -10°C (14°F).

- The DTC runs once per drive cycle within the enabling conditions.

CONDITIONS FOR SETTING THE DTC

The ECM determines that the modeled ECT has met the calibrated target of 92°C (198°F) and the measured ECT is less than 81°C (178°F) for greater than 2 s.

ACTION TAKEN WHEN THE DTC SETS

- DTC P0128 is a Type B DTC.
- The cooling fans will be commanded ON.
- The AC compressor will be commanded OFF.

CONDITIONS FOR CLEARING THE MIL/DTC

DTC P0128 is a Type B DTC.

DIAGNOSTIC AIDS

- DTC P0128 occurring with insufficient vehicle interior heating is an indication of improper thermostat operation.
- Corrosion on the ECT sensor terminals or the ECT harness connector results in a greater voltage on the ECT sensor signal circuit, which is interpreted by the ECM as a colder ECT.
- A slight to moderate resistance in the ECT sensor signal circuit or low reference circuit will affect this diagnostic. This condition results in a greater voltage on the ECT sensor signal circuit, which is interpreted by the ECM as a colder ECT.

REFERENCE INFORMATION

Schematic Reference

Engine Controls 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. Turn OFF the ignition.
2. Inspect the cooling system surge tank for the proper engine coolant level. Refer to **Cooling System Leak Testing** and **Cooling System Draining and Filling (Static)** or **Cooling System Draining and Filling (GE 47716)**.
3. If the ignition has been OFF for 8 h or greater, the IAT, the ambient temperature, and the ECT should be within 9°C (16°F) of each other. Ignition ON, observe the scan tool IAT Sensor, Ambient Temperature, and the ECT Sensor parameters. Compare those sensor parameters to each other and also to the ambient temperature to determine if the ECT sensor is skewed colder.
4. Engine running, observe the ECT Sensor parameter. The reading should be between -39 to +120°C (-38 to +248°F) depending on the current ambient temperature and the vehicle operating conditions.
5. Use the scan tool to verify the proper operation of the engine cooling system fans.

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

6. Verify the proper heat range, and the operation of the thermostat. Refer to **Thermostat Diagnosis**.
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

1. Inspect the MAF/IAT sensor elements for contamination, and debris.
2. Ignition OFF for 90 s, disconnect the harness connector at the B24 ECT sensor.
3. Inspect the ECT sensor terminals and the harness connector for corrosion.
4. 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.
5. Disconnect the ECM.
6. Test the ECT signal circuit between terminal 1 and ECM connector X 1 terminal 60 for less than 5 ohms.
 - If greater than the specified range, test the signal circuit for a high resistance.
7. If the circuits test normal, test or replace the B34 ECT sensor.

COMPONENT TESTING

- Measure and record the resistance of the ECT sensor at various ambient temperatures, then compare those

measurements to the **Temperature Versus Resistance** table.

- Measure and record the resistance of the IAT sensor at various ambient temperatures, then compare those measurements to the **Temperature Versus Resistance** table.

REPAIR PROCEDURES

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

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

DTC P0131, P0132, P0137, OR P0138 (LAF)

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 Sensor 1

DTC P0132

HO2S Circuit High Voltage Sensor 1

DTC P0137

HO2S Circuit Low Voltage Sensor 2

DTC P0138

HO2S Circuit High Voltage Sensor 2

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
HO2S High Signal	P0131,	P0132, P0134,	P0132, P0134,	P0132, P0134,	P0133, P013A, P013B,

	P0137	P0138, P0140	P0138, P0140	P0138, P0140	P013E, P013F, P1133, P2A00
HO2S Low Signal	P0131, P0137	P0132, P0134, P0138, P0140	P0132, P0134, P0138, P0140	P0132, P0134, P0138, P0140	P0133, P013A, P013B, P013E, P013F, P1133, P2A00
HO2S Heater Voltage Supply	P0030, P0036, P0132, P0135, P0138, P0141, *	P0030, P0036, P0132, P0134, P0135, P0138, P0140, P0141	P0030, P0036, P0132, P0134, P0135, P0138, P0140, P0141	P0690	P0135, P0141
HO2S Heater Control	P0030, P0036, P0053, P0054, P0135, P0141	P0030, P0036, P0132, P0134, P0135, P0138, P0140, P0141	P0030, P0036, P0132, P0134, P0135, P0138, P0140, P0141	P0030, P0036, P0132, P0134, P0135, P0138, P0140, P0141	P0135, P0141
* Opens fuse					

TYPICAL SCAN TOOL DATA

HO2S Sensor 1 Voltage

Circuit	Normal Range	Short to Ground	Open	Short to Voltage
HO2S High Signal	200-800 mV	0 V	Approximately 1.27 V	Approximately 1.27 V
HO2S Low Signal	200-800 mV	0 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

- DTCs P0106, P0107, P0108, P0201, P0202, P0203, P0204, P0411, P0412, P0418, P0442, P0443, P0446, P0449, P0451, P0452, P0453, P0454, P0455, P0496 are not set.
- The Loop Status parameter is Closed.
- The Ignition 1 Signal parameter is between 10-32 V.
- The Fuel Level Sensor parameter is more than 10 %.
- DTC P0131 runs when the above conditions are met for 5 s.

P0132

- DTCs P0101, P0102, P0103, P0106, P0107, P0108, P0201, P0202, P0203, P0204, P0442, P0443, P0446, P0449, P0451, P0452, P0453, P0454, P0455, P0496 are not set.
- The Loop Status parameter is Closed.
- The Ignition 1 Signal parameter is between 10-32 V.
- The Fuel Level Sensor parameter is more than 10 %.
- DTC P0132 runs when the above conditions are met for 5 s.

P0137

- DTCs P0106, P0107, P0108, P0201, P0202, P0203, P0204, P0411, P0412, P0418, P0442, P0443, P0446, P0449, P0451, P0452, P0453, P0454, P0455, P0496 are not set.
- The Loop Status parameter is Closed.
- The Ignition 1 Signal parameter is between 10-32 V.
- The Fuel Level Sensor parameter is more than 10 %.
- DTC P0137 runs when the above conditions are met for 5 s.

P0138

- DTCs P0101, P0102, P0103, P0106, P0107, P0108, P0201, P0202, P0203, P0204, P0442, P0443, P0446, P0449, P0451, P0452, P0453, P0454, P0455, P0496 are not set.
- The Loop Status parameter is Closed.
- The Ignition 1 Signal parameter is between 10-32 V.
- The Fuel Level Sensor parameter is more than 10 %.
- DTC P0138 runs when the above conditions are met for 5 s.

CONDITIONS FOR SETTING THE DTC

P0131

- The ECM detects that the HO2S 1 Voltage parameter is less than 50 mV.
- DTC P0131 sets within 50 s when the above condition is met.

P0132

- The ECM detects that the HO2S 1 parameter is more than 1,050 mV.
- DTC P0132 sets within 15 s when the above condition is met.

P0137

- The ECM detects that the HO2S 2 voltage parameter is less than 50 mV.
- DTC P0137 sets within 50 s when the above condition is met.

P0138

- The ECM detects that the HO2S 2 voltage parameter is more than 1,050 mV.
- DTC P0138 sets within 15 s when the above condition is met.

ACTION TAKEN WHEN THE DTC SETS

DTCs P0131, P0132, P0137, P0138 are Type B DTCs.

CONDITIONS FOR CLEARING THE MIL/DTC

DTCs P0131, P0132, P0137, P0138 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**

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** .

NOTE: For DTC P0131 and P0132, in order to ensure that the performance of the catalyst has not been affected by the fault that set this DTC, operate the vehicle within the conditions for running and setting DTC P0420 and verify that P0420 runs and passes. Refer to DTC P0420 .

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Heated Oxygen Sensor Replacement - Sensor 1 (LE5)
- Heated Oxygen Sensor Replacement - Sensor 2 (LE5)
- Control Module References for replacement, setup, and programming

DTC P0133, P0134, P013A, P013B, P013E, P013F, P0140, P1133, P2270, P2271, OR P2A00 (LAF)

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 Sensor 1

DTC P0134

HO2S Circuit Insufficient Activity Sensor 1

DTC P013A

HO2S Slow Response Rich to Lean Sensor 2

DTC P013B

HO2S Slow Response Lean to Rich Sensor 2

DTC P013E

HO2S Delayed Response Rich to Lean Sensor 2

DTC P013F

HO2S Delayed Response Lean to Rich Sensor 2

DTC P0140

HO2S Circuit Insufficient Activity Sensor 2

DTC P1133

HO2S Insufficient Switching Sensor 1

DTC P2270

HO2S Signal Stuck Lean Sensor 2

DTC P2271

HO2S Signal Stuck Rich Sensor 2

DTC P2A00

HO2S Circuit Closed Loop (CL) Performance Sensor 1

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
HO2S High Signal	P0131, P0137	P0132, P0134, P0138, P0140	P0132, P0134, P0138, P0140	P0132, P0134, P0138, P0140	P0133, P013A, P013B, P013E, P013F, P1133, P2A00
HO2S Low Signal	P0131, P0137	P0132, P0134, P0138, P0140	P0132, P0134, P0138, P0140	P0132, P0134, P0138, P0140	P0133, P013A, P013B, P013E, P013F, P1133, P2A00
HO2S Heater Voltage Supply	P0030, P0036, P0132, P0135, P0138, P0141, *	P0030, P0036, P0132, P0134, P0135, P0138, P0140, P0141	P0030, P0036, P0132, P0134, P0135, P0138, P0140, P0141	P0690	P0135, P0141
	P0030, P0036,	P0030, P0036, P0132,	P0030, P0036, P0132,	P0030, P0036, P0132,	

HO2S Heater Control	P0053, P0054, P0135, P0141	P0134, P0135, P0138, P0140, P0141	P0134, P0135, P0138, P0140, P0141	P0134, P0135, P0138, P0140, P0141	P0135, P0141
* Opens fuse					

TYPICAL SCAN TOOL DATA

HO2S Sensor 1 Voltage

Circuit	Normal Range	Short to Ground	Open	Short to Voltage
HO2S High Signal	200-800 mV	0 V	Approximately 1.27 V	Approximately 1.27 V
HO2S Low Signal	200-800 mV	0 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

P0133 and P1133

- DTCs P0101, P0102, P0103, P0106, P0107, P0108, P0116, P0117, P0118, P0128, P0131, P0132, P0134, P0201, P0202, P0203, P0204, P0300, P0411, P0412, P0418, P0442, P0443, P0446, P0449, P0451, P0452, P0453, P0454, P0455, P0496 are not set.
- The Engine Coolant Temperature (ECT) Sensor parameter is more than 70°C (158°F).
- The Ignition 1 Signal parameter is between 10-32 V.
- The Fuel Level Sensor parameter is more than 10 %.
- The Engine Run Time parameter is more than 120 s.
- The Engine Speed parameter is between 1,000-3,500 RPM.
- The EGR device control is not active.

- The idle speed device control is not active.
- The fuel device control is not active.
- The AIR device control is not active.
- The HO2S heaters have been ON for more than 40 s.
- The learned HO2S heater resistance is valid.
- The IAT parameter is more than -40°C (-40°F).
- The fuel composition is less than 87 % ethanol.
- The BARO parameter is more than 70 kPa.
- The fuel control is not in power enrichment.
- DFCO is not active.
- The Mass Airflow (MAF) Sensor parameter is between 14-40 g/s.
- The Loop Status parameter is Closed.
- DTCs P0133 and P1133 run once per drive cycle when the above conditions are met for 3 s.

P0134 and P0140

- DTCs P0068, P0101, P0102, P0103, P0120, P0121, P0122, P0123, P0220, P0222, P0223, P1516, P2101, P2119, P2135, P2176 are not set.
- The Engine Coolant Temperature (ECT) Sensor parameter is more than 70°C (158°F).
- The Ignition 1 Signal parameter is between 10-32 V.
- The engine run time is more than 120 s.
- The fuel composition is less than 87 % ethanol.
- DTCs P0134 and P0140 run continuously when the above conditions are met.

P013A

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0128, P013B, P013E, P013F, P0171, P0172, P0201, P0202, P0203, P0204, P0220, P0222, P0223, P0300, P0411, P0412, P0418, P1174, P1516, P2101, P2119, P2135, P2176, P2270, P2271 are not set.
- The system voltage is between 10-32 V.
- The fuel level is more than 10 %.
- Engine run time is equal to or more than 40 s.
- DTCs P013E and P2270 have run and passed.

THEN

- DFCO is active.
- The accelerator pedal position (APP) is stable.
- The torque converter clutch (TCC) is locked.
- This DTC runs once per trip.

P013B and P013F

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0128, P013A, P013E, P013F, P0171, P0172, P0201, P0202, P0203, P0204, P0220, P0222, P0223, P0300, P0411, P0412, P0418, P1174, P1516, P2101, P2119, P2135, P2176, P2270, P2271 are not set.
- The system voltage is between 10-32 V.
- The fuel level is more than 10 %.
- Engine run time is equal to or more than 40 s.
- DTCs P013A, P013E, P013F, P2270, and P2271 have run and passed.
- DTCs P013B and P013F run once per trip.

P013E

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0128, P013A, P013B, P013F, P0171, P0172, P0201, P0202, P0203, P0204, P0220, P0222, P0223, P0300, P0411, P0412, P0418, P1174, P1516, P2101, P2119, P2135, P2176, P2270, P2271 are not set.
- The system voltage is between 10-32 V.
- The fuel level is more than 10 %.
- Engine run time is equal to or more than 40 s.
- DTC P2270 has run and passed.

THEN

- DFCO is active.
- The APP is stable.
- The TCC is locked.
- This DTC runs once per trip.

P2270

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0128, P013A, P013B, P013E, P013F, P0171, P0172, P0201, P0202, P0203, P0204, P0220, P0222, P0223, P0300, P0411, P0412, P0418, P1174, P1516, P2101, P2119, P2135, P2176, P2270, P2271 are not set.
- The system voltage is between 10-32 V.
- The fuel level is more than 10 %.
- Engine run time is equal to or more than 40 s.
- The engine speed is between 1,250-2,300 RPM.
- The airflow is equal to or more than 3 g/s and equal to or less than 12 g/s.
- The vehicle speed is equal to or more than 55 km/h (34.2 mph) and equal to or less than 120 km/h (74.6 mph).

- The short term fuel trim is equal to or more than 0.9, and equal to or less than 1.065.
- The fuel state is in Closed Loop.
- The evaporative emission (EVAP) diagnostics are not in control of purge.
- The Power Take-Off is not active.
- The exhaust gas recirculation (EGR) diagnostic is not intrusive.
- The HO2S heaters are ON for more than 120 s.
- The predicted catalytic converter temperature is between 650-900°C (1,202-1,652°F).
- This DTC runs once per trip when all of the above conditions have been met for 1 s.

P2271

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0128, P013A, P013B, P013E, P013F, P0171, P0172, P0201, P0202, P0203, P0204, P0220, P0222, P0223, P0300, P0411, P0412, P0418, P1174, P1516, P2101, P2119, P2135, P2176, P2270 are not set.
- The system voltage is between 10-32 V.
- The fuel level is more than 10 %.
- Engine run time is equal to or more than 40 s.
- The learned HO2S heater resistance is valid.
- The engine speed is 1,250-2,300 RPM.
- The MAF parameter is 3-12 gps.
- The vehicle speed is 55-120 kph (34.2-74.6 mph).
- The short term fuel trim is 0.9-1.07.
- The fueling state is in Closed Loop.
- The EVAP is not in control of purge.
- The ethanol estimation is not active.
- Power take-off is not active.
- The EGR diagnostic is not intrusive.
- The HO2S heaters have been on more than 120 s.
- The predicted catalyst temperature is between 650-900°C (1,202-1,652°F).
- DTCs P013A, P013E, and P2270 have run and passed.

THEN

- DFCO is active.
- The APP is stable.
- The TCC is locked.
- This DTC runs once per trip when the above conditions are met for 3 s.

P2A00

- DTCs P0068, P0106, P0107, P0108, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0128, P0131, P0201, P0202, P0203, P0204, P0220, P0222, P0223, P1516, P2101, P2119, P2135, P2176 are not set.
- The Engine Run Time parameter is more than 100 s.
- The Engine speed parameter is between 500-3,400 RPM.
- The Ignition 1 Signal parameter is between 10-32 V.
- The Mass Airflow (MAF) Sensor parameter is between 3.2-30 g/s.
- The ECT Sensor parameter is more than 70°C (158°F).
- DTC P2A00 runs continuously when the above conditions are met for 5 s.

CONDITIONS FOR SETTING THE DTC

P0133

- The ECM detects that the HO2S 1 average response time is more than a calculated value.
- DTC P0133 sets within 60 s when the above condition is met.

P0134

- The ECM detects that the HO2S 1 parameter is between 400-500 mV for 100 milliseconds.
- The Throttle Position (TP) Indicated Angle parameter changes more than 1 %.
- DTC P0134 sets within 100 s when the above conditions are met.

P013A

- The ECM detects that the EWMA of the normalized integral value equals 8.4 integral units.

OR

- The ECM detects that the accumulated mass air flow monitored during rich-to-lean transitions between 450-150 mV is more than 28 grams.

P013B

- The ECM detects that the EWMA of the normalized integral value equals 8.2 integral units.

OR

- The ECM detects that the accumulated mass air flow monitored during lean-to-rich transitions between 300-600 mV is more than 130 grams.

P013E

The ECM detects that the O2 sensor cannot achieve voltage below 450 mV within 28 grams of accumulated air flow.

P013F

The ECM detects that the O2 sensor cannot achieve voltage above 300 mV within 130 grams of accumulated air flow.

P0140

- The ECM detects that the HO2S 2 parameter is between 400-500 mV.
- The TP Indicated Angle parameter changes more than 1 % 3 times.
- DTC P0140 sets within 100 s when the above conditions are met.

P1133

- The ECM detects that the HO2S 1 rich-to-lean counts, or the lean-to-rich counts are less than a calibrated value.
- DTC P1133 sets within 60 s when the above condition is met.

P2270

- The ECM detects that the O2 sensor cannot achieve voltage equal to or more than 775 mV.

AND

- The ECM detects that the accumulated mass air flow monitored during the Stuck Lean Voltage Test is more than 55 grams.

P2271

- The ECM detects that the O2 sensor cannot achieve voltage equal to or less than 100 mV.

AND

- The ECM detects that the accumulated mass air flow monitored during the Stuck Rich Voltage Test is more than 40 grams.

P2A00

- The ECM detects that the Loop Status parameter is open.
- DTC P2A00 sets within 50 s when the above condition is met.

ACTION TAKEN WHEN THE DTC SETS

- DTCs P0133, P0134, P013E, P013F, P0140, P1133, P2270, P2271, P2A00 are Type B DTCs.
- DTCs P013A and P013B are Type A DTCs.

CONDITIONS FOR CLEARING THE MIL/DTC

- DTCs P0133, P0134, P013E, P013F, P0140, P1133, P2270, P2271, P2A00 are Type B DTCs.
- DTCs P013A and P013B are Type A 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

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

P0133, P013A, P013B, P013E, P013F, or P1133

1. Verify none of the following conditions exist:
 - Lean or rich fuel injectors-Refer to **Fuel Injector Solenoid Coil Test** .
 - Water intrusion in the HO2S harness connector
 - Low or high fuel system pressure-Refer to **Fuel System Diagnosis** .
 - Fuel that is contaminated-Refer to **Alcohol/Contaminants-in-Fuel Diagnosis** .
 - Fuel saturation of the evaporative emission (EVAP) canister

- Exhaust leaks near the HO2S-Refer to **Exhaust Leakage** .
 - 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 HO2S.

P0134, P0140, P2270, P2271, or P2A00

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 - Sensor 1 (LE5)**
- **Heated Oxygen Sensor Replacement - Sensor 2 (LE5)**
- **Control Module References** for replacement, setup and programming

DTC P0171 OR P0172

DIAGNOSTIC INSTRUCTIONS

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

DTC DESCRIPTORS

DTC P0171

Fuel Trim System Lean

DTC P0172

Fuel Trim System Rich

CIRCUIT/SYSTEM DESCRIPTION

The engine control module (ECM) controls 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 FT 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 air/fuel ratio of 14.7:1. 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 sets. If the ECM detects an excessively rich condition, DTC P0172 sets.

CONDITIONS FOR RUNNING THE DTC

- DTCs P0030, P0036, P0053, P0054, P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0128, P0131, P0132, P0133, P0134, P0135, P0137, P0138, P0140, P0141, P0201-P0204, P0220, P0222, P0223, P0300, P0442, P0443, P0446, P0449, P0451, P0452, P0453, P0454, P0455, P0496, P0506, P0507, P060D, P1101, P1133, P1516, P2101, P2119, P2120, P2122, P2123, P2125, P2127, P2128, P2135, P2138, P2176, P2A00, P2A01 are not set.
- The engine is in CL status.
- The engine coolant temperature (ECT) is between -38 and +130°C (-36.4 and +266°F).
- The intake air temperature (IAT) is between -20 and +150°C (-4 and +302°F).
- The manifold absolute pressure (MAP) is between 15-105 kPa.
- The vehicle speed is less than 132 km/h (82 mph).

- The engine speed is between 400-6,600 RPM.
- The mass air flow (MAF) is between 1-512 g/s.
- The barometric pressure (BARO) is more than 70 kPa.
- The fuel level is more than 10 %.
- These DTCs run continuously when the above conditions have been met.

CONDITIONS FOR SETTING THE DTC

- The 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

DTCs P0171 and P0172 are Type B DTCs.

CONDITIONS FOR CLEARING THE MIL/DTC

DTCs P0171 and P0172 are Type B DTCs.

REFERENCE INFORMATION

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

NOTE: 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.

- Verify that other DTCs are not set.
 - If any DTCs are set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
- 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.
 - If the value does not vary from approximately 40 mV to approximately 900 mV, refer to **DTC P0030, P0036, P0053, P0054, P0135, or P0141, DTC P0131, P0132, P0137, or P0138 (LAF) or DTC P0133, P0134, P013A, P013B, P013E, P013F, P0140, P1133, P2270, P2271, or P2A00 (LAF)**.

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

- The normal Short Term FT parameter should be between +10 % and -10 %, with near 0 % the optimum, with the engine running at operating temperature.
- The Long Term FT parameter should be between +10 % and -10 %, with near 0 % the optimum, with the engine running at operating temperature.

CIRCUIT/SYSTEM TESTING

P0171

Allow the engine to reach operating temperature. With the engine running, observe the Long Term FT parameter with a scan tool. The reading should be between 0-25 %.

- If not within the specified range, 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** .
 - If the MAP sensor does not indicate the correct barometric pressure, refer to **DTC P0106**.
- With the engine idling, observe the mass air flow (MAF) sensor parameter. The MAF sensor parameter should be between 2-6 g/s at idle.
 - If the MAF sensor parameter is not between 2-6 g/s at idle, refer to **DTC P0101** or **DTC P0102 or P0103**.
- Vacuum hoses for splits, kinks, and improper connections
- Insufficient fuel in the tank
- Low fuel pressure-Refer to **Fuel System Diagnosis** .
- Ethanol concentration greater than 15 %-Refer to **Alcohol/Contaminants-in-Fuel Diagnosis** .
- Fuel contamination-Refer to **Alcohol/Contaminants-in-Fuel Diagnosis** .
- 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-Refer to **Crankcase Ventilation System Inspection/Diagnosis (Without Turbocharger)** .
- 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

Allow the engine to reach operating temperature. With the engine running, observe the Long Term FT parameter with a scan tool. The reading should be between -24 and 0 %.

- If not within the specified range, 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 20-48 kPa.
 - If the MAP sensor parameter is not between 20-48 kPa, refer to **DTC P0106**.
 - With the engine idling, observe the mass air flow (MAF) sensor parameter. The MAF sensor parameter should be between 2-6 g/s at idle.
 - If the MAF sensor parameter is not between 2-6 g/s at idle, refer to **DTC P0101** or **DTC P0102 or P0103**.
- 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 EVAP control system for improper operation
- Malfunctioning fuel injectors-Refer to **Fuel Injector Solenoid Coil Test** .
- Fuel contamination-Refer to **Alcohol/Contaminants-in-Fuel Diagnosis** .
- 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 VERIFICATION

NOTE: **After repairs, use the scan tool Fuel Trim Reset function in order to reset the Long Term Fuel Trim.**

1. Install any components or connectors that have been removed or replaced during diagnosis.
2. Perform any adjustment, programming, or set-up 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 that the DTC does not reset. If the DTC resets, or another DTC is present, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** and perform the appropriate diagnostic procedure.
8. To verify that the performance of the catalytic converter has not been affected by the condition that set this DTC, perform the Repair Verification for DTC P0420. Refer to **DTC P0420** .

DTC 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

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.
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.

- **Fuel Injection Fuel Rail Fuel Pressure Sensor Replacement (LAF)**
- **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 DESCRIPTORS

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, P0641	P0192	P0641	P0191
Fuel Rail Pressure Sensor Signal	P0192	P0192	P0193	P0191
Low Reference	-	P0193, P0506	-	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 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 and 2

- DTC P0016, P0017, P0068, P0090, P0091, P0092, P00C8, P00C9, P00CA, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0121, P0122, P0123, P0128, P0192, P0193, P0201, P0202, P0203, P0204, P0222, P0223, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0300, P0301, P0302, P0303, P0304, P0335, P0336, P0340, P0341, P0365, P0366, P0627, P0628, P0629, P1248, P1249, P124A, P124B, P1682, P16F3, P2101, P2122, P2123, P2127, P2128, P2135, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157 is not set.

- The engine is not cranking.
- The ignition voltage is more than 11 V.
- The engine speed is between 1,000-2,000 RPM.
- The vehicle speed is greater than or equal to 45 km/h (27.96 mph).
- The low side fuel pressure is greater than or equal to 275 kPa (40 psi).
- The Desired Fuel Rail Pressure is between 7-9 MPa (1,015-1,305 psi).
- DTC P0191 runs continuously when the above conditions have been met.

Condition 3

- DTC P0016, P0017, P0068, P0090, P0091, P0092, P00C8, P00C9, P00CA, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0121, P0122, P0123, P0128, P0192, P0193, P0201, P0202, P0203, P0204, P0222, P0223, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0300, P0301, P0302, P0303, P0304, P0335, P0336, P0340, P0341, P0365, P0366, P0627, P0628, P0629, P1248, P1249, P124A, P124B, P1682, P16F3, P2101, P2122, P2123, P2127, P2128, P2135, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157 is not set.
- The engine is not cranking.
- The vehicle speed is greater than or equal to 30 km/h (18.64 mph).
- The engine speed is greater than or equal to 2,000 RPM.
- DTC P0191 runs continuously when the above conditions have been met.

CONDITIONS FOR SETTING THE DTC

Condition 1

The difference between the relief pressure and the measured high pressure is less than or equal to -3 MPa (-435 psi) for greater than 3 s.

Condition 2

The difference between the commanded high pressure and the measured high pressure is greater than or equal to 0.9 MPa (131 psi) and the modeled injection pressure is greater than or equal to 2 MPa (290 psi) for greater than 3 s.

Condition 3

The difference between the measured maximum high pressure and the measured minimum high pressure is less than or equal to 0.1 MPa (14.5 psi) for greater than 60 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

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, P0641, 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 fuel injector multi-way harness connector X111.

NOTE: **Testing for steps 2 through 5 is performed on the ECM side of the multi-way harness connector.**

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 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.
3. 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.
4. 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.
5. 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.
6. Ignition OFF, remove the intake manifold.
7. Connect the fuel injector multi-way harness connector X111.

NOTE: **Testing for steps 9 through 12 is performed at the fuel rail fuel pressure sensor connector.**

8. Disconnect the B47 fuel rail fuel pressure sensor connector.
9. 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.
10. 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.
11. 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.
 12. 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.
 13. 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 Injection Fuel Rail Fuel Pressure Sensor Replacement (LAF)**
- **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, P0641	P0192	P0641	P0191
Fuel Rail Pressure Sensor Signal	P0192	P0192	P0193	P0191
Low Reference	-	P0193, P0506	-	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 greater than 11 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 for greater than 6 s.

P0193

The ECM detects that the fuel rail fuel pressure sensor signal voltage is high for greater than 6 s.

ACTION TAKEN WHEN THE DTC SETS

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

CONDITIONS FOR CLEARING THE DTC

DTCs P0192 and P0193 are Type A DTCs.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Fuel System Description

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. Ignition ON, 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 fuel injector multi-way harness connector X111.

NOTE: **Testing for steps 2 through 5 is performed on the ECM side of the multi-way harness connector.**

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 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.
3. 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.
4. 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.
5. 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.

6. Ignition OFF, remove the intake manifold.

7. Connect the fuel injector multi-way harness connector X111.

NOTE: **Testing for steps 9 through 12 is performed at the fuel rail fuel pressure sensor connector.**

8. Disconnect the B47 fuel rail fuel pressure sensor connector.

9. 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.

10. 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.

11. 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.

12. 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.

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

DTC P0201-P0204, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P1248, P1249, P124A, P124B, P2147, P2148, P2150, P2151, P2153, P2154, P2156, OR P2157

DIAGNOSTIC INSTRUCTIONS

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

DTC DESCRIPTORS

DTC P0201

Cylinder 1 Injector Control Circuit

DTC P0202

Cylinder 2 Injector Control Circuit

DTC P0203

Cylinder 3 Injector Control Circuit

DTC P0204

Cylinder 4 Injector Control Circuit

DTC P0261

Cylinder 1 Injector Control Circuit Low Voltage

DTC P0262

Cylinder 1 Injector Control Circuit High Voltage

DTC P0264

Cylinder 2 Injector Control Circuit Low Voltage

DTC P0265

Cylinder 2 Injector Control Circuit High Voltage

DTC P0267

Cylinder 3 Injector Control Circuit Low Voltage

DTC P0268

Cylinder 3 Injector Control Circuit High Voltage

DTC P0270

Cylinder 4 Injector Control Circuit Low Voltage

DTC P0271

Cylinder 4 Injector Control Circuit High Voltage

DTC P1248

Cylinder 1 Injector High Control Circuit Shorted to Control Circuit

DTC P1249

Cylinder 2 Injector High Control Circuit Shorted to Control Circuit

DTC P124A

Cylinder 3 Injector High Control Circuit Shorted to Control Circuit

DTC P124B

Cylinder 4 Injector High Control Circuit Shorted to Control Circuit

DTC P2147

Cylinder 1 Injector High Control Circuit Low Voltage

DTC P2148

Cylinder 1 Injector High Control Circuit High Voltage

DTC P2150

Cylinder 2 Injector High Control Circuit Low Voltage

DTC P2151

Cylinder 2 Injector High Control Circuit High Voltage

DTC P2153

Cylinder 3 Injector High Control Circuit Low Voltage

DTC P2154

Cylinder 3 Injector High Control Circuit High Voltage

DTC P2156

Cylinder 4 Injector High Control Circuit Low Voltage

DTC P2157

Cylinder 4 Injector High Control Circuit High Voltage

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Short from Supply Circuit to Control Circuit
Direct Fuel Injector High Voltage Supply Cylinder 1	P2147	P0201	P2148	P1248
Direct Fuel Injector High Voltage Control Cylinder 1	P0261	P0201	P0262, P2148	P1248
Direct Fuel Injector High Voltage Supply Cylinder 2	P2150	P0202	P2151	P1249
Direct Fuel Injector High Voltage Control Cylinder 2	P0264	P0202	P0265, P2151	P1249
Direct Fuel Injector High Voltage Supply Cylinder 3	P2153	P0203	P2154	P124A
Direct Fuel Injector High Voltage Control Cylinder 3	P0267	P0203	P0268, P2154	P124A
Direct Fuel Injector High Voltage Supply Cylinder 4	P2156	P0204	P2157	P124B
Direct Fuel Injector High Voltage Control Cylinder 4	P0270	P0204	P0271, P2157	P124B

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

- DTC P062B is not set.
- The engine is running for greater than 5 s.
- The ignition voltage is greater than 11 V.
- The DTCs run continuously once the above conditions are met.

CONDITIONS FOR SETTING THE DTC

P0201, P0202, P0203, or P0204

The ECM detects the injector high voltage supply circuit or the injector high voltage control circuit is open for greater than 2 s.

P0261, P0264, P0267, or P0270

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

P0262, P0265, P0268, or P0271

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

P1248, P1249, P124A, or P124B

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

P2147, P2150, P2153, or P2156

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

P2148, P2151, P2154, or P2157

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

ACTION TAKEN WHEN THE DTC SETS

DTCs P0201, P0202, P0203, P0204, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P1248, P1249, P124A, P124B, P2147, P2148, P2150, P2151, P2153, P2154, P2156, and P2157 are Type A DTCs.

CONDITIONS FOR CLEARING THE DTC

DTCs P0201, P0202, P0203, P0204, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P1248, P1249, P124A, P124B, P2147, P2148, P2150, P2151, P2153, P2154, P2156, and P2157 are Type A DTCs.

DIAGNOSTIC AIDS

- Performing the fuel injector coil test may help isolate an intermittent condition. Refer to **Fuel Injector 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

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, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P1248, P1249, P124A, P124B, P2147, P2148, P2150, P2151, P2153, P2154, P2156, or P2157 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 1-4 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 fuel injector multi-way harness connector X111.
2. Ignition ON, observe the appropriate scan tool Cylinder 1-4 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.

- **Direct Fuel Injector Replacement (LAF)**

- **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

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

DTC P025A

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 P025A

Fuel Pump Control Module Enable Circuit

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open or High Resistance	Short to Voltage	Signal Performance
FPCM Control	P025A	P025A	-	P025A

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

The ignition is ON.

CONDITIONS FOR SETTING THE DTC

The serial data message from the ECM to the fuel pump control module does not agree with the state of the control enable voltage signal supplied from the ECM to the fuel pump control module for more than 2 seconds.

ACTION TAKEN WHEN THE DTC SETS

DTC P025A is a Type A DTC.

CONDITIONS FOR CLEARING THE DTC

DTC P025A is a Type A DTC.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Fuel System Description

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the harness connector at the K27 fuel pump control module.
2. Ignition OFF, connect a test lamp between the control circuit terminal 20 and ground.
3. Ignition ON, command the fuel pump ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.
 - If the test lamp is always ON, test the control circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.
 - 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 K20 ECM.
4. If all circuits test normal, replace the K27 fuel pump control module.

REPAIR PROCEDURES

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

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