

2017 ENGINE PERFORMANCE

Engine Controls and Fuel - 1.4L (LE2) - Diagnostic Information and Procedures - Encore

DIAGNOSTIC INFORMATION AND PROCEDURES

DTC P0010, P0013, OR P2088-P2091: INTAKE/EXHAUST CAMSHAFT POSITION ACTUATOR SOLENOID VALVE CONTROL CIRCUIT

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.
- Refer to [Diagnostic Procedure Instructions](#) to provide 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

DTC P2088

Intake Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage

DTC P2089

Intake Camshaft Position Actuator Solenoid Valve Control Circuit High Voltage

DTC P2090

Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage

DTC P2091

Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit High Voltage

Diagnostic Fault Information

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

Circuit/System Description

The camshaft position actuator system enables the engine control module (ECM) to change the timing of the camshafts while the engine is operating. The camshaft position actuator solenoid valves are each supplied a dedicated pulse width modulated (PWM) control circuit and low reference circuit from the ECM. The ECM operates each camshaft position actuator solenoid valve by controlling the amount of

solenoid valve duty cycle to control the oil flow that applies the pressure to advance or retard the camshafts.

Conditions for Running the DTC

- The ignition voltage is greater than 11 V
- The ignition switch is in the crank or run position.
- The ECM has commanded the camshaft position actuator solenoid valve On.

The DTCs 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.

Actions Taken When the DTC Sets

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

If equipped with a turbocharger = Type A DTC

Conditions for Clearing the DTC

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

If equipped with a turbocharger = Type A DTC

Reference Information

Schematic Reference

Engine Controls Schematics (Buick with LE2)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX (ENCORE)

Component View Reference

Powertrain Component Views (Buick)

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/Vehicle in Service Mode.
2. Verify DTC P0335, P0336, P0340, or P0341 is not set.

- **If the DTC is set**

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

- **If the DTC is not set**

3. Engine Running.
4. Verify the scan tool parameters listed below do not display Malfunction while commanding the appropriate Camshaft Position Actuator Solenoid Valve On and Off:
 - Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit Open Test Status
 - Intake Camshaft Position Actuator Solenoid Valve Control Circuit Open Test Status
 - Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage Test Status
 - Intake Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage Test Status
 - Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit High Voltage Test Status
 - Intake Camshaft Position Actuator Solenoid Valve Control Circuit High Voltage Test Status
5. Verify that none of the scan tool Camshaft Position Actuator Solenoid Valve Control Circuit Test Status parameters change from OK or Not Run to Malfunction while moving the related harness/connectors of the Q6 Camshaft Position Actuator Solenoid Valves.

- **If Malfunction is displayed**

Refer to Circuit/System Testing.

- **If Malfunction is not displayed**

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

Refer to Circuit/System Testing.

- **If the DTC does not set**

8. All OK.

Circuit/System Testing

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

4. Verify the appropriate scan tool Camshaft Position Actuator Solenoid Valve Control Circuit High Voltage Test Status does not display Malfunction.

- **If Malfunction is displayed**

1. Ignition/Vehicle Off, disconnect the harness connector at the K20 Engine Control Module, ignition On/Vehicle in Service Mode.
2. Test for less than 1 V between the control circuit and ground.
 - If greater than 1 V, repair the short to voltage on the control circuit.
 - If less than 1 V, replace the K20 Engine Control Module.

- **If Malfunction is not displayed**

5. Ignition/Vehicle Off, install a 5 A fused jumper wire between the control circuit terminal 1 or A and B+, engine Running.
6. Verify the appropriate scan tool Camshaft Position Actuator Solenoid Valve Control Circuit High Voltage Test Status displays Malfunction.

- **If Malfunction is not displayed**

1. Ignition/Vehicle Off, remove the fused jumper, and disconnect the harness connector at the K20 Engine Control Module.
2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the control circuit.
 - If infinite resistance
3. Test for less than 2 Ω in the control circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.

- **If Malfunction is displayed**

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

Component Testing

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

Replace the Q6 Camshaft Position Actuator Solenoid Valve.
 - **If between 7-12 Ω**
3. Test for infinite resistance between each terminal and the Q6 Camshaft Position Actuator Solenoid Valve housing.
 - **If not infinite resistance**

Replace the Q6 Camshaft Position Actuator Solenoid Valve.
 - **If infinite resistance**
4. All OK.

Repair Instructions

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

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

DTC P0011 OR P0014: INTAKE/EXHAUST CAMSHAFT POSITION SYSTEM PERFORMANCE

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.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptors

DTC P0011

Intake Camshaft Position System Performance

DTC P0014

Exhaust Camshaft Position System Performance

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Intake Actuator Solenoid Control	P0010	P0010	P0010	P0011
Exhaust Actuator Solenoid Control	P0013	P0013	P0013	P0014
Intake Actuator Solenoid Low Reference	-	P0010, P0011	-	P0011
Exhaust Actuator Solenoid Low Reference	-	P0013, P0014	-	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 valves are each supplied a dedicated pulse width modulated (PWM) control circuit and low reference circuit from the ECM. The ECM operates each camshaft position actuator solenoid valve by controlling the amount of solenoid valve signal duty cycle to control the oil flow that applies the pressure to advance or retard the camshafts.

Conditions for Running the DTC

- DTC P0010, P0013, P2088, P2089, P2090 or P2091 is not set.
- The engine is running.
- The ignition voltage is greater than 11 V.
- The camshaft position actuator is enabled.
- The desired camshaft position variation is less than 3° for 4 s.

The DTCs run continuously once the above conditions are met.

Conditions for Setting the DTC

The ECM detects a difference of greater than 8° between the camshaft position angle position and the desired camshaft position for greater than 30 s.

Action Taken When the DTC Sets

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

If equipped with a turbocharger = Type A DTC

- The camshaft position actuator solenoid valve - intake and camshaft position actuator solenoid valve - exhaust are commanded to the park position.

Conditions for Clearing the DTC

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

If equipped with a turbocharger = Type A DTC

Diagnostic Aids

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

Reference Information

Schematic Reference

Engine Controls Schematics (Buick with LE2)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX (ENCORE)

Component View Reference

Powertrain Component Views (Buick)

Description and Operation

Camshaft Actuator System Description

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

NOTE:

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

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

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

Repair as necessary

- If the oil condition, level, and oil pressure are correct

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

- If any DTCs other than P0011 or P0014 are set

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

- If only DTC P0011 or P0014 is set

1. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
2. Verify the DTC does not set.
 - If the DTC sets, refer to Circuit/System Testing.
 - If the DTC does not set, all OK.
 - **If none of the DTCs are set**
3. All OK.

Circuit/System Testing

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

1. Ignition/Vehicle Off, disconnect the harness connector at the appropriate Q6 Camshaft Position Actuator Solenoid Valve, ignition On/vehicle in Service Mode.
2. Verify a test lamp illuminates between the control circuit terminal 1 or A and ground when commanding the appropriate Camshaft Position Actuator Solenoid Valve On with a scan tool.
 - **If the test lamp does not illuminate**
 1. Ignition/Vehicle Off, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for less than 2 Ω in the control circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance or short to ground in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **If the test lamp illuminates**
3. Ignition/Vehicle Off.
4. Remove the appropriate Q6 Camshaft Position Actuator Solenoid Valve. Inspect the Camshaft Position Actuator Solenoid Valve and mounting area for the following conditions:
 - For a torn, restricted, incorrect positioned, or missing screens at the Q6 Camshaft Position Actuator Solenoid Valve
 - For engine oil leaks between the oil sealing lands of the Q6 Camshaft Position Actuator Solenoid Valve
 - For oil seepage at the Q6 Camshaft Position Actuator Solenoid Valve connector
 - **If a condition is found**

Replace the Q6 Camshaft Position Actuator Solenoid Valve.
 - **If a condition is not found**

NOTE: This step is testing the mechanical operation of the camshaft position actuator solenoid valve that set the DTC.

5. Exchange the suspected Q6 Camshaft Position Actuator Solenoid Valve with a Q6 Camshaft Position Actuator Solenoid Valve that is operating correctly.
6. Engine Running.
7. Command the appropriate camshaft position actuator from 0 degrees to 20 degrees and back to zero while observing the appropriate scan tool Intake/Exhaust Camshaft Position Variance parameters. The Intake/Exhaust Camshaft Position Variance should be less than 2 degrees in each of the commanded states.
 - **If the Camshaft Position Variance parameter is greater than 2 degrees**

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

Component Testing

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

Replace the Q6 Camshaft Position Actuator Solenoid Valve.
 - **If between 7-12 Ω**
3. Test for infinite resistance between each terminal and the Q6 Camshaft Position Actuator Solenoid Valve housing.
 - **If not infinite resistance**

Replace the Q6 Camshaft Position Actuator Solenoid Valve.
 - **If infinite resistance**
4. All OK.

Repair Instructions

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

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

DTC P0016 OR P0017: CRANKSHAFT POSITION - INTAKE/EXHAUST CAMSHAFT POSITION NOT PLAUSIBLE

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.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptors

DTC P0016

Crankshaft Position - Intake Camshaft Position Not Plausible

DTC P0017

Crankshaft Position - Exhaust Camshaft Position Not Plausible

Circuit/System Description

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

Conditions for Running the DTC

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

The DTCs run continuously once the above conditions are met.

Conditions for Setting the DTC

The ECM detects a camshaft that is greater than 8 degrees advanced or 12 degrees retarded in relationship to the crankshaft.

Actions Taken When the DTC Sets

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

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

Conditions for Clearing the DTC

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

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

Diagnostic Aids

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

Reference Information

Description and Operation

Camshaft Actuator System Description

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify DTC P0010, P0013, P0335, P0336, P0340, P0341, P0365, or P0366 is not set.

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

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

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

3. Engine Running at normal operating temperature.
4. Verify DTC P0016 or P0017 is not set.

- **If the DTC is set**

Inspect for the following and repair as necessary:

- A Q6 Camshaft Position Actuator Solenoid Valve that is stuck in the full advance or retard position.
- The correct installation of the Q6 Camshaft Position Actuator Solenoid Valves.
- The correct installation of the B23 Camshaft Position Sensors.
- The correct installation of the B26 Crankshaft Position Sensor.
- A timing chain tensioner condition.
- An incorrectly installed timing chain.
- Excessive play in the timing chain.
- A timing chain that jumped teeth.

- A crankshaft reluctor wheel that has moved in relationship to top dead center (TDC) on the crankshaft.
 - **If the DTC is not set**
5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
6. Verify the DTC does not set.
- **If the DTC sets**
- A mechanical condition listed above still exists.
- **If the DTC does not set**
7. All OK.

Repair Instructions

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

- Refer to [Camshaft Position Actuator Solenoid Valve Replacement - Exhaust](#)
- Refer to [Camshaft Position Actuator Solenoid Valve Replacement - Intake](#)
- Refer to [Camshaft Position Sensor Replacement - Exhaust](#)
- Refer to [Camshaft Position Sensor Replacement - Intake](#)
- Refer to [Crankshaft Position Sensor Replacement \(AWD\). Crankshaft Position Sensor Replacement \(FWD\)](#)
- Refer to [Camshaft Timing Chain and Sprocket Cleaning and Inspection](#)

DTC P0030-P0032, P0036-P0038, P0053, P0054, P0135, OR P0141: HO2S HEATER

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.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptors

DTC P0030

HO2S Heater Control Circuit Sensor 1

DTC P0031

HO2S Heater Control Circuit Low Voltage Sensor 1

DTC P0032

HO2S Heater Control Circuit High Voltage Sensor 1

DTC P0036

HO2S Heater Control Circuit Sensor 2

DTC P0037

HO2S Heater Control Circuit Low Voltage Sensor 2

DTC P0038

HO2S Heater Control Circuit High Voltage Sensor 2

DTC 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	Open/High Resistance	Short to Voltage	Signal Performance
HO2S Heater Voltage Supply	P0030, P0036, P0037, P0132, P0135, P0138, P0141, *	P0030, P0036, P0132, P0135, P0138, P0141	P0690	P0135, P0141
HO2S Heater Control	P0030, P0031, P0036, P0037, P0053, P0054, P0135, P0141	P0030, P0036, P0132, P0135, P0138, P0141	P0030, P0032, P0036, P0038, P0132, P0135, P0138, P0141, P0690	P0135, P0141
* Opens Fuse				

Circuit/System Description

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

Conditions for Running the DTC

P0030, P0031, P0032, P0036, P0037 and P0038

- The Ignition voltage is between 11-32 V.
- The engine speed is greater than 400 RPM.

The DTCs run continuously when the above conditions are met for greater than 5 s.

P0053 and P0054

- DTCs P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0119 or P2610 are not set.
- The Ignition voltage is less than 32 V.
- The Ignition is OFF for greater than 8 h.
- The engine is running.
- The engine coolant temperature and the intake air temperature (IAT) are within 8Â°C (14Â°F).
- The engine coolant temperature is between -30 to +125Â°C (-22 to +257Â°F).

The DTCs run once per valid cold start-up when the above conditions are met.

P0135 and P0141

- DTCs P0116, P0117, P0118, P0119 or P0128 are not set.

- The Ignition voltage is between 10-32 V.
- The heated oxygen sensor heaters are at operating temperature.
- The scan tool HO2S Heater device control is not active.
- The commanded HO2S heater duty cycle is greater than 0%.

The DTCs run twice per drive cycle when the above conditions are met for greater than 120 s.

Conditions for Setting the DTC

P0030, P0031, P0032, P0036, P0037 and P0038

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

P0053 and P0054

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

P0135 and P0141

The ECM detects the HO2S heater current is less than 0.30 A or greater than 2.5 A for greater than 10 s.

Action Taken When the DTC Sets

DTC P0030, P0031, P0032, P0036, P0037, P0038, P0053, P0054, P0135, and P0141 are Type B DTCs.

Conditions for Clearing the DTC

DTC P0030, P0031, P0032, P0036, P0037, P0038, 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 status parameters for the component. The circuit status parameters will change from OK or Not Run to Malfunction if there is a condition with the circuit or a connection.
- An open fuse in the 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 with a scan tool to determine if one of the heater elements is the cause of the open fuse. Inspect the sensor pigtail or the harness for contacting the exhaust system.

Reference Information

Schematic Reference

Engine Controls Schematics (Buick with LE2)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX (ENCORE)

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Control Module References for scan tool information

Circuit/System Verification

1. Engine running.
2. Verify the parameters listed below do not display Malfunction.
 - HO2S 1 or 2 Heater Control Circuit High Voltage Test Status
 - HO2S 1 or 2 Heater Control Circuit Open Voltage Test Status
 - HO2S 1 or 2 Heater Control Circuit Low Voltage Test Status
 - **If Malfunction is displayed**

Refer to Circuit/System Testing.
 - **If Malfunction is not displayed**
3. Observe the scan tool HO2S 1 Heater or HO2S 2 Heater parameter. The amperage should be between 0.2-2.4 A.
 - **If not between 0.2-2.4 A**

Refer to Circuit/System Testing.
 - **If between 0.2-2.4 A**
4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed in the Freeze Frame/Failure Records data.
5. Verify the DTC does not set.
 - **If the DTC sets**

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

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the appropriate B52 Heated Oxygen Sensor, ignition ON.
2. Verify that a test lamp illuminates between the ignition voltage circuit terminal 2 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF.
 2. Test for less than 2 Ω in the ignition circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF.
 2. Test for infinite resistance between the test points: Ignition circuit terminal 2 & Ground
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, test all components connected to the fuse and replace as necessary.
 - **If the test lamp illuminates**
3. Verify that a test lamp does not illuminate between the ignition voltage circuit terminal 2 and the control circuit terminal 1.
 - **If the test lamp illuminates**
 1. Ignition OFF, disconnect the harness connector X2 at the K20 Engine Control Module.
 2. Test for infinite resistance between the test points: Ignition circuit terminal 2 & Ground
 - If less than infinite resistance, repair the short to ground on the circuit.

- If infinite resistance, replace the K20 Engine Control Module.
 - **If the test lamp does not illuminate**
4. Remove the test lamp.
 5. Engine running, verify the scan tool HO2S 1 or 2 Heater Control Circuit Open Test Status parameter displays Malfunction.
 - **If Malfunction is not displayed**
 1. Ignition OFF, disconnect the harness connector X2 at the K20 Engine Control Module. Ignition ON.
 2. Test for less than 1 V between the test points: Control circuit terminal 1 & Ground
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.
 - **If Malfunction is displayed**

NOTE:

- **Less than 10 Ω of additional resistance on the ignition voltage circuit or control circuit may set a DTC. If there is resistance on a circuit, the driver will remain ON and the scan tool HO2S High Voltage Test Status parameter will display OK.**
 - **Performing this test may set additional DTCs.**
6. Ignition OFF, install a 3 A fused jumper wire between the control circuit terminal 1 and ground. Engine running.
 7. Verify the scan tool HO2S 1 or 2 Heater Control Circuit Low Voltage Test Status parameter is Malfunction.
 - **If Malfunction is not displayed**
 1. Ignition OFF, disconnect the harness connector X2 at the K20 Engine Control Module.
 2. Test for less than 2 Ω in the control circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **If Malfunction is displayed**
 8. Test or replace the B52 Heated Oxygen Sensor.

Repair Instructions

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

- Refer to **Heated Oxygen Sensor Replacement - Sensor 1**
- Refer to **Heated Oxygen Sensor Replacement - Sensor 2**
- Perform the scan tool Heated Oxygen Sensor Resistance Learn Reset after replacing a HO2S.
- Refer to **Control Module References** for ECM replacement, programming and setup

DTC P0033-P0035: TURBOCHARGER BYPASS SOLENOID VALVE CONTROL CIRCUIT

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.
- Refer to **Diagnostic Procedure Instructions** to provide an overview of each diagnostic category.

DTC Descriptors

DTC P0033

Turbocharger Bypass Solenoid Valve Control Circuit

DTC P0034

DTC P0035

Turbocharger Bypass Solenoid Valve Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Ignition Voltage Circuit	P0033, P0034, P0243, P0245*	P0033	P0033	-	-
Turbocharger Bypass Valve Solenoid Control Circuit	P0033, P0034	P0033, P0034	P0033, P0034	P0035, P0690	P0033
* Ignition fuse opens.					

Circuit/System Description

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

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

Conditions for Running the DTCs

- Ignition is On or the engine is running.
- Battery voltage is at least 11 V.
- Run/Crank voltage is greater than 5 V.
- The DTCs run continuously when the above conditions are met.

Conditions for Setting the DTCs

The ECM detects an open, a short to ground, or a short to voltage on the turbocharger bypass solenoid valve control circuit for greater than 2 s.

Action Taken When the DTCs Set

- DTCs P0033, P0034, and P0035 are Type A DTCs.
- The Service Vehicle Soon Indicator may illuminate.

Conditions for Clearing the MIL/DTCs

DTCs P0033, P0034, and P0035 are Type A DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics (Buick with LE2)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX (ENCORE)

Turbocharger System Description

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

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

Circuit/System Verification

1. Ignition On
2. Verify a click is heard or felt from the Q40 Turbocharger Bypass Solenoid Valve when commanding the Turbocharger Bypass Solenoid Valve between Active and Inactive with a scan tool.
 - **If a click is not heard or felt**
Refer to Circuit/System Testing
 - **If a click is heard or felt**
3. Verify the circuit status parameters listed below do not display Malfunction when commanding the Turbocharger Bypass Solenoid Valve between Active and Inactive with a scan tool:
 - Turbocharger Bypass Solenoid Valve Control Circuit High Voltage Test Status
 - Turbocharger Bypass Solenoid Valve Control Circuit Open Test Status
 - Turbocharger Bypass Solenoid Valve Control Circuit Low Voltage Test Status
 - **If Malfunction is displayed**
Refer to Circuit/System Testing
 - **If Malfunction is not displayed**
4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
5. Verify a DTC does not set.
 - **If a DTC sets**
Refer to Circuit/System Testing
 - **If a DTC does not set**
6. All OK

Circuit/System Testing

1. Ignition Off, disconnect the harness connector at the Q40 Turbocharger Bypass Solenoid Valve, ignition On.
2. Verify a test lamp illuminates between the ignition circuit terminal 1 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition Off.
 2. Test for less than 2 Ω in the ignition circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.

- If less than 2 Ω , verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition Off, remove the test lamp.
- NOTE:** **A short circuit in any component supplied by the fuse may cause the fuse to open and set a DTC when the component is activated.**

2. Test for infinite resistance between the ignition circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, test all components supplied by the fuse and replace as necessary.
- **If the test lamp illuminates**
3. Verify that a test lamp does not illuminate between the control circuit terminal 2 and the ignition circuit terminal 1.
 - **If the test lamp illuminates**
 1. Ignition Off, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K20 Engine Control Module.
 - **If the test lamp does not illuminate**
4. Remove the test lamp.
5. Verify the scan tool Turbocharger Bypass Solenoid Valve Control Circuit High Voltage Test Status parameter is OK when commanding the Turbocharger Bypass Solenoid Valve between Active and Inactive with a scan tool.
 - **If OK is not displayed**
 1. Ignition Off, disconnect the harness connector at the K20 Engine Control Module, ignition On.
 2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.
 - **If OK is displayed**
6. Install a 3 A fused jumper wire between the control circuit terminal 2 and the ignition circuit terminal 1.
7. Verify the scan tool Turbocharger Bypass Solenoid Valve Control Circuit High Voltage Test Status parameter is Malfunction when commanding the Turbocharger Bypass Solenoid Valve between Active and Inactive with a scan tool.
 - **If Malfunction is not displayed**
 1. Ignition Off, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for less than 2 Ω in the control circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **If Malfunction is displayed**
8. Test or replace the Q40 Turbocharger Bypass Solenoid Valve.

Component Testing

Static Test

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

Replace the Q40 Turbocharger Bypass Solenoid Valve.

- **If between 10-14 Ω**

3. All OK

Dynamic Test

1. Install a 10 A fused jumper wire between the ignition terminal 2 of the Q40 Turbocharger Bypass Solenoid Valve and 12 V. Install a jumper wire between the control terminal 1 and ground.
2. Verify the Q40 Turbocharger Bypass Solenoid Valve plunger retracts.

- **If the plunger does not retract.**

Replace the Q40 Turbocharger Bypass Solenoid Valve.

- **If the plunger retracts.**

3. All OK

Repair Instructions

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

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

DTC P0068 OR P1101: THROTTLE BODY/INTAKE AIR FLOW PERFORMANCE

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.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptor

DTC P0068

Throttle Body Air Flow Performance

DTC P1101

Intake Air Flow System Performance

Circuit/System Description

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

Conditions for Running the DTC

DTC P0068

- Engine speed is at least 800 RPM.
- Ignition voltage is at least 6.4 V.

The DTC runs continuously when the above conditions are met.

DTC P1101

- DTC P0101, P0102, P0103, P0107, P0108, P0111, P0112, P0113, P0116, P0117, P0118, P0128, P0335, or P0336 is not set
- Engine speed is between 400-6,100 RPM
- Engine coolant temperature (ECT) is between -7 to +125 $^{\circ}\text{C}$ (+19 to +257 $^{\circ}\text{F}$).

- Intake air temperature (IAT) is between -20 to +125Å°C (-4 to +257Å°F).

The DTC runs continuously when the above conditions are met.

Conditions for Setting the DTCs

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

Action Taken When the DTCs Set

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

Conditions for Clearing the DTCs

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

Reference Information

Schematic Reference

Engine Controls Schematics (Buick with LE2)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX (ENCORE)

Electrical Information Reference

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

Powertrain Component Views

Powertrain Component Views (Buick)

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

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

Refer to Diagnostic Trouble Code (DTC) List - Vehicle for further diagnosis.
 - **If none of the DTCs are set**
3. If you were sent here from DTC P0106, P0121, or P0236; refer to Circuit/System Testing.
4. Ignition ON, verify the scan tool Throttle Body Idle Air Flow Compensation parameter is less than 90%.
 - **90% or greater**

Refer to Throttle Body Inspection and Cleaning .

- **If less than 90%**

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

- **If Disagree**

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

- **If Agree**

6. Determine the current vehicle testing altitude.

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

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

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

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

8. Verify the engine is equipped with a turbocharger.

- **If not equipped with a turbocharger**

Refer to Step 11.

- **If equipped with a turbocharger**

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

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

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

- **If the Boost Pressure Sensor parameter is within range**

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

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

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

- **If the Boost Pressure Sensor parameter does decrease**

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

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

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

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

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

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

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

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

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

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

14. Verify the DTC does not set.

- **If the DTC sets**

Refer to Circuit/System Testing.

- **If the DTC does not set**

15. All OK

Circuit/System Testing

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

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

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

Repair or replace component as appropriate.

- **If no condition is found**

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

- **If a condition is found**

Repair or replace component as appropriate.

- **If no condition is found**

3. All OK

Repair Instructions

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

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

DTC P0089, P00C6, P228C, OR P228D: FUEL PRESSURE

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.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptors

DTC P0089

DTC P00C6

Fuel Rail Pressure Low During Engine Cranking

DTC P228C

Fuel Pressure Regulator Control Performance - Low Pressure

DTC P228D

Fuel Pressure Regulator Control Performance - High Pressure

Circuit/System Description

The high fuel pressure necessary for direct injection is supplied by the high pressure fuel pump. The high pressure fuel pump is mounted on the rear of the engine and is driven by a four-lobe cam on the camshaft. This high pressure fuel pump also regulates the fuel pressure using an actuator in the form of an internal solenoid-controlled valve. In order to keep the engine running efficiently under all operating conditions, the engine control module (ECM) requests pressure ranging from 2 to 15 MPa (290 to 2,176 PSI), depending on engine speed and load. Output drivers in the ECM provide the high pressure fuel pump control circuit with a 12 V pulse-width modulated (PWM) signal, which regulates fuel pressure by opening and closing the control valve at specific times during pump strokes. This effectively regulates the portion of each pump stroke that is delivered to the fuel rail. The high pressure fuel pump is normally closed and will not deliver an increase in fuel pressure when the control solenoid is NOT powered. In the event of pump control failure, the high pressure system is protected by a relief valve in the pump that prevents the pressure from exceeding 24 MPa (3,481 PSI).

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

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

Conditions for Running the DTC**P0089, P228C, or P228D**

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

P00C6

- DTC P0016, P0017, P0090, P0091, P0092, P00C8, P00C9, P00CA, P0111, P0112, P0113, P0114, P0117, P0118, P0119, P0128, P0192, P0193, P0335, P0336, P0340, P0341, P0365, P0366, P0627, P0628, P0629, or P1682 are not present.
- Ignition voltage is greater than 8 V.
- Engine coolant temperature is less than 65°C (149°F).

- Low side fuel pressure is greater than 300 kPa (44 PSI).
- Vehicle is not in a low fuel condition
- The diagnostic runs once for each engine start.

Conditions for Setting the DTC

P0089

- The high pressure fuel pump has exceeded the control limits. This condition exists when the Fuel Rail Pressure Regulator Command is 0° or greater than 92°.
- The above condition exists for 750 out of 938 counts, approximately 30 s at idle.

P00C6 Condition 1

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

P00C6 Condition 2

- If the Fuel Rail Pressure Sensor is greater than the target set point before the engine is cranked, the pressure fall diagnostic is used.
- The pressure fall diagnostic will fail if the Fuel Rail Pressure Sensor has dropped below 2 MPa (290 PSI) for 10 engine cycles if the ECT is less than -16°C (3.2°F) or 0.6 MPa (87 PSI) for 10 engine cycles if the ECT is greater than -16°C (3.2°F).

P228C

- The Fuel Rail Pressure Sensor is 3 MPa (435 PSI) less than the Desired Fuel Rail Pressure.
- The above condition exists for 750 out of 938 counts, approximately 30 s at idle.

P228D

- The Fuel Rail Pressure Sensor is 3 MPa (435 PSI) greater than the Desired Fuel Rail Pressure.
- The above condition exists for 750 out of 938 counts, approximately 30 s at idle.

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.
- Scan tool control of the high pressure fuel pump is inhibited.

Conditions for Clearing the DTC

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

Diagnostic Aids

- Any problem with the camshaft may set fuel pressure DTCs due to the location and design of the high pressure fuel pump. If camshaft position control DTCs are current or in history, a cam control issue may be the root cause.
- A faulty valve, plunger, or solenoid in the high pressure fuel pump may set a DTC. High pressure fuel pump damage will most likely be undetectable upon visual inspection.
- A restricted fuel feed pipe between the fuel feed pipe fuel pressure sensor and the high pressure fuel pump may set a DTC.
- A leaking or restricted fuel injector may set a DTC.

- A leak in the high pressure fuel system may set a DTC.
- A short to voltage on the high control circuit may set DTC P0089 and P228D.
- Vapor lock may set DTC P0089
- For DTC P00C6, park the vehicle outdoors overnight and perform a start in the morning.

Reference Information

Schematic Reference

Engine Controls Schematics (Buick with LE2)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX (ENCORE)

Description and Operation

Fuel System Description

Electrical Information Reference

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- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Attempt to start and idle the engine.
2. Observe the DTC information with a scan tool. DTCs P0089, P00C6, P228C, and P228D should not set.
 - **If any of the DTCs are set**
Refer to Circuit/System Testing.
 - **If none of the DTCs are set**
3. Engine idling.
4. Verify the scan tool Fuel Rail Pressure Sensor parameter is approximately 1.9-5.0 MPa (276-725 PSI).
 - **If not between 1.9-5.0 MPa (276-725 PSI)**
Refer to Circuit/System Testing.
 - **If between 1.9-5.0 MPa (276-725 PSI)**

WARNING: Road test a vehicle under safe conditions and while obeying all traffic laws. Do not attempt any maneuvers that could jeopardize vehicle control. Failure to adhere to these precautions could lead to serious personal injury and vehicle damage.

5. Road test the vehicle and perform a wide open acceleration from a stop until the transmission shifts into second gear. On manual transmission applications, shift to second gear or stop the test near 2,500 RPM. Repeat the test at least three times.

6. Verify DTCs P0089, P00C6, P228C, and P228D do not set.

- **If any of the DTCs set**

Refer to Circuit/System Testing.

- **If none of the DTCs set**

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

8. Verify the DTC does not set.

- **If the DTC sets**

Refer to Circuit/System Testing.

- **If the DTC does not set**

9. All OK.

Circuit/System Testing

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

1. Remove the G18 High Pressure Fuel Pump.

2. Verify the lobes on the camshaft do not have unusual wear or are worn.

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

Replace the Camshaft.

- **If the lobes are OK**

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

Component Testing

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

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

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

- **If not between 1.09-1.21 Ω**

Replace the G18 High Pressure Fuel Pump.

- **If between 1.09-1.21 Ω**

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

- **If less than infinite resistance**

Replace the G18 High Pressure Fuel Pump.

- **If infinite resistance**

4. All OK

Repair Instructions

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

- Refer to [Fuel Injection Pump Replacement](#) for G18 High Pressure Fuel Pump replacement.
- Refer to [Intake Camshaft Replacement](#)
- Perform the Fuel Rail Pressure Relief Valve Reset procedure, if supported on the scan tool.

DTC P0090-P0092, P00C8, P00C9, OR P00CA: FUEL PRESSURE REGULATOR

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.
- Refer to [Diagnostic Procedure Instructions](#) to provide 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 Control	P0090, P0091, P00C8, P00C9	P0090, P00C8	P0089, P228D	-
Low Control	P0090, P0091, P00C8, P00C9	P0090, P00C8	P0092	-

Circuit/System Description

The high fuel pressure necessary for direct injection is supplied by the high pressure fuel pump. The high pressure fuel pump is mounted on the rear of the engine and is driven by a three-lobe cam on the camshaft. This high pressure fuel pump also regulates the fuel pressure using an actuator in the form of an internal solenoid-controlled valve. In order to keep the engine running efficiently under all operating conditions, the engine control module (ECM) requests pressure ranging from 2-15 MPa (290-2,176 psi), depending on engine speed and load. Output drivers in the ECM provide the pump control circuit with a 12 V pulse-width modulated (PWM) signal, which regulates fuel pressure by closing and opening the control valve at specific times during pump strokes. This effectively regulates the portion of each pump stroke that is delivered to the fuel rail.

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

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

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

Conditions for Running the DTC

- Battery voltage is greater than or equal to 11 V.
- Engine speed is greater than or equal to 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 for 4 s.

P0091

The ECM detects a short to ground in the high pressure fuel pump actuator low control circuit for 4 s.

P0092

The ECM detects a short to voltage in the high pressure fuel pump actuator low control circuit for 4 s.

P00C8

The ECM detects an open circuit in the high pressure fuel pump actuator high control circuit for 4 s.

P00C9

The ECM detects a short to ground in the high pressure fuel pump actuator high control circuit for 4 s.

P00CA

The ECM detects a short to voltage in the high pressure fuel pump actuator high control circuit for 4 s.

Action Taken When the DTC Sets

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

Conditions for Clearing the DTC

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

Diagnostic Aids

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

Reference Information

Schematic Reference

Engine Controls Schematics (Buick with LE2)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX (ENCORE)

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

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

Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) for further diagnosis.
 - **If none of the DTCs are set**
3. Verify the scan tool parameters listed below do not display Malfunction when commanding the Fuel Pressure Regulator On and Off.
 - Fuel Pressure Regulator Control Circuit High Voltage Test Status
 - Fuel Pressure Regulator Control Circuit Open Test Status
 - Fuel Pressure Regulator Control Circuit Low Voltage Test Status
 - Fuel Pressure Regulator High Control Circuit High Voltage Test Status
 - Fuel Pressure Regulator High Control Circuit Open Test Status
 - Fuel Pressure Regulator High Control Circuit Low Voltage Test Status
 - **If Malfunction is displayed**

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

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

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the G18 High Pressure Fuel Pump.
2. Ignition ON, verify that a test lamp does not illuminate between ground and the terminals listed below:
 - High control circuit terminal 2
 - Low control circuit terminal 1

- **If the test lamp illuminates**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
 2. Test for less than 1 V between the appropriate control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.
 - **If the test lamp does not illuminate**
- 3. Test for B+ between the high control circuit terminal 2 and ground.
 - **If less than B+**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the high control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 Ω in the high control circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **If B+**
- 4. Ignition OFF, connect a test lamp between the high control circuit terminal 2 and the low control circuit terminal 1.
- 5. Ignition ON, command the Fuel Pressure Regulator On and Off with a scan tool.
- 6. Verify the test lamp turns ON and OFF.
 - **If the test lamp does not turn ON and OFF**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the low control circuit terminal 1 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 Ω in the low control circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **If the test lamp turns ON and OFF**
- 7. Test or replace the G18 High Pressure Fuel Pump.

Component Testing

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

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

2. Test for 1.09-1.21 Ω at 20 $^{\circ}$ C (68 $^{\circ}$ F) between the high control circuit terminal 2 and the low control circuit terminal 1.
 - **If not between 1.09-1.21 Ω**

Replace the G18 High Pressure Fuel Pump.
 - **If between 1.09-1.21 Ω**
3. Test for infinite resistance between each terminal and the G18 High Pressure Fuel Pump housing.
 - **If less than infinite resistance**

Replace the G18 High Pressure Fuel Pump.
 - **If infinite resistance**
4. All OK

Repair Instructions

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

- Refer to [Fuel Injection Pump Replacement](#) for G18 High Pressure Fuel Pump replacement
- Refer to [Control Module References](#) for K20 Engine Control Module replacement, setup, and programming
- Perform the Fuel Rail Pressure Relief Valve Reset procedure, if supported on the scan tool.

DTC P0096 OR P0111: INTAKE AIR TEMPERATURE (IAT) SENSOR 2/1 PERFORMANCE

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.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptor

DTC P0096

Intake Air Temperature (IAT) Sensor 2 Performance

DTC P0111

Intake Air Temperature (IAT) Sensor 1 Performance

Diagnostic Fault Information

IAT Sensor 1

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P0112, P0114, P2199**	P0111, P0113, P0114, P2199**	P0113*, P0114, P2199**	P0111, P2199**
Low Reference	-	P0111, P0113, P2199**, P2227, P2229	P0113*, P0114	-
*Internal ECM or sensor damage may occur if the circuit is shorted to B+. **If applicable.				

IAT Sensor 2 and Intake Air Humidity

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

Typical Scan Tool Data

IAT Sensor 1

Circuit	Short to Ground	Open or High Resistance	Short to Voltage

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

IAT Sensor 2 and Intake Air Humidity Sensor

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

Circuit/System Description

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

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

- IAT sensor 2
- Humidity sensor
- MAF sensor

The multifunction intake air sensor houses the following:

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

IAT Sensor 1 - Temperature, Resistance, Voltage Table

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

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

IAT Sensor 2 - Temperature, Frequency Table

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

Conditions for Running the DTCs

P0096 and P0111

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

Conditions for Setting the DTCs

P0096

- The ECM determines the absolute difference between IAT sensor 1 start-up temperature and the IAT sensor 2 start-up temperature is greater than 25Â°C (45Â°F).

AND

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

P0111

- The ECM determines the absolute difference between IAT sensor 1 start-up temperature and the IAT sensor 2 start-up temperature is greater than 25Â°C (45Â°F).

AND

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

Action Taken When the DTC Sets

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

Conditions for Clearing the DTCs

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

Diagnostic Aids

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

- With the ignition ON, when the engine is cold and not running, properly functioning IAT sensor 1 and IAT sensor 2 will gradually increase the scan tool IAT Sensor 1 and IAT Sensor 2 parameters. This is due to the heat that is generated by the multifunction intake air sensor heating elements.

Reference Information

Schematic Reference

Engine Controls Schematics (Buick with LE2)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX (ENCORE)

Electrical Information Reference

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

Powertrain Component Views

Powertrain Component Views (Buick)

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-38522-A Variable Signal Generator

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

Circuit/System Verification

1. Ignition On.
2. Verify that DTC P0097, P0098, P0099, P00F4, P00F5, P00F6, P0102, P0103, P0112, P0113, P0114, P0641, P0651, P0697, P06A3 or P06D2 is not set.

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

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

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

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

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

Refer to Circuit/System Testing.

- **If within 30Â°C (54Â°F)**

5. Engine running.

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

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

Refer to Circuit/System Testing.

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

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

8. Verify the DTC does not set.

- **If the DTC sets**

Refer to Circuit/System Testing.

- **If the DTC does not set**

9. All OK

Circuit/System Testing

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

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

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

Repair or replace component as necessary.

- **If no condition exists**

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

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

4. Test for less than 5 Ω between the low reference circuit terminal 7 and ground.

- **If 5 Ω or greater**

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

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

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

- **If less than 5 Ω**

5. Determine if the vehicle is equipped with Stop/Start, RPO KL9.

- **If vehicle is not equipped with Stop/Start, RPO KL9**

Refer to Step 9.

- **If vehicle is equipped with Stop/Start, RPO KL9**

6. Ignition OFF, disconnect the harness connector at the B75C Multifunction Intake Air sensor. Connect the test lamp between B+ and the MAF control circuit terminal 4.

7. Ignition ON, the test lamp should be OFF. Engine Running, the test lamp should be ON.

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

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

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

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
2. Test for 2 Ω resistance between the control circuit and ground.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.

- **If the test lamp turns ON and OFF**

8. Refer to Step 10.

9. Test for less than 5 Ω between the MAF sensor enable circuit terminal 4 and ground.

- **If 5 Ω or greater**

1. Ignition Off.
2. Test for less than 2 Ω in the ground circuit end to end.
 - If 2 Ω or greater, repair the open or high resistance in the circuit.
 - If less than 2 Ω , repair the open/high resistance in the ground connection or replace the K20 Engine Control Module, if the ground is internal.

- **If less than 5 Ω**

10. Ignition On

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

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

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

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

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

- **If a test lamp illuminates**

12. Ignition On.

13. Verify the scan tool Intake Air Temperature Sensor 1 parameter is colder than -39°C (-38°F).

- **If warmer than -39°C (-38°F).**

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

- **If colder than -39°C (-38°F).**

14. Ignition Off, install a 3 A fused jumper wire between the IAT 1 signal circuit terminal 8 and the low reference circuit terminal 7.

15. Ignition On.

16. Verify the scan tool Intake Air Temperature Sensor 1 parameter is warmer than 148°C (298°F).

- **If colder than 148°C (298°F).**

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

2. Ignition On.

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

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

4. Ignition Off.

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

- If 2 Ω or greater, repair the open/high resistance in the circuit.
- If less than 2 Ω , replace the K20 Engine Control Module.
- **If warmer than 148°C (298°F).**

17. Ignition On.

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

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

- **If 1% or greater**

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

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

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

- **If less than 1%**

19. Ignition Off, install a 3 A fused jumper wire between the IAT 2 signal circuit terminal 1 and the low reference circuit terminal 7.

20. Ignition On.

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

- **If 99% or less**

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

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

2. Ignition On.

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

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

4. Ignition Off.

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

- If 2 Ω or greater, repair the open/high resistance in the circuit.
- If less than 2 Ω , replace the K20 Engine Control Module.
- **If greater than 99%**

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

Component Testing

Multifunction Intake Air Sensor

1. Vehicle OFF, disconnect the harness connector at the B75C Multifunction Intake Air Sensor.
2. Connect a DMM between the IAT sensor 1 signal terminal 8 and the low reference terminal 7

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

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

- **If not within the specified range**

Replace the B75C Multifunction Intake Air Sensor.

- **If within the specified range**

4. All OK.

Multifunction Intake Air Sensor

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

- **If not within the specified range**

Replace the B75C Multifunction Intake Air Sensor.

- **If within the specified range**

2. All OK.

Testing with EL-38522-A

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

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

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

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

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

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

Replace the K20 Engine Control Module.

- **If all the parameters are within the specified range**

6. All OK.

Repair Instructions

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

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

DTC P0097, P0098, OR P0099: INTAKE AIR TEMPERATURE (IAT) SENSOR 2 CIRCUIT

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.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptors

DTC P0097

Intake Air Temperature (IAT) Sensor 2 Circuit Low Voltage

DTC P0098

Intake Air Temperature (IAT) Sensor 2 Circuit High Voltage

DTC P0099

Intake Air Temperature (IAT) Sensor 2 Circuit Intermittent

Diagnostic Fault Information

IAT Sensor 2 and Intake Air Humidity

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

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

Typical Scan Tool Data

IAT Sensor 2

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

Circuit	Short to Ground	Open or High Resistance	Short to Voltage
*Internal ECM or sensor damage may occur if the circuit is shorted to B+			

Intake Air Humidity Sensor

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

Circuit/System Description

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

- IAT sensor 2
- Humidity sensor
- MAF sensor

The multifunction intake air sensor houses the following:

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

IAT Sensor 2 - Temperature, Frequency Table

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

Conditions for Running the DTCs

P0097, P0098, and P0099

- DTCs P0685, P0686, P0687, P0689, P0690 or P1682 are not set.
- The ignition is ON, or the engine is running.
- The Ignition 1 voltage is at least 11 V.
- The DTCs run continuously within the enabling conditions.

Conditions for Setting the DTCs

P0097

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

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

P0098

The ECM detects that the IAT sensor 2 signal is greater than 390 Hz, warmer than 150Â°C (302Â°F), for greater than 5 s.

P0099

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

Action Taken When the DTC Sets

- P0097, P0098, and P0099 are Type B DTCs for North America.
- P0097, P0098, and P0099 are Type C DTCs for all except North America.
- The ECM commands the cooling fans ON.

Conditions for Clearing the MIL/DTC

- P0097, P0098, and P0099 are Type B DTCs for North America.
- P0097, P0098, and P0099 are Type C DTCs for all except North America.

Diagnostic Aids

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

Reference Information

Schematic Reference

Engine Controls Schematics (Buick with LE2)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX (ENCORE)

Electrical Information Reference

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

Powertrain Component Views

Powertrain Component Views (Buick)

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-38522-A Variable Signal Generator

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

Circuit/System Verification

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

Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) for further diagnosis.
 - **If none of the DTCs are set**

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

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

Refer to Circuit/System Testing.
 - **If within 30Â°C (54Â°F)**
4. Engine running.
5. Verify the following scan tool parameters are between -38 and +149Â°C (-36 and +300Â°F).
 - IAT Sensor 1
 - IAT Sensor 2
 - **If not between: -38 and +149Â°C (-36 and +300Â°F)**

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

Refer to Circuit/System Testing.
 - **If the DTC does not set**
8. All OK

Circuit/System Testing

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

1. Ignition Off, and all vehicle systems OFF, it may take up to 2 min. for all vehicle systems to power down. Disconnect the harness connector at the B75C Multifunction Intake Air sensor.
2. Test for less than 5 Ω between the low reference circuit terminal 7 and ground.
 - **If 5 Ω or greater**
 1. Disconnect the harness connector at the K20 Engine Control Module.
 2. Test for less than 2 Ω in the low reference circuit end to end.
 - If 2 Ω or greater, repair the open or high resistance in the circuit.
 - If less than 2 Ω replace the K20 Engine Control Module.
 - **If less than 5 Ω**
3. Determine if the vehicle is equipped with Stop/Start, RPO KL9.

- **If vehicle is not equipped with Stop/Start, RPO KL9**

Refer to Step 7.

- **If vehicle is equipped with Stop/Start, RPO KL9**

4. Ignition OFF, disconnect the harness connector at the B75C Multifunction Intake Air sensor. Connect the test lamp between B+ and the MAF control circuit terminal 4.

5. Ignition ON, the test lamp should be OFF. Engine Running, the test lamp should be ON.

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

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

2. Test for infinite resistance between the control circuit and ground.

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

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

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

2. Test for 2 Ω resistance between the control circuit and ground.

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

- **If the test lamp turns ON and OFF**

6. Refer to Step 8.

7. Test for less than 5 Ω between the MAF sensor enable circuit terminal 4 and ground.

- **If 5 Ω or greater**

1. Ignition Off.

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

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

- **If less than 5 Ω**

8. Ignition On.

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

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

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

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

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

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

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

1. Ignition Off, remove the test lamp, the fuse for the ignition voltage circuit, and disconnect all components on the circuit.

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

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

- **If a test lamp illuminates**

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

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

- **If 1% or greater**

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

- **If less than 1%**

11. Ignition Off, install a 3 A fused jumper wire between the IAT 2 signal circuit terminal 1 and the low reference circuit terminal 7.

12. Ignition On.

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

- **If 99% or less**

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

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

2. Ignition On.

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

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

4. Ignition Off.

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

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

- **If greater than 99%**

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

Component Testing

Multifunction Intake Air Sensor

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

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

- **If not within the specified range**

Replace the B75C Multifunction Intake Air Sensor.

- **If within the specified range**

3. All OK.

Testing with EL-38522-A

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

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

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

1. Red lead to the signal circuit terminal 1 at the harness connector
2. Black leads to ground
3. Battery voltage supply lead to B+

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

- Signal switch to 5 V
- Duty Cycle switch to 50% (Normal)
- Frequency switch to 250 Hz

4. Ignition On, verify the scan tool IAT Sensor 2 parameters listed below are within the ranges listed below:

- IAT Sensor 2 is between 248-252 Hz

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

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

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

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

Replace the K20 Engine Control Module.

- **If all the parameters are within the specified range**

5. All OK.

Repair Instructions

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

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

DTC P00C7: INTAKE AIR PRESSURE MEASUREMENT SYSTEM - MULTIPLE SENSORS NOT PLAUSIBLE

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.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptor

DTC P00C7

Intake Air Pressure Measurement System - Multiple Sensors Not Plausible

Circuit/System Description

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

Conditions for Running the DTC

- DTCs P0106, P0107, P0108, P2122, P2123, P2127, P2128, P2138 or P2610 are not set.
- The engine is running.
- Time between current ignition cycle and the last time the engine was running is greater than 10 s.
- Manifold pressure between 50-115 kPa (7.25-16.68 PSI).
- BARO pressure between 50-115 kPa (7.25-16.68 PSI).
- Turbocharger boost pressure between 50-115 kPa (7.25-16.68 PSI).

- This DTC runs continuously within the enabling conditions.

Conditions for Setting the DTC

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

Action Taken When the DTC Sets

DTC P00C7 is a Type B DTC.

Conditions for Clearing the DTC

DTC P00C7 is a Type B DTC.

Reference Information

Schematic Reference

Engine Controls Schematics (Buick with LE2)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX (ENCORE)

Powertrain Component View

Powertrain Component Views (Buick)

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/Vehicle in Service mode.
2. Verify that DTCs P0106, P0107, P0236, P0237, P0238, P2227, P2228, P2229 or P2230 are not set.
 - **If any of the DTCs are set**

Refer to Diagnostic Trouble Code (DTC) List - Vehicle for further diagnosis.
 - **If none of the DTCs is set**
3. Verify none of the following conditions exist:
 - The air intake duct system for loose connecting clamps, cracks, or other damage
 - A damaged Q38 Throttle Body blade or shaft
 - Splits, kinks, or improper connections at the vacuum hoses
 - Faulty positive crankcase ventilation system operation
 - Carbon deposits on the throttle blade.

- Vacuum leaks at the intake manifold, Q38 Throttle Body, Q17 Fuel Injector O-rings, and B111B Turbocharger Boost and Intake Air Temperature Sensor.

- **If a condition exists**

Repair as necessary.

- **If none of the conditions exist**

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

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

Refer to the appropriate diagnostic below for further diagnosis.

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

5. All OK

Repair Instructions

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

Refer to [Control Module References](#) for Engine Control Module replacement, programming and setup

DTC P00E9: INTAKE AIR TEMPERATURE (IAT) SENSOR 3 CIRCUIT PERFORMANCE

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.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptor

DTC P00E9

Intake Air Temperature (IAT) Sensor 3 Circuit Performance

Diagnostic Fault Information

IAT Sensor 3

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

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

Typical Scan Tool Data

IAT Sensor 3

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

Circuit	Short to Ground	Open or High Resistance	Short to Voltage
Signal	150Â°C (302Â°F)	-40Â°C (-40Â°F)	-40Â°C (-40Â°F)*
Low Reference	-	-40Â°C (-40Â°F)	-40Â°C (-40Â°F)*
*Internal ECM or sensor damage may occur if the circuit is shorted to B+			

Circuit/System Description

The intake air temperature (IAT) sensor 3 is a variable resistor that changes an engine control module (ECM) supplied 5 V signal. The signal varies with intake manifold air temperature and is displayed by the scan tool as Â°C (Â°F). The IAT sensor 3 is integrated with the manifold absolute pressure sensor in the intake manifold. The ECM provides a ground for the IAT sensor 3 low reference circuit.

IAT Sensor 3 - Temperature, Resistance, Voltage Table

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

Conditions for Running the DTC

P00E9

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

Conditions for Setting the DTC

P00E9 - Condition 1

- The ECM determines the absolute difference between IAT sensor 1 start-up temperature and the IAT sensor 2 start-up temperature is less or equal to 25Â°C (45Â°F).

AND

- The ECM determines the absolute difference between IAT sensor 3 start-up temperature and the IAT sensor 1 start-up temperature is greater than 25Â°C (45Â°F).

AND

- The ECM determines the absolute difference between IAT sensor 3 start-up temperature and the IAT sensor 2 start-up temperature is greater than 25Â°C (45Â°F).

P00E9 - Condition 2

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

AND

- The ECM determines the absolute difference between IAT sensor 3 start-up temperature and the IAT sensor 2 start-up temperature is greater than 25Â°C (45Â°F).

AND

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

P00E9 - Condition 3

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

AND

- The ECM determines the absolute difference between IAT sensor 3 start-up temperature and the IAT sensor 1 start-up temperature is greater than 25Â°C (45Â°F).

AND

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

Action Taken When the DTC Sets

DTC P00E9 is a Type B DTC.

Conditions for Clearing the DTCs

DTC P00E9 is a Type B DTC.

Reference Information

Schematic Reference

Engine Controls Schematics (Buick with LE2)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX (ENCORE)

Electrical Information Reference

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

Powertrain Component Views

Powertrain Component Views (Buick)

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

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

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** for further diagnosis.
 - **If none of the DTCs are set**

NOTE:

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

3. Ignition ON.

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

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

Refer to Circuit/System Testing.

- **If within 30°C (54°F)**

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

NOTE:

On vehicles equipped with Auto Start/Stop, it may be necessary to OPEN the hood to enable the engine to idle.

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

Refer to Circuit System Testing.

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

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

7. Verify the DTC does not set.

- **If the DTC sets**

Refer to Circuit/System Testing.

- **If the DTC does not set**

8. All OK

Circuit/System Testing**NOTE:**

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

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

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

- An Intake Manifold Resonator with a leaking seal, or a cracked or broken housing
- **If a condition exists**

Repair or replace component as appropriate.

- **If no condition exists**

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

- **If 5 Ω or greater**

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
2. Test for less than 2 Ω in the low reference circuit end to end.
 - If 2 Ω or greater, repair the open or high resistance in the circuit.
 - If less than 2 Ω replace the K20 Engine Control Module.

- **If less than 5 Ω**

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

- **If less than 4.8 V**

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
3. Test for less than 2 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.

- **If greater than 5.2 V**

NOTE: If the 5 V reference circuit is shorted to a voltage the engine control module or the sensor may be damaged.

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

- **If between 4.8-5.2 V**

5. Ignition ON, test for 4.8-5.2 V between the intake air temperature signal 1 circuit terminal 8 and ground.

- **If less than 4.8 V**

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
3. Test for less than 2 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.

- **If greater than 5.2 V**

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

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

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

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

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Ignition ON, test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.
 - **If between 4.8-5.2 V**
10. Determine if **EL-38522-A** Variable Signal Generator or equivalent is available.
 - **EL-38522-A, Variable Signal Generator; or equivalent is not available**
 1. Test or replace the B75C Multifunction Intake Air sensor.

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

3. Verify the DTC does not set.

- **If the DTC sets**
- Replace the K20 Engine Control Module.
- **If no DTCs set**

4. All OK.

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

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

- Red lead to the signal circuit terminal 1 at the harness connector
- Black leads to ground
- Battery voltage supply lead to B+

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

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

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

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

Replace the K20 Engine Control Module.

- **If between 28-32 Hz**

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

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

- **If 2 Ω or greater**

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

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

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

- **If less than 2 Ω**

16. Ignition ON, test for 4.8-5.2 V between the signal circuit terminal 1 and ground.

- **If less than 4.8 V**

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

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

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

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

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

- **If greater than 5.2 V**

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

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

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

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

- **If between 4.8-5.2 V**

17. Ignition ON, verify the scan tool IAT Sensor 3 parameter is colder than -39°C (-38°F).

- **If warmer than -39°C (-38°F).**

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

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

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

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

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

- **If colder than -39°C (-38°F).**

18. Ignition OFF, install a 3 A fused jumper wire between the signal circuit terminal 1 and the low reference circuit terminal 3.

19. Verify the scan tool IAT Sensor 3 parameter is warmer than 148°C (298°F).

- **If colder than 148°C (298°F).**

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

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

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

3. Ignition OFF.

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

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

- **If warmer than 148°C (298°F).**

20. Test or replace the appropriate temperature sensor.

Component Testing

Multifunction Intake Air Sensor

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

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

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

- **If not within the specified range**

Replace the B75C Multifunction Intake Air Sensor.

- **If within the specified range**

3. All OK.

Multifunction Intake Air Sensor

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

- **If not within the specified range**

Replace the B75C Multifunction Intake Air Sensor.

- **If within the specified range**

2. All OK.

Intake Manifold Pressure and Air Temperature Sensor

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

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

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

- **If not within the specified range**

Replace the B65 Intake Manifold Pressure and Air Temperature Sensor.

- **If within the specified range**

3. All OK.

Repair Instructions

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

- Refer to [Intake Air Pressure and Temperature Sensor Replacement](#) for intake air temperature sensor 3 replacement
- Refer to [Mass Airflow Sensor Replacement](#) for multifunction intake air sensor replacement
- Refer to [Control Module References](#) for engine control module replacement, programming, and setup

DTC P00EA-P00EC: INTAKE AIR TEMPERATURE (IAT) SENSOR 3 CIRCUIT

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.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptors

DTC P00EA

Intake Air Temperature (IAT) Sensor 3 Circuit Low Voltage

DTC P00EB

Intake Air Temperature (IAT) Sensor 3 Circuit High Voltage

DTC P00EC

Intake Air Temperature (IAT) Sensor 3 Circuit Erratic

Diagnostic Fault Information

IAT Sensor 3

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

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
*Internal ECM or sensor damage may occur if the circuit is shorted to B+.				

Typical Scan Tool Data

IAT Sensor 3

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

Circuit/System Description

The intake air temperature (IAT) sensor 3 is a variable resistor that changes an engine control module (ECM) supplied 5 V signal. The signal varies with intake manifold air temperature and is displayed by the scan tool as Â°C (Â°F). The IAT sensor 3 is integrated with the manifold absolute pressure sensor in the intake manifold. The ECM provides a ground for the IAT sensor 3 low reference circuit.

IAT Sensor 3 - Temperature, Resistance, Voltage Table

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

Conditions for Running the DTCs

P00EA, P00EB, and P00EC

The ignition is ON, or the engine is running.

The DTCs run continuously when the above condition is met.

Conditions for Setting the DTC

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

P00EA

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

P00EB

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

P00EC

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

Action Taken When the DTCs Set

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

Conditions for Clearing the DTCs

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

Schematic Reference

Engine Controls Schematics (Buick with LE2)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX (ENCORE)

Electrical Information Reference

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

Powertrain Component Views

Powertrain Component Views (Buick)

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-38522-A Variable Signal Generator

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

Circuit/System Verification

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

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

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

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

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

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

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

Refer to Circuit/System Testing.

- **If within 30Â°C (54Â°F)**

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

NOTE:

On vehicles equipped with Auto Start/Stop, it may be necessary to OPEN the hood to enable the engine to idle.

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

Refer to Circuit System Testing.

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

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

7. Verify the DTC does not set.

- **If the DTC sets**

Refer to Circuit/System Testing.

- **If the DTC does not set**

8. All OK

Circuit/System Testing

NOTE:

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

1. Ignition OFF, and all vehicle systems OFF, it may take up to 2 min. for all vehicle systems to power down. Disconnect the harness connector at the B65 Intake Manifold Pressure and Air Temperature Sensor.
2. Test for less than 2 Ω between the intake air temperature sensor 3 low reference circuit terminal 3 and ground.

- **If 2 Ω or greater**

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
2. Test for less than 2 Ω in the low reference circuit end to end.
 - If 2 Ω or greater, repair the open or high resistance in the circuit.
 - If less than 2 Ω replace the K20 Engine Control Module.

- **If less than 2 Ω**

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

- **If less than 4.8 V**

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

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

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

- **If greater than 5.2 V**

NOTE:

If the 5 V reference circuit is shorted to a voltage the engine control module or the sensor may be damaged.

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

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

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

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Ignition ON, test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.
 - **If between 4.8-5.2 V**
5. Ignition ON, verify the scan tool IAT Sensor 3 parameter is colder than -39 $^{\circ}$ C (-38 $^{\circ}$ F).
- **If warmer than -39 $^{\circ}$ C (-38 $^{\circ}$ F).**
1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the signal circuit terminal 1 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
- **If colder than -39 $^{\circ}$ C (-38 $^{\circ}$ F).**
6. Ignition OFF, install a 3 A fused jumper wire between the signal circuit terminal 1 and the low reference circuit terminal 3.
7. Verify the scan tool IAT Sensor 3 parameter is warmer than 148 $^{\circ}$ C (298 $^{\circ}$ F).
- **If colder than 148 $^{\circ}$ C (298 $^{\circ}$ F).**
1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 3. Ignition OFF.
 4. Test for less than 2 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
- **If warmer than 148 $^{\circ}$ C (298 $^{\circ}$ F).**
8. Test or replace the B65 Intake Manifold Pressure and Air Temperature Sensor.

Component Testing

Intake Manifold Pressure and Air Temperature Sensor

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

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

2. Test the IAT sensor 3 resistance between terminal 1 and terminal 3 by varying the sensor temperature while monitoring the sensor resistance. Compare the readings with the [Temperature Versus Resistance - Intake Air Temperature Sensor \(Delco Sensor\)](#), [Temperature Versus Resistance - Intake Air Temperature Sensor \(Bosch Sensor\)](#), appropriate table for the sensor. The resistance values should be in range of the table values.

- If not within the specified range

Replace the B65 Intake Manifold Pressure and Air Temperature Sensor.

- If within the specified range

3. All OK.

Repair Instructions

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

- Refer to [Intake Air Pressure and Temperature Sensor Replacement](#) for intake air temperature sensor 3 replacement
- Refer to [Control Module References](#) for engine control module replacement, programming, and setup.

DTC P00F4-P00F6: INTAKE AIR HUMIDITY SENSOR CIRCUIT

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.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptors

DTC P00F4

Intake Air Humidity Sensor Circuit Low Voltage

DTC P00F5

Intake Air Humidity Sensor Circuit High Voltage

DTC P00F6

Intake Air Humidity Sensor Circuit Erratic

Diagnostic Fault Information

Intake Air Humidity

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

Intake Air Humidity

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

Circuit/System Description

The sensors listed below are integrated within the mass air flow/multifunction intake air sensor:

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

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

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

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

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

- IAT sensor 1
- IAT sensor 2
- Humidity sensor
- Barometric pressure (BARO) sensor

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

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

Conditions for Setting the DTCs**P00F4**

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

P00F5

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

P00F6

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

Action Taken When the DTC Sets

DTCs P00F4, P00F5, and P00F6 are Type C DTCs.

Conditions for Clearing the MIL/DTC

DTCs P00F4, P00F5, and P00F6 are Type C DTCs.

Diagnostic Aids

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

Reference Information

Schematic Reference

Engine Controls Schematics (Buick with LE2)

Connector End View Reference

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DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-38522-A Variable Signal Generator

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

Circuit/System Verification

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

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

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

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

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

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

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

Refer to Circuit/System Testing.

- **If within 30Â°C (54Â°F)**

NOTE: On vehicles equipped with Auto Start/Stop, it may be necessary to OPEN the hood to enable the engine to idle.

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

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

Refer to Circuit/System Testing.

- **If between 5 and 90%**

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

6. Verify the DTC does not set.

- **If the DTC sets**

Refer to Circuit/System Testing.

- **If the DTC does not set**

7. All OK

Circuit/System Testing

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

1. Ignition OFF, disconnect the harness connector at the B75C Multifunction Intake Air sensor (Humidity Sensor).
2. Test for less than 5 Ω between the low reference circuit terminal 7 and ground.

- **If 5 Ω or greater**

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

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

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

- **If less than 5 Ω**

3. Ignition OFF, all vehicle systems OFF, test for less than 5 Ω between the MAF sensor enable circuit terminal 4 and ground.

- **If 5 Ω or greater**

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

- **If less than 5 Ω**

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

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

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

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

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

- **If a test lamp illuminates**

5. Test for greater than 10.5 V between the humidity signal circuit terminal 1 and ground.

- **If 10.5 V or less**

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
3. Test for less than 2 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.

- **If greater than 10.5 V**

6. Determine if **EL-38522-A** Variable Signal Generator or equivalent is available.

- **EL-38522-A, Variable Signal Generator; or equivalent is not available**

1. Test or replace the B75C Multifunction Intake Air sensor.
2. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the freeze frame/failure records data.
3. Verify the DTC does not set.
 - **If the DTC sets**
 - Replace the K20 Engine Control Module.
 - **If the DTC does not set**

4. All OK.

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

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

- Red lead to the signal circuit terminal 1 at the harness connector
- Black leads to ground
- Battery voltage supply lead to B+

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

- Signal switch to 5 V
- Frequency switch to 250 Hz

- Duty Cycle switch to 50% (Normal)

9. Ignition ON, observe the scan tool Intake Air Humidity parameter. The scan tool parameter should be between 45-55%.

- **If not between 45-55%.**

Replace the K20 Engine Control Module.

- **If between 45-55%.**

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

Component Testing

Multifunction Intake Air Sensor

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

- **If not within the specified range**

Replace the B75C Multifunction Intake Air Sensor.

- **If within the specified range**

2. All OK.

Repair Instructions

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

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

DTC P0101: MASS AIR FLOW (MAF) SENSOR PERFORMANCE

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.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptor

DTC P0101

Mass Air Flow (MAF) Sensor Performance

Diagnostic Fault Information

MAF Sensor

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition Voltage	P0102, P121B^	P0102, P01101, P121A^	P0690	P0101
Signal	P0102, P1101	P0102, P1101	P0102*	P0101, P1101
MAF Control**	P121B^	P0102, P121A^	P0102*, P121C^	-
Ground***	-	P0102	-	-

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

**Internal ECM low side driver, with Stop/Start RPO (KL9).

***Chassis ground. Without Stop/Start, RPO (KL9).

^ If applicable.

MAF Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine running at various operating conditions			
Parameter Normal Range: 2,000-10,000 Hz			
Ignition Voltage	0 Hz	0 Hz	-
Signal	0 Hz	0 Hz	0 Hz*
Ground	-	0 Hz	-
*Internal ECM or sensor damage may occur if the circuit is shorted to B+.			

Circuit Description

The sensors listed below are integrated within the mass air flow/multifunction intake air sensor:

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

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

The ECM applies 5 V to the MAF sensor signal circuit. The sensor produces a variable frequency signal based on the inlet air flow through the sensor bore. The signal varies with engine load and is displayed by the scan tool as Hertz (Hz) and grams per second (g/s). Vehicle ignition voltage and ground circuits are also supplied to the MAF sensor.

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

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

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

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

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

- IAT sensor 1
- IAT sensor 2
- Humidity sensor
- Barometric pressure (BARO) sensor

Conditions for Running the DTCs

- DTCs P0102, P0103, P0107, P0108, P0111, P0112, P0113, P0116, P0117, P0118, P0128, P0335 or P0336 are not set.
- The engine speed is between 400-6,100 RPM.
- The engine coolant temperature (ECT) is between -7 and +125°C (+19 and +257°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

- Any type of contamination on the MAF sensor heating elements will degrade the proper operation of the sensor. Certain types of contaminants act as a heat insulator, which will impair the response of the sensor to airflow changes. Water or snow can create the opposite effect, and cause the signal to increase rapidly.
- Certain aftermarket air filters may cause this DTC to set.
- Certain aftermarket air induction systems may cause this DTC to set.
- Modifications to the air induction system may cause this DTC to set.

Reference Information

Schematic Reference

Engine Controls Schematics (Buick with LE2)

Connector End View Reference

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Powertrain Component Views

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DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

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

Special Tools

EL-38522-A Variable Signal Generator

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

Circuit/System Verification

1. Ignition ON, verify that DTC P0641, P0651, P0697, P06A3, P06D2, P121A, P121B, or P121C is not set.
 - **If any of the DTCs are set**

Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) for further diagnosis.
 - **If none of the DTCs are set**
2. If you were sent here from DTC P0068, P0106, P0121, P0236, or P1101; refer to Circuit/System Testing.
3. Ignition ON, verify the scan tool Throttle Body Idle Air Flow Compensation parameter is less than 90%.
 - **90% or greater**

Refer to [Throttle Body Inspection and Cleaning](#) .
 - **If less than 90%**
4. Verify the scan tool Throttle Position Sensors 1 and 2 Agree/Disagree parameter displays Agree while performing the Throttle Sweep Test with a scan tool.
 - **If Disagree**

Refer to [DTC P0121-P0123, P0222, P0223, P16A0-P16A2, or P2135](#) for further diagnosis.
 - **If Agree**
5. Determine the current vehicle testing altitude.
6. Verify the scan tool MAP Sensor pressure parameter is within the range specified in the [Altitude Versus Barometric Pressure](#) table.
 - **If the MAP Sensor parameter is not in range**

Refer to [DTC P0106](#) for further diagnosis.
 - **If the MAP Sensor parameter is within range**
7. Verify the engine is equipped with a turbocharger.
 - **If not equipped with a turbocharger**

Refer to Step 10.
 - **If equipped with a turbocharger**
8. Verify the scan tool Boost Pressure Sensor parameter is within the range specified in the [Altitude Versus Barometric Pressure](#) table.
 - **If the Boost Pressure Sensor parameter is not in range**

Refer to [DTC P0236](#) for further diagnosis.
 - **If the Boost Pressure Sensor parameter is within range**
9. Verify the scan tool Boost Pressure Sensor parameter decreases after starting the engine.
 - **If the Boost Pressure Sensor parameter does not decrease**

Refer to [DTC P0236](#) for further diagnosis.
 - **If the Boost Pressure Sensor parameter does decrease**
10. Engine idling, verify the scan tool MAP Sensor pressure parameter is between 26-52 kPa (3.8-7.5 PSI) and changes with accelerator pedal input.
 - **If not between 26-52 kPa (3.8-7.5 PSI) or does not change**

Refer to [DTC P0106](#) for further diagnosis.
 - **If between 26-52 kPa (3.8-7.5 PSI) and changes**

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

1. Engine idling
 2. Perform the scan tool snapshot function.
 3. Increase the engine speed slowly to 3,000 RPM and then back to idle.
 4. Exit from the scan tool snapshot and review the data.
 5. Observe the MAF Sensor parameter frame by frame with a scan tool.
- **If the MAF Sensor parameter does not change smoothly and gradually**

Refer to Circuit/System Testing for further diagnosis.

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

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

13. Verify the DTC does not set.

- **If the DTC sets**

Refer to Circuit/System Testing.

- **If the DTC does not set**

14. All OK

Circuit/System Testing

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

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

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

If a condition is found, repair or replace component as appropriate.

- **If no condition is found**

2. Determine if the vehicle is equipped with Stop/Start, RPO KL9.

- **If vehicle is not equipped with Stop/Start, RPO KL9**

Refer to Step 6.

- **If vehicle is equipped with Stop/Start, RPO KL9**

3. Ignition OFF, disconnect the harness connector at the B75C Multifunction Intake Air sensor. Connect the test lamp between B+ and the MAF control circuit terminal 4.

4. Ignition ON, the test lamp should be OFF. Engine Running, the test lamp should be ON.

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

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

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

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
2. Test for 2 Ω resistance between the control circuit and ground.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.

- **If the test lamp turns ON and OFF**

5. Refer to Step 8.

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

7. Test for less than 5 Ω between the MAF sensor enable circuit terminal 4 and ground.

- **If 5 Ω or greater**

1. Disconnect the harness connector at the K20 Engine Control Module.
2. Test for less than 2 Ω in the ground circuit end to end.
 - If 2 Ω or greater, repair the open or high resistance in the circuit.
 - If less than 2 Ω , repair the open/high resistance in the ground connection.

- **If less than 5 Ω**

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

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

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

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

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

- **If a test lamp illuminates**

9. Ignition ON, test for 4.8-5.2 V between the signal circuit terminal 3 and ground.

- **If less than 4.8 V**

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
3. Test for less than 2 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.

- **If greater than 5.2 V**

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

- **If between 4.8-5.2 V**

10. Determine if **EL-38522-A** Variable Signal Generator or equivalent is available.

- **EL-38522-A, Variable Signal Generator; or equivalent is not available**

1. Test or replace the B75C Multifunction Intake Air sensor.
2. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the freeze frame/failure records data.
3. Verify the DTC does not set.
 - **If the DTC sets**
 - Replace the K20 Engine Control Module.
 - **If the DTC does not set**

4. All OK.

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

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

- Red lead to the signal circuit terminal 3 at the harness connector
- Black leads to ground
- Battery voltage supply lead to B+

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

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

13. Engine idling, verify the scan tool MAF Sensor parameter is between 4,950-5,050 Hz.

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

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

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

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

Repair Instructions

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

- Refer to **Mass Airflow Sensor Replacement** for multifunction intake air sensor replacement
- Refer to **Control Module References** for engine control module replacement, programming, and setup

DTC P0102 OR P0103: MASS AIR FLOW (MAF) SENSOR CIRCUIT LOW/HIGH FREQUENCY

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.
- Refer to **Diagnostic Procedure Instructions** to provide 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

MAF Sensor

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
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Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition Voltage	P0102, P121B^	P0102, P01101, P121A^	P0690	P0101
Signal	P0102, P1101	P0102, P1101	P0102*	P0101, P1101
MAF Control**	P121B^	P0102, P121A^	P0102*, P121C^	-
Ground***	-	P0102	-	-
*Internal ECM or sensor damage may occur if the circuit is shorted to B+. **Internal ECM low side driver, with Stop/Start RPO (KL9). ***Chassis ground. Without Stop/Start, RPO (KL9). ^ If applicable.				

Typical Scan Tool Data

MAF Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine running at various operating conditions			
Parameter Normal Range: 2,000-10,000 Hz			
Ignition Voltage	0 Hz	0 Hz	-
Signal	0 Hz	0 Hz	0 Hz*
Ground	-	0 Hz	-
*Internal ECM or sensor damage may occur if the circuit is shorted to B+.			

Circuit Description

The sensors listed below are integrated within the mass air flow/multifunction intake air sensor:

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

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

The ECM applies 5 V to the MAF sensor signal circuit. The sensor produces a variable frequency signal based on the inlet air flow through the sensor bore. The signal varies with engine load and is displayed by the scan tool as Hertz (Hz) and grams per second (g/s). Vehicle ignition voltage and ground circuits are also supplied to the MAF sensor.

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

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

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

- IAT sensor 1
- IAT sensor 2
- Humidity sensor
- Barometric pressure (BARO) sensor

Conditions for Running the DTC

- The engine is running for at least 1 s.
- The engine speed is at least 300 RPM.
- The ignition signal is at least 10 V.
- The above conditions are met for at least 1 s.

The DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

P0102

The ECM detects that the MAF Sensor signal parameter is less than 1,825 Hz (about 0.37 g/s) for at least 250 cylinder firing events.

P0103

The ECM detects that the MAF Sensor signal parameter is at least 8,712 Hz (about 280 g/s) for at least 250 cylinder firing events.

Action Taken When the DTCs Set

DTCs P0102 and P0103 are Type B DTCs.

Conditions for Clearing the MIL/DTCs

DTCs P0102 and P0103 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics (Buick with LE2)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX (ENCORE)

Electrical Information Reference

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

Powertrain Component Views

Powertrain Component Views (Buick)

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-38522-A Variable Signal Generator

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

Circuit/System Verification

1. Engine idling, observe the scan tool MAF Sensor parameter. The reading should be between 2.5-5.5 g/s.

- **If not between 2.5-5.5 g/s**

Refer to Circuit/System Testing.

- **If between 2.5-5.5 g/s**

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

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

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

Refer to Circuit/System Testing.

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

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

4. Verify the DTC does not set.

- **If the DTC sets**

Refer to Circuit/System Testing.

- **If the DTC does not set**

5. All OK

Circuit/System Testing

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

1. Determine if the vehicle is equipped with Stop/Start, RPO KL9.

- **If vehicle is not equipped with Stop/Start, RPO KL9**

Refer to Step 5.

- **If vehicle is equipped with Stop/Start, RPO KL9**

2. Ignition OFF, disconnect the harness connector at the B75C Multifunction Intake Air sensor. Connect the test lamp between B+ and the MAF control circuit terminal 4.

3. Ignition ON, the test lamp should be OFF. Engine Running, the test lamp should be ON.

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

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

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

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
2. Test for 2 Ω resistance between the control circuit and ground.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.

- **If the test lamp turns ON and OFF**

4. Refer to Step 7.

5. Ignition OFF, disconnect the harness connector at the B75C Multifunction Intake Air sensor.
6. Test for less than 5 Ω between the ground circuit terminal 4 and ground.
 - **If 5 Ω or greater**
 1. Ignition OFF.
 2. Test for less than 2 Ω in the ground circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , repair the open/high resistance in the ground connection.
 - **If less than 5 Ω**
7. Ignition ON, verify that a test lamp illuminates between the ignition circuit terminal 5 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF, remove the test lamp and remove the fuse for the ignition voltage circuit.
 2. Test for less than 2 Ω in the ignition voltage circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF, remove the test lamp and remove the fuse for the ignition voltage circuit.
 2. Test for infinite resistance between the ignition voltage circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, test all components connected to the ignition circuit, replace as necessary.
 - **If a test lamp illuminates**
8. Ignition ON, test for 4.8-5.2 V between the signal circuit terminal 3 and ground.
 - **If less than 4.8 V**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **If greater than 5.2 V**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Ignition ON, test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.
 - **If between 4.8-5.2 V**
9. Determine if **EL-38522-A** Variable Signal Generator or equivalent is available.
 - **EL-38522-A, Variable Signal Generator; or equivalent is not available**
 1. Test or replace the B75C Multifunction Intake Air sensor.
 2. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the freeze frame/failure records data.
 3. Verify the DTC does not set.
 - **If the DTC sets**
 - Replace the K20 Engine Control Module.
 - **If the DTC does not set**
 - **EL-38522-A, Variable Signal Generator; or equivalent is available**
4. All OK.
10. Ignition OFF, connect the leads of the **EL-38522-A** Variable Signal Generator as follows:
 - Red lead to the signal circuit terminal 3 at the harness connector

- Black leads to ground
 - Battery voltage supply lead to B+
- Set the **EL-38522-A** Variable Signal Generator to the following specifications.
 - Signal switch to 5 V
 - Frequency switch to 5 kHz
 - Duty Cycle switch to 50% (Normal)
 - Engine idling, verify the scan tool MAF Sensor parameter is between 4,950-5,050 Hz.
 - **If not between 4,950-5,050 Hz.**
 If not between 4,950-5,050 Hz, replace the K20 Engine Control Module.
 - **If between 4,950-5,050 Hz.**
 - Test or replace the B75C Multifunction Intake Air sensor.

Repair Instructions

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

- Refer to **Mass Airflow Sensor Replacement** for multifunction intake air sensor replacement
- Refer to **Control Module References** for engine control module replacement, programming, and setup

DTC P0106: MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR PERFORMANCE

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.
- Refer to **Diagnostic Procedure Instructions** to provide an overview of each diagnostic category.

DTC Descriptor

DTC P0106

Manifold Absolute Pressure (MAP) Sensor Performance

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P0106, P0107, P018C, P0532, P0641	P0106, P0107	P0106, P018C, P0533, P0641	P0106
Signal	P0106, P0107	P0106, P0108	P0106, P0108*	P0106
Low Reference	-	P0106, P0108	-	P0106

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

Typical Scan Tool Data

MAP Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine idling at normal operating temperature Parameter Normal Range: 26-52 kPa (3.8-7.6 PSI)			
5 V Reference	0 kPa (0 PSI)	0 kPa (0 PSI)	435 kPa (63.1 PSI)
Signal	0 kPa (0 PSI)	435 kPa (63.1 PSI)	435 kPa (63.1 PSI)

Circuit	Short to Ground	Open	Short to Voltage
Low Reference	-	435 kPa (63.1 PSI)	-

Circuit Description

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

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

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

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

Conditions for Running the DTC

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

Conditions for Setting the DTC

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

Action Taken When the DTC Sets

DTC P0106 is a Type B DTC.

Conditions for Clearing the DTC

DTC P0106 is a Type B DTC.

Reference Information

Schematic Reference

Engine Controls Schematics (Buick with LE2)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX (ENCORE)

Powertrain Component View

Powertrain Component Views (Buick)

Turbocharger System Description

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

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

Special Tools

GE-23738-A Vacuum Pump

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

Circuit/System Verification

1. Ignition ON.
2. Verify that DTC P0641, P0651, P0697, P06A3, P06D2 or P06D6 is not set.
 - **If any of the DTCs are set**
Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) for further diagnosis.
 - **If none of the DTC are set**
3. If you were sent here from DTC P0068, P0101, P0121, P0236, or P1101; refer to Circuit/System Testing.
4. Verify the scan tool Throttle Body Idle Airflow Compensation parameter is less than 90%.
 - **If 90% or greater**
Refer to [Throttle Body Inspection and Cleaning](#) .
 - **If less than 90%**
5. Verify the scan tool Throttle Position Sensors 1 and 2 Agree/Disagree parameter displays Agree while performing the Throttle Sweep Test with a scan tool.
 - **If Disagree**
Refer to [DTC P0121-P0123, P0222, P0223, P16A0-P16A2, or P2135](#) for further diagnosis.
 - **If Agree**
6. Determine the current vehicle testing altitude.
7. Verify the scan tool MAP Sensor parameter is within the range specified in the [Altitude Versus Barometric Pressure](#) table.
 - **If the MAP Sensor parameter is not in range**
Refer to Circuit/System Testing.
 - **If the MAP Sensor parameter is in range**
8. Verify the scan tool Boost Pressure Sensor parameter is within the range specified in the [Altitude Versus Barometric Pressure](#) table.

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

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

- **If the Boost Pressure Sensor parameter is in range**

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

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

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

- **If the Boost Pressure Sensor parameter is within range**

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

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

Refer to Circuit/System Testing.

- **If between 24-52 kPa (3.4-7.5 PSI) and changes**

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

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

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

Refer to [DTC P0101](#).

- **If the MAF Sensor parameter does change smoothly and gradually**

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

13. Verify a DTC does not set.

- **If the DTC sets**

Refer to Circuit/System Testing.

- **If the DTC does not set**

14. All OK.

Circuit/System Testing

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

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

- **If a condition is found**

Repair or replace the component as appropriate.

- **If no condition is found**

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

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

- **If 2 Ω or greater**

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

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

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

- **If less than 2 Ω**

4. Ignition ON.

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

- **If less than 4.8 V**

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

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

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

3. Test for less than 2 Ω in the 5 V reference circuit end to end.

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

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

- **If greater than 5.2 V**

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

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

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

- **If between 4.8-5.2 V**

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

- **If 4.7 V or less**

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

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

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

- **If greater than 4.7 V**

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

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

- **If 0.2 V or greater**

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

2. test for less than 1 V between the signal circuit terminal 4 or D and ground.

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

3. Ignition OFF.

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

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

• **If less than 0.2 V**

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

Component Testing

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

Skewed Sensor Test

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

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

Replace the B65 Intake Manifold Pressure and Air Temperature Sensor.

• **If the parameter does decrease between 13-21 kPa (1.8-3.0 PSI).**

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

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

Replace the B65 Intake Manifold Pressure and Air Temperature Sensor.

• **If the parameter does decrease between 30-38 kPa (4.4-5.5 PSI).**

4. All OK.

Erratic Signal Test

1. Ignition OFF, remove the B65 Intake Manifold Pressure and Air Temperature Sensor. and disconnect the harness.
2. Install a 3 A fused jumper wire between the 5 V reference circuit terminal 2 or C of the sensor and the sensor harness.
3. Install a jumper wire between the low reference circuit terminal 3 or A of the sensor and ground.
4. Install a jumper wire to the signal circuit terminal 4 or D of the sensor.
5. Connect a DMM between the jumper wire and ground.
6. Ignition ON, observe the DC voltage on the DMM. Slowly apply -15 kPa (4.4 in Hg) of vacuum to the sensor with the **GE-23738-A**. Verify the voltage changes, without any spikes or dropouts, between 1.3-0.9 V.

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

Replace the B65 Intake Manifold Pressure and Air Temperature Sensor.

• **If between 1.3 -0.9 V and there are no spikes or dropouts**

7. All OK.

Repair Instructions

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

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

- Refer to [Intake Air Pressure and Temperature Sensor Replacement](#)

DTC P0107 OR P0108: MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR CIRCUIT LOW/HIGH VOLTAGE

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.
- Refer to [Diagnostic Procedure Instructions](#) to 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	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P0106, P0107, P018C, P0532, P0641	P0106, P0107	P0106, P018C, P0533, P0641	P0106
Signal	P0106, P0107	P0106, P0108	P0106, P0108*	P0106
Low Reference	-	P0106, P0108	-	P0106

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

Typical Scan Tool Data

MAP Sensor

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

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

Circuit Description

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

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

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

IAT is diagnosed within it's own DTC.

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

Conditions for Running the DTC

P0107

This DTC runs continuously.

P0108

This DTC runs continuously.

Conditions for Setting the DTC

P0107

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

P0108

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

Action Taken When the DTC Sets

DTCs P0107 and P0108 are Type B DTCs.

Conditions for Clearing the DTC

DTCs P0107 and P0108 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics (Buick with LE2)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX (ENCORE)

Powertrain Component View

Powertrain Component Views (Buick)

Description and Operation

Turbocharger System Description

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Special Tools

GE-23738-A Vacuum Pump

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

Circuit/System Verification

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

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

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

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

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

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

Refer to Circuit/System Testing for further diagnosis.

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

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

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

Refer to Circuit/System Testing.

- **If between 24-52 kPa (3.4-7.5 PSI) and changes**

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

6. Verify a DTC does not set.

- **If any DTC sets**

Refer to Circuit/System Testing.

- **If no DTC sets**

7. All OK.

Circuit/System Testing

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

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

- **If 2 Ω or greater**

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

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

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

- **If less than 2 Ω**

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

- **If less than 4.8 V**

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

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

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

- If infinite resistance
3. Test for less than 2 Ω in the 5 V reference circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.

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

- - **If greater than 5.2 V**
 1. Ignition OFF, disconnect the K20 Engine Control Module.
 2. Ignition ON, test for less than 1 V between the 5 V reference circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.
 - **If between 4.8-5.2 V**
4. Ignition ON, verify the scan tool MAP Sensor parameter is greater than 4.7 V.
 - **If 4.7 V or less**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Ignition ON, test for infinite resistance between the signal circuit terminal 4 or D and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K20 Engine Control Module.
 - **If greater than 4.7 V**
 5. Ignition OFF, install a 3 A fused jumper wire between the signal circuit terminal 4 or D and the low reference circuit terminal 3 or A.
 6. Ignition ON, verify the scan tool MAP Sensor voltage parameter is less than 0.2 V.
 - **If 0.2 V or greater**
 1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the K20 Engine Control Module, Ignition ON.
 2. Test for less than 1 V between the signal circuit terminal 4 or D and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 3. Ignition OFF.
 4. Test for less than 2 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open or high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **If less than 0.2 V**
 7. Test or replace the B65 Intake Manifold Pressure and Air Temperature Sensor.

Component Testing

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

Skewed Sensor Test

1. Ignition OFF, remove the B65 Intake Manifold Pressure and Air Temperature Sensor from the engine. Connect the harness to the sensor, if disconnected.
2. Ignition ON, apply -17 kPa (5.0 in Hg) of vacuum to the B65 Intake Manifold Pressure and Air Temperature Sensor, with the **GE-23738-A**. Verify the scan tool MAP Sensor pressure parameter decreases between 13-21 kPa (1.8-3.0 PSI).
 - **If the parameter does not decrease between 13-21 kPa (1.8-3.0 PSI).**

Replace the B65 Intake Manifold Pressure and Air Temperature Sensor.

- **If the parameter does decrease between 13-21 kPa (1.8-3.0 PSI).**
- 3. Apply -34 kPa (10.0 in Hg) of vacuum to the B65 Intake Manifold Pressure and Air Temperature Sensor, with the **GE-23738-A**. Verify the scan tool MAP Sensor pressure parameter decreases between 30-38 kPa (4.4-5.5 PSI).
- **If the parameter does not decrease between 30-38 kPa (4.4-5.5 PSI).**

Replace the B65 Intake Manifold Pressure and Air Temperature Sensor.

- **If the parameter does decrease between 30-38 kPa (4.4-5.5 PSI).**
4. All OK.

Erratic Signal Test

1. Ignition OFF, remove the B65 Intake Manifold Pressure and Air Temperature Sensor and disconnect the harness.
2. Install a 3 A fused jumper wire between the 5 V reference circuit terminal 2 or C of the sensor and the sensor harness.
3. Install a jumper wire between the low reference circuit terminal 3 or A of the sensor and ground.
4. Install a jumper wire to the signal circuit terminal 4 or D of the sensor.
5. Connect a DMM between the jumper wire and ground.
6. Ignition ON, observe the DC voltage on the DMM. Slowly apply -15 kPa (4.4 in Hg) of vacuum to the sensor with the **GE-23738-A**. Verify the voltage changes, without any spikes or dropouts and is between 1.3-0.9 V.

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

Replace the B65 Intake Manifold Pressure and Air Temperature Sensor.

- **If between 1.3-0.9 V and there are no spikes or dropouts**

7. All OK.

Repair Instructions

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

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

DTC P0112, P0113, OR P0114: INTAKE AIR TEMPERATURE (IAT) SENSOR 1 CIRCUIT

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.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptors

DTC P0112

Intake Air Temperature (IAT) Sensor 1 Circuit Low Voltage

DTC P0113

Intake Air Temperature (IAT) Sensor 1 Circuit High Voltage

DTC P0114

Intake Air Temperature (IAT) Sensor 1 Circuit Intermittent

IAT Sensor 1

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P0112, P0114, P2199**	P0111, P0113, P0114, P2199**	P0113*, P0114, P2199**	P0111, P2199**
Low Reference	-	P0111, P0113, P0114, P2199**	P0113*, P0114	-
*Internal ECM or sensor damage may occur if the circuit is shorted to B+.				
**If applicable.				

Typical Scan Tool Data**IAT Sensor 1**

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

Circuit/System Description

The sensors listed below are integrated within the mass air flow/multifunction intake air sensor:

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

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

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

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

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

- IAT sensor 1
- IAT sensor 2
- Humidity sensor
- Barometric pressure (BARO) sensor

IAT Sensor 1 - Temperature, Resistance, Voltage Table

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

Conditions for Running the DTCs

P0112, P0113, and P0114

- The ignition is ON, or the engine is running.
- The P0112 and P0113 run continuously when the above conditions are met.
- Where P0114 is used, the DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

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

P0112

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

P0113

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

P0114

Where this DTC is used, the ECM detects that the IAT sensor signal is intermittent or has abruptly changed for at least 5 s.

Action Taken When the DTCs Set

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

Conditions for Clearing the DTCs

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

Diagnostic Aids

With the ignition ON, the engine OFF, if the engine is cold, a properly functioning IAT sensor 1 will gradually increase the scan tool IAT Sensor 1 parameter. This is due to the heat that is generated by the MAF sensor heating elements.

Reference Information

Schematic Reference

Engine Controls Schematics (Buick with LE2)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX (ENCORE)

Electrical Information Reference

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

Powertrain Component Views

Powertrain Component Views (Buick)

DTC Type Reference

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

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

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

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

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

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

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

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

Refer to Circuit/System Testing.

- **If within 30Â°C (54Â°F)**

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

NOTE: On vehicles equipped with Auto Start/Stop, it may be necessary to OPEN the hood to enable the engine to idle.

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

Refer to Circuit System Testing.

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

6. Operate the vehicle within the conditions for running the DTC. You may also operate the vehicle within the conditions that you observed from the freeze frame/failure records data.
 7. Verify the DTC does not set.
- **If the DTC sets**

Refer to Circuit/System Testing.

- **If the DTC does not set**

8. All OK

Circuit/System Testing

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

1. Ignition OFF, and all vehicle systems OFF, it may take up to 2 min. for all vehicle systems to power down. Disconnect the harness connector at the B75C Multifunction Intake Air sensor.
2. Test for less than 5 Ω between the low reference circuit terminal 7 and ground.
 - **If 5 Ω or greater**
 1. Disconnect the harness connector at the K20 Engine Control Module.
 2. Test for less than 2 Ω in the low reference circuit end to end.
 - If 2 Ω or greater, repair the open or high resistance in the circuit.
 - If less than 2 Ω replace the K20 Engine Control Module.

- **If less than 5 Ω**
3. Ignition ON, test for 4.8-5.2 V between the intake air temperature sensor 1 signal circuit terminal 8 and ground.

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

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

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

- If 2 Ω or greater, repair the open/high resistance in the circuit.
- If less than 2 Ω , replace the K20 Engine Control Module.
- **If warmer than 148 $^{\circ}$ C (298 $^{\circ}$ F).**

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

Component Testing

Multifunction Intake Air Sensor

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

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

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

- **If not within the specified range**

Replace the B75C Multifunction Intake Air Sensor.

- **If within the specified range**

3. All OK.

Repair Instructions

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

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

DTC P0117, P0118, OR P0119: ENGINE COOLANT TEMPERATURE (ECT) SENSOR CIRCUIT

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.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptors

DTC P0117

Engine Coolant Temperature (ECT) Sensor Circuit Low Voltage

DTC P0118

Engine Coolant Temperature (ECT) Sensor Circuit High Voltage

DTC P0119

Engine Coolant Temperature (ECT) Sensor Circuit Intermittent

Diagnostic Fault Information

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

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
*ECM or sensor damage may occur if the circuit is shorted to B+.				

Typical Scan Tool Data

ECT Sensor

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

Circuit/System Description

The engine coolant temperature (ECT) sensor is a variable resistor that measures the temperature of the engine coolant. The engine control module (ECM) supplies 5 V to the ECT sensor signal circuit and a ground for the low reference circuit. This diagnostic checks for an open, short to ground or an intermittent circuit condition between the ECM and ECT sensor.

Conditions for Running the DTC

P0117

- The ignition is ON.
- OR
- The engine is running for greater than 10 s.
 - This DTC runs continuously when the above conditions are met.

P0118

- The ignition is ON.
- OR
- The engine is running for greater than 15 s.
- OR
- The engine run time is less than 15 s when the IAT is warmer than -7Â° C (19Â° F).
 - This DTC runs continuously when the above conditions are met.

P0119

- DTCs P0117, or P0118 are not set.
- The ignition is ON.
- This DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

P0117

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

P0118

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

P0119

The ECM detects that the ECT is intermittent or has abruptly changed for greater than 4 seconds.

Action Taken When the DTC Sets

- DTC P0117, P0118 or P0119 are a Type B DTC.
- The cooling fans will be commanded ON.
- The AC compressor will be commanded OFF.

Conditions for Clearing the DTC

DTC P0117, P0118 or P0119 are a Type B DTC.

Diagnostic Aids

- An open or high resistance in the low reference circuit between the ECM and SP2051 may cause ECT Sensor 1, ECT Sensor 2, IAT Sensor 1, IAT Sensor 2 or BARO DTCs to set.

Reference Information

Schematic Reference

Engine Controls Schematics (Buick with LE2)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX (ENCORE)

Description and Operation

Cooling System Description and Operation (LUV, LE2)

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool ECT Sensor parameter is warmer than -40°C (-40°F) and colder than 150°C (302°F) and changes with engine run time.
 - **If colder than -39°C (-38°F) or warmer than 149°C (300°F) or does not change**

Refer to Circuit/System Testing.

- **If warmer than -40°C (-40°F) and colder than 150°C (302°F) and changes**
3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
 4. Verify the DTC does not set.
 - **If the DTC sets**

Refer to Circuit/System Testing.

- If the DTC does not set

5. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the B34A Engine Coolant Temperature sensor harness connector at the sensor. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 5 Ω between the low reference circuit terminal A or 2 and ground.
 - **If 5 Ω or greater**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for less than 2 Ω in the low reference circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **If less than 5 Ω**
3. Ignition ON.
4. Verify the scan tool ECT Sensor parameter is colder than -39 $^{\circ}$ C (-38 $^{\circ}$ F).
 - **If warmer than -39 $^{\circ}$ C (-38 $^{\circ}$ F)**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the signal circuit terminal B or 1 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K20 Engine Control Module.
 - **If colder than -39 $^{\circ}$ C (-38 $^{\circ}$ F)**
5. Install a 3 A fused jumper wire between the signal circuit terminal B or 1 and the low reference circuit terminal A or 2.
6. Verify the scan tool ECT sensor parameter is warmer than 149 $^{\circ}$ C (300 $^{\circ}$ F).
 - **If 149 $^{\circ}$ C (300 $^{\circ}$ F) or colder**
 1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 - 3. Ignition OFF.
 - 4. Test for less than 2 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **If warmer than 149 $^{\circ}$ C (300 $^{\circ}$ F)**
7. Test or replace the B34A Engine Coolant Temperature Sensor.

Component Testing

1. Ignition OFF, disconnect the harness connector at the B34 Engine Coolant Temperature Sensor.
2. Test the ECT sensor by varying the sensor temperature while monitoring the sensor resistance. Compare the readings with the Temperature Versus Resistance (Engine Coolant Temperature Sensor) table. The resistance values should be in range of the table values.
 - **If not within the specified range**

Replace the B34 Engine Coolant Temperature Sensor.
 - **If within the specified range**
3. Test for infinite resistance between each terminal and the sensor housing.
 - **If less than infinite resistance**

Replace the B34 Engine Coolant Temperature Sensor.

- If infinite resistance

4. All OK.

Repair Instructions

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

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

DTC P0121-P0123, P0222, P0223, P16A0-P16A2, OR P2135: THROTTLE POSITION SENSORS/SENSOR COMMUNICATION

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.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptors

DTC P0121

Throttle Position Sensor 1 Performance

DTC P0122

Throttle Position Sensor 1 Circuit Low Voltage

DTC P0123

Throttle Position Sensor 1 Circuit High Voltage

DTC P0222

Throttle Position Sensor 2 Circuit Low Voltage

DTC P0223

Throttle Position Sensor 2 Circuit High Voltage

DTC P16A0

Sensor Communication Circuit Low Voltage

DTC P16A1

Sensor Communication Circuit High Voltage

DTC P16A2

Sensor Communication Circuit Performance

DTC P2135

Throttle Position Sensors 1-2 Not Plausible

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P06A3	P0122*, P0222*, P16A0	P06A3	P0121, P16A2, P2135*

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P0122*, P0222*, P16A0	P0122*, P0222*, P16A1	P0123*, P0223*, P16A0**, P16A1**, P16A2**	P0121, P16A2, P2135*
Low Reference	-	P0123*, P0223*, P16A1	-	P0121, P16A2, P2135*

* This DTC set indicates an internal throttle body condition.

** A short to voltage causes P16A1 to set. If DTC P16A0, P16A1, and P16A2 set at the same time, an intermittent circuit condition exists.

Typical Scan Tool Data

Throttle Position Sensor 1

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: The engine is operating with the throttle closed. All accessories OFF. Parameter Normal Range: Throttle Position Sensor 1 3.75-4.75 V			
5 V Reference	5.0 V	5.0 V	5.0 V
Signal	5.0 V	0.0 V	0.0 V
Low Reference	-	0.0 V	-

Throttle Position Sensor 2

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: The engine is operating with the throttle closed. All accessories OFF. Parameter Normal Range: Throttle Position Sensor 2 0.45-0.90 V			
5 V Reference	0.0 V	0.0 V	0.0 V
Signal	0.0 V	5.0 V	5.0 V
Low Reference	-	5.0 V	-

Circuit/System Description

The throttle body assembly contains a contact-less inductive throttle position sensing element that is managed by a customized integrated circuit. The throttle position sensor is mounted within the throttle body assembly and is not serviceable. The engine control module (ECM) supplies the throttle body with a 5 V reference circuit, a low reference circuit, an H-bridge motor directional control circuit, and an asynchronous signal/serial data circuit. The asynchronous signal means communication is only going from the throttle body to the ECM. The throttle body cannot receive data from the ECM over the signal/serial data circuit. The throttle position sensor provides a signal voltage that changes relative to throttle blade angle. The customized integrated circuit translates the voltage based position information into serial data using the Society of Automotive Engineers (SAE) J2716 Single Edge Nibble Transmission (SENT) protocol. The throttle position sensor information is transmitted between the throttle body and the ECM on the signal/serial data circuit. The ECM decodes the serial data into a representation of voltage signals that are occurring in the throttle body. The information is then displayed on a scan tool as the voltage inputs from TP sensors 1 and 2.

Conditions for Running the DTC

P0121

- Before the ECM can report that DTC P0121 failed, DTCs P0097, P0098, P0099, P0112, P0113, P0114, P0117, P0118, and P0119 must run and pass.
- DTCs P0097, P0098, P0099, P0102, P0103, P0107, P0108, P0112, P0113, P0114, P0117, P0118, P0119, P0237, P0238, P0335, P0336, P2228, P2229, or P2230 is not set.
- The engine speed is between 400-6,100 RPM.
- The engine coolant temperature (ECT) is -7 to +125Â°C (19-257Â°F).
- The intake air temperature (IAT) is -20 to +126Â°C (-4 to +259Â°F).
- The DTC runs continuously when the above conditions are met.

P0122, P0123, P0222, P0223

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

P16A0, P16A1, or P16A2

- DTC P06A3 is not set.
- The ignition is ON or the engine is operating.
- The run/crank voltage is greater than 6.41 V.
- The DTCs run continuously once the above conditions are met for greater than 1 s.

P2135

- DTCs P0122, P0123, P0222, P0223, or P06A3 are not set.
- The ignition is ON or the engine is running.
- The run/crank or powertrain relay voltage is greater than 6.41 V and reduced power is not active.
- The DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

P0121

The ECM detects that the throttle position sensor input is stuck within normal operating range for greater than 178 ms.

P0122

The ECM detects the throttle position sensor 1 signal voltage is less than 0.33 V for greater than 178 ms, or for 247 ms of a 497 ms time frame.

P0123

The ECM detects the throttle position sensor 1 signal voltage is greater than 4.75 V for greater than 178 ms, or for 247 ms of a 497 ms time frame.

P0222

The ECM detects the throttle position sensor 2 signal voltage is less than 0.25 V for greater than 178 ms, or for 247 ms of a 497 ms time frame.

P0223

The ECM detects the throttle position sensor 2 signal voltage is greater than 4.59 V for greater than 178 ms, or for 247 ms of a 497 ms time frame.

P16A0

The ECM detects a low voltage circuit condition on the throttle position sensor signal circuit for greater than 178 ms, or for 247 ms of a 497 ms time frame.

P16A1

The ECM detects a high voltage circuit condition on the throttle position sensor signal circuit for greater than 178 ms, or for 247 ms of a 497 ms time frame.

P16A2

The ECM detects an incorrect message was received over the throttle position sensor signal circuit for greater than 178 ms, or for 247 ms of a 497 ms time frame.

P2135

- The ECM detects that throttle position sensors 1 and 2 disagree greater than 7% at minimum throttle, with a linear threshold to 10% at wide open throttle (WOT).

OR

- The ECM detects that the TP sensor 1 and 2 learned minimum throttle position voltages is greater than 5 percent of the 5 volt reference voltage.
- Either condition exists for greater than 181 ms, or for 247 ms of a 497 ms time frame.

Action Taken When the DTC Sets

- P0121 is a Type B DTC.
- P0122, P0123, P0222, P0223, P16A0, P16A1, P16A2, and P2135 are Type A DTCs.
- The ECM commands the throttle actuator control (TAC) system to operate in a Reduced Engine Power mode.
- A message center or an indicator displays Reduced Engine Power.
- Under certain conditions, the ECM commands the engine OFF.

Conditions for Clearing the DTC

- P0121 is a Type B DTC.
- P0122, P0123, P0222, P0223, P16A0, P16A1, P16A2, and P2135 are Type A DTCs.

Diagnostic Aids

- 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 that provide estimates of MAF, MAP, and if equipped, barometric pressure (BARO) and throttle inlet air pressure (TIAP). The models are then compared to the actual measured values from the MAF, MAP, BARO, TIAP, the throttle position sensors, and to each other to determine if DTC P0121 is the appropriate DTC to fail.
- A high resistance condition on the throttle position and throttle actuator control circuits could cause a DTC to set.
- If the accelerator pedal is pressed to the wide open throttle position, the throttle blade angle or Throttle Position angle is limited to less than 40 percent.

Reference Information

Schematic Reference

Engine Controls Schematics (Buick with LE2)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX (ENCORE)

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

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE: If you were sent here from DTC P0068, P0101, P0106, or P1101 refer to **Circuit/System Testing**.

1. Ignition ON,
2. Verify that DTC P0601-P0606, P06A3, and P16F3 is not set.
 - **If a DTC is set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** for further diagnosis.
 - **If a DTC is not set**
3. Verify the scan tool Throttle Body Idle Air Flow Compensation parameter is less than 90%.
 - **If 90% or greater**

Refer to **Throttle Body Inspection and Cleaning** .
 - **If less than 90%**
4. Verify that DTC P0122, P0123, P0222, P0223, P16A0, P16A1, P16A2, or P2135 are not set.
 - **If DTC P0122, P0123, P0222, P0223, or P2135 are the only DTCs set**

Replace the Q38 Throttle Body.
 - **If DTC P16A0, P16A1, or P16A2 is set with any of the DTCs**

Refer to Circuit/System Testing
 - **If none of the DTCs are set**
5. Verify the Throttle Position Sensors 1 and 2 parameter displays Agree while performing the Throttle Sweep Test with a scan tool.
 - **If Agree is not displayed**

Replace the Q38 Throttle Body.
 - **If Agree is displayed**
6. Verify DTC P0122, P0123, P0222, P0223, P16A0, P16A1, P16A2, and P2135 is not set.
 - **If a DTC is set**

Refer to Circuit/System Testing.
 - **If a DTC is not set**
7. Determine the current vehicle testing altitude.
8. Verify the scan tool MAP Sensor pressure parameter is within range specified in the **Altitude Versus Barometric Pressure** table.
 - **If the MAP Sensor pressure is not in range**

Refer to **DTC P0106**.
 - **If the MAP Sensor pressure is within range**
9. Engine idling.
10. Verify the scan tool MAP Sensor pressure parameter is between 22-52 kPa (3.2-7.5 psi) and changes with accelerator pedal input.
 - **If not within range or does not change**

Refer to [DTC P0106](#).

- **If within range and changes**

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

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

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

Refer to [DTC P0101](#).

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

12. Verify the scan tool Boost Pressure Sensor pressure and BARO parameters are within 3 kPa (0.4 psi) with engine at idle.

- **If the parameters are not within range**

Refer to [DTC P0236](#).

- **If the parameters are within range**

13. Verify the scan tool MAP Sensor parameter and the Boost Pressure Sensor parameter are within 20 kPa (2.9 psi) during a WOT acceleration at the time of the 1-2 shift.

- **If the parameters are not within range**

Refer to [DTC P0236](#)

- **If the parameters are within range**

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

15. Verify the DTC does not set.

- **If the DTC sets**

Refer to Circuit/System Testing.

- **If the DTC does not set**

16. All OK.

Circuit/System Testing

NOTE: **Disconnecting the throttle body harness connector causes additional DTCs to set.**

1. Ignition OFF, and all vehicle systems OFF, disconnect the harness connector at Q38 Throttle Body. It may take up to 2 min for all vehicle systems to power down.

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

- **If 5 Ω or greater**

1. Disconnect the harness connector X2 at the K20 Engine Control Module.

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

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

- **If less than 5 Ω**

3. Ignition ON.

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

- **If less than 4.8 V**

1. Ignition OFF, disconnect the harness connector X2 at the K20 Engine Control Module.
2. Test for infinite resistance between the 5 V reference circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
3. Test for less than 2 Ω in the 5 V reference circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
- **If greater than 5.2 V**
 1. Ignition OFF, disconnect the harness connector X2 at the K20 Engine Control Module, ignition ON.
 2. Test for less than 1 V between the 5 V reference circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.
- **If between 4.8-5.2 V**
5. Test for 4.8-5.2 V between the signal circuit terminal 3 and ground.
 - **If less than 4.8 V**
 1. Ignition OFF, disconnect the harness connector X2 at the K20 Engine Control Module.
 2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **If greater than 5.2 V**
 1. Ignition OFF, disconnect the harness connector X2 at the K20 Engine Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.
 - **If between 4.8-5.2 V**
6. Test or replace the Q38 Throttle Body.

Repair Instructions

- Refer to [Throttle Body Assembly Replacement](#)
- Refer to [Control Module References](#) for engine control module replacement, programming, and setup

Repair Verification

1. Install any components that have been removed or replaced during diagnosis.
2. Perform any adjustments, programming or setup procedures that are required when a component is removed or replaced.
3. Clear the DTCs with a scan tool.
4. Ignition OFF and all vehicle systems OFF. It may take up to 2 min for all vehicle systems to power down.
5. Ignition ON.
6. Verify the Throttle Position Sensors 1 and 2 parameter displays Agree while performing the Throttle Sweep Test with a scan tool.
 - **If Agree is not displayed**
Test or replace the Q38 Throttle Body.

- If Agree is displayed

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

- If DTC sets

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

- If DTC does not set

8. All OK.

DTC P0128: ENGINE COOLANT TEMPERATURE (ECT) BELOW THERMOSTAT REGULATING TEMPERATURE

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.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptor

DTC P0128

Engine Coolant Temperature (ECT) Below Thermostat Regulating Temperature

Diagnostic Fault Information

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

Typical Scan Tool Data

ECT Sensor

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

Circuit/System Description

The purpose of this diagnostic is to analyze the performance of the thermostat, by using the ECT sensor to determine if the engine coolant will increase at the correct rate, and also meet the calibrated target temperatures under various operating conditions. The ECM uses the start-up ECT and the start-up intake air temperature (IAT) to begin the diagnostic calculation. The air flow into the engine is accumulated, and vehicle speed, distance, and engine run time are also factored in to determine if the ECT does increase normally and reach the calibrated target temperatures.

Conditions for Running the DTC

- DTC P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0119, P0121, P0122, P0123, P0502, P0503, P1104, P16F3, P2101, or P2135 is not set.
- The start-up ECT is colder than 60Â°C (140Â°F).
- The Engine Coolant Thermostat Heater Command is less than 20%.
- The engine OFF time is greater than 30 min.
- The engine run time is between 1 and 30 minutes.

- The vehicle has traveled greater than 2.4 kilometers (1.5 miles).
- The Ethanol in the fuel is less than 87%.
- This DTC runs once per ignition cycle when the above conditions are met.

Conditions for Setting the DTC

- The ECM determines that the ECT has not met its calibrated target of 60Â° C (140 Â°F) when the start-up ambient temperature was between 10 and 52Â° C (50 and 126Â° F), for greater than 1 s.

OR

- The ECM determines that the ECT has not met its calibrated target of 5Â° C (41 Â°F) when the start-up ambient temperature was between -7 and 10Â° C (19 and 50Â° F), for greater than 1 s.

Action Taken When the DTC Sets

- DTC P0128 is a Type B DTC.
- The A/C is commanded OFF and inoperative.
- The Cooling Fans are commanded ON.

Conditions for Clearing the MIL/DTC

DTC P0128 is a Type B DTC.

Diagnostic Aids

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

Reference Information

Schematic Reference

Engine Controls Schematics (Buick with LE2)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX (ENCORE)

Description and Operation

Cooling System Description and Operation (LUV, LE2)

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

1. Verify the cooling system is filled to the correct coolant level. Refer to [Cooling System Leak Testing](#) , and [Cooling System Draining and Filling](#) .

- **If the coolant level is not correct**

Repair as necessary

- **If the coolant level is correct**

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

2. Verify the proper heat range and the operation of the thermostat. Refer to [Thermostat Diagnosis](#) .

- **If a condition is found**

Replace the Thermostat.

- **If a condition is not found**

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

4. Verify the DTC does not set.

- **If the DTC sets**

Refer to Step 1.

- **If the DTC does not set**

5. All OK.

Repair Instructions

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

Refer to [Engine Coolant Thermostat Housing Replacement \(LE2\)](#).

DTC P0131, P0132, P0137, OR P0138: HO2S CIRCUIT VOLTAGE SENSOR 1/2

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.
- Refer to [Diagnostic Procedure Instructions](#) to provide 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	Open/High Resistance	Short to Voltage	Signal Performance
HO2S High Signal	P0131, P0137	P0132, P0138	P0132, P0138	P0133, P1133*, P015A*, P015B*
HO2S Low Signal	P0131, P0137	P0132, P0138	P0132, P0138	P0133, P1133*, P015A*, P015B*
*If equipped				

Typical Scan Tool Data

HO2S 1 or 2

Circuit	Short to Ground	Open/High Resistance	Short to Voltage
Operating Conditions: Engine operating in Closed Loop			
Parameter Normal Range: 23-1 930 mV			
HO2S 1 or 2 High Signal	0 mV	1700-2 100 mV	1700-2 100 mV
HO2S 1 or 2 Low Signal	-	1700-2 100 mV	1700-2 100 mV

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

DTC P0131 or P0137

- DTCs P0068, P0106, P0108, P0122, P0123, P0201, P0202, P0203, P0204, P0222, P0223, P0442, P0443, P0449, P0452, P0455, P0496, P0606, P16F3 and P2101 are not set.
- The Ignition voltage is between 10-32 V.
- The fuel level is greater than 10%.
- The fuel composition is less than 87% ethanol.
- The fuel system is in Closed Loop.
- The engine is not decelerating.
- DTCs run continuously when the above conditions are met for greater than 5 s.

DTC P0132 or P0138

- DTCs P0106, P0108, P0201, P0202, P0203, P0204, P0442, P0443, P0449, P0452, P0453, P0455 and P0496 are not set.
- The Ignition voltage is between 10-32 V.
- The Ignition is OFF for greater than 8 h.
- The fuel level is greater than 10%.
- The fuel composition is less than 87% ethanol.
- The fuel system is in Closed Loop.
- The engine runtime is greater than 5 s.
- The engine is not decelerating.

DTCs run continuously when the above conditions are met for greater than 3 s.

Conditions for Setting the DTC

P0131 or P0137

The engine control module detects that the heated oxygen sensor voltage is less than 40 mV for greater than 40 s.

P0132 or P0138

The engine control module detects that the heated oxygen sensor voltage is greater than 1 050 mV for greater than 10 s.

Action Taken When the DTC Sets

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

Conditions for Clearing the DTC

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

Reference Information

Schematic Reference

Engine Controls Schematics (Buick with LE2)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX (ENCORE)

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify no HO2S heater DTCs are set.
 - **If a HO2S heater DTC is set.**

Refer to Diagnostic Trouble Code (DTC) List - Vehicle .
 - **If no HO2S heater DTC is set.**
3. Allow the engine to reach operating temperature, engine running.
4. Verify the scan tool HO2S Sensor 1 or 2 voltage parameters are between 50-1,050 mV.
 - **If not between 50-1,050 mV.**

Refer to Circuit/System Testing.
 - **If between 50-1,050 mV.**

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

6. Verify the DTC does not set.

- **If the DTC sets.**

Refer to Circuit/System Testing.

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

7. All OK.

Circuit/System Testing

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

2. Test for 1.7-3.0 V between the high signal circuit terminal 4 and ground.

- **If less than 1.7 V**

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

2. Test for infinite resistance between the high signal circuit and ground.

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

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

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

- **If greater than 3.0 V**

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

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

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

- **If between 1.7-3.0 V**

3. Verify the scan tool heated oxygen sensor Bank 1 or 2 Sensor 1 or 2 parameter is between 1.7-2.1 V.

- **If less than 1.7 V**

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

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

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

- **If between 1.7-2.1 V**

4. Connect a 3 A fused jumper wire between the high signal circuit terminal 4 and the low signal circuit terminal 3.

NOTE: The low signal circuit is tied to a pull-up circuit within the engine control module. A voltage of 0.0-1.10 V on the low signal circuit is normal.

5. Verify the scan tool heated oxygen sensor Bank 1 or 2 Sensor 1 or 2 parameter displays 0.0 V.

- **If greater than 0.0 V**

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

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

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

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

- If 1 V or greater, repair the short to voltage on the circuit.
- If less than 1 V, replace the K20 Engine Control Module.
- **If 0.0 V**

6. Verify none of the following conditions exist:

- Lean or rich fuel injectors. Refer to [Fuel Injector Diagnosis](#) .
- Water intrusion in the HO2S harness connector
- Low or high fuel system pressure. Refer to [Fuel System Diagnosis](#) .
- Fuel that is contaminated. Refer to [Alcohol/Contaminants-in-Fuel Diagnosis](#) .
- Fuel saturation of the evaporative emission (EVAP) canister
- Exhaust leaks
- Engine vacuum leaks
- **If any of the conditions exist**

Repair as necessary.

- **If none of the conditions exist**

7. Test or replace the B52 Heated Oxygen Sensor.

Repair Instructions

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

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

DTC P0133, P013A, P013B, P013E, P013F, P015A, P015B, P2270, OR P2271: HO2S RESPONSE SENSOR 1-2/HO2S SIGNAL STUCK SENSOR 2

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.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptors

DTC P0133

HO2S Slow Response 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 P015A

DTC P015B

HO2S Delayed Response Lean to Rich Sensor 1

DTC P2270

HO2S Signal Stuck Lean Sensor 2

DTC P2271

HO2S Signal Stuck Rich Sensor 2

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
HO2S High Signal	P0131, P0137	P0132, P0134, P0138, P0140	P0132, P0134, P0138, P0140	P0133, P013A, P013B, P013E, P013F, P015A, P015B
HO2S Low Signal	P0131, P0137	P0132, P0134, P0138, P0140	P0132, P0134, P0138, P0140	P0133, P013A, P013B, P013E, P013F, P015A, P015B

Typical Scan Tool Data**HO2S 1 or 2**

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

Circuit/System Description

The heated oxygen sensors (HO2S) are used for fuel control and catalyst monitoring. Each HO2S compares the oxygen content of the surrounding air with the oxygen content of the exhaust stream. When the engine is started, the control module operates in an Open Loop mode, ignoring the HO2S signal voltage while calculating the air-to-fuel ratio. While the engine runs, the HO2S heats up and begins to generate a voltage within a range of 0-1,000 mV. Once sufficient HO2S voltage fluctuation is observed by the control module, Closed Loop is entered. The control module uses the HO2S voltage to determine the air-to-fuel ratio. An HO2S voltage that increases toward 1,000 mV indicates a rich fuel mixture. An HO2S voltage that decreases toward 0 mV indicates a lean fuel mixture.

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

Conditions for Running the DTC**P0133**

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0128, P0131, P0132, P0134, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0220, P0222, P0223, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0279, P0280, P0282, P0283, P0300-P0308, P0442, P0443, P0446, P0449, P0452, P0453, P0455, P0496, P1104, P1248, P1249, P124A, P124B, P124C, P124D, P124E, P124F, P1516, P16F3, P2100-P2103, P2119, P2135, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P216B, P216C, P216E, P216F, P217B, P217C, P217E, P217F, P2176, P2227-P2230 are not set.

- The Ignition voltage is between 10-32 V.
- The engine is OFF for greater 8 hours.
- The engine coolant temperature (ECT) is warmer than 70°C (158°F).
- The intake air temperature (IAT) is warmer than -40°C (-40°F)
- The fuel level is greater than 10%.
- The engine run time is greater than 120 s.
- The engine speed is between 1,000-3,500 RPM.
- The barometric (BARO) pressure is greater than 70 kPa.
- The mass airflow (MAF) is between 10-40 g/s.
- The fuel system is in Closed Loop.
- Device controls are not active.
- Ethanol content is less than 87%.
- Fuel control is not in power enrichment.
- Decel fuel cut-off is not active.
- The DTCs run once per drive cycle when the above conditions are met for 3 s.

P013A or P013E

- Before the ECM can report DTC P013A, or P013C failed, DTCs P013E, P014A, P2270, and P2272 must run and pass.
- Before the ECM can report DTC P013E, or P014A failed, DTCs P2270 and P2272 must run and pass.
- DTCs P0030, P0036, P0053, P0054, P0101, P0102, P0103, P0106, P0107, P0108, P0120, P0121, P0122, P0123, P0131, P0132, P0133, P0134, P0135, P0137, P0138, P013A, P013B, P013E, P013F, P0140, P0141, P0171, P0172, P0201-P0208, P0220, P0222, P0223, P0300-P0308, P0442, P0443, P0446, P0449, P0455, P0496, P1133, P1174, P1516, P2101, P2119, P2135, P2176, P2270, P2271, P2A00 are not set.
- The Ignition voltage is between 10-32 V.
- The engine is OFF for greater 8 hours.
- The learned heater resistance is valid.
- The fuel level is greater than 10%.
- After the above conditions are met decel fuel cut-off continues without driver initiated pedal input.
- The DTCs run once per ignition cycle, during decel fuel cut-off (DFCO), when the above conditions are met.

P013B or P013F

- Before the ECM can report DTC P013B, or P013D failed, DTCs P013A, P013C, P013E, P013F, P014A, P014B, P2270, P2271, P2272, and P2273 must run and pass.
- Before the ECM can report DTC P013F, or P014B failed, DTCs P013A, P013C, P013E, P014A, P2270, P2271, P2272, and P2273 must run and pass.
- DTCs P0030, P0036, P0053, P0054, P0101, P0102, P0103, P0106, P0107, P0108, P0120, P0121, P0122, P0123, P0131, P0132, P0133, P0134, P0135, P0137, P0138, P013A, P013B, P013E, P013F, P0140, P0141, P0171, P0172, P0201-P0208, P0220, P0222, P0223, P0300-P0308, P0442, P0443, P0446, P0449, P0455, P0496, P1133, P1174, P1516, P2101, P2119, P2135, P2176, P2270, P2271, P2A00 are not set.
- The Ignition voltage is between 10-32 V.
- The engine is OFF for greater 8 hours.
- The learned heater resistance is valid.
- The fuel level is greater than 10%.
- After the above conditions are met, fuel enrich mode is continued.
- The DTCs run once per ignition cycle when the above conditions are met.

P015A or P015B

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0128, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0220, P0222, P0223, P0442, P0443, P0446, P0449, P0455, P0496, P1516, P2101, P2119, P2135, P2176 are not set.
- The Ignition voltage is between 10-32 V.
- The engine is OFF for greater 8 hours.
- The engine coolant temperature (ECT) is warmer than 70°C (158°F).
- The intake air temperature (IAT) is warmer than -40°C (-40°F)
- The fuel level is greater than 10%.
- The engine run time is greater than 120 s.
- The engine speed is between 1,250-2,300 RPM.
- The vehicle speed is between 56-119 km/h (35-74 mph).
- The mass airflow (MAF) is between 3-12 g/s.
- The fuel system is in Closed Loop.
- Device controls are not active.
- The evaporative emission (EVAP) diagnostics are not in control of purge.
- The heated oxygen sensor 1 heater is on for greater than 40 s.
- The heated oxygen sensor 2 heater is on for greater than 175 s
- After the above conditions are met for 1 s the fuel mixture is forced rich.
- At the end of the forced rich fuel state, the heated oxygen sensor 1 is greater than 0.690 V and decel fuel cut-off is active.
- The DTCs run once per drive cycle when the above conditions are met.

P2270

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0128, P013A, P013B, P013E, P013F, P0171, P0172, P0201, P0202, P0203, P0204, P0220, P0222, P0223, P0300, P0411, P0412, P0418, P1174, P1516, P2101, P2119, P2135, P2176, P2270, P2271 are not set.
- The system voltage is between 10-32 V.
- The fuel level is greater than 10%.
- The pedal position is less than 4%.
- The engine speed is between 1,250-2,300 RPM.
- The engine airflow is between 3-12 g/s.
- The vehicle speed is between 55-120 km/h (35-74 mph).
- The fuel state is in Closed Loop.
- The evaporative emission (EVAP) diagnostics are not in control of purge.
- The HO2S heaters are ON for more than 180 s.
- The predicted catalytic converter temperature is between 600-850°C (1,112-1,562°F).
- This DTC runs once per trip when all of the above conditions have been met for 1 s.

P2271

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

- The evaporative emission (EVAP) diagnostics are not in control of purge.
- Power take-off is not active.
- The heated oxygen sensor heaters have been on more than 180 s.
- The predicted catalyst temperature is between 600-850°C (1,112-1,562°F).
- DTCs P013A, P013E, and P2270 have run and passed.

THEN

- Decel fuel cut-off is active.
- The accelerator pedal position is stable.
- This DTC runs once per trip when the above conditions are met for 3 s.

Conditions for Setting the DTC

P0133, P015A or P015B

- The engine control module detects that the heated oxygen sensor rich-to-lean or lean-to-rich average response time is greater than a calibrated value.
- The DTCs set within 60 s when the above condition is met.

P013A

The engine control module detects that the accumulated mass air flow monitored during rich-to-lean transitions between 450-150 mV is greater than 75 grams.

P013B

The engine control module detects that the accumulated mass air flow monitored during lean-to-rich transitions between 300-600 mV is greater than 75 grams.

P013E

The engine control module detects that the heated oxygen sensor voltage has not decreased below 450 mV within a calibrated value of accumulated air flow.

P013F

The engine control module detects that the heated oxygen sensor voltage has not increased above 300 mV within a calibrated value of accumulated air flow.

P2270

The engine control module does not detect a heated oxygen sensor voltage greater than 825 mV before accumulated mass air flow exceeds a calibrated value.

P2271

The engine control module does not detect an heated oxygen sensor voltage less than 100 mV before accumulated mass air flow exceeds a calibrated value.

Action Taken When the DTC Sets

- DTCs P0133, P013E, P013F, P2270, and P2271 are Type B DTCs.
- DTCs P013A, P013B, P015A, and P015B are Type A DTCs.

Conditions for Clearing the DTC

- DTCs P0133, P013E, P013F, P2270, and P2271 are Type B DTCs.
- DTCs P013A, P013B, P015A, and P015B are Type A DTCs.

Reference Information

[Engine Controls Schematics \(Buick with LE2\)](#)

Connector End View Reference

[COMPONENT CONNECTOR END VIEWS - INDEX \(ENCORE\)](#)

Electrical Information Reference

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

DTC Type Reference

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

Scan Tool Reference

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

[Circuit/System Verification](#)

1. Ignition ON.
2. Verify no HO2S heater DTCs are set.

- **If a DTC is set**

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

- **If a DTC is not set**

3. Verify none of the conditions listed below exist:

- Lean or rich fuel injectors - Refer to [Fuel Injector Diagnosis](#) .
- Water intrusion in the HO2S harness connector
- Low or high fuel system pressure - Refer to [Fuel System Diagnosis](#) .
- Fuel that is contaminated - Refer to [Alcohol/Contaminants-in-Fuel Diagnosis](#) .
- Fuel saturation of the evaporative emission (EVAP) canister
- Exhaust leaks
- Engine vacuum leaks
- Engine oil consumption - Refer to [Oil Consumption Diagnosis](#) .
- Engine coolant consumption - Refer to [Loss of Coolant](#) .
- **If any of the above conditions exist**

Repair as necessary.

- **If none of the conditions exist**

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.

5. Verify the DTC does not reset.

- **If the DTC sets**

Test or replace the appropriate B52 HO2S.

- **If the DTC does not set**

6. All OK.

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

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

DTC P0171 OR P0172: FUEL TRIM SYSTEM LEAN/RICH

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.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptors

DTC P0171

Fuel Trim System Lean

DTC P0172

Fuel Trim System Rich

Circuit/System Description

The engine control module (ECM) controls a Closed Loop air/fuel metering system in order to provide the best possible combination of driveability, fuel economy, and emission control. The ECM monitors the heated oxygen sensor (HO2S) signal voltage, and adjusts the fuel delivery based on the signal voltage while in Closed Loop. A change made to the fuel delivery changes the long and short term fuel trim values. The short term fuel trim values change rapidly in response to the HO2S signal voltages. These changes fine tune the engine fueling. The long term fuel trim values change in response to trends in the short term fuel trim. The long term fuel trim makes coarse adjustments to fueling in order to re-center and restore control to short term fuel trim. The ideal fuel trim values are around 0%. A positive fuel trim value indicates that the ECM is adding fuel in order to compensate for a lean condition. A negative fuel trim value indicates that the ECM is reducing the amount of fuel in order to compensate for a rich condition.

Conditions for Running the DTC

- DTCs P0030, P0053, P0101, P0102, P0103, P0106, P0107, P0108, P0131-P0135, P0201-P0204, P0236, P0237, P0238, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0300-P0304, P0458, P1248, P1249, P124A, P124B, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P2227, P2228, P2229, or P2230 are not set.
- The engine is in Closed Loop status.
- The catalyst monitor diagnostic intrusive test, post 02 diagnostic intrusive test, device control, and evaporative emission leak test are not active.
- The engine coolant temperature (ECT) is between -20 and +150Â°C (-4 and +302Â°F).
- The intake air temperature (IAT) is between -20 and +150Â°C (-4 and +302Â°F).
- The manifold absolute pressure (MAP) is between 5-255 kPa (0.7-37 psi).
- The engine speed is between 400-6,100 RPM.
- The mass air flow (MAF) is between 0.5-510 g/s.
- The barometric pressure (BARO) is greater than 70 kPa (10.2 psi).
- The fuel level is greater than 10% and no fuel level sensor fault is present.
- This diagnostic runs continuously when the above conditions have been met.

Conditions for Setting the DTC

- The average long term fuel trim weighted average value is greater or less than a calibrated value.

- The above condition is present for approximately 3 min after the Conditions for Running the DTC have been met.

Action Taken When the DTC Sets

DTCs P0171 and P0172 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0171 and P0172 are Type B DTCs.

Diagnostic Aids

- Allow the engine to reach operating temperature. With the engine running, observe the HO2S parameter with a scan tool. The HO2S value should vary from approximately 40 mV to approximately 900 mV, and respond to fueling changes.
- The normal Short Term Fuel Trim and Long Term Fuel Trim parameters should be between +10 and -10% with 0% the optimum, with the engine running at operating temperature.
- Any un-metered air into the engine causes this DTC to set. Thoroughly inspect all areas of the engine for vacuum leaks.
- A MAF sensor condition can cause this DTC without setting a MAF DTC. If there is a MAF sensor condition, the MAF sensor parameters will appear to be within range.
- Verify that the air filter is the correct one for this application. Verify that the engine oil fill cap is in place and that it is tight. Verify that the engine oil dip stick is fully seated.
- Certain aftermarket air filters may cause a DTC to set.
- Certain aftermarket air induction systems or modifications to the air induction system may cause a DTC to set.
- Certain aftermarket exhaust system components may cause a DTC to set.

Reference Information

Component View Reference

Powertrain Component Views (Buick)

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

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

Circuit/System Verification

1. Ignition ON.
2. Verify no other DTCs are set.
 - **If any other DTCs are set**

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

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

Refer to Circuit/System Testing.

- **If no DTC is set**

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

5. Verify DTC P0171 or P0172 is not set.

- **If any of the DTCs set**

Refer to Circuit/System Testing.

- **If none of the DTCs set**

6. All OK.

Circuit/System Testing

1. Ignition ON.

2. Verify the manifold absolute pressure sensor is within the range specified for your altitude. Refer to [Altitude Versus Barometric Pressure](#)

- **If not within the specified range**

Refer to [DTC P0106](#)

- **If within the specified range**

3. Engine running at the operating temperature.

4. Verify the Long Term Fuel Trim parameter is between -10% and +10%.

- **If greater than +10%**

1. Ignition OFF.

2. Inspect for the conditions listed below:

- Mass air flow (MAF) sensor signal skewed - If the Short Term Fuel Trim parameter changes greater than 20% when the MAF sensor is disconnected, refer to [DTC P0101](#).
- Fuel contamination - Refer to [Alcohol/Contaminants-in-Fuel Diagnosis](#).
- Missing, restricted, or leaking exhaust components - Refer to [Symptoms - Engine Exhaust](#).
- Malfunctioning fuel injectors - Refer to [Fuel Injector Diagnosis](#).
- Vacuum hoses for splits, kinks, and improper connections
- Insufficient fuel in the tank
- Low fuel pressure - Refer to [Fuel System Diagnosis](#).
- Vacuum leaks at the intake manifold, the throttle body, and the injector O-rings.
- Leaks in the air induction system and the air intake ducts
- Leaks in the components of the vacuum operated engine mount system
- Missing air filter element
- Cracked EVAP canister
- Evaporative pipes obstructed or leaking
- The crankcase ventilation system for leaks - Refer to [Crankcase Ventilation System Inspection/Diagnosis](#).

- If a condition is found, repair as necessary.

- If no condition is found, inspect the engine for a mechanical condition. Refer to [Symptoms - Engine Mechanical](#).

- **If less than -10%**

1. Ignition OFF.

2. Inspect for the conditions listed below:

- Mass air flow (MAF) sensor signal skewed - If the Short Term Fuel Trim parameters for both banks changes greater than 20% when the MAF sensor is disconnected, refer

to **DTC P0101**.

- Fuel contamination - Refer to [Alcohol/Contaminants-in-Fuel Diagnosis](#) .
- Missing, restricted, or leaking exhaust components - Refer to [Symptoms - Engine Exhaust](#) .
- Malfunctioning fuel injectors - Refer to [Fuel Injector Diagnosis](#)
- Collapsed or restricted air intake duct
- Excessive fuel pressure - Refer to [Fuel System Diagnosis](#)
- Dirty or restricted air filter
- Objects blocking the throttle body
- Improper operation of the evaporative emissions control system
- Excessive fuel in the crankcase - Change the engine oil as necessary.
- If a condition is found, repair as necessary.
- If no condition is found, inspect the engine for a mechanical condition. Refer to [Symptoms - Engine Mechanical](#) .
- **If between -10% and +10%**

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

6. Verify DTC P0171 or P0172 is not set.

- **If any of the DTCs set**

Refer to conditions listed above.

- **If none of the DTCs set**

7. All OK.

Repair Instructions

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

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

DTC P0191 OR P0192: FUEL RAIL PRESSURE SENSOR

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.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptors

DTC P0191

Fuel Rail Pressure Sensor Performance

DTC P0192

Fuel Rail Pressure Sensor Circuit Low Voltage

Diagnostic Fault Information

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

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P018C, P0192, P0340, P0365, P0452, P0506, P0522, P0532, P055C, P0641, P2227, P2228	P0192	P018D, P0453, P0523, P0533, P055D, P0641, P2227	P0191
Signal	P0192, P0506	P0192	-	P0191
Low Reference	-	P0506	-	P0191

Circuit/System Description

The fuel pressure/temperature sensor transmits fuel pressure and temperature information by serial data using the Society of Automotive Engineers (SAE) J2716 Single Edge Nibble Transmission (SENT) protocol. The fuel pressure/temperature sensor internal microprocessor allows 4 separate sensor outputs from one 3 wire sensor. The engine control module (ECM) supplies the fuel pressure/temperature sensor with a 5 V reference circuit, a low reference circuit, and an asynchronous signal/serial data circuit. The asynchronous signal means communication is only going from the fuel pressure/temperature sensor to the ECM. The ECM decodes the serial data signal into separate voltages.

Conditions for Running the DTC

P0191

- The engine is running for greater than 1 min.
- The commanded fuel pressure rate of change, increase or decrease, is less than 3 MPa (435 PSI) for greater than or equal to 1.25 s.
- The DTC runs continuously within the enabling conditions.

P0192

- The engine is cranking or running.
- The DTC runs continuously within the enabling condition.

Conditions for Setting the DTC

P0191

The difference between the commanded high pressure and the measured high pressure is greater than or less than a predefined threshold for greater than or equal to 1.5 s.

P0192

The ECM detects that the fuel pressure/temperature sensor signal voltage is low for greater than 30 s with the engine running or greater than 10 s with the engine cranking.

Action Taken When the DTC Sets

- DTCs P0191, P0192, are Type A DTCs.
- A message center or an indicator may display Reduced Engine Power.

Conditions for Clearing the DTC

DTCs P0191, P0192 are Type A DTCs.

Diagnostic Aids

- A high resistance condition on the fuel pressure/temperature sensor circuits could cause a DTC to set.
- Inspect for a contaminated fuel system.

Reference Information

Schematic Reference

Engine Controls Schematics (Buick with LE2)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX (ENCORE)

Powertrain Component View

Powertrain Component Views (Buick)

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/Vehicle In Service Mode
2. Verify there are no DTCs set related to the following system/component: 5V Reference
 - **If any of the DTCs are set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**
 - **If none of the DTCs are set**
3. Verify there are no DTCs set related to the following system/component: B310 Fuel Pressure/Temperature Sensor
 - **If other DTCs are set - With DTC P0191 set.**

Refer to Circuit/System Testing.
 - **If only DTC P0191 is set & No other DTCs related to the concerned component are set.**

Replace the component: B310 Fuel Pressure/Temperature Sensor
 - **If none of the DTCs are set**
4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
5. Verify that no DTCs are set.

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

Refer to Circuit/System Testing.

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

6. All OK.

Circuit/System Testing

NOTE: Disconnecting the fuel pressure/temperature sensor harness connector causes additional DTCs to set.

1. Ignition OFF, and all vehicle systems OFF, disconnect the harness connector at B310 Fuel Pressure/Temperature Sensor. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 5 Ω between the low reference circuit terminal 1 and ground.
 - **If 5 Ω or greater**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for less than 2 Ω in the low reference circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **If less than 5 Ω**
3. Ignition ON.
4. Test for 4.8-5.2 V between the 5 V reference circuit terminal 3 and ground.
 - **If less than 4.8 V**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the 5 V reference circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 Ω in the 5 V reference circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **If greater than 5.2 V**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
 2. Test for less than 1 V between the 5 V reference circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.
 - **If between 4.8-5.2 V**
5. Test for 4.8-5.2 V between the signal circuit terminal 2 and ground.
 - **If less than 4.8 V**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **If greater than 5.2 V**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.

- If less than 1 V, replace the K20 Engine Control Module.

- **If between 4.8-5.2 V**

6. Replace the B310 Fuel Pressure/Temperature Sensor.

Repair Instructions

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

- Refer to **Fuel Injection Fuel Rail Fuel Pressure Sensor Replacement** for B310 Fuel Pressure/Temperature Sensor.
- Refer to **Control Module References** for control module replacement, programming and setup.

DTC P0182, P0183, P0187, P0188, P111F, P126E, OR P126F: FUEL TEMPERATURE SENSORS

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.
- Refer to **Diagnostic Procedure Instructions** to provide an overview of each diagnostic category.

DTC Descriptors

DTC P0182

Fuel Temperature Sensor Circuit Low Voltage

DTC P0183

Fuel Temperature Sensor Circuit High Voltage

DTC P0187

Fuel Temperature Sensor 2 Circuit Low Voltage

DTC P0188

Fuel Temperature Sensor 2 Circuit High Voltage

DTC P111F

Fuel Temperature Sensor 1 - Fuel Temperature Sensor 2 Not Plausible

DTC P126E

Fuel Rail Temperature Sensor 1 Performance

DTC P126F

Fuel Rail Temperature Sensor 2 Performance

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P018C, P0236, P0237, P0340, P0345, P0365, P0390, P0452, P0522, P0532, P0641, P16E5	P128C, P128D, P128F, P16E4, P16E5	P0121, P018D, P0236, P0641, P1400, P16E5, P2227, P222B	-
Signal	P16E4	P16E5	P16E5	-
Low Reference	-	P16E5	-	-

Fuel Rail Pressure Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: The engine is operating with the throttle closed. All accessories OFF. Parameter Normal Range: 2.9-3.2 MPa			
5 V Reference	655.4 MPa	655.4 MPa	655.4 MPa
Signal	655.4 MPa	655.4 MPa	655.4 MPa
Low Reference	-	655.4 MPa	-

Circuit/System Description

The fuel pressure/temperature sensor transmits fuel pressure and temperature information by serial data using the Society of Automotive Engineers (SAE) J2716 Single Edge Nibble Transmission (SENT) protocol. The fuel pressure/temperature sensor internal microprocessor allows 4 separate sensor outputs from one 3 wire sensor. The engine control module (ECM) supplies the fuel pressure/temperature sensor with a 5 V reference circuit, a low reference circuit, and an asynchronous signal/serial data circuit. The asynchronous signal means communication is only going from the fuel pressure/temperature sensor to the ECM. The ECM decodes the serial data signal into separate voltages.

Conditions for Running the DTC**P0182 or P0183**

- DTC P126E, P128C, P16E4, or P16E5 is not set.
- DTC P126E or P128C is not pending.
- Ignition is ON.
- The DTCs run continuously when the above conditions are met.

P0187 or P0188

- DTC P126F, P128D, P16E4, or P16E5 is not set.
- DTC P126F or P128D is not pending.
- Ignition is ON.
- The DTCs run continuously when the above conditions are met.

P111F

- DTC P0182, P0183, P0187, P0188, P126E, P126F, P128C, P128D, P16E4, or P16E5 is not set.
- DTC P128C, P128D, P16E4, or P16E5 is not pending.
- Ignition is ON.
- The DTC runs continuously when the above conditions are met.

P126E

- DTC P128C, P16E4, or P16E5 is not set.
- DTC P128C is not pending.
- Ignition is ON.
- The DTC runs continuously when the above conditions are met.

P126F

- DTC P128D, P16E4, or P16E5 is not set.
- DTC P128D is not pending.
- Ignition is ON.
- The DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

P0182

The engine control module detects the fuel temperature sensor 1 SENT digital read value is less than 145 for greater than 6 s.

P0183

The engine control module detects the fuel temperature sensor 1 SENT digital read value is greater than 1,865 for greater than 6 s.

P0187

The engine control module detects the fuel temperature sensor 2 SENT digital read value is less than 145 for greater than 6 s.

P0188

The engine control module detects the fuel temperature sensor 2 SENT digital read value is greater than 1,865 for greater than 6 s.

P111F

The engine control module detects the difference between fuel temperature sensor 1 and fuel temperature sensor 2 is greater than 20Â°C (68Â°F) for greater than 12.5 s.

P126E

The engine control module detects the fuel temperature sensor 1 SENT digital read value is greater than or equal to 4,089 for greater than 6 s.

P126F

The engine control module detects the fuel temperature sensor 2 SENT digital read value is greater than or equal to 4,089 for greater than 6 s.

Action Taken When the DTC Sets

DTC P0182, P0183, P0187, P0188, P111F, P126E, and P126F are Type B DTCs.

Conditions for Clearing the DTC

DTC P0182, P0183, P0187, P0188, P111F, P126E, and P126F are Type B DTCs.

Diagnostic Aids

- A high resistance condition on the fuel pressure/temperature sensor circuits could cause a DTC to set.
- Inspect for a contaminated fuel system.

Reference Information

Schematic Reference

Engine Controls Schematics (Buick with LE2)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX (ENCORE)

Powertrain Component View

Powertrain Component Views (Buick)

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/Vehicle in Service Mode.
2. Verify that DTC P0641, P0651, P0697, or P06A3 is not set.
 - **If any of the DTCs are set**

Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) for further diagnosis.
 - **If none of the DTCs are set**
3. Verify that DTC P0182, P0183, P0187, P0188, P111F, P126E, P126F, P127C, P128A, P128B, P128C, P128D, P128F, P16E4, or P16E5 are not set.
 - **If DTC P0182, P0183, P0187, P0188, P111F, P126E, or P126F are the only DTCs set**

Replace the B310 Fuel Pressure/Temperature Sensor.
 - **If DTC P127C, P128A, P128B, P128C, P128D, P128F, P16E4, or P16E5 is set with any of the DTCs**

Refer to Circuit/System Testing.
 - **If none of the DTCs are set**
4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
5. Verify that no DTCs are set.
 - **If any of the DTCs are set**

Refer to Circuit/System Testing.
 - **If none of the DTCs are set**
6. All OK.

Circuit/System Testing

NOTE: **Disconnecting the fuel pressure/temperature sensor harness connector causes additional DTCs to set.**

1. Ignition/Vehicle OFF, and all vehicle systems OFF, disconnect the harness connector at B310 Fuel Pressure/Temperature Sensor. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 5 Ω between the low reference circuit terminal 1 and ground.
 - **If 5 Ω or greater**
 1. Ignition/Vehicle OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for less than 2 Ω in the low reference circuit end to end.

- If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **If less than 5 Ω**
3. Ignition/Vehicle ON.
 4. Test for 4.8-5.2 V between the 5 V reference circuit terminal 2 and ground.
 - **If less than 4.8 V**
 1. Ignition/Vehicle OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the 5 V reference circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 Ω in the 5 V reference circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **If greater than 5.2 V**
 1. Ignition/Vehicle OFF, disconnect the harness connector at the K20 Engine Control Module, ignition/vehicle ON.
 2. Test for less than 1 V between the 5 V reference circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.
 - **If between 4.8-5.2 V**
 5. Test for 4.8-5.2 V between the signal circuit terminal 3 and ground.
 - **If less than 4.8 V**
 1. Ignition/Vehicle OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **If greater than 5.2 V**
 1. Ignition/Vehicle OFF, disconnect the harness connector at the K20 Engine Control Module, ignition/vehicle ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.
 - **If between 4.8-5.2 V**
 6. Replace the B310 Fuel Pressure/Temperature Sensor.

Repair Instructions

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

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

DTC P018B-P018D: FUEL PRESSURE SENSOR (CHASSIS CONTROL MODULE)

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.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptors

DTC P018B

Fuel Pressure Sensor Performance

DTC P018C

Fuel Pressure Sensor Circuit Low Voltage

DTC P018D

Fuel Pressure Sensor Circuit High Voltage

Diagnostic Fault Information

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

Circuit/System Description

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

Conditions for Running the DTC

- The engine is running.
- DTCs 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 chassis control module does not detect a change in the fuel pressure of at least 30 kPa (4.4 psi) when the fuel pump is operating. The fuel pressure sensor performance diagnostic provides a means to detect fuel pressure sensor output that is stuck within the normal operating range of the sensor.

Action Taken When the DTC Sets

DTCs P018B, P018C and P018D are Type A DTCs.

Conditions for Clearing the DTC

DTCs 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 (Buick with LE2)

Connector End View Reference

Description and Operation

Fuel System Description

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Engine running.
2. Verify the scan tool Fuel Pressure Sensor Voltage parameter is between 0.2-4.8 V.
 - **If not between 0.2-4.8 V**
Refer to Circuit/System Testing.
 - **If between 0.2-4.8 V**
3. All OK.

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 resets before proceeding with the circuit system testing. If the DTC does not reset, refer to **Strategy Based Diagnosis** .

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B47 Fuel Pressure Sensor. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 Ω between the low reference circuit terminal 2 and ground.
 - **If 10 Ω or greater**
 1. Ignition OFF, disconnect the harness connector at the K38 Chassis Control Module.
 2. Test for less than 2 Ω in the low reference circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K38 Chassis Control Module.
 - **If less than 10 Ω**
3. Ignition ON.
4. Test for 4.8-5.2 V between the 5 V reference circuit terminal 3 and ground.
 - **If less than 4.8 V**
 1. Ignition OFF, disconnect the harness connector at the K38 Chassis Control Module.
 2. Test for infinite resistance between the 5 V reference circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 Ω in the 5 V reference circuit end to end.

- If 2 Ω or greater, repair the open/high resistance in the circuit.
- If less than 2 Ω , replace the K38 Chassis Control Module.
- **If greater than 5.2 V**
 1. Ignition OFF, disconnect the harness connector at the K38 Chassis Control Module, ignition ON.
 2. Test for less than 1 V between the 5 V reference circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K38 Chassis Control Module.
- **If between 4.8-5.2 V**
- 5. Verify the scan tool Fuel Pressure Sensor Voltage parameter is less than 1 V.
 - **If 1 V or greater**
 1. Ignition OFF, disconnect the harness connector at the K38 Chassis Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit terminal 1 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K38 Chassis Control Module.
 - **If less than 1 V**
- 6. Install a 3 A fused jumper wire between the signal circuit terminal 1 and the 5 V reference circuit terminal 3, wait 15 seconds.
- 7. Verify the scan tool Fuel Pressure Sensor Voltage parameter is greater than 4.8 V.
 - **If 4.8 V or less**
 1. Ignition OFF, disconnect the harness connector at the K38 Chassis Control Module.
 2. Test for infinite resistance between the signal circuit terminal 1 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K38 Chassis Control Module.
 - **If greater than 4.8 V**
- 8. Test or replace the B47 Fuel Pressure Sensor.

Repair Instructions

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

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

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

Diagnostic Instructions

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

DTC Descriptor

DTC 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 P1247

Cylinder 1 Injector High Control Circuit Low Voltage

DTC P1248

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 Between Circuits
Control circuit terminal 2 @ Q17A Fuel Injector 1	P2147	P0201	P2148	P1248
Control circuit terminal 1 @ Q17A Fuel Injector 1	P0261	P0201	P0262	P1248
Control circuit terminal 2 @ Q17B Fuel Injector 2	P2150	P0202	P2151	P1249
Control circuit terminal 1 @ Q17B Fuel Injector 2	P0264	P0202	P0265	P1249
Control circuit terminal 2 @ Q17C Fuel Injector 3	P2153	P0203	P2154	P124A
Control circuit terminal 1 @ Q17C Fuel Injector 3	P0267	P0203	P0268	P124A
Control circuit terminal 2 @ Q17D Fuel Injector 4	P2156	P0204	P2157	P124B
Control circuit terminal 1 @ Q17D Fuel Injector 4	P0270	P0204	P0271	P124B

Typical Scan Tool Data**Fuel Injector Control Circuit Test Status**

Circuit	Short to Ground	Open	Short to Voltage	Short between the circuits
Operating Conditions: Engine at Idle Parameter Normal Range: OK or Not Run				
Control circuit terminal 2	High Control Circuit Low Voltage	Open	High Control Circuit High Voltage	High Control Circuit Shorted to Control Circuit
Control circuit terminal 1	Control Circuit Low Voltage	Open	Control Circuit High Voltage	High Control Circuit Shorted to Control Circuit

Circuit/System Description

Circuit	Description
Control circuit terminal 2	Regulated voltage supplied by the control module.
Control circuit terminal 1	The output circuit is switched to ground to activate the component.

Component	Description
Q17 Fuel Injector	Fuel injectors are solenoid valves that inject fuel either into the intake system or directly into the cylinder. The amount of fuel injected depends on the length of the electrical pulse that is applied. The fuel injectors of this system have an operating voltage range of 12 to 65 V.
K20 Engine Control Module	The control module controls a series of actuators to ensure optimal engine performance. The control module does this by reading values from a variety of sensors, interprets the data and adjusts the engine actuators accordingly.

Conditions for Running the DTC

- DTC P062B = Not set
- Engine is Running
- Battery Voltage = Greater than 11 V

DTCs run continuously when the above conditions are met.

Conditions for Setting the DTC

P0201, P0202, P0203, P0204

Control circuit = Open - For greater than 1 s

P0261, P0264, P0267, P0270

Control circuit - Low = Short to Ground - For greater than 1 s

P0262, P0265, P0268, P0271

Control circuit - Low = Short to Voltage - For greater than 1 s

P1248, P1249, P124A, P124B

Control Circuit Shorted to Control Circuit - For greater than 1 s

P2147, P2150, P2153, P2156

Control circuit - High = Short to Ground - For greater than 1 s

P2148, P2151, P2154, P2157

Control circuit - High = Short to Voltage - For greater than 1 s

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category are Type A DTCs.

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category are Type A DTCs.

Diagnostic Aids

If the condition is intermittent, wiggle the related wiring harnesses and connectors, with the engine running, while monitoring the scan tool circuit status parameters for the component. The parameters will display if there is a condition with the circuit or a connection.

Reference Information

Schematic Reference

Engine Controls Schematics (Buick with LE2)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX (ENCORE)

Component View Reference

Powertrain Component Views (Buick)

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

Circuit/System Verification

1. Ignition On/Vehicle In Service Mode
2. Verify the scan tool parameter:
 - Cylinder 1 Injector Control Circuit Status = OK
 - Cylinder 2 Injector Control Circuit Status = OK
 - Cylinder 3 Injector Control Circuit Status = OK
 - Cylinder 4 Injector Control Circuit Status = OK
 - **If not the specified state**

Refer to: Circuit/System Testing
 - **If the specified state**
3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
4. Verify the DTC does not set.
 - **If the DTC sets**

Refer to: Circuit/System Testing
 - **If the DTC is not set**
5. All OK.

Circuit/System Testing

1. Ignition/Vehicle Off
2. Disconnect the appropriate electrical connector: Q17 Fuel Injector
3. Ignition On/Vehicle In Service Mode
4. Test for 5 to 6 V between the test points: Control circuit terminal 2 & Ground
 - **If less than 5 V**
 1. Ignition/Vehicle Off
 2. Disconnect the electrical connector: X2 @ K20 Engine Control Module
 3. Test for infinite resistance between the test points: Control circuit terminal 2 @ Component harness & Ground
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 4. Test for less than 2 Ω between the test points: Control circuit terminal 2 @ Component harness &
 - {Q17A Fuel Injector 1} Terminal 71 @ Control module harness
 - {Q17B Fuel Injector 2} Terminal 68 @ Control module harness
 - {Q17C Fuel Injector 3} Terminal 70 @ Control module harness
 - {Q17D Fuel Injector 4} Terminal 69 @ Control module harness
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the component: K20 Engine Control Module
 - **If greater than 6 V**
 1. Ignition/Vehicle Off
 2. Test for infinite resistance between the test points: Control circuit terminal 2 & Control circuit terminal 1 @ Component harness
 - If less than infinite resistance, repair the short between the circuits.
 - If infinite resistance
 3. Disconnect the electrical connector: X2 @ K20 Engine Control Module
 4. Ignition On/Vehicle In Service Mode
 5. Test for less than 1 V between the test points: Control circuit terminal 2 @ Component harness & Ground
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the component: K20 Engine Control Module
 - **If between 5 and 6 V**
5. Clear the DTCs.
6. Ignition/Vehicle Off
7. Connect a test lamp between the test points: Control circuit terminal 2 & Control circuit terminal 1 @ Q17 Fuel Injector - Component harness
8. Engine cranking.
9. Verify the test lamp flashes - For 2 s
 - **If the test lamp does not flash**
 1. Ignition/Vehicle Off & Remove Test lamp
 2. Disconnect the electrical connector: X2 @ K20 Engine Control Module
 3. Test for infinite resistance between the test points: Control circuit terminal 1 @ Component harness & Ground
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 4. Test for less than 2 Ω between the test points: Control circuit terminal 1 @ Component harness &
 - {Q17A Fuel Injector 1} Terminal 51 @ Control module harness
 - {Q17B Fuel Injector 2} Terminal 48 @ Control module harness
 - {Q17C Fuel Injector 3} Terminal 50 @ Control module harness

- {Q17D Fuel Injector 4} Terminal 59 @ Control module harness
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω
5. Ignition On/Vehicle In Service Mode
 6. Test for less than 1 V between the test points: Control circuit terminal 1 @ Component harness & Ground
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the component: K20 Engine Control Module
 - **If the test lamp flashes**
 10. Test or replace the component: Q17 Fuel Injector

Component Testing

Refer to [Fuel Injector Diagnosis](#)

Repair Instructions

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

- Refer to [Fuel Injector Replacement](#)
- For control module replacement, programming, and setup refer to: [Control Module References](#)

DTC P0234 OR P0299: ENGINE OVERBOOST/UNDERBOOST

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.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptors

DTC P0234

Engine Overboost

DTC P0299

Engine Underboost

Circuit Description

The boost pressure sensor measures the range of pressures between the turbocharger and the throttle body. The sensor used on this engine is a three atmosphere sensor. Pressure in this portion of the induction system is affected by engine speed, throttle opening, turbocharger boost pressure, Intake air temperature (IAT), barometric pressure (BARO), and the efficiency of the charge air cooler.

The sensor provides a signal voltage to the engine control module (ECM), relative to the pressure changes. Under normal operation the greatest pressure that can exist in this portion of the induction system at ignition On, engine Off is equal to the BARO. When the engine is operated at wide-open throttle (WOT) the turbocharger can increase the pressure to near 240 kPa (34.8 psi). The pressure is equal to the BARO when the engine is idling or decelerating.

Conditions for Running the DTCs

- DTC P00C0, P00C1, P00C2, P0033, P0034, P0035, P0045, P0047, P0048, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0119, P0128, P0236, P0237, P0238, P0243, P0245, P0246, P0247, P0249, P0250, P111E, P2227, P2228, P2229, or P2230 is not set.
- Engine speed is between 1,500-6,500 RPM.
- Desired boost pressure is between 140-240 kPa (20.3-35 psi)
- Barometric Pressure (BARO) is between 60-120 kPa (8.7-17.4 psi).

- Engine coolant temperature (ECT) is between -40 to +126Â°C (-40 to +259Â°F).
- Intake air temperature (IAT) is between -40 to +80Â°C (-40 to +176Â°F)
- Turbocharger bypass valve is not under output device control.
- Pressure control is in closed loop.

The DTCs run continuously when the above conditions have been met.

OR

- DTC P00C0, P00C1, P00C2, P0033, P0034, P0035, P0045, P0047, P0048, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0119, P0128, P0236, P0237, P0238, P0243, P0245, P0246, P0247, P0249, P0250, P111E, P2227, P2228, P2229, P2230 or P2261 is not set.
- Engine speed is between 2,000-3,500 RPM.
- Barometric Pressure (BARO) is between 60-120 kPa (8.7-17.4 psi).
- Engine coolant temperature (ECT) is between -40 to +126Â°C (-40 to +259Â°F).
- Intake air temperature (IAT) is between -40 to +80Â°C (-40 to +176Â°F)
- Turbocharger bypass valve is not under output device control.
- Pressure control is in open loop.

The DTCs run continuously when the above conditions have been met.

Conditions for Setting the DTC

P0234

The ECM detects that the actual boost pressure is greater than the desired boost pressure by a calibrated amount for greater than 3 s.

P0299

The ECM detects that the actual boost pressure is less than the desired boost pressure by a calibrated amount for greater than 3 s.

Action Taken When the DTCs Set

- DTCs P0234 and P0299 are Type A DTCs.
- The Service Vehicle Soon Indicator may illuminate.

Conditions for Clearing the MIL/DTCs

DTCs P0234 and P0299 are Type A DTCs.

Diagnostic Aids

- The charge air cooler is connected to the turbocharger and to the throttle body by flexible duct work that requires the use of special high torque fastening clamps. These clamps cannot be substituted. In order to prevent any type of air leak when servicing the ductwork, the tightening specifications and proper positioning of the clamps is critical, and must be strictly adhered to.
- Use a smoke generating device or a solution of dish soap and water in a spray bottle to pinpoint any suspected air leaks in the induction system and in the charge air cooler assembly.

Reference Information

Schematic Reference

Engine Controls Schematics (Buick with LE2)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX (ENCORE)

Description and Operation

Turbocharger System Description

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

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

Special Tools

GE-23738-A Vacuum Pump

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

Circuit/System Verification

1. Ignition On.
2. Verify DTC P0106, P0107, P0108, P0236, P0237, P0238, P0243, P0245, P0246, P2227, P2228, P2229, or P2230 is not set.
 - **If any of the DTCs are set**
Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) .
 - **If none of the DTCs are set**
3. Verify the scan tool BARO Sensor parameter is within the range specified in the [Altitude Versus Barometric Pressure](#) table for the current testing altitude.
 - **If the parameter is not within the range specified in the table.**
Refer to [DTC P2227-P2230](#) .
 - **If the parameter is within the range specified in the table.**
4. Verify the scan tool MAP Sensor and BARO Sensor parameters are within 3 kPa (0.4 psi).
 - **If the parameters are not within 3 kPa (0.4 psi).**
Refer to [DTC P0106](#).
 - **If the parameters are within 3 kPa (0.4 psi).**
5. Verify the scan tool Boost Pressure Sensor and BARO Sensor parameters are within 3 kPa (0.4 psi).
 - **If the parameters are not within 3 kPa (0.4 psi).**
Refer to [DTC P0236](#).
 - **If the parameters are within 3 kPa (0.4 psi).**
6. Verify a click is heard or felt from the Q40 turbocharger bypass valve solenoid when commanding the Turbocharger Bypass Solenoid Valve between Active and Inactive with a scan tool.
 - **If a click is not heard or felt**
Refer to [DTC P0033-P0035](#).
 - **If a click is heard or felt**

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

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

Refer to [DTC P0033-P0035](#).

- **If Malfunction is not displayed**

8. Verify a series of clicks, which increase in frequency, are heard or felt from the Q42 turbocharger wastegate solenoid valve when commanding the Turbocharger Wastegate Solenoid Valve between 5-95% with a scan tool.

- **If a series of clicks in increasing frequency are not heard or felt**

Refer to [DTC P0243, P0245, or P0246](#).

- **If a series of clicks in increasing frequency is heard or felt**

9. Verify the parameters listed below do not display Malfunction when commanding the Turbocharger Wastegate Solenoid Valve between 5-95% with a scan tool.

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

Refer to [DTC P0243, P0245, or P0246](#).

- **If Malfunction is not displayed**

10. Engine running.

11. Verify the scan tool MAP Sensor parameter and the Boost Pressure Sensor parameter are within 20 kPa (2.9 psi) during a WOT acceleration at the time of the 1-2 shift.

- **The parameters are not within 20 kPa (2.9 psi)**

Refer to Circuit/System Testing.

- **parameter are within 20 kPa (2.9 psi)**

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

13. Verify a DTC does not set.

- **If a DTC sets**

Refer to Circuit/System Testing

- **If a DTC does not set**

14. All OK

Circuit/System Testing

1. Verify the conditions listed below do not exist:

- Loose clamps, cracks or other damage in the air intake duct system
- Collapsed or restricted intake duct system
- Restricted air filter
- Any air flow restriction
- Any air leak between the turbocharger and the throttle body, including the charge air cooler assembly
- Splits, kinks or improper connections at the vacuum hoses

- Any vacuum leak
- Restricted, leaking or incorrect routing of hoses going to the components listed below:
 - Q42 turbocharger wastegate solenoid valve
 - Turbocharger wastegate actuator
 - Turbocharger
- Missing, restricted or leaking exhaust components.
- Exhaust leak between the turbocharger and the exhaust manifold
- Restricted or leaking turbocharger oil supply line
- Loose or incorrect installation of any components
- **If a condition exists**

Repair or replace the component as necessary.

- **If none of the conditions exist**

2. Ignition Off, disconnect the Compressor Inlet to Solenoid hose at the turbocharger and apply 51 kPa (15 inches Hg) of vacuum to the hose with the **GE 23738-A**, ignition On.
3. Verify the pressure decreases to 0 kPa (0 inches Hg) when commanding the Turbocharger Wastegate Solenoid Valve to at least 15% with a scan tool.

- **The pressure does not decrease to 0 kPa (0 inches Hg)**

Replace the Q42 turbocharger wastegate solenoid valve

- **The pressure decreases to 0 kPa (0 inches Hg)**

4. Connect the Compressor Inlet to Solenoid hose to the turbocharger.
5. Disconnect the hose from the turbocharger wastegate actuator and connect the exhaust/pressure port of the **GE 23738-A**, or a suitable hand pressure pump, to the actuator.
6. Verify the wastegate actuator rod moves when applying pressure to the actuator.

- **If the actuator does not move**

1. Disconnect the wastegate actuator arm from the wastegate.
2. Verify the wastegate actuator rod moves when applying pressure to the actuator.
 - If the actuator does not move, replace the turbocharger wastegate actuator
 - If the actuator moves, replace the turbocharger

- **If the actuator moves**

NOTE: **Leave harness connector connected or re-connect it after removing valve.**

7. Ignition Off. Disconnect the Q40 turbocharger bypass solenoid valve ignition On.
8. Verify the turbocharger bypass valve plunger retracts and extends when commanding the Turbocharger Bypass Solenoid Valve between Active and Inactive with a scan tool.

- **The valve plunger does not retract and extend**

Replace the Q40 turbocharger bypass solenoid valve

- **The valve plunger retracts and extends**

9. Verify the conditions listed below do not exist with the turbocharger assembly. Refer to **Turbocharger Cleaning and Inspection**

- Cracked, damaged or worn turbine blades
- Restricted wastegate, turbine, ports or passages
- Foreign material
- **A condition exists**

Repair or replace the turbocharger as necessary

- **None of the conditions exist**

10. Replace the turbocharger.

Repair Instructions

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

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

DTC P0236: TURBOCHARGER BOOST SENSOR PERFORMANCE

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.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptor

DTC P0236

Turbocharger Boost Sensor Performance

Circuit Description

The boost pressure sensor measures the range of pressures between the turbocharger and the throttle body. The sensor used on this engine is a three atmosphere sensor. Pressure in this portion of the induction system is affected by engine speed, throttle opening, turbocharger boost pressure, Intake air temperature (IAT), barometric pressure (BARO), and the efficiency of the charge air cooler.

The sensor provides a signal voltage to the engine control module (ECM), relative to the pressure changes. Under normal operation the greatest pressure that can exist in this portion of the induction system at ignition On, engine Off is equal to the BARO. When the engine is operated at wide-open throttle (WOT) the turbocharger can increase the pressure to near 240 kPa (34.8 psi). The pressure is equal to the BARO when the engine is idling or decelerating.

Conditions for Running the DTC

- DTC P0106, P0107, P0108, P0237, P0238, P2227, P2228, P2229, or P2230 is not set.
- DTC P0106, P0107, P0108, P0237, or P0238 is not pending.
- Ignition is On.
- Engine is Off.
- The time between current ignition cycle and the last time the engine was running is greater than 10 s.

The DTC runs continuously when the above conditions have been met.

OR

- DTC P0102, P0103, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0128, P0237, P0238, P0335, P0336, P2227, P2228, P2229 or P2230 is not set.
- DTC P0112, P0113, P0117, or P0118 is not pending.
- Engine speed is between 400-6,100 RPM.
- Engine Coolant Temperature (ECT) is between -7 to +125Â°C (19.4-257Â°F).
- Intake Air Temperature (IAT) is between -20 to +125Â°C (-4 to +257Â°F).

The DTC runs continuously when the above conditions have been met.

Conditions for Setting the DTC

- The ECM detects that the boost pressure sensor signal is not within range of a model derived from engine speed, the BARO sensor, the MAF sensor, the MAP sensor, the throttle position sensor and the turbocharger boost pressure sensor when the engine is running.

OR

- The ECM detects that the boost pressure sensor signal is less than 44 kPa (6 psi) or greater than 115 kPa (16.7 psi) when the ignition is On and the engine is NOT rotating.

OR

- The ECM detects that the difference between MAP and BARO is less than or equal to 10 kPa and the difference between turbocharger boost pressure and MAP is greater than 10 kPa and the difference between turbocharger boost pressure and BARO is greater than 10 kPa when the ignition is On and the engine is NOT rotating.

Action Taken When the DTCs Set

- DTC P0236 is a Type C DTC.
- The Service Vehicle Soon Indicator may illuminate.

Conditions for Clearing the MIL/DTCs

DTC P0236 is a Type C DTC.

Diagnostic Aids

- The charge air cooler is connected to the turbocharger and to the throttle body by flexible duct work that requires the use of special high torque fastening clamps. These clamps cannot be substituted. In order to prevent any type of air leak when servicing the duct work, the tightening specifications and proper positioning of the clamps is critical, and must be strictly adhered to.
- Use a smoke generating device or a solution of dish soap and water in a spray bottle to pinpoint any suspected air leaks in the induction system and in the charge air cooler assembly.

Reference Information

Schematic Reference

Engine Controls Schematics (Buick with LE2)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX (ENCORE)

Description and Operation

Turbocharger System Description

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

1. Verify that DTC P0237, P0238, P0641, P0651, P0697, P06A3, or P06D2 is not set.

- **If the DTC is set**

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

- **If the DTC is not set**

2. If you were sent here from DTC P0068, P0101, P0106, P0121, or P1101 refer to Circuit/System Testing.

3. Ignition On.

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

- **If 90% or greater**

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

- **If less than 90%**

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

- **If Disagree**

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

- **If Agree**

6. Verify the scan tool BARO parameter is within the range specified in the [Altitude Versus Barometric Pressure](#) table, for the current vehicle testing altitude.

- **If not within the specified range**

Refer to [DTC P2227-P2230](#) .

- **If within the specified range**

7. Verify the scan tool MAP Sensor pressure and BARO parameters are within 3 kPa (0.4 psi).

- **If not within 3 kPa (0.4 psi).**

Refer to [DTC P0106](#).

- **If within 3 kPa (0.4 psi).**

8. Engine idling.

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

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

Refer to [DTC P0106](#).

- **If between 24-52 kPa (3.4-7.5 psi) and changes**

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

1. Engine idling

2. Perform the scan tool snapshot function.

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

4. Exit from the scan tool snapshot and review the data.

5. Observe the MAF Sensor parameter frame by frame with a scan tool.

- **If it does not change smoothly and gradually**

Refer to [DTC P0101](#).

- **If it changes smoothly and gradually**

11. Verify the scan tool Boost Pressure Sensor pressure and BARO parameters are within 3 kPa (0.4 psi).

- **If not within 3 kPa (0.4 psi).**

Refer to Circuit/System Testing

- **If within 3 kPa (0.4 psi).**

12. Verify the scan tool MAP Sensor parameter and the Boost Pressure Sensor parameter are within 20 kPa (2.9 psi) during a WOT acceleration at the time of the 1-2 shift.

- **If not within 20 kPa (2.9 psi)**

Refer to Circuit/System Testing.

- **If within 20 kPa (2.9 psi)**

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

14. Verify a DTC does not set.

- **If the DTC sets**

Refer to Circuit/System Testing.

- **If the DTC does not set**

15. All OK.

Circuit/System Testing

1. Verify the conditions listed below do not exist:

- Loose clamps, cracks, or other damage in the air intake duct system.
- Loose clamps, cracks, or other damage in the charge air cooler system.
- Collapsed or restricted air intake duct system.
- Restricted air filter.
- Splits, kinks or improper connections at the vacuum hoses.
- Missing, restricted or leaking exhaust components - Refer to [Symptoms - Engine Exhaust](#).
- Vacuum leaks at the intake manifold and throttle body.
- **If a condition exists**

Repair as necessary.

- **If none of the conditions exist**

2. Replace the B111 Turbocharger Boost Sensor.

Repair Instructions

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

- Refer to [Turbocharger Air Pressure Sensor Replacement](#) for turbocharger boost sensor replacement.
- Refer to [Control Module References](#) for engine control module replacement, programming, and setup

DTC P0237 OR P0238: TURBOCHARGER BOOST SENSOR CIRCUIT LOW/HIGH VOLTAGE

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.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptors

DTC P0237

Turbocharger Boost Sensor Circuit Low Voltage

DTC P0238

Turbocharger Boost Sensor Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P0236, P0237, P0340, P0365, P0452, P0532, P0641, P2227	P0236, P0237, P2227	P0236, P0238, P0453, P0641, P2227	P0236
Intake Air Pressure Signal	P0236, P0237, P2227	P0236, P0237, P2227	P0236, P0238, P2227	P0236
Low Reference	-	P0098, P0236, P0238, P2227	-	-

Typical Scan Tool Data

Boost Pressure Sensor

Circuit	Short to Ground	Open	Short to Voltage
Parameter Normal Range: BARO to 240 kPa (34.8 psi)			
Operating Conditions: Engine running			
5 V Reference	0 kPa (0 psi)	0 kPa (0 psi)	269 kPa (39 psi)
Boost Pressure Signal	0 kPa (0 psi)	0 kPa (0 psi)	269 kPa (39 psi)
Low Reference	-	267 kPa (38.7 psi)	-

Circuit Description

The boost pressure sensor measures the range of pressures between the turbocharger and the throttle body. The sensor used on this engine is a three atmosphere sensor. Pressure in this portion of the induction system is affected by engine speed, throttle opening, turbocharger boost pressure, Intake air temperature (IAT), barometric pressure (BARO), and the efficiency of the charge air cooler.

The sensor provides a signal voltage to the engine control module (ECM), relative to the pressure changes. Under normal operation the greatest pressure that can exist in this portion of the induction system at ignition On, engine Off is equal to the BARO. When the engine is operated at wide-open throttle (WOT) the turbocharger can increase the pressure to near 240 kPa (34.8 psi). The pressure is equal to the BARO when the engine is idling or decelerating.

Conditions for Running the DTC

- Ignition is On or the engine is running.
- The DTCs run continuously when the above conditions have been met.

Conditions for Setting the DTC

P0237

The ECM detects that the boost pressure sensor voltage is less than 0.66 V for greater than 5 s.

P0238

The ECM detects that the boost pressure sensor voltage is greater than 4.3 V for greater than 5 s.

Action Taken When the DTC Sets

- DTCs P0237 and P0238 are Type C DTCs.
- The Service Vehicle Soon Indicator may illuminate.
- The ECM will disable boost control and limit the system to mechanical boost only, resulting in a substantial decrease in engine power.

Conditions for Clearing the MIL/DTC

DTCs P0237 and P0238 are Type C DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics (Buick with LE2)

Connector End View Reference

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DTC Type Reference

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Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition On.
2. Verify that DTC P0651 is not set.
 - **If the DTC is set**
Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
 - **If the DTC is not set**
3. Verify the scan tool BARO parameter is within the range specified in the **Altitude Versus Barometric Pressure** table, for the current vehicle testing altitude.
 - **BARO is not in range**
Refer to **DTC P2227-P2230** .
 - **BARO is within range**
4. Verify the scan tool Boost Pressure Sensor pressure and BARO parameters are within 3 kPa (0.4 psi).
 - **The parameters are not within 3 kPa (0.4 psi).**
Refer to Circuit/System Testing.
 - **The parameters are within 3 kPa (0.4 psi).**

5. Verify the scan tool MAP Sensor parameter and the Boost Pressure Sensor parameter are within 20 kPa (2.9 psi) during a WOT acceleration at the time of the 1-2 shift.

- **The parameters are not within 20 kPa (2.9 psi)**

Refer to Circuit/System Testing.

- **The parameters are within 20 kPa (2.9 psi)**

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

7. Verify a DTC does not set.

- **If the DTC sets**

Refer to Circuit/System Testing.

- **If the DTC does not set**

8. All OK.

Circuit/System Testing

1. Ignition Off, and all vehicle systems Off, disconnect the harness connector at the B111 Turbocharger Boost Sensor. It may take up to 2 minutes for all vehicle systems to power down.

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

- **If 5 Ω or greater**

1. Ignition Off, disconnect the X3 harness connector at the K20 engine control module.

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

- If 2 Ω or greater, repair the open/high resistance in the circuit.
- If less than 2 Ω , replace the K20 engine control module.

- **If less than 5 Ω**

3. Ignition On.

4. Test for 4.8-5.2 V between the 5 V reference circuit terminal 1 and ground.

- **If less than 4.8 V**

1. Ignition Off, disconnect the X3 harness connector at the K20 engine control module.

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

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

3. Test for less than 2 Ω in the 5 V reference circuit end to end.

- If 2 Ω or greater, repair the open/high resistance in the circuit.
- If less than 2 Ω , replace the K20 engine control module.

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

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- **If greater than 5.2 V**

1. Ignition Off, disconnect the X3 harness connector at the K20 engine control module, ignition On.

2. Test for less than 1 V between the 5 V reference circuit and ground.

- If 1 V or greater, repair the short to voltage on the circuit.
- If less than 1 V, replace the K20 engine control module.

- **If between 4.8-5.2 V**

5. Verify the scan tool Boost Pressure Sensor voltage parameter is greater than 4.5 V.

- **If 4.5 V or less**

1. Ignition Off, disconnect the X3 harness connector at the K20 engine control module, ignition On.

2. Test for infinite resistance between the signal circuit terminal 3 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K20 Engine Control Module.
- **If greater than 4.5 V**
6. Install a 3 A fused jumper wire between the signal circuit terminal 3 and the low reference circuit terminal 2.
7. Verify the scan tool Boost Pressure Sensor voltage parameter is less than 0.2 V.
 - **If 0.2 V or greater**
 1. Ignition Off, remove the jumper wire, disconnect the X3 harness connector at the K20 engine control module, Ignition On.
 2. Test for less than 1 V between the signal circuit terminal 3 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 3. Ignition OFF.
 4. Test for less than 2 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open or high resistance in the circuit.
 - If less than 2 Ω , replace the K20 engine control module.
 - **If less than 0.2 V**
8. Test or replace the B111 Turbocharger Boost Sensor.

Repair Instructions

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

- Refer to [Turbocharger Air Pressure Sensor Replacement](#) for turbocharger boost sensor replacement.
- Refer to [Control Module References](#) for ECM replacement, programming, and setup.

DTC P0243, P0245, OR P0246: TURBOCHARGER WASTEGATE SOLENOID VALVE CONTROL CIRCUIT

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.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptors

DTC P0243

Turbocharger Wastegate Solenoid Valve Control Circuit

DTC P0245

Turbocharger Wastegate Solenoid Valve Control Circuit Low Voltage

DTC P0246

Turbocharger Wastegate Solenoid Valve Control Circuit High Voltage

Diagnostic Fault Information

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

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Ignition Voltage	P0033, P0034, P0243, P0245, P0443, P06DA, P06DB*	P0243	P0243	-	-
Turbocharger Wastegate Solenoid Control	P0243, P0245	P0243, P0245	P0243, P0245	P0246	P0243
* Ignition fuse opens. A message center or an indicator may display ENGINE POWER IS REDUCED. Engine may experience NO Crank - NO Start condition.					

Circuit/System Description

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

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

Conditions for Running the DTCs

- Ignition is On or the engine is running.
- Battery voltage is at least 11 V.

The DTCs run continuously when the above conditions are met.

Conditions for Setting the DTCs

P0243

The ECM detects an open circuit on the turbocharger wastegate solenoid control circuit for greater than 2 s.

P0245

The ECM detects a short to ground on the turbocharger wastegate solenoid control circuit for greater than 2 s.

P0246

The ECM detects a short to voltage on the turbocharger wastegate solenoid control circuit for greater than 2 s.

Action Taken When the DTCs Set

- DTCs P0243, P0245, and P0246 are Type C DTCs.
- The Service Vehicle Soon Indicator may illuminate.
- The ECM will disable boost control and limit the system to mechanical boost only, resulting in a substantial decrease in engine power.

Conditions for Clearing the MIL/DTCs

DTCs P0243, P0245, and P0246 are Type C DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics (Buick with LE2)

Connector End View Reference

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DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition On
2. Verify a series of clicks, which increase in frequency, are heard or felt from the Q42 turbocharger wastegate solenoid valve when commanding the Turbocharger Wastegate Solenoid Valve between 5-95% with a scan tool.
 - **If a series of clicks in increasing frequency are not heard or felt**
Refer to Circuit/System Testing.
 - **If a series of clicks in increasing frequency is heard or felt**
3. Verify the parameters listed below do not display Malfunction when commanding the Turbocharger Wastegate Solenoid Valve between 5-95% with a scan tool.
 - Turbocharger Wastegate Solenoid Valve Control Circuit High Voltage Test Status
 - Turbocharger Wastegate Solenoid Valve Control Circuit Open Test Status
 - Turbocharger Wastegate Solenoid Valve Control Circuit Low Voltage Test Status
 - **If Malfunction is displayed**
Refer to Circuit/System Testing.
 - **If Malfunction is not displayed**
4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
5. Verify a DTC does not set.
 - **If a DTC sets**
Refer to Circuit/System Testing
 - **If a DTC does not set**
6. All OK

Circuit/System Testing

1. Ignition Off, disconnect the harness connector at the Q42 Turbocharger Wastegate Solenoid Valve, ignition On.

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

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

1. Ignition Off.

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

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

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

1. Ignition Off, remove the test lamp.

NOTE:

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

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

- If less than infinite resistance, repair the short to ground on the circuit.
- If infinite resistance, test all components supplied by the fuse and replace as necessary.

- **If the test lamp illuminates**

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

- **If the test lamp illuminates**

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

2. Test for infinite resistance between the control circuit and ground.

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

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

4. Remove the test lamp.

5. Verify the scan tool Turbocharger Wastegate Solenoid Valve Control Circuit High Voltage Test Status parameter is OK when commanding the Turbocharger Wastegate Solenoid Valve between 5-95% with a scan tool.

- **If OK is not displayed**

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

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

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

- **If OK is displayed**

6. Install a 3 A fused jumper wire between the control circuit terminal 1 and the ignition circuit terminal 2.

7. Verify the scan tool Turbocharger Wastegate Solenoid Valve Control Circuit High Voltage Test Status parameter is Malfunction when commanding the Turbocharger Wastegate Solenoid Valve between 5-95% with a scan tool.

- **If Malfunction is not displayed**

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

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

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

- **If Malfunction is displayed**

8. Test or replace the Q42 Turbocharger Wastegate Solenoid valve.

Static Test

1. Ignition/Vehicle Off
2. Disconnect the electrical connector: Q42 Turbocharger Wastegate Solenoid Valve
3. Test for 20 to 26 Ω between the test points: Control terminal 2 & 12 V Reference terminal 1
 - **If not between 20 and 26 Ω**

Replace the component: Q42 Turbocharger Wastegate Solenoid Valve

- **If between 20 and 26 Ω**
4. Test for infinite resistance between the test points: Each terminal of the component & The component's housing
 - **If less than infinite resistance**

Replace the component: Q42 Turbocharger Wastegate Solenoid Valve

- **If infinite resistance**
5. All OK.

Dynamic Test

1. Ignition/Vehicle Off
2. Disconnect the electrical connector: Q42 Turbocharger Wastegate Solenoid Valve
3. Connect a 10 A fused jumper wire between the test points: 12 V Reference terminal 1 & 12 V

CAUTION: Complete the testing as quickly as possible in order to prevent overheating and damaging the component.

- 4.
5. Momentarily connect a jumper wire between the test points: Control terminal 1 & Ground

Verify the component turns On and Off when connecting and disconnecting the jumper wire: Q42 Turbocharger Wastegate Solenoid Valve

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

Replace the component: Q42 Turbocharger Wastegate Solenoid Valve

- **If the component turns On and Off**

6. All OK.

Repair Instructions

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

- Refer to [Turbocharger Wastegate Regulator Solenoid Valve Replacement](#)
- Refer to [Control Module References](#) for ECM replacement, programming and setup.

DTC P0231, P0232, OR P023F: FUEL PUMP CONTROL CIRCUIT (CHASSIS CONTROL MODULE)

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.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptors

DTC P0231

Fuel Pump Control Circuit Low Voltage

DTC P0232

Fuel Pump Control Circuit High Voltage

DTC P023F

Fuel Pump Control Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Control	P0231	P023F	P0232	P023F, P2635
Low Reference	-	P023F	-	P023F, P2635

Circuit/System Description

The engine control module (ECM) supplies voltage to the chassis control module when the ECM detects that the ignition is on. The voltage from the ECM to the chassis control module remains active for 2 seconds, unless the engine is in crank or run. While this voltage is being received, the chassis control module supplies a varying voltage to the fuel tank pump module in order to maintain the desired fuel line 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 chassis control module is inactive for 4 seconds after engine has been shut off.

Conditions for Setting the DTC

The chassis control module detects a fault on the fuel pump voltage circuit that is less than 11 V or greater than 18 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.

On vehicles equipped with a high pressure mechanical pump on Direct Fuel Injection engines, the vehicle may continue to run even though the pump in the fuel tank is not operating.

Reference Information

Schematic Reference

Connector End View Reference

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- [Wiring Repairs](#)

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

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

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the A7 Fuel Pump and Level Sensor Assembly. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 Ω between the low reference circuit terminal 2 and ground.
 - **If 10 Ω or greater**
 1. Ignition OFF, disconnect the harness connector at the K38 Chassis Control Module.
 2. Test for less than 2 Ω in the low reference circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K38 Chassis Control Module.
 - **If less than 10 Ω**
3. Connect a test lamp between the control circuit terminal 1 and the low reference circuit terminal 2.
4. Ignition ON.
5. Verify the test lamp turns ON and OFF when commanding the fuel pump ON and OFF using the scan tool ECM fuel pump enable control function.
 - **If the test lamp is always OFF**
 1. Ignition OFF, disconnect the harness connector at the K38 Chassis Control Module.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 Ω in the control circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K38 Chassis Control Module.
 - **If the test lamp is always ON**
 1. Ignition OFF, disconnect the harness connector at the K38 Chassis Control Module, ignition ON.
 2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K38 Chassis Control Module.
 - **If the test lamp turns ON and OFF**
6. Replace the A7 Fuel Pump and Level Sensor Assembly.

Repair Instructions

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

- Refer to [Fuel Tank Fuel Pump Module Replacement \(FWD\)](#), [Fuel Tank Fuel Pump Module Replacement \(AWD\)](#).
- Refer to [Control Module References](#) for control module replacement, programming and setup.

DTC P025A: FUEL PUMP CONTROL MODULE ENABLE CIRCUIT (CHASSIS CONTROL MODULE)

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.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptor

DTC P025A

Fuel Pump Control Module Enable Circuit

Diagnostic Fault Information

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

Circuit/System Description

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

Conditions for Running the DTC

The ignition is ON.

Conditions for Setting the DTC

The serial data message from the ECM to the chassis control module does not agree with the state of the control enable voltage signal supplied from the ECM to the chassis 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 \(Buick with LE2\)](#)

Connector End View Reference

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Fuel System Description

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- [Wiring Repairs](#)

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

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

Circuit/System 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 resets before proceeding with the circuit system testing. If the DTC does not reset, refer to [Strategy Based Diagnosis](#) .

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the K38 Chassis Control Module, ignition ON.
2. Connect a test lamp between the control circuit terminal 20 and ground.
3. Verify the test lamp turns ON and OFF when commanding the fuel pump ON and OFF using the scan tool ECM fuel pump enable control function.
 - **If the test lamp is always OFF**
 1. Ignition OFF, disconnect the harness connector at the K20 engine control module.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 Ω in the control circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 engine control module.
 - **If the test lamp is always ON**
 1. Ignition OFF, disconnect the harness connector at the K20 engine control module, ignition ON.
 2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 engine control module.
 - **If the test lamp turns ON and OFF**
4. Test or replace the K38 Chassis Control Module.

Repair Instructions

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

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

DTC P0300-P0304: MISFIRE DETECTED

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.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptors

DTC P0300

Engine Misfire Detected

DTC P0301

Cylinder 1 Misfire Detected

DTC P0302

Cylinder 2 Misfire Detected

DTC P0303

Cylinder 3 Misfire Detected

DTC P0304

Cylinder 4 Misfire Detected

Circuit/System Description

The engine control module (ECM) uses information from the crankshaft position sensor and the camshaft position sensor to determine when a engine cylinder misfire is occurring. By monitoring variations in the crankshaft rotation speed for each cylinder, the ECM can detect individual cylinder misfire events.

Extreme cylinder misfire events can cause catalytic converter damage. The malfunction indicator lamp (MIL) will flash when the conditions for catalytic converter damage are present. DTCs P0301 through P0304 correspond to cylinders 1 through 4. When the ECM detects that one or more specific cylinders are misfiring, the DTC for the respective misfiring cylinder will set and up to 2 of the corresponding fuel injectors are disabled for a minimum of 30 s. The ECM will then re-enable the fuel injector and, after approximately 200 engine revolutions, will determine if the misfire is still present. If the misfire is still present, the ECM will disable the fuel injector again repeating the process. If the misfire is not present, the fuel injector will remain enabled by the ECM. In Spark Ignition Direct Injection (SIDI) system applications, if a fuel injector fault DTC is set during a misfire event, the ECM will not re-enable the injector.

Conditions for Running the DTC

- DTC P0010, P0011, P0013, P0014, P0016, P0017, P0068, P00C8, P00C9, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0117, P0118, P0119, P0122, P0123, P0191, P0192, P0193, P0222, P0223, P0335, P0336, P0340, P0341, P0365, P0366, P0601, P0604, P0606, P0651, P16A0, P16A1, P16A2, P16F3, P2101, P2135, P2227, P2228, P2229, or P2230 is not set.
- The engine speed is less than 1,000 RPM and DTC P0315 is set.
- The engine speed is greater than 1,400 RPM.
- The crankshaft position and camshaft position sensors are synchronized.
- The engine coolant temperature (ECT) is between -7 and 127Â°C (19-261Â°F).
- If the ECT is colder than -7Â°C (19Â°F) at start-up, this diagnostic will not run until the ECT is between 21-127Â°C (70-261Â°F).
- The battery voltage is between 9-32 V.
- The vehicle is not in a acceleration or deceleration condition.
- The ECM is not detecting a rough road signal.
- The fuel level is at least 11%.
- The ECM is not in fuel cut-off or deceleration fuel cut-off mode.

The DTCs run continuously when the above conditions are met.

Conditions for Setting the DTC

P0300

The ECM detects a crankshaft rotation speed variation indicating a misfire rate sufficient to cause emissions levels to exceed a predetermined value or a misfire rate high enough to cause catalyst damage.

P0301, P0302, P0303, or P0304

The ECM detects a crankshaft rotation speed variation indicating a single cylinder misfire rate sufficient to cause emissions levels to exceed mandated standards.

Action Taken When the DTC Sets

- DTCs P0300-P0304 are Type B DTCs.
- The ECM will flash the malfunction indicator lamp (MIL) when a catalyst damaging level of misfire is present.

Conditions for Clearing the DTC

DTCs P0300-P0304 are Type B DTCs.

Diagnostic Aids

- A misfire DTC could be caused by an excessive vibration from sources other than the engine. Inspect for the conditions listed below:
 - A tire or wheel that is out of round or out of balance
 - Variable thickness brake rotors
 - An unbalanced drive shaft
 - Certain rough road conditions
 - Transmission operation
 - A damaged or defective accessory drive component or belt
- Observe misfire counters after Active Fuel Management is commanded Off for a sticking lifter.
- High resistance in the circuits of the injectors may set a misfire DTC without setting an injector DTC. Test the injector circuits of the affected cylinder(s) for a high resistance if you suspect a condition.
- If the condition is intermittent, observing the scan tool IC Circuit Test and Fuel Injector Circuit Test Status parameters may help isolate the condition. The circuit test status parameters will change from OK or Not Run to Fault/Malfunction if a condition exists.
- A condition in the heated oxygen sensor (HO2S) heater control circuits may set a DTC P0300.

Reference Information

Description and Operation

- [Electronic Ignition System Description](#)
- [Fuel System Description](#)

DTC Type Reference

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

Scan Tool Reference

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

Special Tools

EL26792 HEI Spark Tester

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

Circuit/System Verification

NOTE: Before starting the engine, review the freeze frame failure records data to determine if the misfire sets during a cold start or at operating temperature. If there is a cold start condition and the engine is started, the engine will need to be cooled down before the next attempt to start the engine within the fail conditions.

1. Engine Running at normal operating temperature.
2. Verify there is no abnormal engine noise.
 - **If abnormal engine noise is present**
Refer to [Symptoms - Engine Mechanical](#) .
 - **If abnormal engine noise is not present**
3. Perform the scan tool [Crankshaft Position Variation Learn](#) procedure.
4. Verify no DTCs are set.
 - **If any DTCs other than P0300-P0304 are set**
Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) .
 - **If DTC P0300-P0304 is set**
Refer to Circuit/System Testing.
 - **If no DTCs are set**
5. Verify the scan tool Cylinder 1-4 Current Misfire Counter parameters do not increment.
 - **If increments**
Refer to Circuit/System Testing.
 - **If does not increment**
6. Engine Running, perform the Cylinder Power Balance Test with a scan tool.
7. Verify the engine speed changes when each injector is disabled and then enabled.
 - **If engine speed does not change**
Refer to Circuit/System Testing.
 - **If engine speed does change**
8. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
9. Verify the DTC does not set.
 - **If the DTC sets**
Refer to Circuit/System Testing.
 - **If the DTC does not set**
10. All OK.

Circuit/System Testing

1. Verify none of the following conditions listed below exist:
 - Damage, carbon tracking, or fluid intrusion of the spark plug boots and/or spark plugs
 - Vacuum hose splits, kinks, and incorrect connections
 - Engine vacuum leaks
 - Crankcase ventilation system for vacuum leaks

- Fuel pressure that is too low or too high. Refer to [Fuel System Diagnosis](#) .
- Contaminated fuel. Refer to [Alcohol/Contaminants-in-Fuel Diagnosis](#) .
- Exhaust system restrictions

- **If a condition exists**

Repair or replace as necessary.

- **If no conditions exist**

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

2. Ignition OFF, remove the appropriate T 8 Ignition Coil from the spark plug and connect the **EL 26792** HEI Spark Tester to the spark plug boot, engine Cranking.

3. Verify the spark output.

- **If no output or the output is weak**

Refer to [Electronic Ignition System Diagnosis](#) .

- **If the output is good**

4. Ignition OFF.

5. Verify the conditions listed below. Refer to [Ignition System Specifications](#) .

- The correct spark plug type
- The correct spark plug gap
- The correct spark plug torque
- **If a condition exists**

Repair or replace as necessary.

- **If no conditions exist**

6. Exchange the suspect spark plug with another cylinder that is operating correctly.

7. Engine Running.

8. Verify the scan tool Cylinder 1-4 Current Misfire Counter does not increment for the cylinder where the suspect spark plug was installed.

- **If increments**

Replace the spark plug.

- **If does not increment**

9. Test or inspect for the conditions listed below:

- A lean or rich Q17 Fuel Injector - Refer to [Fuel Injector Diagnosis](#) .
- An engine mechanical condition - Refer to [Symptoms - Engine Mechanical](#) .

Repair Instructions

- Refer to [Ignition Coil Replacement](#)
- Refer to [Spark Plug Replacement](#)

Repair Verification

1. Install any components or connectors that have been removed or replaced during diagnosis.
2. Perform any adjustment, programming or setup procedures that are required when a component or module is removed or replaced.
3. Clear the DTCs.
4. Turn OFF the ignition for 60 s.
5. If the repair was related to a DTC, duplicate the Conditions for Running the DTC and use the Freeze Frame/Failure Records, if applicable, in order to verify the DTC does not reset. If the DTC

resets or another DTC is present, refer to the [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) and perform the appropriate diagnostic procedure.

6. Engine Running, verify the scan tool Cylinder 1-4 Current Misfire Counter parameters do not increment.
 - If the misfire counter parameters increment, a misfire condition still exists.
7. To verify that the performance of the catalytic converter has not been affected by the condition that set this DTC, perform the Repair Verification for DTC P0420. Refer to [DTC P0420](#).

DTC P0315: CRANKSHAFT POSITION SYSTEM VARIATION NOT LEARNED

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.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptor

DTC P0315

Crankshaft Position System Variation Not Learned

Circuit/System Description

The crankshaft position variation learn feature is used to calculate reference period errors caused by slight tolerance variations in the crankshaft, and the crankshaft position sensor. The calculated error allows the engine control module (ECM) to accurately compensate for reference period variations. This enhances the ability of the ECM to detect misfire events over a wider range of engine speed and load conditions.

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

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

Conditions for Running the DTC

Engine is Running.

The DTC runs continuously when the above condition is met.

Conditions for Setting the DTC

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

Action Taken When the DTC Sets

DTC P0315 is a Type A DTC.

Conditions for Clearing the MIL/DTC

DTC P0315 is a Type A DTC.

Diagnostic Aids

This test procedure requires that the vehicle battery has passed a load test and is completely charged. Refer to [Battery Inspection/Test](#).

Reference Information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

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

Circuit/System Verification

1. Perform the scan tool [Crankshaft Position Variation Learn](#) procedure.
2. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed in the Freeze Frame/Failure Records data.
3. Verify the DTC is not set.
 - **If the DTC sets**

Replace the K20 Engine Control Module.
 - **If the DTC does not set**
4. All OK

Repair Instructions

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

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

DTC P0324, P0326, OR P06B6: KNOCK SENSOR PERFORMANCE/KNOCK SENSOR CONTROL MODULE PROCESSOR PERFORMANCE

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.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptors

DTC P0324

Knock Sensor System Performance

DTC P0326

Knock Sensor Performance

DTC P06B6

Control Module Knock Sensor Processor Performance

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
High Signal	P0327, P06B6	P0325	P0328	P0324*, P0326**
Low Signal	P0327	P0325	P0328	P0324*, P0326**
* Signal Performance High				
** Signal Performance Low				

Circuit/System Description

The knock sensor enables the engine control module (ECM) to control the ignition timing for the best possible performance while protecting the engine from potentially damaging levels of detonation. The knock sensor produces an alternating current (AC) voltage signal that varies depending on the vibration level during engine operation. The ECM adjusts the spark timing based on the amplitude and the

frequency of the knock sensor signal. The ECM learns a minimum knock sensor noise level for all of the engine speed ranges and monitors the normal knock sensor signal. The ECM monitors the internal knock sensor processor test circuits which perform the open circuit diagnostic.

Conditions for Running the DTCs

P0324 or P0326

- Engine is running for 2 s or greater.
- The engine coolant temperature (ECT) is -40°C (-40°F) or warmer.
- The intake air temperature (IAT) sensor 1 is -40°C (-40°F) or warmer.

AND

- Engine speed is 8,500 RPM or less.
- Engine air flow is 2000 mg or less per cylinder.

OR

- Engine speed is 8500 RPM or greater for 200 or more cumulative revolutions.
- Engine air flow is 2000 mg or greater per cylinder.

OR

- Engine speed is 2250 RPM or greater for 75 or more cumulative revolutions.
- Engine air flow is 30 mg or greater per cylinder.

OR

- Engine speed is 8500 RPM or greater for 100 or more cumulative revolutions.
- Engine air flow is 2000 mg or greater per cylinder.

P06B6

- Engine is running for 2 s or greater.
- Engine speed is between 400-8,500 RPM for 150 or more cumulative revolutions.
- Engine air flow is between 20-2000 mg per cylinder.

The DTCs run continuously when the above conditions are met.

Conditions for Setting the DTCs

P0324

The ECM detects that the knock sensor signal performance is out of the normal calibrated range due to excessive engine knock on a per cylinder basis.

P0326

The ECM detects that the knock sensor signal performance is out of the normal calibrated range due to low signal level.

P06B6

The ECM has detected a fault in the knock sensor processor open circuit diagnostic internal test circuit.

Action Taken When the DTCs Set

- DTCs P0324, P0326, and P06B6, are Type C DTCs.
- The ignition timing is retarded to reduce the potential of engine damaging spark knock.

Conditions for Clearing the DTCs

DTCs P0324, P0326, and P06B6 are Type C DTCs.

Reference Information

Description and Operation

Electronic Ignition System Description

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Engine Running
2. Verify DTC P0325, P0327, P0328 or P06B6 is not set.
 - **If DTC P0325, P0327, or P0328 is set with P06B6**
Refer to DTC P0325, P0327, or P0328 .
 - **If only DTC P06B6 is set**
Replace the K20 Engine Control Module.
 - **If none of the DTCs are set**
3. Ignition OFF.
4. Verify none of the conditions listed below exist:
 - B68 Knock Sensor or wiring harness damage.
 - Incorrect B68 Knock Sensor installation. Refer to Fastener Specifications .
 - B68 Knock Sensor and engine mounting surface burrs, casting flash, and foreign material.
 - Close proximity of hoses, brackets, and engine wiring.
 - Loose brackets.
 - Loose or broken accessory drive belts, brackets, components.
 - An engine mechanical condition. Refer to Symptoms - Engine Mechanical .
 - Contaminated or poor quality fuel.
 - **If a condition exists**
Repair or replace as necessary.
 - **If no conditions exist**
5. Operate the vehicle within the conditions for running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
 - **If the DTC sets**
Test or replace the B68 Knock Sensor.
 - **If the DTC does not set**
6. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.

- Refer to Knock Sensor Replacement
- Refer to Control Module References for engine control module replacement, programming, and setup.

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