PSI55002-R1

POWER SOLUTIONS INTERNATIONAL

6.0L ENGINE DIAGNOSTIC MANUAL

Power Solutions International, Inc (PSI)
201 Mittel Drive
Wood Dale, IL 60191
USA
630-350-9400

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1.1 Review *STRATEGY BASED DIAGNOSIS* for an overview of the diagnostic approach.

1.2 Perform the *DIAGNOSTIC SYSTEM CHECK* prior to using this diagnostic procedure.

2 TEST DESCRIPTION

Water contamination in the fuel system may cause drivability conditions such as hesitation, stalling, no start, or misfires in one or more cylinders. Water may collect near a single fuel injector at the lowest point in the fuel injection system and cause a misfire in that cylinder. If the fuel system is contaminated with water, inspect the fuel system components for rust or deterioration.

Ethanol concentrations of greater than 10 percent in non-blended gasoline or greater than 85 percent with E85 blended gasoline for flexible fuel applications can cause drivability conditions such as hesitation, lack of power, stalling, or no start. Excessive concentrations of ethanol used in vehicles not designed for it may cause fuel system corrosion, deterioration of rubber components, and fuel filter restriction.

3 REFERENCE INFORMATION

3.1 SPECIAL TOOLS

3.1.1 *J44175* Fuel Composition Tester

4 SYSTEM VERIFICATION

The fuel sample should be drawn from the bottom of the tank so that any water present in the tank will be detected. The sample should be bright and clear.

4.1 If the sample appears cloudy, or contaminated with water, as indicated by a water layer at the bottom of the sample, perform a Particulate Contaminants in Fuel Testing Procedure.

4.2 If alcohol contamination is suspected, perform an Alcohol in Fuel Testing Procedure.

5 ALCOHOL IN FUEL TESTING WITH SPECIAL TOOL

5.1 Test the fuel composition using *J 44175* Fuel Composition Tester.

5.2 If water appears in the fuel sample, clean the fuel system.

5.3 Subtract50 from the reading on the DMM in order to obtain the percentage of alcohol in the fuel sample.

5.4 If the non-blended gasoline fuel sample measures more than 15percent ethanol add fresh regular gasoline to the vehicle's fuel tank.

5.5 Test the fuel composition.

5.6 If additional testing indicates that the ethanol percentage is still above 15percent for a non-blended gasoline sample, drain and replace the vehicle's fuel. Refer to Fuel Tank Draining. If additional testing indicates that the E85 blended gasoline sample still measures above 91percent, continue adding fresh, regular gasoline until the ethanol content is 85percent or less.

6 ALCOHOL IN FUEL TESTING WITHOUT SPECIAL TOOL

6.1 Using a 100ml (3.38oz) specified cylinder with 1ml (0.034oz) graduation marks, fill the cylinder with fuel to the 90ml (3.04oz) mark.

6.2 Add 10ml (0.34oz) of water in order to bring the total fluid volume to 100ml (3.38oz) and install a stopper.

6.3 Shake the cylinder vigorously for 10–15seconds.

6.4 Carefully loosen the stopper in order to release the pressure.

6.5 Re-install the stopper and shake the cylinder vigorously again for 10–15seconds.

6.6 Put the cylinder on a level surface for approximately 5 minutes in order to allow adequate liquid separation. If alcohol is present in the fuel, the volume of the lower layer, which would now contain both alcohol and water, will be more than 10ml (0.34oz). For example, if the volume of the lower layer is increased to 15ml (0.51oz), this indicates at least 5percent alcohol in the fuel. The actual amount of alcohol may be somewhat more because this procedure does not extract all of the alcohol from the fuel

7 PARTICULATE CONTAMINANTS IN FUEL TESTING PROCEDURE

7.1 Using an approved fuel container, draw approximately 0.5 liter (0.53 qt) of fuel

7.2 Place the container on a level surface for approximately 5 minutes in order to allow settling of the particulate contamination. Particulate contamination will show up in various shapes and colors. Sand will typically be identified by a white or light brown crystals. Rubber will appear as black and irregular particles.

7.3 Observe the fuel sample. If any physical contaminants or water are present, clean the fuel system.

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Electronic Ignition System Diagnosis

1 DIAGNOSTIC INSTRUCTIONS

1.1 Review *STRATEGY BASED DIAGNOSIS* for an overview of the diagnostic approach.

1.2 Perform the *DIAGNOSTIC SYSTEM CHECK* prior to using this diagnostic procedure.

2 CIRCUIT/SYSTEM DESCRIPTION

This ignition system uses individual ignition module/coil assemblies for each cylinder. The engine control module (ECM) controls the spark events by transmitting the timing pulses on the ignition control (IC) circuits to the individual ignition module/coil assemblies in firing order sequence. Each ignition module/coil has the following circuits:

2.1 An ignition 1 voltage circuit

2.2 A ground circuit

2.3 An IC circuit

2.4 A low reference circuit

3 DIAGNOSTIC AIDS

3.1 This test procedure requires that the vehicle battery has passed a load test and is completely charged.

3.2 There is an adequate supply of fuel in the fuel tank.

3.3 When disconnecting electrical connectors or removing fuses and relays from a fuse block, always inspect both mating electrical terminals for corrosion and terminal tightness

3.4 Use the *J 35616-A/BT-8637* Connector Test Adapter Kit for any test that requires probing the underhood fuse block terminals, component wire harness terminals, or the ECM wire harness terminals.

4 REFERENCE INFORMATION

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4.5 SPECIAL TOOLS

4.5.1 *J 26792* Spark Plug Tester

4.5.2 *J 35616-A/BT-8637* Connector Test Adapter Kit

5 CIRCUIT/SYSTEM VERIFICATION

Observe the Engine Controls Schematic for the ignition module/coils, and review the Ignition System Specifications to verify the following concerns:

5.1 The ignition modules/coils are correctly wired and connected

5.2 The proper spark plug type

5.3 The proper spark plug gap and torque

5.4 The proper ohm values for the spark plug wires

5.5 Refer to *IGNITION SYSTEM SPECIFICATIONS*.

6 CIRCUIT/SYSTEM TESTING

NOTE: This engine application uses 2 fuses, one for each bank, to supply ignition 1 voltage to the ignition module/coil assemblies and also to the fuel injectors. A good indication that a fuse is open is that all 4 misfire counters are incrementing on one side of the engine

6.1 Turn OFF the ignition.

6.2 Inspect both fuses that supply ignition voltage to the ignition module/coils.

6.2.1 If a fuse is open, test all 8ignition voltage circuits to the ignition module/coils or the fuel injectors on that engine bank, for a short to ground.

6.3 Disconnect the 4 ignition module/coil, and the 4fuel injector electrical connectors, for the engine bank that has the open fuse.

6.4 Replace the open fuse with a new fuse.

6.5 Ignition ON, engine OFF.

6.6 Reconnect each ignition module/coil, and fuel injector electrical connectors, one at a time.

6.6.1 If the fuse opens when connecting an ignition module/coil or fuel injector electrical connector, then replace the component that caused the fuse to open.

6.7 Ignition OFF, disconnect the appropriate ignition module/coil electrical connector.

6.8 Ignition ON, verify that a test lamp illuminates between the ignition voltage circuit and ground.

6.8.1 If the test lamp does not illuminate test the ignition voltage circuit for an open/high resistance.

6.9 Verify that a test lamp illuminates between the ignition module/coil ground circuit and B+.

6.9.1 If the test lamp does not illuminate, test the ignition module/coil ground circuit for an open/high resistance.

6.10 Inspect and measure the resistance of the spark plug wire. Refer to *SPARK PLUG WIRE INSPECTION AND IGNITION SYSTEM SPECIFICATIONS*.

6.10.1 If the resistance value is not within the specified range, or does not pass the inspection, replace the spark plug wire.

6.11 Exchange the misfiring cylinder, ignition module/coil assembly with the ignition module/coil assembly from a non-misfiring cylinder.

6.12 Start and idle the engine. Observe the misfire counters on the scan tool.

6.12.1 If the misfire transfers with the suspect ignition module/coil, then replace the ignition module/coil assembly.

6.12.2 If the misfire does not transfer with the suspect ignition module/coil, then measure the resistance of the IC circuit. The IC circuit should measure less than 5 ohms. If the circuit tests normal, replace the ECM.

7 COMPONENT TESTING

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

7.1 Use the Spark Plug Inspection procedure to verify the integrity of the spark plugs. Replace the spark plug if necessary.

7.2 Use the *J 26792* Spark Plug Tester to verify the output of each ignition module/coil. If no spark is detected across the gap of the spark plug tester, then replace the ignition module/coil assembly.

8 REPAIR INSTRUCTIONS

8.1 Perform the *DIAGNOSTIC REPAIR VERIFICATION*after completing the diagnostic procedure.

Electronic Ignition System Diagnosis

8.2 Engine Control Module Programming and Setup

8.3 Engine Control Module Replacement

8.4 Ignition Coil Replacement

8.5 Spark Plug Replacement

Camshaft Position Actuator and Solenoid Valve Diagnosis and Testing

1 CAMSHAFT POSITION ACTUATOR AND SOLENOID VALVE DIAGNOSIS AND TESTING

1.1 Measure the engine oil level. Fill, as required.

1.2 Using the scan tool, inspect for diagnostic codes within the engine control module (ECM). Refer to *DIAGNOSTIC SYSTEM CHECK*. Repair, as required.

1.3 Verify proper engine oil pressure and operation of the active fuel management oil pressure relief valve. Refer to *OIL PRESSURE DIAGNOSIS AND TESTING*.

1.4 Inspect the CMP actuator solenoid valve for proper operation. Refer to Camshaft Position Actuator Solenoid Valve Inspection.

1.4.1 If valve inspection confirms proper movement of the spool, replace the CMP actuator and CMP valve.

1.4.2 If valve inspection confirms improper movement of the spool, replace only the CMP valve.

1.5 Verify proper operation of the CMP actuator control system. Refer to *DIAGNOSTIC SYSTEM CHECK*.

Coolant in Combustion Chamber

DEFINITION: Excessive white smoke and/or coolant type odor coming from the exhaust pipe may indicate coolant in the combustion chamber. Low coolant levels, an inoperative cooling fan, or a faulty thermostat may lead to an over temperature condition, which may cause engine component damage.

1) A slower than normal cranking speed may indicate coolant entering the combustion chamber. Refer to Engine Will Not Crank-Crankshaft Will Not Rotate.

2) Remove the spark plugs and inspect for spark plugs saturated by coolant or coolant in the cylinder bore.

3) Inspect by performing a cylinder leak-down test. During this test, excessive air bubbles within the coolant may indicate a faulty gasket or damaged component.

4) Inspect by performing a cylinder compression test. Two cylinders side-by-side on the engine block, with low compression, may indicate a failed cylinder head gasket. Refer to Engine Compression Test.

Cause	Correction
Faulty cylinder head gasket	Replace the head gasket and components, as required. Refer to Cylinder Head Cleaning and Inspection and Cylinder Head Removal-Left Side and Cylinder Head Installation-Left Side, or Cylinder Head Removal- Right Side and Cylinder Head Installation- Right Side.
Warped cylinder head	Machine the cylinder head to the proper flatness, if applicable and replace the cylinder head gasket. Refer to Cylinder Head Cleaning and Inspection.
Cracked cylinder head	Replace the cylinder head and gasket.
Cracked cylinder liner or engine block	Replace the components, as required.

Coolant in Engine Oil

DEFINITION: Foamy or discolored oil or engine oil overfill condition may indicate coolant entering the engine crankcase. Low coolant levels, an inoperative cooling fan, or a faulty thermostat may lead to an over temperature condition which may cause engine component damage. Contaminated engine oil and oil filter should be changed.

1) Inspect the oil for excessive foaming or an overfill condition. Oil diluted by coolant may not properly lubricate the crankshaft bearings and may lead to component damage. Refer to Lower Engine Noise, Regardless of Engine Speed .

2) Inspect by performing a cylinder leak-down test. During this test, excessive air bubbles within the cooling system may indicate a faulty gasket or damaged component.

3) Inspect by performing a cylinder compression test. Two cylinders side-by-side on the engine block with low compression may indicate a failed cylinder head gasket. Refer to Engine Compression Test.

Cause	Correction
Faulty external engine oil cooler	Replace the components, as required.
Faulty cylinder head gasket	Replace the head gasket and components, as required. Refer to Cylinder Head Cleaning and Inspection and Cylinder Head Removal - Left Side and Cylinder Head Installation - Left Side , or Cylinder Head Removal - Right Side and Cylinder Head Installation - Right Side .
Warped cylinder head	Machine the cylinder head to proper flatness, if applicable, and replace the cylinder head gasket. Refer to Cylinder Head Cleaning and Inspection.
Cracked cylinder head	Replace the cylinder head and gasket.
Cracked cylinder liner or engine block	Replace the components, as required.
Cylinder head, block, or manifold porosity	Replace the components, as required.

Crankcase Ventilation System Inspection and Diagnosis

Symptom	Correction
External oil leak	Inspect for any of the following conditions: • Restricted or kinked PCV hose or engine vent hose • Damaged, incorrect, or incorrectly installed PCV hose • Excessive crankcase pressure
Rough or Rolling Idle	Inspect for any of the following conditions: • Restricted or kinked PCV hose or engine vent hose • Leaking (damaged) PCV hose • Vacuum hoses worn or not properly installed
Stalling or slow idle speed	Inspect for any of the following conditions: • Restricted or kinked engine vent hose • Leaking (damaged) PCV hose
High idle speed	Inspect for a leaking (damaged) PCV hose
Sludge in the engine	Inspect for restricted or kinked PCV hose or engine vent hose

Cylinder Leakage Test

1 SPECIAL TOOLS

1.1.1 J 35667-A Cylinder Head Leak-down Tester, or equivalent

1.1.2 For equivalent regional tools, refer to Special Tools.

2 CYLINDER LEAKAGE TEST

Note: A leakage test may be performed in order to measure cylinder/combustion chamber leakage. High cylinder leakage may indicate one or more of the following conditions:

- Worn or burnt valves
- Broken valve springs
- Stuck valve lifters
- Incorrect valve lash
- Damaged piston
- Worn piston rings
- Worn or scored cylinder bore
- Damaged cylinder head gasket
- Cracked or damaged cylinder head
- Cracked or damaged engine block

WARNING: **See OEM Service or Owner's Manual for Battery Disconnect Warning.**

2.1 Disconnect the battery ground negative cable.

2.2 Remove the spark plugs. Refer to Spark Plug Replacement.

2.3 Rotate the crankshaft to place the piston in the cylinder being tested at top dead center (TDC) of the compression stroke.

2.4 Install the J 35667-A tester , or equivalent.

Note: It may be necessary to hold the crankshaft balancer bolt to prevent the crankshaft from rotating.

2.5 Apply shop air pressure to the J 35667-A tester and adjust according to the manufacturer's instructions.

Cylinder Leakage Test

2.6 Record the cylinder leakage value. Cylinder leakage that exceeds 25 percent is considered excessive and may require component service. In excessive leakage situations, inspect for the following conditions:

2.6.1 Air leakage noise at the throttle body or air inlet hose that may indicate a worn or burnt intake valve or a broken valve spring

2.6.2 Air leakage noise at the exhaust system tailpipe that may indicate a worn or burnt exhaust valve or a broken valve spring

2.6.3 Air leakage noise from the crankcase, oil level indicator tube, or oil fill tube that may indicate worn piston rings, a damaged piston, a worn or scored cylinder bore, a damaged engine block or a damaged cylinder head.

2.6.4 Air bubbles in the cooling system may indicate a damaged cylinder head or a damaged cylinder head gasket.

2.7 Perform the leakage test on the remaining cylinders and record the values.

Drive Belt Chirping, Squeal, and Whine Diagnosis

1 DIAGNOSTIC AIDS

1.1 A chirping or squeal noise may be intermittent due to moisture on the drive belts or the pulleys. It may be necessary to spray a small amount of water on the drive belts in order to duplicate the customers concern. If spraying water on the drive belt duplicates the symptom, cleaning the belt pulleys may be the probable solution.

1.2 If the noise is intermittent, verify the accessory drive components by varying their loads making sure they are operated to their maximum capacity. An overcharged A/C system, power steering system with a pinched hose or wrong fluid, or a generator failing are suggested items to inspect.

1.3 A chirping, squeal or whine noise may be caused by a loose or improper installation of a body or suspension component. Other items of the vehicle may also cause the noise.

1.4 The drive belts will not cause a whine noise.

2 TEST DESCRIPTION

The Steps below refer to the Step Numbers on the diagnostic table.

2.1 Step 2: The noise may not be engine related. This step is to verify that the engine is making the noise. If the engine is not making the noise do not proceed further with this table.

2.2 Step 3: The noise may be an internal engine noise. Removing the drive belts one at a time and operating the engine for a brief period will verify the noise is related to the drive belt. When removing the drive belt the water pump may not be operating and the engine may overheat. Also DTCs may set when the engine is operating with the drive belts removed.

2.3 Step 4: Inspect all drive belt pulleys for pilling. Pilling is the small balls or pills or it can be strings in the drive belt grooves from the accumulation of rubber dust.

2.4 Step 6: Misalignment of the pulleys may be caused from improper mounting of the accessory drive component, incorrect installation of the accessory drive component pulley, or the pulley bent inward or outward from a previous repair. Test for a misaligned pulley using a straight edge in the pulley grooves across 2 or 3 pulleys. If a misaligned pulley is found refer to that accessory drive component for the proper installation procedure for that pulley.

2.5 Step 10: Inspecting of the fasteners can eliminate the possibility that a wrong bolt, nut, spacer, or washer was installed.

2.6 Step 12: Inspecting the pulleys for being bent should include inspecting for a dent or other damage to the pulleys that would prevent the drive belt from not seating properly in all of the pulley grooves or on the smooth surface of a pulley when the back side of the belt is used to drive the pulley.

2.7 Step 14: This test is to verify that the drive belt tensioner operates properly. If the drive belt tensioner is not operating properly, proper belt tension may not be achieved to keep the drive belt from slipping which could cause a squeal noise.

Drive Belt Chirping, Squeal, and Whine Diagnosis

2.8 Step 15: This test is to verify that the drive belt is not too long, which would prevent the drive belt tensioner from working properly. Also if an incorrect length drive belt was installed, it may not be routed properly and may be turning an accessory drive component in the wrong direction.

2.9 Step 16: Misalignment of the pulleys may be caused from improper mounting of the accessory drive component, incorrect installation of the accessory drive component pulley, or the pulley bent inward or outward from a previous repair. Test for a misaligned pulley using a straight edge in the pulley grooves across 2 or 3 pulleys. If a misaligned pulley is found refer to that accessory drive component for the proper installation procedure for that pulley.

2.10 Step 17: This test is to verify that the pulleys are the correct diameter or width. Using a known good vehicle compare the pulley sizes.

2.11 Step 19: Replacing the drive belt when it is not damaged or there is not excessive pilling will only be a temporary repair.

DEFINITION: The following items are indications of chirping:

- A high pitched noise that is heard once per revolution of the drive belt or a pulley.
- Chirping may occur on cold damp start-ups and will subside once the vehicle reaches normal operating temp.

DEFINITION: The following items are indications of drive belt squeal:

- A loud screeching noise that is caused by a slipping drive belt. This is unusual for a drive belt with multiple ribs.
- The noise occurs when a heavy load is applied to the drive belt, such as an air conditioning compressor engagement snapping the throttle, or slipping on a seized pulley or a faulty accessory drive component.

DEFINITION: The following items are indications of drive belt whine:

- A high pitched continuous noise.
- The noise may be caused by an accessory drive component failed bearing.

Step	Action	Yes	No
1	Did you review the drive belt symptom operation and perform the necessary inspections?	Go to Step 2	Go to Symptoms - Engine Mechanical
2	Verify that there is a chirping, squeal or whine noise. Does the engine make the chirping squeal or whine noise?	Go to Step 3	Go to Diagnostic Aids
3	1 Remove the drive belt.If the engine has multiple drive belts, remove the belts one at a time and perform the test below each time a belt is removed. 2 Operate the engine for no longer than 30–40 seconds. 3 Repeat this test if necessary by removing the remaining belts. Does the chirping, squeal or whine noise still exist?	Go to Symptoms - Engine Mechanical	Go to Step 4

Drive Belt Chirping, Squeal, and Whine Diagnosis

4	If diagnosing a chirping noise, inspect for severe pilling exceeding 1/3 of the belt groove depth. If diagnosing a squeal or whine noise, proceed to step 13. Do the belt grooves have pilling?	Go to Step 5	Go to Step 6
5	Clean the drive belt pulleys with a suitable wire brush. Did you complete the repair?	Go to Step 20	Go to Step 6
6	Inspect for misalignment of the pulleys. Are any of the pulleys misaligned?	Go to Step 7	Go to Step 8
7	Replace or repair any misaligned pulleys. Did you complete the repair?	Go to Step 20	Go to Step 8
8	Inspect for bent or cracked brackets. Did you find any bent or cracked brackets?	Go to Step 9	Go to Step 10
9	Replace any bent or cracked brackets. Did you complete the repair?	Go to Step 20	Go to Step 10
10	Inspect for improper, loose or missing fasteners. Did you find the condition?	Go to Step 11	Go to Step 12
11	Caution: Refer to Fastener Caution. 1 Tighten any loose fasteners. Refer to Fastener Tightening Specifications. 2 Replace any improper or missing fasteners. Did you complete the repair?	Go to Step 20	Go to Step 12
12	Inspect for a bent pulley. Did you find the condition?	Go to Step 18	Go to Step 19
13	Inspect for an accessory drive component seized bearing or a faulty accessory drive component. If diagnosing a whine noise and the condition still exist, proceed to Diagnostic Aids. Did you find and correct the condition?	Go to Step 20	Go to Step 14
14	Test the drive belt tensioner for proper operation. Refer to Drive Belt Tensioner Diagnosis. Did you find and correct the condition?	Go to Step 20	Go to Step 15

Drive Belt Chirping, Squeal, and Whine Diagnosis

15	Inspect for the correct drive belt length. Did you find and correct the condition?	Go to Step 20	Go to Step 16
16	Inspect for misalignment of a pulley. Did you find and correct the condition?	Go to Step 20	Go to Step 17
17	Inspect for the correct pulley size. Did you find and correct the condition?	Go to Step 20	Go to Diagnostic Aids
18	Replace the bent pulley. Did you complete the repair?	Go to Step 20	Go to Step 19
19	Replace the drive belt. Refer to Drive Belt Replacement - Accessory or Air Conditioning Compressor Belt Replacement. Did you complete the repair?	Go to Step 20	Go to Diagnostic Aids
20	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 3

Drive Belt Falls Off and Excessive Wear Diagnosis

1 DIAGNOSTIC AIDS

If the drive belt repeatedly falls off the drive belt pulleys, this is because of pulley misalignment.

An extra load that is quickly applied on released by an accessory drive component may cause the drive belt to fall off the pulleys. Verify the accessory drive components operate properly.

If the drive belt is the incorrect length, the drive belt tensioner may not keep the proper tension on the drive belt.

Excessive wear on a drive belt is usually caused by an incorrect installation or the wrong drive belt for the application.

Minor misalignment of the drive belt pulleys will not cause excessive wear, but will probably cause the drive belt to make a noise or to fall off.

Excessive misalignment of the drive belt pulleys will cause excessive wear but may also make the drive belt fall off.

2 TEST DESCRIPTION

The Steps below refer to the step numbers on the diagnostic table.

2.1 Step 2: This inspection is to verify the condition of the drive belt. Damage may of occurred to the drive belt when the drive belt fell off. The drive belt may of been damaged, which caused the drive belt to fall off. Inspect the belt for cuts, tears, sections of ribs missing, or damaged belt plys.

2.2 Step 4: Misalignment of the pulleys may be caused from improper mounting of the accessory drive component, incorrect installation of the accessory drive component pulley, or the pulley bent inward or outward from a previous repair. Test for a misaligned pulley using a straight edge in the pulley grooves across two or three pulleys. If a misaligned pulley is found refer to that accessory drive component for the proper installation procedure of that pulley.

2.3 Step 5: Inspecting the pulleys for being bent should include inspecting for a dent or other damage to the pulleys that would prevent the drive belt from not seating properly in all of the pulley grooves or on the smooth surface of a pulley when the back side of the belt is used to drive the pulley.

2.4 Step 6: Accessory drive component brackets that are bent or cracked will let the drive belt fall off.

2.5 Step 7: Inspection of the fasteners can eliminate the possibility that a wrong bolt, nut, spacer, or washer was installed. Missing, loose, or the wrong fasteners may cause pulley misalignment from the bracket moving under load. Over tightening of the fasteners may cause misalignment of the accessory component bracket.

2.6 Step 13: The inspection is to verify the drive belt is correctly installed on all of the drive belt pulleys. Wear on the drive belt may be caused by mis-positioning the drive belt by one groove on a pulley.

2.7 Step 14: The installation of a drive belt that is too wide or too narrow will cause wear on the drive belt. The drive belt ribs should match all of the grooves on all of the pulleys.

Drive Belt Falls Off and Excessive Wear Diagnosis

2.8 Step 15: This inspection is to verify the drive belt is not contacting any parts of the engine or body while the engine is operating. There should be sufficient clearance when the drive belt accessory drive components load varies. The drive belt should not come in contact with an engine or a body component when snapping the throttle.

	DEFINITION: The drive belt falls off the pulleys or may not ride correctly on the pulleys. DEFINITION: Wear at the outside ribs of the drive belt due to an incorrectly installed drive belt.		
Step	**Action**	**Yes**	**No**
1	Did you review the Drive Belt Symptom operation and perform the necessary inspections?	Go to Step 2	Go to Symptoms - Engine Mechanical
2	• If diagnosing excessive wear, proceed to step 13. • If diagnosing a drive belt that falls off, inspect for a damaged drive belt. Did you find the condition?	Go to Step 3	Go to Step 4
3	Install a new drive belt. Refer to Drive Belt Replacement - Accessory or Air Conditioning Compressor Belt Replacement . Does the drive belt continue to fall off?	Go to Step 4	System OK
4	Inspect for misalignment of the pulleys. Did you find and repair the condition?	Go to Step 12	Go to Step 5
5	Inspect for a bent or dented pulley. Did you find and repair the condition?	Go to Step 12	Go to Step 6
6	Inspect for a bent or a cracked bracket. Did you find and repair the condition?	Go to Step 12	Go to Step 7
7	Inspect for improper, loose or missing fasteners. Did you find loose or missing fasteners?	Go to Step 8	Go to Step 9
8	Caution: Refer to Fastener Caution. 1 Tighten any loose fasteners. Refer to Fastener Tightening Specifications. 2 Replace improper or missing fasteners. Does the drive belt continue to fall off?	Go to Step 9	System OK
9	Test the drive belt tensioner for operating correctly. Refer to Drive Belt Tensioner Diagnosis. Does the drive belt tensioner operate correctly?	Go to Step 11	Go to Step 10

Drive Belt Falls Off and Excessive Wear Diagnosis

10	Replace the drive belt tensioner. Refer to Drive Belt Tensioner Replacement - Accessory. Does the drive belt continue to fall off?	Go to Step 11	System OK
11	Inspect for failed drive belt idler and drive belt tensioner pulley bearings. Did you find and repair the condition?	Go to Step 12	Go to Diagnostic Aids
12	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 13
13	Inspect the drive belt for the proper installation. Refer to Drive Belt Replacement - Accessory or Air Conditioning Compressor Belt Replacement Did you find this condition?	Go to Step 16	Go to Step 14
14	Inspect for the proper drive belt. Did you find this condition?	Go to Step 16	Go to Step 15
15	Inspect for the drive belt rubbing against a bracket, hose, or wiring harness. Did you find and repair the condition?	Go to Step 17	Go to Diagnostic Aids
16	Replace the drive belt. Refer to Drive Belt Replacement - Accessory or Air Conditioning Compressor Belt Replacement. Did you complete the replacement?	Go to Step 17	—
17	Operate the system in order to verify the repair. Did you correct the condition?	System OK	—

Drive Belt Rumbling and Vibration Diagnosis

1 DIAGNOSTIC AIDS

The accessory drive components can have an effect on engine vibration. Vibration from the engine operating may cause a body component or another part of the vehicle to make rumbling noise. Vibration can be caused by, but not limited to the air conditioning (A/C) system over charged, the power steering system restricted or the incorrect fluid, or an extra load on the generator. To help identify an intermittent or an improper condition, vary the loads on the accessory drive components.

The drive belt may have a rumbling condition that cannot be seen or felt. Sometimes replacing the drive belt may be the only repair for the symptom.

If replacing the drive belt, completing the diagnostic table, and the noise is only heard when the drive belts are installed, there might be an accessory drive component with a failure. Varying the load on the different accessory drive components may aid in identifying which component is causing the rumbling noise.

2 TEST DESCRIPTION

The Steps below refer to the step numbers on the diagnostic table.

2.1 Step 2: This test is to verify that the symptom is present during diagnosing. Other vehicle components may cause a similar symptom.

2.2 Step 3: This test is to verify that one of the drive belts is causing the rumbling noise or vibration. Rumbling noise may be confused with an internal engine noise due to the similarity in the description. Remove only one drive belt at a time if the vehicle has multiple drive belts. When removing the drive belts the water pump may not be operating and the engine may overheat. Also DTCs may set when the engine is operating with the drive belts removed.

2.3 Step 4: Inspecting the drive belts is to ensure that they are not causing the noise. Small cracks across the ribs of the drive belt will not cause the noise. Belt separation is identified by the plys of the belt separating and may be seen at the edge of the belt our felt as a lump in the belt.

2.4 Step 5: Small amounts of pilling is normal condition and acceptable. When the pilling is severe the drive belt does not have a smooth surface for proper operation.

2.5 Step 9: Inspecting of the fasteners can eliminate the possibility that the wrong bolt, nut, spacer, or washer was installed.

2.6 Step 11: This step should only be performed if the water pump is driven by the drive belt. Inspect the water pump shaft for being bent. Also inspect the water pump bearings for smooth operation and excessive play. Compare the water pump with a known good water pump.

2.7 Step 12: Accessory drive component brackets that are bent, cracked, or loose may put extra strain on that accessory component causing it to vibrate.

Drive Belt Rumbling and Vibration Diagnosis

DEFINITION: The following items are indications of drive belt rumbling:

- A low pitch tapping, knocking, or thumping noise heard at or just above idle.
- Heard once per revolution of the drive belt or a pulley.

Rumbling may be caused from:

Pilling, the accumulation of rubber dust that forms small balls (pills) or strings in the drive belt pulley groove

The separation of the drive belt

A damaged drive belt

DEFINITION: The following items are indications of drive belt vibration:

- The vibration is engine-speed related.
- The vibration may be sensitive to accessory load.

Step	Action	Yes	No
1	Did you review the drive belt symptom operation and perform the necessary inspections?	Go to Step 2	Go to Symptoms - Engine Mechanical
2	Verify that there is a rumbling noise or that the vibration is engine related. Does the engine make the rumbling noise or vibration?	Go to Step 3	Go to Diagnostic Aids
3	**Note:** If the engine has multiple drive belts, remove the belts one at a time and perform the test below each time a belt is removed. 1 Remove the drive belt. 2 Operate the engine for no longer than 30–40 seconds. 3 Repeat this test if necessary by removing the remaining belt(s). Does the rumbling or vibration still exist?	Go to Symptoms - Engine Mechanical	Go to Step 4
4	Inspect the drive belts for wear, damage, separation, sections of missing ribs, and debris build-up. Did you find any of these conditions?	Go to Step 7	Go to Step 5
5	Inspect for severe pilling of more than 1/3 of the drive belt pulley grooves. Did you find severe pilling?	Go to Step 6	Go to Step 7

Drive Belt Rumbling and Vibration Diagnosis

6	1 Clean the drive belt pulleys using a suitable wire brush. 2 Reinstall the drive belts. Refer to Drive Belt Replacement - Accessory or Air Conditioning Compressor Belt Replacement. Did you correct the condition?	Go to Step 8	Go to Step 7
7	Install a new drive belt. Refer to Drive Belt Replacement - Accessory or Air Conditioning Compressor Belt Replacement. Did you complete the replacement?	Go to Step 8	Go to Step 9
8	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 9
9	Inspect for improper, loose or missing fasteners. Did you find any of these conditions?	Go to Step 10	Go to Step 11
10	Caution: Refer to Fastener Caution. 1 Tighten any loose fasteners. Refer to Fastener Tightening Specifications. 2 Replace improper or missing fasteners. Did you complete the repair?	Go to Step 13	Go to Step 11
11	Inspect for a bent water pump shaft. Refer to Water Pump Replacement. Did you find and correct the condition?	Go to Step 13	Go to Step 12
12	Inspect for bent or cracked brackets. Did you find and correct the condition?	Go to Step 13	Go to Diagnostic Aids
13	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 3

Fuel Injector Diagnosis (CH47976)

1 DIAGNOSTIC INSTRUCTIONS

1.1 Review *STRATEGY BASED DIAGNOSIS* for an overview of the diagnostic approach.

1.2 Perform the *DIAGNOSTIC SYSTEM CHECK*prior to using this diagnostic procedure.

2 CIRCUIT/SYSTEM DESCRIPTION

The engine control module (ECM) enables the appropriate fuel injector pulse for each cylinder. The ignition voltage is supplied directly to the fuel injectors. The ECM controls each fuel injector by grounding the control circuit via a solid state device called a driver. A fuel injector coil winding resistance that is too high or too low will affect the engine drivability. A fuel injector control circuit DTC may not set, but a misfire may be apparent. The fuel injector coil windings are affected by temperature. The resistance of the fuel injector coil windings will increase as the temperature of the fuel injector increases.

The *CH-47976* Active Fuel Injector Tester is used to test the fuel pump, fuel system leak down, and the fuel injectors. Following the User Guide, CH 47976–11, and the on screen prompts or selections, will indicate the steps required to perform each of the available tests. The tester will perform all of the tests automatically and display results of the test. The results can also be down loaded for storage and printing.

3 DIAGNOSTIC AIDS

3.1 Downloading the AFIT test results to the shop TISterminal will clearly show which injector is at fault by the bar graph turning red.

3.2 On some vehicles cleaning the injectors may be performed if the graph shows erratic or values close to the specified values.

3.3 A second test can be performed to verify repair. Compare the first balance test to the second.

4 REFERENCE INFORMATION

4.1 SCHEMATIC REFERENCE

4.1.1 Engine Controls Schematics

4.2 CONNECTOR END VIEW REFERENCE

4.2.1 Component Connector End Views

4.3 ELECTRICAL INFORMATION REFERENCE

4.3.1 Circuit testing

4.3.2 Connector repairs

4.3.3 Testing for intermittent conditions and poor connections

4.3.4 Wiring repairs

4.4 SPECIAL TOOLS

4.4.1 *CH-47976* Active Fuel Injector Tester

5 COMPONENT TESTING

5.1 FUEL INJECTOR COIL TEST

5.1.1 Verify the resistance of each fuel injector:

5.1.2 Ignition ON, verify the scan tool ECT temperature is between 10–32°C (50–90° F).

5.1.2.1 If not within the specified range, measure and record the resistance of each fuel injector with a DMM. Subtract the lowest resistance value from the highest resistance value. The difference between the lowest value and the highest value should be equal to or less than 3 0. If the difference is greater than 30, add all of the fuel injector resistance values to obtain a total resistance value. Divide the total resistance value by the number of injectors to obtain an average resistance value. Subtract the lowest individual fuel injector resistance value from the average resistance value. Subtract the average resistance value from the highest individual injector resistance value. Replace the fuel injector that displays the greatest difference above or below the average.

5.1.3 Test for 11–140 between each fuel injector.

5.1.3.1 If not within the specified range, replace the fuel injector.

5.1.4 If all the injectors test OK, refer to the Active Fuel Injector Tester(AFIT) Procedure.

5.2 ACTIVE FUEL INJECTOR TESTER (AFIT) PROCEDURE

NOTE: Do not perform this test if the engine coolant temperature (ect) is above 94°c (201°f). Irregular fuel pressure readings may result due to hot soak fuel boiling. Verify that adequate fuel is in the fuel tank before proceeding with this diagnostic.

5.2.1 Verify the battery is fully charged and all accessories are OFF.

5.2.2 Ignition OFF

5.2.3 Install the *CH-47976* Active Fuel Injector Tester.

5.2.4 Turn ON the AFIT and select the vehicle.

5.2.5 Follow the setup screen on the AFIT.

5.2.6 Ignition ON, perform the Injector Test. The test should run and pass all injectors.

5.2.6.1 If the AFIT aborts testing due to fuel pressure or fuel leak down, refer to OEM Service Manual.

5.2.6.2 If any injector exceeds the recommended tolerance, replace the injector(s), E-85 only. All other engines refer to Fuel Injector Cleaning.

6 REPAIR INSTRUCTIONS

6.1 Perform the *DIAGNOSTIC REPAIR VERIFICATION*after completing the diagnostic procedure.

6.2 Fuel Injector Replacement

Fuel Injector Diagnosis (J39021 or scan tool)

1 DIAGNOSTIC INSTRUCTIONS

1.1 Review *STRATEGY BASED DIAGNOSIS* for an overview of the diagnostic approach.

1.2 Perform the *DIAGNOSTIC SYSTEM CHECK* prior to using this diagnostic procedure.

2 CIRCUIT/SYSTEM DESCRIPTION

The engine control module (ECM) enables the appropriate fuel injector pulse for each cylinder. The ignition voltage is supplied directly to the fuel injectors. The ECM controls each fuel injector by grounding the control circuit via a solid state device called a driver. A fuel injector coil winding resistance that is too high or too low will affect the engine drivability. A fuel injector control circuit DTC may not set, but a misfire may be apparent. The fuel injector coil windings are affected by temperature. The resistance of the fuel injector coil windings will increase as the temperature of the fuel injector increases.

When performing the fuel injector balance test, the scan tool is first used to energize the fuel pump relay. The fuel injector tester or the scan tool is then used to pulse each injector for a precise amount of time, allowing a measured amount of the fuel to be injected. This causes a drop in the system fuel pressure that can be recorded and used to compare each injector.

3 DIAGNOSTIC AIDS

3.1 Monitoring the misfire current counters, or misfire graph, may help to isolate the fuel injector that is causing the condition.

3.2 Operating the vehicle over a wide temperature range may help isolate the fuel injector that is causing the condition.

3.3 Perform the fuel injector coil test within the conditions of the customer's concern. A fuel injector condition may only be apparent at a certain temperature, or under certain conditions.

4 REFERENCE INFORMATION

4.1 SCHEMATIC REFERENCE

4.1.1 Engine controls schematics

4.1.2 Instrument cluster schematics

4.2 CONNECTOR END VIEW REFERENCE

4.2.1 Component Connector End Views

4.3 ELECTRICAL INFORMATION REFERENCE

4.3.1 Circuit testing

Fuel Injector Diagnosis (J39021 or scan tool)

4.3.2 Connector repairs

4.3.3 Testing for intermittent conditions and poor connections

4.3.4 Wiring repairs

4.4 SCAN TOOL REFERENCE

4.4.1 Control Module References for scan tool information

4.5 SPECIAL TOOLS

4.5.1 *CH-48027* Digital Pressure Gauge

4.5.2 *J-39021* Fuel Injector Coil and Balance Tester

4.5.3 *J-44602* Injector Test Adapter

5 COMPONENT TESTING

5.1 FUEL INJECTOR COIL TEST

Verify the resistance of each fuel injector:

5.1.1 Ignition ON, verify the scan tool ECT temperature is between 10–32°C (50–90°F).

5.1.1.1 If not within the specified range, measure and record the resistance of each injector with a DMM. Subtract the lowest resistance value from the highest resistance value. The difference between the lowest value and the highest value should be equal to or less than 3 Ω. If the difference is greater than 3Ω, add all of the fuel injector resistance values to obtain a total resistance value. Divide the total resistance by the number of injectors to obtain an average resistance value. Subtract the lowest individual fuel injector resistance value from the average resistance value, Subtract the average resistance value from the highest individual fuel injector resistance value. Replace the fuel injector that displays the greatest difference above or below the average.

5.1.2 Test for 11–14Ω between each fuel injector.

5.1.2.1 If not within the specified range, replace the fuel injector.

5.1.3 If all the injectors test OK, refer to the Fuel Injector Balance Test–Fuel Pressure Test.

5.2 FUEL INJECTOR BALANCE TEST-FUEL PRESSURE TEST

NOTE: D**o** not perform this test if the engine coolant temperature (ECT) is above 94°c (201°f). Irregular fuel pressure readings may result due to hot soak fuel boiling. Verify that adequate fuel is in the fuel tank before proceeding with this diagnostic. Before proceeding with this test, review the user manual CH 48027-5 for safety information and instructions.

Fuel Injector Diagnosis (J39021 or scan tool)

5.2.1 Install a *CH-48027* pressure gauge. Refer to Fuel Pressure Gauge Installation and Removal.

5.2.2 Ignition ON, engine OFF.

NOTE: The fuel pump relay may need to be commanded on a few times in order to obtain the highest possible fuel pressure. Do not start the engine.

5.2.3 Command the Fuel Pump Relay ON with a scan tool.

5.2.4 Observe the fuel pressure gauge with the fuel pump commanded ON. The fuel pressure should be 345– 414 kPa (50–60 psi).

5.2.4.1 If not within the specified range, refer to OEM Service Manual for fuel system diagnosis.

5.2.5 Monitor the *CH-48027* pressure gauge for one minute. The fuel pressure should not decrease greater than 34 kPa (5 psi).

5.2.5.1 If greater than the specified range, refer to Fuel System Diagnosis.

5.2.6 Perform the Fuel Injector Balance Test with Special Tool or the Fuel Injector Balance Test with Scan Tool.

5.3 FUEL INJECTOR BALANCE TEST WITH SPECIAL TOOL

5.3.1 Install a *CH-48027* pressure gauge.

5.3.2 Set the amperage supply selector switch on the *J-39021* fuel injector coil and balance tester to 0.5–2.5 amp position.

5.3.3 Connect the *J-39021* fuel injector coil and balance tester to a fuel injector with a *J-44602* test adapter.

5.3.4 Command the Fuel Pump Relay ON three times with a scan tool. On the last command, as the fuel pressure begins to slowly degrade and stabilize, select a fuel pressure within 34 kPa (5 psi) of the maximum pump pressure. Record this fuel pressure. This is the starting pressure at which you will pulse each injector.

5.3.5 Command the Fuel Pump Relay ON one more time and energize the fuel injector by depressing the Push to Start Test button on the *J-39021* fuel injector coil and balance tester at the previously selected pressure.

5.3.6 After the injector stops pulsing, select Min from the Display Mode on the *CH-48027* pressure gauge and record the Min pressure.

5.3.6.1 **NOTE:** New test results will not be recorded if the min/max results are not cleared after each injector is tested.

5.3.7 Clear the Min/Max results on the *CH-48027* pressure gauge.

5.3.8 Select Normal from the Display Mode on the *CH-48027* pressure gauge.

5.3.9 Repeat steps 2 and 4 through 7 for each fuel injector.

Fuel Injector Diagnosis (J39021 or scan tool)

5.3.10 Perform the Pressure Drop Calculation.

5.4 FUEL INJECTOR BALANCE TEST WITH SCAN TOOL

5.4.1 Command the Fuel Pump Relay ON three times with a scan tool. On the last command, as the fuel pressure begins to slowly degrade and stabilize, select a fuel pressure within 34 kPa (5 psi) of the maximum pump pressure. Record this fuel pressure. This is the starting pressure at which you will pulse each injector.

5.4.2 Select the Fuel Injector Balance Test with a scan tool.

5.4.3 Select an injector to be tested.

5.4.4 Press Enter to prime the fuel system.

5.4.5 Energize the fuel injector by depressing the Pulse Injector button on the scan tool at the previously selected pressure.

5.4.6 After the injector stops pulsing, select Min from the Display Mode on the *CH-48027* pressure gauge and record the Min pressure.

5.4.6.1 **NOTE:** New test results will not be recorded if the min/max results are not cleared after each injector is tested.

5.4.7 Clear the Min/Max results on the *CH-48027* pressure gauge.

5.4.8 Select Normal from the Display Mode on the *CH-48027* pressure gauge.

5.4.9 Press Enter on the scan tool to bring you back to the Select Injector screen.

5.4.10 Repeat steps 3 through 9 for each fuel injector.

5.4.11 Perform the Pressure Drop Calculation.

5.5 PRESSURE DROP CALCULATION

5.5.1 Subtract the minimum pressure from the starting pressure for one fuel injector. The result is the pressure drop value.

5.5.2 Obtain a pressure drop value for each fuel injector.

5.5.3 Add all the individual pressure drop values except for the injector suspected of being faulty. This is the total pressure drop.

5.5.4 Divide the total pressure drop by the number of fuel injectors that were added together. This is the average pressure drop. The difference between any individual pressure drop and the average pressure drop should not be greater than 20 kPa (3 psi).

5.5.4.1 If greater than the specified value, replace the fuel injector, E-85 only. All other engine, refer to Fuel Injector Cleaning.

6 REPAIR INSTRUCTIONS

6.1 Perform the *DIAGNOSTIC REPAIR VERIFICATION*after completing the diagnostic procedure.

6.2 Fuel Injector Replacement

Malfunction Indicator Lamp (MIL) Diagnosis

1 DIAGNOSTIC INSTRUCTIONS

1.1 Review *STRATEGY BASED DIAGNOSIS* for an overview of the diagnostic approach.

1.2 Perform the *DIAGNOSTIC SYSTEM CHECK* prior to using this diagnostic procedure.

2 CIRCUIT/SYSTEM DESCRIPTION

The malfunction indicator lamp (MIL) illuminates to inform the driver that an emission system fault has occurred and the engine control system requires service. Ignition voltage is supplied directly to the MIL and, when the emission system fault occurs, the engine control module (ECM) turns the MIL ON by grounding the MIL control circuit. Under normal operating conditions, the MIL should be ON only when the ignition is ON and the engine is OFF.

3 DIAGNOSTIC AIDS

If the condition is intermittent, move the related harnesses and connectors with the ignition ON and the engine OFF, and with the engine operating while monitoring the scan tool MIL control circuit status parameters. The MIL control circuit status parameters will change from OK or Not Run to Malfunction if there is a condition with the circuit or a connection.

4 REFERENCE INFORMATION

4.1 SCHEMATIC REFERENCE

4.1.1 ENGINE CONTROLS SCHEMATICS

4.1.2 INSTRUMENT CLUSTER SCHEMATICS

4.2 CONNECTOR END VIEW REFERENCE

4.2.1 Component Connector End Views

4.3 ELECTRICAL INFORMATION REFERENCE

4.3.1 Circuit testing

4.3.2 Connector repairs

4.3.3 Testing for intermittent conditions and poor connections

4.3.4 Wiring repairs

4.4 SCAN TOOL REFERENCE

4.4.1 Control Module References

Malfunction Indicator Lamp (MIL) Diagnosis

5 CIRCUIT/SYSTEM VERIFICATION

NOTE: Any MIL requesting DTCs that may be set should be diagnosed first.

5.1 Ignition ON, command the MIL ON and OFF with a scan tool. The MIL should turn ON and OFF as commanded.

5.2 Command the MIL ON and OFF with a scan tool while observing the control circuit status parameters listed below:

5.2.1 MIL Ckt Short Gnd Test Status

5.2.2 MIL Ckt Open Test Status

5.2.3 MIL Ckt Short Volts Test Status

5.2.4 Each parameter should display OK or Not Run.

5.3 Engine running, command the MIL ON and OFF with a scan tool while observing the control circuit status parameters listed below:

5.3.1 MIL Ckt Short Gnd Test Status

5.3.2 MIL Ckt Open Test Status

5.3.3 MIL Ckt Short Volts Test Status

5.3.4 Each parameter should display OK or Not Run.

6 CIRCUIT/SYSTEM TESTING

6.1 Ignition OFF, disconnect the X1 harness connector at the K20 ECM.

6.2 Ignition ON, the MIL should not illuminate.

6.2.1 If the MIL illuminates, test the MIL control circuit terminal 68 X1 for a short to ground. If the circuit tests normal, replace the P16 instrument panel cluster.

6.3 Connect a 3 A fused jumper wire between the MIL control circuit terminal 68 X1 and ground. The MIL should illuminate.

6.3.1 If the MIL illuminates, replace the K20 ECM.

6.3.2 If the MIL does not illuminate, test the MIL control circuit for a short to voltage or an open/high resistance. If the MIL control circuit tests normal, test the instrument cluster ignition voltage circuit for a short to ground or an open/high resistance. If the circuits test normal, replace the P16 instrument panel cluster/bulb.

Malfunction Indicator Lamp (MIL) Diagnosis

7 REPAIR INSTRUCTIONS

7.1 Perform the *DIAGNOSTIC REPAIR VERIFICATION*after completing the diagnostic procedure.

7.2 Instrument Cluster Replacement

7.3 Control Module References for ECM replacement, setup, and programming

Oil Consumption Diagnosis

Checks	Causes
Excessive oil consumption, not due to leaks, is the use of 1 L (1 qt) or more of engine oil within 3,200 kilometers (2,000 miles).	
Preliminary	The causes of excessive oil consumption may include the following conditions:
	• External oil leaks - Refer to Oil Leak Diagnosis.
	• Incorrect oil level or improper reading of the oil level indicator With the vehicle on a level surface, run the engine for a few minutes, allow adequate drain down time, 2–3 minutes, and measure for the correct engine oil level.
	• Improper oil viscosity - Refer to the vehicle owner's manual and use the recommended SAE grade and viscosity for the prevailing temperatures.
	• Continuous high speed driving and/or severe usage
	• Crankcase ventilation system restrictions or malfunctioning components - Refer to Crankcase Ventilation System Inspection/Diagnosis.
	• Worn valve guides and/or valve stems
	• Worn or improperly installed valve stem oil seals - Refer to Spark Plug Inspection.
	• Piston rings broken, worn, or not seated properly Allow adequate time for the rings to seat. Replace worn piston rings, as necessary. Refer to Cylinder Leakage Test.
	• Piston and rings improperly installed or not fitted to the cylinder bore Refer to Lower Engine Noise, Regardless of Engine Speed.

Oil Leak Diagnosis

Important: You can repair most fluid leaks by first visually locating the leak, repairing or replacing the component, or by resealing the gasket surface. Once the leak is identified, determine the cause of the leak. Repair the cause of the leak as well as the leak itself.

Step	Action	Yes	No
1	1 Operate the vehicle until it reaches normal operating temperature. 2 Park the vehicle on a level surface, over a large sheet of paper or other clean surface. 3 Wait 15 minutes. 4 Inspect for drippings. Are drippings present?	Go to Step 2	System OK
2	Can you identify the type of fluid and the approximate location of the leak?	Go to Step 10	Go to Step 3
3	1 Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. 2 Inspect for leaks at the following locations: • Sealing surfaces • Fittings • Cracked or damaged components Can you identify the type of fluid and the approximate location of the leak?	Go to Step 10	Go to Step 4
4	1 Completely clean the entire engine and surrounding components. 2 Operate the vehicle for several kilometers, miles, at normal operating temperature and at varying speeds. 3 Park the vehicle on a level surface, over a large sheet of paper or other clean surface. 4 Wait 15 minutes. 5 Identify the type of fluid, and the approximate location of the leak. Can you identify the type of fluid and the approximate location of the leak?	Go to Step 10	Go to Step 5
5	1 Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. 2 Inspect for leaks at the following locations: • Sealing surfaces • Fittings • Cracked or damaged components Can you identify the type of fluid and the approximate location of the leak?	Go to Step 10	Go to Step 6

Oil Leak Diagnosis

6	1 Completely clean the entire engine and surrounding components. 2 Apply an aerosol-type powder, baby powder, foot powder, etc., to the suspected area. 3 Operate the vehicle for several kilometers, miles, at normal operating temperature and at varying speeds. 4 Identify the type of fluid, and the approximate location of the leak, from the discolorations in the powder surface. Can you identify the type of fluid and the approximate location of the leak?	Go to Step 10	Go to Step 7
7	1 Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. 2 Inspect for leaks at the following locations: • Sealing surfaces • Fittings • Cracked or damaged components Can you identify the type of fluid and the approximate location of the leak?	Go to Step 10	Go to Step 8
8	Use the *J 28428-E* High-Intensity Black Light Kit in order to identify the type of fluid, and the approximate location of the leak. Refer to the manufacturer's instructions when using the tool. Can you identify the type of fluid and the approximate location of the leak?	Go to Step 10	Go to Step 9
9	1 Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. 2 Inspect for leaks at the following locations: • Sealing surfaces • Fittings • Cracked or damaged components Can you identify the type of fluid and the approximate location of the leak?	Go to Step 10	System OK

Oil Leak Diagnosis

10	1 Inspect the engine for mechanical damage. Special attention should be shown to the following areas: • Higher than recommended fluid levels • Higher than recommended fluid pressures • Plugged or malfunctioning fluid filters or pressure bypass valves • Plugged or malfunctioning engine ventilation system • Improperly tightened or damaged fasteners • Cracked or porous components • Improper sealants or gaskets, where required • Improper sealant or gasket installation • Damaged or worn gaskets or seals • Damaged or worn sealing surfaces 2 Inspect the engine for customer modifications. Is there mechanical damage, or customer modifications to the engine?	Go to Step 11	System OK
11	Repair or replace all damaged or modified components. Does the engine still leak oil?	Go to Step 1	System OK

Oil Pressure Diagnosis and Testing

1 SPECIAL TOOLS

1.1 EN 21867 Pressure Gauge

1.2 EN-21867-16 Oil Pressure Adapter

2 OIL PRESSURE DIAGNOSIS AND TESTING

2.1 With the vehicle on a level surface, run the vehicle for a few minutes. Allow adequate drain down time, 2–3 minutes, and measure the oil level.

2.2 If required, add the recommended grade engine oil and fill the crankcase until the oil level measures full on the oil level indicator.

2.3 Run the engine briefly, 10–15 seconds, and verify low or no oil pressure on the vehicle gauge or light.

2.4 Listen for a noisy valve train or a knocking noise.

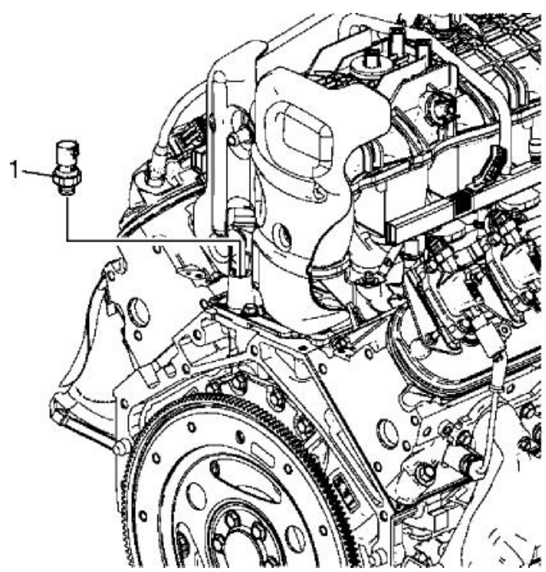
2.5 Inspect for the following conditions:

2.5.1 Oil diluted by water or glycol antifreeze

2.5.2 Refer to Coolant in Engine Oil

2.5.3 Foamy oil, which may be caused by a cut or damaged oil pump screen O-ring seal

2.6 Remove the oil pressure sensor (1)



2.7 Install the EN-21867-16 adapter (2) and EN-21867 pressure gauge (1), or equivalent.

Oil Pressure Diagnosis and Testing

2.8 Run the engine and measure the engine oil pressure.

2.9 Compare the readings to Engine Mechanical Specifications.

2.10 **If the engine oil pressure is below specifications, inspect the engine for 1 or more of the following conditions:**

2.10.1 Oil pump worn or dirty. Refer to Oil Pump Cleaning and Inspection.

2.10.2 Oil pump-to-engine block bolts loose. Refer to Oil Pump, Screen and Crankshaft Oil Deflector Installation

2.10.3 Oil pump screen loose, plugged, or damaged

2.10.4 Oil pump screen O-ring seal missing or damaged

2.10.5 Excessive debris in the oil pan and/or oil filters (possibly indicating internal engine damage).

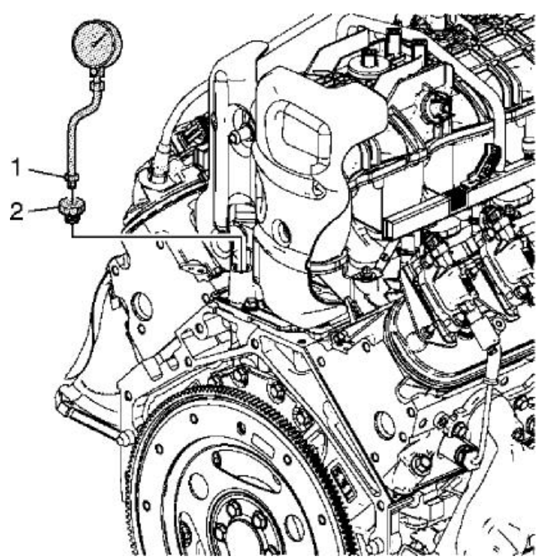
2.10.6 Malfunctioning oil pump pressure relief valve

2.10.7 Excessive bearing clearance and/or bearing damage - refer to Crankshaft and Bearing Cleaning and Inspection and Camshaft and Bearings Cleaning and Inspection

2.10.8 Cracked, porous, or restricted oil galleries

2.10.9 Oil gallery plugs missing or incorrectly installed. Refer to Engine Block Plug Installation

2.10.10 Improper operation of the active fuel management oil pressure relief valve - refer to Oil Pressure Relief Valve Diagnosis and Testing.



Engine Cranks But Does NOT Run

1 DIAGNOSTIC REPRESENTS MORE THAN ONE DOCUMENT. IN ORDER TO PROVIDE THE MOST ACCURATE INFORMATION, PLEASE SELECT A DOCUMENT FROM THE FOLLOWING CHOICES:

1.1 Engine Cranks But Does Not Run (LC8\FHZ)

1.2 Engine Cranks But Does Not Run (Without LC8)

1.3 Engine Cranks But Does Not Run (LC8\KO7)

Engine Cranks But Does NOT Run (L96 / Gasoline)

1 DIAGNOSTIC INSTRUCTIONS

1.1 Review *STRATEGY BASED DIAGNOSIS* for an overview of the diagnostic approach.

1.2 Perform the *DIAGNOSTIC SYSTEM CHECK* prior to using this diagnostic procedure.

2 CIRCUIT/SYSTEM DESCRIPTION

This Engine Cranks but Does Not Run diagnostic is an organized approach to identify a condition which causes the engine to crank but does not continue to run. This diagnostic directs the service technician to the appropriate system diagnosis. This diagnostic assumes the vehicle system voltage levels are adequate for starter motor operation. Refer to Battery Inspection/Test and Engine Cranks Slowly. The fuel level supply must be adequate, and the fuel quality must be able to sustain the combustion process.

3 DIAGNOSTIC AIDS

3.1 Inspect for any of the following conditions:

3.1.1 Insufficient fuel can cause a no start condition. Thoroughly inspect the fuel delivery system for sufficient fuel volume to the fuel injectors. Inspect the fuel supply components for partial blockage or restrictions.

3.1.2 Fuel injectors with partially blocked and restricted nozzles, or a malfunctioning solenoid, can cause a no start condition.

3.1.3 There may be fuel spray at the fuel injectors and the indicated fuel pressure may be correct, yet there may not be enough fuel to start the engine. If the fuel injectors and the injector circuit are OK and fuel spray is detected, the fuel injector ON time may be inadequate. If the engine control module (ECM) receives incorrect inputs from the various information sensors, the fuel delivered by the fuel injectors may be inadequate to start the engine. Observe all the engine data parameters with a scan tool and compare the values indicated with the expected values or the values from a known good vehicle.

3.1.4 Observe the Engine Speed parameter while cranking the engine. The scan tool should indicate a steady 200–300 RPM while cranking. If erratic values such as sudden spikes in the engine speed are displayed, the engine reference signal is not stable enough for the engine to start and run properly.

3.1.5 Inspect the engine for good secure electrical grounds.

3.1.6 If the engine almost starts and then stalls, inspect for an open in the ground circuits of the CKP sensor and the camshaft position (CMP) sensor.

3.1.7 Water or foreign material in the fuel can cause a no start or engine will not stay running condition. During freezing weather water can freeze inside the fuel system. The engine may start after 30 minutes in a heated repair shop. The malfunction may not recur until parked overnight in freezing temperatures. Extreme weather conditions can cause contaminated fuel to prevent the vehicle from starting.

3.1.8 A vehicle that starts and runs after being brought to the repair shop for a no start condition may have an ignition system that is susceptible to moisture. Spray water on the ignition system components and the wiring in order to verify for an engine starting or will not stay running concern.

3.1.9 When disconnecting electrical connectors or removing fuses and relays, always inspect electrical terminals for corrosion and for adequate terminal tension.

3.1.10 Use the *J 35616* GM Approved Terminal Test Kit for any test that requires probing the underhood electrical center terminals, component wire harness terminals, or the controller wire harness terminals. Inspect for any of the following conditions:

4 REFERENCE INFORMATION

4.1 Schematic Reference

4.1.1 Engine Controls Schematics

4.2 Connector End View Reference

4.2.1 Component Connector End Views

4.2.2 Electrical Center Identification Views

4.3 Electrical Information Reference

4.3.1 Circuit Testing

4.3.2 Connector Repairs

4.3.3 Testing for Intermittent Conditions and Poor Connections

4.3.4 Wiring Repairs

4.4 DTC Type Reference

4.4.1 Powertrain Diagnostic Trouble Code (DTC) Type Definitions

4.5 Scan Tool Reference

4.5.1 Control Module References for scan tool information

4.6 Special Tools

4.6.1 CH-48027 Digital Pressure Gauge

4.6.2 J 35616 GM Approved Terminal Test Kit

4.6.3 J 35616-A/BT-8637 Connector Test Adapter Kit

4.6.4 J 43244Relay Puller Pliers

Engine Cranks But Does NOT Run (L96 / Gasoline)

5 CIRCUIT/SYSTEM VERIFICATION

5.1 Engine cranking for 15 seconds; observe the DTC information with a scan tool. Verify that DTC P0117, P0118, P0122, P0123, P0201–P0208, P0222, P0223, P0300–P0308, P0335, P0336, P0351–P0358, P0562, P0563, P0601– P0604, P0606, P0607, P062F, P0633, P0685, P0690, P1631, P1682, or P2610 is not set.

⇒ If any DTCs are set, refer to *DIAGNOSTIC TROUBLE CODE (DTC) LIST*.

5.2 Ignition ON; view the security indicator. The security indicator should not remain illuminated after the vehicle bulb check has completed.

⇒ If the security indicator remains illuminated after the bulb check, refer to *DIAGNOSTIC TROUBLE CODE (DTC) LIST* and diagnose any theft deterrent DTCs set as current.

5.3 Engine cranking; observe the scan tool Engine Speed parameter. The scan tool should indicate an engine speed greater than 0 RPM.

⇒ If the engine speed is 0 RPM, refer to DTC P0335 or DTC P0336 for further diagnosis.

Note: Additional DTCs may set when using the fuel pump output control.

5.4 Ignition ON; command the fuel pump ON with a scan tool. You should hear the fuel pump turn ON.

⇒ If the fuel pump does not turn ON, refer to OEM Service Manual for fuel system diagnosis.

5.5 Ignition OFF; install the CH-48027 Digital Pressure Gauge.

Note:
- The fuel pump may need to be commanded ON several times in order to obtain the highest possible fuel pressure.
- Do NOT start the engine for this test.

5.6 Ignition ON, command the fuel pump ON with a scan tool. The fuel pressure should be between 345–414 kPa (50–60 psi).

⇒ If not within the specified range, refer to OEM Service Manual for fuel system diagnosis.

5.7 Verify the following conditions do not exist:

5.7.1 Collapsed air intake duct to the throttle body

5.7.2 Restricted air filter element

5.7.3 Spark plugs for being fouled

5.7.4 A skewed manifold absolute pressure (MAP) sensor—Refer to DTC P0106.

5.7.5 A skewed engine coolant temperature (ECT) sensor—Refer to DTC P0116.

5.7.6 Exhaust system restricted—Refer to OEM Service Manual.

5.7.7 Fuel contamination—Refer to *ALCOHOL/CONTAMINANTS-IN-FUEL DIAGNOSIS.*

5.7.8 Engine mechanical condition—Refer to *SYMPTOMS - ENGINE MECHANICAL*

6 REPAIR INSTRUCTIONS

6.1 Perform the *DIAGNOSTIC REPAIR VERIFICATION*after completing the diagnostic procedure.

Engine Cranks But Does NOT Run (LC8 / Dedicated CNG)

1 DIAGNOSTIC INSTRUCTIONS

1.1 Review *STRATEGY BASED DIAGNOSIS* for an overview of the diagnostic approach.

1.2 Perform the *DIAGNOSTIC SYSTEM CHECK* prior to using this diagnostic procedure.

2 CIRCUIT/SYSTEM DESCRIPTION

This Engine Cranks but Does Not Run diagnostic is an organized approach to identify a condition which causes the engine to crank but does not continue to run. This diagnostic directs the service technician to the appropriate system diagnosis. This diagnostic assumes the vehicle system voltage levels are adequate for starter motor operation. Refer to Battery Inspection/Test and Engine Cranks Slowly. The fuel level supply must be adequate, and the fuel quality must be able to sustain the combustion process.

3 DIAGNOSTIC AIDS

3.1 Inspect for any of the following conditions:

3.1.1 An open Ignition/Injector fuse may prevent the engine from starting and/or continuing to run. This engine application uses 2 fuses, one for each cylinder bank, to supply ignition 1 voltage to the ignition module/coil assemblies and also to the fuel injectors. If either fuse is open, ignition spark and fuel injection spray will be lost for the entire cylinder bank affected.

3.1.2 Insufficient fuel can cause a no start condition. Verify that the 1/4 turn isolation valve and all 4 CNG fuel tank manual shut-off valves are ON. Thoroughly inspect the fuel supply lines and components for partial blockage or restrictions.

3.1.3 Fuel injectors with partially blocked and restricted nozzles, or a malfunctioning solenoid, can cause a no start condition.

3.1.4 There may be fuel spray at the fuel injectors and the indicated fuel pressure may be correct, yet there may not be enough fuel to start the engine. If the fuel injectors and the injector circuit are OK and fuel spray is detected, the fuel injector ON time may be inadequate. If the engine control module (ECM) receives incorrect inputs from the various information sensors, the fuel delivered by the fuel injectors may be inadequate to start the engine. Observe all the engine data parameters with a scan tool and compare the values indicated with the expected values or the values from a known good vehicle.

3.1.5 Observe the Engine Speed parameter while cranking the engine. The scan tool should indicate a steady 200–300 RPM while cranking. If erratic values such as sudden spikes in the engine speed are displayed, the engine reference signal is not stable enough for the engine to start and run properly.

3.1.6 Inspect the engine for good secure electrical grounds.

3.1.7 If the engine almost starts and then stalls, inspect for an open in the ground circuits of the crankshaft position sensor and the camshaft position sensor.

3.1.8 A vehicle that starts and runs after being brought to the repair shop for a no start condition may have an ignition system that is susceptible to moisture. Spray water on the ignition system components and the wiring in order to verify for an engine starting or will not stay running concern.

3.1.9 When disconnecting electrical connectors or removing fuses and relays, always inspect electrical terminals for corrosion and for adequate terminal tension

3.1.10 Use the *J 35616* GM Approved Terminal Test Kit for any test that requires probing the underhood electrical center terminals, component wire harness terminals, or the controller wire harness terminals.

4 REFERENCE INFORMATION

4.1 Schematic Reference

4.1.1 Engine Controls Schematics

4.2 Connector End View Reference

4.2.1 Component Connector End Views

4.2.2 Electrical Center Identification Views

4.3 Electrical Information Reference

4.3.1 Circuit Testing

4.3.2 Connector Repairs

4.3.3 Testing for Intermittent Conditions and Poor Connections

4.3.4 Wiring Repairs

4.4 DTC Type Reference

4.4.1 Powertrain Diagnostic Trouble Code (DTC) Type Definitions

4.5 Scan Tool Reference

4.5.1 Control Module References for scan tool information

4.6 Special Tools

4.6.1 CH-48027 Digital Pressure Gauge

4.6.2 J 35616 GM Approved Terminal Test Kit

4.6.3 J 35616-A/BT-8637 Connector Test Adapter Kit

Engine Cranks But Does NOT Run (LC8 / Dedicated CNG)

4.6.4 J 26792 HEI Spark Tester

5 CIRCUIT/SYSTEM VERIFICATION

5.1 Engine cranking for 15 seconds; observe the DTC information with a scan tool. Verify that DTC P0117, P0118, P0122, P0123, P0201–P0208, P0222, P0223, P0300–P0308, P0335, P0336, P0351–P0358, P0562, P0563, P0601–P0604, P0606, P0607, P062F, P0633, P0685, P0690, P1631, P1682, or P2610 is not set.

⇒If any DTCs are set, refer to *DIAGNOSTIC TROUBLE CODE (DTC) LIST*.

5.2 Ignition ON, view the security indicator. The security indicator should not remain illuminated after the vehicle bulb check has completed.

⇒If the security indicator remains illuminated after the bulb check, refer to *DIAGNOSTIC TROUBLE CODE (DTC) LIST*, and diagnose any theft deterrent DTCs set as current.

5.3 Engine cranking, observe the scan tool Engine Speed parameter. The scan tool should indicate an engine speed greater than 0 RPM.

⇒If the engine speed is 0 RPM, refer to DTC P0335 or DTC P0336 for further diagnosis.

5.4 Ignition OFF, connect a *J 26792* HEI Spark Tester onto the boot of a spark plug wire and ground for each cylinder bank of the engine.

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

5.5 While cranking the engine, verify that both spark testers spark.

⇒If the spark tester does not spark for any cylinder tested, refer to *ELECTRONIC IGNITION SYSTEM*

DIAGNOSIS. **Note:** Additional DTCs may set when using the fuel pump relay output control.

5.6 Ignition ON, command the fuel pump relay ON with a scan tool. You should hear the high pressure lock-out solenoids energize.

⇒If the high pressure lock-out solenoids do not energize, refer to OEM Service Manual for fuel system diagnosis.

5.7 Ignition OFF; install the *CH-48027* Digital Pressure Gauge.

Note:

- Before verifying fuel pressure, allow the engine to cool until the engine coolant temperature is below 60°C (150°F). Coolant temperatures higher than 60°C (150°F) will result in higher than normal fuel pressure, due to hot soak fuel boiling. If the fuel pressure reading is taken while hot soak fuel boiling is present, pressure readings may exceed 930 kPa(135 psi) and will not be accurate.
- Do NOT start the engine.

- The fuel pump relay may need to be commanded ON several times in order to obtain the highest possible fuel pressure.

5.8 Ignition ON, command the fuel pump ON with a scan tool. The fuel pressure should be between 620–758 kPa (90–110 psi).

⇒If not within the specified range, refer to OEM Service Manual for fuel system diagnosis.

5.9 Verify the following conditions do not exist:

5.9.1 Collapsed air intake duct to the throttle body

5.9.2 Restricted air filter element

5.9.3 Gas or oil fouled spark plugs—Refer to Spark Plug Inspection

5.9.4 A skewed manifold absolute pressure (MAP) sensor—Refer to DTC P0106.

5.9.5 A skewed engine coolant temperature (ECT) sensor—Refer to DTC P0116.

5.9.6 Restricted exhaust system—Refer to OEM Service Manual.

5.9.7 An engine mechanical condition, for example, worn timing chain or low compression—Refer to *SYMPTOMS - ENGINE MECHANICAL*.

6 REPAIR INSTRUCTIONS

6.1 Perform the *DIAGNOSTIC REPAIR VERIFICATION*after completing the diagnostic procedure.

Engine Cranks But Does NOT Run (LC8 / LPG)

1 DIAGNOSTIC INSTRUCTIONS

1.1 Review *STRATEGY BASED DIAGNOSIS* for an overview of the diagnostic approach.

1.2 Perform the *DIAGNOSTIC SYSTEM CHECK* prior to using this diagnostic procedure.

2 CIRCUIT/SYSTEM DESCRIPTION

This Engine Cranks but Does Not Run diagnostic is an organized approach to identify a condition which causes the engine to crank but does not continue to run. This diagnostic directs the service technician to the appropriate system diagnosis. This diagnostic assumes the vehicle system voltage levels are adequate for starter motor operation. Refer to Battery Inspection/Test and Engine Cranks Slowly. The fuel level supply must be adequate, and the fuel quality must be able to sustain the combustion process.

3 DIAGNOSTIC AIDS

3.1 Inspect for any of the following conditions:

3.1.1 An open Ignition/Injector fuse may prevent the engine from starting and/or continuing to run. This engine application uses 2 fuses, one for each cylinder bank, to supply ignition 1 voltage to the ignition module/coil assemblies and also to the fuel injectors. If either fuse is open, ignition spark and fuel injection spray will be lost for the entire cylinder bank affected.

3.1.2 Fuel injectors with partially blocked and restricted nozzles, or a malfunctioning solenoid, can cause a no start condition.

3.1.3 There may be fuel spray at the fuel injectors and the indicated fuel pressure may be correct, yet there may not be enough fuel to start the engine. If the fuel injectors and the injector circuit are OK and fuel spray is detected, the fuel injector ON time may be inadequate. If the engine control module (ECM) receives incorrect inputs from the various information sensors, the fuel delivered by the fuel injectors may be inadequate to start the engine. Observe all the engine data parameters with a scan tool and compare the values indicated with the expected values or the values from a known good vehicle.

3.1.4 Observe the Engine Speed parameter while cranking the engine. The scan tool should indicate a steady 200–300 RPM while cranking. If erratic values such as sudden spikes in the engine speed are displayed, the engine reference signal is not stable enough for the engine to start and run properly.

3.1.5 Inspect the engine for good secure electrical grounds.

3.1.6 If the engine almost starts and then stalls, inspect for an open in the ground circuits of the crankshaft position sensor and the camshaft position sensor.

3.1.7 A vehicle that starts and runs after being brought to the repair shop for a no start condition may have an ignition system that is susceptible to moisture. Spray water on the ignition system components and the wiring in order to verify for an engine starting or will not stay running concern.

3.1.8 When disconnecting electrical connectors or removing fuses and relays, always inspect electrical terminals for corrosion and for adequate terminal tension.

3.1.9 Use the *J 35616* GM Approved Terminal Test Kit for any test that requires probing the underhood electrical center terminals, component wire harness terminals, or the controller wire harness terminals.

4 REFERENCE INFORMATION

4.1 Schematic Reference

4.1.1 Engine Controls Schematics

4.2 Connector End View Reference

4.2.1 Component Connector End Views

4.2.2 Electrical Center Identification Views

4.3 Electrical Information Reference

4.3.1 Circuit Testing

4.3.2 Connector Repairs

4.3.3 Testing for Intermittent Conditions and Poor Connections

4.3.4 Wiring Repairs

4.4 DTC Type Reference

4.4.1 Powertrain Diagnostic Trouble Code (DTC) Type Definitions

4.5 Scan Tool Reference

4.5.1 Control Module References for scan tool information

4.6 Special Tools

4.6.1 J 26792 HEI Spark Tester

4.6.2 J 35616 GM Approved Terminal Test Kit

4.6.3 J 35616-A/BT-8637 Connector Test Adapter Kit

5 CIRCUIT/SYSTEM VERIFICATION

5.1 Engine cranking for 15 seconds; observe the DTC information with a scan tool. Verify that DTC P0117, P0118, P0122, P0123, P0201–P0208, P0222, P0223, P0300–P0308, P0335, P0336, P0351–P0358, P0562, P0563, P0601–P0604, P0606, P0607, P062F, P0633, P0685, P0690, P1631, P1682, or P2610 is not set.

⇒If any DTCs are set, refer to *DIAGNOSTIC TROUBLE CODE (DTC) LIST*.

5.2 Ignition ON, observe the security indicator. The security indicator should illuminate momentarily and then go out.

⇒If the security indicator stays On or is flashing, review the scan tool DTC information for Immobilizer system DTCS—Refer to *DIAGNOSTIC TROUBLE CODE (DTC) LIST*.

5.3 Engine cranking; observe the scan tool Engine Speed parameter. The scan tool should indicate an engine speed greater than 0 RPM.

⇒If the engine speed is 0 RPM, refer to DTC P0335 or DTC P0336 for further diagnosis.

5.4 Ignition OFF, connect a J 26792 HEI Spark Tester onto the boot of a spark plug wire and ground for each cylinder bank of the engine.

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

5.5 While cranking the engine, verify that both spark testers spark.

⇒If either spark tester does not spark, refer to *ELECTRONIC IGNITION SYSTEM DIAGNOSIS*.

Note: Additional DTCs may set when using the fuel pump relay output control.

5.6 Ignition ON; command the Fuel Pump Relay ON with a scan tool. You should hear the fuel pump relay, the fuel supply solenoid, and the fuel return solenoid click as they energize.

⇒If you do not hear the fuel pump relay click, refer to OEM Service Manual for fuel pump electrical circuit diagnosis.

⇒If you hear the fuel pump relay click, but do not hear the fuel supply solenoid and fuel return solenoids click, refer to OEM Service Manual for fuel system diagnosis.

5.7 Verify the operation of the fuel system—Refer to OEM Service Manual for fuel system diagnosis.

5.8 Verify the following conditions do not exist:

5.8.1 Collapsed air intake duct to the throttle body

5.8.2 Restricted air filter element

5.8.3 Gas or oil fouled spark plugs—Refer to Spark Plug Inspection

5.8.4 A skewed manifold absolute pressure (MAP) sensor—Refer to DTC P0106.

5.8.5 A skewed engine coolant temperature (ECT) sensor—Refer to DTC P0116.

5.8.6 Restricted exhaust system—Refer to OEM Service Manual.

5.8.7 An engine mechanical condition—Refer to *SYMPTOMS - ENGINE MECHANICAL*

Engine Cranks But Does NOT Run (LC8 / LPG)

6 REPAIR INSTRUCTIONS

6.1 Perform the *DIAGNOSTIC REPAIR VERIFICATION*after completing the diagnostic procedure.

Engine Compression Test

1 ENGINE COMPRESSION TEST

1.1 Charge the battery if the battery is not fully charged.

1.2 Disable the ignition system.

1.3 Disable the fuel injection system by removing the injector fuse or removing the injector electrical connectors.

1.4 Remove all spark plugs.

1.5 Turn the ignition to the ON position.

1.6 Depress the accelerator pedal to position the throttle plate wide open.

1.7 Start with the compression gauge at zero and crank the engine through 4 compression strokes, 4 puffs.

1.8 Measure the compression for each cylinder. Record the readings.

1.9 If a cylinder has low compression, inject approximately 15 ml (1 tablespoon) of engine oil into the combustion chamber through the spark plug hole. Measure the compression again and record the reading.

1.10 The minimum compression in any 1 cylinder should not be less than 70 percent of the highest cylinder. No cylinder should read less than 690 kPa (100 psi). For example, if the highest pressure in any 1 cylinder is 1 035 kPa (150 psi), the lowest allowable pressure for any other cylinder would be 725 kPa (105 psi). (1 035 x 70% = 725) (150 x 70% = 105).

1.10.1 Normal — Compression builds up quickly and evenly to the specified compression for each cylinder.

1.10.2 Piston Rings Leaking — Compression is low on the first stroke. Compression builds up with the following strokes, but does not reach normal. Compression improves considerably when you add oil.

1.10.3 Valves Leaking — Compression is low on the first stroke. Compression usually does not build up on the following strokes. Compression does not improve much when you add oil.

1.10.4 If 2 adjacent cylinders have lower than normal compression, and injecting oil into the cylinders does not increase the compression, the cause may be a head gasket leaking between the cylinders.

Engine Noise on Start-Up, but Only Lasting a Few Seconds

Cause	Correction
Incorrect oil filter without anti-drainback feature	Install the correct oil filter.
Incorrect oil viscosity	1) Drain the oil. 2) Install the correct viscosity oil.
High valve lifter leak down rate	Replace the lifters, as required.
Worn crankshaft thrust bearing	3) Inspect the crankshaft end play. 4) Inspect the thrust bearing and crankshaft. 5) Repair or replace, as required.
Damaged or faulty oil filter bypass valve The bypass valve is now internal to the oil filter.	6) Inspect the oil filter bypass valve for proper operation. 7) Repair or replace, as required.

Engine Noise Under Load

Cause	Correction
Low oil pressure	8) Perform an oil pressure test. Refer to Oil Pressure Diagnosis and Testing. 9) Repair or replace damaged components, as required.
Detonation or spark knock	Verify the correct operation of the ignition controls.
Loose torque converter bolts	4) Inspect the torque converter bolts and flex plate. 5) Repair, as required.
Cracked flex plate– automatic transmission	6) Inspect the flex plate bolts and flex plate. 7) Repair, as required.
Excessive connecting rod bearing clearance	Inspect the following components and repair, as required: - Connecting rod bearings - Connecting rods - Crankshaft
Excessive crankshaft bearing clearance	Inspect the following components and repair, as required: - Crankshaft bearings - Crankshaft journals - Cylinder block crankshaft bearing bore

Engine Will Not Crank - Crankshaft Will Not Rotate

Cause	Correction
Seized accessory drive system component	8) Remove the accessory drive belts. 9) Confirm that the engine will rotate. Rotate the crankshaft by hand at the crankshaft balancer or flex plate location. 10) Repair or replace the components, as required.
Seized automatic transmission torque converter	11) Remove the torque converter-to-flex plate bolts. 12) Confirm that the engine will rotate. Rotate the crankshaft by hand at the crankshaft balancer or flex plate location. 13) Repair or replace the components, as required.
Broken timing chain	14) Inspect the timing chain and sprockets. 15) Repair or replace the components, as required.
Seized timing chain or timing sprockets	10) Inspect the timing chain and sprockets for foreign material or a seized chain. 11) Repair or replace the components, as required.
Seized or broken camshaft	16) Inspect the camshaft and the camshaft bearings. 17) Repair or replace the components, as required.
Bent valve in the cylinder head	18) Inspect the valves and the cylinder heads. 19) Repair or replace the components, as required.
Seized oil pump	20) Inspect the oil pump assembly. 21) Repair or replace, as required.
Hydraulically locked cylinder - Coolant/antifreeze in the cylinder - Oil in the cylinder - Fuel in the cylinder	22) Remove the spark plugs and inspect for fluid in the cylinder. When rotating the engine with the spark plugs removed, the piston, on compression stroke, will push fluid from the combustion chamber. Refer to Coolant in Combustion Chamber . 23) Inspect for failed/broken head gaskets. 24) Inspect for a cracked engine block or cylinder head. 25) Inspect for a sticking fuel injector. 26) Repair or replace the components, as required.
Material in the cylinder - Broken valve - Broken piston rings - Piston material - Foreign material	12) Inspect the cylinder for damaged components and/or foreign materials. 13) Repair or replace the components, as required.
Seized crankshaft or connecting rod bearings	27) Inspect crankshaft and connecting rod bearings. 28) Repair or replace the components, as required.
Bent or broken connecting rod	29) Inspect the connecting rods. 30) Replace the piston and pin as an assembly, as required.
Broken crankshaft	31) Inspect the crankshaft. 32) Repair or replace the components, as required.

Lower Engine Noise, Regardless of Engine Speed

Cause	Correction
Low oil pressure	14) Perform an oil pressure test. Refer to Oil Pressure Diagnosis and Testing. 15) Repair or replace damaged components, as required.
Worn accessory drive components Abnormalities such as severe cracking, bumps or missing areas in the accessory drive belt and/or misalignment of system components.	33) Inspect the accessory drive system. 34) Repair or replace, as required.
Loose or damaged crankshaft balancer	35) Inspect the crankshaft balancer. 36) Repair or replace, as required.
Detonation or spark knock	Verify the correct operation of the ignition controls system. Refer to Symptoms - Engine Controls.
Loose torque converter bolts	37) Inspect the torque converter bolts and flex plate. 38) Repair or replace, as required.
Loose or damaged flywheel or flex plate	Repair or replace the flywheel or flex plate.
Oil pump screen loose, damaged, or restricted	39) Inspect the oil pump screen. 40) Repair or replace, as required.
Excessive piston-to-cylinder bore clearance	41) Inspect the piston and cylinder bore. 42) Repair or replace, as required.
Excessive piston pin-to-bore clearance	43) Inspect the piston, pin, and connecting rod. 44) Replace the piston and pin as an assembly, as required.
Excessive connecting rod bearing clearance	Inspect the following components and repair, as required: - Connecting rod bearings - Connecting rods - Crankshaft - Crankshaft journals
Excessive crankshaft bearing clearance	Inspect the following components and repair, as required: - Connecting rod bearings - Crankshaft journals
Incorrect piston, piston pin, and connecting rod installation Pistons must be installed with the mark or dimple on the top of the piston facing the front of the engine. Piston pins must be centered in the connecting rod pin bore.	16) Verify the pistons, piston pins and connecting rods are installed correctly. Refer to Piston, Connecting Rod, and Bearing Installation. 17) Repair, as required.

Symptoms – Engine Controls (L96 – Gasoline)

1 DIAGNOSTIC INSTRUCTIONS

1.1 Review *STRATEGY BASED DIAGNOSIS* for an overview of the diagnostic approach.

1.2 Perform the *DIAGNOSTIC SYSTEM CHECK* prior to using this diagnostic procedure.

2 SYMPTOMS DESCRIPTION

Symptoms cover conditions that are not covered DTCs. Certain conditions can cause multiple symptoms. These conditions are listed together under Symptoms Testing. Conditions that may only cause certain symptoms are listed separately under Additional Symptoms Test. Perform the Symptoms Testing before using the Additional Symptoms Tests. Poor Fuel Fill Quality test may be performed separately from the Symptoms Testing and Additional Symptoms Tests procedures.

3 SYMPTOMS DEFINITION

3.1 **Backfire:** Fuel ignites in the intake manifold or in the exhaust system, making a loud popping noise.

3.2 **Cuts Out, Misses:** A steady pulsation or jerking that follows engine speed, which is usually more pronounced as the engine load increases. This condition is not normally felt above 1500RPM or 48km/h (30mph). The exhaust has a steady spitting sound at idle or at low speed.

3.3 **Engine Control Module (ECM) Reduced Engine Power:** The ECM illuminates the Reduced engine Power lamp and will limit engine power under potential engine/vehicle damaging or emissions related conditions. A DTC may not be set.

3.4 **Detonation/Spark Knock:** A mild to severe ping which usually occurs worse while under acceleration. The engine makes sharp metallic knocks that change with throttle opening.

3.5 **Dieseling, Run-On:** The engine continues to run after the key is turned OFF, but runs very rough.

3.6 **Hard Start:** Engine cranks OK, but does not start for a long time. The vehicle does eventually run, or may start but immediately stalls.

3.7 **Hesitation, Sag, Stumble:** Momentary lack of response as the accelerator is pushed down. This condition can occur at any vehicle speed. This condition is usually more pronounced when first trying to make the vehicle move, as from a stop. This condition may cause the engine to stall in severe conditions.

3.8 **Lack of Power, Sluggishness, or Sponginess:** The engine delivers less than expected power. Little or no increase in speed when the accelerator pedal is pushed down part way

3.9 **Poor Fuel Economy:** Fuel economy, as measured by an actual road test, is noticeably lower than expected. Also, the fuel economy is noticeably lower than it was on this vehicle at one time, as previously shown by an actual road test.

3.10 **Poor Fuel Fill Quality:** Difficulty when refueling the vehicle.

3.11 **Rough, Unstable, or Incorrect Idle and Stalling:** The engine runs unevenly at idle. If severe, the engine or the vehicle may shake. Engine idle may vary in speed. Either condition may be severe enough to stall the engine.

3.12 **Surges/Chuggles:** Engine power variation under steady throttle or cruise. Feels like the vehicle speeds up and slows down with no change in the accelerator pedal position.

4 SYMPTOMS VERIFICATION

Before using the Symptom tables, perform the following inspections:

4.1 Verify the engine control module (ECM) and malfunction indicator lamp (MIL), if equipped, are operating correctly.

4.2 Verify there are no DTCs that are stored

4.3 Verify the scan tool data is within a normal operating range.

4.4 Verify the customer concern.

4.5 Perform the Visual/Physical Inspection in this section. The visual/physical inspection is extremely important, and can lead to correcting a condition without additional testing. It may also help reveal the cause of an intermittent condition.

5 IDENTIFYING INTERMITTENT CONDITIONS

Many intermittent conditions occur with harness or connector movement due to engine torque, rough pavement, vibration or physical movements of a component. Refer to the following for a list of issues that may cause an intermittent condition:

5.1 Moisture and water intrusion in connectors, terminals, and components

5.2 Incomplete connector mating

5.3 Poor terminal contact

5.4 High circuit or component resistance—High resistance can include any resistance, regardless of the amount, which can interrupt the operation of the component.

5.5 Harness that is too short or tight

5.6 Wire insulation that is chaffed or cut

5.7 High or low ambient temperature

5.8 High or low engine coolant temperatures

5.9 High under hood temperatures

5.10 Heat buildup in component or circuit due to circuit resistance, poor terminal contact, or high electrical load

5.11 High or low system voltage

5.12 High vehicle load conditions

5.13 Rough road surfaces

5.14 Electro-magnetic interference (EMI)/circuit interference from relays, solenoids or other electrical surge

5.15 Incorrect installation of aftermarket, add on accessories

6 VISUAL/PHYSICAL CHECK

6.1 Verify the control module grounds are clean, tight, and correctly located.

6.2 Verify the vacuum hoses are not split or kinked, and are properly connected, as shown on the Vehicle Emission Control Information label.

6.3 Verify the air filter is clean and free from restrictions.

6.4 Verify there is no water intrusion in connector's terminals and components.

6.5 Inspect the air intake ducts for the following conditions:

6.5.1 Collapsed

6.5.2 Damaged areas

6.5.3 Looseness

6.5.4 Incorrect installation

6.5.5 Leaking

6.6 Inspect for air leaks at the throttle body mounting area, the mass air flow (MAF) sensor and intake manifold sealing surfaces.

6.7 Inspect the wiring harness for the following conditions:

6.7.1 Poor connections

6.7.2 Pinches

6.7.3 Cuts

6.8 Inspect for loose, damaged, unseated, or missing sensors/components.

6.9 Inspect the terminals for corrosion and correct contact.

Symptoms – Engine Controls (L96 – Gasoline)

7 SYMPTOMS TESTING

Backfire, Cuts Out/Misses, Detonation/Spark Knock, Dieseling/Run-On, Engine Control Module (ECM) Commanded Reduced Engine Power, Fuel Odor, Hard Start, Hesitation/Sag/Stumble, Lack of Power/Sluggishness/Sponginess, Poor Fuel Economy, Rough, Unstable, or Incorrect Idle and Stalling, or Surges/Chuggles

7.1 Test the fuel system for the following:

7.1.1 Correct fuel system operation and pressure—Refer to OEM Service Manual for fuel system diagnosis.

7.1.2 Incorrectly connected, fuel injectors - verify each injector is connected to the correct fuel injector, harness connector.

7.1.3 Improperly operating or leaking fuel injectors—Refer to *FUEL INJECTOR DIAGNOSIS*.

7.1.4 Poor fuel quality condition—Refer to *ALCOHOL/CONTAMINANTS-IN-FUEL DIAGNOSIS*

7.2 Test the ignition system for the following conditions:

7.2.1 Spark plugs with incorrect heat range or an abnormal condition—Refer to Spark Plug Inspection.

7.2.2 Coolant or oil fouled spark plugs—For diagnosis, refer to Coolant in Combustion Chamber or Oil Consumption Diagnosis.

7.2.3 Weak spark using the J 26792 Spark Tester—Refer to *ELECTRONIC IGNITION SYSTEM DIAGNOSIS*.

7.3 Inspect for the following conditions:

7.3.1 Improperly operating transmission torque converter clutch

7.3.2 Improperly operating A/C compressor

7.3.3 Items that can cause an engine to run rich or lean—Refer to DTC P0171, P0172, P0174, or P0175.

7.3.4 Slow responding heated oxygen sensors (HO2S). The HO2S should respond quickly to different throttle positions—Refer to DTC P0133, P013A-P013F, P014A, P014B, P0153, P1133, or P1153 for more information.

7.3.5 Water intrusion in the HO2S connector

NOTE:the embossed arrows on the mass airflow (MAF) sensor indicate the direction of the intake air flow. The arrows must point toward the engine.

7.3.6 Improper MAF sensor installation

7.3.7 A MAF sensor that is incorrectly installed may cause a hard start. Install the MAF in the proper direction. Refer to Mass Airflow Sensor with Intake Air Temperature Sensor Replacement (Powertrain Integration Service Manual).

7.3.8 Engine oil contaminated by fuel

Symptoms – Engine Controls (L96 – Gasoline)

7.3.9 Split or kinked vacuum hoses

7.3.10 Excessive knock sensor (KS) system spark retard activity—Refer to DTC P0324, P0325, P0326, P0327, P0328, P0330, P0332, or P0333.

7.3.11 Electromagnetic interference (EMI) on the reference circuit, which can cause a misfire condition. You can usually detect EMI with a scan tool by monitoring the engine speed parameter. A sudden increase in the engine speed parameter with little change in actual engine speed indicates that EMI is present. Inspect the high voltage components near the ignition control circuit if a condition exists.

7.3.12 Improperly operating crankcase ventilation valve—Refer to Crankcase Ventilation System Inspection/Diagnosis.

7.3.13 A stuck open evaporative emission (EVAP) canister purge solenoid

7.4 Inspect the exhaust system components for the following conditions:

7.4.1 Physical damage or possible internal failure

7.4.2 Restricted three-way catalytic converters

7.4.3 For more information, refer to OEM Service Manual.

7.5 Inspect the engine cooling system for the following conditions:

7.5.1 Thermostat with incorrect heat range

7.5.2 Improper engine coolant level

7.6 Inspect the engine for the following mechanical conditions:

7.6.1 Excessive oil in the combustion chamber or leaking valve seals

7.6.2 Incorrect cylinder compression

7.6.3 Sticking or leaking valves

7.6.4 Worn camshaft lobes

7.6.5 Incorrect valve timing

7.6.6 Worn rocker arms

7.6.7 Broken valve springs

7.6.8 Excessive carbon buildup in the combustion chambers—Clean the chambers with top engine cleaner, if necessary. Follow the instructions on the can.

7.6.9 Incorrect engine parts

7.7 For more information, refer to *SYMPTOMS - ENGINE MECHANICAL*.

7.8 If the above conditions do not address the symptom, refer to the additional symptoms tests.

8 ADDITIONAL SYMPTOMS TESTS

Detonation/Spark Knock

8.1 Test the engine for an overheating condition.

8.2 Inspect for excessive carbon buildup in the combustion chambers. Clean the chambers with Top Engine Cleaner, if necessary. Follow the instructions on the can.

8.3 If there are no engine mechanical faults, fill the fuel tank with a known high quality fuel that meets the vehicle minimum octane requirements.

9 ENGINE CONTROL MODULE (ECM) COMMANDED REDUCED ENGINE POWER

Under certain conditions the ECM may limit engine power by reducing engine torque and, for some vehicles, fuel pressure as well. For most, but not all of the conditions, the ECM will illuminate the reduced engine power lamp on the instrument panel cluster; however a DTC may not be set. Observe the scan tool Reduced Engine Power History parameter or refer to Engine Control Module Scan Tool Information to determine the reason for the reduced engine power event.

Verify or inspect for the following:

9.1 Vehicle being driven inappropriately. Towing heavy loads up an incline for an extended period of time or operating the vehicle at sustained, excessively high engine speeds may cause the engine oil or coolant to overheat. A repair may not be necessary. Inspect the airflow passageways in front of the engine for obstructions and clear away any debris or foreign material that is found. If no obstructions or conditions are found, review approved driving habits with the customer. The customer may need to operate the vehicle at a higher engine speed to improve cooling system performance, or, at a slower engine speed to reduce engine load.

10 FUEL ODOR

10.1 Inspect for a saturated EVAP canister—Refer to OEM Service Manual.

10.2 Inspect for leaking, damaged, or deteriorated fuel lines and components.

10.3 Inspect for a condition with the internal components of the fuel tank assembly—Refer to OEM Service Manual.

11 HARD START

11.1 Observe the TB Idle Airflow Compensation parameter with a scan tool. A value greater than 80% may indicate an excessive accumulation of deposits in the throttle bore. Inspect the throttle body and bore and clean, if necessary.

11.2 Test the engine coolant temperature (ECT) sensor. Compare the ECT sensor value to the intake air temperature (IAT) sensor value on a cold engine. The ECT and IAT sensor values should be within ± 3°C (5°F). If the ECT sensor is out of range with the IAT sensor, test the resistance of the ECT sensor. Refer to Temperature Versus Resistance for resistance specifications. Replace the ECT sensor if the resistance is not within specification. Refer to Engine Coolant Temperature Sensor Replacement. If the sensor is within the specification, test the ECT circuits for a high resistance.

11.3 Verify that the fuel pump operates and provides adequate pressure for engine startup. The fuel pump should turn ON for 2 s when the ignition is turned to ON. Refer to Fuel System Diagnosis for fuel pressure specifications and testing procedures.

12 HESITATION, SAG, STUMBLE

12.1 Test the fuel pressure. Refer to OEM Service Manual for fuel system diagnosis.

12.2 Test the generator. Refer to OEM Service Manual.

12.3 Test the manifold absolute pressure (MAP) sensor. Refer to DTC P0106.

13 POOR FUEL ECONOMY

13.1 Inspect for heavy loads being carried or towed.

13.2 Inspect for acceleration rate too much or too often.

13.3 Inspect the brake system for brake drag.

13.4 Inspect for incorrect operation of the speedometer.

13.5 Observe the TB Idle Airflow Compensation parameter with a scan tool. A value greater than 80% may indicate an excessive accumulation of deposits in the throttle bore. Inspect the throttle body and bore and clean, if necessary.

14 POOR FUEL FILL QUALITY

14.1 Inspect for restricted vent lines

14.2 Inspect for a stuck closed evaporative emission (EVAP) vent valve

14.3 Inspect for high fuel temperature

14.4 Inspect for a condition with the internal components of the fuel tank assembly

14.5 For more information, refer to OEM Service Manual for Fuel System and Evaporative Emission Control System descriptions.

Symptoms – Engine Controls (L96 – Gasoline)

15 ROUGH, UNSTABLE, OR INCORRECT IDLE AND STALLING

15.1 Observe the TB Idle Airflow Compensation parameter with a scan tool. A value greater than 80% may indicate an excessive accumulation of deposits in the throttle bore. Inspect the throttle body and bore and clean, if necessary.

15.2 Inspect the engine mounts.

16 SURGES/CHUGGLES

16.1 Inspect the mass air flow (MAF) sensor for obstruction, contamination, and damage—Refer to DTC P0101 or P1101 and DTC P0102 or P0103 for more information.

16.2 Inspect for slow responding heated oxygen sensors (HO2S). The HO2S should respond quickly to a change in throttle position. If the HO2S do not respond to different throttle positions, inspect for contamination from fuel, silicon, or the incorrect use of RTV sealant. The sensors may have a white powdery coating and result in a high, but false, signal voltage, which gives a rich exhaust indication. The ECM reduces the amount of fuel delivered to the engine, causing a drivability condition—Refer to DTC P0133, P013A-P013F, P014A, P014B, P0153, P1133, or P1153 for more information.

Symptoms – Engine Controls (LC8 / CNG)

1 DIAGNOSTIC INSTRUCTIONS

1.1 Review *STRATEGY BASED DIAGNOSIS* for an overview of the diagnostic approach.

1.2 Perform the *DIAGNOSTIC SYSTEM CHECK* prior to using this diagnostic procedure.

2 SYMPTOMS DESCRIPTION

Symptoms cover conditions that are not covered by DTCs. Certain conditions can cause multiple symptoms. These conditions are listed together under Symptoms Testing. Conditions that may only cause certain symptoms are listed separately under Additional Symptoms Test. Perform the Symptoms Testing before using the Additional Symptoms Tests.

3 SYMPTOMS DEFINITION

3.1 **Backfire:** Fuel ignites in the intake manifold or in the exhaust system, making a loud popping noise.

3.2 **Cuts Out, Misses**: A steady pulsation or jerking that follows engine speed, which is usually more pronounced as the engine load increases. This condition is not normally felt above 1500 RPM or 48 km/h (30 mph). The exhaust has a steady spitting sound at idle or at low speed.

3.3 **Detonation/Spark Knock:** A mild to severe ping which usually occurs worse while under acceleration. The engine makes sharp metallic knocks that change with throttle opening.

3.4 **Dieseling, Run-On:** The engine continues to run after the key is turned OFF, but runs very rough.

3.5 **Engine Control Module (ECM) Commanded Reduced Engine Power: The** ECM illuminates the Reduced Engine Power lamp and will limit engine power under potential engine damaging or emissions related conditions. A DTC may not be set.

3.6 **Hard Start**: Engine cranks OK, but does not start for a long time. The vehicle does eventually run, or may start but immediately stalls.

3.7 **Hesitation, Sag, Stumble:** Momentary lack of response as the accelerator is pushed down. This condition can occur at any vehicle speed. This condition is usually more pronounced when first trying to make the vehicle move, as **from a stop. This condition may cause the engine to stall in severe conditions.**

3.8 **Lack of Power, Sluggishness, or Sponginess:** The engine delivers less than expected power. Little or no increase in speed when the accelerator pedal is pushed down part way.

3.9 **Poor Fuel Economy:** Fuel economy, as measured by an actual road test, is noticeably lower than expected. Also, the fuel economy is noticeably lower than it was on this vehicle at one time, as previously shown by an actual road test.

3.10 **Reduced Vehicle Range**: The distance that the vehicle can be driven, before running out of fuel, is reduced.

3.11 **Rough, Unstable, or Incorrect Idle and Stalling:** The engine runs unevenly at idle. If severe, the engine or the vehicle may shake. Engine idle may vary in speed. Either condition may be severe enough to stall the engine.

3.12 **Surges/Chuggles:** Engine power variation under steady throttle or cruise. Feels like the vehicle speeds up and slows down with no change in the accelerator pedal position.

4 SYMPTOMS VERIFICATION

Before using the Symptom tables, perform the following inspections:

4.1 Verify that the engine control module (ECM) and malfunction indicator lamp (MIL) are operating correctly.

4.2 Verify that there are no DTCs that are stored.

4.3 Verify that the scan tool data is within a normal operating range.

4.4 Verify the customer concern.

4.5 Perform the Visual/Physical Inspection in this section. The visual/physical inspection is extremely important, and can lead to correcting a condition without additional testing. It may also help reveal the cause of an intermittent condition.

5 Identifying Intermittent Conditions

Many intermittent conditions occur with harness or connector movement due to engine torque, rough pavement, vibration or physical movements of a component. Refer to the following for a list of issues that may cause an intermittent condition:

5.1 Moisture and water intrusion in connectors, terminals, and components

5.2 Incomplete connector mating

5.3 Poor terminal contact

5.4 High circuit or component resistance—High resistance can include any resistance, regardless of the amount, which can interrupt the operation of the component.

5.5 Harness that is too short or tight

5.6 Wire insulation that is chaffed or cut.

5.7 High or low ambient temperature

5.8 High or low engine coolant temperatures

5.9 High underhood temperatures

5.10 Heat build-up in component or circuit due to circuit resistance, poor terminal contact, or high electrical load

5.11 High or low system voltage

5.12 High vehicle load conditions

5.13 Rough road surfaces

5.14 Electro-magnetic interference (EMI)/circuit interference from relays, solenoids or other electrical surge

5.15 Incorrect installation of aftermarket, add on accessories

6 VISUAL/PHYSICAL CHECK

6.1 Verify that the control module grounds are clean, tight, and correctly located.

6.2 Verify that the vacuum hoses are not split or kinked.

6.3 Verify that the air filter is clean and free from restrictions.

6.4 Verify that there is no water intrusion in connectors, terminals, and components.

6.5 Inspect the air intake ducts for the following conditions:

6.5.1 Collapsed

6.5.2 Damaged areas

6.5.3 Looseness

6.5.4 Incorrect installation

6.5.5 Leaking

6.6 Inspect for air leaks at the throttle body mounting area, the mass air flow (MAF) sensor and intake manifold sealing surfaces.

6.7 Inspect the fuel system lines and components for damage or external fuel leaks.

6.8 Inspect the wiring harness for the following conditions:

6.8.1 Poor connections

6.8.2 Pinches

6.8.3 Cuts

6.9 Inspect for loose, damaged, unseated, or missing sensors/components.

6.10 Inspect the terminals for corrosion and correct contact.

7 SYMPTOMS TESTING

Backfire, Cuts Out/Misses, Detonation/Spark Knock, Dieseling/Run-On, Engine Control Module (ECM) Commanded Reduced Engine Power, Hard Start, Hesitation/Sag/Stumble, Lack of Power/Sluggishness/Sponginess, Poor Fuel Economy, Rough, Unstable, or Incorrect Idle and Stalling, or Surges/Chuggles

7.1 Test for the following conditions:

7.1.1 Test the fuel system for the following:

7.1.1.1 Incorrect fuel pressure-refer to OEM Service Manual for fuel system diagnosis.

7.1.1.2 Fuel injectors that are leaking or improperly operating—refer to FUEL INJECTOR DIAGNOSIS

7.2 The ignition system for the following:

7.2.1 Spark plugs with incorrect heat range or an abnormal condition—Refer to Spark Plug Inspection.

7.2.2 Coolant or oil fouled spark plugs—Refer to Loss of Coolant or *SYMPTOMS - ENGINE MECHANICAL*.

7.2.3 Weak spark using the J 26792 HEI Spark Tester—Refer to *ELECTRONIC IGNITION SYSTEM DIAGNOSIS*.

7.3 Inspect for the following conditions:

7.3.1 Improper operation of the transmission torque converter clutch

7.3.2 Improper operation of the A/C compressor

7.3.3 Items that can cause an engine to run rich or lean

7.3.4 Slow responding heated oxygen sensors (HO2S). The HO2S should respond quickly to different throttle positions.

7.3.5 Water intrusion in the HO2S connector

Note: The embossed arrows on the MAF sensor indicate the direction of the intake air flow. The arrows must point toward the engine.

7.3.6 Improper MAF sensor installation. A MAF sensor that is incorrectly installed may cause a hard start. Install the MAF in the proper direction.

7.3.7 Loose or improper MAF sensor connections

7.3.8 Split or kinked vacuum hoses

7.3.9 Excessive knock sensor (KS) system spark retard activity—Refer to DTC P0324, P0325, P0326, P0327, P0328, P0330, P0332, or P0333.

7.3.10 The exhaust system components for the following:

7.3.10.1 Physical damage or possible internal failure

7.3.10.2 Restricted three-way catalytic converters

7.3.11 Electromagnetic interference (EMI) on the reference circuit can cause a misfire condition. You can usually detect EMI with a scan tool by monitoring the engine speed parameter. A sudden increase in the engine speed parameter with little change in actual engine speed indicates that EMI is present. Inspect the high voltage components near the ignition control circuit if a condition exists.

7.3.12 Improper operation of the crankcase ventilation valve

7.4 Inspect the engine cooling system for the following conditions:

7.4.1 A thermostat with incorrect heat range

7.4.2 Improper engine coolant level

7.5 Inspect the engine for the following mechanical conditions:

7.5.1 Excessive oil in the combustion chamber or leaking valve seals

7.5.2 Incorrect cylinder compression

7.5.3 Sticking or leaking valves

7.5.4 Worn camshaft lobes

7.5.5 Incorrect valve timing

7.5.6 Worn rocker arms

7.5.7 Broken valve springs

7.5.8 Excessive carbon buildup in the combustion chambers—Clean the chambers with top engine cleaner, if necessary. Follow the instructions on the can.

7.5.9 Incorrect engine parts

7.6 For more information refer to *SYMPTOMS - ENGINE MECHANICAL*.

7.7 If the above conditions do not address the symptom, refer to the additional symptoms tests.

8 ADDITIONAL SYMPTOMS TESTS

Detonation/Spark Knock

8.1 Test the engine for an overheating condition.

8.2 Verify that the engine coolant temperature (ECT) has not shifted in value. Allow the engine to run and reach operating temperature. Observe the ECT Sensor parameter with a scan tool and compare the reading to that parameter listed on the Engine Control Module Scan Tool Information list. If the reading is not in the range specified in the list, test the resistance of the ECT sensor. Refer to Temperature Versus Resistance for resistance specifications. Replace the ECT sensor if the resistance is not within specification. Refer to Engine Coolant Temperature Sensor Replacement. If the sensor is within the specification, test the ECT sensor circuits for high resistance.

8.3 Inspect for excessive carbon buildup in the combustion chambers. Clean the chambers with Top Engine Cleaner, if necessary. Follow the instructions on the can.

9 ECM COMMANDED REDUCED ENGINE POWER

Under certain conditions the ECM may limit engine torque to reduce engine power. For most, but not all of the conditions, the ECM will illuminate the reduced engine power lamp on the instrument panel cluster, however a DTC may not be set. Observe the scan tool Reduced Engine Power History parameter or refer to Engine Control Module Scan Tool Information to determine the reason for the reduced engine power event.

Verify or inspect for the following:

9.1 Vehicle being operated at sustained high engine speeds, or, towing heavy loads up an incline for an extended period of time, which may cause the engine oil or coolant to overheat. A repair may not be necessary. Inspect the airflow passageways in front of the engine for obstructions and clear away any debris or foreign material that is found. If no obstructions are found, review approved driving habits with the customer. The customer may need to operate the vehicle at a higher engine speed to improve cooling system performance, or, at a slower engine speed to reduce engine load.

9.2 A cooling fan condition which may cause the ECM to reduce engine power

10 FUEL ODOR

10.1 Engine running, inspect for CNG fuel leaks using a commercially available combustible gas detector or a soapy water mist.

11 HARD START

11.1 Observe the Throttle Body Idle Airflow Compensation parameter with a scan tool. A value greater than 90 % may indicate an excessive accumulation of deposits in the throttle bore. Inspect the throttle body and bore and clean, if necessary.

11.2 Test the engine coolant temperature (ECT) sensor. Compare the ECT sensor value to the intake air temperature (IAT) sensor value on a cold engine. The ECT and IAT sensor values should be within ± 3°C (5°F). If the ECT sensor is out of range with the IAT sensor, test the resistance of the ECT sensor. Refer to Temperature Versus Resistance for resistance specifications. Replace the ECT sensor if the resistance is not within specification. Refer to Engine Coolant Temperature Sensor Replacement. If the sensor is within the specification, test the ECT circuits for a high resistance.

11.3 Verify that the fuel system has adequate pressure for engine start-up. Refer to OEM Service Manual for fuel system diagnosis for fuel pressure specifications.

Symptoms – Engine Controls (LC8 / CNG)

12 HESITATION, SAG, STUMBLE

12.1 Test the manifold absolute pressure (MAP) sensor. Refer to DTC P0106.

12.2 Test the generator.

13 POOR FUEL ECONOMY

13.1 Inspect for heavy loads being carried or towed.

13.2 Inspect for acceleration rate too much or too often.

13.3 Observe the Throttle Body Idle Airflow Compensation parameter with a scan tool. A value greater than 90 % may indicate an excessive accumulation of deposits in the throttle bore. Inspect the throttle body and bore and clean, if necessary.

14 REDUCED VEHICLE RANGE

14.1 If a condition exists which prevents fuel from being transferred from one or more of the fuel tanks to the fuel supply line, vehicle driving range may be greatly reduced. Verify or inspect for correct operation of the CNG high pressure lock-off (HPL) solenoid valves. Refer to OEM Service Manual for fuel System diagnosis or CNG supplement manual.

15 ROUGH, UNSTABLE, OR INCORRECT IDLE AND STALLING

15.1 Observe the Throttle Body Idle Airflow Compensation parameter with a scan tool. A value greater than 90 % may indicate an excessive accumulation of deposits in the throttle bore. Inspect the throttle body and bore and clean, if necessary.

15.2 Inspect the engine mounts.

16 SURGES/CHUGGLES

16.1 Inspect for slow responding heated oxygen sensors (HO2S). The HO2S should respond quickly to a change in throttle position. If the HO2S do not respond to different throttle positions, inspect for contamination from fuel, silicon, or the incorrect use of RTV sealant. The sensors may have a white powdery coating and result in a high, but false, signal voltage, which gives a rich exhaust indication. The ECM reduces the amount of fuel delivered to the engine, causing a drivability condition.

16.2 Inspect the mass air flow (MAF) sensor for obstruction, contamination, and damage. Refer to Mass Airflow Sensor with Intake Air Temperature Sensor Replacement

16.3 Verify that each injector harness is connected to the correct injector.

Symptoms – Engine Controls (LC8 / LPG)

1 DIAGNOSTIC INSTRUCTIONS

1.1 Review *STRATEGY BASED DIAGNOSIS* for an overview of the diagnostic approach.

1.2 Perform the *DIAGNOSTIC SYSTEM CHECK* prior to using this diagnostic procedure.

2 SYMPTOMS DESCRIPTION

Symptoms cover conditions that are not covered by DTCs. Certain conditions can cause multiple symptoms. These conditions are listed together under Symptoms Testing. Conditions that may only cause certain symptoms are listed separately under Additional Symptoms Test. Perform the Symptoms Testing before using the Additional Symptoms Tests.

3 SYMPTOMS DEFINITION

3.1 **Backfire:** Fuel ignites in the intake manifold or in the exhaust system, making a loud popping noise.

3.2 **Cuts Out, Misses**: A steady pulsation or jerking that follows engine speed, which is usually more pronounced as the engine load increases. This condition is not normally felt above 1500 RPM or 48 km/h (30 mph). The exhaust has a steady spitting sound at idle or at low speed.

3.3 **Detonation/Spark Knock:** A mild to severe ping which usually occurs worse while under acceleration. The engine makes sharp metallic knocks that change with throttle opening.

3.4 **Dieseling, Run-On:** The engine continues to run after the key is turned OFF, but runs very rough.

3.5 **Engine Control Module (ECM) Commanded Reduced Engine Power: The** ECM illuminates the Reduced Engine Power lamp and will limit engine power under potential engine damaging or emissions related conditions. A DTC may not be set.

3.6 **Hard Start**: Engine cranks OK, but does not start for a long time. The vehicle does eventually run, or may start but immediately stalls.

3.7 **Hesitation, Sag, Stumble:** Momentary lack of response as the accelerator is pushed down. This condition can occur at any vehicle speed. This condition is usually more pronounced when first trying to make the vehicle move, as **from a stop. This condition may cause the engine to stall in severe conditions.**

3.8 **Lack of Power, Sluggishness, or Sponginess:** The engine delivers less than expected power. Little or no increase in speed when the accelerator pedal is pushed down part way.

3.9 **Poor Fuel Economy:** Fuel economy, as measured by an actual road test, is noticeably lower than expected. Also, the fuel economy is noticeably lower than it was on this vehicle at one time, as previously shown by an actual road test.

3.10 **Reduced Vehicle Range**: The distance that the vehicle can be driven, before running out of fuel, is reduced.

3.11 **Rough, Unstable, or Incorrect Idle and Stalling:** The engine runs unevenly at idle. If severe, the engine or the vehicle may shake. Engine idle may vary in speed. Either condition may be severe enough to stall the engine.

3.12 **Surges/Chuggles:** Engine power variation under steady throttle or cruise. Feels like the vehicle speeds up and slows down with no change in the accelerator pedal position.

4 SYMPTOMS VERIFICATION

Before using the Symptom tables, perform the following inspections:

4.1 Verify that the engine control module (ECM) and malfunction indicator lamp (MIL) are operating correctly.

4.2 Verify that there are no DTCs that are stored.

4.3 Verify that the scan tool data is within a normal operating range.

4.4 Verify the customer concern.

4.5 Perform the Visual/Physical Inspection in this section. The visual/physical inspection is extremely important, and can lead to correcting a condition without additional testing. It may also help reveal the cause of an intermittent condition.

5 Identifying Intermittent Conditions

Many intermittent conditions occur with harness or connector movement due to engine torque, rough pavement, vibration or physical movements of a component. Refer to the following for a list of issues that may cause an intermittent condition:

5.1 Moisture and water intrusion in connectors, terminals, and components

5.2 Incomplete connector mating

5.3 Poor terminal contact

5.4 High circuit or component resistance—High resistance can include any resistance, regardless of the amount, which can interrupt the operation of the component.

5.5 Harness that is too short or tight

5.6 Wire insulation that is chaffed or cut.

5.7 High or low ambient temperature

5.8 High or low engine coolant temperatures

5.9 High underhood temperatures

5.10 Heat build-up in component or circuit due to circuit resistance, poor terminal contact, or high electrical load

5.11 High or low system voltage

Symptoms – Engine Controls (LC8 / LPG)

5.12 High vehicle load conditions

5.13 Rough road surfaces

5.14 Electro-magnetic interference (EMI)/circuit interference from relays, solenoids or other electrical surge

5.15 Incorrect installation of aftermarket, add on accessories

6 VISUAL/PHYSICAL CHECK

6.1 Verify that the engine control module grounds are clean, tight, and correctly located.

6.2 Verify that the vacuum hoses are not split or kinked.

6.3 Verify that the air filter is clean and free from restrictions.

6.4 Verify that there is no water intrusion in connectors, terminals, and components.

6.5 Inspect the air intake ducts for the following conditions:

6.5.1 Collapsed

6.5.2 Damaged areas

6.5.3 Looseness

6.5.4 Incorrect installation

6.5.5 Leaking

6.6 Inspect for air leaks at the throttle body mounting area, the mass air flow (MAF) sensor and intake manifold sealing surfaces.

6.7 Inspect the fuel system lines and components for damage or external fuel leaks.

6.8 Inspect the wiring harness for the following conditions:

6.8.1 Poor connections

6.8.2 Pinches

6.8.3 Cuts

6.9 Inspect for loose, damaged, unseated, or missing sensors/components.

6.10 Inspect the terminals for corrosion and correct contact.

Symptoms – Engine Controls (LC8 / LPG)

7 SYMPTOMS TESTING

Backfire, Cuts Out/Misses, Detonation/Spark Knock, Dieseling/Run-On, Engine Control Module (ECM) Commanded Reduced Engine Power, Hard Start, Hesitation/Sag/Stumble, Lack of Power/Sluggishness/Sponginess, Poor Fuel Economy, Rough, Unstable, or Incorrect Idle and Stalling, or Surges/Chuggles

7.1 Test for the following conditions:

7.1.1 Test the fuel system for the following:

7.1.1.1 Incorrect fuel pressure-refer to OEM Service Manual for fuel system diagnosis.

7.1.1.2 Fuel injectors that are leaking or improperly operating—refer to FUEL INJECTOR DIAGNOSIS

7.2 The ignition system for the following:

7.2.1 Spark plugs with incorrect heat range or an abnormal condition—Refer to Spark Plug Inspection.

7.2.2 Coolant or oil fouled spark plugs—Refer to Loss of Coolant or *SYMPTOMS - ENGINE MECHANICAL*.

7.2.3 Weak spark using the J 26792 HEI Spark Tester—Refer to *ELECTRONIC IGNITION SYSTEM DIAGNOSIS*.

7.3 Inspect for the following conditions:

7.3.1 Improper operation of the transmission torque converter clutch

7.3.2 Improper operation of the A/C compressor

7.3.3 Items that can cause an engine to run rich or lean

7.3.4 Slow responding heated oxygen sensors (HO2S). The HO2S should respond quickly to different throttle positions.

7.3.5 Water intrusion in the HO2S connector

Note: The embossed arrows on the MAF sensor indicate the direction of the intake air flow. The arrows must point toward the engine.

7.3.6 Improper MAF sensor installation. A MAF sensor that is incorrectly installed may cause a hard start. Install the MAF in the proper direction.

7.3.7 Loose or improper MAF sensor connections

7.3.8 Split or kinked vacuum hoses

7.3.9 Excessive knock sensor (KS) system spark retard activity—Refer to DTC P0324, P0325, P0326, P0327, P0328, P0330, P0332, or P0333.

7.3.10 The exhaust system components for the following:

7.3.10.1 Physical damage or possible internal failure

7.3.10.2 Restricted three-way catalytic converters

7.3.11 Electromagnetic interference (EMI) on the reference circuit can cause a misfire condition. You can usually detect EMI with a scan tool by monitoring the engine speed parameter. A sudden increase in the engine speed parameter with little change in actual engine speed indicates that EMI is present. Inspect the high voltage components near the ignition control circuit if a condition exists.

7.3.12 Improper operation of the crankcase ventilation valve

7.4 Inspect the engine cooling system for the following conditions:

7.4.1 A thermostat with incorrect heat range

7.4.2 Improper engine coolant level

7.5 Inspect the engine for the following mechanical conditions:

7.5.1 Excessive oil in the combustion chamber or leaking valve seals

7.5.2 Incorrect cylinder compression

7.5.3 Sticking or leaking valves

7.5.4 Worn camshaft lobes

7.5.5 Incorrect valve timing

7.5.6 Worn rocker arms

7.5.7 Broken valve springs

7.5.8 Excessive carbon buildup in the combustion chambers—Clean the chambers with top engine cleaner, if necessary. Follow the instructions on the can.

7.5.9 Incorrect engine parts

7.6 For more information refer to *SYMPTOMS - ENGINE MECHANICAL*.

7.7 If the above conditions do not address the symptom, refer to the additional symptoms tests.

8 ADDITIONAL SYMPTOMS TESTS

Detonation/Spark Knock

8.1 Test the engine for an overheating condition.

8.2 Verify that the engine coolant temperature (ECT) has not shifted in value. Allow the engine to run and reach operating temperature. Observe the ECT Sensor parameter with a scan tool and compare the reading to that parameter listed on the Engine Control Module Scan Tool Information list. If the reading is not in the range specified in the list, test the resistance of the ECT sensor. Refer to Temperature Versus Resistance for resistance specifications. Replace the ECT sensor if the resistance is not within specification. Refer to Engine Coolant Temperature Sensor Replacement. If the sensor is within the specification, test the ECT sensor circuits for high resistance.

8.3 Inspect for excessive carbon buildup in the combustion chambers. Clean the chambers with Top Engine Cleaner, if necessary. Follow the instructions on the can.

9 ECM COMMANDED REDUCED ENGINE POWER

Under certain conditions the ECM may limit engine torque to reduce engine power. For most, but not all of the conditions, the ECM will illuminate the reduced engine power lamp on the instrument panel cluster, however a DTC may not be set. Observe the scan tool Reduced Engine Power History parameter or refer to Engine Control Module Scan Tool Information to determine the reason for the reduced engine power event.

Verify or inspect for the following:

9.1 Vehicle being operated at sustained high engine speeds, or, towing heavy loads up an incline for an extended period of time, which may cause the engine oil or coolant to overheat. A repair may not be necessary. Inspect the airflow passageways in front of the engine for obstructions and clear away any debris or foreign material that is found. If no obstructions are found, review approved driving habits with the customer. The customer may need to operate the vehicle at a higher engine speed to improve cooling system performance, or, at a slower engine speed to reduce engine load.

9.2 A cooling fan condition which may cause the ECM to reduce engine power

10 HARD START

10.1 Observe the Throttle Body Idle Airflow Compensation parameter with a scan tool. A value greater than 90 % may indicate an excessive accumulation of deposits in the throttle bore. Inspect the throttle body and bore and clean, if necessary.

10.2 Test the engine coolant temperature (ECT) sensor. Compare the ECT sensor value to the intake air temperature (IAT) sensor value on a cold engine. The ECT and IAT sensor values should be within ± 3°C (5°F). If the ECT sensor is out of range with the IAT sensor, test the resistance of the ECT sensor. Refer to Temperature Versus Resistance for resistance specifications. Replace the ECT sensor if the resistance is not within specification. Refer to Engine Coolant Temperature Sensor Replacement. If the sensor is within the specification, test the ECT circuits for a high resistance.

10.3 Verify that the fuel system has adequate pressure for engine start-up. Refer to OEM Service Manual for fuel system diagnosis for fuel pressure specifications.

11 HESITATION, SAG, STUMBLE

11.1 Test the manifold absolute pressure (MAP) sensor. Refer to DTC P0106.

11.2 Test the generator.

12 POOR FUEL ECONOMY

12.1 Inspect for heavy loads being carried or towed.

12.2 Inspect for acceleration rate too much or too often.

12.3 Observe the Throttle Body Idle Airflow Compensation parameter with a scan tool. A value greater than 90 % may indicate an excessive accumulation of deposits in the throttle bore. Inspect the throttle body and bore and clean, if necessary.

13 REDUCED VEHICLE RANGE

13.1 If a condition exists which prevents fuel from being transferred from the secondary fuel tanks to the main fuel tank, vehicle driving range may be greatly reduced. Refer to OEM Service manual or LPG supplement manual.

14 ROUGH, UNSTABLE, OR INCORRECT IDLE AND STALLING

14.1 Observe the Throttle Body Idle Airflow Compensation parameter with a scan tool. A value greater than 90 % may indicate an excessive accumulation of deposits in the throttle bore. Inspect the throttle body and bore and clean, if necessary.

14.2 Inspect the engine mounts.

15 SURGES/CHUGGLES

15.1 Inspect for slow responding heated oxygen sensors (HO2S). The HO2S should respond quickly to a change in throttle position. If the HO2S do not respond to different throttle positions, inspect for contamination from fuel, silicon, or the incorrect use of RTV sealant. The sensors may have a white powdery coating and result in a high, but false, signal voltage, which gives a rich exhaust indication. The ECM reduces the amount of fuel delivered to the engine, causing a drivability condition.

15.2 Inspect the mass air flow (MAF) sensor for obstruction, contamination, and damage. Refer to Mass Airflow Sensor with Intake Air Temperature Sensor Replacement

15.3 Verify that each injector harness is connected to the correct injector.

Symptoms – Engine Controls

1 DIAGNOSTIC INSTRUCTIONS

1.1 Review *STRATEGY BASED DIAGNOSIS* for an overview of the diagnostic approach.

1.2 Perform the *DIAGNOSTIC SYSTEM CHECK* prior to using this diagnostic procedure.

2 SYMPTOMS DESCRIPTION

Symptoms cover conditions that are not covered DTCs. Certain conditions can cause multiple symptoms. These conditions are listed together under Symptoms Testing. Conditions that may only cause certain symptoms are listed separately under Additional Symptoms Test. Perform the Symptoms Testing before using the Additional Symptoms Tests. Poor Fuel Fill Quality test may be performed separately from the Symptoms Testing and Additional Symptoms Tests procedures.

3 SYMPTOMS DEFINITION

3.1 **Backfire:** Fuel ignites in the intake manifold or in the exhaust system, making a loud popping noise.

3.2 **Cuts Out, Misses:** A steady pulsation or jerking that follows engine speed, which is usually more pronounced as the engine load increases. This condition is not normally felt above 1500RPM or 48km/h (30mph). The exhaust has a steady spitting sound at idle or at low speed.

3.3 **Engine Control Module (ECM) Reduced Engine Power:** The ECM illuminates the Reduced engine Power lamp and will limit engine power under potential engine/vehicle damaging or emissions related conditions. A DTC may not be set.

3.4 **Detonation/Spark Knock:** A mild to severe ping which usually occurs worse while under acceleration. The engine makes sharp metallic knocks that change with throttle opening.

3.5 **Dieseling, Run-On:** The engine continues to run after the key is turned OFF, but runs very rough.

3.6 **Hard Start:** Engine cranks OK, but does not start for a long time. The vehicle does eventually run, or may start but immediately stalls.

3.7 **Hesitation, Sag, Stumble:** Momentary lack of response as the accelerator is pushed down. This condition can occur at any vehicle speed. This condition is usually more pronounced when first trying to make the vehicle move, as from a stop. This condition may cause the engine to stall in severe conditions.

3.8 **Lack of Power, Sluggishness, or Sponginess:** The engine delivers less than expected power. Little or no increase in speed when the accelerator pedal is pushed down part way

3.9 **Poor Fuel Economy:** Fuel economy, as measured by an actual road test, is noticeably lower than expected. Also, the fuel economy is noticeably lower than it was on this vehicle at one time, as previously shown by an actual road test.

3.10 **Poor Fuel Fill Quality:** Difficulty when refueling the vehicle.

Symptoms – Engine Controls

3.11 **Rough, Unstable, or Incorrect Idle and Stalling:** The engine runs unevenly at idle. If severe, the engine or the vehicle may shake. Engine idle may vary in speed. Either condition may be severe enough to stall the engine.

3.12 **Surges/Chuggles:** Engine power variation under steady throttle or cruise. Feels like the vehicle speeds up and slows down with no change in the accelerator pedal position.

4 SYMPTOMS VERIFICATION

Before using the Symptom tables, perform the following inspections:

4.1 Verify the engine control module (ECM) and malfunction indicator lamp (MIL), if equipped, are operating correctly.

4.2 Verify there are no DTCs that are stored

4.3 Verify the scan tool data is within a normal operating range.

4.4 Verify the customer concern.

4.5 Perform the Visual/Physical Inspection in this section. The visual/physical inspection is extremely important, and can lead to correcting a condition without additional testing. It may also help reveal the cause of an intermittent condition.

5 IDENTIFYING INTERMITTENT CONDITIONS

Many intermittent conditions occur with harness or connector movement due to engine torque, rough pavement, vibration or physical movements of a component. Refer to the following for a list of issues that may cause an intermittent condition:

5.1 Moisture and water intrusion in connectors, terminals, and components

5.2 Incomplete connector mating

5.3 Poor terminal contact

5.4 High circuit or component resistance—High resistance can include any resistance, regardless of the amount, which can interrupt the operation of the component.

5.5 Harness that is too short or tight

5.6 Wire insulation that is chaffed or cut

5.7 High or low ambient temperature

5.8 High or low engine coolant temperatures

5.9 High under hood temperatures

5.10 Heat buildup in component or circuit due to circuit resistance, poor terminal contact, or high electrical load

5.11 High or low system voltage

Symptoms – Engine Controls

5.12 High vehicle load conditions

5.13 Rough road surfaces

5.14 Electro-magnetic interference (EMI)/circuit interference from relays, solenoids or other electrical surge

5.15 Incorrect installation of aftermarket, add on accessories

6 VISUAL/PHYSICAL CHECK

6.1 Verify the control module grounds are clean, tight, and correctly located.

6.2 Verify the vacuum hoses are not split or kinked, and are properly connected, as shown on the Vehicle Emission Control Information label.

6.3 Verify the air filter is clean and free from restrictions.

6.4 Verify there is no water intrusion in connector’s terminals and components.

6.5 Inspect the air intake ducts for the following conditions:

6.5.1 Collapsed

6.5.2 Damaged areas

6.5.3 Looseness

6.5.4 Incorrect installation

6.5.5 Leaking

6.6 Inspect for air leaks at the throttle body mounting area, the mass air flow (MAF) sensor and intake manifold sealing surfaces.

6.7 Inspect the wiring harness for the following conditions:

6.7.1 Poor connections

6.7.2 Pinches

6.7.3 Cuts

6.8 Inspect for loose, damaged, unseated, or missing sensors/components.

6.9 Inspect the terminals for corrosion and correct contact.

Symptoms – Engine Controls

7 SYMPTOMS TESTING

Backfire, Cuts Out/Misses, Detonation/Spark Knock, Dieseling/Run-On, Engine Control Module (ECM) Commanded Reduced Engine Power, Fuel Odor, Hard Start, Hesitation/Sag/Stumble, Lack of Power/Sluggishness/Sponginess, Poor Fuel Economy, Rough, Unstable, or Incorrect Idle and Stalling, or Surges/Chuggles

7.1 Test the fuel system for the following:

7.1.1 Correct fuel system operation and pressure—Refer to OEM Service Manual for fuel system diagnosis.

7.1.2 Incorrectly connected, fuel injectors - verify each injector is connected to the correct fuel injector, harness connector.

7.1.3 Improperly operating or leaking fuel injectors—Refer to *FUEL INJECTOR DIAGNOSIS*.

7.1.4 Poor fuel quality condition—Refer to *ALCOHOL/CONTAMINANTS-IN-FUEL DIAGNOSIS*

7.2 Test the ignition system for the following conditions:

7.2.1 Spark plugs with incorrect heat range or an abnormal condition—Refer to Spark Plug Inspection.

7.2.2 Coolant or oil fouled spark plugs—For diagnosis, refer to Coolant in Combustion Chamber or Oil Consumption Diagnosis.

7.2.3 Weak spark using the J 26792 Spark Tester—Refer to *ELECTRONIC IGNITION SYSTEM DIAGNOSIS*.

7.3 Inspect for the following conditions:

7.3.1 Improperly operating transmission torque converter clutch

7.3.2 Improperly operating A/C compressor

7.3.3 Items that can cause an engine to run rich or lean—Refer to DTC P0171, P0172, P0174, or P0175.

7.3.4 Slow responding heated oxygen sensors (HO2S). The HO2S should respond quickly to different throttle positions—Refer to DTC P0133, P013A-P013F, P014A, P014B, P0153, P1133, or P1153 for more information.

7.3.5 Water intrusion in the HO2S connector

NOTE:the embossed arrows on the mass airflow (MAF) sensor indicate the direction of the intake air flow. The arrows must point toward the engine.

7.3.6 Improper MAF sensor installation

7.3.7 A MAF sensor that is incorrectly installed may cause a hard start. Install the MAF in the proper direction. Refer to Mass Airflow Sensor with Intake Air Temperature Sensor Replacement (Powertrain Integration Service Manual).

7.3.8 Engine oil contaminated by fuel

7.3.9 Split or kinked vacuum hoses

7.3.10 Excessive knock sensor (KS) system spark retard activity—Refer to DTC P0324, P0325, P0326, P0327, P0328, P0330, P0332, or P0333.

7.3.11 Electromagnetic interference (EMI) on the reference circuit, which can cause a misfire condition. You can usually detect EMI with a scan tool by monitoring the engine speed parameter. A sudden increase in the engine speed parameter with little change in actual engine speed indicates that EMI is present. Inspect the high voltage components near the ignition control circuit if a condition exists.

7.3.12 Improperly operating crankcase ventilation valve—Refer to Crankcase Ventilation System Inspection/Diagnosis.

7.3.13 A stuck open evaporative emission (EVAP) canister purge solenoid

7.4 Inspect the exhaust system components for the following conditions:

7.4.1 Physical damage or possible internal failure

7.4.2 Restricted three-way catalytic converters

7.4.3 For more information, refer to OEM Service Manual.

7.5 Inspect the engine cooling system for the following conditions:

7.5.1 Thermostat with incorrect heat range

7.5.2 Improper engine coolant level

7.6 Inspect the engine for the following mechanical conditions:

7.6.1 Excessive oil in the combustion chamber or leaking valve seals

7.6.2 Incorrect cylinder compression

7.6.3 Sticking or leaking valves

7.6.4 Worn camshaft lobes

7.6.5 Incorrect valve timing

7.6.6 Worn rocker arms

7.6.7 Broken valve springs

7.6.8 Excessive carbon buildup in the combustion chambers—Clean the chambers with top engine cleaner, if necessary. Follow the instructions on the can.

7.6.9 Incorrect engine parts

7.7 For more information, refer to *SYMPTOMS - ENGINE MECHANICAL*.

7.8 If the above conditions do not address the symptom, refer to the additional symptoms tests.

8 ADDITIONAL SYMPTOMS TESTS

Detonation/Spark Knock

8.1 Test the engine for an overheating condition.

8.2 Inspect for excessive carbon buildup in the combustion chambers. Clean the chambers with Top Engine Cleaner, if necessary. Follow the instructions on the can.

8.3 If there are no engine mechanical faults, fill the fuel tank with a known high quality fuel that meets the vehicle minimum octane requirements.

9 ENGINE CONTROL MODULE (ECM) COMMANDED REDUCED ENGINE POWER

Under certain conditions the ECM may limit engine power by reducing engine torque and, for some vehicles, fuel pressure as well. For most, but not all of the conditions, the ECM will illuminate the reduced engine power lamp on the instrument panel cluster; however a DTC may not be set. Observe the scan tool Reduced Engine Power History parameter or refer to Engine Control Module Scan Tool Information to determine the reason for the reduced engine power event.

Verify or inspect for the following:

9.1 Vehicle being driven inappropriately. Towing heavy loads up an incline for an extended period of time or operating the vehicle at sustained, excessively high engine speeds may cause the engine oil or coolant to overheat. A repair may not be necessary. Inspect the airflow passageways in front of the engine for obstructions and clear away any debris or foreign material that is found. If no obstructions or conditions are found, review approved driving habits with the customer. The customer may need to operate the vehicle at a higher engine speed to improve cooling system performance, or, at a slower engine speed to reduce engine load.

10 FUEL ODOR

10.1 Inspect for a saturated EVAP canister—Refer to OEM Service Manual.

10.2 Inspect for leaking, damaged, or deteriorated fuel lines and components.

10.3 Inspect for a condition with the internal components of the fuel tank assembly—Refer to OEM Service Manual.

11 HARD START

11.1 Observe the TB Idle Airflow Compensation parameter with a scan tool. A value greater than 80% may indicate an excessive accumulation of deposits in the throttle bore. Inspect the throttle body and bore and clean, if necessary.

11.2 Test the engine coolant temperature (ECT) sensor. Compare the ECT sensor value to the intake air temperature (IAT) sensor value on a cold engine. The ECT and IAT sensor values should be within ± 3°C (5°F). If the ECT sensor is out of range with the IAT sensor, test the resistance of the ECT sensor. Refer to Temperature Versus Resistance for resistance specifications. Replace the ECT sensor if the resistance is not within specification. Refer to Engine Coolant Temperature Sensor Replacement. If the sensor is within the specification, test the ECT circuits for a high resistance.

11.3 Verify that the fuel pump operates and provides adequate pressure for engine startup. The fuel pump should turn ON for 2 s when the ignition is turned to ON. Refer to Fuel System Diagnosis for fuel pressure specifications and testing procedures.

12 HESITATION, SAG, STUMBLE

12.1 Test the fuel pressure. Refer to OEM Service Manual for fuel system diagnosis.

12.2 Test the generator. Refer to OEM Service Manual.

12.3 Test the manifold absolute pressure (MAP) sensor. Refer to DTC P0106.

13 POOR FUEL ECONOMY

13.1 Inspect for heavy loads being carried or towed.

13.2 Inspect for acceleration rate too much or too often.

13.3 Inspect the brake system for brake drag.

13.4 Inspect for incorrect operation of the speedometer.

13.5 Observe the TB Idle Airflow Compensation parameter with a scan tool. A value greater than 80% may indicate an excessive accumulation of deposits in the throttle bore. Inspect the throttle body and bore and clean, if necessary.

14 POOR FUEL FILL QUALITY

14.1 Inspect for restricted vent lines

14.2 Inspect for a stuck closed evaporative emission (EVAP) vent valve

14.3 Inspect for high fuel temperature

14.4 Inspect for a condition with the internal components of the fuel tank assembly

14.5 For more information, refer to OEM Service Manual for Fuel System and Evaporative Emission Control System descriptions.

Symptoms – Engine Controls

15 ROUGH, UNSTABLE, OR INCORRECT IDLE AND STALLING

15.1 Observe the TB Idle Airflow Compensation parameter with a scan tool. A value greater than 80% may indicate an excessive accumulation of deposits in the throttle bore. Inspect the throttle body and bore and clean, if necessary.

15.2 Inspect the engine mounts.

16 SURGES/CHUGGLES

16.1 Inspect the mass air flow (MAF) sensor for obstruction, contamination, and damage—Refer to DTC P0101 or P1101 and DTC P0102 or P0103 for more information.

16.2 Inspect for slow responding heated oxygen sensors (HO2S). The HO2S should respond quickly to a change in throttle position. If the HO2S do not respond to different throttle positions, inspect for contamination from fuel, silicon, or the incorrect use of RTV sealant. The sensors may have a white powdery coating and result in a high, but false, signal voltage, which gives a rich exhaust indication. The ECM reduces the amount of fuel delivered to the engine, causing a drivability condition—Refer to DTC P0133, P013A-P013F, P014A, P014B, P0153, P1133, or P1153 for more information.

Symptoms – Engine Mechanical

1 STRATEGY BASED DIAGNOSTICS

1.1 Perform the *DIAGNOSTIC SYSTEM CHECK* before using the symptom tables.

1.2 Review the system operations in order to familiarize yourself with the system functions. Refer to

- Disassembled Views
- Engine Content Specifications
- Engine Component Description
- Lubrication Description
- Camshaft Position Actuator and Solenoid Valve Description

1.3 All diagnosis on a vehicle should follow a logical process. *STRATEGY BASED DIAGNOSTICS*is a uniform approach for repairing all systems. The diagnostic flow may always be used in order to resolve a system condition. The diagnostic flow is the place to start when repairs are necessary. For a detailed explanation, refer to *STRATEGY BASED DIAGNOSIS*.

2 Visual/Physical Inspection

2.1 Inspect for aftermarket devices which could affect the operation of the engine.

2.2 Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.

2.3 Inspect for the correct oil level, proper oil viscosity, and correct filter application.

2.4 Verify the exact operating conditions under which the concern exists. Note factors such as engine RPM, ambient temperature, engine temperature, amount of engine warm-up time, and other specifics.

2.5 Compare the engine sounds, if applicable, to a known good engine and make sure you are not trying to correct a normal condition.

3 Intermittent

3.1 Test the vehicle under the same conditions that the customer reported in order to verify the system is operating properly.

4 Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

4.1 *BASE ENGINE MISFIRE WITH ABNORMAL INTERNAL LOWER ENGINE NOISES*

4.2 *BASE ENGINE MISFIRE WITH ABNORMAL VALVE TRAIN NOISE*

4.3 *BASE ENGINE MISFIRE WITH COOLANT CONSUMPTION*

4.4 *BASE ENGINE MISFIRE WITH EXCESSIVE OIL CONSUMPTION*

Symptoms – Engine Mechanical

Upper Engine Noise, Regardless of Engine Speed

Cause	Correction
Incorrect oil filter without anti-drainback feature	Install the correct oil filter.
Incorrect oil viscosity	18) Drain the oil. 19) Install the correct viscosity oil.
High valve lifter leak down rate	Replace the lifters, as required.
Worn crankshaft thrust bearing	20) Inspect the crankshaft end play. 21) Inspect the thrust bearing and crankshaft. 22) Repair or replace, as required.
Damaged or faulty oil filter bypass valve The bypass valve is now internal to the oil filter.	23) Inspect the oil filter bypass valve for proper operation. 24) Repair or replace, as required.
Low oil pressure	25) Perform an oil pressure test. 26) Repair or replace, as required.
Loose and/or worn valve rocker arm attachments	27) Inspect the valve rocker arm, bolt, and pedestal. 28) Repair or replace, as required.
Worn or damaged valve rocker arm	45) Inspect the rocker arm for wear or missing needle bearings 46) Replace the valve rocker arms, as required.
Bent or damaged push rod	Inspect the following components and replace, as required: - Valve rocker arm - Valve push rod - Valve lifter - Valve lifter guide - Piston Inspect the top of the pistons for valve contact. If the top of the piston shows valve contact, replace the piston and pin assembly.
Improper lubrication to the valve rocker arms	Inspect the following components and replace, as required: - Valve rocker arm - Valve push rod - Valve lifter - Oil filter bypass valve - Oil pump and screen - Improper operation of the active fuel management oil pressure relief valve - Engine block oil galleries
Broken valve spring	Replace the valve spring and spring shim.
Worn or dirty valve lifters	Replace the valve lifters, as required.
Improper operation of the active fuel management oil pressure relief valve	Repair, as required.
Improper operation of the camshaft position (CMP) actuator and/or control system	Repair, as required. Refer to Camshaft Position Actuator and Solenoid Valve Diagnosis and Testing
Stretched or broken timing chain and/or damaged sprocket teeth	Replace the timing chain and sprockets.

Upper Engine Noise, Regardless of Engine Speed

Worn engine camshaft lobes	47) Inspect the engine camshaft lobes. 48) Replace the camshaft and valve lifters, as required.
Worn valve guides or valve stems	Inspect the following components and repair, as required:-Valves- Valve guides
Stuck valves Carbon on the valve stem or valve seat may cause the valve to stay open.	Inspect the following components and repair, as required: - Valves - Valve guides
Cut or damaged oil pump screen O-ring seal which may cause aeration of the engine oil	Repair, as required. Refer to Oil Pressure Diagnosis and Testing.

Inspection / Maintenance (I/M) DTC Table

System	DTCs Required to Set System Status to YES
If an I/M System Status indicator did NOT update to YES during the *INSPECTION/MAINTENANCE COMPLETE SYSTEM SET PROCEDURE*, review each indicator and reference this table to determine each DTC associated with the I/M System Status Indicator. Each DTC listed below has specific conditions that must be met for the diagnostic to run. Included within the conditions are additional DTCs which, if set, may inhibit the DTCs listed below from running. Reviewing and operating the vehicle within the Conditions for Running for each DTC listed below will allow the I/M System Status Indicators to transition to YES.	
Catalyst	DTC P0420 DTC P0430
EVAP	DTC P0442 DTC P0446 DTC P0451-P0454 DTC P0455
Oxygen Sensor	DTC P0134, P0140, P0154, or P0160 DTC P2270 or P2272 DTC P2271 or P2273
Oxygen Sensor Heater	DTC P0030, P0036, P0050, P0053, P0054, P0056, P0059, P0060, P0135, P0141, P0155, or P0161
Camshaft Position	DTC P0011

Malfunction Indicator Lamp (MIL) Diagnosis

1 DIAGNOSTIC INSTRUCTIONS

1.1 Review *STRATEGY BASED DIAGNOSIS* for an overview of the diagnostic approach.

1.2 Perform the *DIAGNOSTIC SYSTEM CHECK* prior to using this diagnostic procedure.

2 CIRCUIT/SYSTEM DESCRIPTION

The malfunction indicator lamp (MIL) illuminates to inform the driver that an emission system fault has occurred and the engine control system requires service. Ignition voltage is supplied directly to the MIL and, when the emission system fault occurs, the engine control module (ECM) turns the MIL ON by grounding the MIL control circuit. Under normal operating conditions, the MIL should be ON only when the ignition is ON and the engine is OFF.

3 DIAGNOSTIC AIDS

If the condition is intermittent, move the related harnesses and connectors with the ignition ON and the engine OFF, and with the engine operating while monitoring the scan tool MIL control circuit status parameters. The MIL control circuit status parameters will change from OK or Not Run to Malfunction if there is a condition with the circuit or a connection.

4 REFERENCE INFORMATION

4.1 SCHEMATIC REFERENCE

4.1.1 ENGINE CONTROLS SCHEMATICS

4.1.2 INSTRUMENT CLUSTER SCHEMATICS

4.2 CONNECTOR END VIEW REFERENCE

4.2.1 Component Connector End Views

4.3 ELECTRICAL INFORMATION REFERENCE

4.3.1 Circuit testing

4.3.2 Connector repairs

4.3.3 Testing for intermittent conditions and poor connections

4.3.4 Wiring repairs

4.4 SCAN TOOL REFERENCE

4.4.1 Control Module References

Malfunction Indicator Lamp (MIL) Diagnosis

5 CIRCUIT/SYSTEM VERIFICATION

NOTE: Any MIL requesting DTCs that may be set should be diagnosed first.

5.1 Ignition ON, command the MIL ON and OFF with a scan tool. The MIL should turn ON and OFF as commanded.

5.2 Command the MIL ON and OFF with a scan tool while observing the control circuit status parameters listed below:

5.2.1 MIL Ckt Short Gnd Test Status

5.2.2 MIL Ckt Open Test Status

5.2.3 MIL Ckt Short Volts Test Status

5.2.4 Each parameter should display OK or Not Run.

5.3 Engine running, command the MIL ON and OFF with a scan tool while observing the control circuit status parameters listed below:

5.3.1 MIL Ckt Short Gnd Test Status

5.3.2 MIL Ckt Open Test Status

5.3.3 MIL Ckt Short Volts Test Status

5.3.4 Each parameter should display OK or Not Run.

6 CIRCUIT/SYSTEM TESTING

6.1 Ignition OFF, disconnect the X1 harness connector at the K20 ECM.

6.2 Ignition ON, the MIL should not illuminate.

6.2.1 If the MIL illuminates, test the MIL control circuit terminal 68 X1 for a short to ground. If the circuit tests normal, replace the P16 instrument panel cluster.

6.3 Connect a 3 A fused jumper wire between the MIL control circuit terminal 68 X1 and ground. The MIL should illuminate.

6.3.1 If the MIL illuminates, replace the K20 ECM.

6.3.2 If the MIL does not illuminate, test the MIL control circuit for a short to voltage or an open/high resistance. If the MIL control circuit tests normal, test the instrument cluster ignition voltage circuit for a short to ground or an open/high resistance. If the circuits test normal, replace the P16 instrument panel cluster/bulb.

Malfunction Indicator Lamp (MIL) Diagnosis

7 REPAIR INSTRUCTIONS

7.1 Perform the *DIAGNOSTIC REPAIR VERIFICATION*after completing the diagnostic procedure.

7.2 Instrument Cluster Replacement

7.3 Control Module References for ECM replacement, setup, and programming

Inspection / Maintenance (I/M) Complete System Set Procedure

1 DIAGNOSTIC INSTRUCTIONS

1.1 Review *STRATEGY BASED DIAGNOSIS* for an overview of the diagnostic approach.

1.2 Perform the *DIAGNOSTIC SYSTEM CHECK* prior to using this diagnostic procedure.

2 DESCRIPTION

The purpose of the *INSPECTION/MAINTENANCE (I/M) COMPLETE SYSTEM SET PROCEDURE* is to satisfy the enable criteria necessary to execute all I/M readiness diagnostics and complete the trips for those particular diagnostics. When all I/M monitored diagnostic tests are completed, I/M System Status indicators are set to YES; perform the *INSPECTION/MAINTENANCE (I/M) COMPLETE SYSTEM SET PROCEDURE* if any I/M System Status indicators are set to NO.

3 CONDITIONS FOR MEETING A COLD START

3.1 The ignition voltage is between 10 and 15 V.

3.2 The barometric pressure (BARO) is more than 75 kPa.

3.3 The engine coolant temperature (ECT) at start-up is less than 42°C (108°F).

3.4 The intake air temperature (IAT) is between 2–32°C (36–90°F).

3.5 The engine is OFF for greater than 6 hours or the following conditions must be met:

3.5.1 The start-up IAT minus start-up ECT is within 12°C (22°F).

3.5.2 The start-up ECT minus start-up IAT is within 50°C (90°F).

3.6 Fuel level is between 25 and 75 %.

4 CIRCUIT/SYSTEM VERIFICATION

Review the Inspection/Maintenance (I/M) System Status indicators. All I/M System Status indicators should report YES, and no I/M Test DTCs should be present.

5 INSPECTION/MAINTENANCE (I/M) SYSTEM SET PROCEDURE

5.1 Ensure that the vehicle meets the conditions for a cold start listed above.

5.1.1 If the EVAP I/M System Status indicator displays NO, perform the EVAP Service bay test if applicable.

Inspection / Maintenance (I/M) Complete System Set Procedure

5.2 Turn OFF all of the accessories; HVAC system, other electrical loads, including aftermarket/add-on equipment, etc., and open the hood.

5.3 Set the vehicle parking brake and ensure the vehicle is in park for automatic transmission or neutral for manual transmission.

5.4 Start and idle the engine for 2min.

5.5 Close the hood, release the parking brake and Accelerate at part throttle to 72–80km/h (45–50mph) with this speed maintained until the engine reaches operating temperature, 8–10min.

5.6 Continue operation under these conditions for an additional 6min.

5.7 Accelerate at part throttle to 90km/h (55mph) with this speed maintained for 2min.

5.8 Release the accelerator pedal for at least 10s. This will allow the vehicle to enter the decel fuel cut off.

5.8.1 **NOTE:** Do not touch the accelerator pedal until told to do so. A change in TP sensor angle or an increase in engine speed may invalidate this portion of the test.

5.9 Safely stop the vehicle, with the engine in drive for automatic or neutral with the clutch pedal depressed and parking brake applied for manual. Allow the vehicle to idle for 2min.

5.10 Shift the vehicle to park for automatic and neutral for manual. Turn OFF the ignition and exit the vehicle. Do NOT disturb the vehicle for 45min.

5.11 Observe the Inspection/Maintenance (I/M) System Status with a scan tool. All of the I/M System Status indicators should display YES.

5.11.1 If the EVAP I/M System Status indicator displays NO, turn OFF the ignition, ensure that the vehicle meets the conditions for a cold start, and repeat steps 6-11 three more times, or until the EVAP I/M System Status indicator transitions to YES. If the indicator continues to display NO, refer to the Inspection/Maintenance (I/M) Test DTC Table to identify the DTCs that did not run.

5.11.2 If any of the I/M System Status indicators display NO, refer to the Inspection/Maintenance (I/M) Test DTC Table for the indicator which did not display YES. The I/M System DTC Table identifies the DTCs associated with each I/M System Status Indicator.

5.11.3 **NOTE: A**n I/M test DTC will not be stored or erased from the ECU except at the end of trip processing, which occurs 5s after ignition off.

5.12 Observe the I/M Test DTC information with a scan tool. Verify there are no I/M Test DTCs present.

5.12.1 If an I/M Test DTC is set, diagnose the DTC using the *DIAGNOSTIC TROUBLE CODE (DTC) LIST INDEX*and refer to *INSPECTION/MAINTENANCE SYSTEM CHECK* instruction.

5.13 Observe the engine DTC information with a scan tool. Verify no DTCs are present.

Inspection / Maintenance (I/M) Complete System Set Procedure

5.14 If a DTC is set, diagnose using the *DIAGNOSTIC TROUBLE CODE (DTC) LIST INDEX*. After repairs, perform the *INSPECTION/MAINTENANCE COMPLETE SYSTEM SET PROCEDURE* to verify no further DTCs are set.

Inspection / Maintenance (I/M) System Check

1 DIAGNOSTIC INSTRUCTIONS

1.1 Review *STRATEGY BASED DIAGNOSIS* for an overview of the diagnostic approach.

1.2 Perform the *DIAGNOSTIC SYSTEM CHECK* prior to using this diagnostic procedure.

2 DESCRIPTION

Several states require that a vehicle pass on-board diagnostic (OBD) system tests and the inspection/maintenance (I/M) emission inspection in order to renew license plates. This is accomplished by viewing the I/M System Status display on a scan tool. Using a scan tool, the technician can observe the I/M System Status in order to verify that the vehicle meets the criteria that complies with the local area requirements. While testing in the I/M System Status mode, some DTCs may occur that are called I/M Test DTCs. An I/M Test DTC is defined as a fault code that is currently commanding the MIL ON, and is stored in non-volatile memory. The intended use of this data is to prevent vehicles from passing I/M inspection without proper repair to the vehicle. These fault codes are not erasable from any scan tool command or erasable by disconnecting power to the controller. The I/M Test DTCs will be supported by all emissions related ECUs such as ECMs, TCMs, FPCMs, etc. An I/M Test DTC will not be stored or erased from the ECU except at the end of trip processing which occurs 5 s after ignition OFF.

3 CONDITIONS FOR UPDATING THE I/M SYSTEM STATUS

Each system requires at least one, and sometimes several, diagnostic tests. The results of these tests are reported by a diagnostic trouble code (DTC). A system monitor is complete when either all of the DTCs comprising the monitor have Run and Passed, or any one of the DTCs comprising the monitor have illuminated the malfunction indicator lamp (MIL). Once all of the tests are completed, the I/M System Status display will indicate YES in the Completed column.

For example, when the HO2S Heater Status indicates YES, either all of the oxygen sensor heater tests have passed or one of the tests has illuminated the MIL. If the vehicle has four heated oxygen sensors, either all four heater circuit tests have passed or one of the heater circuit tests has illuminated the MIL. The I/M System Status will indicate NO under the Completed column when any of the required tests for that system have not run. The following is a list of conditions that would set the I/M System Status indicator to NO:

3.1 The vehicle is new from the factory and has not yet been driven through the necessary drive conditions to complete the tests

3.2 The battery has been disconnected or discharged below operating voltage.

3.3 The control module power or ground has been interrupted.

3.4 The control module has been reprogrammed.

3.5 The control module DTCs have been cleared as part of a service procedure.

4 CONDITIONS FOR CLEARING I/M TEST DTCS

4.1 Only the OBD II System can erase the I/M Test DTC. The OBD II system must determine that the malfunction that caused the I/M Test DTC to be stored is no longer present and is not commanding the MIL. Each of the following represents ways to clear an I/M Test DTC:

4.1.1 If the MIL goes out due to 3 passing drive cycles, scan tool code clear is not used, the I/M Test DTC is erased at power down of the last drive cycle.

4.1.2 If a scan tool code clear is used to turn OFF the MIL, the I/M Test DTC is not erased, the DTC must PASS and not FAIL. The I/M Test DTC is erased at power down of the drive cycle.

4.1.3 If the controller is reflashed/reprogrammed, all I/M Test DTCs are erased.

4.2 For the OBD II System to run a single drive cycle for clearing an I/M Test DTC, all of the following conditions must occur

4.2.1 Cumulative time of engine run time is greater than 600 s.

4.2.2 Cumulative vehicle operation above 41 km/h (25 mph) for over 300 s.

4.2.3 Continuous vehicle idle for greater than 30 s.

4.2.4 Turn ignition OFF for 5 s and allow the code to clear.

5 MONITORED EMISSION CONTROL SYSTEMS

The OBD II system monitors all emission control systems that are on-board. Not all vehicles need every possible emission control system. For example, a vehicle may not be equipped with secondary air injection (AIR) or exhaust gas recirculation (EGR). The OBD II regulations require monitoring of the following; if equipped:

5.1 The air conditioning system

5.2 The catalytic converter efficiency

5.3 Comprehensive component monitoring—Emission related inputs and outputs

5.4 The evaporative emission (EVAP) system

5.5 The fuel delivery system

5.6 Heated catalyst monitoring

5.7 Misfire monitoring

5.8 The oxygen sensor system (O2S or HO2S)

5.9 The oxygen sensor heater system (HO2S heater)

Inspection / Maintenance (I/M) System Check

For the specific DTCs required for each system, refer to Inspection/Maintenance (I/M) Test DTC Table . Systems such as misfire and comprehensive components may not be listed in a system status list. These tests run continuously and do not require an I/M System Status indicator.

6 DIAGNOSTIC AIDS

The I/M System Status display provides an indication of when the control module has completed the required tests. This does not necessarily mean that the test has passed, only that a decision was made. If the diagnostic fails, a DTC will indicate the failure. If a failure indication is present for a DTC associated with one of the I/M regulated systems, it may prevent other required tests from running. For example, a DTC for the control circuit of the EVAP purge solenoid may not be listed in the Inspection/Maintenance System DTC Table because it is a continuous test. If this DTC is set, the Active Tests for the EVAP system may not run.

The I/M System Status information may be useful for a technician to determine if diagnostics have run when verifying repairs.

7 CIRCUIT/SYSTEM VERIFICATION

Review the I/M System Status indicators. All I/M System Status indicators should report YES, and no I/M Test DTCs should be present.

8 CIRCUIT/SYSTEM TESTING

NOTE: Many DTC related repairs will instruct the technician to clear the DTC information. Clearing the DTC will reset the I/M system status indicators to no. Performing the I/M complete system set procedure will set each of the I/M system status indicators to yes.

8.1 Observe the Engine DTC information with a scan tool. Verify no I/M DTCs are present.

8.1.1 If an I/M DTC is set that would prevent the I/M System Status tests from completing, diagnose that DTC before continuing. Refer to Inspection/Maintenance (I/M) Test DTC Table.

8.2 Review applicable service bulletins for software updates that would prevent the I/M System Status tests from completing.

8.2.1 If a control module re-program or other repair is required, perform the *INSPECTION/MAINTENANCE COMPLETE SYSTEM SET PROCEDURE*.

8.3 Observe theI/M System Status indicators.

8.3.1 If any I/M System Status indicators report NO, perform the *INSPECTION/MAINTENANCE COMPLETE SYSTEM SET PROCEDURE*.

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

1 Emissions Related DTCs

1.1 Action Taken When the DTC Sets – Type A

1.1.1 The control module illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.

1.1.2 The control module records the operating conditions at the time the diagnostic fails. The control module stores this information in the Freeze Frame/Failure Records.

1.2 Action Taken When the DTC Sets – Type B

1.2.1 The control module illuminates the MIL on the second consecutive ignition cycle that the diagnostic runs and fails.

1.2.2 The control module records the operating conditions at the time the diagnostic fails. The first time the diagnostic fails, the control module stores this information in the Failure Records. If the diagnostic reports a failure on the second consecutive ignition cycle, the control module records the operating conditions at the time of the failure. The control module writes the operating conditions to the Freeze Frame and updates the Failure Records

1.2.3 The following applies to misfire DTCs:

1.2.3.1 If the control module detects a low level or an emission level misfire condition during 2 consecutive trips, the control module illuminates the MIL.

1.2.3.2 If the control module detects a high level or catalyst damaging misfire, the control module flashes the MIL at a rate of once per second.

1.2.3.3 If the control module detects a misfire during 2 non-consecutive trips, the stored conditions are compared with the current conditions. The control module illuminates the MIL when the following conditions occur:

1.2.3.3.1 The engine load is within 20 percent of the previous test that failed.

1.2.3.3.2 The engine speed is within 375 RPM of the previous test that failed.

1.2.3.3.3 The engine coolant temperature is in the same range of the previous test that failed.

1.2.4 The following applies to fuel trim DTCs:

1.2.4.1 If the control module detects a fuel trim condition during 2 consecutive trips, the control module illuminates the MIL.

1.2.4.2 If the control module detects a fuel trim condition during 2 non-consecutive trips, the stored conditions are compared with the current conditions. The control module illuminates the MIL when the following conditions occur:

1.2.4.2.1 The engine load is within 20 percent of the previous test that failed.

1.2.4.2.2 The engine speed is within 375 RPM of the previous test that failed.

1.2.4.2.3 The engine coolant temperature is in the same range of the previous test that failed.

1.3 Conditions for Clearing the MIL/DTC – Type A or Type B

1.3.1 The control module turns OFF the MIL after 4 consecutive ignition cycles that the diagnostic runs and does not fail.

1.3.2 A current DTC, Last Test Failed, clears when the diagnostic runs and passes.

1.3.3 A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other emission related diagnostic.

1.3.4 Clear the MIL and the DTC with a scan tool.

2 Non-Emissions Related DTCs

2.1 Action Taken When the DTC Sets – Type C

2.1.1 The control module stores the DTC information into memory when the diagnostic runs and fails.

2.1.2 The MIL will not illuminate

2.1.3 The control module records the operating conditions at the time the diagnostic fails. The control module stores this information in the Failure Records.

2.1.4 The driver information center, if equipped, may display a message.

2.2 Conditions for Clearing the DTC – Type C

2.2.1 A current DTC Last Test Failed clears when the diagnostic runs and passes.

2.2.2 A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other non-emission related diagnostic.

2.2.3 Clear the DTC with a scan tool

Diagnostic Trouble Code (DTC) Index		
This master DTC list includes all applicable DTCs in alphanumeric order.		
DTC	**Diagnostic Procedure**	**Description**
P0010	DTC P0010, P2088, or P2089	Camshaft Position (CMP) Acuator Solenoid Control Circuit
P0011	DTC P0011	Camshaft Position (CMP) System Performance
P0016	DTC P0016	Crankshaft Position (CKP) Camshaft Position (CMP) Correlation
P0030 **P0036** **P0050** **P0053** **P0054** **P0056** **P0060**	DTC P0030, P0036, P0050, P0053, P0054, P0056, P0059, P0060, P0135, P0141, P0155, or P0161	Heated Oxygen (HO2) Sensors
P0068	DTC P0068 or P1101	Throttle Body Airflow Performance
P0101	DTC P0101	Mass Air Flow (MAF) Sensor Performance
P0102 **P0103**	DTC P0102 or P0103	Mass Air Flow (MAF) Low Frequency Mass Air Flow (MAF) High Frequency
P0106	DTC P0106	Manifold Absolute Pressure (MAP) Sensor Performance
P0107 **P0108**	DTC P0107 or P0108	Manifold Absolute Pressure (MAP)Low Frequency Manifold Absolute Pressure (MAP)High Frequency
P0111	DTC P0111	Intake Air Temperature (IAT) Sensor Performance
P0112 **P0113** **P0114**	DTC P0112, P0113, or P0114	Intake Air Temperature (IAT) Sensor Circuit – Low Voltage Intake Air Temperature (IAT) Sensor Circuit – High Voltage Intake Air Temperature (IAT) Sensor Circuit – Intermittent
P0116	DTC P0116	Engine Coolant Temperature (ECT) Sensor Performance
P0117 **P0118**	DTC P0117 or P0118	Engine Coolant Temperature (ECT) Low Voltage Engine Coolant Temperature (ECT) High Voltage
P0120 **P0121** **P0122** **P0123**	DTC P0120-P0123, P0220, P0222, P0223, or P2135	Throttle Position (TP) Sensor Circuits
P0128	DTC P0128	Engine Coolant Temperature (ECT) Below Thermostat Regulating Temperature
P0131 **P0132**	DTC P0131, P0132, P0137, P0138, P0151, P0152, P0157, or P0158	Heated Oxygen (HO2) Sensors
P0133	DTC P0133, P013A-P013F, P014A, P014B, P0153, P015A, P015B, P015C, or P015D	Heated Oxygen (HO2) Sensors
P0134	DTC P0134, P0140, P0154, or P0160	Heated Oxygen (HO2) Sensors
P0135	DTC P0030, P0036, P0050, P0053, P0054, P0056, P0059, P0060, P0135, P0141, P0155, or P0161	Heated Oxygen (HO2) Sensors
P0137 **P0138**	DTC P0131, P0132, P0137, P0138, P0151, P0152, P0157, or P0158	Heated Oxygen (HO2) Sensors

P013A **P013B** **P013C** **P013D** **P013E** **P013F**	DTC P0133, P013A-P013F, P014A, P014B, P0153, P015A, P015B, P015C, or P015D	Heated Oxygen (HO2) Sensors
P0140	DTC P0134, P0140, P0154, or P0160	Heated Oxygen (HO2) Sensors
P0141	DTC P0030, P0036, P0050, P0053, P0054, P0056, P0059, P0060, P0135, P0141, P0155, or P0161	Heated Oxygen (HO2) Sensors
P014A **P014B**	DTC P0133, P013A-P013F, P014A, P014B, P0153, P015A, P015B, P015C, or P015D	Heated Oxygen (HO2) Sensors
P0151 **P0152**	DTC P0131, P0132, P0137, P0138, P0151, P0152, P0157, or P0158	Heated Oxygen (HO2) Sensors
P0153	DTC P0133, P013A-P013F, P014A, P014B, P0153, P015A, P015B, P015C, or P015D	Heated Oxygen (HO2) Sensors
P0154	DTC P0134, P0140, P0154, or P0160	Heated Oxygen (HO2) Sensors
P0155	DTC P0030, P0036, P0050, P0053, P0054, P0056, P0059, P0060, P0135, P0141, P0155, or P0161	Heated Oxygen (HO2) Sensors
P0157 **P0158**	DTC P0131, P0132, P0137, P0138, P0151, P0152, P0157, or P0158	Heated Oxygen (HO2) Sensors
P015A **P015B** **P015C** **P015D**	DTC P0133, P013A-P013F, P014A, P014B, P0153, P015A, P015B, P015C, or P015D	Heated Oxygen (HO2) Sensors
P0160	DTC P0134, P0140, P0154, or P0160	Heated Oxygen (HO2) Sensors
P0161	DTC P0030, P0036, P0050, P0053, P0054, P0056, P0059, P0060, P0135, P0141, P0155, or P0161	Heated Oxygen (HO2) Sensors
P0171 **P0172** **P0174** **P0175**	DTC P0171, P0172, P0174, or P0175	Fuel Trim System - Lean Bank 1 Fuel Trim System - Rich Bank 1 Fuel Trim System - Lean Bank 2 Fuel Trim System - Rich Bank 2
P0191	DTC P0191	Fuel Rail Pressure (FRP) Sensor Performance
P0192 **P0193**	DTC P0192 or P0193	Fuel Rail Pressure (FRP) Sensor Circuit LowVoltage Fuel Rail Pressure (FRP) Sensor Circuit High Voltage

P0201 **P0202** **P0203** **P0204** **P0205** **P0206** **P0208** **P0207**	DTC P0201, P0202, P0203, P0204, P0205, P0206, P0207, or P0208	Fuel Injector 1 Control Circuit Fuel Injector 2 Control Circuit Fuel Injector 3 Control Circuit Fuel Injector 4 Control Circuit Fuel Injector 5 Control Circuit Fuel Injector 6 Control Circuit Fuel Injector 7 Control Circuit Fuel Injector 8 Control Circuit
P0219 A **P0219 B**	DTC P219A, P219B	Fuel Trim Balance
P0220 **P0222** **P0223**	DTC P0120-P0123, P0220, P0222, P0223, or P2135	Throttle Position (TP) Sensor Circuits
P0263 **P0266** **P0269** **P0272** **P0275** **P0278** **P0281** **P0284**	DTC 4P0263, P0266, P0269, P0272, P0275, P0278, P0281, P0284	Cly 1 Balance System Cly 2 Balance System Cly 3 Balance System Cly 4 Balance System Cly 5 Balance System Cly 6 Balance System Cly 7 Balance System Cly 8 Balance System
P0300 **P0301** **P0302** **P0303** **P0304** **P0305** **P0306** **P0307** **P0308**	DTC P0300-P0308	Engine Misfire Detected Cylinder 1 Misfire Detected Cylinder 2 Misfire Detected Cylinder 3 Misfire Detected Cylinder 4 Misfire Detected Cylinder 5 Misfire Detected Cylinder 6 Misfire Detected Cylinder 7 Misfire Detected Cylinder 8 Misfire Detected
P0315	DTC P0315	Crankshaft Position (CKP) System Variation Not Learned
P0324 **P0325** **P0326** **P0327** **P0328** **P0330** **P0332** **P0333**	DTC P0324, P0325, P0326, P0327, P0328, P0330, P0332, or P0333	Knock Sensor Module Performance Knock Sensor Circuit Bank 1 Knock Sensor Performance Knock Sensor Circuit Low Voltage Bank 1 Knock Sensor Circuit High Voltage Bank 1 Knock Sensor Circuit Bank 2 Knock Sensor Circuit Low Voltage Bank 2 Knock Sensor Circuit High Voltage Bank 2
P0335	DTC P0335	Crankshaft Position (CKP) Sensor Circuit
P0336	DTC P0336	Crankshaft Position (CKP) Sensor Performance
P0340 **P0341**	DTC P0340 or P0341	Camshaft Position (CMP) Sensor Circuit Camshaft Position (CMP) Sensor Performance

P0351 **P0352** **P0353** **P0354** **P0355** **P0356** **P0357** **P0358**	DTC P0351-P0358	Ignition Coil 1 Control Circuit Ignition Coil 2 Control Circuit Ignition Coil 3 Control Circuit Ignition Coil 4 Control Circuit Ignition Coil 5 Control Circuit Ignition Coil 6 Control Circuit Ignition Coil 7 Control Circuit Ignition Coil 8 Control Circuit
P0420 **P0430**	DTC P0420 or P0430	Catalyst System Low Efficiency Bank 1 Catalyst System Low Efficiency Bank 2
P0442	DTC P0442	Evaporative Emission (EVAP) System Small Leak Detected
P0443	DTC P0443 or P0449	Evaporative Emission (EVAP) Purge Solenoid Circuit
P0446	DTC P0446	Evaporative Emission (EVAP) Vent System Performance
P0449	DTC P0443 or P0449	Evaporative Emission (EVAP) Vent Solenoid Control Circuit
P0455	DTC P0455	Evaporative Emission (EVAP) Large Leak Detected
P0496	DTC P0496	Evaporative Emission (EVAP) System During Non-Purge
P0506 **P0507**	DTC P0506 or P0507	Idle Speed Low Idle Speed High
P0522 **P0523**	DTC P0522 or P0523	Engine Oil Pressure (EOP) Sensor Circuit LowVoltage Engine Oil Pressure (EOP) Sensor Circuit High Voltage
P0601 **P0602** **P0603** **P0604** **P0606**	DTC P0601-P0604, P0606, P0607, P060D, P062F, P2610, or P264F	Control Module Read Only Memory Performance Control Module Not Programmed Control Module Long Term Memory Reset Control Module Random Access Memory Performance Control Module Processor Performance
P0607 **P060D** **P062F**	DTC P0601-P0604, P0606, P0607, P060D, P062F, P2610, or P264F	Control Module Performance Control Module Accelerator Pedal (APP) Position System Circuitry Performance Control Module Long Term Memory Performance
P0641	DTC P0641 or P0651	5V Reference 1 Circuit
P0650	DTC P0650	Malfunction Indicator Lamp (MIL) Control Circuit
P0651	DTC P0641 or P0651	5V Reference 2 Circuit
P0685 **P0690**	DTC P0685, P0690, or P1682	P0685: Engine Controls Ignition Relay Control Circuit P0690: Engine Controls Ignition Relay Feedback Circuit High Voltage
P1101	DTC P0068 or P1101	Intake Air Flow System Performance
P1258	DTC P1258	Engine Coolant Over-temperature – Protection Mode Active
P1380 **P1381**	DTC P1380 or P1381	Misfire Detected – Rough Road Data Not Available Misfire Detected – No Communication with Brake Control Module
P1400	DTC P1400	Cold Start Emission Reduction Control System
P1516	DTC P1516, P2101, P2119, or P2176	Throttle Actuator Control (TAC) Module Throttle Actuator Position Performance
P1682	DTC P0685, P0689, P0690, or P1682	Ignition 1 Switch Circuit 2
P2088 **P2089**	DTC P0010, P2088, or P2089	Camshaft Position (CMP) Actuator Solenoid Control Circuit Low Voltage Camshaft Position (CMP) Actuator Solenoid Control Circuit High Voltage
P2101 **P2119**	DTC P1516, P2101, P2119, or P2176	Throttle Actuator Position Performance Throttle Closed Position Performance

P2120 **P2122** **P2123** **P2125** **P2127** **P2128**	DTC P2120, P2122, P2123, P2125, P2127, P2128, or P2138	Accelerator Pedal Position (APP) Sensor 1 Circuit Accelerator Pedal Position (APP) Sensor 1 Circuit Low Voltage Accelerator Pedal Position (APP) Sensor 1 Circuit High Voltage Accelerator Pedal Position (APP) Sensor 2 Circuit Accelerator Pedal Position (APP) Sensor 2 Circuit Low Voltage Accelerator Pedal Position (APP) Sensor 2 Circuit High Voltage
P2135	DTC P0120-P0123, P0220, P0222, P0223, or P2135	Throttle Position (TP) Sensor Circuits
P2138	DTC P2120, P2122, P2123, P2125, P2127, P2128, or P2138	Accelerator Pedal Position (APP) Sensor 1-2 Correlation
P2176	DTC P1516, P2101, P2119, or P2176	Minimum Throttle Position Not Learned
P2181	DTC 2181	Engine Cooling System Performance
P2270	DTC P2270 or P2272	HO2S Signal Stuck Lean Bank 1 Sensor 2
P2271	DTC P2271 or P2273	HO2S Signal Stuck Rich Bank 1 Sensor 2
P2272	DTC P2270 or P2272	HO2S Signal Stuck Lean Bank 2 Sensor 2
P2273	DTC P2271 or P2273	HO2S Signal Stuck Rich Bank 2 Sensor 2
P2610	DTC P0601-P0604, P0606, P0607, P060D, P062F, P2610, or P264F	Control Module Ignition Off Timer Performance

P0010, P2088, or P2089 – Camshaft Position (CMP) Actuator Solenoid Control Circuit

1 DIAGNOSTICINSTRUCTIONS

1.1 Review *STRATEGY BASED DIAGNOSIS* for an overview of the diagnostic approach.

1.2 Perform the *DIAGNOSTIC SYSTEM CHECK* prior to using this diagnostic procedure.

2 DTC DESCRIPTOR

2.1 **DTC P0010**: Camshaft Position (CMP) Actuator Solenoid Control Circuit

2.2 **DTC P2088:** Camshaft Position (CMP) Actuator Solenoid Control Circuit Low Voltage

2.3 **DTC P2089:**Camshaft Position (CMP) Actuator Solenoid Control Circuit High Voltage

3 DIAGNOSTIC FAULT INFORMATION

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

4 CIRCUIT/SYSTEM DESCRIPTION

The camshaft position (CMP) actuator system enables the engine control module (ECM) to change the timing of the camshaft while the engine is operating. The ECM controls the Camshaft Position Actuator Magnet duty cycle by controlling the amount of ON time. The magnet controls the amount of engine oil flow to the CMP actuator by extending a pintle within the solenoid. The pintle acts against a spool valve in the CMP actuator mechanism which is attached to the front of the camshaft. As the spool valve is moved, oil is directed to the CMP actuator, which rotates the camshaft. The ECM can only command the camshaft position actuator to retard the valve timing from the camshaft park position, or advance the valve timing back to the park position. The total range of valve timing command is 26 degree as measured at the camshaft or 52 degree as measured at the crankshaft.

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

P0010, P2088, or P2089 – Camshaft Position (CMP) Actuator Solenoid Control Circuit

5 CONDITIONS FOR RUNNING THE DTC

5.1 The ignition switch is in the crank or run position.

5.2 The system voltage is between 11–18 V.

5.3 The CMP actuator is command ON.

5.4 DTC P0010 runs continuously when the above conditions are met.

6 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.

7 ACTION TAKEN WHEN THE DTC SETS

7.1 DTC P0010, P2088, and P2089 are Type B DTC.

7.2 The camshaft position actuator is commanded to the park position.

8 CONDITIONS FOR CLEARING THE DTC

8.1 DTCP0010, P2088, and P2089 are a TypeB DTC.

9 REFERENCE INFORMATION

9.1 SCHEMATIC REFERENCE

9.1.1 Engine Controls Schematics

9.2 CONNECTOR END VIEW REFERENCE

9.2.1 Component Connector End Views

9.3 DESCRIPTION AND OPERATION

9.3.1 Camshaft Actuator System Description

9.4 ELECTRICAL INFORMATION REFERENCE

9.4.1 Circuit testing

9.4.2 Connector repairs

9.4.3 Testing for intermittent conditions and poor connections

9.4.4 Wiring repairs

P0010, P2088, or P2089 – Camshaft Position (CMP) Actuator Solenoid Control Circuit

9.5 DTC TYPE REFERENCE

9.5.1 Powertrain Diagnostic Trouble Code (DTC) Type Definitions

9.6 SCAN TOOL REFERENCE

9.6.1 Control Module References for scan tool information

10 CAMSHAFT ACTUATOR SYSTEM DESCRIPTION

10.1 CAMSHAFT POSITION (CMP) ACTUATOR SYSTEM

The camshaft (CMP) actuator system is an electro-hydraulic operated device used for a variety of engine performance and operational enhancements. These enhancements include lower emission output through exhaust gas dilution of the intake charge in the combustion chamber, a broader engine torque range, and improved fuel economy. The CMP actuator system accomplishes this by, changing the angle or timing of the camshaft, relative to the crankshaft position. The CMP actuator simply allows earlier or later intake and exhaust valve opening, during the four stroke engine cycle. The CMP actuator cannot vary the duration of valve opening, or the valve lift.

During engine OFF, engine idling conditions, and engine shutdown, the camshaft actuator is held in the park position. Internal to the CMP actuator assembly is a return spring and a locking pin. During non-phasing modes of the camshaft, the return spring rotates the camshaft back to the park position, and the locking pin retains the CMP actuator sprocket to the camshaft. The engine control module (ECM) can only command the CMP actuator to retard the valve timing from the park position, or advance the valve timing back to the park position.

10.2 CMP ACTUATOR SYSTEM OPERATION

The camshaft position (CMP) actuator system is controlled by the engine control module (ECM). The ECM sends a pulse width modulated, signal to the CMP actuator solenoid to control the amount of pressurized engine oil, into the CMP actuator. A low reference circuit, or ground wire between the CMP actuator solenoid and the ECM completes the electrical circuit. To regulate the pressurized engine oil into the CMP actuator, the solenoid uses electromagnetic force on the solenoid pintle to pulse the oil control spool valve. The pressurized engine oil is sent to unseat the locking pin, and to the vane and rotor assembly of the CMP actuator, to either retard or advance the valve timing. The ECM will control the amount of ON time applied to the solenoid, through the signal from the ECM.

The ECM uses the following inputs before assuming control of the CMP actuator, and to calculate the optimum valve timing.

- Engine speed
- Manifold absolute pressure (MAP)
- Throttle position angle
- Camshaft position sensor (CMP)
- Crankshaft position sensor (CKP)
- Crankshaft/camshaft correlation
- Engine coolant temperature (ECT)

P0010, P2088, or P2089 – Camshaft Position (CMP) Actuator Solenoid Control Circuit

- Closed loop fuel control
- Engine oil pressure (EOP)
- Engine oil level
- CMP actuator solenoid circuit state

11 CIRCUIT/SYSTEM VERIFICATION

NOTE: IF A CRANKSHAFT OR CAMSHAFT POSITION SENSOR DTC IS SET, THE CAMSHAFT POSITION ACTUATOR OUTPUT CONTROL WILL NOT FUNCTION.

11.1 Ignition ON, observe the DTC information with a scan tool. Verify DTC P0335, P0336, P0340, and P0341 is not set.

11.1.1 If a DTC is set, refer to Diagnostic Trouble Code (DTC) List for further diagnosis.

11.2 Engine idling, command the Camshaft Position Actuator to 10° while observing the following control circuit status parameters with a scan tool:

11.2.1 The CMP Actuator Solenoid Ckt Short To Ground Test Status

11.2.2 The CMP Actuator Solenoid Ckt Open Test Status

11.2.3 The CMP Actuator Solenoid Ckt Short To Volts Test Status

11.2.4 Each parameter should display OK or Not Run

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

12 CIRCUIT/SYSTEM TESTING

12.1 Ignition OFF, disconnect the Camshaft Position Sensor and Actuator Magnet jumper harness connector. Refer to *INLINE HARNESS CONNECTOR END VIEWS* for connector identification.

12.1.1 **NOTE:** TESTING FOR STEPS 2–4 IS PERFORMED ON THE ECM SIDE OF THE JUMPER HARNESS CONNECTOR.

12.2 Ignition OFF for 1 minute, test for less than 5 Ω between the low reference circuit terminal E and ground.

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

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

12.3 Ignition ON, engine OFF, verify that a test lamp does not illuminate between the control circuit terminalD and ground.

12.3.1 If the test lamp illuminates, test the control circuit for a short to voltage. If the circuit tests normal, replace the ECM.

P0010, P2088, or P2089 – Camshaft Position (CMP) Actuator Solenoid Control Circuit

12.4 Connect the DMM black lead to the control circuit terminalD. Connect the DMM red lead to B+. Set the DMM on the diode setting. Command the CMP actuator solenoid ON and OFF with a scan tool. The DMM should transition from OL when commanded OFF to less than 1V when commanded ON.

12.4.1 If the circuit voltage does not correspond to the specified values, test the control circuit for an open/high resistance or a short to ground. If the circuit tests normal, replace the ECM.

12.4.2 **NOTE:** Testing for steps 5 and 6 is performed on the engine side of the jumper harness connector**.**

12.5 Ignition OFF, test for infinite resistance between the control circuit terminalD and ground.

12.5.1 If not the specified value, repair the control circuit for a short to ground.

12.6 Test for 5.0–9.0Ω between the control circuit terminalD and the low reference circuit terminalE.

12.6.1 If less than the specified range, test for a short between the control circuit and the low reference circuit. If the circuits/connections test normal, test or replace the Camshaft Position Actuator Magnet.

12.6.2 If greater than the specified range, test the control circuit and the low reference for an open/high resistance. If the circuits/connections test normal, test or replace the Camshaft Position Actuator Magnet.

12.7 If all circuits test normal, repair the poor connection at the camshaft position sensor jumper wire harness.

13 COMPONENTTESTING

13.1 STATIC TEST

13.1.1 Ignition OFF, remove the Camshaft Position Actuator Magnet.

13.1.2 Test for 5.0–9.0Ω between the solenoid control terminal2 and the low reference terminal1 at the Camshaft Position Actuator Magnet.

13.1.3 If not within the specified range, replace the Camshaft Position Actuator Magnet.

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

13.1.5 If not the specified value, replace the Camshaft Position Actuator Magnet.

13.2 DYNAMIC TEST

13.2.1 Remove the Camshaft Position Actuator Magnet.

13.2.1.1 THE CAMSHAFT POSITION ACTUATOR MAGNET PINTLE SHOULD BE FACING DOWNWARD FOR THIS TEST.

13.2.1.2 DO NOT ALLOW ELECTRICAL CURRENT TO FLOW THROUGH THE CAMSHAFT POSITION ACTUATOR MAGNET FOR GREATER THAN 1–2S.

13.2.2 Install a 20A fused jumper wire between the control circuit terminal2 and B+. Momentarily install a jumper wire between the low reference terminal1 and ground. The pintle should extent.

13.2.2.1 If the function does not perform as specified, replace the Camshaft Position Actuator Magnet.

P0010, P2088, or P2089 – Camshaft Position (CMP) Actuator Solenoid Control Circuit

14 REPAIR INSTRUCTIONS

14.1 Perform the *DIAGNOSTIC REPAIR VERIFICATION*after completing the diagnostic procedure.

14.2 Camshaft Position Actuator Magnet Replacement

14.3 Control Module References for Engine Control Module replacement, programming, and setupScope

P0011 – Camshaft Position (CMP)System Performance

1 DIAGNOSTICINSTRUCTIONS

1.1 Review *STRATEGY BASED DIAGNOSIS* for an overview of the diagnostic approach.

1.2 Perform the *DIAGNOSTIC SYSTEM CHECK*prior to using this diagnostic procedure.

2 DTC DESCRIPTOR

2.1 **DTC P0011**: Camshaft Position (CMP) System Performance

3 DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Camshaft Position Actuator Solenoid High Control	P0010	P0010	P0010	P0011
Low Reference	—	P0010, P0011	—	—

4 CIRCUIT/SYSTEM DESCRIPTION

The camshaft position (CMP) actuator system enables the engine control module (ECM) to change the timing of the camshaft while the engine is operating. The ECM controls the Camshaft Position Actuator Magnet duty cycle by controlling the amount of ON time. The magnet controls the amount of engine oil flow to the CMP actuator by extending a pintle within the solenoid. The pintle acts against a spool valve in the CMP actuator mechanism which is attached to the front of the camshaft. As the spool valve is moved, oil is directed to the CMP actuator, which rotates the camshaft. The ECM can only command the camshaft position actuator to retard the valve timing from the camshaft park position, or advance the valve timing back to the park position. The total range of valve timing command is 26 degree as measured at the camshaft or 52 degree as measured at the crankshaft.

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

5 CONDITIONS FOR RUNNING THE DTC

5.1 DTCP0010, P0016, P0335, P0336, P0340, or P0341 is not set.

5.2 The engine is running.

5.3 The system voltage is greater than 11V.

5.4 The CMP actuator is enabled and commanded greater than 0degrees.

5.5 The power take off (PTO) is not active - If equipped.

5.6 The desired camshaft position does not vary greater than 7.5degrees for 2s.

5.7 DTCP0011 runs continuously when the above conditions are met.

6 CONDITIONS FOR SETTING THE DTC

The ECM detects the difference between the desired camshaft position angle and the actual camshaft position angle is greater than 8degrees.

6.1 ACTION TAKEN WHEN THE DTC SETS

6.1.1 DTC P0011 is a Type B DTC.

6.1.2 The camshaft position actuator is commanded to the park position.

7 CONDITIONS FOR CLEARING THE DTC

7.1 DTCP0011 is a TypeB DTC.

8 DIAGNOSTIC AIDS

8.1 The engine oil condition has a major impact on the camshaft actuator system.

8.2 A low oil level condition may set this DTC. The engine may require an oil change. Inquire with the customer when the last oil change was performed. You may also monitor the scan tool Engine Oil Life parameter. Advise the customer an oil change may be required.

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

9 REFERENCE INFORMATION

9.1 SCHEMATIC REFERENCE

9.1.1 Engine Controls Schematics

9.2 CONNECTOR END VIEW REFERENCE

9.2.1 Component Connector End Views

9.3 DESCRIPTION AND OPERATION

9.3.1 Camshaft Actuator System Description

9.4 ELECTRICAL INFORMATION REFERENCE

9.4.1 Circuit testing

9.4.2 Connector repairs

10 CAMSHAFT ACTUATOR SYSTEM DESCRIPTION

10.1 CAMSHAFT POSITION (CMP) ACTUATOR SYSTEM

The camshaft (CMP) actuator system is an electro-hydraulic operated device used for a variety of engine performance and operational enhancements. These enhancements include lower emission output through exhaust gas dilution of the intake charge in the combustion chamber, a broader engine torque range, and improved fuel economy. The CMP actuator system accomplishes this by, changing the angle or timing of the camshaft, relative to the crankshaft position. The CMP actuator simply allows earlier or later intake and exhaust valve opening, during the four stroke engine cycle. The CMP actuator cannot vary the duration of valve opening, or the valve lift.

During engine OFF, engine idling conditions, and engine shutdown, the camshaft actuator is held in the park position. Internal to the CMP actuator assembly is a return spring and a locking pin. During non-phasing modes of the camshaft, the return spring rotates the camshaft back to the park position, and the locking pin retains the CMP actuator sprocket to the camshaft. The engine control module (ECM) can only command the CMP actuator to retard the valve timing from the park position, or advance the valve timing back to the park position.

10.2 CMP ACTUATOR SYSTEM OPERATION

The camshaft position (CMP) actuator system is controlled by the engine control module (ECM). The ECM sends a pulse width modulated, signal to the CMP actuator solenoid to control the amount of pressurized engine oil, into the CMP actuator. A low reference circuit, or ground wire between the CMP actuator solenoid and the ECM completes the electrical circuit. To regulate the pressurized engine oil into the CMP actuator, the solenoid uses electromagnetic force on the solenoid pintle to pulse the oil control spool valve. The pressurized engine oil is sent to unseat the locking pin, and to the vane and rotor assembly of the CMP actuator, to either retard or advance the valve timing. The ECM will control the amount of ON time applied to the solenoid, through the signal from the ECM.

The ECM uses the following inputs before assuming control of the CMP actuator, and to calculate the optimum valve timing.

- Engine speed
- Manifold absolute pressure (MAP)
- Throttle position angle
- Camshaft position sensor (CMP)
- Crankshaft position sensor (CKP)
- Crankshaft/camshaft correlation

- Engine coolant temperature (ECT)
- Closed loop fuel control
- Engine oil pressure (EOP)
- Engine oil level
- CMP actuator solenoid circuit state

11 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.

11.1 Verify the engine has the correct oil pressure. Refer to Oil Pressure Diagnosis and Testing.

11.2 Ignition ON, observe the scan tool DTC information. Verify that none of the following DTCs are set:

- **P0335**
- **P0336**
- **P0340**
- **P0341**
- **P0521**
- **P0522**
- **P0523**
- **P1516**
- **P2101**
- **P2119**
- **P2176**

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

11.4 **NOTE: I**f a crankshaft or camshaft position sensor DTC is set, the camshaft position actuator output control will not function.

11.5 Engine idling, command the camshaft position actuator solenoid to 20° with a scan tool. The Desired Camshaft Position parameter should match the Camshaft Position parameter.

11.6 Observe the Camshaft Position Variance parameter with a scan tool. The Camshaft Position Variance will increment for several seconds, until the Camshaft Position value matches the Desired Camshaft Position value. The Camshaft Position Variance value should return to 0°.

P0011 – Camshaft Position (CMP)System Performance

11.7 Operate the vehicle within the Conditions for Running the DTC, to verify the DTC does not reset. You may also operate the vehicle within the conditions that are captured in the Freeze Fame/Failure Records Data List.

12 CIRCUIT/SYSTEM TESTING

12.1 Ignition OFF, disconnect the Camshaft Position Sensor and Actuator Magnet jumper harness connector.

12.1.1 **NOTE:** TESTING FOR STEPS 2–4 IS PERFORMED ON THE ECM SIDE OF THE JUMPER HARNESS CONNECTOR.

12.2 Ignition OFF for 1 minute, test for less than 5 Ω between the low reference circuit terminal E and ground.

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

12.2.2 **NOTE:** A TEST LAMP MUST BE USED FOR THIS TEST. THE CONTROL CIRCUIT IS PULLED-UP TO A LOW CURRENT VOLTAGE. A VOLTAGE ON THE CONTROL CIRCUIT IS NORMAL.

12.3 Ignition ON, engine OFF, verify that a test lamp does not illuminate between the control circuit terminalD and ground.

12.3.1 If the test lamp illuminates, test the control circuit for a short to voltage. If the circuit tests normal, replace the ECM.

12.4 Connect the DMM black lead to the control circuit terminalD. Connect the DMM red lead to B+. Set the DMM on the diode setting. Command the CMP actuator solenoid ON and OFF with a scan tool. The DMM should transition from OL when commanded OFF to less than 1V when commanded ON.

12.4.1 If the circuit voltage does not correspond to the specified values, test the control circuit for an open/high resistance or a short to ground. If the circuit tests normal, replace the ECM.

12.4.2 **NOTE:** TESTING FOR STEPS 5 AND 6 ARE PERFORMED ON THE ENGINE SIDE OF THE JUMPER HARNESS CONNECTOR**.**

12.5 Ignition OFF, test for infinite resistance between the control circuit terminalD and ground.

12.5.1 If not the specified value, repair the control circuit for a short to ground.

12.6 Test for 5.0–9.0Ω between the control circuit terminalD and the low reference circuit terminalE.

12.6.1 If less than the specified range, test for a short between the control circuit and the low reference circuit. If the circuits/connections test normal, test or replace the Camshaft Position Actuator Magnet.

12.6.2 If greater than the specified range, test the control circuit and the low reference for an open/high resistance. If the circuits/connections test normal, test or replace the Camshaft Position Actuator Magnet.

12.7 Remove the camshaft position actuator magnet. Perform the Camshaft Position Actuator Magnet Cleaning and Inspection. The camshaft position actuator magnet should pass the inspection.

12.7.1 If the inspection fails, replace the camshaft position actuator magnet.

12.8 Perform the Camshaft Position Actuator Solenoid Valve Inspection. The Camshaft Position Actuator Solenoid Valve should pass the inspection.

12.8.1 If the inspection fails, replace the Camshaft Position Actuator Solenoid Valve.

12.9 If all circuits and components test normal, replace the mechanical Camshaft Position Actuator.

13 COMPONENTTESTING

13.1 STATIC TEST

13.1.1 Ignition OFF, remove the Camshaft Position Actuator Magnet.

13.1.2 Test for 5.0–9.0Ω between the solenoid control terminal2 and the low reference terminal1 at the Camshaft Position Actuator Magnet.

13.1.3 If not within the specified range, replace the Camshaft Position Actuator Magnet.

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

13.1.5 If not the specified value, replace the Camshaft Position Actuator Magnet.

13.2 DYNAMIC TEST

13.2.1 Remove the Camshaft Position Actuator Magnet.

13.2.1.1 THE CAMSHAFT POSITION ACTUATOR MAGNET PINTLE SHOULD BE FACING DOWNWARD FOR THIS TEST.

13.2.1.2 DO NOT ALLOW ELECTRICAL CURRENT TO FLOW THROUGH THE CAMSHAFT POSITION ACTUATOR MAGNET FOR GREATER THAN 1–2 S.

13.2.1.3 Install a 20 A fused jumper wire between the control circuit terminal 2 and B+. Momentarily install a jumper wire between the low reference terminal 1 and ground. The pintle should extent.

13.2.1.4 If the function does not perform as specified, replace the Camshaft Position Actuator Magnet.

14 REPAIR INSTRUCTIONS

14.1 Perform the *DIAGNOSTIC REPAIR VERIFICATION*after completing the diagnostic procedure.

14.2 Camshaft Position Actuator Cleaning and Inspection

14.3 Camshaft Position Actuator Magnet Replacement

14.4 Camshaft Position Actuator Replacement

14.5 Camshaft Position Actuator Solenoid Valve Replacement

14.6 Control Module References for ECM replacement, programming, and setup

P0016 –Crankshaft Position (CKP)Camshaft Position (CMP) Correlation

1 DIAGNOSTIC INSTRUCTIONS

1.1 Review *STRATEGY BASED DIAGNOSIS* for an overview of the diagnostic approach.

1.2 Perform the *DIAGNOSTIC SYSTEM CHECK* prior to using this diagnostic procedure.

2 DTC DESCRIPTOR

2.1 **DTC P0016**: Crankshaft Position (CKP) Camshaft Position (CMP) Correlation

3 CIRCUIT/SYSTEM DESCRIPTION

The engine control module (ECM) uses the crankshaft position (CKP) sensor and the camshaft position (CMP) sensor pulses to monitor the correlation between the crankshaft and the camshaft position. The crankshaft reluctor wheel consists of a 60-tooth pattern with 2teeth missing for the reference gap. Each tooth is evenly spaced 6 degrees apart, except for the reference gap. The camshaft reluctor wheel has 4teeth, 2narrow, and 2wide. The 4 trailing edges of each tooth are evenly spaced at 90degrees apart around the circumference of the camshaft sprocket. With the engine running, and the CMP actuator in the parked position, the ECM expects the camshaft signal pulses to occur 36crankshaft degrees before top dead center (BTDC) for cylinder number1, and every 90degrees thereafter.

4 CONDITIONS FOR RUNNING THE DTC

4.1 DTCP0335, P0336, P0340, P0341, P0641, or P0651 is not set.

4.2 The engine is running.

4.3 The engine speed is less than 2,000RPM.

4.4 The CMP actuator is commanded to the parked position.

4.5 DTCP0016 runs continuously when the above conditions are met.

5 CONDITIONS FOR SETTING THE DTC

The ECM detects that the CMP sensor pulses occur more than 11 crank degrees before or 11 crank degrees after, nominal position for 24 out of 30 engine cycles.

6 ACTION TAKEN WHEN THE DTC SETS

6.1 DTCP0016 is a TypeB DTC.

6.2 The CMP actuator is commanded to the park position.

P0016 –Crankshaft Position (CKP)Camshaft Position (CMP) Correlation

7 CONDITIONS FOR CLEARING THE DTC

7.1 DTC P0016 is a Type B DTC.

8 REFERENCE INFORMATION

8.1 SCHEMATIC REFERENCE

8.1.1 Engine Controls Schematics

8.2 CONNECTOR END VIEW REFERENCE

8.2.1 Component Connector End Views

8.3 DESCRIPTION AND OPERATION

8.3.1 Camshaft actuator system description

8.3.2 Electronic ignition system description

8.4 ELECTRICAL INFORMATION REFERENCE

8.4.1 Circuit testing

8.4.2 Connector repairs

8.4.3 Testing for intermittent conditions and poor connections

8.4.4 Wiring repairs

8.5 DTC TYPE REFERENCE

8.5.1 Powertrain Diagnostic Trouble Code (DTC) Type Definitions

8.6 SCAN TOOL REFERENCE

8.6.1 Control Module References for scan tool information

9 CIRCUIT/SYSTEM TESTING

9.1 Idle the engine at normal operating temperature. Observe the DTC information with a scan tool. DTCP0016 should not set.

9.1.1 If a DTC sets, inspect for the following:

9.1.2 The correct installation of the camshaft sensor

9.1.3 The correct installation of the crankshaft sensor

9.1.4 A timing chain tensioner condition

9.1.5 An incorrectly installed timing chain

P0016 –Crankshaft Position (CKP)Camshaft Position (CMP) Correlation

9.1.6 Excessive play in the timing chain or sprockets

9.1.7 A timing chain that jumped teeth

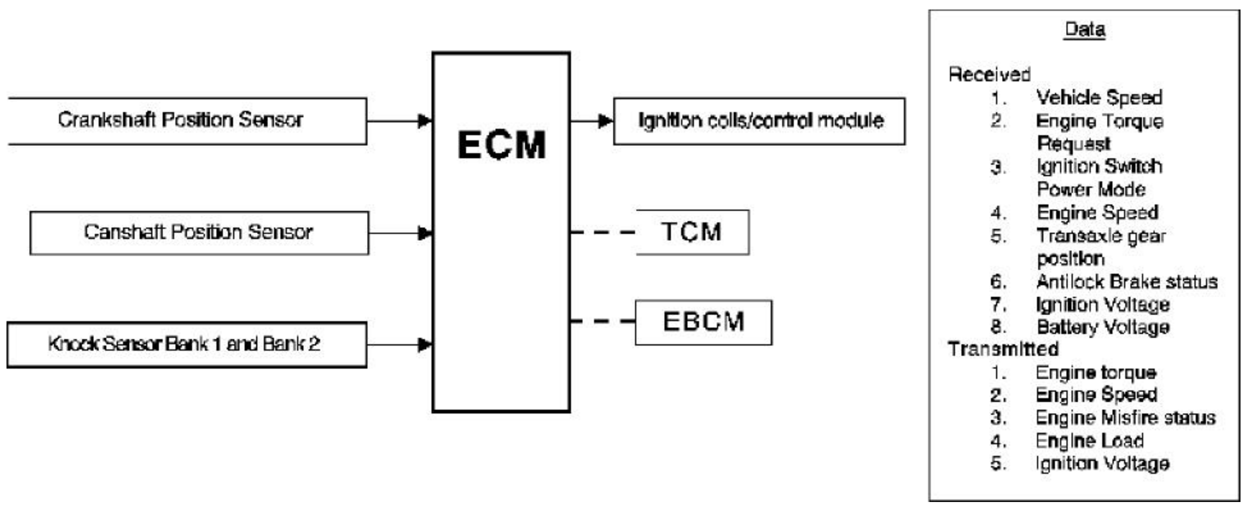
9.1.8 If you find a condition, repair as necessary.

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

10 REPAIR INSTRUCTIONS

Perform the *DIAGNOSTIC REPAIR VERIFICATION*after completing the diagnostic procedure.

10.1 Timing Chain, Crankshaft Sprocket, Camshaft Position Actuator, and Solenoid Valve Replacement



P018B, P018C, P018D– Fuel Pressure Sensor

1 DIAGNOSTIC INSTRUCTIONS

1.1 Review *STRATEGY BASED DIAGNOSIS* for an overview of the diagnostic approach.

1.2 Perform the *DIAGNOSTIC SYSTEM CHECK* prior to using this diagnostic procedure.

2 DTC DESCRIPTOR

2.1 **DTCP018B:** Fuel Pressure Sensor Performance

2.2 **DTCP018C:** Fuel Pressure Sensor Circuit Low Voltage

2.3 **DTCP018D:** Fuel Pressure Sensor Circuit High Voltage

3 DIAGNOSTIC FAULT INFORMATION

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

4 CIRCUIT/SYSTEM DESCRIPTION

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

5 CONDITIONS FOR RUNNING THE DTC

5.1 The engine is running.

5.2 DTC P018C, P018D, P0231, P0232, P023F, P064A, P1255 or P06A6 are not active.

5.3 DTC P018C, P018D, P0231, P0232, P023F, P064A, P1255 or P06A6 are not active.

5.4 DTCP0641 has not failed this ignition cycle.

5.5 Fuel pump control is enabled and the fuel pump control state is normal.

5.6 The engine has been running for at least 5 seconds.

P018B, P018C, P018D– Fuel Pressure Sensor

6 CONDITIONS FOR SETTING THE DTC

The fuel pump control module does not detect a change in the fuel rail pressure of at least 30 kPa (4.4 psi) when the fuel pump is operating. The fuel rail pressure sensor performance diagnostic provides a means to detect fuel pressure sensor output that is stuck within the normal operating range of the sensor.

7 ACTION TAKEN WHEN THE DTC SETS

7.1 DTCP018B, P018C and P018D are Type A DTCs.

7.2 DTCP018B, P018C and P018D are Type A DTCs.

8 CONDITIONS FOR CLEARING THE DTC

9 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.

10 REFERENCE INFORMATION

10.1 SCHEMATIC REFERENCE

10.1.1 Engine controls schematics

10.2 CONNECTOR END VIEW REFERENCE

10.2.1 Component connector end views

10.3 ELECTRICAL INFORMATION REFERENCE

10.3.1 Circuit testing

10.3.2 Connector repairs

10.3.3 Testing for intermittent conditions and poor connections

10.3.4 Wiring repairs

10.4 DTC TYPE REFERENCE

10.4.1 Powertrain diagnostic trouble code (DTC) type definitions

10.5 SCAN TOOL REFERENCE

10.5.1 CONTROL MODULE REFERENCESfor scan tool information

P018B, P018C, P018D– Fuel Pressure Sensor

11 CIRCUIT/SYSTEM TESTING

NOTE: VERIFY THAT THE FUEL TANK IS NOT EMPTY. ONLY PERFORM THIS DIAGNOSTIC IF THERE IS AT LEAST 2 GALLONS OF FUEL IN THE FUEL TANK. CLEAR THE DTC, AND START AND RUN THE ENGINE. VERIFY THAT THE DTC P0118B RESETS BEFORE PROCEEDING WITH THE CIRCUIT SYSTEM TESTING. IF THE DTC DOES NOT RESET, REFER TO DIAGNOSTIC AIDS**.**

11.1 Ignition OFF, disconnect the harness connector at the B47 fuel pressure sensor.

11.2 Ignition OFF and all vehicle systems OFF. It may take up to 2 minutes for all vehicle systems to power down. Test for less than 10Ω between the low reference circuit terminal 2 and ground.

11.2.1 If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the K27 fuel pump flow control module.

11.3 Ignition ON, test for 4.8–5.2V between the B47 fuel pressure sensor 5V reference circuit terminal 3 and ground.

11.3.1 If less than the specified range, test the 5V reference circuit for a short to ground or an open/high

11.3.2 If greater than the specified range, test the 5V reference circuit for a short to voltage. If the circuit tests normal, replace the K27 fuel pump flow control module.

11.4 Verify the scan tool fuel pressure sensor voltage is less than 1V.

11.4.1 If greater than the specified range, test the signal circuit terminal 1 for a short to voltage. If the circuit tests normal, replace the K27 fuel pump flow control module.

11.5 Install a 3A fused jumper wire between the signal circuit terminal 1 and the 5V reference circuit terminal 3. Verify the scan tool fuel pressure sensor voltage is greater than 4.8V.

11.5.1 If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K27 fuel pump flow control module.

11.5.2 If all circuits test normal, replace the B47 fuel pressure sensor.

12 REPAIR INSTRUCTIONS

12.1 Perform the *DIAGNOSTIC REPAIR VERIFICATION* after completing the repair.

12.2 FUEL PRESSURE SENSOR REPLACEMENT

12.3 *CONTROL MODULE REFERENCES* for fuel pump control module replacement, programming and setup.

P0030, P0036, P0050, P0053, P0054, P0056, P0059, P0060, P0135, P0141, P0155, or P0161– Heated Oxygen (HO2) Sensors

1 DIAGNOSTIC INSTRUCTIONS

1.1 Review *STRATEGY BASED DIAGNOSIS* for an overview of the diagnostic approach.

1.2 Perform the *DIAGNOSTIC SYSTEM CHECK* prior to using this diagnostic procedure.

2 DTC DESCRIPTOR

2.1 **DTC P0030:** HO2S Heater Control Circuit Bank1 Sensor1

2.2 **DTC P0036:** HO2S Heater Control Circuit Bank1 Sensor2

2.3 **DTC P0050:** HO2S Heater Control Circuit Bank 2 Sensor1

2.4 **DTC P0053:** HO2S Heater Resistance Bank1 Sensor1

2.5 **DTC P0054:** HO2S Heater Resistance Bank 1 Sensor 2

2.6 **DTC P0056:** HO2S Heater Control Circuit Bank2 Sensor 2

2.7 **DTC P0059:** HO2S Heater Resistance Bank 2 Sensor1

2.8 **DTC P0060:** HO2S Heater Resistance Bank 2 Sensor2

2.9 **DTC P0135:**HO2S Heater Performance Bank 1 Sensor 1

2.10 **DTC P0141:**HO2S Heater Performance Bank 1 Sensor 2

2.11 **DTC P0155**: HO2S Heater Performance Bank 2 Sensor 1

2.12 **DTC P0161**: HO2S Heater Performance Bank 2 Sensor 2

P0030, P0036, P0050, P0053, P0054, P0056, P0059, P0060, P0135, P0141, P0155, or P0161– Heated Oxygen (HO2) Sensors

3 DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
HO2S Heater Voltage Supply	P0030, P0036, P0050, P0056, P0135, P0138, P0141, P0155, P0158, P0161*	P0030, P0036, P0050, P0053, P0054, P0056, P0059, P0060, P0135, P0141, P0155, P0161	P0030, P0036, P0050, P0056, P0135, P0141, P0155, P0158, P0160, P0161	P0690	P0135, P0141, P0155, P0161
HO2S Heater Control	P0030, P0036, P0050, P0056	P0053, P0054, P0059, P0060, P0138, P0140, P0158, P0160	P0030, P0036, P0050, P0056, P0135, P0141, P0152, P0154, P0155, P0158, P0160, P0161	P0030, P0036, P0050, P0056, P0135, P0141, P0151, P0155, P0158, P0160, P0161	P0135, P0141, P0155, P0161

4 TYPICAL SCAN TOOL DATA

HO2S Bank 1 or 2 / Sensor 1 or 2 Heater

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: *Engine Running*			
Parameter Normal Range:0.3 – 1.5 A			
Ignition Voltage	0 A	0 A	0.3 – 1.5 A
HO2S Heater Low Control	0 A	0 A	0 A

5 CIRCUIT/SYSTEM DESCRIPTION

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

P0030, P0036, P0050, P0053, P0054, P0056, P0059, P0060, P0135, P0141, P0155, or P0161– Heated Oxygen (HO2) Sensors

6 CONDITIONS FOR RUNNING THE DTC

6.1 P0030, P0036, P0050, or P0056

6.1.1 The Ignition voltage is between 11–32 volts.

6.1.2 The engine speed is greater than 400 RPM.

6.1.3 The DTCs run continuously when the above conditions are met for 1 second.

6.2 P0053, P0054, P0059, or P0060

6.2.1 DTCs P0112, P0113, P0117, P0118, or P2610 are not set.

6.2.2 The Ignition voltage is less than 32 volts.

6.2.3 The engine run time is greater than 3 seconds.

6.2.4 The Ignition is OFF for greater than 8 hours.

6.2.5 The engine coolant temperature (ECT) is between −30 to +45°C (−22 to +113°F) at engine start-up.

6.2.6 The ECT and the intake air temperature (IAT) are within 8°C (14°F) at engine start-up.

6.2.7 The DTCs run once per drive cycle when the above conditions are met.

6.3 P0135, P0141, P0155, or P0161

6.3.1 DTCs P0116, P0117, P0118, P0125, or P0128 are not set.

6.3.2 The Ignition voltage is between 10–32 volts.

6.3.3 The HO2S is at operating temperature.

6.3.4 The HO2S is commanded ON.

6.3.5 The DTCs run once per drive cycle when the above conditions are met for 120 seconds.

7 CONDITIONS FOR SETTING THE DTC

7.1 P0030, P0036, P0050, or P0056

The ECM detects that the commanded state of the driver and the actual state of the control circuit do not match for greater than 7 seconds.

7.2 P0053, P0054, P0059, or P0060

P0030, P0036, P0050, P0053, P0054, P0056, P0059, P0060, P0135, P0141, P0155, or P0161– Heated Oxygen (HO2) Sensors

The ECM detects the HO2S heater is not within a specified resistance range at engine start-up for greater than 1 second.

7.3 P0135 or P0155

The ECM detects that the HO2S 1 heater current is greater than 3.1 amps or less than 0.3 amps for greater than 10 seconds.

7.4 P0141 or P0161

The ECM detects that the HO2S 2 heater current is greater than 2.9 amps, or less than 0.3 amp for greater than 10 seconds.

8 ACTION TAKEN WHEN THE DTC SETS

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

9 CONDITIONS FOR CLEARING THE MIL/DTC

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

10 REFERENCE INFORMATION

10.1 SCHEMATIC REFERENCE

10.1.1 Engine controls schematics

10.2 CONNECTOR END VIEW REFERENCE

10.2.1 Component connector end views

10.3 ELECTRICAL INFORMATION REFERENCE

10.3.1 Circuit testing

10.3.2 Connector repairs

10.3.3 Heated oxygen sensor wiring repairs

10.3.4 Testing for intermittent conditions and poor connections

10.3.5 Wiring repairs

10.4 DTC TYPE REFERENCE

10.4.1 Powertrain diagnostic trouble code (DTC) type definitions

10.5 SCAN TOOL REFERENCE

10.5.1 CONTROL MODULE REFERENCESfor scan tool information

11 CIRCUIT/SYSTEM VERIFICATION

11.1 Engine idling; command the appropriate Heated Oxygen Sensor heater to 100% and 0% with a scan tool while observing the control circuit status parameters listed below. Each parameter should toggle between OK and Not Run or Not Run and OK.

11.1.1 HO2S Bn or 2 Sen 1 or 2 HtrCkt Short Volts Test Status

11.1.2 HO2S Bn 1 or 2 Sen 1 or 2 HtrCkt Open Test Status

11.1.3 HO2S Bn 1 or 2 Sen 1 or 2 HtrCkt Short Gnd Test Status

11.2 Engine idling at operating temperature; observe the scan tool HO2S Bank 1 or 2 Sensor 1 or 2 Heater parameter. The amperage should be within the specified range listed below:

11.2.1 0.3–3.0 A for HO2S Bank 1 or 2 Sensor 1

11.2.2 0.3–2.8 A for HO2S Bank 1 or 2 Sensor 2

11.3 Engine idling at operating temperature, move the related wiring and connectors while observing the Heated Oxygen Sensor heater parameter with a scan tool. The parameter should not change with movement.

11.3.1 If movement affects the parameter, repair the appropriate harness or connector.

11.4 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.

12 CIRCUIT/SYSTEM TESTING

12.1 Ignition OFF, disconnect the harness connector at the appropriate B52 HO2S.

12.2 Ignition ON, verify that a test lamp illuminates between the ignition voltage circuit terminal D and ground.

12.2.1 If the test lamp does not illuminate, test the ignition voltage circuit for a short to ground or an open/high resistance. If the circuit tests normal and the B52 HO2S heater circuit fuse is open, test all components connected to the fuse and replace as necessary.

12.3 Probe the appropriate control circuit terminal listed below with a test lamp connected to B+. Verify that the test lamp does not illuminate.

12.3.1 B52 HO2S 1 terminal E

12.3.2 B52 HO2S 2 terminal E

12.3.3 If the test lamp illuminates, test the control circuit for a short to ground. If the circuit tests normal, replace the K20 ECM.

12.4 Engine idling, the test lamp should illuminate, or flash.

12.4.1 If the test lamp does not illuminate, or flash, test the control circuit for a short to voltage, or an open/high resistance. If the circuit/connections test normal, replace the K20 ECM.

NOTE:

- Less than 10 Ω 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 will display greater than 0.00 amps.
- Performing this test may set additional DTCs.

12.5 Ignition OFF, connect a 10 A fused jumper wire between the control circuit terminal listed below and the ignition voltage circuit terminal D.

12.5.1 B52 HO2S 1 terminal E

12.5.2 B52 HO2S 2 terminal E

12.6 Engine idling; observe the appropriate B52 HO2S Heater parameter. The scan tool should display 0.00 A.

12.6.1 If greater than the specified value, test the control circuit and the ignition voltage circuit for high resistance.

12.7 If all circuits test normal, test or replace the appropriate B52 HO2S.

13 REPAIR INSTRUCTIONS

13.1 Perform theDIAGNOSTIC REPAIR VERIFICATION after completing the diagnostic procedure.

13.2 See OEM Service Manual for Heated O2 sensor replacement.

13.3 CONTROL MODULE REFERENCES for ECM replacement, setup, and programming

P0068 – Throttle Body Airflow Performance
P1101 –Intake Air Flow System Performance

1 DIAGNOSTIC INSTRUCTIONS

1.1 Review *STRATEGY BASED DIAGNOSIS* for an overview of the diagnostic approach.

1.2 Perform the *DIAGNOSTIC SYSTEM CHECK* prior to using this diagnostic procedure.

2 DTC DESCRIPTOR

2.1 **DTC P0068:** Throttle Body Airflow Performance

2.2 **DTC P1101:** Intake Air Flow System Performance

3 CIRCUIT/SYSTEM DESCRIPTION

3.1 The engine control module (ECM) uses the following information to calculate an expected airflow rate:

- The throttle position (TP)
- The barometric pressure (BARO)
- The manifold absolute pressure (MAP)
- The intake air temperature (IAT)
- The engine RPM

3.2 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 (TP) sensors. This is an explicit model-based diagnostic containing 4 separate models for the intake system.

3.2.1 The throttle model describes the flow through the throttle body and is used to estimate the MAF through the throttle body as a function of barometric pressure (BARO), TP, intake air temperature (IAT), and estimated MAP. The information from this model is displayed on the scan tool as the MAF Performance Test parameter.

3.2.2 The first intake manifold model describes the intake manifold and is used to estimate MAP as a function of the MAF into the manifold from the throttle body and the MAF out of the manifold caused by engine pumping. The flow into the manifold from the throttle uses the MAF estimate calculated from the above throttle model. The information from this model is displayed on the scan tool as the MAP Performance Test 1 parameter.

3.2.3 The second intake manifold model is identical to the first intake manifold model except that the MAF sensor measurement is used instead of the throttle model estimate for the throttle air input. The information from this model is displayed on the scan tool as the MAP Performance Test 2 parameter.

3.2.4 The fourth model is created from the combination and additional calculations of the throttle model and the first intake manifold model. The information from this model is displayed on the scan tool as the TP Performance Test parameter.

3.3 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 TP sensors and to each other to determine the appropriate DTC to fail.

4 CONDITIONS FOR RUNNING THE DTC

4.1 P0068

4.1.1 The engine is running above 800 RPM

4.1.2 Ignition voltage is at least 6 V.

4.1.3 DTCP0068 run continuously when the above conditions are met

4.2 P1101

4.2.1 DTCsP0102, P0103, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0128, P0335, and P0336 are not set.

4.2.2 The engine speed is between450 - 5,750 RPM.

4.2.3 The intake air temperature is between -20 and +125^{o} C (-4 and +257^{o} F)

4.2.4 The engine coolant temperature is between -20 and +125^{o} C (-4 and +257^{o}

F) 4.2.5 This DTCrun continuously when the above conditions are met

5 CONDITIONS FOR SETTING THE DTC

5.1 P0068

5.1.1 The ECM detects that the throttle position and the indicated engine load do not correspond with the expected load and throttle position for less than 1second.

5.2 P1101

5.2.1 The engine control module (ECM) detects that the actual measured airflow from the MAF, MAP, and TP sensors is not within range of the calculated airflow that is derived from the system of models for more than 0.5 s.

6 ACTION TAKEN WHEN THE DTC SETS

6.1 P0068

6.1.1 DTCP0068 is a TypeA DTC.

6.1.2 The control module commands the throttle actuator control (TAC) system to operate in the Reduced Engine Power mode.

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

6.1.4 Under certain conditions the control module commands the engine OFF.

6.2 P1101

6.2.1 DTCP1101 is a TypeB DTC.

7 CONDITIONS FOR CLEARING THE MIL/DTC

7.1 DTCP0068 is a TypeA DTC.

7.2 DTCP1101 is a TypeB DTC.

8 DIAGNOSTIC AIDS

8.1 A steady or intermittent high resistance of 15 ohms or greater on the ignition 1 voltage circuit will cause the MAF sensor signal to be increased by as much as 60 g/s. To pinpoint this condition perform a voltage drop test on the circuit.

8.2 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.

8.3 Depending on the current ambient temperature, and the vehicle operating conditions, a MAF sensor signal circuit that is shorted to the IAT signal circuit will increase or decrease the MAF sensor signal that is interpreted by the ECM. Additionally it may cause a rapid fluctuation in the IAT Sensor parameter.

8.4 A skewed or stuck engine coolant temperature (ECT) or IAT sensor will cause the calculated models to be inaccurate and may cause this DTC to run when it should not. Refer to Temperature Versus Resistance.

8.5 Certain aftermarket air filters may cause this DTC to set.

8.6 Certain aftermarket air induction systems may cause this DTC to set.

8.7 Modifications to the air induction system may cause this DTC

9 REFERENCE INFORMATION

9.1 SCHEMATIC REFERENCE

9.1.1 Engine Controls Schematics

P0068 – Throttle Body Airflow Performance
P1101 –Intake Air Flow System Performance

9.2 CONNECTOR END VIEW REFERENCE

9.2.1 Component Connector End Views

9.3 ELECTRICAL INFORMATION REFERENCE

9.3.1 Circuit testing

9.3.2 Connector repairs

9.3.3 Testing for intermittent conditions and poor connections

9.3.4 Wiring repairs

9.4 DTC TYPE REFERENCE

9.4.1 Powertrain Diagnostic Trouble Code (DTC) Type Definitions

9.5 SCAN TOOL REFERENCE

9.5.1 Control Module References for scan tool information

10 CIRCUIT/SYSTEM TESTING

10.1 Ignition ON

10.2 Verify the scan tool TB Idle Airflow Compensation parameter is less than 90 %.

10.2.1 90 % or greater, clean throttle body

10.3 Verify the scan tool TP Sensors 1 and 2 Agree/Disagree parameter displays Agree while performing the Throttle Sweep Test with a scan tool.

10.3.1 If Disagree Refer to DTC P0120-P0123, P0220, P0222, P0223, or P2135 for further diagnosis

10.4 Determine the current vehicle testing altitude.

10.5 Verify the scan tool MAP Sensor pressure parameter is within the range specified in the Altitude Versus Barometric Pressure table.

10.5.1 The MAP Sensor pressure is not in range Refer to DTC P0106 for further diagnosis.

10.6 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.

10.6.1 If not between 26–52 kPa (3.8–7.5 psi) or does not change Refer to DTC P0106 for further diagnosis.

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

10.7.1 Engine idling

10.7.2 Perform the scan tool snapshot function.

10.7.3 Increase the engine speed slowly to 3,000 RPM and then back to idle.

10.7.4 Exit from the scan tool snapshot and review the data.

10.7.5 Observe the MAF Sensor parameter frame by frame with a scan tool.

10.7.5.1 The MAF Sensor parameter does not change smoothly and gradually Refer to DTC P0068 or P1101 for further diagnosis.

10.8 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.

10.9 Verify a DTC does not set.

10.9.1 If any DTC sets Refer to Diagnostic Trouble Code (DTC) List for further diagnosis

10.10 All OK

11 REPAIR INSTRUCTIONS

11.1 Perform the *DIAGNOSTIC REPAIR VERIFICATION*after completing the repair.

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

P0101 – Mass Air Flow (MAF) Sensor Performance

1 DIAGNOSTIC INSTRUCTIONS

1.1 Review *STRATEGY BASED DIAGNOSIS* for an overview of the diagnostic approach.

1.2 Perform the *DIAGNOSTIC SYSTEM CHECK* prior to using this diagnostic procedure.

2 DTC DESCRIPTOR

2.1 **DTC P0101:** Mass Air Flow (MAF) Sensor Performance

3 DIAGNOSTIC FAULT INFORMATION

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

4 TYPICAL SCAN TOOL DATA

4.1 MAF Sensor Circuit

	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine running at various operating conditions ***Parameter Normal Range:*** 2,000–9,500 Hz			
Ignition Voltage	0 Hz	0 Hz	—
MAF Sensor Signal	0 Hz	0 Hz	0 Hz
Ground	—	0 Hz	—

5 CIRCUIT DESCRIPTION

The engine control module (ECM) uses the following information to calculate an expected airflow rate:

- Throttle Position (TP)
- Barometric Pressure (BARO)
- Intake Air Temperature (IAT)
- Engine RPM

P0101 – Mass Air Flow (MAF) Sensor Performance

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 (TP) sensors. This is an explicit model-based diagnostic containing 4 separate models for the intake system.

5.1 The throttle model describes the flow through the throttle body and is used to estimate the MAF through the throttle body as a function of barometric pressure (BARO), TP, intake air temperature (IAT), and estimated MAP. The information from this model is displayed on the scan tool as the MAF Performance Test parameter.

5.2 The first intake manifold model describes the intake manifold and is used to estimate MAP as a function of the MAF into the manifold from the throttle body and the MAF out of the manifold caused by engine pumping. The flow into the manifold from the throttle uses the MAF estimate calculated from the above throttle model. The information from this model is displayed on the scan tool as the MAP Performance Test 1 parameter.

5.3 The second intake manifold model is identical to the first intake manifold model except that the MAF sensor measurement is used instead of the throttle model estimate for the throttle air input. The information from this model is displayed on the scan tool as the MAP Performance Test 2 parameter.

5.4 The fourth model is created from the combination and additional calculations of the throttle model and the first intake manifold model. The information from this model is displayed on the scan tool as the TP Performance Test parameter.

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

6 CONDITIONS FOR RUNNING THE DTC

6.1 DTCs P0102, P0103, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0128, P0335, P0336 and P3400 are not set.

6.1.1 The engine speed is between 450–5,750 RPM.

6.1.2 The IAT Sensor is between −20 and +125°C (−4 and +257°F).

6.1.3 The ECT Sensor is between −20 and +125°C (−4 and +257°F).

6.1.4 This DTC runs continuously within the enabling conditions.

7 CONDITIONS FOR SETTING THE DTC

The engine control module (ECM) detects that the actual measured airflow from the MAF, MAP, and TP sensors is not within range of the calculated airflow that is derived from the system of models for greater than 0.5 s.

8 ACTION TAKEN WHEN THE DTC SETS

8.1 DTC P0101 is a Type B DTCs.

P0101 – Mass Air Flow (MAF) Sensor Performance

9 CONDITIONS FOR CLEARING THE MIL/DTC

9.1 DTC P0101 is a Type B DTCs.

10 DIAGNOSTIC AIDS

10.1 Inspect the harness of the MAF sensor to verify that it is not routed too close to the following components:

- The ignition coil module
- Any solenoids
- Any relays
- Any motors

10.2 A steady or intermittent high resistance of 15 Ω or greater on the ignition voltage circuit will cause the MAF sensor signal to be increased by as much as 60 g/s. To pinpoint this condition perform a voltage drop test on the circuit.

10.3 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. Inspect for any contamination, water intrusion, or debris on the sensing elements of the MAF sensor. If debris is present, clean the sensor. If the sensor cannot be cleaned, replace the sensor.

10.4 A high resistance may cause a drivability concern before this DTC sets.

10.5 Certain aftermarket air filters may cause this DTC to set.

10.6 Certain aftermarket air induction systems may cause this DTC to set.

10.7 Modifications to the air induction system may cause this DTC to set.

10.8 A skewed or stuck engine coolant temperature (ECT) or IAT sensor will cause the calculated models to be inaccurate and may cause this DTC to run when it should not.

11 REFERENCE INFORMATION

11.1 SCHEMATIC REFERENCE

11.1.1 Engine Controls Schematics

11.2 CONNECTOR END VIEW REFERENCE

11.2.1 Component Connector End Views

11.3 ELECTRICAL INFORMATION REFERENCE

11.3.1 Circuit testing

11.3.2 Connector repairs

P0101 – Mass Air Flow (MAF) Sensor Performance

11.3.3 Testing for intermittent conditions and poor connections

11.3.4 Wiring repairs

11.4 DTC TYPE REFERENCE

11.4.1 Powertrain Diagnostic Trouble Code (DTC) Type Definitions

11.5 SCAN TOOL REFERENCE

11.5.1 Control Module References for scan tool information

11.6 SPECIAL TOOLS

11.6.1 J 38522 Variable Speed Generator

12 CIRCUIT/SYSTEM VERIFICATION

12.1 If you were sent here from DTC P0068, P0106, P0121, or P1101 refer to Circuit/System Testing.

12.2 Ignition ON

12.3 Verify the scan tool TB Idle Airflow Compensation parameter is less than 90 %.

12.3.1 90 % or greater refer, clean Throttle Body.

12.4 If less than 90 % verify the scan tool TP Sensors 1 and 2 Agree/Disagree parameter displays Agree while performing the Throttle Sweep Test.

12.4.1 If Disagree refer to DTC P0120-P0123, P0220, P0222, P0223, or P2135 for further diagnosis.

12.5 If Agree determine the current vehicle testing altitude.

12.6 Verify the scan tool MAP Sensor pressure parameter is within the range specified in the Altitude Versus Barometric Pressure table.

12.6.1 If the MAP Sensor pressure is not in range refer to DTC P0106 for further diagnosis.

12.7 Engine idling; verify the scan tool MAP Sensor pressure parameter is between 26–52 kPa (3.8–7.5 psi) and changes with accelerator pedal input.

12.7.1 If not between 26–52 kPa (3.8–7.5 psi) or does not change refer to DTC P0106 for further diagnosis.

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

12.8.1 Engine idling

12.8.2 Perform the scan tool snapshot function.

12.8.3 Increase the engine speed slowly to 3,000 RPM and then back to idle.

12.8.4 Exit from the scan tool snapshot and review the data.

12.8.5 Observe the MAF Sensor parameter frame by frame with a scan tool.

12.8.5.1 If the MAF Sensor parameter does not change smoothly and gradually refer to Circuit/System Testing.

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

12.10 Verify a DTC does not set.

12.10.1 If any DTC sets refer to *DIAGNOSTIC TROUBLE CODE (DTC) LIST*for further diagnosis.

12.11 If no DTCs set, all OK

13 CIRCUIT/SYSTEM TESTING

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

13.1 Verify the integrity of the entire air induction system by inspecting for the following conditions:

13.1.1 Improperly installed components

13.1.2 Collapsed, restricted, or damaged components

13.1.3 Loose clamps, cracks, or other damage

13.1.4 An air flow restriction

13.1.5 Restricted air filter

13.1.6 Splits, kinks, leaks, or improper connections at the vacuum hoses

13.1.7 Vacuum leaks at the intake manifold, MAP sensor, and throttle body

13.1.8 Water intrusion

13.1.9 In cold climates, inspect for any snow or ice buildup

13.1.10 Inspect the B75B mass air flow sensor element for contamination

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

13.1.12 ⇓ No condition found

13.2 Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B75B mass air flow /intake air temperature sensor. It may take up to 2 minutes for all vehicle systems to power down.

13.3 Test for less than 2 C) between the ground circuit terminal B and ground.

⇒ If 2 C) or greater

13.3.1 3.1 Ignition OFF.

13.3.2 Test for less than 2 C) in the ground circuit end to end.

13.3.2.1 ⇒ If 2 C) or greater, repair the open/high resistance in the circuit.

13.3.2.2 ⇒ If less than 2 C), repair the open/high resistance in the ground connection.
J.L If less than 2 C)

13.4 Ignition ON, verify a test lamp illuminates between the ignition 1 voltage circuit terminal C and ground.

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

13.4.1 Ignition OFF.

13.4.2 Test for less than 2 C) in the ignition 1 voltage circuit end to end.

13.4.2.1 ⇒ If 2 C) or greater, repair the open/high resistance in the circuit.

13.4.2.2 ⇒ If less than 2 C), 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

13.4.3 Ignition OFF.

13.4.4 Test for infinite resistance between the ignition 1 voltage circuit and ground.

13.4.4.1 ⇒ If less than infinite resistance, repair the short to ground on the circuit.
J.L If infinite resistance

13.4.5 Test for greater than 2 C) between the ignition 1 voltage circuit terminal C and ground. 13.4.5.1 ⇒ If less than 2 C), repair the short to ground on the circuit.

13.4.5.2 ⇒ If greater than 2 C), refer to DTC P0685, P0689, P0690, or P1682 to verify the operation of the Powertrain Ign 1 Relay.
J.L If the test lamp illuminates

13.5 Ignition ON, test for 4.8–5.2 volts between the signal circuit terminal A and ground.

⇒ If less than 4.8 V

13.5.1 Ignition OFF, disconnect the harness connector at the K20 ECM.

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

13.5.2.1 ⇒ If less than infinite resistance, repair the short to ground on the circuit.
J.L If infinite resistance

13.5.3 Test for less than 2 C) in the signal circuit end to end.

P0101 – Mass Air Flow (MAF) Sensor Performance

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

13.5.3.2 ⇒ If less than 2 Ω, replace the K20 ECM.

⇒ If greater than 5.2 V

13.5.4 Ignition OFF, disconnect the harness connector at the K20 ECM, ignition ON.

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

13.5.5.1 ⇒ If 1 V or greater, repair the short to voltage on the circuit.

13.5.5.2 ⇒ If less than 1 V, replace the K20 ECM.

J.L If between 4.8–5.2 V

13.6 Ignition OFF, connect the red lead of the J 38522 Variable Speed Generator to the signal circuit terminal A at the harness connector. Connect the battery voltage supply to B+, and the black lead to ground.

13.7 Set the J 38522 Variable Speed Generator to the following specifications:

13.7.1 Signal switch to 5 V

13.7.2 Frequency switch to 5 KHz

13.7.3 Duty Cycle switch to Normal

13.8 Engine idling; observe the scan tool MAF Sensor parameter. The scan tool MAF Sensor parameter should be between 4,950–5,050 Hz.

⇒ If not between 4,950–5,050 Hz.

13.8.1 If not between 4,950–5,050 Hz., replace the K20 ECM.

J.L If between 4,950–5,050 Hz.

13.9 Test or replace the B75B mass air flow/intake air temperature sensor. Verify the following conditions do not exist:

14 REPAIR INSTRUCTIONS

14.1 Perform the*Diagnostic Repair Verification*after completingthe diagnostic procedure.

14.2 Control Module References for ECM replacement

14.3 Mass airflow sensor with intake air temperature sensor replacement

P0102 – Mass Air Flow (MAF) Sensor Circuit Low Frequency
P0103–Mass Air Flow (MAF) Sensor Circuit High Frequency

1 DIAGNOSTIC INSTRUCTIONS

1.1 Review *STRATEGY BASED DIAGNOSIS* for an overview of the diagnostic approach.

1.2 Perform the *DIAGNOSTIC SYSTEM CHECK* prior to using this diagnostic procedure.

2 DTC DESCRIPTOR

2.1 **DTC P0102:**Mass Air Flow (MAF) Sensor Circuit Low Frequency

2.2 **DTC P0103:**Mass Air Flow (MAF) Sensor Circuit High Frequency

3 DIAGNOSTIC FAULT INFORMATION

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

4 TYPICAL SCAN TOOL DATA

4.1 MAF Sensor Circuit

	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine running at various operating conditions ***Parameter Normal Range:*** 2,000–9,500 Hz			
Ignition Voltage	0 Hz	0 Hz	—
MAF Sensor Signal	0 Hz	0 Hz	0 Hz
Ground	—	0 Hz	—

5 CIRCUIT/SYSTEM DESCRIPTION

The mass air flow (MAF) sensor is integrated with the intake air temperature(IAT) sensor. The MAF sensor is an air flow meter that measures the amount of air entering the engine. The engine control module(ECM) uses the MAF sensor signal to provide the correct fuel delivery for all engine speeds and loads. A small quantity of air entering the engine indicates a deceleration or idle condition. A large quantity of air entering the engine indicates an acceleration or high load condition. The ECM applies 5V to the MAF sensor on the MAF sensor signal circuit. The sensor uses the voltage to produce a frequency based on the inlet air flow through the sensor bore. The frequency varies within a range of near 2,000Hertz at idle to near 9,700Hertz at maximum engine load.

6 CONDITIONS FOR RUNNING THE DTC

6.1 The engine is running for greater than 1s.

6.2 The engine speed is at least 300RPM.

6.3 The ignition signal is greater than 8V.

6.4 The above conditions are met for greater than 1s.

6.5 These DTCs run continuously when the above conditions are met.

7 CONDITIONS FOR SETTING THE DTC

7.1 P0102

The ECM detects that the MAF Sensor parameter is less than 1,400Hz or 1.0g/s for greater than 1minute.

7.2 P0103

The ECM detects that the MAF Sensor parameter is more than 14,500Hz or 1,037.5g/s for greater than 1minute.

8 ACTION TAKEN WHEN THE DTC SETS

8.1 DTCsP0102 and P0103 are TypeB DTCs.

9 CONDITIONS FOR CLEARING THE MIL/DTC

9.1 DTCsP0102 and P0103 are TypeB DTCs.

10 DIAGNOSTIC AIDS

10.1 Verify the integrity of the air induction system by inspecting for the following conditions:

- Any water intrusion in the induction system
- Any contamination or debris on the sensing elements of the MAF sensor

- Damaged components
- Verify that any electrical aftermarket devices are properly connected and grounded.

11 REFERENCE INFORMATION

11.1 SCHEMATIC REFERENCE

11.1.1 Engine Controls Schematics

11.2 CONNECTOR END VIEW REFERENCE

11.2.1 Component Connector End Views

11.3 ELECTRICAL INFORMATION REFERENCE

11.3.1 Circuit testing

11.3.2 Connector repairs

11.3.3 Testing for intermittent conditions and poor connections

11.3.4 Wiring repairs

11.4 DTC TYPE REFERENCE

11.4.1 Powertrain Diagnostic Trouble Code (DTC) Type Definitions

11.5 SCAN TOOL REFERENCE

11.5.1 Control Module References for scan tool information

11.6 Special Tools

11.6.1 J 38522 Variable Signal Generator

12 CIRCUIT/SYSTEM VERIFICATION

12.1 Engine idling; observe the scan tool MAF Sensor parameter. The reading should be between 2,000–3,900Hz, depending on the engine coolant temperature(ECT).

12.2 Wide open throttle (WOT) acceleration from a stop should cause the MAF sensor parameter on the scan tool to increase rapidly. This increase should be from 4–9g/s at idle to greater than 180g/s at the time of the 1-2shift.

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

P0102 – Mass Air Flow (MAF) Sensor Circuit Low Frequency
P0103–Mass Air Flow (MAF) Sensor Circuit High Frequency

13 CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the harness connector at the MAF/IAT sensor.

13.1 Ignition OFF, all vehicle systems OFF. It may take up to 2minutes for all vehicle systems to power down. Test for less than 5Ω between the ground circuit terminalE and ground.

13.1.1 If greater than the specified range, test the ground circuit for an open/high resistance.

13.2 Ignition ON, verify that a test lamp illuminates between the ignition voltage circuit terminalD and ground.

13.2.1 If the test lamp does not illuminate, test the ignition voltage circuit for a short to ground or an open/high resistance.

13.3 Ignition ON, test for 4.8–5.2V between the MAF sensor signal circuit terminalC and ground.

13.3.1 If less than the specified range, test the MAF sensor signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the ECM.

13.3.2 If greater than the specified range, test the MAF sensor signal circuit for a short to voltage. If the circuit tests normal, replace the ECM.

13.4 Ignition OFF, connect the red lead of the J 38522 to the MAF sensor signal circuit terminalC at the MAF/IAT sensor harness connector. Connect the battery voltage supply to B+, and the black lead to ground.

13.5 Set the J 38522 to the following specifications.

13.5.1 Signal switch to 5V

13.5.2 Frequency switch to 5KHz

13.5.3 Duty Cycle switch to Normal

13.6 Engine idling; observe the scan tool MAF Sensor parameter. The reading should be between 4,950–5,050Hz.

13.6.1 If not within the specified range, replace the ECM.

13.7 If all circuits test normal, test or replace the MAF/IAT sensor.

14 REPAIR INSTRUCTIONS

14.1 Perform the *DIAGNOSTIC REPAIR VERIFICATION*after completing the diagnostic procedure.

14.2 Mass airflow sensor with intake air temperature sensor replacement

14.3 CONTROL MODULE REFERENCES for ECM replacement, programming, and setup

P0106 – Manifold Absolute Pressure (MAP) Sensor Performance

1 DIAGNOSTIC INSTRUCTIONS

1.1 Review *STRATEGY BASED DIAGNOSIS* for an overview of the diagnostic approach.

1.2 Perform the *DIAGNOSTIC SYSTEM CHECK* prior to using this diagnostic procedure.

2 DTC DESCRIPTOR

2.1 **DTC P0106**: Manifold Absolute Pressure (MAP) Sensor Performance

3 DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
5V Reference	P0107, P0452, P0522, P0532, P0641	P0106, P0107	P0107	P0106, P010, P053, P0533, P0641	P0106, P0107
MAP Sensor Signal	P0107	P0106, P0107	P0107	P0106, P0108	P0106, P0107, P1101
Low Reference	—	P0106, P0108	P0106, P0108	—	P0106, P0108

4 TYPICAL SCAN TOOL DATA

4.1 MAP Sensor Circuit

	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine running, transmission in Park or Neutral ***Parameter Normal Range:***20 – 48 kPa (Varies with altitude)			
5V Reference	10 kPa	10 kPa	104 kPa
MAP Sensor Signal	10 kPa	10 kPa	104 kPa
Low Reference	—	80 – 103 kPa	—

5 CIRCUIT DESCRIPTION

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

P0106 – Manifold Absolute Pressure (MAP) Sensor Performance

5.1 The throttle model describes the flow through the throttle body and is used to estimate the MAF through the throttle body as a function of barometric pressure (BARO), TP, intake air temperature (IAT), and estimated MAP. The information from this model is displayed on the scan tool as the MAF Performance Test parameter.

5.2 The first intake manifold model describes the intake manifold and is used to estimate MAP as a function of the MAF into the manifold from the throttle body and the MAF out of the manifold caused by engine pumping. The flow into the manifold from the throttle uses the MAF estimate calculated from the above throttle model. The information from this model is displayed on the scan tool as the MAP Performance Test1 parameter.

5.3 The second intake manifold model is identical to the first intake manifold model except that the MAF sensor measurement is used instead of the throttle model estimate for the throttle air input. The information from this model is displayed on the scan tool as the MAP Performance Test2 parameter.

5.4 The fourth model is created from the combination and additional calculations of the throttle model and the first intake manifold model. The information from this model is displayed on the scan tool as the TP Performance Test parameter.

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

SCAN TOOL DIAGNOSTIC TEST RESULTS					
MAF Performance Test	**MAP Performance Test 1**	**MAP Performance Test 2**	**TP Performance Test**	**DTCs Passed**	**DTCs Failed**
—	—	OK	OK	P0101, P0106, P0121, P1101	None
OK	OK	Fault	OK	P0101, P0106, P0121, P1101	None
Fault	OK	Fault	OK	P0106, P0121, P1101	P0101
OK	Fault	Fault	OK	P0101, P0121, P1101	P0106
Fault	Fault	Fault	OK	P0121, P1101	P0101, P0106
—	—	OK	Fault	P0101, P0106, P1101	P0121
OK	OK	Fault	Fault	P0101, P0106, P0121, P1101	None
Fault	OK	Fault	Fault	P0101, P0106, P0121	P1101
—	Fault	Fault	Fault	P0101, P0106, P0121	P1101

P0106 – Manifold Absolute Pressure (MAP) Sensor Performance

6 CONDITIONS FOR RUNNING THE DTC

6.1 DTCsP0102, P0103, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0128, P0335, and P0336 are not set.

6.2 The engine is running.

6.3 The IAT Sensor parameter is between −7 and +125°C (+19 and 257°F).

6.4 The ECT Sensor parameter is between 70–125°C (158–257°F).

6.5 This DTC runs continuously when the above conditions are met.

7 CONDITIONS FOR SETTING THE DTC

The engine control module(ECM) detects that the MAP sensor pressure is not within range of the calculated pressure that is derived from the system of models for more than 0.5s.

8 ACTION TAKEN WHEN THE DTC SETS

8.1 DTCP0106 is a TypeB DTC.

9 CONDITIONS FOR CLEARING THE MIL/DTC

9.1 DTCP0106 is a TypeB DTC.

10 DIAGNOSTIC AIDS

NOTE:VERIFY THAT THE ENGINE IS IN GOOD MECHANICAL CONDITION BEFORE CONTINUING WITH THIS DIAGNOSTIC**.**

10.1 A skewed or stuck engine coolant temperature(ECT) or IAT sensor will cause the calculated models to be inaccurate and may cause this DTC to run when it should not. Refer to Temperature Versus Resistance.

10.2 The BARO that is used by the ECM to calculate the air flow models is initially based on the MAP sensor at ignition ON. When the engine is running, the ECM will continually update the BARO value near wide open throttle using the MAP sensor and a calculation. A skewed MAP sensor will cause the BARO value to be inaccurate. Use the scan tool and compare the BARO parameter at ignition ON to the Altitude vs. Barometric Pressure Table. Refer to Altitude Versus Barometric Pressure.

10.3 A skewed MAP sensor will also cause the first and second intake manifold models to disagree with the actual MAP sensor measurements. Use the scan tool and compare the MAP Sensor parameter to a known good vehicle, under various operating conditions.

10.4 Inspect for worn piston rings. Refer to Engine Compression Test.

P0106 – Manifold Absolute Pressure (MAP) Sensor Performance

11 REFERENCE INFORMATION

11.1 SCHEMATIC REFERENCE

11.1.1 Engine Controls Schematics

11.2 CONNECTOR END VIEW REFERENCE

11.2.1 Component Connector End Views

11.3 ELECTRICAL INFORMATION REFERENCE

11.3.1 Circuit testing

11.3.2 Connector repairs

11.3.3 Testing for intermittent conditions and poor connections

11.3.4 Wiring repairs

11.4 DTC TYPE REFERENCE

11.4.1 Powertrain Diagnostic Trouble Code (DTC) Type Definitions

11.5 SCAN TOOL REFERENCE

11.5.1 Control Module References for scan tool information

11.6 SPECIAL TOOLS

11.6.1 J-35555 Metal Mityvac

11.6.2 J-23738-A Mityvac

12 CIRCUIT/SYSTEM VERIFICATION

12.1 If DTCP0641 or P0651 are set, refer to DTC P0641 or P0651.

12.2 Verify that restrictions do not exist in the exhaust system. Refer to Restricted Exhaust.

12.3 Verify that the engine is in good mechanical condition. Refer to Symptoms - Engine Mechanical for the 4.8L, 5.3L, 6.0L and 6.2L engine.

12.4 Ignition OFF for 90s, determines the current vehicle testing altitude. Ignition ON, observe the scan tool BARO Sensor parameter. Compare the parameter to the Altitude Versus Barometric Pressure table. The BARO sensor pressure parameter should be within the specified range indicated in the table.

12.5 A skewed MAP sensor will also cause the first and second intake manifold models to disagree with the actual MAP sensor measurements. Use the scan tool and compare the MAP Sensor parameter to a known good vehicle under various operating conditions. The readings should be within 3kPa of the known good vehicle.

12.6 Ignition ON, observe the scan tool MAP sensor parameter. Start the engine. The MAP Sensor parameter should change.

12.6.1 If the vehicle passes the Circuit System Verification Test, operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that are captured in the Freeze Frame/Failure Records list.

13 CIRCUIT/SYSTEM TESTING

NOTE: ALL ELECTRICAL COMPONENTS AND ACCESSORIES MUST BE TURNED OFF AND ALLOWED TO POWER DOWN.

13.1 Verify the integrity of the air induction system by inspecting for the following conditions:

13.1.1 Any damaged components

13.1.2 Loose or improper installation

13.1.3 Any vacuum leak

13.1.4 Any type of restriction

13.1.5 MAP sensor seal that is missing or damaged

13.2 Verify that restrictions do not exist in the MAP sensor vacuum source.

13.3 Verify that restrictions do not exist in the exhaust system. Refer to Restricted Exhaust

13.4 Ignition OFF, disconnect the MAP harness connector at the MAP sensor.

13.5 Ignition OFF for 90s, test for less than 5Ω between the low reference circuit terminalA and ground.

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

13.6 Ignition ON, test for 4.8–5.2V between the 5V reference circuit terminalC and ground.

13.6.1 If less than the specified range, test the 5V reference circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the ECM.

13.6.2 If greater than the specified range, test the 5V reference circuit for a short to voltage. If the circuit tests normal, replace the ECM.

13.7 Verify the scan tool MAP Sensor parameter is less than 12kPa.

13.7.1 If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the ECM.

13.8 Install a 3A fused jumper wire between the signal circuit terminal B and the 5V reference circuit terminalC. Verify the scan tool MAP Sensor parameter is greater than 103kPa.

13.8.1 If less than the specified range, test the signal circuit terminal B for a short to ground or an open/high resistance. If the circuit tests normal, replace the ECM.

13.9 If all circuits test normal, test or replace the MAP sensor.

P0106 – Manifold Absolute Pressure (MAP) Sensor Performance

14 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.

14.1 SKEWED SENSOR TEST

14.1.1 Using the following steps and referencing the table below will determine if the MAP sensor is skewed.

14.1.2 Ignition ON, engine OFF, observe the MAP sensor scan tool parameter.

14.1.3 Use the observed MAP Sensor Scan Tool parameter that is closest to a value that is indicated in the first column.

14.1.4 Using the J-23738-A or the J-35555 to apply 5inHg of vacuum to the MAP sensor, the parameter in the first column should decrease by 17kPa. The acceptable range is indicated in the second column.

14.1.5 Using the J-23738-A or the J-35555 to apply 10inHg of vacuum to the MAP sensor, the parameter in the first column should decrease by 34kPa. The acceptable range is indicated in the third column.

Ignition ON, Engine OFF, MAP Sensor Parameter	MAP Sensor Parameter With 5 Inches of Vacuum Applied	MAP Sensor Parameter With 10 Inches of Vacuum Applied
100 kPa	79–87 kPa	62–70 kPa
95 kPa	74–82 kPa	57–65 kPa
90 kPa	69–77 kPa	52–60 kPa
80 kPa	59–67 kPa	42–50 kPa
70 kPa	49–57 kPa	32–40 kPa
60 kPa	39–47 kPa	22–30 kPa

14.2 ERRATIC SIGNAL TEST

14.2.1 Ignition OFF, remove the MAP sensor.

14.2.2 Install a 3A fused jumper wire between the 5V reference circuit terminalC and the corresponding terminal of the MAP sensor.

14.2.3 Install a jumper wire between the low reference terminalA of the MAP sensor and ground.

14.2.4 Install a jumper wire at terminalB of the MAP sensor.

14.2.5 Connect a DMM between the jumper wire from the terminalB of the MAP sensor and ground.

14.2.6 Ignition ON, with the J-23738-A or J-35555, slowly apply vacuum to the sensor while observing the voltage on the DMM. The voltage should vary between 4.9–0.2V without any spikes or dropouts.

14.2.6.1 If the voltage is erratic, replace the MAP sensor.

P0106 – Manifold Absolute Pressure (MAP) Sensor Performance

15 REPAIR INSTRUCTIONS

15.1 Perform the *DIAGNOSTIC REPAIR VERIFICATION*after completing the diagnostic procedure.

15.2 Manifold absolute pressure sensor replacement

15.3 CONTROL MODULE REFERENCES for ECM replacement, setup, and programming.

P0107 – Manifold Absolute Pressure (MAP) Sensor Circuit Low Voltage Or P0108 – Manifold Absolute Pressure (MAP) Sensor Circuit High Voltage

1 DIAGNOSTIC INSTRUCTIONS

1.1 Review *STRATEGY BASED DIAGNOSIS* for an overview of the diagnostic approach.

1.2 Perform the *DIAGNOSTIC SYSTEM CHECK* prior to using this diagnostic procedure.

2 DTC DESCRIPTORS

2.1 **DTC P0107:** Manifold Absolute Pressure (MAP) Sensor Circuit Low Voltage

2.2 **DTC P0108:**Manifold Absolute Pressure (MAP) Sensor Circuit High Voltage

3 DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open	Short to Voltage	Short to Voltage	Signal Performance
5 V Reference	P0107, P0641, P2229	P0106, P0107	P0107	P0106, P0108, P0641, P2229	P0106
Signal	P0107	P0106, P0107	P0107	P0106, P0108*	P0106, P1101
Low Reference	—	P0106, P0108	P0106, P0108	—	P0106
*Internal ECM or sensor damage may occur if the circuit is shorted to B+.					

4 TYPICAL SCAN TOOL DATA

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine running at various operating conditions ***Parameter Normal Range:***12–103 kPa (1.7–14.9 psi)			
5 V Reference	0 kPa (0 psi)	0 kPa (0 psi)	104 kPa (15.1 psi)
Signal	0 kPa (0 psi)	0 kPa (0 psi)	104 kPa (15.1 psi)*
Low Reference	—	80–103 kPa (11.6–14.9 psi)	—
*Internal ECM or sensor damage may occur if the circuit is shorted to B+.			

5 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, and barometric pressure (BARO). A diaphragm within the MAP sensor is displaced by the pressure changes that occur from the varying load and operating conditions of the engine. The sensor translates this action into electrical resistance. The MAP sensor wiring includes 3 circuits. The engine control module (ECM) supplies a regulated 5 volts to the sensor on a 5-volt reference circuit. The ECM supplies a ground on a low reference circuit. The MAP sensor provides a signal voltage to the ECM, relative to the pressure changes, on the MAP sensor signal circuit. The ECM converts the signal voltage input to a pressure value.

Under normal operation the highest pressure that can exist in the intake manifold is equal to BARO. This occurs when the vehicle is operated at wide-open throttle (WOT) or when the ignition is ON while the engine is OFF. Under these conditions, the ECM uses the MAP sensor to determine the current BARO. The lowest manifold pressures occur when the vehicle is idling or decelerating. The ECM monitors the MAP sensor signal for pressure outside of the sensor operating range.

6 CONDITIONS FOR RUNNING THE DTC

6.1 P0107

6.1.1 This DTC runs continuously.

6.2 P0108

6.2.1 This DTC runs continuously.

7 CONDITIONS for Setting the DTC

7.1 P0107

7.1.1 The ECM detects that the MAP sensor voltage is less than 0.1 volt for more than 4 seconds.

7.2 P0108

7.2.1 The ECM detects that the MAP sensor voltage is more than 4.9 volts for greater than 4 seconds.

8 ACTION TAKEN WHEN THE DTC SETS

8.1 DTCs P0107 and P0108 are Type B DTCs.

9 CONDITIONS FOR CLEARING THE MIL/DTC

9.1 DTCs P0107 and P0108 are Type B DTCs.

10 REFERENCE INFORMATION

10.1 SCHEMATIC REFERENCE

P0107 – Manifold Absolute Pressure (MAP) Sensor Circuit Low Voltage Or P0108 – Manifold Absolute Pressure (MAP) Sensor Circuit High Voltage

10.1.1 Engine controls schematics

10.2 CONNECTOR END VIEW REFERENCE

10.2.1 Component connector end views

10.3 ELECTRICAL INFORMATION REFERENCE

10.3.1 Circuit testing

10.3.2 Connector repairs

10.3.3 Testing for intermittent conditions and poor connections

10.3.4 Wiring repairs

10.4 DTC TYPE REFERENCE

10.4.1 Powertrain diagnostic trouble code (DTC) type definitions

10.5 SCAN TOOL REFERENCE

10.5.1 CONTROL MODULE REFERENCESfor scan tool information

11 CIRCUIT/SYSTEM VERIFICATION

11.1 Verify that DTC P0641, or P0651 is not set.

11.1.1 ⇒If the DTC is set
11.1.2 Refer to DTC P0641 or P0651 for further diagnosis.

11.1.3 ⇓If the DTC is not set

11.2 Engine Idling.

11.3 Verify the scan tool MAP voltage parameter is between 0.3–4.8 V and changes with accelerator pedal input.

11.3.1 ⇒ If not between 0.3–4.8 V or does not change
11.3.2 Refer to Circuit/System Testing – step 1.

11.3.3 ⇓ If between 0.3–4.8 V and changes

11.4 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 in the Freeze Frame/Failure Records data.

11.5 Verify the DTC does not set.

11.5.1 ⇒ If the DTC sets

11.5.2 Verify that DTC P0641, or P0651 is not set.

11.5.3 Refer to Circuit/System Testing – step 1.

11.5.4 J.LIf the DTC does not set

11.6 All OK.

12 CIRCUIT/SYSTEM TESTING

12.1 Ignition OFF, and all vehicle systems OFF, disconnect the harness connector at the B74 manifold absolute pressure sensor. It may take up to 2 minutes for all vehicle systems to power down.

12.2 Test for less than 2 C) between the low reference circuit terminal A or 2 and ground.

12.2.1 ⇒ If 2 C) or greater
12.2.2 Ignition OFF, disconnect the X2 harness connector at the K20 engine control module.

12.2.3 Test for less than 2 C) in the low reference circuit end to end.

12.2.4 ⇒ If 2 C) or greater, repair the open/high resistance in the circuit.

12.2.5 ⇒ If less than 2 C), replace the K20 engine control module.
12.2.6 J.L If less than 2 C)

12.3 Ignition ON.

12.4 Test for 4.8–5.2 V between the 5 V reference circuit terminal C or 1 and ground.

12.4.1 ⇒ If less than 4.8 V
12.4.2 Ignition OFF, disconnect the X2 harness connector at the K20 engine control module.

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

12.4.4 ⇒ If less than infinite resistance, repair the short to ground on the circuit.
12.4.5 J.L If infinite resistance

12.4.6 Test for less than 2 C) in the 5 V reference circuit end to end.

12.4.7 ⇒ If 2 C) or greater, repair the open/high resistance in the circuit.

12.4.8 ⇒ If less than 2 C), replace the K20 engine control module.

P0107 – Manifold Absolute Pressure (MAP) Sensor Circuit Low Voltage Or P0108 – Manifold Absolute Pressure (MAP) Sensor Circuit High Voltage

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

12.4.9 ⇒If greater than 5.2 V
12.4.10 Ignition OFF, disconnect the X2 harness connector at the K20 engine control module, ignition ON.

12.4.11 Test for less than 1 V between the 5 V reference circuit and ground.

12.4.12 ⇒ If 1 V or greater, repair the short to voltage on the circuit.

12.4.13 ⇒ If less than 1 V, replace the K20 engine control module.
12.4.14 J.L If between 4.8–5.2 V

12.5 5. Verify the scan tool MAP voltage parameter is less than 0.2 V.

12.5.1 ⇒ If 0.2 V or greater
12.5.2 Ignition OFF, disconnect the X2 harness connector at the K20 engine control module, ignition ON.

12.5.3 Test for less than 1 V between the signal circuit terminal B or 3 and ground.

12.5.4 ⇒ If 1 V or greater, repair the short to voltage on the circuit.

12.5.5 ⇒ If less than 1 V, replace the K20 engine control module.
12.5.6 J.L If less than 0.2 V

12.6 Install a 3 A fused jumper wire between the signal circuit terminal B or 3 and the 5 V reference circuit terminal C or 1.

12.7 Verify the scan tool MAP voltage parameter is greater than 4.5 V.

12.7.1 ⇒ If 4.5 V or less
12.7.2 Ignition OFF, remove the jumper wire, disconnect the X2 harness connector at the K20 engine control module.

12.7.3 Test for infinite resistance between the signal circuit terminal B or 3 and ground.

12.7.4 ⇒ If less than infinite resistance, repair the short to ground on the circuit.
12.7.5 J.L If infinite resistance

12.7.6 7.3 Test for less than 2 C) in the signal circuit end to end.

12.7.7 ⇒ If 2 C) or greater, repair the open or high resistance in the circuit.

12.7.8 ⇒ If less than 2 C), replace the K20 engine control module.

12.7.9 J.LIf greater than 4.5 V

12.8 Test or replace the B74 manifold absolute pressure sensor.

13 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.

13.1 Skewed Sensor Test

13.1.1 Using the following steps and referencing the table below will determine if the B74 manifold absolute pressure sensor is skewed.

13.1.2 Ignition ON, engine OFF, observe the MAP Sensor scan tool parameter.

13.1.3 Use the observed MAP Sensor Scan Tool parameter that is closest to a value that is indicated in the first column.

THEN

13.1.4 Using the J-23738-A Vacuum Pump to apply 5 in Hg of vacuum to the B74 manifold absolute pressure sensor, the parameter in the first column should decrease by 17 kPa (2.5 psi). The acceptable range is indicated in the second column.

13.1.4.1 ⇒ If not within the acceptable range

13.1.4.2 Replace the B74 manifold absolute pressure sensor.

13.1.4.3 J.L If within the acceptable range

13.1.5 Using the J-23738-A Vacuum Pump to apply 10 in Hg of vacuum to the B74 manifold absolute pressure sensor, the parameter in the first column should decrease by 34 kPa (5.0 psi). The acceptable range is indicated in the third column.

13.1.5.1 ⇒ If not within the acceptable range

13.1.5.2 Replace the B74 manifold absolute pressure sensor.

13.1.5.3 J.L If within the acceptable range

13.1.6 All OK.

P0107 – Manifold Absolute Pressure (MAP) Sensor Circuit Low Voltage Or P0108 – Manifold Absolute Pressure (MAP) Sensor Circuit High Voltage

Ignition ON, Engine OFF, MAP Sensor Parameter	MAP Sensor Parameter With 5 Inches of Vacuum Applied	MAP Sensor Parameter With 10 Inches of Vacuum Applied
100 kPa (14.5 psi)	79–87 kPa (11.5–12.6 psi)	62–70 kPa (9.0–10.2 psi)
95 kPa (13.8 psi)	74–82 kPa (10.7–11.9 psi)	57–65 kPa (8.3–9.4 psi)
90 kPa (13.1 psi)	69–77 kPa (10.0–11.2 psi)	52–60 kPa (7.5–8.7 psi)
80 kPa (11.6 psi)	59–67 kPa (8.6–9.7 psi)	42–50 kPa (6.1–7.3 psi)
70 kPa (10.2 psi)	49–57 kPa (7.2–8.3 psi)	32–40 kPa (4.6–5.8 psi)
60 kPa (8.7 psi)	39–47 kPa (5.7–6.9 psi)	22–30 kPa (3.2–4.4 psi)

13.2 Erratic Signal Test

13.2.1 Ignition OFF, remove the B74 manifold absolute pressure sensor.

13.2.2 Install a 3A fused jumper wire between the 5 V reference circuit terminal C or 1 and the corresponding terminal of the B74 manifold absolute pressure sensor.

13.2.3 Install a jumper wire between the low reference terminal A or 2 of the B74 manifold absolute pressure sensor and ground.

13.2.4 Install a jumper wire at terminal B or 3 of the B74 manifold absolute pressure sensor.

13.2.5 Connect a DMM between the jumper wire from the terminal B or 3 of the B74 manifold absolute pressure sensor and ground.

13.2.6 Ignition ON, with the J-23738-A Vacuum Pump, slowly apply vacuum to the sensor while observing the voltage on the DMM. The voltage should vary between 4.9–0.2 V without any spikes or dropouts.

13.2.6.1 ⇒ If not between 4.9–0.2 V or has spikes or dropouts

13.2.6.2 Replace the B74 manifold absolute pressure sensor.

13.2.6.3 ⇓ If between 4.9–0.2 V and there are no spikes or dropouts

13.2.7 All OK.

14 REPAIR INSTRUCTIONS

14.1 Perform the *DIAGNOSTIC REPAIR VERIFICATION*after completing the diagnostic procedure.

14.2 Manifold Absolute Pressure Sensor Replacement

14.3 Control Module References for ECM replacement, programming, and setup

P0111 – Intake Air Temperature (IAT) Sensor Performance

1 DIAGNOSTIC INSTRUCTIONS

1.1 Review *STRATEGY BASED DIAGNOSIS* for an overview of the diagnostic approach.

1.2 Perform the *DIAGNOSTIC SYSTEM CHECK* prior to using this diagnostic procedure.

2 DTC DESCRIPTOR

2.1 **DTC P0111:** Intake Air Temperature (IAT) Sensor Performance

3 DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open / High Resistance	Short to Voltage	Signal Performance
IAT Sensor Signal	P0112, P0114	P0111, P0113, P0114	*P0113, P0114	P0111
Low Reference	—	P0111, P0113, P0114	P0113, P0114	P0111
*Internal ECM or sensor damage may occur if the circuit is shorted to B+.				

4 TYPICAL SCAN TOOL DATA

4.1 IAT Sensor Signal

	Short to Ground	Open / High Resistance	Short to Voltage
Operating Conditions:Key ON, Engine OFF ***Parameter Normal Range:*** Varies with ambient temperature			
IAT Sensor Signal	150°C (302°F)	−40°C (−40°F)	−40°C (−40°F)*
Low Reference	—	—	—
* Internal ECM or sensor damage may occur if the circuit is shorted to B+.			

4.2 Engine Coolant Temperature (ECT) Sensor

	Short to Ground	Open / High Resistance	Short to Voltage
Operating Conditions: Engine operating in Closed Loop ***Parameter Normal Range:*** Varies with coolant temperature			
IAT Sensor Signal	150°C (302°F)	−40°C (−40°F)	−40°C (−40°F)*
Low Reference	—	—	—
* Internal ECM or sensor damage may occur if the circuit is shorted to B+.			

5 CIRCUIT DESCRIPTION

5.1 The intake air temperature (IAT) sensor is a variable resistor that measures the temperature of the air entering the engine. The IAT sensor has a signal circuit and a low reference circuit. The engine control module (ECM) supplies 5 volts to the IAT signal circuit and a ground for the IAT low reference circuit.

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

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

6 CONDITIONS FOR RUNNING THE DTC

6.1 DTCs P0112, P0113, P0117, P0118 are not set.

6.2 The ignition has been OFF at least 8 hours.

6.3 The ignition is ON.

6.4 This DTC runs once per ignition cycle when the enabling conditions are met.

7 CONDITIONS FOR SETTING THE DTC

7.1 The ECM determines the absolute difference between IAT start-up temperature and the ECT start-up temperature is greater than 20°C (36°F).

8 ACTION TAKEN WHEN THE DTC SETS

8.1 DTC P0111 is a Type B DTC.

P0111 – Intake Air Temperature (IAT) Sensor Performance

9 CONDITIONS FOR CLEARING THE MIL/DTC

9.1 DTC P0111 is a Type B DTC.

10 DIAGNOSTIC AIDS

10.1 The use of non-thermostatically controlled aftermarket block heater will cause this DTC to set.

10.2 An IAT sensor that is skewed, due to more resistance than is normal, can widen the spread between the 2 sensors and cause this DTC to set. Measure and record the resistance of the IAT sensor at various ambient temperatures, and then compare those measurements to the Temperature vs. Resistance Table. Refer to Temperature Versus Resistance.

10.3 A slight to moderate resistance in the IAT sensor signal circuit or low reference circuit will increase the range between these two sensors. This condition results in a greater voltage on the IAT sensor signal circuit, which is interpreted by the ECM as a colder IAT.

10.4 Inspect the mass air flow MAF/IAT sensor terminals for corrosion.

11 REFERENCE INFORMATION

11.1 SCHEMATIC REFERENCE

11.1.1 Engine Controls Schematics

11.2 CONNECTOR END VIEW REFERENCE

11.2.1 Component Connector End Views

11.3 ELECTRICAL INFORMATION REFERENCE

11.3.1 Circuit testing

11.3.2 Connector repairs

11.3.3 Testing for intermittent conditions and poor connections

11.3.4 Wiring repairs

11.4 DTC TYPE REFERENCE

11.4.1 Powertrain Diagnostic Trouble Code (DTC) Type Definitions

11.5 SCAN TOOL REFERENCE

11.5.1 Control Module References for scan tool information

11.6 SPECIAL TOOLS

P0111 – Intake Air Temperature (IAT) Sensor Performance

12 CIRCUIT/SYSTEM VERIFICATION

Note: Perform this verification procedure only if the ignition has been OFF for 8 hours or more.

12.1 Inspect the thermostatically-controlled coolant heater, if equipped, for damage or modifications. Test for proper operation of the coolant heater.

12.2 Ignition ON, observe the scan tool IAT Sensor and ECT Sensor parameters. The readings should be within 20°C (36°F) of each other and ambient temperature.

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

13 CIRCUIT/SYSTEM TESTING

13.1 Ignition OFF, disconnect the harness connector at the B75B MAF/IAT sensor.

13.2 Ignition OFF, all vehicles systems OFF. It may take up to for 2 minutes for all vehicle systems to power down. Test for less than 5 Ω of resistance between the low reference circuit terminal D and ground.

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

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

13.3.1 If warmer than the specified range, test the signal circuit for a short to ground. If the circuit tests normal, replace the K20 ECM.

13.4 Install a 3 A fused jumper wire between the signal circuit terminal E and ground. Verify the scan tool IAT Sensor parameter is warmer than 149°C (300°F).

13.4.1 If colder than the specified range, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the K20 ECM.

13.5 If all circuits test normal, test or replace the B75B MAF/IAT sensor.

14 COMPONENT TESTING

14.1 Ignition OFF, disconnect the harness connector at the IAT sensor.

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

14.2 Test the IAT sensor by varying the sensor temperature while monitoring the sensor resistance. Compare the readings with the Temperature Versus Resistance

14.2.1 If not within the specified range, replace the IAT sensor.

P0111 – Intake Air Temperature (IAT) Sensor Performance

15 REPAIR INSTRUCTIONS

15.1 Perform the *DIAGNOSTIC REPAIR VERIFICATION*after completing the diagnostic procedure.

15.2 Mass Airflow Sensor with Intake Air Temperature Sensor Replacement

15.3 Control Module References for ECM replacement, setup, and programming

P0112, P0113, or P0114 – Intake Air Temperature (IAT) Sensor Circuit – Low, High Voltage, or Intermittent

1 DIAGNOSTIC INSTRUCTIONS

1.1 Review *STRATEGY BASED DIAGNOSIS* for an overview of the diagnostic approach.

1.2 Perform the *DIAGNOSTIC SYSTEM CHECK*prior to using this diagnostic procedure.

2 DTC DESCRIPTORS

2.1 **DTC P0112**: Intake Air Temperature (IAT) Sensor Circuit Low Voltage

2.2 **DTC P0113:** Intake Air Temperature (IAT) Sensor Circuit High Voltage

2.3 **DTC P0114:** Intake Air Temperature (IAT) Sensor Circuit Intermittent

3 DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
IAT Sensor Signal	P0112, P0114	P0113, P0114	*P0113, P0114	P0111
Low Reference	—	P0113, P0113	P0113, P0114	P0111
*ECM or sensor damage may occur if the circuit is shorted to B+.				

4 TYPICAL SCAN TOOL DATA

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine running ***Parameter Normal Range:*** Varies with ambient temperature			
IAT Sensor Signal	150°C (302°F)	−40°C (−40°F)	−40°C (−40°F)*
Low Reference	—	−40°C (−40°F)	−40°C (−40°F)
* Internal ECM or sensor damage may occur if the circuit is shorted to B+.			

5 CIRCUIT DESCRIPTION

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

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

P0112, P0113, or P0114 – Intake Air Temperature (IAT) Sensor Circuit – Low, High Voltage, or Intermittent

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

6 CONDITIONS FOR RUNNING THE DTC

6.1 P0112

6.1.1 The engine is running.

6.1.2 This DTC runs continuously when the above conditions are met.

6.2 P0113

6.2.1 The engine is running.

6.2.2 This DTC runs continuously when the above conditions are met.

6.3 P0114

6.3.1 The engine is running.

6.3.2 This DTC runs continuously within the enabling conditions.

7 CONDITIONS FOR SETTING THE DTC

7.1 P0112

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

7.2 P0113

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

7.2.1 The ECM detects that the IAT sensor signal is colder than −59°C (−72°F) for greater than 5 s.

7.3 P0114

7.3.1 The ECM detects that the IAT sensor signal is intermittent or has abruptly changed greater than 10°C (18°F).

8 ACTION TAKEN WHEN THE DTC SETS

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

P0112, P0113, or P0114 – Intake Air Temperature (IAT) Sensor Circuit – Low, High Voltage, or Intermittent

9 CONDITIONS FOR CLEARING THE MIL/DTC

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

10 DIAGNOSTIC AIDS

10.1 With the ignition ON, the engine OFF, if the engine is cold, a properly functioning IAT sensor will gradually increase the scan tool IAT Sensor parameter. This is due to the heat that is generated by the mass air flow (MAF) sensor heating elements.

10.2 Depending on the ambient temperature, an IAT sensor signal circuit or low reference circuit that is shorted to the MAF sensor signal circuit can cause a DTC P0113 to set. This condition causes a rapid fluctuation in the IAT Sensor parameter

10.3 An IAT sensor signal circuit that is shorted to the MAF sensor circuit can cause a DTC P0113 and/or a DTC P0114 to set.

10.4 A MAF sensor ground circuit that is open will cause a DTC P0113 and/or a DTC P0114 to set.

11 REFERENCE INFORMATION

11.1 SCHEMATIC REFERENCE

11.1.1 Engine controls schematics

11.2 CONNECTOR END VIEW REFERENCE

11.2.1 Component connector end views

11.3 ELECTRICAL INFORMATION REFERENCE

11.3.1 Circuit testing

11.3.2 Connector repairs

11.3.3 Testing for intermittent conditions and poor connections

11.3.4 Wiring repairs

11.4 DTC TYPE REFERENCE

11.4.1 Powertrain diagnostic trouble code (DTC) type definitions

11.5 SCAN TOOL REFERENCE

11.5.1 Control module referencesFor scan tool information.

P0112, P0113, or P0114 – Intake Air Temperature (IAT) Sensor Circuit – Low, High Voltage, or Intermittent

12 CIRCUIT/SYSTEM VERIFICATION

12.1 Engine idling; observe the scan tool IAT Sensor parameter. The reading should be between −38 to +149°C (−36 to +300°F) depending on the current ambient temperature and the vehicle operating conditions.

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

13 CIRCUIT/SYSTEM TESTING

13.1 Ignition OFF, disconnect the harness connector at the MAF/IAT sensor.

13.2 Ignition OFF, all vehicles systems OFF. It may take up to for 2 minutes for all vehicle systems to power down. Test for less than 5 Ω between the IAT low reference circuit terminal A and ground.

13.2.1 If greater than the specified range, test the IAT low reference circuit for an open/high resistance. If the circuit tests normal, replace the ECM.

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

13.3.1 If warmer than the specified range, test the IAT signal circuit terminal B for a short to ground. If the circuit tests normal, replace the ECM.

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

13.4 Install a 3 A fused jumper wire between the IAT signal circuit terminal B and ground. Verify the scan tool IAT Sensor parameter is warmer than 149°C (300°F).

13.4.1 If colder than the specified range, test the IAT signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the ECM.

13.5 If all circuits test normal, test or replace the MAF/IAT sensor.

14 COMPONENT TESTING

14.1 Ignition OFF, disconnect the harness connector at the mass air flow (MAF)/intake air temperature (IAT) sensor.

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

14.2 Test the IAT sensor by varying the sensor temperature while monitoring the sensor resistance. Compare the readings with the *temperature versus resistance.* The resistance values should be in range of the table values.

14.2.1 If not within the specified range, MAF/IAT sensor

P0112, P0113, or P0114 – Intake Air Temperature (IAT) Sensor Circuit – Low, High Voltage, or Intermittent

15 REPAIR INSTRUCTIONS

15.1 Perform the *DIAGNOSTIC REPAIR VERIFICATION* after completing the diagnostic procedure.

15.2 MASS AIRFLOW SENSOR WITH INTAKE AIR TEMPERATURE SENSOR REPLACEMENT

15.3 CONTROL MODULE REFERENCES for ECM replacement, programming, and setup.

P0116 – Engine Coolant Temperature (ECT) Sensor Performance

1 DIAGNOSTIC INSTRUCTIONS

1.1 Review *STRATEGY BASED DIAGNOSIS* for an overview of the diagnostic approach.

1.2 Perform the *DIAGNOSTIC SYSTEM CHECK* prior to using this diagnostic procedure.

2 DTC DESCRIPTOR

2.1 **DTC P0116:**Engine Coolant Temperature (ECT) Sensor Performance

3 DIAGNOSTIC FAULT INFORMATION

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

4 CIRCUIT/SYSTEM DESCRIPTION

The engine coolant temperature (ECT) sensor is a variable resistor that measures the temperature of the engine coolant. The engine control module (ECM) supplies 5V to the ECT sensor signal circuit, and supplies a ground to the low reference circuit. The ECM uses this high side coolant rationality diagnostic to determine if the input from the ECT sensor is skewed warmer than normal. The internal clock of the ECM will record the amount of time the ignition is OFF. If the calibrated ignition OFF timer is met at start-up, the ECM will compare the temperature difference between the ECT and the intake air temperature (IAT), to determine if the temperatures are within an acceptable operating range of each other.

5 CONDITIONS FOR RUNNING THE DTC

5.1 DTCs P0111, P0112, P0113, P0117, P0118, P0502, P0503, and P2610 are not set.

5.2 The engine has had a minimum ignition OFF time of 8h.

5.3 The ignition is ON.

5.4 The start-up IAT is warmer than −7°C (+19°F).

5.5 This DTC runs once per cold start when the above conditions are met.

6 CONDITIONS FOR SETTING THE DTC

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

6.2 The ECM detects a temperature difference at power-up that indicates that the ECT sensor is 10°C (18°F) warmer than the IAT sensor, and the time spent cranking the engine is greater than 10 s, when the fuel level is greater than 5 %, **OR**

6.3 With the power-up IAT more than −7°C (+19°F), the ECM detects a temperature difference at power-up that indicates that the ECT sensor is 20°C (36°F) greater than the IAT sensor. Then the vehicle must be driven for more than 6min and 40s at greater than 40km/h (25mph). If the IAT sensor then decreases greater than 4°C (7°F), an engine block heater was detected and the test is aborted. If the IAT sensor does not decrease, an engine block heater was not detected and DTCP0116 will set.

7 ACTION TAKEN WHEN THE DTC SETS

7.1 DTCP0116 is a TypeB DTC.

8 CONDITIONS FOR CLEARING THE MIL/DTC

8.1 DTCP0116 is a TypeB DTC.

9 DIAGNOSTIC AIDS

9.1 The use of non-thermostatically controlled aftermarket block heater will cause this DTC to set.

9.2 Inspect the ECT sensor terminals for corrosion and for engine coolant leaking through the sensor. Engine coolant that is leaking through the sensor will create a high resistance short to ground. This condition results in less voltage on the ECT sensor signal circuit, which is interpreted by the ECM as a warmer ECT.

9.3 An IAT sensor that is skewed colder at various ambient temperatures due to greater resistance than is normal will increase the range between these two sensors. Measure and record the resistance of the IAT sensor at various ambient temperatures, then compare those measurements to the Temperature vs. Resistance table. Refer to *TEMPERATURE VERSUS RESISTANCE.*

9.4 An IAT sensor that is skewed colder at various ambient temperatures due to greater resistance than is normal will increase the range between these two sensors. Measure and record the resistance of the IAT sensor at various ambient temperatures, then compare those measurements to the Temperature vs. Resistance table. Refer to TEMPERATURE VERSUS RESISTANCE.High resistance in the IAT sensor signal circuit or low reference circuit will increase the range between these two sensors. This condition results in a greater voltage on the IAT sensor signal circuit, which is interpreted by the ECM as a colder IAT.

10 REFERENCE INFORMATION

10.1 SCHEMATIC REFERENCE

10.1.1 Engine controls schematics

10.2 CONNECTOR END VIEW REFERENCE

10.2.1 Component connector end views

10.3 ELECTRICAL INFORMATION REFERENCE

10.3.1 Circuit testing

10.3.2 Connector repairs

10.3.3 Testing for intermittent conditions and poor connections

10.3.4 Wiring repairs

10.4 DTC TYPE REFERENCE

10.4.1 Powertrain diagnostic trouble code (DTC) type definitions

10.5 SCAN TOOL REFERENCE

10.5.1 Control module referencesfor scan tool information.

11 CIRCUIT/SYSTEM VERIFICATION

11.1 Inspect the thermostatically-controlled coolant heater, if equipped, for damage or modifications. Test for proper operation of the coolant heater.

11.2 Ignition ON, verify the P0116 Freeze Frame Start Up ECT and the Start Up IAT parameters are within 14°C (25°F).

11.3 Ignition OFF for 8h or greater.

11.4 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.

11.4.1 If less than the specified range, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the K20 engine control module.

12 CIRCUIT/SYSTEM TESTING

12.1 Ignition OFF, disconnect the harness connector at the B34engine coolant temperature sensor.

12.2 Ignition OFF and all vehicle systems OFF. It may take may take up to 2 minutes for all vehicle systems to power down. Test for less than 5Ω between the low reference circuit terminalA and ground.

12.2.1 If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the K20engine control module.

12.3 Ignition ON, verify the scan tool ECT parameter is colder than −40°C (−40°F).

12.3.1 If warmer than the specified range, test the signal circuit terminalB for a short to ground. If the circuit tests normal, replace the K20engine control module.

12.4 Install a 3A fused jumper wire between the signal circuit terminalB and the low reference circuit terminalA. Verify the scan tool ECT parameter is warmer than 140°C (284°F).

12.4.1 If less than the specified range, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the K20engine control module.

12.5 If all circuits test normal, test or replace the B34engine coolant temperature sensor.

13 COMPONENT TESTING

13.1 Measure and record the resistance of the ECT sensor at various ambient temperatures, then compare those measurements to the temperature versus resistance.

14 REPAIR INSTRUCTIONS

14.1 Perform the DIAGNOSTIC REPAIR VERIFICATION after completing the diagnostic procedure.

14.2 Engine coolant temperature sensor replacement

14.3 CONTROL MODULE REFERENCES for engine control module replacement, programming, and setup.

P0117 – Engine Coolant Temperature (ECT) Sensor Circuit Low Voltage
P0118 – Engine Coolant Temperature (ECT) Sensor Circuit High Voltage

1 DIAGNOSTIC INSTRUCTIONS

1.1 Review *STRATEGY BASED DIAGNOSIS* for an overview of the diagnostic approach.

1.2 Perform the *DIAGNOSTIC SYSTEM CHECK* prior to using this diagnostic procedure.

2 DTC DESCRIPTOR

2.1 **DTC P0117:** Engine Coolant Temperature (ECT) Sensor Circuit Low Voltage

2.2 **DTC P0118:** Engine Coolant Temperature (ECT) Sensor Circuit High Voltage

3 DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
ECT Sensor Signal	P0117, P0119	P0118, P0119	P0118*	P0116, P0128
Low Reference	—	P0118, P0119	P0118*	P0128
*ECM or sensor damage may occur if the circuit is shorted to B+				

4 TYPICAL SCAN TOOL DATA

Engine Coolant Temperature (ECT) Sensor	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine operating in Closed Loop ***Parameter Normal Range:*** Varies with coolant temperature			
ECT Sensor Signal	140°C (284°F)	0°C (−40°F)	−40°C (−40°F)
Low Reference	—	−40°C (−40°F)	−40°C (−40°F)

5 CIRCUIT/SYSTEM DESCRIPTION

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

6 CONDITIONS FOR RUNNING THE DTC

6.1 P0117

6.1.1 This DTC runs continuously.

6.2 P0118

6.2.1 The engine is running for greater than 10 s, **OR**

6.2.2 The ignition is ON when the IAT minimum is greater than -7°C (45°F).

6.2.3 This DTC runs continuously when the above conditions are met.

7 CONDITIONS FOR SETTING THE DTC

7.1 P0117

7.1.1 The ECM detects that the ECT is warmer than 150°C (302°F) for greater than 5s.

7.2 P0118

7.2.1 The ECM detects that the ECT is colder than −60°C (−76°F) for greater than 5s.

8 ACTION TAKEN WHEN THE DTC SETS

8.1 DTCs P0117 and P0118 are Type B DTCs.

9 CONDITIONS FOR CLEARING THE MIL/DTC

9.1 DTCsP0117 and P0118 are TypeB DTCs.

10 REFERENCE INFORMATION

10.1 SCHEMATIC REFERENCE

10.1.1 Engine controls schematics

10.2 CONNECTOR END VIEW REFERENCE

10.2.1 Component connector end views

10.3 ELECTRICAL INFORMATION REFERENCE

10.3.1 Circuit testing

10.3.2 Connector repairs

10.3.3 Testing for intermittent conditions and poor connections

P0117 – Engine Coolant Temperature (ECT) Sensor Circuit Low Voltage
P0118 – Engine Coolant Temperature (ECT) Sensor Circuit High Voltage

10.3.4 Wiring repairs

10.4 DTC TYPE REFERENCE

10.4.1 Powertrain diagnostic trouble code (DTC) type definitions

10.5 SCAN TOOL REFERENCE

10.5.1 CONTROL MODULE REFERENCES for scan tool information.

11 CIRCUIT/SYSTEM VERIFICATION

11.1 Engine idling for 1 minute. Observe the DTC information with a scan tool. DTCs P0117 and P0118 should not set.

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

12 CIRCUIT/SYSTEM TESTING

12.1 Ignition OFF, disconnect the harness connector at the B34 engine coolant temperature sensor.

12.2 Ignition OFF, all vehicle systems OFF. This may take up to 2 minutes for all vehicle systems to power down. Test for less than 5 Ω between the low reference circuit terminalA and ground.

12.2.1 If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the K20engine control module.

12.3 Ignition ON, verify the scan tool ECT Sensor parameter is colder than −40°C (−40°F).

12.3.1 If greater than the specified range, test the signal circuit terminalB for a short to ground. If the circuit tests normal, replace the K20engine control module.

12.4 Install a 3 A fused jumper wire between the signal circuit terminalB and the low reference circuit terminal A. Verify the scan tool ECT Sensor parameter is warmer than 140°C (284°F).

12.4.1 If less than the specified range, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the K20engine control module.

12.5 If less than the specified range, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the K20engine control module.

13 COMPONENT TESTING

13.1 Measure and record the resistance of the ECT sensor at various ambient temperatures, then compare those measurements to the Temperature vs. Resistance table. Refer to TEMPERATURE VERSUS RESISTANCE.

P0117 – Engine Coolant Temperature (ECT) Sensor Circuit Low Voltage
P0118 – Engine Coolant Temperature (ECT) Sensor Circuit High Voltage

14 REPAIR INSTRUCTIONS

14.1 Perform the *DIAGNOSTIC REPAIR VERIFICATION* after completing the diagnostic procedure.

14.2 Engine coolant temperature sensor replacement

14.3 CONTROL MODULE REFERENCES for engine control module replacement, programming, and setup.

P0120 – PP0123, P0220, P0222, P0223, or P2135 – Throttle Position (TP) Sensor

1 DIAGNOSTIC INSTRUCTIONS

1.1 Review *STRATEGY BASED DIAGNOSIS* for an overview of the diagnostic approach.

1.2 Perform the *DIAGNOSTIC SYSTEM CHECK* prior to using this diagnostic procedure.

2 DTC DESCRIPTOR

2.1 **DTC P0120**: Throttle Position (TP) Sensor 1 Circuit

2.2 **DTC P0121**: Throttle Position (TP) Sensor 1 Performance

2.3 **DTC P0122**: Throttle Position (TP) Sensor 1 Circuit Low Voltage

2.4 **DTC P0123**: Throttle Position (TP) Sensor 1 Circuit High Voltage

2.5 **DTC P0220:**Throttle Position (TP) Sensor 2 Circuit

2.6 **DTC P0222**: Throttle Position (TP) Sensor 2 Circuit Low Voltage

2.7 **DTC P0223**: Throttle Position (TP) Sensor 2 Circuit High Voltage

2.8 **DTC P2135**: Throttle Position (TP) Sensor 1-2 Correlation

3 DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
5 V Reference	P0107, P0651, P0335	P2135	P022, P0222	P0651	P0068, P0121
TP Sensor 1 Signal	P0122	P2135	P0122	P0123	P0068, P0121
TP Sensor 2 Signal	P0222	P2135	P0223	P0223	P0068, P0121
Low Reference	—	P2135	P0123, P0223	—	P0068, P0121

4 TYPICAL SCAN TOOL DATA

TP Sensor 1 Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine running at various operating conditions ***Normal Range:*** 4.74–0.33 V			
5 V Reference	0 V	0 V	5 V
TP Sensor 1 Signal	0 V	0 V	5 V
Low Reference	—	4–5 V	—

P0120 – PP0123, P0220, P0222, P0223, or P2135 – Throttle Position (TP) Sensor

TP Sensor 2 Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine running at various operating conditions ***Parameter Normal Range:*** 0.26–4.5 V			
5 V Reference	0 V	0 V	5 V
TP Sensor 2 Signal	0 V	5 V	5 V
Low Reference		5 V	—

5 CIRCUIT/SYSTEM DESCRIPTION

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

The TP sensors have opposite functionality. TP sensor1 signal voltage decreases and TP sensor2 signal voltage increases as the accelerator pedal increases to wide open throttle (WOT).

6 CONDITIONS FOR RUNNING THE DTC

6.1 P0120, P0122, P0123, P0220, P0222, and P0223

6.1.1 DTC P0641 or P0651 is not set.

6.1.2 The run/crank or powertrain relay voltage is greater than 6 V and reduced power is not active.

6.1.3 The ignition is ON or the engine is operating.

6.1.4 DTC P0120, P0122, P0123, P0220, P0222, P0223, P2135 run continuously when the above conditions are met

6.2 P0121

6.2.1 DTCs P0102, P0103, P0107, P0108, P0111, P0112, P0113, P0116, P0117, P0118, P0128, P0315, P0335, P0336, or P3400 is not set

6.2.2 The engine speed is between 450–6,700 RPM.

6.2.3 The engine coolant temperature (ECT) is between −7 to +125°C (19–257°F).

6.2.4 The intake air temperature (IAT) is between −20 to +125°C (-4 to +257°F).

6.2.5 DTC P0121 runs continuously when the above conditions are met.

6.3 P2135

6.3.1 DTC P0120, P0122, P0123, P0220, P0222, P0223, or P0651 is not set.

6.3.2 The run/crank or powertrain relay voltage is greater than 6 V and reduced power is not active.

6.3.3 The ignition is ON or the engine is operating.

6.3.4 DTC P2135 runs continuously when the above conditions are met.

7 CONDITIONS FOR SETTING THE DTC

7.1 P0121

7.1.1 The ECM detects the TP sensor is stuck within a range for greater than 1 s.

7.2 P0120

7.2.1 TP sensor1 voltage is less than 0.325V or greater than 4.75V for greater than 1s.

7.3 P0122

7.3.1 The ECM detects that the TP sensor1 voltage is less than 0.325V for greater than 1s.

7.4 P0123

7.4.1 The ECM detects that the TP sensor1 voltage is greater than 4.75V for greater than 1s.

7.5 P0220

7.5.1 The TP sensor2 voltage is less than 0.25V or greater than 4.59V for greater than 1s.

7.6 P0222

7.6.1 The ECM detects that the TP sensor2 voltage is less than 0.25V for greater than 1s.

7.7 P0223

7.7.1 The ECM detects that the TP sensor2 voltage is greater than 4.59V for greater than 1s.

7.8 P2135

7.8.1 The difference between the TP sensor1 and TP sensor2 exceeds a predetermined value for greater than 2s.

8 ACTION TAKEN WHEN THE DTC SETS

8.1 DTC P0120, P0122, P0123, P0220, P0222, P0223, and P2135 are Type A DTCs.

8.2 DTC P0121 is a Type B DTC.

8.3 The ECM commands the TAC system to operate in the Reduced Engine Power mode.

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

8.5 Under certain conditions the control module commands the engine OFF.

9 CONDITIONS FOR CLEARING THE MIL/DTC

9.1 DTCsP0120, P0122, P0123, P0220, P0222, P0223, and P2135 are TypeA DTCs.

10 DIAGNOSTIC AIDS

10.1 If the Throttle Sweep Test is not available on the scan tool, observe the scan tool TP Sensor 1 and 2 Agree/Disagree parameter while performing the following tests:

10.1.1 Slowly depress the accelerator pedal to WOT and then slowly return the pedal to closed throttle. Repeat the procedure several times.

10.1.2 Rapidly depress the accelerator pedal from the rest position to the wide open throttle position (WOT) and release pedal. Repeat the procedure several times.

10.1.3 The TP Sensor 1 and 2 Agree/Disagree parameter should display Agree. If Disagree is displayed, continue diagnosis in Circuit/System Testing.

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

11 REFERENCE INFORMATION

11.1 SCHEMATIC REFERENCE

11.1.1 Engine controls schematics

11.2 CONNECTOR END VIEW REFERENCE

11.2.1 Component connector end views

11.3 ELECTRICAL INFORMATION REFERENCE

11.3.1 Circuit testing

11.3.2 Connector repairs

11.3.3 Testing for intermittent conditions and poor connections

11.3.4 Wiring repairs

11.4 DTC TYPE REFERENCE

11.4.1 Powertrain diagnostic trouble code (DTC) type definitions

11.5 SCAN TOOL REFERENCE

11.5.1 Control module referencesfor scan tool information

12 DESCRIPTION AND OPERATION

12.1 THROTTLE ACTUATOR CONTROL (TAC) SYSTEM DESCRIPTION

P0120 – PP0123, P0220, P0222, P0223, or P2135 – Throttle Position (TP) Sensor

13 CIRCUIT/SYSTEM VERIFICATION

13.1 If you were sent here from DTC P0068, P0101, P0106, or P1101 refer to Circuit System Testing

13.2 Ignition ON

13.3 Verify that DTC P0641 or P0651 is not set.

13.3.1 If a DTC is set, refer to DTC P0641 OR P0651 for further diagnosis.

13.3.2 If neither DTC is set continue to next step.

13.4 Verify the scan tool TP Idle Airflow Compensation parameter is less than 90%.

13.4.1 If greater than 90% clean throttle body

13.4.2 If less than 90% proceed to next step.

13.5 Observe the TP sensor 1 and 2 voltage parameters. Both parameters should be between 1.0–4.0 V and change with accelerator pedal input.

13.5.1 **NOTE:** If the throttle sweep test is not available on the scan tool, use the accelerator to perform the test. Refer to diagnostic aids for further details.

13.6 Perform the Throttle Sweep Test while observing the TP Sensor1 and 2 Agree/Disagree parameter with a scan tool. The TP Sensor 1 and 2 Agree/Disagree parameter should display Agree.

13.7 Clear the DTCs with the scan tool. Operate the vehicle within the Conditions for Running the DTC or within the conditions that you observed from the Freeze Frame/Failure Records.

13.8 Ignition ON, observe the DTC information with a scan tool. Verify that DTCP0120 or P0220 are not the only TP sensor DTCs set.

13.8.1 If DTCP0120 or P0220 are the only DTCs set, replace the ECM.

13.9 Verify DTC P0120, P0121, P0122, P0123, P0220, P0222, P0223, and P2135 is not set.

13.9.1 If any of the DTCs are set refer to Circuit/System Testing

13.9.2 If none of the DTCs are set proceed to next step

13.10 Determine the current vehicle testing altitude.

13.11 Verify the scan tool MAP Sensor pressure parameter is within range specified in the Altitude Versus Barometric Pressure table.

13.11.1 If the MAP Sensor pressure is not in range refer to DTC P0106.

13.11.2 The MAP Sensor pressure is within range proceed to next step.

13.12 With 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.

13.12.1 If not between 26–52 kPa (3.8–7.5 psi) or does not change refer to DTC P0106.

13.12.2 If between 26–52 kPa (3.8–7.5 psi) and changes proceed to next step

13.13 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.

13.13.1 Engine idling

13.13.2 Perform the scan tool snapshot function.

13.13.3 Increase the engine speed slowly to 3,000 RPM and then back to idle.

13.13.4 Exit from the scan tool snapshot and review the data.

13.13.5 Observe the MAF Sensor parameter frame by frame with a scan tool.

13.13.5.1 The MAF Sensor parameter does not change smoothly and gradually refer to DTC P0101

13.13.5.2 The MAF Sensor parameter changes smoothly and gradually proceed to next step

13.14 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.

13.15 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.

14 CIRCUIT/SYSTEM TESTING

14.1 Ignition OFF, disconnect the harness connector at the throttle body assembly.

14.2 Ignition OFF and all vehicle systems OFF. It may take up to 2 minutes for all vehicle systems to power down. Test for less than 5Ω between the low reference circuit terminalC and ground.

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

14.3 Ignition ON, test for 4.8–5.2V between the 5V reference circuit terminalE and ground.

14.3.1 If less than the specified range, test the 5V reference circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the ECM.

14.3.2 If greater than the specified range, test the 5V reference circuit for a short to voltage. If the circuit tests normal, replace the ECM.

14.4 Test for less than 1V between the TP sensor1 signal circuit terminalD and ground.

14.4.1 If greater than specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the ECM.

14.5 Install a 3A fused jumper wire between TP sensor1 signal circuit terminalD and the 5V reference circuit terminalE. Verify the scan tool TP sensor 1 voltage parameter is greater than 4.8V.

14.5.1 If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the ECM.

14.6 Test for 4.8–5.2V between the TP sensor2 signal circuit terminalF and ground.

14.6.1 If less than specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the ECM.

14.6.2 If greater than specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the ECM.

14.7 If all circuits test normal, test or replace the throttle body assembly.

15 REPAIR INSTRUCTIONS

15.1 Perform the *DIAGNOSTIC REPAIR VERIFICATION* after completing the diagnostic procedure.

15.2 THROTTLE BODY ASSEMBLY REPLACEMENT

15.3 CONTROL MODULE REFERENCES for Engine Control Module replacement, programming, and setup

P0128 – Engine Coolant Temperature (ECT) Below Thermostat Regulating Temperature

1 DIAGNOSTIC INSTRUCTIONS

1.1 Review *STRATEGY BASED DIAGNOSIS* for an overview of the diagnostic approach.

1.2 Perform the *DIAGNOSTIC SYSTEM CHECK*to using this diagnostic procedure.

2 DTC DESCRIPTOR

2.1 **DTC P0128**: Engine Coolant Temperature (ECT) Below Thermostat Regulating Temperature

3 DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open / High Resistance	Short to Voltage	Signal Performance
ECT Sensor	P0117, P0119	P0118, P0119	P0118*	P0116, P0128
Low Reference	—	P0118, P0119	P0118*	P0128
*ECM or sensor damage may occur if the circuit is shorted to B+				

4 TYPICAL SCAN TOOL DATA

4.1 ECT Sensor Temperature

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine operating in Closed Loop ***Parameter Normal Range:*** Varies with coolant temperature			
ECT Sensor Signal	150°C (302°F)	-40°C (−40°F)	−40°C (−40°F)
Low Reference	—	−40°C (−40°F)	−40°C (−40°F)

5 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 supplies a ground to the low reference circuit.

P0128 – Engine Coolant Temperature (ECT) Below Thermostat Regulating Temperature

The purpose of this diagnostic is to analyze the performance of the thermostat by using the ECT sensor to determine if the engine coolant will increase at the correct rate, and also to meet the calibrated target temperatures under various operating conditions.

The ECM uses the start-up ECT and the start-up intake air temperature (IAT) to begin the diagnostic calculation. The air flow into the engine is accumulated, and vehicle speed, distance, and engine run time are also factored in to determine if the ECT does increase normally and reach the calibrated target temperatures.

6 CONDITIONS FOR RUNNING THE DTC

6.1 DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0116, P0117, P0118, P0121, P0122, P0123, P0223, P0502, P0503, P1516, P2101, P2135 are not set.

6.2 The start-up IAT is warmer than −7°C (+19°F).

6.3 The start-up ECT is colder than 70°C (158°F), when the IAT is above 10°C (50°F).

6.4 **OR** The start-up ECT is colder than 50°C (122°F), when the IAT is below 10°C (50°F).

6.5 The engine OFF time is greater than 30 min.

6.6 The engine run time is between 90 s and 22 min.

6.7 The vehicle has traveled greater than 2.4 kilometers (1.5 miles) at greater than 8 km/h (5 mph).

6.8 The accumulated airflow is between 20–75 g/s, with the minimum average airflow greater than 10 g/s.

6.9 The fuel ethanol percentage is less than 87%.

6.10 This DTC runs once per ignition cycle when the above conditions are met.

7 CONDITIONS FOR SETTING THE DTC

7.1 The ECM detects that the minimum ECT of 75°C (167°F) has not been met, when the IAT is greater than 10°C (50°F).

7.2 **OR** The ECM detects that the minimum ECT of 55°C (131°F) has not been met, when the IAT is less than 10°C (50°F).

8 ACTION TAKEN WHEN THE DTC SETS

8.1 DTC P0128 is a Type B DTC.

P0128 – Engine Coolant Temperature (ECT) Below Thermostat Regulating Temperature

9 CONDITIONS FOR CLEARING THE MIL/DTC

9.1 DTC P0128 is a Type B DTC.

10 DIAGNOSTIC AIDS

10.1 DTC P0128 occurring with insufficient vehicle interior heating is an indication of improper thermostat operation.

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

10.3 Inspect the ECT sensor terminals and the ECT harness connector for corrosion. This condition results in a greater voltage on the ECT sensor signal circuit, which is interpreted by the ECM as a colder ECT.

10.4 This diagnostic runs in a specific range. Measure and record the resistance of the ECT sensor at various ambient temperatures between −7 to +80°C (+19 to +176°F), then compare those measurements to the Temperature Versus Resistance table.

10.5 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.

11 REFERENCE INFORMATION

11.1 SCHEMATIC REFERENCE

11.1.1 Engine controls schematics

11.2 CONNECTOR END VIEW REFERENCE

11.2.1 Component connector end views

11.3 ELECTRICAL INFORMATION REFERENCE

11.3.1 Circuit testing

11.3.2 Connector repairs

11.3.3 Testing for intermittent conditions and poor connections

11.3.4 Wiring repairs

11.4 DTC TYPE REFERENCE

11.4.1 Powertrain diagnostic trouble code (DTC) type definitions

11.5 SCAN TOOL REFERENCE

11.5.1 Control module references for scan tool information.

12 CIRCUIT/SYSTEM VERIFICATION

12.1 Ignition OFF, inspect the cooling system surge tank for the proper coolant level. Refer to Cooling System Leak Testing and Cooling System Draining and Filling.

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

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

12.3 Ignition ON, observe the scan tool IAT Sensor and ECT Sensor parameters. The ECT, IAT, and ambient temperatures should be within 6°C (11°F) of each other.

12.4 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.

13 CIRCUIT/SYSTEM TESTING

13.1 Ignition OFF, disconnect the harness connector at the B34 engine coolant temperature sensor.

13.2 Ignition OFF and all vehicle systems OFF. It may take up to 2 minutes for all vehicle systems to power down. Test for less than 5 Ω between the low reference circuit terminal A and ground.

13.2.1 If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the K20 engine control module.

13.3 Ignition ON, verify the scan tool ECT Sensor parameter is less than −40°C (−40°F).

13.3.1 If warmer than the specified range, test the signal circuit terminal B for a short to ground. If the circuit tests normal, replace the K20 engine control module.

13.4 Install a 3 A fused jumper wire between the signal circuit terminal B and the low reference circuit terminal A. Verify the scan tool ECT Sensor parameter is warmer than 149°C (300°F).

13.4.1 If colder than the specified range, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the K20 engine control module.

13.5 If all circuits test normal, test or replace the B34 engine coolant temperature sensor.

14 COMPONENT TESTING

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

P0128 – Engine Coolant Temperature (ECT) Below Thermostat Regulating Temperature

15 REPAIR INSTRUCTIONS

15.1 Perform the *DIAGNOSTIC REPAIR VERIFICATION*after completing the diagnostic procedure.

15.2 Engine Coolant Temperature Sensor Replacement

15.3 Control Module References for ECM replacement, setup, and programming

P0131, P0132, P0137, P0138, P0151, P0152, P0157 or P0158– Heated Oxygen (HO2) Sensors

1 DIAGNOSTIC INSTRUCTIONS

1.1 Review *STRATEGY BASED DIAGNOSIS* for an overview of the diagnostic approach.

1.2 Perform the *DIAGNOSTIC SYSTEM CHECK* prior to using this diagnostic procedure.

2 DTC DESCRIPTOR

2.1 **DTC P0131:** HO2S Circuit Low Voltage Bank1 Sensor1

2.2 **DTC P0132:** HO2S Circuit High Voltage Bank1 Sensor1

2.3 **DTC P0137:** HO2S Circuit Low Voltage Bank1 Sensor2

2.4 **DTC P0138:** HO2S Circuit High Voltage Bank1 Sensor2

2.5 **DTC P0151:** HO2S Circuit Low Voltage Bank2 Sensor1

2.6 **DTC P0152:** HO2S Circuit High Voltage Bank2 Sensor1

2.7 **DTC P0157:** HO2S Circuit Low Voltage Bank2 Sensor2

2.8 **DTC P0158:** HO2S Circuit High Voltage Bank2 Sensor2

P0131, P0132, P0137, P0138, P0151, P0152, P0157 or P0158– Heated Oxygen (HO2) Sensors

3 DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
HO2S High Signal	P011, P0137, P0151, P0157, P1133, P1153	P0131, P0132, P0133, P0134, P0137, P0140, P0151, P0152, P0153, P0154, P0157, P0160, P1133, P1153	P013A, P013B, P013C, P013D, P013E, P013F, P0131, P0132, P0133, P0134, P0137, P0138, P0140, P0151, P0152, P0153, P0154, P0157, P0158, P0160, P1133, P1153	P0132, P0134, P0138, P0140, P0152, P0154, P0158, P0160, P1133, P1153	P013A, P013B, P013C, P013D, P013E, P013F, P0133, P0134, P0140, P0153, P0154, P0160, P1133, P1153
HO2S Low Signal	P0131, P0137, P0151, P0157	P0131, P0132, P0133, P0134, P0138, P0140, P0151, P0152, P0153, P0154, P0158, P0160, P1133, P1153	P013A, P013B, P013C, P013D, P013E, P013F, P0131, P0132, P0133, P0134, P0138, P0140, P0151, P0152, P0153, P0154, P0158, P0160, P1133, P1153	P0134, P0138, P0140, P0154, P0158, P0160, P1133, P1153	—

4 TYPICAL SCAN TOOL DATA

HO2S Sensor 1 Voltage/HO2S Sensor 2 Voltage Circuit	Short to Ground	Open	Short to Voltage
Parameter Normal Range: 200–800 mV			
HO2S High Signal	0 mV	Approximately 470 mV	Approximately 1,100 mV
HO2S Low Signal	455 mV	Approximately 470 mV	Approximately 445 mV

5 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 begin to generate a voltage within a range of 0-1,275 mV. Once sufficient HO2S voltage

P0131, P0132, P0137, P0138, P0151, P0152, P0157 or P0158– Heated Oxygen (HO2) Sensors

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.

6 CONDITIONS FOR RUNNING THE DTC

6.1 P0131, P0137, P0151, OR P0157

6.1.1 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.

6.1.2 The engine is operating in Closed Loop.

6.1.3 The Ignition 1 voltage is between 10–32V.

6.1.4 The fuel level is greater than 10%.

6.1.5 The throttle position (TP) is between 3–70%.

6.1.6 The DTCs run continuously when the above conditions are met for 2s.

6.2 P0132, P0138, P0152, OR P0158

6.2.1 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.

6.2.2 The engine is operating in Closed Loop.

6.2.3 The Ignition1 voltage is between 10–32V.

6.2.4 The fuel level is greater than 10%.

6.2.5 The throttle position (TP) is between 0–70%.

6.2.6 The DTCs run continuously when the above conditions are met for 2s.

7 CONDITIONS FOR SETTING THE DTC

7.1 P0131, P0137, P0151, OR P0157

7.1.1 The ECM detects that the HO2S voltage is less than 50mV.

7.1.2 The DTCs set within 100s when the above condition is met.

7.2 P0132, P0138, P0152, OR P0158

7.2.1 The ECM detects that the HO2S voltage is greater than 1,050mV.

7.2.2 The DTCs set within 15s when the above condition is met.

8 ACTION TAKEN WHEN THE DTC SETS

8.1 DTCs P0131, P0132, P0137, P0138, P0151, P0152, and P0158 are TypeB DTCs.

9 CONDITIONS FOR CLEARING THE MIL/DTC

9.1 DTCs P0131, P0132, P0137, P0138, P0151, P0152, and P0158 are TypeB DTCs.

10 REFERENCE INFORMATION

10.1 SCHEMATIC REFERENCE

10.1.1 Engine controls schematics

10.2 CONNECTOR END VIEW REFERENCE

10.2.1 Component connector end views

10.3 ELECTRICAL INFORMATION REFERENCE

10.3.1 Circuit testing

10.3.2 Connector repairs

10.3.3 Heated oxygen sensor wiring repairs

10.3.4 Testing for intermittent conditions and poor connections

10.3.5 Wiring repairs

10.4 DTC TYPE REFERENCE

10.4.1 Powertrain diagnostic trouble code (DTC) type definitions

10.5 SCAN TOOL REFERENCE

10.5.1 CONTROL MODULE REFERENCESfor scan tool information

P0131, P0132, P0137, P0138, P0151, P0152, P0157 or P0158– Heated Oxygen (HO2) Sensors

11 CIRCUIT/SYSTEM VERIFICATION

11.1 Ignition ON, observe the DTC information with a scan tool. Verify no B52HO2S heater DTCs are set.

11.1.1 If a B52HO2S heater DTC is set, refer to *DIAGNOSTIC TROUBLE CODE (DTC) LIST*

11.2 Engine running, observe the appropriate scan tool B52HO2S voltage parameter. The reading should be within the range of 50-1,050mV.

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

12 CIRCUIT/SYSTEM TESTING

NOTE: ALL MODULES MUST BE POWERED DOWN OR MISDIAGNOSIS MAY RESULT.

12.1 Ignition OFF, disconnect the harness connector at the appropriate B52HO2S.

12.2 Ignition OFF, all vehicle systems OFF, this may take up to 2minutes, test for less than 5Ω between the low reference circuit terminalA and ground.

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

12.3 Ignition ON, verify the appropriate scan tool B52HO2S parameter is approximately 450mV.

12.3.1 If less than the specified value, test the signal circuit for a short to ground. If the circuit tests normal,replace the K20ECM.

12.3.2 If greater than the specified value, test the signal circuit for a short to voltage. If the circuit tests normal, replace the K20ECM.

12.4 Ignition ON, install a 3A fused jumper wire between the signal circuit terminalB and ground. Verify the appropriate scan tool B52HO2S parameter is less than 60mV.

12.4.1 Ignition ON, install a 3A fused jumper wire between the signal circuit terminalB and ground. Verify the appropriate scan tool B52HO2S parameter is less than 60mV.

12.5 If all circuits test normal, replace the appropriate B52HO2S.

13 REPAIR INSTRUCTIONS

13.1 Perform theDIAGNOSTIC REPAIR VERIFICATION after completing the diagnostic procedure.

13.2 Refer to OEM Service Manual for replacement of HO2s.

CONTROL MODULE REFERENCES for ECM replacement, setup, and programming

P0133, P013A-P013F, P014A, P014B, P0153, P015A-P015D– Heated Oxygen (HO2) Sensors

1 DIAGNOSTIC INSTRUCTIONS

1.1 Review *STRATEGY BASED DIAGNOSIS* for an overview of the diagnostic approach.

1.2 Perform the *DIAGNOSTIC SYSTEM CHECK*prior to using this diagnostic procedure.

2 DTC DESCRIPTORS

2.1 DTC P0133: HO2S Slow Response Bank 1 Sensor 1

2.2 DTC P013A: HO2S Slow Response Rich to Lean Bank 1 Sensor 2

2.3 DTC P013B: HO2S Slow Response Lean to Rich Bank 1 Sensor 2

2.4 DTC P013C: HO2S Slow Response Rich to Lean Bank 2 Sensor 2

2.5 DTC P013D: HO2S Slow Response Lean to Rich Bank 2 Sensor 2

2.6 DTC P013E: HO2S Delayed Response Rich to Lean Bank 1 Sensor 2

2.7 DTC P013F: HO2S Delayed Response Lean to Rich Bank 1 Sensor 2

2.8 DTC P014A: HO2S Delayed Response Rich to Lean Bank 2 Sensor 2

2.9 DTC P014B: HO2S Delayed Response Lean to Rich Bank 2 Sensor 2

2.10 DTC P0153: HO2S Slow Response Bank 2 Sensor 1

2.11 DTC P015A: HO2S Delayed Response Rich to Lean Bank 1 Sensor 1

2.12 DTC P015B: HO2S Delayed Response Lean to Rich Bank 1 Sensor 1

2.13 DTC P015C: HO2S Delayed Response Rich to Lean Bank 2 Sensor 1

2.14 DTC P015D: HO2S Delayed Response Lean to Rich Bank 2 Sensor 1

P0133, P013A-P013F, P014A, P014B, P0153, P015A-P015D– Heated Oxygen (HO2) Sensors

3 DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
HO2 High Signal	P0131, P0137, P0151, P0157, P0171, P0174	P0132, P0134, P0138, P0140, P0152, P0154, P0158, P0160	P0132, P0134, P0138, P0140, P0152, P0154, P0158, P0160	P0132, P0134, P0138, P0140, P0152, P0154, P0158, P0160	P0133, P013A, P013B, P013C, P013D, P013E, P013F, P014A, P014B, P0153, P015A, P015B, P015C, P015D
HO2S Low Signal	P0131, P0137, P0151, P0157	P0132, P0134, P0138, P0140, P0152, P0154, P0158, P0160	P0132, P0134, P0138, P0140, P0152, P0154, P0158, P0160	P0132, P0134, P0138, P0140, P0152, P0154, P0158, P0160	P0133, P013A, P013B, P013C, P013D, P013E, P013F, P014A, P014B, P0153, P015A, P015B, P015C, P015D

4 CIRCUIT/SYSTEM DESCRIPTION

Heated oxygen sensors (HO2S) are used for fuel control and post catalyst monitoring. Each HO2S compares the oxygen content of the surrounding air with the oxygen content in the exhaust stream. The HO2S must reach operating temperature to provide an accurate voltage signal. Heating elements inside the HO2S minimize the time required for the sensors to reach operating temperature. The control module supplies the HO2S with a reference, or bias, voltage of about 450 mV. When the engine is first started, the control module operates in Open Loop, ignoring the HO2S voltage signal. Once the HO2S reaches operating temperature and Closed Loop is achieved, the HO2S generates a voltage within a range of 0– 1,275 mV that fluctuates above and below the bias voltage. A high HO2S voltage indicates a rich exhaust stream. A low HO2S voltage indicates a lean exhaust stream.

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.

5 CONDITIONS FOR RUNNING THE DTC

5.1 P0133 or P0153

5.1.1 DTC 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 or P2176 is not set.

5.1.2 The ignition voltage is between 10–32 V.

5.1.3 The engine coolant temperature (ECT) is warmer than 50°C (122°F).

5.1.4 The intake air temperature (IAT) is warmer than −40°C (−40°F).

5.1.5 The fuel level is greater than 10 percent.

5.1.6 The engine run time is greater than 120 s.

5.1.7 The engine speed is between 1,200–3,000 RPM.

5.1.8 The barometric (BARO) pressure is greater than 70 kPa.

5.1.9 The mass airflow (MAF) is between 20–55 g/s.

5.1.10 The fuel system is in Closed Loop.

5.1.11 Ethanol content is less than 87 percent.

5.1.12 The fuel control state is not in power enrichment.

5.1.13 Decel fuel cut off is not active.

5.1.14 The DTCs run once per drive cycle when the above conditions are met for greater than 3.5 s.

5.2 P013A P013C, P013E, P014A, P015A, or P015C

5.2.1 Before the ECM can report DTC P013E, or P014A failed, DTCs P2270 and P2272 must run and pass.

5.2.2 Before the ECM can report DTC P013A, or P013C failed, DTCs P013E, P014A, P2270, and P2272 must run and pass.

5.2.3 DTC P0030, P0036, P0053, P0054, P0101, P0102, P0103, P0106, P0107, P0108, P0120, P0121, P0122, P0123, P0131, P0132, P0133, P0134, P0135, P0137, P0138, P013A, P013B, P013E, P013F, P0140, P0141, P0171, P0172, P0201, P0202, P0203, P0204, P0220, P0222, P0223, P0300, P0442, P0443, P0446, P0449, P0455, P0496, P1174, P1175, P1516, P2101, P2119, P2135, P2176, P2270, P2271 or P2A00 is not set.

5.2.4 The ignition voltage is between 10–32 V.

5.2.5 The fuel level is greater than 10 percent.

5.2.6 The accelerator pedal (APP) is steady.

5.2.7 Decel fuel cut-off is continued without driver input after the above conditions are met.

5.2.8 The DTCs run once per ignition cycle, during decel fuel cut-off (DFCO), when the above conditions are met.

5.3 P013B P013D, P013F, P014B, P015B or P015D

P0133, P013A-P013F, P014A, P014B, P0153, P015A-P015D– Heated Oxygen (HO2) Sensors

5.3.1 Before the ECM can report DTC P013F, or P014B failed, DTCs P2271, P2273, P013A, P013C, P013E, P014A, P2270, and P2272 and must run and pass.

5.3.2 Before the ECM can report DTC P013B or P013D failed, DTCs P013F, P014B, P2271, P2273, P013A, P013C, P013E, P014A, P2270, and P2272 and must run and pass.

5.3.3 DTC P0030, P0036, P0053, P0054, P0101, P0102, P0103, P0106, P0107, P0108, P0120, P0121, P0122, P0123, P0131, P0132, P0133, P0134, P0135, P0137, P0138, P013A, P013B, P013E, P013F, P0140, P0141, P0171, P0172, P0201, P0202, P0203, P0204, P0220, P0222, P0223, P0300, P0442, P0443, P0446, P0449, P0455, P0496, P1174, P1175, P1516, P2101, P2119, P2135, P2176, P2270, P2271 or P2A00 is not set.

5.3.4 The ignition voltage is between 10–32 V.

5.3.5 The fuel level is greater than 10 percent.

5.3.6 Fuel enrich mode continues after the above conditions are met.

5.3.7 The DTCs run once per ignition cycle when the above conditions are met.

6 CONDITIONS FOR SETTING THE DTC

6.1 P0133 or P0153

6.1.1 The ECM detects that the HO2S 1 rich-to-lean or lean-to-rich average response time is greater than a calibrated value.

6.1.2 The DTCs set within 100 s when the above condition is met.

6.2 P013A or P013C

6.2.1 The ECM detects that the HO2S 2 has a slow response when the accumulated mass air flow monitored during rich-to-lean transitions between 500–200 mV is greater than a calibrated value.

6.3 P013B or P013D

6.3.1 The ECM detects that the HO2S 2 has a slow response when the accumulated mass air flow monitored during lean-to-rich transitions between 350–650 mV is greater than a calibrated value.

6.4 P013E or P014A

6.4.1 The ECM detects that the HO2S 2 sensor has an initial delayed rich-to-lean response when the voltage has not decreased below 500 mV within a calibrated value of accumulated air flow.

6.5 P013F or P014B

P0133, P013A-P013F, P014A, P014B, P0153, P015A-P015D– Heated Oxygen (HO2) Sensors

6.5.1 The ECM detects that the HO2S 2 sensor has an initial delayed lean-to-rich response when the voltage has not increased above 350 mV within a calibrated value of accumulated air flow.

6.6 P015A or P015C

6.6.1 The ECM detects that the HO2S 1 sensor has an initial delayed rich-to-lean response when the voltage has not decreased below 550 mV within a calibrated value of accumulated air flow.

6.7 P015B or P015D

6.7.1 The ECM detects that the HO2S 1 sensor has an initial delayed lean-to-rich response when the voltage has not increased above 350 mV within a calibrated value of accumulated air flow.

7 ACTION TAKEN WHEN THE DTC SETS

7.1 DTCs P0133, P013E, P013F, P014A, P014B, and P0153 are Type B DTCs.

7.2 DTCs P013A, P013B, P013C, P013D, P015A, P015B, P015C, and P015D are Type A DTCs.

8 CONDITIONS FOR CLEARING THE DTC

8.1 DTCs P0133, P013E, P013F, P014A, P014B, and P0153 are Type B DTCs.

8.2 DTCs P013A, P013B, P013C, P013D, P015A, P015B, P015C, and P015D are Type A DTCs.

9 DIAGNOSTIC AID

The following diagnostics are run in sequence while the vehicle is in decel cut-off:

9.1 HO2S Bank 1 Sensor 2: P2270, P013E, P013A, and P2271.

9.2 HO2S Bank 2 Sensor 2: P2272, P014A, P013C, P2273.

9.3 At the same time, after P2270 and P2272 run and pass, diagnostics for P015A and P015C are also running. Any accelerator input will stop the tests, causing the sequence to start over.

9.4 After the above tests run and pass, the following diagnostics are run in sequence and are not affected by accelerator pedal input:

9.4.1 HO2S Bank 1 Sensor 2: P013F, P013B.

9.4.2 HO2S Bank 2 Sensor 2: P014B, P013D.

9.4.3 At the same time, diagnostics for P015B and P015D are also running.

P0133, P013A-P013F, P014A, P014B, P0153, P015A-P015D– Heated Oxygen (HO2) Sensors

10 REFERENCE INFORMATION

10.1 SCHEMATIC REFERENCE

10.1.1 Engine controls schematics

10.2 CONNECTOR END VIEW REFERENCE

10.2.1 Component connector end views

10.3 ELECTRICAL INFORMATION REFERENCE

10.3.1 Circuit testing

10.3.2 Connector repairs

10.3.3 Testing for intermittent conditions and poor connections

10.3.4 Wiring repairs

10.4 DTC TYPE REFERENCE

10.4.1 Powertrain diagnostic trouble code (DTC) type definitions

10.5 SCAN TOOL REFERENCE

10.5.1 CONTROL MODULE REFERENCESfor scan tool information

11 CIRCUIT/SYSTEM VERIFICATION

11.1 Ignition ON, observe the DTC information with a scan tool. Verify no HO2S heater DTCs are set.

11.1.1 If a HO2S heater DTC is set, refer to *DIAGNOSTIC TROUBLE CODE (DTC) LIST.*

11.2 Verify none of the following conditions exist:

11.2.1 Lean or rich fuel injectors—Refer to *FUEL INJECTOR DIAGNOSIS*

11.2.2 Water intrusion in the HO2S harness connector

11.2.3 Low or high fuel system pressure—Refer to *FUEL SYSTEM DIAGNOSIS*

11.2.4 Fuel that is contaminated—Refer to *ALCOHOL/CONTAMINANTS-IN-FUEL DIAGNOSIS*

11.2.5 Fuel saturation of the evaporative emission (EVAP) canister

11.2.6 Exhaust leaks

11.2.7 Engine vacuum leaks

11.2.8 Engine oil consumption

11.2.9 Engine coolant consumption

11.2.9.1 If you find any of the above conditions, repair as necessary.

11.3 If all conditions test normal, test or replace the appropriate B52 Heated Oxygen Sensor.

11.4 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.

12 CIRCUIT/SYSTEM VERIFICATION

12.1 Ignition ON, observe the DTC information with a scan tool. Verify no HO2S heater DTCs are set.

12.1.1 If a HO2S heater DTC is set, refer to DIAGNOSTIC TROUBLE CODE (DTC) LIST - VEHICLE

12.2 Verify none of the following conditions exist:.

12.2.1 Lean or rich fuel injectors—Refer to FUEL INJECTOR DIAGNOSIS

12.2.2 Water intrusion in the HO2S harness connector

12.2.3 Low or high fuel system pressure—Refer to FUEL SYSTEM DIAGNOSIS

12.2.4 Fuel that is contaminated—Refer to ALCOHOL/CONTAMINANTS-IN-FUEL DIAGNOSIS

12.2.5 Fuel saturation of the evaporative emission (EVAP) canister

12.2.6 Exhaust leaks near the HO2S

12.2.7 Engine vacuum leaks

12.2.8 Engine oil consumption—Refer to *OIL CONSUMPTION DIAGNOSIS*

12.2.9 Engine coolant consumption—Refer to LOSS OF COOLANT

12.2.9.1 If you find any of the above conditions, repair as necessary.

12.2.9.2 If you find any of the above conditions, repair as necessary.

12.3 If all conditions test normal, test or replace the appropriate B52HO2S.

12.4 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.

P0133, P013A-P013F, P014A, P014B, P0153, P015A-P015D– Heated Oxygen (HO2) Sensors

13 REPAIR INSTRUCTIONS

13.1 Perform the *DIAGNOSTIC REPAIR VERIFICATION* after completing the repair.

13.2 Refer to OEM Service Manual for replacement of H02s

13.3 Control Module References for ECM replacement, programming and setup.

P0134, P0140, P0154, P0160 – Heated Oxygen (HO2) Sensors

1 DIAGNOSTIC INSTRUCTIONS

1.1 Review *STRATEGY BASED DIAGNOSIS* for an overview of the diagnostic approach.

1.2 Perform the *DIAGNOSTIC SYSTEM CHECK* prior to using this diagnostic procedure.

2 DTC DESCRIPTOR

2.1 **DTC P0134:** HO2S Circuit Insufficient Activity Bank1 Sensor1

2.2 **DTC P0140:** HO2S Circuit Insufficient Activity Bank1 Sensor2

2.3 **DTC P0154:** HO2S Circuit Insufficient Activity Bank2 Sensor1

2.4 **DTC P0160:** HO2S Circuit Insufficient Activity Bank2 Sensor2

3 DIAGNOSTIC FAULT INFORMATION

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

P0134, P0140, P0154, P0160 – Heated Oxygen (HO2) Sensors

4 TYPICAL SCAN TOOL DATA

HO2S Sensor 1 Voltage, HO2S Sensor 2 Voltage Circuit	Short to Ground	Open	Short to Voltage
Parameter Normal Range: 200–800 mV			
HO2S Signal	0 mV	Approximately 470 mV	Approximately 1,100 mV
HO2S Low Reference	455 mV	Approximately 450 mV	Approximately 445 mV

5 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 heatup and begin to generate a voltage within a range of 0-1,275mV. 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 1,000mV indicates a rich fuel mixture. An HO2S voltage that decreases toward 0mV indicates a lean fuel mixture.

5.1 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.

6 CONDITIONS FOR RUNNING THE DTC

6.1 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.

6.2 The ignition 1 voltage is between 10–32 V.

6.3 The engine run time is greater than 300 s.

6.4 The fuel system is in Closed Loop.

6.5 The DTCs run continuously when the above conditions are met.

7 CONDITIONS FOR SETTING THE DTC

7.1 P0134 or P0154

7.1.1 The ECM detects that the HO2S1 voltage is between 350–550mV for at least 50s.

7.2 P0140 or P0160

7.2.1 The ECM detects that the HO2S2 voltage is between 410–490mV for at least 74s.

8 ACTION TAKEN WHEN THE DTC SETS

8.1 DTCsP0134, P0140, P0154, and P0160 are TypeB DTCs.

9 CONDITIONS FOR CLEARING THE DTC

9.1 DTCsP0134, P0140, P0154, and P0160 are TypeB DTCs.

10 REFERENCE INFORMATION

10.1 SCHEMATIC REFERENCE

10.1.1 Engine controls schematics

10.2 CONNECTOR END VIEW REFERENCE

10.2.1 Component connector end views

10.3 ELECTRICAL INFORMATION REFERENCE

10.3.1 Circuit testing

10.3.2 Connector repairs

10.3.3 Testing for intermittent conditions and poor connections

10.3.4 Wiring repairs

10.3.5 Heated oxygen sensor wiring repairs

10.4 DTC TYPE REFERENCE

10.4.1 Powertrain diagnostic trouble code (DTC) type definitions

10.5 SCAN TOOL REFERENCE

10.5.1 CONTROL MODULE REFERENCESfor scan tool information

11 CIRCUIT/SYSTEM VERIFICATION

11.1 Ignition ON, observe the DTC information with a scan tool. Verify no B52HO2S heater DTCs are set. If a HO2S heater DTC is set, refer to *DIAGNOSTIC TROUBLE CODE (DTC) LIST.*

11.1.1 If a HO2S heater DTC is set, refer to.

11.1.2 If a HO2S heater DTC is set, refer to *DIAGNOSTIC TROUBLE CODE (DTC) LIST*

11.2 Run the engine for more than 5 minutes.

11.3 Engine idling at operating temperature; observe the appropriate B52HO2S parameter with a scan tool. Verify the following:

11.3.1 The B52HO2S1 value should vary from below 200mV to above 800mV and respond to fueling

11.3.2 The B52HO2S2 value should fluctuate at less than 380mV or greater than 520mV. The values should not remain within 380mV and 520mV.

11.4 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.

12 CIRCUIT/SYSTEM TESTING

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

12.1 Ignition OFF, disconnect the harness connector at the appropriate B52HO2S.

12.2 Ignition OFF, all vehicle systems OFF, this may take up to 2minutes, test for less than 5C) between the low reference circuit terminalA and ground.

12.2.1 Ignition OFF, all vehicle systems OFF, this may take up to 2minutes, test for less than 5C) between the low reference circuit terminalA and ground.

12.3 Ignition ON, verify the appropriate scan tool B52HO2S parameter is approximately 450mV.

12.3.1 If less than the specified value, test the signal circuit for a short to ground. If the circuit tests normal, replace the K20ECM.

12.3.2 If greater than the specified value, test the signal circuit for a short to voltage. If the circuit tests normal, replace the K20ECM.

12.4 Ignition ON, install a 3A fused jumper wire between the signal circuit terminalB and ground. Verify the appropriate scan tool B52HO2S parameter is less than 60mV.

12.4.1 If greater than the specified range, test the signal circuit for an open/high resistance. If the circuit tests normal, replace the K20ECM.

12.5 If all circuits test normal, replace the appropriate B52HO2S.

P0134, P0140, P0154, P0160 – Heated Oxygen (HO2) Sensors

13 REPAIR INSTRUCTIONS

13.1 Perform the *DIAGNOSTIC REPAIR VERIFICATION* after completing the diagnostic procedure.

13.2 Refer to OEM Service Manual for replacement of H02s.

13.3 CONTROL MODULE REFERENCES for ECM replacement, setup, and programming

P0171, P0172, P0174, P0175– Fuel Trim System

1 DIAGNOSTIC INSTRUCTIONS

1.1 Review *STRATEGY BASED DIAGNOSIS* for an overview of the diagnostic approach.

1.2 Perform the *DIAGNOSTIC SYSTEM CHECK* prior to using this diagnostic procedure.

2 DTC DESCRIPTOR

2.1 **DTC P0171**: Fuel Trim System Lean Bank 1

2.2 **DTC P0172**: Fuel Trim System Rich Bank 1

2.3 **DTC P0174**: Fuel Trim System Lean Bank 2

2.4 **DTC P0175:**Fuel Trim System Rich Bank 2

3 CIRCUIT/SYSTEM DESCRIPTION

The engine control module(ECM) controls the air/fuel metering system in order to provide the best possible combination of drivability, 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(FT) values. The short term FT values change rapidly in response to the HO2S voltage signals. These changes fine tune the engine fueling. The long term FT makes coarse adjustments in order to maintain an optimum air/fuel ratio. The ideal FT values are around zero percent. A positive FT value indicates that the ECM is adding fuel in order to compensate for a lean condition. A negative FT value indicates that the ECM is reducing the amount of fuel in order to compensate for a rich condition.

4 CONDITIONS FOR RUNNING THE DTC

4.1 DTCs P0030, P0050, P0053, P0059, P0101, P0102, P0103, P0106, P0107, P0108, P0131, P0132, P0133, P0134, P0135, P0151, P0152, P0153, P0154, P0155, P0201–P0208, P0300, P0301-P0308, P0442, P0443, P0446, P0449, P0452, P0453, P0455, P0496, P0506, P0507, P2227, P2228, P2229, P2230 are not set.

4.2 The engine is in Closed Loop status.

4.3 The Catalyst Monitor Intrusive Test, Post O2Diagnosis Intrusive Test, Device Control, and EVAP Diagnosis “tank pull down” are Not Active.

4.4 The engine coolant temperature(ECT) is between −40 and +150°C (−40 and +302°F).

4.5 The intake air temperature(IAT) is between −7 and +150°C (+19 and +302°F).

4.6 The manifold absolute pressure(MAP) is between 10–255kPa (1.45–37psi).

4.7 The engine speed is between 375–7,000RPM.

4.8 The mass air flowMAF) is between 1–510g/s.

4.9 The barometric pressure(BARO) is greater than 70kPa (10.2psi).

4.10 The fuel level is greater than 10percent.

4.11 This diagnostic runs continuously when the above conditions have been met.

5 CONDITIONS FOR SETTING THE DTC

5.1 The average long-term FT weighted average value is greater or less than a calibrated value.

5.2 The above condition is present for approximately 3 minutes after the Conditions for Running the DTC have been met.

6 ACTION TAKEN WHEN THE DTC SETS

6.1 DTCsP0171, P0172, P0174, and P0175 are TypeBDTCs.

7 CONDITIONS FOR CLEARING THE MIL/DTC

7.1 DTCsP0171, P0172, P0174, and P0175 are TypeBDTCs.

8 DIAGNOSTIC AIDS

8.1 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 40mV to approximately 900mV, and respond to fueling changes.

8.2 The normal Short Term FT and Long Term FT parameters should be between +10 and −10percent the optimum with the engine running at operating temperature.

8.3 A fuel system delivery condition causes this DTC to set. Thoroughly inspect all items that cause a rich or a lean condition. Refer to FUEL SYSTEM DIAGNOSIS.

8.4 Any un-metered air into the engine causes this DTC to set. Thoroughly inspect all areas of the engine for vacuum leaks.

8.5 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.

8.6 Inspect the air filter for being the correct one for this application. Make sure that the engine oil fill cap is in place, and that it is tight. Verify that the engine oil dip stick is fully seated.

8.7 Certain aftermarket air filters may cause a DTC to set.

8.8 Certain aftermarket air induction systems or modifications to the air induction system may cause a DTC to set.

8.9 Certain aftermarket exhaust system components may cause a DTC to set.

9 REFERENCE INFORMATION

9.1 SCHEMATIC REFERENCE

9.1.1 Engine controls schematics

9.2 CONNECTOR END VIEW REFERENCE

9.2.1 Component connector end views

9.3 ELECTRICAL INFORMATION REFERENCE

9.3.1 Circuit testing

9.3.2 Connector repairs

9.3.3 Testing for intermittent conditions and poor connections

9.3.4 Wiring repairs

9.4 DTC TYPE REFERENCE

9.4.1 Powertrain diagnostic trouble code (DTC) type definitions

9.5 SCAN TOOL REFERENCE

9.5.1 CONTROL MODULE REFERENCESfor scan tool information

10 CIRCUIT/SYSTEM VERIFICATION

10.1 Engine running, observe the DTC information with a scan tool. Verify there are no HO2S DTCs set.

10.1.1 If any DTCs are set, refer to *DIAGNOSTIC TROUBLE CODE (DTC) LIST.*

10.2 Ignition ON, engine OFF, observe; the Manifold Absolute Pressure (MAP) Sensor parameter. The MAP sensor pressure should be within the range specified for your altitude.

10.2.1 If the MAP sensor pressure is not within the range specified for your altitude, refer to DTC P0106.

10.3 With the engine idling, observe the Mass Air Flow(MAF) Sensor parameter. The MAF Sensor parameter should be within 2–6g/s at idle.

10.3.1 If not within the specified range, refer to DTC P0101 OR P1101 or DTC P0102 OR P0103

NOTE: EVAP PURGE ENABLEMENT MAY CAUSE THE FT TO BE MOMENTARILY OUTSIDE THE NORMAL RANGE.

10.4 Engine at normal operating temperature, observe the scan tool Long Term FT parameter. The reading should be between −19 to +19 percent.

10.4.1 If not within the specified range, verify none of the following conditions exist:

10.4.2 Vacuum hoses for splits, kinks, and improper connections

10.4.3 Insufficient fuel in the tank

10.4.4 Low fuel pressure – Refer *TO FUEL SYSTEM DIAGNOSIS*

10.4.5 Fuel contamination – Refer to *ALCOHOL/CONTAMINANTS-IN-FUEL DIAGNOSI*S

10.4.6 Malfunctioning fuel injectors – Refer to *FUEL INJECTOR DIAGNOSIS*

10.4.7 Missing, restricted, or leaking exhaust components

10.4.8 Vacuum leaks at the intake manifold, the throttle body, and the injector O-rings

10.4.9 The air induction system and the air intake ducts for leaks or for a missing filter element

10.4.10 A cracked EVAP canister

10.4.11 Evaporative pipes obstructed or leaking

10.4.12 The crankcase ventilation system for leaks

10.4.13 The air intake duct for being collapsed or restricted

10.4.14 The air filter for being dirty or restricted

10.4.15 Objects blocking the throttle body

10.4.16 Excessive fuel in the crankcase

10.4.17 The evaporative emissions control system for improper operation

10.4.18 Missing, restricted, or leaking exhaust components

10.4.19 Fuel contamination – Refer to *ALCOHOL/CONTAMINANTS-IN-FUEL DIAGNOSIS* for gasoline

10.5 If all conditions test normal, test the engine for a mechanical condition. Refer to *SYMPTOMS - ENGINE MECHANICAL*.

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

10.7 Perform the *DIAGNOSTIC REPAIR VERIFICATION* after completing the diagnostic procedure.

P0191 – Fuel Rail Pressure (FRP) Sensor Performance (Gasoline)

1 DIAGNOSTIC INSTRUCTIONS

1.1 Review *STRATEGY BASED DIAGNOSIS* for an overview of the diagnostic approach.

1.2 Perform the *DIAGNOSTIC SYSTEM CHECK* prior to using this diagnostic procedure.

2 DTC DESCRIPTOR

2.1 **DTC P0191**: Fuel Rail Pressure (FRP) Sensor Performance

3 DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Fuel Rail Pressure Sensor 5 V Reference	P0193, P0641	P0191	P0193, P0641	P0191
Fuel Rail Pressure Sensor Signal	P0192	P0193	P0193	P0191
Fuel Rail Pressure Low Reference	—	P0191	*	P0191
*Opens circuit fuse or opens circuit				

4 TYPICAL SCAN TOOL DATA

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine at Idle			
Parameter Normal Range: 30 – 200 MPa (4350 – 29,008 psi)			
Fuel Rail Pressure Sensor Signal	0 MPa (0.0 psi)	220 MPa (31,900 psi)	220 MPa (31,900 psi)

5 CIRCUIT/SYSTEM DESCRIPTION

5.1 Idle Mode

During certain engine operating modes the engine control module (ECM) calculates an adaptation factor to adjust the fuel pressure regulator 2 set point pressure with the actual fuel pressure. The adaptation factor is the fuel pressure regulator 2 learned current that is required to maintain the desired fuel pressure at idle. This is done to adjust for manufacturing tolerances and aging of components. If the ECM calculates an adaptation factor outside the minimum or maximum calibrated limits, DTC P0191 is set.

5.2 Post Drive Mode

During post-drive mode, the fuel pressure regulator 2 relieves any remaining fuel pressure from the rails. After a 30 second bleed-down and the ignition is off, the fuel rail pressure sensor should read atmospheric pressure and return the proper signal voltage to the ECM. If the signal voltage is outside of the specified limits, DTC P0191 is set. When this DTC sets in post drive mode the engine will be in Reduced Power Mode on the next key cycle.

6 CONDITIONS FOR RUNNING THE DTC

6.1 Idle Mode

6.1.1 Fuel level is greater than 15 %.

6.1.2 Fuel temperature is greater than 10°C (50°F).

6.1.3 Engine speed is between 400−1000 RPM.

6.1.4 DTC P0016, P0117, P0118, P0192, P0193, P0335, P0336, P0340, or P0341 is not set.

6.1.5 Engine has run above 2000 RPM for 15 s during current key cycle.

6.1.6 Fuel pressure control is in fuel pressure regulator 2 mode or in combined pressure control mode.

6.2 Post Drive Mode

6.2.1 Fuel level is greater than 15 %.

6.2.2 DTCs P0016, P0117, P0118, P0192, P0193, P0335, P0336, P0340, or P0341 are not set.

6.2.3 Fuel Temperature is greater than 0° C (32° F).

6.2.4 Fuel pressure regulator 2 current is less than 1.71 A.

6.2.5 Engine OFF time is greater than 30 s.

6.2.6 Fault condition exists for more than 30 s.

7 CONDITIONS FOR SETTING THE DTC

7.1 Idle Mode

7.1.1 The ECM detects a drifted fuel rail pressure value by determining the adaptation factor of fuel pressure regulator 2.

7.1.2 The fuel pressure regulator 2 adaptation factor is outside the ECM's correction limits.

7.2 Post Drive Mode

7.2.1 When the ignition is off and the fuel rail pressure sensor voltage is not between 0.352 V and 0.65 V.

7.2.2 The fault condition exists for more than 30 s.

8 ACTION TAKEN WHEN THE DTC SETS

8.1 DTC P0191 is a Type A DTC.

8.2 If Post Drive Mode fails, engine will go to Reduced Power Mode the next key cycle.

8.3 If Idle Mode fails, there will be no power limiting.

9 CONDITIONS FOR CLEARING THE MIL/DTC

9.1 DTC P0191 is a Type A DTC.

10 DIAGNOSTIC AIDS

10.1 Review the freeze frame data to determine if the engine was running when the DTC set.

10.2 Connector terminal fretting or poor connections of the wiring harness may cause this DTC to set.

10.3 Contaminated fuel may cause this DTC to set.

10.4 Contaminates trapped in the filter screen of fuel pressure regulator 2 may cause this DTC to set.

10.5 Post Drive Mode failures are most likely an electrical concern.

10.6 Idle Mode failures are most likely a hydraulic (fuel) or mechanical concern.

10.7 Erosion or damage of the mating surface between Q18B Fuel Pressure Regulator 2 and the fuel rail may cause this DTC to set.

10.8 Improper fuel pressure regulator 2 torque may cause this DTC to set.

10.9 High current flow at Fuel Pressure Regulator 2 may be caused by the following. Listed in order from most probable to least probable.

10.9.1 Leaking Fuel Pressure Regulator 2 due to improper torque.

10.9.2 Skewed Fuel Rail Pressure Sensor.

10.9.3 Low flow at Fuel Pressure Regulator 1.

10.9.4 Fuel Injector high flow.

10.10 Low current flow at Fuel Pressure Regulator 2 may be caused by the following. Listed in order from most probable to least probable.

10.10.1 Restricted Fuel Pressure Regulator 2 — Plugged Filter Screen.

P0191 – Fuel Rail Pressure (FRP) Sensor Performance (Gasoline)

10.10.2 Skewed Fuel Rail Pressure Sensor.

10.10.3 High flow at Fuel Pressure Regulator 1.

10.10.4 Fuel Injector low flow.

11 TYPICAL FUEL PRESSURE REGULATOR 2 CURRENT

Engine Speed	Typical Low Current	Low Current Service Limit	Typical High Current	High Current Service Limit
Operating Conditions: Engine running at normal operating temperature, stable idle, and fuel temperature greater than 15°C(59°F) ***Parameter Normal Range:***Current measurements may fluctuate between the typical high and low current values depending on engine speed				
640 RPM	335 mA	185 mA	683 mA	833 mA
800 RPM	402 mA	252 mA	819 mA	969 mA

12 REFERENCE INFORMATION

12.1 SCHEMATIC REFERENCE

12.1.1 Engine controls schematics

12.2 CONNECTOR END VIEW REFERENCE

12.2.1 Component connector end views

12.3 ELECTRICAL INFORMATION REFERENCE

12.3.1 Circuit testing

12.3.2 Connector repairs

12.3.3 Testing for intermittent conditions and poor connections

12.3.4 Wiring repairs

12.4 DTC TYPE REFERENCE

12.4.1 Powertrain diagnostic trouble code (DTC) type definitions

12.5 SCAN TOOL REFERENCE

12.5.1 Control module references for scan tool information.

13 CIRCUIT/SYSTEM VERIFICATION

13.1 Ignition ON.

13.2 Observe the DTC information with a scan tool. Verify no other DTCs are set.

13.2.1 If other DTCs are set refer to Diagnostic Trouble Code (DTC) List for further diagnosis.

13.3 Engine at idle.

13.4 The Actual Fuel Rail Pressure should be within 690 kPa (100 psi) of the Desired Fuel Rail

Pressure. 13.4.1 If not within 690 kPa (100 psi) Refer to Circuit/System Testing.

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

13.5.1 If DTC resets Refer to Circuit/System Testing

13.6 If DTC does not reset, All OK.

14 CIRCUIT/SYSTEM TESTING

- You must perform the Circuit/System Verification before proceeding with Circuit/System Testing.
- Review Freeze Frame Data to determine which operating mode the DTC was set.
- If Post Drive Mode fails, engine will go to Reduced Power Mode the next key cycle.
- Improper Fuel Pressure Regulator 2 torque may cause this DTC to set.

14.1 Idle Mode Testing

Note: Only perform this test when the fuel temperature is warmer than 15°C (59°F).

14.1.1 Ignition OFF.

14.1.2 Remove the fuel pressure regulator 2 return hose and plug the hose to prevent fuel leakage.

14.1.3 Install a section of rubber fuel hose on the fuel pressure regulator 2 outlet and place the loose end of hose into a clean fuel container.

14.1.4 Engine at idle and normal operating temperature.

14.1.5 Increase engine speed to 1800 RPM for 15 seconds.

Note: Measure only the amount of fuel that leaks after the engine has reached 1800 RPM.

14.1.6 Observe the volume of fuel from fuel pressure regulator 2. The volume of fuel should be less than 10 ml (0.4 oz).

14.1.6.1.1 If greater than 10 ml (0.4 oz) Replace the Fuel Injection Fuel Rail Assembly — Bank 2 (Left Side).

14.1.7 If less than 10 ml (0.4 oz) Ignition OFF.

14.1.8 Disconnect the harness connector at the Q18B Fuel Pressure Regulator 2.

14.1.9 Measure the current at Q18B Fuel Pressure Regulator 2 by using jumper wires and test terminals to connect a DMM between the wiring harness connector terminal 1 and the Q18B Fuel Pressure Regulator 2 terminal 1.

14.1.10 Use another jumper wire to connect the wiring harness connector terminal 2 and the Q18B Fuel Pressure Regulator 2 terminal 2.

Note: Refer to Typical Fuel Pressure Regulator 2 Idle Current table for service limits in Diagnostic Aids.

14.1.11 Engine at stable idle, verify the Q18B Fuel Pressure Regulator 2 current is between 185 and 969 mA.

14.1.11.1 If current is less than 185 mA Inspect for contaminates in the Fuel Pressure Regulator 2 Filter Screen, (1) identifies Q18B Fuel Pressure Regulator 2 & (2) identifies the Filter Screen. If contaminates are present, refer to Contaminants-in-Fuel Diagnosis . If no contaminates are present, replace the Q18B Fuel Pressure Regulator 2.

14.1.12 Verify the Q18B Fuel Pressure Regulator 2 is properly torqued. If properly torqued, replace the Q18B Fuel Pressure Regulator 2.

14.1.13 Verify DTC does not reset. If DTC resets, refer to Fuel System Diagnosis - High Pressure Side .

14.1.14 If current is between 185 and 969 mA Ignition OFF.

14.1.15 Open a fuel injector high pressure fuel line.

14.1.16 Ignition ON.

14.1.17 Verify the scan tool Fuel Rail Pressure Sensor Voltage parameter is between 0.352–0.65 V.

14.1.18 If less than 0.352 V Test the B47B Fuel Rail Pressure Sensor Signal circuit terminal 2 and the B47B Fuel Rail Pressure Sensor 5 Volt Reference circuit terminal 3 for high resistance. If the circuits tests normal, replace the B47B Fuel Rail Pressure Sensor

14.1.19 If greater than 0.65 V Test B47B Fuel Rail Pressure Sensor Low Reference circuit terminal 1 for high resistance. If the circuit tests normal, replace the B47B Fuel Rail Pressure Sensor.

Note: Complete Post Drive Mode Testing only if reduced power is reported.

14.2 Post Drive Mode Testing

14.2.1 Ignition OFF.

14.2.2 Open a fuel injector high pressure fuel line.

14.2.3 Ignition ON.

14.2.4 Verify the scan tool Fuel Rail Pressure Sensor Voltage parameter is between 0.352 and 0.65 V.

14.2.5 If less than 0.352 V Test the B47B Fuel Rail Pressure Sensor Signal circuit terminal 2 and the Fuel Rail Pressure Sensor 5 Volt Reference circuit terminal 3 for high resistance. If the circuits tests normal, replace the B47B Fuel Rail Pressure Sensor.

14.2.6 If greater than 0.65 V Test B47B Fuel Rail Pressure Sensor Low Reference circuit terminal 1 for high resistance. If the circuit tests normal, replace the B47B Fuel Rail Pressure Sensor.

14.2.7 If between 0.352 and 0.65 VInstall the fuel injector high pressure line.

14.2.8 Engine running for 2 minutes.

Note: Contaminated fuel could cause Q18B Fuel Pressure Regulator 2 to hold rail pressure during key OFF.

14.2.9 Ignition OFF, wait 30 s.

14.2.10 Verify the scan tool Fuel Rail Pressure Sensor Voltage parameter is less than 0.65 V.

14.2.11 If greater than 0.65 V Replace the Q18B Fuel Pressure Regulator 2.

14.2.12 If less than 0.65 VEngine at idle.

14.2.13 Command the fuel pressure incrementally through the entire fuel pressure range with a scan tool . The Actual Fuel Rail Pressure and the Desired Fuel Rail Pressure should be within 690 kPa (100 psi) for the entire fuel pressure range.

14.2.14 If not within 690 kPa (100 psi) Replace the Q18B Fuel Pressure Regulator 2.

14.2.15 If within 690 kPa (100 psi)If the system tests normal, refer to Diagnostic Aids.

15 REPAIR INSTRUCTIONS

15.1 Perform the *DIAGNOSTIC REPAIR VERIFICATION*after completing the diagnostic procedure.

15.2 Fuel Injection Fuel Rail Fuel Pressure Sensor Replacement

15.3 Fuel Injection Fuel Rail Assembly Replacement - Bank 2

15.4 Fuel Pressure Relief Valve Replacement for Q18B Fuel Pressure Regulator 2 Bottom of Form

P0192 or P0193 – Fuel Rail Pressure (FRP) Sensor Circuit Low / High Voltage

1 DIAGNOSTIC INSTRUCTIONS

1.1 Review STRATEGY BASED DIAGNOSIS for an overview of the diagnostic approach.

1.2 Perform the *DIAGNOSTIC SYSTEM CHECK* prior to using this diagnostic procedure.

2 DTC DESCRIPTOR

2.1 **DTC P0192**: Fuel Rail Pressure (FRP) Sensor Circuit Low Voltage

2.2 **DTC P0193**: Fuel Rail Pressure (FRP) Sensor Circuit High Voltage

3 DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Fuel Rail Pressure Sensor 5 V Reference	P0193, P0641	P0191	P0193, P0641	P0191
Fuel Rail Pressure Sensor Signal	P0192	P0193	P0193	P0191
Fuel Rail Pressure Low Reference	—	P0191	*	P0191
*Opens circuit fuse or opens circuit				

4 TYPICAL SCAN TOOL DATA

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine at Idle			
Parameter Normal Range: 30 – 200 MPa (4350 – 29,008 psi)			
Fuel Rail Pressure Sensor Signal	0 MPa (0.0 psi)	220 MPa (31,900 psi)	220 MPa (31,900 psi)

5 CIRCUIT/SYSTEM DESCRIPTION

The fuel rail pressure sensor has a 5 volt reference circuit, a signal circuit, and a low reference circuit. The engine control module (ECM) monitors the voltage on the fuel rail pressure sensor circuits. When the fuel pressure is high, the signal voltage is high. When the fuel pressure is low, the signal voltage is low. The ECM uses this signal to compare the calculated desired fuel rail pressure with the actual fuel rail pressure from the fuel rail pressure sensor in order to maintain proper engine performance. If the ECM detects a fault on any of the fuel rail pressure sensor circuits a DTC will set.

P0192 or P0193 – Fuel Rail Pressure (FRP) Sensor Circuit Low / High Voltage

6 CONDITIONS FOR RUNNING THE DTC

6.1 The ignition is ON.

6.2 DTC runs continuously.

7 CONDITIONS FOR SETTING THE DTC

7.1 P0192

7.1.1 The ECM detects the signal circuit voltage that is less than 0.189 V for less than 1 s.

7.2 P0193

7.2.1 The ECM detects that the signal circuit voltage is more than 4.81 V for less than 1 s.

8 ACTION TAKEN WHEN THE DTC SETS

8.1 DTCs P0192 and P0193 are Type A DTCs.

8.2 The ECM commands the engine to operate in the Reduced Engine Power mode.

8.3 The message center displays Reduced Engine Power.

9 CONDITIONS FOR CLEARING THE MIL/DTC

9.1 DTCs P0192 and P0193 are Type A DTCs

10 REFERENCE INFORMATION

10.1 SCHEMATIC REFERENCE

10.1.1 Engine controls schematics

10.2 CONNECTOR END VIEW REFERENCE

10.2.1 Component connector end views

10.3 ELECTRICAL INFORMATION REFERENCE

10.3.1 Circuit testing

10.3.2 Connector repairs

10.3.3 Testing for intermittent conditions and poor connections

10.3.4 Wiring repairs

10.4 DTC TYPE REFERENCE

10.4.1 Powertrain diagnostic trouble code (DTC) type definitions

10.5 SCAN TOOL REFERENCE

10.5.1 Control module references for scan tool information.

11 CIRCUIT/SYSTEM VERIFICATION

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

11.1 Ignition ON.

11.2 Observe the DTC information with a scan tool. Verify DTC P0641 is not set.

11.2.1 If DTC P0641 is set Refer to DTC P0641, P0651, P0697, P06A3, P06D2, or P06D6 for further diagnosis.

11.2.2 If DTC P0641 is not set,Engine Cranking

11.3 Observe the Fuel Rail Pressure Sensor parameters with a scan tool. The pressure should be at least 10 MPa (1450 psi).

11.3.1 If less than 10 MPa (1450 psi) Refer to Circuit/System Testing.

11.3.2 If 10 MPa (1450 psi) or greater,Engine Idling

11.4 Observe the Fuel Rail Pressure Sensor parameters with a scan tool. The Actual Fuel Rail Pressure should be close to the Desired Fuel Rail Pressure.

11.4.1 If pressures are not close Refer to Circuit/System Testing

11.5 If pressures are close Increase engine speed to 1800 RPM

11.6 Observe the Fuel Rail Pressure Sensor parameters with a scan tool. The Actual Fuel Rail Pressure should be close to the Desired Fuel Rail Pressure.

11.6.1 If pressures are not close Refer to Circuit/System Testing

11.7 If pressures are close,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.

11.7.1 If the DTC resets Refer to Circuit/System Testing

11.8 If the DTC does not reset,All OK

P0192 or P0193 – Fuel Rail Pressure (FRP) Sensor Circuit Low / High Voltage

12 CIRCUIT/SYSTEM TESTING

Note: Fuel pressure control will be disable if DTC P128E, P0192, or P0193 are set. Codes must be cleared to enable the device control.

12.1 Ignition OFF.

12.2 All vehicle systems OFF, wait 2 minutes for the ECM to power down. Disconnect the harness connector at the B47B fuel rail pressure sensor.

12.3 Test for less than 5 C) between the Fuel Rail Pressure Sensor Low Reference circuit terminal 1 and ground.

12.3.1 If greater than 5 C) Test the Fuel Rail Pressure Sensor Low Reference circuit for an open/high resistance. If the circuit tests normal, replace the K20 engine control module.

12.4 If less than 5 C) Ignition ON.

12.5 Test for 4.8–5.2 V between the Fuel Rail Pressure Sensor 5 Volt Reference circuit terminal 3 and ground.

12.5.1 If less than 4.8 V Test the Fuel Rail Pressure Sensor 5 Volt Reference circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K20 engine control module.

12.5.2 If greater than 5.2 V Test the Fuel Rail Pressure Sensor 5 Volt Reference circuit for a short to voltage. If the circuit tests normal, replace the K20 engine control module.

12.6 If between 4.8 and 5.2 V Verify the scan tool Fuel Rail Pressure is greater than 219 MPa (31,763 psi).

12.6.1 If less than 219 MPa (31,763 psi) Test the Fuel Rail Pressure Sensor Signal circuit terminal 2 for a short to ground. If the circuit tests normal, replace the K20 engine control module.

12.7 Install a 3 A fused jumper wire between the Fuel Rail Pressure Sensor Signal circuit terminal 2 and the Fuel Rail Pressure Sensor Low Reference circuit terminal 1.

12.8 Verify the scan tool Fuel Rail Pressure parameter is less than 1 MPa (145 psi).

12.8.1 If greater than 1 MPa (145 psi) Test the Fuel Rail Pressure Sensor Signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the K20 engine control module.

12.9 If less than 1 MPa (145 psi) Replace the B47B fuel rail pressure sensor.

13 REPAIR INSTRUCTIONS

13.1 Perform the *DIAGNOSTIC REPAIR VERIFICATION*after completing the diagnostic procedure.

13.2 Fuel Injection Fuel Rail Fuel Pressure Sensor Replacement

13.3 Control Module References for ECM replacement, programming, and setup.

P0201 – P0208– Fuel Injectors (1-8) Control Circuit

1 DIAGNOSTIC INSTRUCTIONS

1.1 Review *STRATEGY BASED DIAGNOSIS* for an overview of the diagnostic approach.

1.2 Perform the *DIAGNOSTIC SYSTEM CHECK* prior to using this diagnostic procedure.

2 DTC DESCRIPTOR

2.1 **DTCP0201:** Injector1 Control Circuit

2.2 **DTCP0202:** Injector2 Control Circuit

2.3 **DTCP0203:** Injector3 Control Circuit

2.4 **DTCP0204:** Injector4 Control Circuit

2.5 **DTCP0205:** Injector5 Control Circuit

2.6 **DTCP0206:** Injector6 Control Circuit

2.7 **DTCP0207:** Injector7 Control Circuit

2.8 **DTCP0208:** Injector8 Control Circuit

P0201 – P0208– Fuel Injectors (1-8) Control Circuit

3 DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition Voltage	P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0300	P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0300	—	—
Fuel Injector 1 Control	P0201	P0201	P0201	—
Fuel Injector 2 Control	P0202	P0202	P0202	—
Fuel Injector 3 Control	P0203	P0203	P0203	—
Fuel Injector 4 Control	P0204	P0204	P0204	—
Fuel Injector 5 Control	P0205	P0205	P0205	—
Fuel Injector 6 Control	P0206	P0206	P0206	—
Fuel Injector 7 Control	P0207	P0207	P0207	—
Fuel Injector 8 Control	P0208	P0208	P0208	—

4 CIRCUIT/SYSTEM DESCRIPTION

The control module enables the appropriate fuel injector pulse for each cylinder. Ignition voltage is supplied to the fuel injectors. The control module controls each fuel injector by grounding the control circuit via a solid state device called a driver. The control module monitors the status of each driver. If the control module detects an incorrect voltage for the commanded state of the driver, a fuel injector control circuit DTC sets.

5 CONDITIONS FOR RUNNING THE DTC

5.1 The engine is running.

5.2 The ignition voltage is greater than 11V.

5.3 DTCP0201–P0208 runs continuously when the above conditions are met.

P0201 – P0208– Fuel Injectors (1-8) Control Circuit

6 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 2s.

7 ACTION TAKEN WHEN THE DTC SETS

7.1 DTCsP0201, P0202, P0203, P0204, P0205, P0206, P0207, and P0208 are TypeB DTCs.

8 CONDITIONS FOR CLEARING THE MIL/DTC

8.1 DTCsP0201, P0202, P0203, P0204, P0205, P0206, P0207, and P0208 are TypeB DTCs.

9 DIAGNOSTIC AIDS

9.1 The MIL indicator flashes when there is an engine misfire.

9.2 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.

9.3 Performing the Fuel Injector Diagnosis may help isolate an intermittent condition. Refer to *FUEL INJECTOR DIAGNOSIS.*

10 REFERENCE INFORMATION

10.1 SCHEMATIC REFERENCE

10.1.1 Engine controls schematics

10.2 CONNECTOR END VIEW REFERENCE

10.2.1 Component connector end views

10.3 ELECTRICAL INFORMATION REFERENCE

10.3.1 Circuit testing

10.3.2 Connector repairs

10.3.3 Testing for intermittent conditions and poor connections

10.3.4 Wiring repairs

10.4 DTC TYPE REFERENCE

10.4.1 Powertrain diagnostic trouble code (DTC) type definitions

10.5 SCAN TOOL REFERENCE

10.5.1 CONTROL MODULE REFERENCESfor scan tool information

10.6 SPECIAL TOOLS

10.6.1 *J-34730-405* Injector Test Lamp

11 CIRCUIT/SYSTEM VERIFICATION

11.1 Engine idling, observe the following control circuit status parameters with a scan tool:

11.1.1 Cyl1–8 Inj. Ckt. Short Gnd Test Status

11.1.2 Cyl1–8 Inj. Ckt. Open Test Status

11.1.3 Cyl1–8 Inj. Ckt. Short Volts Test Status

11.1.4 Each parameter should display OK or Not Run.

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

12 CIRCUIT/SYSTEM TESTING

12.1 Ignition OFF, disconnect the affected fuel injector harness connector at the fuel injector.

12.2 Ignition ON, verify that a test lamp illuminates between the ignition voltage circuit terminalA and ground.

12.2.1 If the test lamp does not illuminate, test the ignition voltage circuit for a short to ground or an open/high resistance. If the circuit tests normal and the ignition voltage circuit fuse is open, test or replace the fuel injector.

12.3 Connect the *J-34730-405* test lamp between the control circuit terminalB and the ignition voltage circuit terminalA.

12.4 Engine cranking; verify the test lamp flashes ON and OFF.

12.4.1 If the test lamp is always ON, test the control circuit for a short to ground. If the circuit tests normal, replace the engine control module (ECM).

12.4.2 If the test lamp is always OFF, test the control circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the ECM.

12.5 If all circuits test normal, test or replace the fuel injector.

P0201 – P0208– Fuel Injectors (1-8) Control Circuit

13 COMPONENT TESTING

NOTE: THE ENGINE COOLANT TEMPERATURE (ECT) SENSOR MUST BE BETWEEN 10–32°C (50–90°F) FOR AN ACCURATE MEASUREMENT.

13.1 Ignition OFF, disconnect the harness connector at the appropriate fuel injector.

13.2 Test for 11–14Ω between the terminals of the fuel injector.

13.2.1 If not within the specified range, replace the fuel injector.

13.3 Test for infinite resistance between each terminal and the fuel injector housing/case.

13.3.1 If not the specified value, replace the fuel injector.

14 REPAIR INSTRUCTIONS

14.1 Perform the *DIAGNOSTIC REPAIR VERIFICATION* after completing the diagnostic procedure.

14.2 FUEL INJECTOR REPLACEMENT

14.3 CONTROL MODULE REFERENCES for Engine Control Module replacement, programming, and setup.

P219A or P219B – Fuel Trim Cylinder Balance Bank 1 or 2

1 DIAGNOSTIC INSTRUCTIONS

1.1 Perform the *DIAGNOSTIC SYSTEM CHECK - VEHICLE* prior to using this diagnostic procedure.

1.2 Review *STRATEGY BASED DIAGNOSIS* for an overview of the diagnostic approach.

1.3 *DIAGNOSTIC PROCEDURE INSTRUCTIONS* provides an overview of each diagnostic category.

2 DTC DESCRIPTOR

2.1 **DTC P219A**: Fuel Trim Cylinder Balance Bank 1

2.2 **DTC P219B**: Fuel Trim Cylinder Balance Bank 2

3 CIRCUIT/SYSTEM DESCRIPTION

The Fuel Trim Cylinder Balance diagnostic detects a rich or lean cylinder to cylinder air/fuel ratio imbalance in each bank. The diagnostic monitors the pre-catalyst heated oxygen sensor (HO2S) signal's frequency and amplitude characteristics by calculating an accumulated voltage over a predetermined sample period. An imbalance is indicated when multiple samples of the accumulated voltage are consistently higher than the desired value.

4 CONDITIONS FOR RUNNING THE DTC

4.1 DTCsP0030, P0050, P0053, P0059, P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0116, P0117, P0118, P0120, P0122, P0123, P0128, P0131, P0132, P0133, P0134, P0135, P0151, P0152, P0153, P0154, P0155, P0201–P0208, P0220, P0222, P0223, P0300, P0301–P0308, P0442, P0443, P0446, P0449, P0452, P0453, P0455, P0496, P0606, P0641, P0651, P1133, P1153, P1516, P2101, P2120, P2122, P2123, P2125, P2127, P2128, P2135, P2138, P2176 are not set.

4.2 The scan tool device control is not active.

4.3 The intrusive diagnostics are not active.

4.4 The engine overspeed protection is not active.

4.5 The power take-off (PTO) is not active.

4.6 The traction control is not active.

4.7 The engine is in air-fuel Closed Loop.

4.8 The system voltage is between 10–32V for greater than 4s.

4.9 The engine run time is greater than 125s.

4.10 The engine coolant temperature (ECT) is warmer than −20°C (−4°F).

4.11 The engine speed is between 425–6,000RPM.

4.12 The mass air flow is between 20–510g/s.

4.13 The fuel ethanol content is less than 87percent.

5 CONDITIONS FOR SETTING THE DTC

5.1 Multiple samples of the pre-catalyst HO2S accumulated voltage are consistently greater than the desired value.

6 ACTION TAKEN WHEN THE DTC SETS

6.1 DTCsP219A and P219B are TypeB DTCs.

7 CONDITIONS FOR CLEARING THE MIL/DTC

7.1 DTCsP219A and P219Bare TypeB DTCs.

8 DIAGNOSTIC AIDS

8.1 The fuel trim cylinder balance diagnostic is very sensitive to heated oxygen sensor (HO2S) design. A non-OE sensor or an incorrect part number may cause a DTC to set.

8.2 Monitoring the misfire current counters, or misfire graph, may help to isolate the cylinder that is causing the condition.

8.3 Certain aftermarket air filters may cause a DTC to set.

8.4 Certain aftermarket air induction systems or modifications to the air induction system may cause a DTC to set.

8.5 Certain aftermarket exhaust system components may cause a DTC to set.

9 REFERENCE INFORMATION

9.1 SCHEMATIC REFERENCE

9.1.1 Engine controls schematics

9.2 CONNECTOR END VIEW REFERENCE

9.2.1 Component connector end views

9.3 ELECTRICAL INFORMATION REFERENCE

9.3.1 Circuit testing

9.3.2 Connector repairs

9.3.3 Testing for intermittent conditions and poor connections

9.3.4 Wiring repairs

9.4 DTC TYPE REFERENCE

9.4.1 Powertrain diagnostic trouble code (DTC) type definitions

9.5 SCAN TOOL REFERENCE

9.5.1 CONTROL MODULE REFERENCESfor scan tool information

10 CIRCUIT/SYSTEM TESTING

10.1 Ignition ON, observe the scan tool DTC information. Verify there are no other DTCs set.

10.1.1 If a DTC is set, refer to Diagnostic Trouble Code (DTC) List - Vehicle for further diagnosis.

10.2 Engine idling, observe the MAP sensor parameter. The reading should be between 19–42kPa (2.7–6PSI). 10.2.1 If not within the specified range, refer to DTC P0106 or DTC P0107 or P0108.

10.3 Ignition OFF, verify that none of the conditions listed below exists:

10.3.1 Inspect the air induction system for modified, damaged, leaking, or restricted components.

10.3.2 Inspect the crankcase ventilation system for improper operation.

10.3.3 Inspect the vacuum hoses for splits, kinks, and improper connections.

10.3.4 Test for a restricted, damaged, leaking, or modified exhaust system from the catalytic converter forward. Refer to Symptoms - Engine Exhaust.

10.3.5 Inspect for vacuum leaks at the intake manifold, the throttle body, and the injector O-rings.

10.3.6 Test the fuel injectors for improper operation. Refer to *FUEL INJECTOR DIAGNOSIS*.

10.3.7 Test for fuel contamination. Refer to *ALCOHOL/CONTAMINANTS-IN-FUEL DIAGNOSIS*

10.3.8 Test for excessive fuel in the crankcase due to leaking injectors.

10.3.9 Test the ignition system for improper operation. Refer to *ELECTRONIC IGNITION SYSTEM DIAGNOSIS*.

10.4 If all the above conditions test normal, test the engine for any mechanical conditions which could alter the flow into the combustion chamber. Refer to *SYMPTOMS - ENGINE MECHANICAL.*

P219A or P219B – Fuel Trim Cylinder Balance Bank 1 or 2

11 REPAIR INSTRUCTIONS

11.1 Perform the *DIAGNOSTIC REPAIR VERIFICATION*after completing the diagnostic procedure.

P0263, P0266, P0269, P0272,P0275, P0278, P0281, P0284 – Cly Balance System

1 DIAGNOSTIC INSTRUCTIONS

1.1 Review *STRATEGY BASED DIAGNOSIS* for an overview of the diagnostic approach.

1.2 Perform the *DIAGNOSTIC SYSTEM CHECK* prior to using this diagnostic procedure.

2 DTC DESCRIPTORS

2.1 DTC P0263: Cly 1 Balance System

2.2 DTC P0266: Cly 2 Balance System

2.3 DTC P0269: Cly 3 Balance System

2.4 DTC P0272: Cly 4 Balance System

2.5 DTC P0275: Cly 5 Balance System

2.6 DTC P0278: Cly 6 Balance System

2.7 DTC P0281: Cly 7 Balance System

2.8 DTC P0284: Cly 8 Balance System

3 CIRCUIT/SYSTEM DESCRIPTION

The engine control module (ECM) monitors changes in crankshaft speed using input from the crankshaft position sensor. The ECM adjusts the fuel delivery to each cylinder in order to minimize crankshaft speed changes. If the ECM identifies a cylinder or cylinders requiring an excessive adjustment of fuel in order to maintain the correct crankshaft speed, a DTC will set.

4 CONDITIONS FOR RUNNING THE DTC

4.1 DTCs P0117, P0118, P0335, P0336, P2146, P2149, P2152, P2155 and P062C are not set

4.2 The ECT is more than 40°C (104°F).

4.3 Engine is running.

4.4 The engine RPM is between 600-2,700 RPM.

4.5 The calculated fuel rate is between 15 mm^3 and 90 mm^3.

4.6 DTC runs continuous when the above conditions are met.

5 CONDITIONS FOR SETTING THE DTC

5.1 The fuel injector balance correction is greater than the calibrated limit.

6 ACTION TAKEN WHEN THE DTC SETS

6.1 DTCs P0263, P0266, P0269, P0272, P0275, P0278, P0281 and P0284 are Type B DTCs.

7 CONDITIONS FOR CLEARING THE DTC

7.1.1 DTCs P0263, P0266, P0269, P0272, P0275, P0278, P0281 and P0284 are Type B DTCs.

8 REFERENCE INFORMATION

8.1 SCHEMATIC REFERENCE

8.1.1 Engine controls schematics

8.2 CONNECTOR END VIEW REFERENCE

8.2.1 Component connector end views

8.3 ELECTRICAL INFORMATION REFERENCE

8.3.1 Circuit testing

8.3.2 Connector repairs

8.3.3 Testing for intermittent conditions and poor connections

8.3.4 Wiring repairs

8.4 DTC TYPE REFERENCE

8.4.1 Powertrain diagnostic trouble code (DTC) type definitions

8.5 SCAN TOOL REFERENCE

8.5.1 CONTROL MODULE REFERENCESfor scan tool information

9 CIRCUIT/SYSTEM VERIFICATION

9.1 Ignition ON.

9.2 Observe the DTC information with a scan tool. Verify no other DTCs are set.

9.2.1 ⇒ If other DTCs are set refer to *DIAGNOSTIC TROUBLE CODE (DTC) LIST* for further diagnosis.

9.2.2 ⇓If no other DTCs are set

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

9.3.1 ⇒ If DTC resets refer to Circuit/System Testing.

9.3.2 ⇓ In DTC does not reset

9.4 All OK.

10 CIRCUIT/SYSTEM TESTING

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

10.1 Perform an engine compression test.

10.1.1 ⇒If engine compression is not within specifications repair as necessary.

10.1.2 ⇓If engine compression is within specifications

10.2 Refer to *FUEL INJECTOR DIAGNOSIS*.

11 REPAIR INSTRUCTIONS

11.1 Perform the *DIAGNOSTIC REPAIR VERIFICATION*after completing the diagnostic procedure.

P0315 – Crankshaft Position (CKP) System Variation Not Learned

1 DIAGNOSTIC INSTRUCTIONS

1.1 Review *STRATEGY BASED DIAGNOSIS* for an overview of the diagnostic approach.

1.2 Perform the *DIAGNOSTIC SYSTEM CHECK* prior to using this diagnostic procedure.

2 DTC DESCRIPTOR

2.1 **DTC P0315:** Crankshaft Position (CKP) System Variation Not Learned

3 CIRCUIT/SYSTEM DESCRIPTION

The crankshaft position (CKP) system variation learn feature is used to calculate reference period errors caused by slight build tolerance variations in the CKP sensor, crankshaft, and CKP sensor position. 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 wide range of engine speeds and load conditions. The ECM stores the Crankshaft Position System Variation values after a learn procedure has been performed. If the actual crankshaft position variation is not stored within the CKP compensating value look up table, then DTCP0300 may set. If the CKP system variation values are not stored in the ECM memory, or a proper ECM power down does not occur after completing the CKP Learn Procedure, then DTCP0315 sets.

4 CONDITIONS FOR RUNNING THE DTC

4.1 DTC P0315 runs continuously.

5 CONDITIONS FOR SETTING THE DTC

5.1 The ECM detects that the CKP system variation values are not stored in memory.

6 ACTION TAKEN WHEN THE DTC SETS

6.1 DTCP0315 is a TypeA code.

7 CONDITIONS FOR CLEARING THE MIL/DTC

7.1 DTCP0315 is a TypeA code.

P0315 – Crankshaft Position (CKP) System Variation Not Learned

8 DIAGNOSTIC AIDS

8.1 This test procedure requires that the vehicle battery has passed a load test and is completely charged.

9 REFERENCE INFORMATION

9.1 SCHEMATIC REFERENCE

9.1.1 Engine controls schematics

9.2 CONNECTOR END VIEW REFERENCE

9.2.1 Component connector end views

9.3 ELECTRICAL INFORMATION REFERENCE

9.3.1 Circuit testing

9.3.2 Connector repairs

9.3.3 Testing for intermittent conditions and poor connections

9.3.4 Wiring repairs

9.4 DTC TYPE REFERENCE

9.4.1 Powertrain diagnostic trouble code (DTC) type definitions

9.5 SCAN TOOL REFERENCE

9.5.1 CONTROL MODULE REFERENCESfor scan tool information

10 CIRCUIT/SYSTEM TESTING

IMPORTANT: THE CKP SYSTEM VARIATION LEARN PROCEDURE MAY HAVE TO BE REPEATED UP TO 5 TIMES BEFORE THE PROCEDURE IS LEARNED.

10.1 Perform the CKP System Variation Learn Procedure.

10.2 If the CKP System Variation Learn Procedure cannot be performed successfully, inspect for the following conditions:

10.2.1 Interference in the signal circuit of the CKP sensor

10.2.2 The ignition switch is left in the ON position, until the battery is discharged

10.2.3 An ECM power disconnect, with the ignition ON, that may have erased the CKP system variation values and set DTC P0315

10.2.4 Any debris between the CKP sensor and the reluctor wheel

10.2.5 A damaged crankshaft.

10.2.6 Excessive crankshaft runout

10.2.7 Any worn crankshaft main bearings

10.2.8 A damaged or misaligned reluctor wheel

10.2.9 If the ECM is still unable to complete the learn procedure, replace the K20 ECM

11 REPAIR INSTRUCTIONS

11.1 Perform the *DIAGNOSTIC REPAIR VERIFICATION* after completing the diagnostic procedure.

11.2 *CONTROL MODULE REFERENCES* for ECM replacement, setup, and programming

P0324, P0325, P0326, P0327, P0328, P0330, P0332, P0333– Knock Sensor (KS)

1 DIAGNOSTIC INSTRUCTIONS

1.1 Review *STRATEGY BASED DIAGNOSIS* for an overview of the diagnostic approach.

1.2 Perform the *DIAGNOSTIC SYSTEM CHECK* prior to using this diagnostic procedure.

2 DTC DESCRIPTOR

2.1 **DTC P0324:** Knock Sensor (KS) Module Performance

2.2 **DTC P0325:** Knock Sensor (KS) Circuit Bank1

2.3 **DTC P0326:** Knock Sensor (KS) Performance

2.4 **DTC P0327:** Knock Sensor (KS) Circuit Low Voltage Bank1

2.5 **DTC P0328:** Knock Sensor (KS) Circuit High Voltage Bank1

2.6 **DTC P0330:** Knock Sensor (KS) Circuit Bank2

2.7 **DTC P0332:** Knock Sensor (KS) Circuit Low Voltage Bank2

2.8 **DTC P0333:** Knock Sensor (KS) Circuit High Voltage Bank2

3 DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Knock Sensor Signal Bank 1	P0327, P0328	P0325	P0328	P0326
Knock Sensor Return Bank 1	P0327	P0325	P0328	P0326
Knock Sensor Signal Bank 2	P0332, P0333	P0330	P0333	P0326
Knock Sensor Return Bank 2	P0332	P0330	P0333	P0326

4 CIRCUIT/SYSTEM DESCRIPTION

The knock sensor (KS) system 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 ECM monitors 2separate KS, one on each side of the engine block. Each KS produces an AC voltage that varies, depending on the vibration levels detected during engine operation. The ECM receives the KS signal through 2isolated signal circuits for each KS. The ECM adjusts the spark timing based on the amplitude and frequency of each KS signal. The ECM learns a minimum noise level for each sensor at idle speeds, and uses calibrated noise level values for the rest of the RPM range. The ECM should monitor a normal KS signal within the noise channel.

5 CONDITIONS FOR RUNNING THE DTC

5.1 P0324

5.1.1 DTC P0325, P0326, P0327, P0328, P0330, P0332, or P0333 are not set.

5.1.2 The engine speed is at least 400 RPM

5.1.3 DTC P0324 runs continuously when the above conditions are met.

5.2 P0325 or P0330

5.2.1 DTC P0324, P0326, P0327, P0328, P0330, or P0332 are not set.

5.2.2 The engine speed is at least 400 RPM.

5.2.3 The engine coolant temperature (ECT) is warmer than −40°C (−40°F).

5.2.4 The engine run time is at least 2 s.

5.2.5 The power take-off (PTO) is not active.

5.2.6 DTCs P0325 and P0330 run continuously when the above conditions are met

5.3 P0326

5.3.1 DTC P0068, P0120, P0122, P0123, P0220, P0222, P0223, P1516, P2135, or P2176 are not set.

5.3.2 The engine speed is at least 400 RPM.

5.3.3 The MAP is at least 10 kPa.

5.3.4 DTC P0324 runs continuously when the above conditions are met.

5.4 P0327, P0328, P0332, and P0333

5.4.1 DTCs P0327, P0328, P0332, and P0333 run continuously when the above conditions are met

5.4.2 The engine coolant temperature (ECT) is warmer than −40°C (−40°F).

5.4.3 The engine run time is at least 2 s.

5.4.4 DTCs P0327, P0328, P0332, and P0333 run continuously when the above conditions are met.

P0324, P0325, P0326, P0327, P0328, P0330, P0332, P0333– Knock Sensor (KS)

6 CONDITIONS FOR SETTING THE DTC

6.1 P0324

6.1.1 The ECM has detected an internal circuitry fault for greater than 5s.

6.2 P0325 and P0330

6.2.1 The KS signal circuits are open or shorted together for greater than 5 s.

6.3 P0326

6.3.1 The KS signal indicates an engine knock is present.

6.3.2 The ECM has commanded the spark retard to a value, which is more than the calibrated value, for a specific engine load and speed.

6.3.3 The above conditions exist for more greater than 5s.

6.4 P0327, P0328, P0332, AND P0333

6.4.1 The KS signal circuits are shorted to voltage or ground.

6.4.2 The above conditions exist for greater than 5s.

7 ACTION TAKEN WHEN THE DTC SETS

7.1 DTCsP0324, P0325, P0326, P0327, P0328, P0330, P0332, and P0333 are TypeB codes.

7.2 The ignition timing is retarded to reduce the potential of engine damaging spark knock.

8 DIAGNOSTIC AIDS

8.1 Inspect the KS for physical damage. A KS that is dropped or damaged may cause a DTC to set.

8.2 Inspect the KS for proper installation. A KS that is loose or over torqued may cause a DTC to set.

8.3 The KS mounting surface should be free of burrs, casting flash and foreign material.

8.4 The KS must be clear of hoses, brackets, and engine electrical wiring.

9 REFERENCE INFORMATION

9.1 SCHEMATIC REFERENCE

9.1.1 Engine controls schematics

9.2 CONNECTOR END VIEW REFERENCE

9.2.1 Component connector end views

9.3 ELECTRICAL INFORMATION REFERENCE

9.3.1 Circuit testing

9.3.2 Connector repairs

9.3.3 Testing for intermittent conditions and poor connections

9.3.4 Wiring repairs

9.4 DTC TYPE REFERENCE

9.4.1 Powertrain diagnostic trouble code (DTC) type definitions

9.5 SCAN TOOL REFERENCE

9.5.1 CONTROL MODULE REFERENCESfor scan tool information

9.6 SPECIAL TOOLS

9.6.1 *J 35616* GM Approved Terminal Test Kit

10 CIRCUIT/SYSTEM VERIFICATION

10.1 Engine idling at operating temperature; observe the DTC information with a scan tool. DTCP0324, P0325, P0326, P0327, P0328, P0330, P0332, or P0333 should not set.

10.2 Move the related harnesses and connectors for the knock sensor circuits while observing the scan tool parameters listed below. The parameters should say NO.

10.2.1 Knock Detected Cyl. 1

10.2.2 Knock Detected Cyl. 2

10.2.3 Knock Detected Cyl. 3

10.2.4 Knock Detected Cyl. 4

10.2.5 Knock Detected Cyl. 5

10.2.6 Knock Detected Cyl. 6

10.2.7 Knock Detected Cyl. 7

10.2.8 Knock Detected Cyl. 8

10.2.9 If the parameters change, repair the wiring or the harness connectors

10.2.10 If the parameters change, repair the wiring or the harness connectors.

10.2.11 If the parameters change, repair the wiring or the harness connectors.

10.3 Observe the DTC information with a scan tool. DTCP0324, P0325, P0326, P0327, P0328, P0330, P0332, or P0333 should not set.

10.4 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.

11 CIRCUIT/SYSTEM TESTING

NOTE: Must perform the Circuit/System Verification first

11.1 If an engine mechanical noise can be heard, repair the condition before proceeding with this diagnostic. Refer to *SYMPTOMS - ENGINE MECHANICAL.*

11.2 P0324

11.2.1 **NOTE:**If DTC P0325, P0326, P0327, P0328, P0330, P0332, or P0333 are also set, diagnose those DTCs first. DTC P0324 indicates an internal control module circuitry failure. If no external knock sensor circuit issues exist, replace the ECM.

11.3 P0325, P0326, P0327, P0328, P0330, P0332, P0333

11.3.1 Verify the affected KS is properly tightened

11.3.2 Ignition OFF, disconnect the affected KS.

11.3.3 Ignition OFF. Connect a DMM to both KS signal circuits, terminals A and B, at the affected KS. Set the DMM to the 400mVAC scale, select the Hz mode. Let the reading stabilize at 0Hz.

11.3.3.1 NOTE**:** DO NOT TAP ON PLASTIC ENGINE COMPONENTS.

11.3.4 Tap on the engine block with a non-metallic object near the KS and observe the DMM for a fluctuating frequency.

11.3.4.1 If the DMM does not display a fluctuating frequency while tapping on the engine block then replace the KS.

11.3.5 Ignition OFF; with appropriate length jumper wires, connect the KS1 harness to the KS2 sensor and the KS2 harness to the KS1 sensor.

11.3.6 Monitor the DTCs using a scan tool. Operate the vehicle within the conditions for running the DTC. Verify the fault does not follow the sensor in question.

11.3.6.1 If the fault follows the sensor in question, replace the KS.

11.3.7 Ignition OFF, remove the jumper wires from the previous step.

11.3.8 Measure for 2–3volts between each of the following circuits and ground on the ECM side of the harness connector:

11.3.8.1 The KS signal circuit, terminal A

11.3.8.2 The KS signal circuit, terminalB

11.3.9 Test for intermittent or poor connections at the ECM, KS, and in-line connectors where present.

11.3.10 If all circuits test normal, replace the ECM.

12 REPAIR INSTRUCTIONS

12.1 Perform the *DIAGNOSTIC REPAIR VERIFICATION*after completing the diagnostic procedure.

12.2 Knock Sensor 1 Replacement

12.3 Knock Sensor 2 Replacement

12.4 Control Module References for ECM replacement, setup, and programming

P0335 – Crankshaft Position (CKP) Sensor Circuit

1 DIAGNOSTIC INSTRUCTIONS

1.1 Review *STRATEGY BASED DIAGNOSIS* for an overview of the diagnostic approach.

1.2 Perform the *DIAGNOSTIC SYSTEM CHECK - VEHICLE* prior to using this diagnostic procedure.

2 DTC DESCRIPTOR

2.1 **DTC P0335:** Crankshaft Position Sensor Circuit

3 DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference Circuit	P0651	P0335	P0651, P2135	P0336
Crankshaft Position Sensor Signal Circuit	P0335	P0335	P0335	P0336
Low Reference Circuit	—	P0335	P0335	P0336

4 CIRCUIT/SYSTEM DESCRIPTION

The crankshaft position sensor circuits consist of an engine control module (ECM) supplied 5V circuit, low reference circuit and an output signal circuit. The crankshaft position sensor is an internally magnetic biased digital output integrated circuit sensing device. The sensor detects magnetic flux changes between the peaks and valleys of a 58-tooth reluctor wheel on the crankshaft. Each tooth on the reluctor wheel is spaced at 60-tooth spacing, with 2missing teeth for the reference gap. The crankshaft position sensor produces an ON/OFF DC voltage of varying frequency, with 58 output pulses per crankshaft revolution. The frequency of the crankshaft position sensor output depends on the velocity of the crankshaft. The crankshaft position sensor sends a digital signal, which represents an image of the crankshaft reluctor wheel, to the ECM as each tooth on the wheel rotates past the crankshaft position sensor. The ECM uses each crankshaft position signal pulse to determine crankshaft speed and decodes the crankshaft reluctor wheel reference gap to identify crankshaft position. This information is then used to sequence the ignition timing and fuel injection events for the engine. The ECM also uses crankshaft position sensor output information to determine the crankshaft relative position to the camshaft, to detect cylinder misfire, and to control the camshaft position actuator if equipped.

5 CONDITIONS FOR RUNNING THE DTC

5.1 CONDITION 1

P0335 – Crankshaft Position (CKP) Sensor Circuit

5.1.1 DTCP0101, P0102, or P0103 is not set.

5.1.1.1 The engine is cranking.

5.1.1.2 The engine airflow is greater than 3g/s.

5.2 CONDITION 2

5.2.1 DTC P0651 is not set.

5.2.2 The engine is running starter is not engaged.

5.3 CONDITION 3

5.3.1 DTC P0340, P0341, P0641, or P0651 is not set.

5.3.2 The engine is running or starter is engaged.

5.3.3 The engine airflow is greater than 3g/s.

5.4 The DTCP0335 runs continuously when the above conditions are met.

6 CONDITIONS FOR SETTING THE DTC

6.1 The ECM detects that the starter is commanded ON and the engine has been cranking for greater than 4s without a crankshaft position sensor pulse.

6.2 The ECM detects that the engine is running and the starter is not engaged and no crankshaft position sensor pulse for greater than 0.3seconds.

6.3 The ECM detects that the engine is running, but has not received a crankshaft position sensor pulse for 2 of 10engine cycles.

7 ACTION TAKEN WHEN THE DTC SETS

7.1 DTCP0335 is a TypeA DTC.

7.2 The camshaft position actuator, if equipped, is commanded to the parked position.

7.3 The ignition system defaults to a limp home mode. The camshaft position sensor is used to determine engine position.

8 CONDITIONS FOR CLEARING THE DTC

8.1 DTCP0335 is a TypeA DTC.

P0335 – Crankshaft Position (CKP) Sensor Circuit

9 DIAGNOSTIC AIDS

9.1 With this DTC set, the engine may crank for an extended period of time during start-up.

10 REFERENCE INFORMATION

10.1 SCHEMATIC REFERENCE

10.1.1 Engine controls schematics

10.2 CONNECTOR END VIEW REFERENCE

10.2.1 Component connector end views

10.3 ELECTRICAL INFORMATION REFERENCE

10.3.1 Circuit testing

10.3.2 Connector repairs

10.3.3 Testing for intermittent conditions and poor connections

10.3.4 Wiring repairs

10.4 DTC TYPE REFERENCE

10.4.1 Powertrain diagnostic trouble code (DTC) type definitions

10.5 SCAN TOOL REFERENCE

10.5.1 CONTROL MODULE REFERENCESfor scan tool information

10.6 SPECIAL TOOLS

10.6.1 *J35616-A/BT-8637* Connector Test Adapter Kit

11 CIRCUIT/SYSTEM VERIFICATION

11.1 Ignition ON, observe the DTC information with scan tool. Verify that DTC P0641 or P0651 is not set.

11.1.1 If the DTC is set, refer to *DIAGNOSTIC TROUBLE CODE (DTC) LIST*for DTCP0641 or P0651 for further diagnosis.

11.2 Clear the DTC information with a scan tool. Attempt to start the engine. Observe the DTC information with a scan tool. DTCP0335 should not set.

11.3 Engine idling; observe the scan tool Crankshaft Position Resync Counter parameter. The parameter should always display zero. Move the related harnesses/connectors of the B26 crankshaft position sensor while observing the parameter. Verify the engine does not stumble or stall, and the parameter does not increment.

P0335 – Crankshaft Position (CKP) Sensor Circuit

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

12 CIRCUIT/SYSTEM TESTING

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

12.1 Ignition OFF, disconnect the harness connector at the B26crankshaft position sensor.

12.2 Ignition OFF and all vehicle systems OFF. It may take 2minutes for all vehicle systems to power down. Test for less than 5Ω between the low reference circuit terminalB and ground.

12.2.1 If greater than the specified value, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the K20 engine control module.

12.3 Ignition ON, engine OFF, test for 4.8–5.2V between the 5V reference circuit terminalC and ground.

12.3.1 If less than the specified range, test the 5V reference circuit for an open/high resistance or short to ground. If the circuit tests normal, replace the K20 engine control module.

12.3.2 If greater than the specified range, test the 5V reference circuit for a short to voltage. If the circuit tests normal, replace the K20 engine control module.

12.4 Ignition ON, test for 4.8–5.2V between the signal circuit terminalA and ground.

12.4.1 If less than the specified range, test the signal circuit for an open/high resistance or short to ground. If the circuit tests normal, replace the K20 engine control module.

12.4.2 If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the K20 engine control module.

12.5 Ignition OFF, connect a 3A fused jumper wire to the signal circuit terminalA.

12.5.1 NOTE: ADDITIONAL DTCS MAY SET WHEN PERFORMING THIS TEST.

12.5.2 Ignition ON, momentarily touch the other end of the fused jumper wire to ground repeatedly while.

13 COMPONENT TESTING

Note: You must perform the Circuit/System testing before proceeding with Component Testing.

13.1 Inspect the crankshaft position sensor for correct installation. Remove the crankshaft position sensor from the engine and inspect the sensor O-ring for damage.

13.1.1 If the sensor is loose, incorrectly installed, or damaged, replace the B26 crankshaft position sensor.

13.2 Connect the crankshaft position sensor harness connector to the B26 crankshaft position sensor.

P0335 – Crankshaft Position (CKP) Sensor Circuit

13.3 Ignition ON, engine OFF. Observe the Crankshaft Position Sensor Active Counter parameter on the scan tool.

13.4 Pass a flat steel object across the tip of the sensor repeatedly. The Crankshaft Position Active counter parameter should increment with each pass of the steel object.

13.4.1 If the parameter does not increment, replace the B26 crankshaft position sensor.

14 REPAIR INSTRUCTIONS

14.1 Perform the *DIAGNOSTIC REPAIR VERIFICATION* after completing the diagnostic repair.

14.2 CRANKSHAFT POSITION SENSOR REPLACEMENT

14.3 CONTROL MODULE REFERENCES for ECM replacement, programming, and setup

14.4

P0336 – Crankshaft Position (CKP) Sensor Performance

1 DIAGNOSTIC INSTRUCTIONS

1.1 Review *STRATEGY BASED DIAGNOSIS* for an overview of the diagnostic approach.

1.2 Perform the *DIAGNOSTIC SYSTEM CHECK* prior to using this diagnostic procedure.

2 DTC DESCRIPTOR

2.1 **DTCP0336:** Crankshaft Position Sensor Performance

3 DIAGNSOTIC FAULT INFORMATION

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference Circuit	P0651	P0335	P0651, P2135	--
Crankshaft Position Signal	P0335	P0335	P0335	P0336
Low Reference	—	P0335	P0335	--

4 CIRCUIT/SYSTEM DESCRIPTION

The crankshaft position sensor circuits consist of an engine control module (ECM) supplied 5V reference circuit, low reference circuit and an output signal circuit. The crankshaft position sensor is an internally magnetic biased digital output integrated circuit sensing device. The sensor detects magnetic flux changes between the peaks and valleys of a 58-tooth reluctor wheel on the crankshaft. Each tooth on the reluctor wheel is spaced at 60-tooth spacing, with two missing teeth for the reference gap. The crankshaft position sensor produces an ON/OFF DC voltage of varying frequency, with 58output pulses per crankshaft revolution. The frequency of the crankshaft position sensor output depends on the velocity of the crankshaft. The crankshaft position sensor sends a digital signal, which represents an image of the crankshaft reluctor wheel, to the ECM as each tooth on the wheel rotates past the crankshaft position sensor. The ECM uses each crankshaft position signal pulse to determine crankshaft speed and decodes the crankshaft reluctor wheel reference gap to identify crankshaft position. This information is then used to sequence the ignition timing and fuel injection events for the engine. The ECM also uses crankshaft position sensor output information to determine the crankshaft relative position to the camshaft, to detect cylinder misfire, and to control the camshaft position actuator if equipped.

5 CONDITIONS FOR RUNNING THE DTC

5.1 Condition1

5.1.1 DTCs P0101, P0102, P0103 is not set.

5.1.2 The engine is cranking.

5.1.3 The engine airflow is greater than 3 g/s.

5.2 Condition2

5.2.1 DTCP0651 is not set.

5.2.2 The engine is running.

5.3 Condition3

5.3.1 DTCsP0335 or P0651 is not set.

5.3.2 The engine is running and engine speed is greater than 450RPM.

5.3.3 The engine airflow is greater than 3g/s.

5.4 Condition4

5.4.1 DTCs P0340, P0341, P0641, or P0651 is not set.

5.4.2 The engine is running or engine is cranking.

5.5 The DTCP0336 runs continuously when the above conditions are met.

6 CONDITIONS FOR SETTING THE DTC

6.1 The ECM detects that the engine is running, but receives less than 53or more than 63crankshaft position sensor pulses, during each engine revolution, for 8of 10engine revolutions.

6.2 The ECM detects that the engine is running, but more than 25crankshaft resyncs have occurred within 20s.

6.3 The ECM detects that the engine has been running, but the crankshaft does not sync for 0.4s.

7 ACTION TAKEN WHEN THE DTC SETS

7.1 DTCP0336 is a TypeA DTC.

8 CONDITIONS FOR CLEARING THE DTC

8.1 DTCP0336 is a TypeA DTC.

P0336 – Crankshaft Position (CKP) Sensor Performance

9 DIAGNOSTIC AIDS

9.1 With this DTC set, the engine may crank for an extended period of time during start-up.

10 REFERENCE INFORMATION

10.1 SCHEMATIC REFERENCE

10.1.1 Engine controls schematics

10.2 CONNECTOR END VIEW REFERENCE

10.2.1 Component connector end views

10.3 ELECTRICAL INFORMATION REFERENCE

10.3.1 Circuit testing

10.3.2 Connector repairs

10.3.3 Testing for intermittent conditions and poor connections

10.3.4 Wiring repairs

10.4 DTC TYPE REFERENCE

10.4.1 Powertrain diagnostic trouble code (DTC) type definitions

10.5 SCAN TOOL REFERENCE

10.5.1 CONTROL MODULE REFERENCESfor scan tool information

11 CIRCUIT/SYSTEM VERIFICATION

11.1 Clear the DTC information with a scan tool. Attempt to start the engine. Observe the DTC information with a scan tool. DTCP0335 should not set.

11.2 Engine idling, observe the scan tool Crankshaft Position Resync Counter parameter. The parameter should always display zero. Move the related harnesses/connectors of the B26 crankshaft position sensor while observing the parameter. Verify the engine does not stumble or stall, and the parameter does not increment.

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

12 CIRCUIT/SYSTEM TESTING

NOTE:YOU MUST PERFORM THE CIRCUIT/SYSTEM VERIFICATION BEFORE PROCEEDING WITH CIRCUIT/SYSTEM TESTING.

12.1 DTC P0336 should not be set.

P0336 – Crankshaft Position (CKP) Sensor Performance

12.1.1 If DTCP0336 is set, inspect the engine for the conditions listed below and repair as necessary:

12.1.2 Excessive play or looseness of the CKP sensor or the reluctor wheel.

12.1.3 Improper installation of the CKP sensor.

12.1.4 Foreign material passing between the CKP sensor and the reluctor wheel.

12.1.5 Excessive air gap between the CKP sensor and the reluctor wheel.

12.1.6 Engine oil for debris.

12.1.7 Timing chain, tensioner, and sprockets for wear or damage.

12.2 Ignition OFF, disconnect the harness connector at the B26crankshaft position sensor.

12.3 Ignition OFF, vehicle systems OFF. It may take 2 minutes, test for less than 1Ω between the low reference circuit, terminalB, and ground.

12.3.1 If greater than the specified value, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the K20 engine control module.

12.4 Ignition ON, test for 4.8–5.2V between the 5V reference circuit, terminalC and ground.

12.4.1 If less than the specified range, test the 5V reference circuit for an open/high resistance or short to ground. If the circuit tests normal, replace the K20 engine control module.

12.4.2 If greater than the specified range, test the 5V reference circuit for a short to voltage. If the circuit tests normal, replace the K20 engine control module.

12.5 Ignition ON, test for 4.8–5.2V between the signal circuit terminalA and ground.

12.5.1 If less than the specified range, test the signal circuit for an open/high resistance or short to ground. If the circuit tests normal, replace the K20 engine control module.

12.5.2 If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the K20 engine control module.

12.6 Ignition OFF, connect a 3A fused jumper wire to the signal circuit terminalA.

12.6.1 Note: Additional DTCs may set when performing this test.

12.7 Ignition ON, momentarily touch the other end of the fused jumper wire to ground repeatedly while monitoring the scan tool Crankshaft Position Sensor Active Counter parameter. The Crankshaft Position Active counter, should increment.

12.7.1 If the Crankshaft Position Active counter does not increment, replace the K20 engine control module.

12.8 If all circuits and components test normal, test or replace the B26 crankshaft position sensor.

P0336 – Crankshaft Position (CKP) Sensor Performance

13 COMPONENT TESTING

Note:You must perform the Circuit/System testing before proceeding with Component Testing.

13.1 Inspect the crankshaft position sensor for correct installation. Remove the B26crankshaft position sensor from the engine and inspect the sensor O-ring for damage.

13.1.1 If the sensor is loose, incorrectly installed, or damaged, replace the B26crankshaft position sensor.

13.2 Connect the crankshaft position sensor harness connector to the B26crankshaft position sensor.

13.3 Ignition ON, observe the Crankshaft Position Active counter parameter with a scan tool while passing a flat steel object across the tip of the sensor repeatedly. The Crankshaft Position Active counter parameter should increment with each pass of the steel object.

13.3.1 If the function does not perform as specified, replace the B26crankshaft position sensor.

14 REPAIR INSTRUCTIONS

14.1 Perform the *DIAGNOSTIC REPAIR VERIFICATION* after completing the diagnostic procedure.

14.2 CRANKSHAFT POSITION SENSOR REPLACEMENT

14.3 CONTROL MODULE REFERENCES for ECM replacement, setup, and programming

P0340 or P0341 – Camshaft Position (CMP) Sensor Circuit or Sensor Performance

1 DIAGNOSTIC INSTRUCTIONS

1.1 Review *STRATEGY BASED DIAGNOSIS* for an overview of the diagnostic approach.

1.2 Perform the *DIAGNOSTIC SYSTEM CHECK* prior to using this diagnostic procedure.

2 DTC DESCRIPTOR

2.1 **DTC P0340**: Camshaft Position Sensor Circuit

2.2 **DTC P0340:** Camshaft Position Sensor Performance

3 DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference Circuit	P0107, P0452, P0522, P0532, P0641	P0340	P0641	—
Camshaft Position Sensor Signal Circuit	P0340	P0340	P0340	P0341
Low Reference Circuit	—	P0340	P0340	—

4 CIRCUIT/SYSTEM DESCRIPTION

The 4Xcamshaft position sensor circuits consist of an engine control module (ECM) supplied 5V reference circuit, low reference circuit, and an output signal circuit. The camshaft position sensor is an internally magnetic biased digital output integrated circuit sensing device. The sensor detects magnetic flux changes between the peaks and valleys of a 4-tooth reluctor wheel attached to the camshaft. As each reluctor wheel tooth rotates past the camshaft position sensor, the resulting change in the magnetic field is used by the sensor electronics to produce a digital output pulse. The sensor returns a digital ON/OFF DC voltage pulse of varying frequency, with 2narrow, and 2wide output pulses per camshaft revolution that represent an image of the camshaft reluctor wheel. The frequency of the camshaft position sensor output depends on the velocity of the camshaft. The ECM decodes the narrow and wide tooth pattern to identify camshaft position. This information is then used to sequence the ignition timing and fuel injection events for the engine. The ECM also uses camshaft position sensor output information to determine the camshaft relative position to the crankshaft, to control the camshaft position actuator if equipped, and for limp-home operation.

5 CONDITIONS FOR RUNNING THE DTC

5.1 P0340 Condition 1

P0340 or P0341 – Camshaft Position (CMP) Sensor Circuit or Sensor Performance

5.1.1 The starter is engaged and the engine control module detects camshaft position (CMP) pulses.

5.1.2 DTC P0101, P0102, and P0103 are not set.

5.1.3 Airflow into the engine is greater than 3 g/s.

5.2 P0340 Condition 2

5.2.1 The engine is running

5.2.2 The starter is not engaged

5.2.3 DTC P0641 is not set

5.3 P0340 Condition 3

5.3.1 The crankshaft is synchronized

5.3.2 The starter is engaged and then disengaged.

5.3.3 DTC P0335, P0336, P0641, or P0651 are not set.

5.4 P0340 Condition 4

5.4.1 The crankshaft is synchronized

5.4.2 DTC P0335, P0336, P0641, or P0651 are not set.

5.5 Condition 2

5.5.1 The crankshaft is synchronized

5.5.2 DTC P0335, P0336, P0641, or P0651 are not set

6 CONDITIONS FOR SETTING THE DTC

6.1 P0340 Condition 1

6.1.1 The ECM does not detect a camshaft position (CMP) pulse for greater than 5.5 s or greater than 4.0 s since the time the starter has been engaged.

6.2 P0340 Condition 2

6.2.1 The ECM detects less than 4 camshaft position sensor pulses for greater than 3.0 s

6.3 P0340 Condition 3

6.3.1 The ECM did not detect a camshaft position sensor pulse during the first 2 engine revolutions.

6.4 P0340 Condition 4

6.4.1 The ECM does not detect a camshaft position sensor pulse during 200 engine revolutions.

6.5 P0341 Condition 1

6.5.1 The ECM detects less than 2 or greater than 8 camshaft position sensor pulses during the first 2 engine revolutions.

6.6 P0341 Condition 2

6.6.1 The ECM detects less than 398 or greater than 402 camshaft position sensor pulses during 200 engine revolutions.

7 ACTION TAKEN WHEN THE DTC SETS

7.1 DTCP0340 and P0341 are a TypeB DTCs.

7.2 The camshaft position actuator if equipped is commanded to the Home or parked position

7.3 The ignition system defaults to a failed camshaft position sensor limp home mode.

8 CONDITIONS FOR CLEARING THE DTC

8.1 DTCP0340 and P0341 are a TypeB DTCs.

9 DIAGNOSTIC AIDS

9.1 With a DTC set, the engine may crank for an extended period of time during start-up.

10 REFERENCE INFORMATION

10.1 SCHEMATIC REFERENCE

10.1.1 Engine controls schematics

10.2 CONNECTOR END VIEW REFERENCE

10.2.1 Component connector end views

10.3 ELECTRICAL INFORMATION REFERENCE

10.3.1 Circuit testing

10.3.2 Connector repairs

10.3.3 Testing for intermittent conditions and poor connections

10.3.4 Wiring repairs

10.4 DTC TYPE REFERENCE

10.4.1 Powertrain diagnostic trouble code (DTC) type definitions

10.5 SCAN TOOL REFERENCE

10.5.1 CONTROL MODULE REFERENCESfor scan tool information

11 CIRCUIT/SYSTEM VERIFICATION

11.1 Ignition ON, observe the DTC information with scan tool. Verify that DTCP0641 or P0651 is not set.

11.1.1 If a DTC is set, refer to DTCP0641 or P0651 for further diagnosis.

11.2 Engine idling, observe the scan tool CMP Active Counter parameter. The parameter should be incrementing.

11.3 Engine idling, observe the DTC information with a scan tool. DTCP0340 should not set.

11.4 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.

12 CIRCUIT/SYSTEM TESTING

12.1 Ignition OFF, disconnect the harness connector at the B23camshaft position sensor.

12.2 Ignition OFF and all vehicle systems OFF. It may take 2minutes for all vehicle systems to power down, test for less than 5Ω on the low reference circuit, terminalB, and ground.

12.2.1 If greater than the specified value, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the K20ECM.

12.3 Ignition ON, test for 4.8–5.2V between the 5V reference circuit terminalA and ground.

12.3.1 If less than the specified range, test the 5V reference circuit for an open/high resistance or short to ground. If the circuit tests normal, replace the K20ECM.

12.3.2 If greater than the specified range, test the 5V reference circuit for a short to voltage. If the circuit tests normal, replace the K20ECM.

12.4 Ignition ON, test for 4.8–5.2V between the signal circuit terminalC and ground.

12.4.1 If less than the specified range, test the signal circuit for an open/high resistance or short to ground. If the circuit tests normal, replace the K20ECM.

12.4.2 If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the K20ECM.

12.5 Ignition OFF, connect a 3A fused jumper wire to the signal circuit terminalC.

12.6 Ignition ON, momentarily touch the other end of the 3A fused jumper wire to the battery negative post. The scan tool CMP Active counter should increment.

12.6.1 If the parameter does not increment, replace the K20ECM.

12.7 If all circuits test normal, test or replace the B23 camshaft position sensor.

13 COMPONENT TESTING

Note: You must perform the Circuit/System Testing before proceeding with Component Testing.

13.1 Inspect the camshaft position sensor for correct installation. Remove the B23 camshaft position sensor from the engine and inspect the sensor O-ring for damage.

13.1.1 If the sensor is loose, incorrectly installed, or damaged, replace the B23camshaft position sensor.

13.2 Connect the camshaft position sensor harness connector to the B23camshaft position sensor.

13.3 Ignition ON, engine OFF. Observe the CMP Active counter parameter on the scan tool.

13.4 Pass a flat steel object across the tip of the sensor repeatedly. The CMP Active counter parameter should increment with each pass of the steel object.

13.4.1 If the parameter does not increment, replace the B23camshaft position sensor.

14 REPAIR INSTRUCTIONS

14.1 Perform the *DIAGNOSTIC REPAIR VERIFICATION* after completing the diagnostic procedure.

14.2 CAMSHAFT POSITION SENSOR REPLACEMENT

14.3 CONTROL MODULE REFERENCES

P0351 – P0358 –Ignition Coil Control Circuit

1 DIAGNOSTIC INSTRUCTIONS

1.1 Review *STRATEGY BASED DIAGNOSIS* for an overview of the diagnostic approach.

1.2 Perform the *DIAGNOSTIC SYSTEM CHECK* prior to using this diagnostic procedure.

2 DTC DESCRIPTOR

2.1 **DTC P0351:**Ignition Coil 1 Control Circuit

2.2 **DTC P0352:**Ignition Coil 2 Control Circuit

2.3 **DTC P0353:**Ignition Coil 3 Control Circuit

2.4 **DTC P0354**: Ignition Coil 4 Control Circuit

2.5 **DTC P0355:**Ignition Coil 5 Control Circuit

2.6 **DTC P0356:**Ignition Coil 6 Control Circuit

2.7 **DTC P0357:**Ignition Coil 7 Control Circuit

2.8 **DTC P0358**: Ignition Coil 8 Control Circuit

P0351 – P0358 –Ignition Coil Control Circuit

3 DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition Coil 1 Control Circuit	P0300, P0351	P0300 P0351	P0300, P0351	—
Ignition Coil 2 Control Circuit	P0300, P0352	P0300 P0352	P0300, P0352	—
Ignition Coil 3 Control Circuit	P0300, P0353	P0300 P0353	P0300, P0353	—
Ignition Coil 4 Control Circuit	P0300, P0354	P0300 P0354	P0300, P0354	—
Ignition Coil 5 Control Circuit	P0300, P0355	P0300 P0355	P0300, P0355	—
Ignition Coil 6 Control Circuit	P0300, P0356	P0300 P0356	P0300, P0356	—
Ignition Coil 7 Control Circuit	P0300, P0357	P0300 P0357	P0300, P0357	—
Ignition Coil 8 Control Circuit	P0300, P0358	P0300 P0358	P0300, P0358	—
Ignition Coil Low Reference Circuit	—	P0300 P0358	P0300, P0358	—
Ignition Coil Ground Circuit	—	P0300 P0358	P0300, P0358	—

4 CIRCUIT/SYSTEM DESCRIPTION

The ignition system on this engine uses an individual coil/module for each cylinder. The engine control module (ECM) controls the spark event for each cylinder through the eight individual ignition control (IC) circuits. When the ECM commands the IC circuit ON, electrical current will flow through the primary winding of the ignition coil, creating a magnetic field. When a spark event is requested, the ECM will command the IC circuit OFF, interrupting current flow through the primary winding. The magnetic field created by the primary winding will collapse across the secondary coil windings, producing a high voltage across the spark plug electrodes. The ECM uses information from the crankshaft position sensor, and the camshaft position sensor for sequencing and timing of the spark events.

If the ECM detects that the IC circuit has an incorrect voltage level, DTCP0351–P0358 will set.

5 CONDITIONS FOR RUNNING THE DTC

5.1 Engine running.

5.2 Ignition voltage greater than 6V.

5.3 DTC P0351–P0358 runs continuously when the above condition is met.

P0351 – P0358 –Ignition Coil Control Circuit

6 CONDITIONS FOR SETTING THE DTC

6.1 The ECM detects one of the following failures on the IC circuit:

6.1.1 An open

6.1.2 A short to ground

6.1.3 A short to voltage

7 ACTION TAKEN WHEN THE DTC SETS

7.1 DTCs P0351–P0358 are TypeB DTCs.

8 CONDITIONS FOR CLEARING THE DTC

8.1 DTCs P0351–P0358 are Type B DTCs.

9 DIAGNOSTIC AIDS

9.1 A high resistance condition on any IC circuit can cause an engine misfire without setting DTCP0351–P0358.

10 REFERENCE INFORMATION

10.1 SCHEMATIC REFERENCE

10.1.1 Engine controls schematics

10.2 CONNECTOR END VIEW REFERENCE

10.2.1 Component connector end views

10.3 ELECTRICAL INFORMATION REFERENCE

10.3.1 Circuit testing

10.3.2 Connector repairs

10.3.3 Testing for intermittent conditions and poor connections

10.3.4 Wiring repairs

10.4 DTC TYPE REFERENCE

10.4.1 Powertrain diagnostic trouble code (DTC) type definitions

10.5 SCAN TOOL REFERENCE

10.5.1 CONTROL MODULE REFERENCESfor scan tool information

11 CIRCUIT/SYSTEM VERIFICATION

11.1 With the engine running, monitor the following ignition control (IC) circuit status parameters with a scan tool:

11.1.1 Cylinder 1–8 IC Ckt. Short Gnd Test Status

11.1.2 Cylinder 1–8 IC Ckt. Open Test Status

11.1.3 Cylinder 1–8 IC Ckt. Short to Volts Test Status

11.1.4 Each parameter should display OK.

11.2 With the engine running, observe the Misfire Current counters with a scan tool.

11.2.1 The counters should not be incrementing.

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

12 CIRCUIT/SYSTEM TESTING

12.1 With the engine running, monitor the Cylinder 1–8 IC Ckt. Status parameters with a scan tool.

12.1.1 If a short to GND or Open status test displays FAULT, test for an open/high resistance or short to ground on the affected IC circuit terminalC.

12.1.2 If a short to volts status test displays FAULT, test for a short to voltage on the affected IC circuit terminalC.

12.1.3 IMPORTANT:A HIGH RESISTANCE ON ANY IC CIRCUIT CAN CAUSE A MISFIRE CONDITION BEFORE DTCS P0351–P0358 SET.

12.2 Exchange the affected ignition coil/module with the ignition coil/module of a cylinder that is not affected.

12.3 Start and run the engine. With a scan tool, monitor the IC circuit parameters and the Misfire Current counters.

12.3.1 If the circuit status fault identified or the misfire transfers with the ignition coil/module, replace the ignition coil/module assembly.

12.3.2 If the circuit status fault identified or the misfire does not transfer with the ignition coil/module, replace the ECM.

13 REPAIR INSTRUCTIONS

13.1 Ignition coil replacement

13.2 Engine control module replacement

13.3 Engine control module programming and setup

14 REPAIR VERIFICATION

IMPORTANT:AN IC CIRCUIT FAULT CONDITION WILL RESULT IN AN ENGINE MISFIRE, AND UNDER CERTAIN DRIVING CONDITIONS COULD POSSIBLY OVERHEAT THE 3-WAY CATALYTIC CONVERTER.

14.1 Install any components or connectors that have been removed or replaced during diagnosis.

14.2 Perform any adjustment, programming, or setup procedures that are required when a component or module is removed or replaced.

14.3 Start and run the engine. With a scan tool, monitor the IC circuit status parameters. All IC circuit status parameters should display OK.

14.3.1 If another DTC is present, refer to *DIAGNOSTIC TROUBLE CODE (DTC) LIST*and perform the appropriate diagnostic.

14.4 To verify that the performance of the catalytic converter has not been affected by the condition that set this DTC, perform the Repair Verification for DTC P0420 or P0430. Refer to DTC P0420 or P0430

P0420 or P0430 –Catalyst System Low Efficiency Bank 1 or Bank 2

1 DIAGNOSTIC INSTRUCTIONS

1.1 Review *STRATEGY BASED DIAGNOSIS* for an overview of the diagnostic approach.

1.2 Perform the *DIAGNOSTIC SYSTEM CHECK* prior to using this diagnostic procedure.

2 DTC DESCRIPTOR

2.1 **DTC P0420**: Catalyst System Low Efficiency Bank 1

2.2 **DTC P0430**: Catalyst System Low Efficiency Bank 2

3 CIRCUIT/SYSTEM DESCRIPTION

Note:A new converter with less than 100mi on it may set DTCP0420 or P0430 due to out-gassing of the internal matting. Operating the vehicle at highway speeds for approximately 1h may correct the condition.

A 3-way catalytic converter controls emissions of hydrocarbons, CO and NOx. The catalyst within the converter promotes a chemical reaction, which oxidizes the hydrocarbons and the CO that are present in the exhaust gas. This process converts the hydrocarbons and the CO into water vapor and CO2, and reduces the NOx, by converting the NOx into nitrogen. The catalytic converter also stores oxygen. The ECM monitors this process by using a heated oxygen sensor (HO2S) that is in the exhaust stream after the 3-way catalytic converter. The HO2S2 produces an output signal that the ECM uses to calculate the oxygen storage capacity of the catalyst. This indicates the ability of the catalyst to convert the exhaust emissions efficiently. The ECM monitors the efficiency of the catalyst by allowing the catalyst to heat, and then wait for a stabilization period while the engine is idling. The ECM then adds and removes fuel while monitoring the HO2S2. When the catalyst is functioning properly, the HO2S2 response to the extra fuel is slow compared to the response of the HO2S1, which is located before the 3-way catalytic converter. When the HO2S2 response is near that of the HO2S1, the oxygen storage capability and efficiency of the catalyst may be degraded below an acceptable threshold.

4 CONDITIONS FOR RUNNING THE DTC

4.1 DTC P0030, P0031, P0036, P0037, P0038, P0068, P0106, P0107, P0108, P0112, P0113, P0117, P0118, P0120, P0121, P0122, P0123, P0125, P0128, P0130, P0131, P0132, P0133, P0134, P0135, P0136, P0137, P0138, P0140, P0141, P0171, P0172, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0220, P0300, P0315, P0326, P0327, P0336, P0340, P0341, P0442, P0446, P0452, P0453, P0455, P0496, P0500, P0502, P0506, P0507, P0601, P0602, P0606, P0641, P0722, P0723, P1133, P1134, P1516, P1621, P2135, P2138, or P2176 is not set.

4.2 Before the ECM performs the idle test, the vehicle must be driven under the following conditions:

4.2.1 The engine speed is greater than 1,300RPM.

4.2.2 The engine run time is greater than 100s.

4.2.3 Both conditions exist for greater than 16s.

4.3 The vehicle speed is less than 1.6km/h (1mph).

4.4 The throttle position is less than 2%.

4.5 The Mass Air Flow (MAF) is between 2–21g/s.

4.6 The engine is operating in Closed Loop.

4.7 The fuel trim learn is enabled.

4.8 The Engine Coolant Temperature (ECT) is between 45–129°C (113–264°F).

4.9 The Barometric Pressure (BARO) is greater than 70kPa.

4.10 The Catalytic Converter Calculated Temperature parameter is between 600–900°C (1,112–1,652°F) for greater than 6min.

4.11 The Intake Air Temperature (IAT) is between −20 and +250°C (−4 and +482°F).

4.12 The battery voltage is greater than 11V.

4.13 The transmission is in Drive Range—Automatic transmissions only.

4.14 The short term fuel trim is between −10 and +10%.

4.15 The engine is idling for less than 50s.

4.16 This diagnostic attempts one test during each valid idle period when the above conditions have been met. This diagnostic attempts up to 8tests during each drive cycle.

5 CONDITIONS FOR SETTING THE DTC

5.1 The ECM has determined the catalyst efficiency has degraded below a calibrated threshold.

6 ACTION TAKEN WHEN THE DTC SETS

6.1 DTCs P0420 and P0430 are Type A DTCs.

7 CONDITIONS FOR CLEARING THE MIL/DTC

7.1 DTCsP0420 and P0430 are TypeA DTCs.

8 REFERENCE INFORMATION

8.1 SCHEMATIC REFERENCE

8.1.1 Engine controls schematics

8.2 CONNECTOR END VIEW REFERENCE

8.2.1 Component connector end views

8.3 ELECTRICAL INFORMATION REFERENCE

8.3.1 Circuit testing

8.3.2 Connector repairs

8.3.3 Testing for intermittent conditions and poor connections

8.3.4 Wiring repairs

8.4 DTC TYPE REFERENCE

8.4.1 Powertrain diagnostic trouble code (DTC) type definitions

8.5 SCAN TOOL REFERENCE

8.5.1 CONTROL MODULE REFERENCESfor scan tool information

9 CIRCUIT/SYSTEM VERIFICATION

9.1 Verify that no other DTCs are set.

9.1.1 If any DTCs are set, refer to *DIAGNOSTIC TROUBLE CODE (DTC) LIST*.

9.2 Operate the vehicle within the Conditions for Running the DTC while observing the scan tool Catalyst monitor Not At Idle Test Conditions Met parameter. The parameter will change to Yes when the OFF Idle Conditions have been met.

9.2.1 If not the specified value, operate the vehicle within the OFF Idle Conditions.

9.3 When the parameter has changed to Yes and the conditions are safe, stop and idle the vehicle in gear.

9.4 Apply the service brake.

9.5 Monitor the scan tool Catalyst Monitor Test State parameter. When the parameter indicates Active, the Catalyst Monitor Test is running.

9.6 Continue to monitor the parameter. When the parameter indicates Inactive, the Catalyst Monitor Test has completed.

9.7 When the test has completed, the Catalyst Monitor Test Counter Bank1 or Bank2 parameter will increment by one and the Catalyst Monitor Test Result Bank1 or Bank2 parameter will indicate Pass, Fail, or No Decision.

9.7.1 If no decision has been made, repeat steps2–6 until the Test Result parameter indicates a Pass or Fail.

P0420 or P0430 –Catalyst System Low Efficiency Bank 1 or Bank 2

10 CIRCUIT/SYSTEM TESTING

CAUTION:refer to heated oxygen sensor resistance learn reset caution.

NOTE:A NEW CONVERTER WITH LESS THAN 161 KM (100 MI) ON IT MAY SET DTC P0420 OR P0430 DUE TO OUT-GASSING OF THE INTERNAL MATTING. OPERATING THE VEHICLE AT HIGHWAY SPEEDS FOR APPROXIMATELY 1 H MAY CORRECT THE CONDITION.

10.1 Engine idling, observe the DTC information with a scan tool. Verify there are no HO2S or misfire DTCs set.

10.1.1 If any DTCs are set, refer to *DIAGNOSTIC TROUBLE CODE (DTC) LIST* to diagnosis the applicable DTC before proceeding with this diagnostic procedure.

10.2 Verify the following conditions do not exist with the catalytic converter:

10.2.1 Dents

10.2.2 A severe discoloration caused by excessive temperatures

10.2.3 An internal rattle caused by damaged catalyst substrate

10.2.4 Restrictions

10.2.5 If a condition is found, replace the catalytic converter.

10.3 Verify the following conditions do not exist with the exhaust system:

10.3.1 Leaks

10.3.2 Physical damage

10.3.3 Loose or missing hardware

10.3.4 Improperly torqued HO2S

10.3.5 If a condition is found, repair the exhaust system.

10.4 Verify the following conditions do not exist with the HO2S2:

10.4.1 A grounded wiring harness

10.4.2 Damage

10.4.3 If a condition is found, replace the HO2S2.

10.5 If no physical condition is detected and the HO2S 2 is as active as the HO2S 1 after operating the engine at 1,500 RPM for 1 min and then returning to a stabilized idle, then replace the catalytic converter.

P0420 or P0430 –Catalyst System Low Efficiency Bank 1 or Bank 2

11 REPAIR INSTRUCTIONS

11.1 See OEM Service Manual for repairs

12 REPAIR VERIFICATION

12.1 Verify that no other DTCs are set.

12.1.1 If any DTCs are set, refer to *DIAGNOSTIC TROUBLE CODE (DTC) LIST.*

12.2 Operate the vehicle within the Conditions for Running the DTC while observing the scan tool Catalyst Monitor Not At Idle Test Conditions Met parameter. The parameter will change to Yes when the OFF Idle Conditions have been met.

12.2.1 If not the specified value, operate the vehicle within the OFF Idle Conditions.

12.3 When the parameter has changed to Yes and the conditions are safe, stop and idle the vehicle in gear.

12.4 Apply the service brake.

12.5 Monitor the scan tool Catalyst Monitor Test State parameter. When the parameter indicates Active, the Catalyst Monitor Test is running.

12.6 Continue to monitor the parameter. When the parameter indicates Inactive, the Catalyst Monitor Test has completed.

12.7 When the test has completed, the Catalyst Monitor Test Counter Bank1 or Bank2 parameter will increment by one and the Catalyst Monitor Test Result Bank1 or Bank2 parameter will indicate Pass, Fail, or No Decision.

12.7.1 If no decision has been made, repeat steps2–6 until the Test Result parameter indicates a Pass or Fail.

P0442–Evaporative Emission (EVAP) System Small Leak Detected

1 DIAGNOSTIC INSTRUCTIONS

1.1 Review *STRATEGY BASED DIAGNOSIS* for an overview of the diagnostic approach.

1.2 Perform the *DIAGNOSTIC SYSTEM CHECK* prior to using this diagnostic procedure.

2 DTC DESCRIPTOR

2.1 **DTC P0442**: Evaporative Emission (EVAP) System Small Leak Detected

3 CIRCUIT/SYSTEM DESCRIPTION

The engine off natural vacuum (EONV) test is the small leak detection diagnostic for the evaporative emission system. This diagnostic tests the evaporative emission (EVAP) system for a small leak when the key is turned OFF and the correct conditions are met. Heat from the exhaust system is transferred into the fuel tank while the vehicle is operating. When the vehicle is turned OFF and the EVAP system is sealed a change in the fuel tank vapor temperature occurs which results in a corresponding pressure change in the fuel tank vapor space. This change is monitored by the ECM using the fuel tank pressure (FTP) sensor input. With a leak in the system, the amount of pressure change will be less than that of a sealed system.

4 CONDITIONS FOR RUNNING THE DTC

4.1 DTCs P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0116, P0117, P0118, P0125, P0128, P0443, P0446, P0449, P0452, P0453, P0455, P0461, P0462, P0463, P0496, P0502, P0503, P0722, P0723, P2066, P2067, P2068, P2610, P2227, P2228, P2229 are not set.

4.2 The barometric pressure (BARO) is greater than 70 kPa.

4.3 No fuel filling during the EONV test period.

4.4 The fuel level is between 10–90 percent.

4.5 The start-up engine coolant temperature (ECT) and the start-up intake air temperature (IAT) are between 8–40°C (32–104°F).

4.6 The engine run time before engine shut-off was greater than 10 minutes.

4.7 The drive distance before engine shut-off was greater than 5 kilometers (3.1 miles).

4.8 The ignition is OFF.

4.9 The ambient air temperature at the end of the drive cycle is between 0–34°C (32–93°F).

4.10 DTC P0442 runs once per drive cycle during the hot soak period after the ignition is turned OFF and may require up to 40 minutes to complete. The controller will not make more than 2 test attempts per day. The time since the last completed EONV test must be at least 17 hours if passed or 10 hours if failed.

5 CONDITIONS FOR SETTING THE DTC

5.1 The ECM detects a leak in the EVAP system that is greater than a calibrated amount.

5.2 The ECM must complete several EONV tests before the diagnostic can turn the MIL on or off.

6 ACTION TAKEN WHEN THE DTC SETS

6.1 DTC P0442 is a Type A DTC.

7 CONDITIONS FOR CLEARING THE DTC

7.1 DTC P0442 is a Type A DTC.

8 DIAGNOSTIC AIDS

8.1 The EVAP system can be filled with smoke more quickly and completely by opening the system opposite the end where the smoke is injected. When injecting smoke at the service port remove the fuel fill cap, or temporarily leave the vent open, until smoke is observed then close the system and continue testing. If using a fuel cap adapter at the filler neck, use the *J-41413-VLV* service port vent tool at the service port to allow the system to fill faster.

8.2 To help locate intermittent leaks using the *J-41413-200* evaporative emissions system tester , move all EVAP components while observing smoke with the *GE-41413-SPT* high intensity white light.

8.3 Individual components can be isolated and tested using adapters in the *J-41413-300* cap and plug kit.

8.4 Do not disturb any of the fuel system components after verification of a DTC P0442 on the vehicle.

8.5 Close the EVAP canister vent valve with a scan tool to seal the EVAP system and monitor FTP sensor in mm Hg for approximately two minutes. If vacuum is present remove the purge solenoid valve and test with J 41413-200. Add smoke on the fuel tank side of the purge solenoid and allow pressure to stabilize for 2 minutes then observe for leaks.

8.6 A condition may exist where a leak in the EVAP system only exists under a vacuum condition. This type of leak may be detected by using the scan tool Purge/Seal function to create a vacuum in the EVAP system and then observe the FTP parameter for vacuum decay.

9 REFERENCE INFORMATION

9.1 SCHEMATIC REFERENCE

9.1.1 Engine controls schematics

9.2 CONNECTOR END VIEW REFERENCE

9.2.1 Component connector end views

9.3 ELECTRICAL INFORMATION REFERENCE

9.3.1 Circuit testing

9.3.2 Connector repairs

9.3.3 Testing for intermittent conditions and poor connections

9.3.4 Wiring repairs

9.4 DTC TYPE REFERENCE

9.4.1 Powertrain diagnostic trouble code (DTC) type definitions

9.5 SCAN TOOL REFERENCE

9.5.1 CONTROL MODULE REFERENCESfor scan tool information

9.6 SPECIAL TOOLS

9.6.1 *CH-48096* EVAP Service Access Port Tool

9.6.2 *GE-41413-SPT* High Intensity White Light

9.6.3 *J-41413-200* Evaporative Emissions System Tester (EEST)

9.6.4 *J-41413-300* EVAP Cap and Plug Kit

9.6.5 *J-41413-VLV* EVAP Service Port Vent Tool

9.6.6 *J-41413-VLV* EVAP Service Port Vent Tool

10 CIRCUIT/SYSTEM TESTING

NOTE: REFER TO THE *J-41413-200* EVAPORATIVE EMISSIONS SYSTEM TESTER OPERATION MANUAL FOR DETAILED INSTRUCTIONS IN *EVAPORATIVE EMISSION SYSTEM DIAGNOSIS* .

10.1 LARGER VOLUME FUEL TANKS AND/OR THOSE WITH LOWER FUEL LEVELS MAY REQUIRE SEVERAL MINUTES FOR THE FLOATING

10.2 THE FUEL LEVEL SHOULD BE BETWEEN 1/4 AND 3/4 OF A TANK.

10.3 ENSURE THAT THE UNDERBODY TEMPERATURE OF THE VEHICLE AND THE TESTER ARE SIMILAR.

10.4 Disconnect the purge tube at the quick connector on the EVAP canister side of the purge solenoid valve and install the *CH-48096* service access port tool service port adapter. Connect the *J-41413-200* evaporative emissions system tester to the vehicle at the EVAP service port adapter.

10.5 Using a scan tool close the EVAP canister vent valve to seal the EVAP system.

10.6 Use the flow meter on the *J-41413-200* evaporative emissions system tester , calibrated to 0.51mm (0.020 in) to determine that there is no leak in the EVAP system.

10.6.1 If a leak is detected, use the *J-41413-200* evaporative emissions system tester to apply smoke to the EVAP system at the service port until the leak is located using the *GE-41413-SPT* high intensity white light.

11 REPAIR VERIFICATION

11.1 Seal the EVAP system and use the flow meter on the *J-41413-200* evaporative emissions system tester , calibrated to 0.51mm (0.020 in) to determine that there is no leak in the EVAP system.

11.2 Clear DTCs.

P0443–Evaporative Emission (EVAP) Purge Solenoid Circuit

1 DIAGNOSTIC INSTRUCTIONS

1.1 Review *STRATEGY BASED DIAGNOSIS* for an overview of the diagnostic approach.

1.2 Perform the *DIAGNOSTIC SYSTEM CHECK* prior to using this diagnostic procedure.

2 DTC DESCRIPTOR

2.1 **DTC P0443**: Evaporative Emission (EVAP) Purge Solenoid Control Circuit

3 DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Ignition 1 Voltage – Purge Supply	P0443	P0443	P0443	—	—
EVAP Purge Solenoid Control	P0443	P0443	P0443	P0443	—

4 CIRCUIT/SYSTEM DESCRIPTION

An ignition voltage is supplied directly to the evaporative emission (EVAP) canister purge solenoid valve. The engine control module (ECM) grounds the EVAP canister purge solenoid valve control circuit through an internal switch called a driver. The ECM monitors the status of the driver. The EVAP canister purge solenoid valve is pulse width modulated (PWM). A scan tool will display the amount of ON time as a percentage.

5 CONDITIONS FOR RUNNING THE DTC

5.1 The system voltage is between 11–32volts.

5.2 DTCP0443 runs continuously when the above conditions are met.

6 CONDITIONS FOR SETTING THE DTC

6.1 The ECM detects that the commanded state of the driver and the actual state of the control circuit do not match for a minimum of 0.25seconds.

7 ACTION TAKEN WHEN THE DTC SETS

7.1 DTC P0443 is a Type B DTC.

P0443–Evaporative Emission (EVAP) Purge Solenoid Circuit

8 CONDITIONS FOR CLEARING THE MIL/DTC

8.1 DTCP0443 is a TypeB DTC.

9 REFERENCE INFORMATION

9.1 SCHEMATIC REFERENCE

9.1.1 Engine controls schematics

9.2 CONNECTOR END VIEW REFERENCE

9.2.1 Component connector end views

9.3 ELECTRICAL INFORMATION REFERENCE

9.3.1 Circuit testing

9.3.2 Connector repairs

9.3.3 Testing for intermittent conditions and poor connections

9.3.4 Wiring repairs

9.4 DTC TYPE REFERENCE

9.4.1 Powertrain diagnostic trouble code (DTC) type definitions

9.5 SCAN TOOL REFERENCE

9.5.1 CONTROL MODULE REFERENCESfor scan tool information

10 CIRCUIT/SYSTEM VERIFICATION

10.1 Ignition ON, engine OFF, command the EVAP purge solenoid to 50percent with a scan tool. You should hear the solenoid clicking when commanded to 50percent.

10.2 Engine Idling, command the EVAP purge solenoid from 0 to 50percent and back to 0percent with a scan tool while observing the following control circuit status parameters:

NOTE: EACH PARAMETER SHOULD DISPLAY OK OR NOT RUN.

10.2.1 EVAP Purge Sol Open Test Status

10.2.2 EVAP Purge Sol Short Volts Test Status

10.3 Engine Idling, command the EVAP purge solenoid from 0 to 50percent and back to 0percent with a scan tool while observing the following control circuit status parameters:

P0443–Evaporative Emission (EVAP) Purge Solenoid Circuit

11 CIRCUIT/SYSTEM TESTING

11.1 Ignition OFF, disconnect the harness connector at the EVAP canister purge solenoid valve.

11.2 Ignition ON, verify that a test lamp illuminates between the ignition circuit terminalA and ground.

11.2.1 If the test lamp does not illuminate, test the ignition circuit for a short to ground or an open/high resistance. If the circuit tests normal and the ignition circuit fuse is not open, test or replace the EVAP canister purge solenoid.

11.3 Verify that a test lamp does not illuminate between the ignition circuit terminalA and the control circuit terminalB.

11.3.1 If the test lamp illuminates, test the control circuit for a short to ground. If the circuit tests normal, replace the ECM.

11.4 Remove the test lamp, and install a 3 A fused jumper wire between the control circuit terminal B and the ignition circuit terminal A. Command the purge solenoid to 50 percent with a scan tool. Verify the scan tool purge solenoid Ckt. Short Volts Test Status Parameter is Fault.

11.4.1 If not the specified value and, the circuit tests normal, replace the ECM.

11.5 If all circuits test normal, replace the purge solenoid valve.

12 COMPONENT TESTING

12.1 Ignition OFF, disconnect the harness connector at the EVAP purge solenoid.

12.2 Test for 18–28Ω between the control terminalA and the ignition voltage terminal B.

12.2.1 If not within the specified range, replace the EVAP purge solenoid.

12.3 Test for infinite resistance between each terminal and the EVAP purge solenoid housing.

12.3.1 If not the specified value, replace the EVAP purge solenoid.

13 REPAIR INSTRUCTIONS

13.1 Perform the DIAGNOSTIC REPAIR VERIFICATION after completing the diagnostic

procedure. 13.2 *EVAPORATIVE EMISSION CANISTER PURGE SOLENOID VALVE REPLACEMENT*

13.3 *CONTROL MODULE REFERENCES* for ECM replacement, setup, and programming

P0446–Evaporative Emission (EVAP) Vent System Performance

1 DIAGNOSTIC INSTRUCTIONS

1.1 Review *STRATEGY BASED DIAGNOSIS* for an overview of the diagnostic approach.

1.2 Perform the *DIAGNOSTIC SYSTEM CHECK* prior to using this diagnostic procedure.

2 DTC DESCRIPTOR

2.1 **DTC P0446:** Evaporative Emissions (EVAP) Vent System Performance

3 TYPICAL SCAN TOOL DATA

FTP Sensor Signal Voltage	Fuel Tank Pressure
1.5 V	Atmospheric Pressure/BARO
Less than 1.5 V	Positive Pressure
More than 1.5 V	Negative Pressure/Vacuum

4 CIRCUIT/SYSTEM DESCRIPTION

This DTC tests the evaporative emission (EVAP) system for a restricted or blocked EVAP vent path that would cause excess amounts of vacuum to be developed in the EVAP system. With the purge valve open and the canister vent valve open, if the EVAP system vacuum goes above a calibrated threshold, the test will fail.

5 CONDITIONS FOR RUNNING THE DTC

5.1 DTCsP0068, P0101, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0122, P0123, P0125, P0128, P0220, P0222, P0223, P0443, P0449, P0452, P0453, P0454, P0502, P0503, P0606, P0641, P0651, P0722, P0723, P2138, P2227, P2228, P2229 are not set

5.2 The ignition voltage is between 11–32V.

5.3 The barometric pressure (BARO) is more than 70kPa.

5.4 The fuel level is between 10–90percent.

5.5 The engine coolant temperature (ECT) is less than 35°C (95°F).

5.6 The intake air temperature (IAT) is between 4–30°C (39–86°F).

5.7 DTCP0446 runs once per cold start when the above conditions are met.

5.8 Diagnostic test will abort after 16.6minutes.

6 CONDITIONS FOR SETTING THE DTC

6.1 The fuel tank vacuum is greater than −12inchesH2O vacuum for 5seconds, OR

6.2 The FTP is less than −2.5 inches H2O or more than +5inches for 60seconds after a cold start.

7 ACTION TAKEN WHEN THE DTC SETS

7.1 DTCP0446 is a TypeB DTC.

8 CONDITIONS FOR CLEARING THE MIL/DTC

8.1 DTCP0446 is a TypeB DTC.

9 DIAGNOSTIC AIDS

9.1 An intermittent condition could be caused by a damaged EVAP vent housing, a temporary blockage at the EVAP canister vent solenoid valve inlet, or a pinched vent hose. A blockage in the vent system may also cause a poor fuel fill condition.

9.2 An EVAP canister filter that is restricted can cause this DTC to set.

10 REFERENCE INFORMATION

10.1 SCHEMATIC REFERENCE

10.1.1 Engine controls schematics

10.2 CONNECTOR END VIEW REFERENCE

10.2.1 Component connector end views

10.3 ELECTRICAL INFORMATION REFERENCE

10.3.1 Circuit testing

10.3.2 Connector repairs

10.3.3 Testing for intermittent conditions and poor connections

10.3.4 Wiring repairs

10.4 DTC TYPE REFERENCE

10.4.1 Powertrain diagnostic trouble code (DTC) type definitions

10.5 SCAN TOOL REFERENCE

10.5.1 CONTROL MODULE REFERENCESfor scan tool information

11 CIRCUIT/SYSTEM VERIFICATION

11.1 Ignition ON and fuel cap removed, verify the scan tool Fuel Tank Pressure Sensor parameter is between 1.3–1.7volts.

11.1.1 If not within the specified range, go to the fuel tank pressure sensor section in Circuit/System Testing.

11.2 Install the fuel cap.

11.3 Engine running, the EVAP canister vent solenoid valve open, command the EVAP canister purge solenoid valve to 100percent with a scan tool. The reading should not increase to greater than −15mmHg (−8inchesH2O).

11.3.1 If greater than the specified range, go to the restriction section in Circuit/System Testing.

11.4 Using the scan tool, decrease the canister purge duty cycle from 100 percent to 0 percent. The vacuum should decrease to near zero.

11.4.1 If the fuel tank vacuum does not return to zero or appears to decrease too slowly go to the restriction section in Circuit/System Testing.

11.5 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.

12 CIRCUIT/SYSTEM TESTING

NOTE:perform the circuit/system verification before proceeding with the circuit/system testing.

12.1 Restriction

12.1.1 Engine running, the EVAP canister vent solenoid valve open, and the EVAP canister purge solenoid valve commanded to 100percent, the fuel tank vacuum should not increase to greater than −15mmHg (−8inchesH2O)

12.1.1.1 If greater than the specified value, isolate the restriction by disconnecting one component at a time while the EVAP canister purge solenoid valve is commanded to 100percent and the vent valve is open.

12.1.2 Decrease the canister purge duty cycle from 100percent to 0 percent with a scan tool. The vacuum should decrease to near zero.

12.1.2.1 If not the specified value or appears to decrease too slowly, inspect the components in the EVAP vent system for a restriction.

12.1.2.2 Fuel Tank Pressure Sensor

12.1.3 Ignition OFF, disconnect the harness connector at the B150fuel tank pressure sensor

12.1.4 Ignition OFF, all vehicle systems OFF, this may take up to 2minutes, test for less than 5ohms between the low reference circuit terminal and ground.

12.1.4.1 If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the fuel tank pressure sensor.

13 REPAIR INSTRUCTIONS

13.1 EVAPORATIVE EMISSION SYSTEM HOSE/PIPE REPLACEMENT

13.2 EVAPORATIVE EMISSION CANISTER VENT SOLENOID VALVE REPLACEMENT

13.3 EVAPORATIVE EMISSION CANISTER REPLACEMENT

13.4 EVAPORATIVE EMISSION LINE REPLACEMENT – ENGINE

13.5 EVAPORATIVE EMISSION LINE REPLACEMENT – CHASSIS

13.6 EVAPORATIVE EMISSION SYSTEM CLEANING

13.7 FUEL TANK PRESSURE SENSOR REPLACEMENT

13.8 CONTROL MODULE REFERENCES

14 REPAIR VERIFICATION

14.1 Perform the *DIAGNOSTIC REPAIR VERIFICATION* after completing the diagnostic procedure.

14.2 With the engine running, the EVAP canister vent solenoid valve open and the EVAP canister purge solenoid valve commanded to 100percent, the fuel tank vacuum should not increase to more than −15mmHg (−8inchesH2O).

P0449–Evaporative Emission (EVAP) Vent Solenoid Control Circuit

1 DIAGNOSTIC INSTRUCTIONS

1.1 Review *STRATEGY BASED DIAGNOSIS* for an overview of the diagnostic approach.

1.2 Perform the *DIAGNOSTIC SYSTEM CHECK* prior to using this diagnostic procedure.

2 DTC DESCRIPTOR

2.1 **DTC P0449**: Evaporative Emission (EVAP) Vent Solenoid Control Circuit

3 DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Battery Positive – Vent Supply	P0449	P0449	P0449	—	—
EVAP Vent Solenoid Control	P0449	P0449	P0449	P0449	—

4 CIRCUIT/SYSTEM DESCRIPTION

Battery voltage is supplied to the evaporative emissions (EVAP) vent solenoid valve. The engine control module (ECM) grounds the EVAP vent solenoid valve control circuit through an internal switch called a driver. The ECM monitors the status of the driver. A scan tool will display the commanded state of the EVAP vent solenoid valve as Venting or Not Venting.

5 CONDITIONS FOR RUNNING THE DTC

5.1 The system voltage is between 11–32V.

5.2 DTCP0449 runs continuously when the above conditions are met.

6 CONDITIONS FOR SETTING THE DTC

6.1 The ECM detects that the commanded state of the driver and the actual state of the control circuit do not match for a minimum of 0.25 s.

7 ACTION TAKEN WHEN THE DTC SETS

7.1 DTCP0449 is a TypeB DTC.

P0449–Evaporative Emission (EVAP) Vent Solenoid Control Circuit

8 CONDITIONS FOR CLEARING THE MIL/DTC

8.1 DTCP0449 is a TypeB DTC.

9 REFERENCE INFORMATION

9.1 SCHEMATIC REFERENCE

9.1.1 Engine controls schematics

9.2 CONNECTOR END VIEW REFERENCE

9.2.1 Component connector end views

9.3 ELECTRICAL INFORMATION REFERENCE

9.3.1 Circuit testing

9.3.2 Connector repairs

9.3.3 Testing for intermittent conditions and poor connections

9.3.4 Wiring repairs

9.4 DTC TYPE REFERENCE

9.4.1 Powertrain diagnostic trouble code (DTC) type definitions

9.5 SCAN TOOL REFERENCE

9.5.1 CONTROL MODULE REFERENCESfor scan tool information

10 CIRCUIT/SYSTEM VERIFICATION

10.1 Ignition ON, engine OFF, command the EVAP vent solenoid Not Venting - On and Venting - Off with a scan tool. You should hear the solenoid click when commanded ON and OFF.

10.2 Engine idling, command the EVAP vent solenoid ON and OFF with a scan tool while observing the following control circuit status parameters:

10.2.1 EVAP Vent Sol Ckt Short Gnd Test Status

10.2.2 EVAP Vent Sol Ckt Open Test Status

10.2.3 EVAP Vent Sol Ckt Short Volts Test Status

10.2.4 Each parameter should display OK or Not Run.

10.3 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.

11 CIRCUIT/SYSTEM TESTING

11.1 Ignition OFF, disconnect the harness connector at the Q13evaporative emissions vent solenoid valve.

11.2 Ignition OFF, verify that a test lamp illuminates between the B+ circuit terminalB or 2 and ground.

11.2.1 If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance. If the circuit tests normal and the B+ circuit fuse is open, test all components connected to the B+ circuit and replace as necessary.

11.3 Ignition ON, verify that a test lamp does not illuminate between the B+ circuit terminalB or 2 and the control circuit terminalA or 1.

11.3.1 If the test lamp illuminates, test the control circuit for a short to ground. If the circuit tests normal, replace the K20engine control module.

11.4 Remove the test lamp, and install a 3A fused jumper wire between the control circuit terminalA or 1 and the B+ circuit terminalB or 2. Command the vent solenoid ON with a scan tool. Verify the scan tool vent solenoid Ckt. Short Volts Test Status Parameter is Fault.

11.4.1 If not the specified value, test the control circuit for an open/high resistance. If the circuit tests normal, replace the K20engine control module.

11.5 If all circuits test normal, test or replace the Q13evaporative emissions vent solenoid valve.

12 COMPONENT TESTING

12.1 Ignition OFF, disconnect the harness connector at the Q13evaporative emission vent solenoid valve.

12.2 Test for 15–25Ω between the control terminalA or 1 and the B+ voltage terminalB or 2.

12.2.1 If not within the specified range, replace the Q13evaporative emission vent solenoid valve.

13 REPAIR INSTRUCTIONS

13.1 Perform the *DIAGNOSTIC REPAIR VERIFICATION* after completing the diagnostic procedure.

13.2 *EVAPORATIVE EMISSION CANISTER VENT SOLENOID VALVE REPLACEMENT*

13.3 *CONTROL MODULE REFERENCES* for ECM replacement, setup, and programming

P0455–Evaporative Emission (EVAP) Large Leak Detected

1 DIAGNOSTIC INSTRUCTIONS

1.1 Review *STRATEGY BASED DIAGNOSIS* for an overview of the diagnostic approach.

1.2 Perform the *DIAGNOSTIC SYSTEM CHECK* prior to using this diagnostic procedure.

2 DTC DESCRIPTOR

2.1 **DTC P0455:** Evaporative Emission (EVAP) System Large Leak Detected

3 CIRCUIT/SYSTEM DESCRIPTION

The ECM tests the Evaporative Emission (EVAP) System for a large leak or restrictions to the purge path in the EVAP system. When the enabling criteria has been met the ECM commands the EVAP canister vent solenoid valve OFF and the EVAP canister purge solenoid valve ON, allowing vacuum into the EVAP system. The ECM monitors the fuel tank pressure (FTP) sensor voltage to verify that the system is able to reach a predetermined level of vacuum within a set amount of time.

4 CONDITIONS FOR RUNNING THE DTC

4.1 DTCs P0068, P0606, P0106, P0107, P0108, P0112, P0133, P0116, P0117, P0118, P0120, P0122, P0123, P0125, P0220, P0222, P0443, P0449, P0452, P0453, P0454, P0502, P0503, P0722, P0723, P2227, P2227, P2229 are not set.

4.2 The ignition voltage is between 11–32volts.

4.3 The barometric pressure (BARO) is more than 70kPa.

4.4 The fuel level is between 10–90percent.

4.5 The engine coolant temperature (ECT) is less than 35°C (95°F).

4.6 The intake air temperature (IAT) is between 4–30°C (39–86°F).

4.7 DTCP0455 runs once per cold start when the above conditions are met.

5 CONDITIONS FOR SETTING THE DTC

5.1 The EVAP system is not able to achieve or maintain a calibrated level of vacuum within a set amount of time.

6 ACTION TAKEN WHEN THE DTC SETS

6.1 DTCP0455 is a TypeB DTC.

P0455–Evaporative Emission (EVAP) Large Leak Detected

7 CONDITIONS FOR CLEARING THE MIL/DTC

7.1 DTCP0455 is a TypeB DTC.

8 DIAGNOSTIC AIDS

8.1 Inspect for a loose, missing, damaged, or incorrect fuel fill cap.

8.2 Inspect for a damaged fuel filler neck seal surface.

8.3 A blockage or restriction in the EVAP purge solenoid valve, purge pipe, EVAP canister, or vapor pipe, can cause this DTC to set.

8.4 The EVAP system can be filled with smoke more quickly and completely by opening the system opposite the end where the smoke is injected. For example, when injecting smoke at the service port remove the fuel fill cap, or temporarily leave the vent open, until smoke is observed, then close the system and continue testing. If using a fuel cap adapter at the filler neck, use the *J-41413-VLV* service port vent tool at the service port to allow the system to fill faster.

8.5 To help locate intermittent leaks using the *J-41413-200* evaporative emissions system tester, move all EVAP components while observing smoke with the *GE-41413-SPT* high intensity white light.

8.6 Individual components can be isolated and tested using adapters in the *J-41413-300* cap and plug kit.

8.7 A condition may exist where a leak in the EVAP system only exists under a vacuum condition. This type of leak may be detected by using the scan tool Purge/Seal function to create a vacuum in the EVAP system and then observe the FTP parameter for vacuum decay.

9 REFERENCE INFORMATION

9.1 SCHEMATIC REFERENCE

9.1.1 Engine controls schematics

9.2 CONNECTOR END VIEW REFERENCE

9.2.1 Component connector end views

9.3 ELECTRICAL INFORMATION REFERENCE

9.3.1 Circuit testing

9.3.2 Connector repairs

9.3.3 Testing for intermittent conditions and poor connections

9.3.4 Wiring repairs

9.4 DTC TYPE REFERENCE

9.4.1 Powertrain diagnostic trouble code (DTC) type definitions

9.5 SCAN TOOL REFERENCE

9.5.1 CONTROL MODULE REFERENCESfor scan tool information

9.5.2 Special Tools

9.5.2.1 CH-48096 – EVAP Service Access Port Tool

9.5.2.2 GE-41415-50 – Fuel Tank Cap Adapter

9.5.2.3 GE-41413-SPT – High Intensity White Light

9.5.2.4 J-41413-200 – Evaporative Emissions System Tester (EEST)

9.5.2.5 J-41413-300 – EVAP Cap and Plug Kit

9.5.2.6 J-41413-311 – EVAP Plug

9.5.2.7 J-41413-VLV – EVAP Service Port Vent Tool

10 CIRCUIT/SYSTEM TESTING

IMPORTANT:

- Larger volume fuel tanks and/or those with lower fuel levels may require several minutes for the floating indicator to stabilize.

10.1 Disconnect the purge tube at the quick connector on the EVAP canister side of the purge solenoid valve and install the *CH-48096* service access port tool service port adapter tool. Connect the *J-41413-200* evaporative emissions system tester to the vehicle EVAP service port adapter.

10.2 Seal the system with a scan tool and use the flow meter on the J 41413-200, calibrated to 0.51 millimeter (0.020 inch) to determine that there is no leak in the EVAP system.

10.2.1 If a leak is detected, use the *J-41413-200* evaporative emissions system tester to apply smoke to the EVAP system at the service port or the purge tube until the leak is located using the *GE-41413-SPT* high intensity white light.

10.3 Connect the *J-41413-200* evaporative emissions system tester nitrogen/smoke hose to the *J-41413-311* EVAP Plug brass cone adapter. Disconnect the hose at the fuel cap end of the *GE-41415-50* fuel tank cap adapter. Connect the *J-41413-311* EVAP Plug to the disconnected hose on the *GE-41415-50* fuel tank cap adapter. Install the *GE-4141550* fuel tank cap adapter filler neck end only to the vehicle.

10.4 Engine idling, command Purge/Seal function to seal the system with a scan tool.

10.5 Command the EVAP canister purge solenoid valve to 30 percent.

10.6 The vacuum/pressure gauge on the *J-41413-200* evaporative emissions system tester and the FTP parameter on the scan tool should display vacuum.

10.6.1 If the vacuum/pressure gauge shows vacuum, but the FTP parameter does not show vacuum, replace the FTP sensor.

10.6.2 If neither the FTP parameter nor the vacuum/pressure gauge shows vacuum, repair the restriction in the purge path.

10.7 Verify that the vacuum increases to the abort limit on the scan tool, greater than 3.2 volts, and the values are similar between the scan tool and the vacuum/pressure gauge on the *J-41413-200* evaporative emissions system tester.

10.7.1 If the values are not similar, or the voltage did not reach 3.2 volts, replace the FTP sensor.

11 REPAIR INSTRUCTIONS

11.1 Perform the *DIAGNOSTIC REPAIR VERIFICATION*after completing the diagnostic procedure.

11.2 Fuel Tank Pressure Sensor Replacement

P0496–Evaporative Emission (EVAP) System During Non-Purge

1 DIAGNOSTIC INSTRUCTIONS

1.1 Review *STRATEGY BASED DIAGNOSIS* for an overview of the diagnostic approach.

1.2 Perform the *DIAGNOSTIC SYSTEM CHECK* prior to using this diagnostic procedure.

2 DTC DESCRIPTOR

2.1 **DTC P0496:** Evaporative Emission System Flow during Non-Purge

3 CIRCUIT/SYSTEM DESCRIPTION

This DTC tests for undesired intake manifold vacuum flow to the evaporative emission (EVAP) system. The engine control module (ECM) seals the EVAP system by commanding the EVAP canister purge solenoid valve OFF and the EVAP canister vent solenoid valve ON. The ECM monitors the fuel tank pressure (FTP) sensor to determine if a vacuum is being drawn on the EVAP system. If vacuum in the EVAP system is more than a predetermined value within a predetermined time, this DTC sets.

FTP Sensor Signal Voltage	Fuel Tank Pressure
High, Approximately 1.5 Volts or More	Negative Pressure/Vacuum
Low, Approximately 1.5 Volts or Less	Positive Pressure

The following table illustrates the relationship between the ON and OFF states, and the Open or Closed states of the EVAP canister purge and vent solenoid valves.

Control Module Command	EVAP Canister Purge Solenoid Valve	EVAP Canister Vent Solenoid Valve
ON	Open	Closed
OFF	Closed	Open

4 CONDITIONS FOR RUNNING THE DTC

4.1 DTCs P0106, P0107, P0108, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0220, P0222, P0223, P0442, P0443, P0446, P0449, P0451, P0452, P0453, P0454, P0464, P0608, P0609, P0641, P0651, P1516, P2101, P2119, P2120, P2122, P2123, P2125, P2127, P2128, P2135, P2138 are not set.

4.2 The ignition voltage is between 11–32volts.

4.3 The barometric pressure (BARO) is more than 70kPa.

4.4 The fuel level is between 10–90percent.

P0496–Evaporative Emission (EVAP) System During Non-Purge

4.5 The engine coolant temperature (ECT) is less than 35°C (95°F).

4.6 The intake air temperature (IAT) is between 4–30°C (39–86°F).

4.7 DTCP0496 runs once per cold start when the above conditions are met for up to 16 min.

5 CONDITIONS FOR SETTING THE DTC

5.1 The ECM detects greater than 10inchH2O (2.49kPa) vacuum for 5seconds during a non-purge condition.

6 ACTION TAKEN WHEN THE DTC SETS

6.1 DTCP0496 is a TypeB DTC.

7 CONDITIONS FOR CLEARING THE MIL/DTC

7.1 DTCP0496 is a TypeB DTC.

8 DIAGNOSTIC AIDS

8.1 Observe the freeze frame/failure records vehicle mileage since the diagnostic test last failed may help determine how often the condition occurs that caused the DTC to set. This may assist in diagnosing the condition.

8.2 The EVAP system tests run when engine is first started and meets the conditions for running the DTC. An intermittent condition could be caused by an improperly installed or damaged EVAP canister purge solenoid valve, or by a temporary blockage or restriction in the EVAP canister purge solenoid valve or the vent side of the EVAP system.

9 REFERENCE INFORMATION

9.1 SCHEMATIC REFERENCE

9.1.1 Engine controls schematics

9.2 CONNECTOR END VIEW REFERENCE

9.2.1 Component connector end views

9.3 ELECTRICAL INFORMATION REFERENCE

9.3.1 Circuit testing

9.3.2 Connector repairs

9.3.3 Testing for intermittent conditions and poor connections

9.3.4 Wiring repairs

9.4 DTC TYPE REFERENCE

9.4.1 Powertrain diagnostic trouble code (DTC) type definitions

9.5 SCAN TOOL REFERENCE

9.5.1 CONTROL MODULE REFERENCESfor scan tool information

10 CIRCUIT/SYSTEM VERIFICATION

10.1 Ignition ON, engine OFF, observe the Fuel Tank Pressure sensor parameter with a scan tool. The reading should not display negative inches of H2O.

10.1.1 If not the specified value, remove the gas cap. If vacuum is gone inspect and repair any restriction or blockage in the vent side of the EVAP system.

10.2 Reinstall the gas cap then seal the EVAP system using the Purge/Seal function with a scan tool.

10.3 Start the engine.

10.4 Observe the FTP sensor with a scan tool. The Fuel Tank Pressure Sensor parameter should be less than 1.7volts after 90seconds.

10.4.1 If the Fuel Tank Pressure Sensor parameter is greater than the specified range, replace the EVAP canister purge solenoid valve.

11 REPAIR INSTRUCTIONS

11.1 Perform the *DIAGNOSTIC REPAIR VERIFICATION* after completing the diagnostic procedure.

11.2 Evaporative Emission Canister Purge Solenoid Valve Replacement

P0506 or P0507 – Idle Speed Low and Idle Speed High

1 DIAGNOSTIC INSTRUCTIONS

1.1 Review *STRATEGY BASED DIAGNOSIS* for an overview of the diagnostic approach.

1.2 Perform the *DIAGNOSTIC SYSTEM CHECK* prior to using this diagnostic procedure.

2 DTC DESCRIPTOR

2.1 **DTC P0506:** Idle Speed Low

2.2 **DTC P0507:** Idle Speed High

3 CIRCUIT/SYSTEM DESCRIPTION

The throttle actuator control (TAC) motor is controlled by the engine control module (ECM). The DC motor located in the throttle body drives the throttle blade. In order to decrease idle speed, along with spark and fuel delivery changes the ECM commands the throttle closed reducing air flow into the engine and the idle speed decreases. In order to increase idle speed, the ECM commands the throttle plate open allowing more air to pass the throttle plate.

4 CONDITIONS FOR RUNNING THE DTC

4.1 DTCs P0068, P0101, P0102, P0103, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0128, P0171, P0172, P0174, P0175, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0220, P0221, P0222, P0223, P0300–P0308, P0351–P0358, P0461– P0463, P0496, P0502, P0503, P0606, P0722, P0723, P0806–P0808, P1516, P2066–P2068, P2101, P2135, P2227–P2230 are not set.

4.2 The engine is operating for at least 60s.

4.3 The engine is idling for greater than 10s.

4.4 The barometric pressure (BARO) is greater than 70kPa (11psi).

4.5 The engine coolant temperature (ECT) is greater than 60°C (140°F).

4.6 The intake air temperature (IAT) is warmer than −20°C (−4°F).

4.7 The vehicle speed is less than 3km/h (2mph).

4.8 The commanded engine speed is steady within 25RPM.

4.9 The transmission is not changing gears.

4.10 The torque converter clutch (TCC) is not changing states.

4.11 The manual transmission clutch pedal position is between 20–88percent - If equipped.

4.12 The manual transmission clutch is not depressed - If equipped.

4.13 The power take-off (PTO) is not active - If equipped.

4.14 The transfer case is not in 4WD Low - If equipped.

4.15 A scan tool output control is not active.

4.16 The system voltage is between11–18V.

4.17 DTC P0506 and P0507 run continuously when the above conditions are met for greater than 10 s.

5 CONDITIONS FOR SETTING THE DTC

5.1 P0506

5.1.1 The actual idle speed is approximately 90 RPM lower than the desired idle speed.

5.2 P0507

5.2.1 The actual idle speed is approximately 180 RPM greater than the desired idle speed.

6 ACTION TAKEN WHEN THE DTC SETS

6.1 DTCsP0506 and P0507 are TypeB DTCs.

7 CONDITIONS FOR CLEARING THE MIL/DTC

7.1 DTCsP0506 and P0507 are TypeB DTCs.

8 DIAGNOSTIC AIDS

8.1 A stalling condition can cause DTCP0506 to set.

8.2 An intermittent vehicle speed sensor (VSS) signal can cause DTCP0507 to set.

8.3 An intermittent clutch pedal position sensor signal, if equipped, can cause DTCP0506 to set.

9 REFERENCE INFORMATION

9.1 SCHEMATIC REFERENCE

9.1.1 Engine controls schematics

9.2 CONNECTOR END VIEW REFERENCE

9.2.1 Component connector end views

9.3 ELECTRICAL INFORMATION REFERENCE

9.3.1 Circuit testing

9.3.2 Connector repairs

9.3.3 Testing for intermittent conditions and poor connections

9.3.4 Wiring repairs

9.4 DTC TYPE REFERENCE

9.4.1 Powertrain diagnostic trouble code (DTC) type definitions

9.5 SCAN TOOL REFERENCE

9.5.1 CONTROL MODULE REFERENCESfor scan tool information

10 CIRCUIT/SYSTEM VERIFICATION

10.1 Ignition ON, observe the DTC information with a scan tool. Verify there are no other DTCs set.

10.1.1 If a DTC is set, refer to Diagnostic Trouble Code (DTC) List - Vehicle for further diagnosis.

10.1.2 **NOTE:** The engine must run for greater than 60 s, and then idle at a steady state for an additional 10s before comparing the actual and desired engine speed parameters.

10.2 Idle the engine at the normal operating temperature. Compare the Desired Idle Speed to the actual Engine Speed with a scan tool. The actual Engine Speed should not be less than 100RPM of the Desired Idle Speed or 200RPM greater than the Desired Idle Speed.

10.3 Allow the engine to idle within the Conditions for Running the DTC. DTCP0506 or P0507 should not set.

10.4 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.

11 CIRCUIT/SYSTEM TESTING

11.1 P0506

11.1.1 Verify none of the following conditions exist:

11.1.1.1 Excess deposits in the Q38 throttle body.

11.1.1.2 Restricted exhaust

11.1.2 Mechanical conditions that limits engine speed

11.1.3 Parasitic load on the engine—For example, a transmission condition, a belt driven accessory condition.

11.1.4 If a condition is found, repair as necessary.

11.2 P0507

11.2.1 Vacuum leaks

11.2.2 A throttle valve that does not close correctly

11.2.3 Verify the correct operation of the crankcase ventilation system. Inspect for the following conditions:

11.2.3.1 The routing of the positive crankcase ventilation (PCV) system

11.2.3.2 Vacuum leaks in the PCV system

11.2.3.3 If a condition is found, repair as necessary.

12 REPAIR INSTRUCTIONS

12.1 Perform the *DIAGNOSTIC REPAIR VERIFICATION* after completing the diagnostic procedure.

P0522 or P0523 – Engine Oil Pressure (EOP) Sensor Circuit Low/High Voltage

1 DIAGNOSTIC INSTRUCTIONS

1.1 Review *STRATEGY BASED DIAGNOSIS* for an overview of the diagnostic approach.

1.2 Perform the *DIAGNOSTIC SYSTEM CHECK* prior to using this diagnostic procedure.

2 DTC DESCRIPTOR

2.1 **DTC P0522:** Engine Oil Pressure (EOP) Sensor Circuit Low Voltage

2.2 **DTC P0523:** Engine Oil Pressure (EOP) Sensor Circuit High Voltage

3 DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Engine Oil Pressure 5 Volt Reference	P0522	*	P0522	P0523	—
Engine Oil Pressure Signal	P0522	*	P0522	P0523	—
Low Reference	—	*	P0523	—	—
*Engine Oil Pressure Indicator Malfunction					

4 CIRCUIT / SYSTEM DESCRIPTION

The engine oil pressure (EOP) sensor changes voltage based on the engine oil pressure. The EOP sensor is a 3-wire sensor comprising of the signal circuit, the low reference circuit and the 5-volt reference circuit. The engine control module (ECM) supplies 5 volts to the EOP sensor via the 5-volt reference circuit and provides ground via the EOP low reference circuit. The ECM monitors the signal circuit of the EOP sensor to determine the EOP sensor voltage is within the normal operating range of approximately 1–4 volts. When the engine oil pressure is high, the EOP sensor voltage is high and the ECM senses a high signal voltage. When the engine oil pressure is low, the EOP sensor voltage is low and the ECM senses a low signal voltage. The ECM sends the EOP information to the instrument panel cluster (IPC) via the serial data circuit.

5 CONDITIONS FOR RUNNING THE DTC

5.1 The engine is running.

P0522 or P0523 – Engine Oil Pressure (EOP) Sensor Circuit Low/High Voltage

6 CONDITIONS FOR SETTING THE DTC

6.1 P0522

6.1.1 The ECM detects that the EOP sensor signal circuit is less than 0.1 volt.

6.1.2 The above condition is present for greater than 10 seconds.

6.2 P0523

6.2.1 The ECM detects that the EOP sensor signal circuit is greater than 4.4 volts.

6.2.2 The above condition is present for greater than 10 seconds.

7 ACTION TAKEN WHEN THE DTC SETS

7.1 The ECM records the operating conditions at the time the diagnostics test fails. The ECM displays this information in the Failure Records on the scan tool.

7.2 The IPC illuminates the EOP indicator.

8 CONDITIONS FOR CLEARING THE DTC

8.1 The DTC becomes history when the conditions for setting the DTC are no longer present.

8.2 The history DTC clears after 40 malfunction-free warm-up cycles.

9 REFERENCE INFORMATION

9.1 SCHEMATIC REFERENCE

9.1.1 Engine controls schematics

9.2 CONNECTOR END VIEW REFERENCE

9.2.1 Component connector end views

9.3 ELECTRICAL INFORMATION REFERENCE

9.3.1 Circuit testing

9.3.2 Connector repairs

9.3.3 Testing for intermittent conditions and poor connections

9.3.4 Wiring repairs

9.4 DTC TYPE REFERENCE

P0522 or P0523 – Engine Oil Pressure (EOP) Sensor Circuit Low/High Voltage

9.4.1 Powertrain diagnostic trouble code (DTC) type definitions

9.5 SCAN TOOL REFERENCE

9.5.1 Control module references for scan tool information.

10 CIRCUIT/SYSTEM VERIFICATION

10.1 Engine running, observe the scan tool Engine Oil Pressure Sensor parameter. The reading should be between 41– 448 kPa (6–65 psi).

10.2 Verify the engine oil pressure.

11 CIRCUIT / SYSTEM TESTING

11.1 Ignition OFF, disconnect the harness connector at the engine oil pressure (EOP) sensor.

11.2 Ignition OFF, test for less than 1.0 Ω between the low reference terminal 3 and ground:

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

11.3 Ignition ON, test for 4.8–5.2 volts between the 5-volt reference terminal 2 and ground:

11.3.1 If less than the specified range, test the 5-volt reference circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the ECM.

11.3.2 If greater than the specified range, test the 5-volt reference circuit for a short to voltage. If the circuit tests normal, replace the ECM.

11.4 Verify the scan tool Engine Oil Pressure Sensor parameter is less than 8 kPa (1.2 psi).

11.4.1 If greater than the specified range, test the signal circuit terminal listed below for a short to voltage or an open/high resistance. If the circuit tests normal, replace the ECM.

11.5 Install a 3 A fused jumper wire between the signal circuit terminal and the 5-volt reference circuit terminal listed below. Verify the scan tool Engine Oil Pressure Sensor parameter is greater than 550 kPa (80 psi).

11.5.1 Signal Terminal 1

11.5.2 5-Volt Reference Terminal 2

11.5.3 If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the ECM.

11.6 If all circuits test normal, test or replace the EOP sensor.

P0522 or P0523 – Engine Oil Pressure (EOP) Sensor Circuit Low/High Voltage

12 REPAIR INSTRUCTIONS

12.1 Perform the *DIAGNOSTIC REPAIR VERIFICATION*after completing the diagnostic procedure.

12.2 Engine Oil Pressure Sensor and/or Switch Replacement

12.3 Control Module References for ECM replacement, setup, and programming

P0601, P0602, P0603, P0604, P0606, P0607, P060D, P062F, P2610 - ECM

1 DIAGNOSTIC INSTRUCTIONS

1.1 Review *STRATEGY BASED DIAGNOSIS* for an overview of the diagnostic approach.

1.2 Perform the *DIAGNOSTIC SYSTEM CHECK* prior to using this diagnostic procedure.

2 DTC DESCRIPTOR

2.1 **DTC P0601:** Control Module Read Only Memory Performance

2.2 **DTC P0602:** Control Module Not Programmed

2.3 **DTC P0603:** Control Module Long Term Memory Reset

2.4 **DTC P0604:** Control Module Random Access Memory Performance

2.5 **DTC P0606:** Control Module Processor Performance

2.6 **DTC P0607:** Control Module Performance

2.7 **DTC P060D:** Control Module Accelerator Pedal (APP) Position System Circuitry Performance

2.8 **DTC P062F:** Control Module Long Term Memory Performance

2.9 **DTC P2610:** Control Module Ignition Off Timer Performance

3 CIRCUIT/SYSTEM DESCRIPTION

This diagnostic applies to internal microprocessor integrity conditions within the engine control module (ECM) and the throttle actuator control (TAC) system. This diagnostic also addresses if the ECM is not programmed.

The ECM monitors its ability to read and write to the memory. It also monitors a timing function. The ECM and the TAC processors are used to monitor the TAC system data. Both processors monitor the other processors data to verify that the indicated APP calculation is correct. The ECM performs an intrusive test in order to confirm that the APP signals are not shorted together. The ECM accomplishes this by pulling the APP sensor 2 low momentarily and looking for sensor 1 to also be pulled low.

4 CONDITIONS FOR RUNNING THE DTCS

4.1 P0601, P0604

4.1.1 The ignition switch is in Run or Crank.

4.1.2 These DTCs run continuously when the above condition is met.

4.2 P0602, P0603, P062F

4.2.1 The ignition switch is in Run or Crank.

4.2.2 These DTCs run once per ignition cycle.

4.3 P0606, P0607, P060D

4.3.1 The ignition switch is in Run or Crank.

4.3.2 The system voltage is more than 6.0 V.

4.3.3 Reduced Engine Power is not active.

4.3.4 These DTCs run continuously when the above conditions are met.

4.4 P2610

4.4.1 The intake air temperature is between −40 to +125°C (−40 to +257°F).

4.4.2 DTC P2610 runs once per ignition cycle on ECM power down.

5 CONDITIONS FOR SETTING THE DTCS

5.1 The ECM detects an internal failure or incomplete programming for more than 10 s.

6 ACTIONS TAKEN WHEN THE DTC SETS

6.1 DTCs P0601, P0602, P0603, P0604, P0606, P060D, and P062F are Type A DTCs.

6.2 DTC P0607 is a Type C DTC.

6.3 DTC P2610 is a Type B DTC.

7 CONDITIONS FOR CLEARING THE MIL/DTC

7.1 DTCs P0601, P0602, P0603, P0604, P0606, P060D, and P062F are Type A DTCs.

7.2 DTC P0607 is a Type C DTC.

7.3 DTC P2610 is a Type B DTC.

P0601, P0602, P0603, P0604, P0606, P0607, P060D, P062F, P2610 - ECM

8 DIAGNOSTIC AIDS

Low voltage or a momentary loss of power or ground to the ECM may cause a DTC to set.

8.1 Verify that the battery cables are clean and tight, and the battery is fully charged.

8.2 Verify the ECM ground circuits do not have an open or high resistance.

8.3 Verify the ECM power circuits do not have an open, short to ground, or high resistance.

9 REFERENCE INFORMATION

9.1 SCHEMATIC REFERENCE

9.1.1 Engine controls schematics

9.2 CONNECTOR END VIEW REFERENCE

9.2.1 Component connector end views

9.3 ELECTRICAL INFORMATION REFERENCE

9.3.1 Circuit testing

9.3.2 Connector repairs

9.3.3 Testing for intermittent conditions and poor connections

9.3.4 Wiring repairs

9.4 DTC TYPE REFERENCE

9.4.1 Powertrain diagnostic trouble code (DTC) type definitions

9.5 SCAN TOOL REFERENCE

9.5.1 CONTROL MODULE REFERENCESfor scan tool information

10 CIRCUIT/SYSTEM VERIFICATION

10.1 Observe the DTC information with a scan tool. DTC P0601, P0602, P0603, P0604, P0606, P0607, P060D, P062F, or P2610 should not set.

10.2 Operate the vehicle within the conditions for running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the freeze frame/failure records data.

P0601, P0602, P0603, P0604, P0606, P0607, P060D, P062F, P2610 - ECM

11 CIRCUIT/SYSTEM TESTING

11.1 Ignition ON, clear the DTC information with a scan tool. Observe the scan tool DTC information.

11.1.1 If DTCP0602 is set, reprogram the K20ECM. Refer to *CONTROL MODULE REFERENCES* for K20ECM replacement, setup, and programming. If DTCP0602 resets, replace the K20ECM.

11.2 Observe the DTC information with a scan tool. Verify that DTC P0601, P0603, P0604, P0605, P0606, P0607, P060D, P062F, or P2610 does not set.

11.2.1 If a DTC failed this ignition, replace the K20ECM.

12 REPAIR INSTRUCTIONS

12.1 Perform the *DIAGNOSTIC REPAIR VERIFICATION* after completing the diagnostic procedure.

12.2 Control Module References for ECM replacement, programming and setup

P0641 –5V Reference 1 Circuit
P0651 – 5V Reference 2 Circuit

1 DIAGNOSTIC INSTRUCTIONS

1.1 Review *STRATEGY BASED DIAGNOSIS* for an overview of the diagnostic approach.

1.2 Perform the *DIAGNOSTIC SYSTEM CHECK* prior to using this diagnostic procedure.

2 DTC DESCRIPTOR

2.1 **DTC P0641**: 5 V Reference 1 Circuit

2.2 **DTC P0651**: 5 V Reference 2 Circuit

3 CIRCUIT/SYSTEM DESCRIPTION

The engine control module (ECM) has 2internal 5V reference circuits. Each internal reference circuit provides external 5V reference circuits for more than one sensor. A short to ground or short to voltage on one external 5V reference circuit can affect all the components connected to the same internal 5V reference circuit.

4 CONDITIONS FOR RUNNING THE DTC

4.1 Reduced engine power is not active.

4.2 The ignition voltage is greater than 6 V.

4.3 DTCs P0641 and P0651 run continuously when the above conditions are met

4.4 The ECM detects a voltage out of tolerance condition on the 5 V reference 1 or 2 circuit for more than 0.5 s.

5 ACTION TAKEN WHEN THE DTC SETS

5.1 DTCs P0641 and P0651 are Type A DTCs.

6 CONDITIONS FOR CLEARING THE MIL/DTC

6.1 DTCs P0641 and P0651 are Type A DTCs.

7 DIAGNOSTIC AIDS

7.1 The 5V reference1 circuit provides 5V to the following sensors:

7.2 Manifold absolute pressure (MAP) sensor

7.3 Fuel tank pressure (FTP) sensor

7.4 Accelerator pedal position (APP) sensor 2

7.5 Engine oil pressure (EOP) switch

7.6 Air conditioning (A/C) refrigerant pressure sensor

7.7 Camshaft position sensor

7.8 The 5V reference2 circuit provides 5V to the following sensors:

7.8.1 APP sensor 1

7.8.2 Throttle position sensor 1 and 2

7.8.3 Crankshaft position sensor

It may be possible to locate the fault by disconnecting one component at a time from the affected 5 V reference circuit while viewing the 5 V Reference circuit status parameter on the scan tool. The scan tool parameter will change from Fault to OK when the source of the fault is disconnected. If all 5 V reference components have been disconnected and a fault is still indicated, the fault may exist in the wiring harness.

8 REFERENCE INFORMATION

8.1 SCHEMATIC REFERENCE

8.1.1 Engine controls schematics

8.2 CONNECTOR END VIEW REFERENCE

8.2.1 Component connector end views

8.3 ELECTRICAL INFORMATION REFERENCE

8.3.1 Circuit testing

8.3.2 Connector repairs

8.3.3 Testing for intermittent conditions and poor connections

8.3.4 Wiring repairs

8.4 DTC TYPE REFERENCE

8.4.1 Powertrain diagnostic trouble code (DTC) type definitions

8.5 SCAN TOOL REFERENCE

8.5.1 CONTROL MODULE REFERENCESfor scan tool information

9 CIRCUIT/SYSTEM VERIFICATION

9.1 Observe the scan tool 5 V reference 1 circuit status and the 5 V reference 2 circuit status parameters. Verify the parameters display OK.

9.2 Ignition ON, observe the DTC information with a scan tool. DTC P0641 and P0651 should not set.

9.3 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.

10 CIRCUIT/SYSTEM TESTING

NOTE:ADDITIONAL DTCS MAY SET WHEN DISCONNECTING COMPONENTS.

10.1 Ignition ON, disconnect the harness connector of all the sensors for the applicable DTC. Refer to Diagnostic Aids for the appropriate sensors.

10.2 Ignition ON, measure for 4.8–5.2V between one of the 5V reference circuits and ground.

10.2.1 If less than the specified range, test for a short to ground on the 5V reference circuit of each affected component. If all circuits test normal, replace the K20ECM.

10.2.2 If greater than the specified range, test for a short to voltage on the 5V reference circuit of each affected component. If all circuits test normal, replace the K20ECM.

10.2.3 **NOTE:** A **s**hort to voltage on the signal circuit of certain components may cause this dtc to set.

10.3 Connect each component associated with the 5V reference circuit, one at a time, while monitoring the appropriate scan tool 5V Reference Voltage parameter. Verify the voltage remains between 4.8–5.2V.

10.3.1 If not the specified range when a component is connected, test the signal circuit for a short to voltage. If the circuit tests normal, replace the appropriate component.

11 REPAIR INSTRUCTIONS

11.1 Perform the *DIAGNOSTIC REPAIR VERIFICATION* after completing the diagnostic procedure.

11.2 Accelerator pedal position sensor replacement

11.3 Air conditioning (A/C) refrigerant pressure sensor replacement

11.4 Camshaft position sensor replacement

11.5 Crankshaft position sensor replacement

11.6 Engine oil pressure sensor and/or switch replacement

11.7 Fuel tank pressure sensor replacement

11.8 Manifold absolute pressure sensor replacement

11.9 Throttle body assembly replacement

11.10 CONTROL MODULE REFERENCES for ECM replacement, setup, and programming

P0685, P0690, P1682 –Engine Controls / Ignition Circuit

1 DIAGNOSTIC INSTRUCTIONS

1.1 **Review *STRATEGY BASED DIAGNOSIS* for an overview of the diagnostic approach.**

1.2 **Perform the *DIAGNOSTIC SYSTEM CHECK* prior to using this diagnostic procedure.**

2 DTC DESCRIPTOR

2.1 **DTC P0685: Engine Controls Ignition Relay Control Circuit**

2.2 **DTC P0690: Engine Controls Ignition Relay Feedback Circuit High Voltage**

2.3 **DTC P1682: Ignition 1 Switch Circuit 2**

3 DIAGNOSTIC FAULT INFORMATION

Powertrain Relay Circuit	Short to Ground	Open/High Resistance	Short to Voltage
Relay Coil Supply Voltage	P0685	P0685	—
Relay Control Circuit	P0685	P0685, P1682	P0685, P0690, P162
Relay Feedback Circuit	—	—	P0690

Run / Crank Relay Circuit	Short to Ground	Open/High Resistance	Short to Voltage
Ignition 1 Signal	1	1	2
1. Will cause a No Crank condition. 2. Engine continues to operate with ignition OFF.			

P0685, P0690, P1682 –Engine Controls / Ignition Circuit

4 TYPICAL SCAN TOOL DATA

4.1 EC IGNITION RELAY CONTROL CKT OPEN, SHORT GND, SHORT VOLTS TEST STATUS

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Component commanded OFF			
Parameter Normal Range: The following illustrates the normal parameter state with no circuit conditions:			
* Component OFF – OK for Open/Short Gnd test and Not Run for Short to Volts test * Component ON – Not Run for Open/Short Gnd test and OK for Short to Volts test			
Battery Voltage	—	Fault	—
EC Ignition Relay Control Circuit	Fault	Fault	Not Run
Operating Conditions: Component commanded ON ***Parameter Normal Range:*** The following illustrates the normal parameter state with no circuit conditions: * Component OFF – OK for Open/Short Gnd test and Not Run for Short to Volts test * Component ON – Not Run for Open/Short Gnd test and OK for Short to Volts test			
Battery Voltage	—	Not Run	—
EC Ignition Relay Control Circuit	Not Run	Not Run	Fault

5 CIRCUIT/SYSTEM DESCRIPTION

There are 2ignition voltage circuits supplied to the engine control module(ECM). One is supplied by the powertrain relay and the other is supplied by the Run/Crank relay. The ECM monitors and compares the ignition voltage supplied by the 2relays.

6 CONDITIONS FOR RUNNING THE DTC

6.1 P0685

6.1.1 The ignition is ON.

6.1.2 Ignition 1 signal voltage is between 11–32 V.

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

6.2 P0690

6.2.1 P0685 is not set.

6.2.2 The powertrain relay is commanded on.

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

6.3 P1682

6.3.1 The powertrain relay is commanded on.

6.3.2 Ignition 1 Signal voltage is greater than 6 V.

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

7 CONDITIONS FOR SETTING THE DTC

7.1 P0685

7.1.1 The ECM detects that the commanded state of the driver and the actual state of the control circuit do not match for greater than 2 s.

7.2 P0690

7.2.1 The ECM detects the engine controls ignition relay feedback circuit is greater than 2 V when the relay is commanded OFF.

7.2.2 The ECM detects the engine controls ignition relay feedback circuit is greater than 18 V when the relay is commanded ON.

7.2.3 The condition is present for greater than 2 s.

7.3 P1682

7.3.1 The ECM detects that the voltage level difference is greater than 3 V between the 2 ignition voltage circuits for less than 1 s.

8 ACTION TAKEN WHEN THE DTC SETS

8.1 DTCsP0685 and P0690 are TypeBDTCs.

8.2 DTCP1682 is a TypeADTC.

9 CONDITIONS FOR CLEARING THE DTC

9.1 DTCs P0685 and P0690 are Type B DTCs.

9.2 DTCs P0685 and P0690 are Type B DTCs.

9.3 DTC P1682 is a Type A DTC.

P0685, P0690, P1682 –Engine Controls / Ignition Circuit

10 REFERENCE INFORMATION

10.1 SCHEMATIC REFERENCE

10.1.1 Engine controls schematics

10.2 CONNECTOR END VIEW REFERENCE

10.2.1 Component connector end views

10.3 ELECTRICAL INFORMATION REFERENCE

10.3.1 Circuit testing

10.3.2 Connector repairs

10.3.3 Testing for intermittent conditions and poor connections

10.3.4 Wiring repairs

10.4 DTC TYPE REFERENCE

10.4.1 Powertrain diagnostic trouble code (DTC) type definitions

10.5 SCAN TOOL REFERENCE

10.5.1 CONTROL MODULE REFERENCESfor scan tool information

11 CIRCUIT/SYSTEM VERIFICATION

NOTE: A short to voltage on other components may cause DTC p0690 to set. If any other DTC is set, diagnose that DTC first. If you were sent here from engine cranks but does not run, proceed to circuit/system testing.

11.1 Ignition ON, command the EC Ignition Relay ON and OFF with a scan tool while observing the following EC Ignition Relay control circuit status parameters:

11.1.1 EC Ignition Relay Control Ckt Short Gnd Test Status

11.1.2 EC Ignition Relay Control Ckt Open Test Status

11.1.3 EC Ignition Relay Control Ckt Short Volts Test Status

11.1.4 Each parameter should display OK or Not Run in each commanded state.

11.2 Ignition ON, view the DTC information with a scan tool. DTC P0685, P0690, or P1682 should not set.

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

P0685, P0690, P1682 –Engine Controls / Ignition Circuit

12 CIRCUIT/SYSTEM TESTING

NOTE:You must perform the circuit/system verification before proceeding with circuit/system testing unless sent here from engine cranks but does not run.

12.1 Ignition OFF, disconnect the KR75 powertrain relay.

12.2 Verify a test lamp illuminates between ground and the relay circuit terminals listed below:

12.2.1 Terminal 85

12.2.2 Terminal 30

12.2.3 If the test lamp does not illuminate, test the relay battery voltage circuit for an open/high resistance.

NOTE: The ignition voltage circuit is between the powertrain relay and the ECM. The ignition voltage circuit is a feedback circuit. High resistance in the circuit/underhood fuse block for either the powertrain relay or the run/crank relay can cause DTC P1682 to set.

12.3 Ignition ON, verify that a test lamp does not illuminate between the ignition voltage circuit terminal 87 and ground.

12.3.1 If the test lamp illuminates, test the ignition voltage circuit for a short to voltage.

12.4 Connect a 20A fused jumper wire between the relay switch B+ circuit terminal30 and the relay switch ignition voltage circuit terminal87.

12.5 Ignition ON, observe the scan tool EC Ignition Relay Feedback Signal parameter. The ECM should communicate, and the parameter should display B+.

12.5.1 If not the specified value, or the ECM does not communicate, test the ignition voltage circuit between the powertrain relay and the ECM for a short to ground or for an open/high resistance. If the circuit/connections test normal, replace the K20ECM.

12.6 Ignition OFF, connect a DMM set to the diode setting between control circuit terminal86 and ground. Verify the DMM displays OL.

12.6.1 If not the specified value, test the control circuit for a short to ground. If the circuit tests normal, replace the K20ECM.

12.7 Ignition ON, verify the DMM displays less than 1V.

12.7.1 If not the specified range, test the control circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the K20ECM.

12.8 If all circuits test normal, replace the KR75 powertrain relay.

13 COMPONENT TESTING

NOTE: Depending on the application, the relay coil resistance will be within one of the following ranges.

P0685, P0690, P1682 –Engine Controls / Ignition Circuit

13.1 Test for one of the following resistance specifications between terminals 85 and 86 of the KR75 powertrain relay:

13.1.1 range, replace the KR75powertrain relay.

13.1.2 70–110Ω

13.1.3 200–250Ω

13.2 If not within the specified Test for infinite resistance between the following terminals of the KR75powertrain relay:

13.2.1 30 and 86

13.2.2 30 and 87

13.2.3 30 and 85

13.2.4 85 and 87

13.2.5 If not the specified value, replace the KR75powertrain relay.

13.3 Install a 20 A fused jumper wire between relay terminal85 and 12V. Install a jumper wire between relay terminal86 and ground. Test for less than 2Ω between terminals30 and 87.

13.3.1 If greater than the specified range, replace the KR75 powertrain relay.

14 REPAIR INSTRUCTIONS

14.1 Perform the *DIAGNOSTIC REPAIR VERIFICATION* after completing the diagnostic procedure.

14.2 *RELAY REPLACEMENT*

14.3 *CONTROL MODULE REFERENCES* for ECM replacement, setup, and programming

P1258 – Engine Coolant Over-temperature – Protection Mode Active

1 DIAGNOSTIC INSTRUCTIONS

1.1 Review *STRATEGY BASED DIAGNOSIS* for an overview of the diagnostic approach.

1.2 Perform the *DIAGNOSTIC SYSTEM CHECK*prior to using this diagnostic procedure.

2 DTC DESCRIPTOR

2.1 **DTC P1258**: Engine Coolant Over-temperature – Protection Mode Active

3 CIRCUIT/SYSTEM DESCRIPTION

The engine control module (ECM) uses the engine coolant temperature (ECT) sensor to monitor the engine for an over-temperature condition. This condition occurs when the coolant temperature is above a calibrated value for a calibrated length of time. The ECM will disable half of the cylinders by turning OFF the fuel injectors. By disabling half of the cylinders, the ECM is able to reduce the temperature of the coolant.

4 CONDITIONS FOR RUNNING THE DTC

4.1 The engine is operating.

5 CONDITIONS FOR SETTING THE DTC

5.1 The coolant temperature is warmer than 129°C (264°F) for greater than 10 seconds.

6 ACTION TAKEN WHEN THE DTC SETS

6.1 DTC P1258 is a Type A DTC.

6.2 The engine will operate in the Overheated Engine Protection Operating Mode.

6.3 The engine coolant temperature indicator lamp, if equipped, will illuminate.

6.4 The driver information center (DIC), if equipped, may display a message.

6.5 If the protection mode is active and an ECT sensor DTC sets, the protection mode will activate during the next drive cycle until the ECT sensor DTC runs and passes.

7 CONDITIONS FOR CLEARING THE DTC

7.1 DTC P1258 is a Type A DTC.

P1258 – Engine Coolant Over-temperature – Protection Mode Active

8 REFERENCE INFORMATION

8.1 SCHEMATIC REFERENCE

8.1.1 Engine controls schematics

8.2 CONNECTOR END VIEW REFERENCE

8.2.1 Component connector end views

8.3 ELECTRICAL INFORMATION REFERENCE

8.3.1 Circuit testing

8.3.2 Connector repairs

8.3.3 Testing for intermittent conditions and poor connections

8.3.4 Wiring repairs

8.4 DTC TYPE REFERENCE

8.4.1 Powertrain diagnostic trouble code (DTC) type definitions

8.5 SCAN TOOL REFERENCE

8.5.1 CONTROL MODULE REFERENCESfor scan tool information

9 DESCRIPTION AND OPERATION

9.1 Cooling System Description and Operation

9.2 Instrument Cluster Description and Operation

9.3 Indicator/Warning Message Description and Operation

9.4 Audible Warnings Description and Operation

10 CIRCUIT/SYSTEM VERIFICATION

10.1 Observe the engine coolant level. The engine coolant level should be within operating range.

10.2 Ensure that the vehicle has the correct engine coolant, with correct concentration, and is not old, contaminated or contains additives.

10.3 Inspect the cooling system for the following:

10.3.1 Leaks

10.3.2 Kinked or pinched hoses, especially at the radiator

10.3.3 Loose, missing, or damaged radiator air seals or deflectors

10.3.4 The radiator and A/C condenser for any air flow obstructions or bent fins

11 CIRCUIT/SYSTEM TESTING

11.1 Test the thermostat for correct operation.

11.2 Test the fan clutch for proper operation.

11.3 Test the engine cooling system for overheating.

11.4 Inspect the water pump and coolant flow for correct operation.

11.5 Inspect the engine for worn/leaking/cracked cylinder heads and engine block.

12 REPAIR INSTRUCTIONS

12.1 Perform the *DIAGNOSTIC REPAIR VERIFICATION*after completing the diagnostic procedure.

P1380 or P1381 – Misfire Detected

1 DIAGNOSTIC INSTRUCTIONS

1.1 Review *STRATEGY BASED DIAGNOSIS* for an overview of the diagnostic approach.

1.2 Perform the *DIAGNOSTIC SYSTEM CHECK* prior to using this diagnostic procedure.

2 DTC DESCRIPTOR

2.1 **DTC P1380**: Misfire Detected – Rough Road Data Not Available

2.2 **DTC P1381**: Misfire Detected – No Communication with Brake Control Module

3 SYSTEM DESCRIPTION

The engine control module (ECM) detects engine misfire by detecting variations in crankshaft deceleration between firing strokes. For accurate detection of engine misfire, the ECM must distinguish between crankshaft deceleration caused by actual misfire and deceleration caused by rough road conditions. The antilock brake system (ABS) can detect if the vehicle is on a rough road based on wheel acceleration/deceleration data supplied by the wheel speed sensors. If the ABS detects rough road above predetermined threshold, this information is sent to the ECM. The ECM uses the rough road information when calculating engine misfire. If the ABS is malfunctioning and cannot detect rough roads, the misfire diagnostic will continue to run; however, if an engine misfire DTC sets, this DTC also sets indicating that rough road data was not available, or there was no communication with the brake control module during the misfire calculation due to an ABS malfunction.

4 CONDITIONS FOR RUNNING THE DTC

4.1 The vehicle speed is greater than 8km/h (5mph).

4.2 The engine speed is less than 8,192RPM.

4.3 The engine load is less than 60percent.

4.4 Engine misfire is detected and DTCP0300 sets with the MIL illuminated.

4.5 DTCsP1380 and P1381 run continuously when the above conditions are met

5 CONDITIONS FOR SETTING THE DTC

5.1 P1380

5.1.1 The electronic brake control module (EBCM) sends a message to the ECM indicating that a failure has occurred in the ABS module

5.1.2 Engine misfire is detected and DTCP0300 sets with the MIL illuminated.

P1380 or P1381 – Misfire Detected

5.2 P1381

5.2.1 An EBCM malfunction exists for greater than 10s, preventing the ECM from receiving rough road detection data.

5.2.2 Engine misfire is detected and DTCP0300 sets with the MIL illuminated.

6 ACTION TAKEN WHEN THE DTC SETS

6.1 DTCsP1380 and P1381 are TypeC DTCs.

7 CONDITIONS FOR CLEARING THE DTC

7.1 DTCsP1380 and P1381 are TypeC DTCs.

8 REFERENCE INFORMATION

8.1 SCHEMATIC REFERENCE

8.1.1 Engine controls schematics

8.2 CONNECTOR END VIEW REFERENCE

8.2.1 Component connector end views

8.3 ELECTRICAL INFORMATION REFERENCE

8.3.1 Circuit testing

8.3.2 Connector repairs

8.3.3 Testing for intermittent conditions and poor connections

8.3.4 Wiring repairs

8.4 DTC TYPE REFERENCE

8.4.1 Powertrain diagnostic trouble code (DTC) type definitions

8.5 SCAN TOOL REFERENCE

8.5.1 CONTROL MODULE REFERENCESfor scan tool information

9 CIRCUIT/SYSTEM VERIFICATION

9.1 Ignition ON, observe the DTC information with a scan tool. DTC UXXXX should not be set.

9.1.1 If a DTC is set, refer to OEM Service Manual for further diagnosis.

9.2 Engine idling, observe the EBCM DTC information with a scan tool. EBCM DTCs should not set.

9.2.1 If a DTC sets, refer to OEM Service Manual for further diagnosis.

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

10 REPAIR INSTRUCTIONS

10.1 Perform the *DIAGNOSTIC REPAIR VERIFICATION*after completing the diagnostic procedure.

P1400 – Cold Start Emission Reduction Control System

1 DIAGNOSTIC INSTRUCTIONS

1.1 Review *STRATEGY BASED DIAGNOSIS* for an overview of the diagnostic approach.

1.2 Perform the *DIAGNOSTIC SYSTEM CHECK* prior to using this diagnostic procedure.

2 DTC DESCRIPTOR

2.1 **DTC P1400:** Cold Start Emission Reduction Control System

3 CIRCUIT/SYSTEM DESCRIPTION

The catalytic converter must be warmed to efficiently reduce the emissions. The cold start strategy is to reduce the amount of time it takes to warm the catalytic converter. During a cold start, the engine idle speed is elevated and spark timing is retarded to allow the catalyst to warm quickly. This diagnostic monitors the following to build an exhaust energy model:

3.1 Engine speed

3.2 Spark advance

3.3 Throttle position

3.4 Engine airflow

3.5 Engine coolant temperature

3.6 Engine runtime

3.7 Park/neutral position

3.8 Vehicle speed

The actual model is then compared to the expected exhaust energy model.

4 CONDITIONS FOR RUNNING THE DTC

4.1 The engine is running, and a cold start has been detected.

4.2 Vehicle speed is less than 2km/h (1mph).

4.3 The engine is at idle with no input from the accelerator pedal.

4.4 DTCsP0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0220, P0222, P0223, P0201, P0202, P0203, P0204, P0205, P0206, P0300, P0335, P0336, P0351, P0352, P0353, P0501, P0502, P0506, P0507, P0601, P0602, P0603, P0604, P0606, P0607, P060D, P062F, P0641, P0651, P1101, P1516, P1682, P2101, P2119, P2120, P2122, P2123, P2125, P2127, P2128, P2135, P2138, P2176, P2610 are not set.

This DTC runs for 15seconds within the first 2minutes of start-up. This diagnostic runs once per trip when a cold start has been determined.

5 CONDITIONS FOR SETTING THE DTC

5.1 The actual exhaust energy model does not match the expected exhaust energy model.

6 ACTION TAKEN WHEN THE DTC SETS

6.1 DTCP1400 is a TypeA DTC.

7 CONDITIONS FOR CLEARING THE MIL/DTC

7.1 DTCP1400 is a TypeA DTC.

8 REFERENCE INFORMATION

8.1 SCHEMATIC REFERENCE

8.1.1 Engine controls schematics

8.2 CONNECTOR END VIEW REFERENCE

8.2.1 Component connector end views

8.3 ELECTRICAL INFORMATION REFERENCE

8.3.1 Circuit testing

8.3.2 Connector repairs

8.3.3 Testing for intermittent conditions and poor connections

8.3.4 Wiring repairs

8.4 DTC TYPE REFERENCE

8.4.1 Powertrain diagnostic trouble code (DTC) type definitions

8.5 SCAN TOOL REFERENCE

8.5.1 CONTROL MODULE REFERENCESfor scan tool information

9 DIAGNOSTIC AIDS

Any loading of the engine that lowers engine RPM, such as with partial application of the clutch, A/C cycling etc., during the first 120 seconds of engine runtime may set this DTC.

10 CIRCUIT/SYSTEM VERIFICATION

10.1 Allow the engine to cool.

10.2 Start and idle the engine for at least 2 minutes.

10.3 DTCP1400 should run and pass.

11 CIRCUIT/SYSTEM TESTING

11.1 Inspect the air intake system for the following:

11.1.1 Damage, restriction, or modification

11.1.2 Dirty or deteriorating air filter element

11.1.3 Crankcase ventilation system for correct operation

11.1.4 Water intrusion

11.1.5 Vacuum leak and other un-metered air downstream of the mass air flow (MAF) sensor

11.1.6 Intake manifold leak

11.2 Inspect the exhaust system for the following:

11.2.1 Water intrusion

11.2.2 Exhaust leak

11.2.3 Damaged, restricted, modified or enhanced exhaust system—Refer to OEM Service Manual.

11.3 Inspect the engine mechanical for items that could alter the air flow into the combustion chamber. Refer to *SYMPTOMS - ENGINE MECHANICAL*.

12 REPAIR INSTRUCTIONS

12.1 Perform the *DIAGNOSTIC REPAIR VERIFICATION*after completing the diagnostic procedure.

P1516, P2101, P2119, P2176 – Throttle Actuator

1 DIAGNOSTIC INSTRUCTIONS

1.1 Review *STRATEGY BASED DIAGNOSIS* for an overview of the diagnostic approach.

1.2 Perform the *DIAGNOSTIC SYSTEM CHECK* prior to using this diagnostic procedure.

2 DTC DESCRIPTOR

2.1 **DTC P1516:** Throttle Actuator Control (TAC) Module Throttle Actuator Position Performance

2.2 **DTC P2101:** Throttle Actuator Position Performance

2.3 **DTC P2119:** Throttle Closed Position Performance

2.4 **DTC P2176:** Minimum Throttle Position Not Learned

3 DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
TAC Motor Control Closed	P1516, P2101, P2176	P1516, P2101, P2176	P1516, P2101, P2176	P1516, P2101, P2176
TAC Motor Control Open	P1516, P2101, P2176	P1516, P2101, P2176	P1516, P2101, P2176	P1516, P2101, P2176

4 CIRCUIT/SYSTEM DESCRIPTION

The engine control module (ECM) controls the throttle valve by applying a varying voltage to the control circuits of the throttle actuator control (TAC) motor. The ECM monitors the duty cycle that is required to actuate the throttle valve. The ECM monitors the throttle position (TP) sensors 1 and 2 to determine the actual throttle valve position.

5 CONDITIONS FOR RUNNING THE DTC

5.1 P1516 and P2101

5.1.1 DTC P0606 and P1682 are not set.

5.1.2 The run/crank or powertrain relay voltage is greater than 6 V and reduced power is not active.

5.1.3 The engine is running or the following conditions are met:

5.1.4 The engine is not running.

5.1.5 The ignition voltage is greater than 11 V.

5.1.6 The TAC system is not in the Battery Saver mode.

5.1.7 The ECM is commanding the throttle.

5.1.8 The ECM has learned the minimum throttle position.

5.1.9 DTC P1516 and P2101 run continuously when the above conditions are met.

5.2 P2119

5.2.1 The ignition is ON.

5.2.2 The run/crank or powertrain relay voltage is greater than 6 V and reduced power is not active.

5.2.3 The TP sensor 1 voltage is greater than 1.7 V

5.2.4 The ECM is not commanding the throttle blade.

5.2.5 DTC P2119 runs continuously when the above conditions are met.

5.3 P2176

5.3.1 DTCs P0120, P0121, P0122, P0123, P0220, P0222, P0223, or P1682 is not set

5.3.2 The ignition is ON.

5.3.3 The run/crank or powertrain relay voltage is greater than 6 V and reduced power is not active.

5.3.4 The ECM enable the minimum throttle learn procedure.

5.3.5 DTC P2176 run continuously when the above conditions are met

6 CONDITIONS FOR SETTING THE DTC

6.1 P1516

6.1.1 The actual throttle position does not match the predicted throttle position for greater than 1 s.

6.2 P2101

6.2.1 The actual throttle position does not match the predicted throttle position for greater than 1 s.

6.3 P2119

6.3.1 The ECM detects that the throttle blade did not return to the default position when the TAC motor is de-energized for greater than 1 s.

6.4 P2176

6.4.1 The ECM detects that both throttle position (TP) sensors were greater than a predetermined voltage during the minimum throttle learn procedure for greater than 2 s.

7 ACTION TAKEN WHEN THE DTC SETS

7.1 P1516, P2101, and P2176

7.1.1 DTCs P1516, P2101, and P2176 are Type A DTCs.

7.1.2 The control module commands the TAC system to operate in the Reduced Engine Power mode.

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

7.1.4 Under certain conditions, the control module commands the engine OFF.

7.2 P2119

7.2.1 DTC P2119 is a Type C DTC.

7.2.2 The driver information center, if equipped, may display a message.

8 CONDITIONS FOR CLEARING THE MIL/DTC

8.1 DTCs P1516, P2101, and P2176 are Type A DTCs.

8.2 DTC P2119 is a Type C DTC.

9 DIAGNOSTIC AIDS

9.1 If the Throttle Sweep Test is not available on the scan tool, observe the scan tool TAC Motor parameter while performing the following tests:

9.1.1 Slowly depress the accelerator pedal to WOT and then slowly return the pedal to closed throttle. Repeat the procedure several times.

9.1.2 Rapidly depress the accelerator pedal from the rest position to the wide open throttle position (WOT) and release pedal. Repeat the procedure several times.

9.1.3 The TAC Motor parameter should display Enabled. If Disabled is displayed, continue diagnosis in Circuit/System Testing.

9.2 Inspect for a condition in which the throttle valve may have been held open. For example, ice may have formed in the throttle bore causing the throttle valve not to close.

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

9.4 A low battery condition may cause a DTC to set.

P1516, P2101, P2119, P2176 – Throttle Actuator

10 REFERENCE INFORMATION

10.1 SCHEMATIC REFERENCE

10.1.1 Engine controls schematics

10.2 CONNECTOR END VIEW REFERENCE

10.2.1 Component connector end views

10.3 ELECTRICAL INFORMATION REFERENCE

10.3.1 Circuit testing

10.3.2 Connector repairs

10.3.3 Testing for intermittent conditions and poor connections

10.3.4 Wiring repairs

10.4 DTC TYPE REFERENCE

10.4.1 Powertrain diagnostic trouble code (DTC) type definitions

10.5 SCAN TOOL REFERENCE

10.5.1 CONTROL MODULE REFERENCESfor scan tool information

11 CIRCUIT/SYSTEM VERIFICATION

NOTE: a low battery voltage or charging system condition may cause a DTC to set.

11.1 Ignition ON, observe the DTC information with a scan tool. DTC P0120, P0122, P0123, P0220, P0222, P0223, P0562, P0621, P0622, or P2135 should not set.

11.1.1 If a DTC sets, refer to *DIAGNOSTIC TROUBLE CODE (DTC) LIST*for further diagnosis.

11.2 Clear the DTCs with a scan tool. Ignition OFF and all vehicle systems OFF. It may take up to 2 minutes for all vehicle systems to power down.

11.3 Ignition ON, observe the scan tool TAC Motor parameter. The reading should display Enabled.

11.4 Observe the DTC information with a scan tool. DTC P1516, P2101, P2119, or P2176 should not set.

11.4.1 **NOTE**: If the Throttle Sweep Test is not available on the scan tool, use the accelerator to perform the test. Refer to Diagnostic Aids for further details.

11.4.2 If there is a condition with the throttle body, the TAC Motor Command parameter will go to 99% for a predetermined amount of time and then a DTC sets. Once a DTC is set, the TAC Motor Command parameter will go to 0% and the TAC Motor parameter will display Disabled.

11.5 Perform the Throttle Sweep Test while observing the TAC Motor parameter with a scan tool. The TAC Motor parameter should display Enabled while the Throttle Sweep Test is in progress.

11.5.1 **NOTE**:if the throttle sweep test is not available on the scan tool, use the accelerator to perform the test. Refer to diagnostic aids for further details.

11.5.2 If there is a condition with the throttle body, the TAC motor command parameter will go to 99 % for a predetermined amount of time and then a DTC sets. Once a DTC is set, the TAC motor command parameter will go to 0 % and the TAC motor parameter will display disabled.

11.5.3 If not the specified value, replace the throttle body assembly.

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

12 CIRCUIT/SYSTEM TESTING

WARNING: Turn off the ignition before inserting fingers into the throttle bore. Unexpected movement of the throttle blade could cause personal injury.

12.1 Ignition OFF, verify the following conditions do not exist with the throttle body assembly:

12.1.1 A throttle blade that is not in the rest position

12.1.2 A throttle blade that is binding open or closed

12.1.3 A throttle blade that is free to move open or closed without spring pressure

12.1.4 If a condition is found, replace the throttle body assembly.

12.1.5 **NOTE:** Disconnecting the throttle body harness connector may cause additional DTCs to set.

12.2 Ignition OFF, disconnect the harness connector at the throttle body assembly.

12.3 Ignition ON, verify that a test lamp does not illuminate continuously between each control circuit listed below and ground.

12.3.1 TAC Motor Control Closed circuit terminalA

12.3.2 TAC Motor Control Open circuit terminalB

12.3.3 If test lamp illuminates continuously, test the control circuit for a short to voltage. If the circuit tests normal, replace the ECM.

12.4 Verify that a test lamp does not illuminate between each control circuit listed below and B+.

12.4.1 TAC Motor Control Closed circuit terminalA

12.4.2 TAC Motor Control Open circuit terminalB

12.4.3 If the test lamp illuminates, test the control circuit for a short to ground. If the circuit tests normal, replace the ECM.

12.5 Ignition OFF, set the DMM to the 40V scale, select the Min/Max Recording Mode, and set the Peak Min/Max response time to 1ms.

12.5.1 **NOTE:**The DMM min/max recording mode and the response time of 1 ms must be reset after testing each circuit or a lower voltage will be recorded.

12.5.2 The ignition must be off and the ECM completely powered down before testing each circuit or a lower voltage will be recorded.

12.6 Ignition OFF, measure the voltage using the DMM Min/Max Recording Mode function on each circuit listed below as the ignition is turned ON. The Max voltage should be within 1V of B+.

12.6.1 TAC Motor Control Closed circuit terminalA

12.6.2 TAC Motor Control Open circuit terminalB

12.6.3 If not within the specified range, test the circuit for an open/high resistance. If the circuit tests normal, replace the ECM.

12.7 If all circuits and connections test normal, replace the throttle body assembly.

13 REPAIR INSTRUCTIONS

13.1 Throttle Body Assembly Replacement

13.2 Control Module References for Engine Control Module replacement, programming, and setup

14 REPAIR VERIFICATION

14.1 Install any components that have been removed or replaced during diagnosis.

P1516, P2101, P2119, P2176 – Throttle Actuator

14.2 Perform any adjustments, programming or setup procedures that are required when a component is removed or replaced.

14.3 Clear the DTCs with a scan tool.

14.4 Turn OFF the ignition for 60 s.

14.4.1 **NOTE:** If the throttle sweep test is not available on the scan tool, use the accelerator to perform the test. Refer to diagnostic aids for further details.

14.5 Perform the Throttle Sweep Test while observing the TAC Motor parameter with a scan tool. The TAC Motor parameter should display Enabled while the Throttle Sweep Test is in progress.

14.6 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*and perform the appropriate diagnostic procedure.

P2120, P2122, P2123, P2125, P2127, P2128, P2138 – Accelerator Pedal Position (APP) Circuit

1 DIAGNOSTIC INSTRUCTIONS

1.1 Review *STRATEGY BASED DIAGNOSIS* for an overview of the diagnostic approach.

1.2 Perform the *DIAGNOSTIC SYSTEM CHECK* prior to using this diagnostic procedure.

2 DTC DESCRIPTOR

2.1 **DTC P2120:**Accelerator Pedal Position (APP) Sensor 1 Circuit

2.2 **DTC P2122:** Accelerator Pedal Position (APP) Sensor 1 Circuit Low Voltage

2.3 **DTC P2123:** Accelerator Pedal Position (APP) Sensor 1 Circuit High Voltage

2.4 **DTC P2125:** Accelerator Pedal Position (APP) Sensor 2 Circuit

2.5 **DTC P2127:** Accelerator Pedal Position (APP) Sensor 2 Circuit Low Voltage

2.6 **DTC P2128:** Accelerator Pedal Position (APP) Sensor 2 Circuit High Voltage

2.7 **DTC P2138:** Accelerator Pedal Position (APP) Sensor 1-2 Correlation

3 DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
APP Sensor 1 5 V Reference	P2122	P2138	P2122	P2123	P2138
APP Sensor 2 5 V Reference	P2127	P2138	P2127	P2128	P2138
APP Sensor 1 Signal	P2122	P2138	P2122	P2123	P2138
APP Sensor 2 Signal	P2127	P2138	P2127	P2128	P2138
APP Sensor 1 Low Reference	—	P2138	P2123	—	P2138
APP Sensor 2 Low Reference	—	P2138	P2128	—	P2138

P2120, P2122, P2123, P2125, P2127, P2128, P2138 – Accelerator Pedal Position (APP) Circuit

4 TYPICAL SCAN TOOL DATA

APP Sensor 1 and 2 Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: The engine is operating at idle. ***Parameter Normal Range:*** APP Sensor 1 0.88–1.08 V ***Parameter Normal Range:*** APP Sensor 2 0.39–0.59 V			
APP Sensor 1 5 V Reference	0.00 V	0.00 V	2.7–3.7 V
APP Sensor 2 5 V Reference	0.00 V	0.00 V	1–2 V
APP Sensor 1 Signal	0.00 V	0.00 V	4–5 V
APP Sensor 2 Signal	0.00 V	0.00 V	4–5 V
APP Sensor 1 Low Reference	—	4–5 V	—
APP Sensor 2 Low Reference	—	4–5 V	—

5 CIRCUIT/SYSTEM DESCRIPTION

The accelerator pedal assembly contains 2accelerator pedal position(APP) sensors. The APP sensors are mounted to the accelerator pedal assembly and are not serviceable. The APP sensors provide a signal voltage that changes relative to pedal position. The engine control module(ECM) supplies each APP sensor with a 5V reference circuit, a low reference circuit, and a signal circuit.

6 CONDITIONS FOR RUNNING THE DTC

6.1 P2120, P2122, P2123, P2125, P2127, P2128

6.1.1 DTC P0641 or P0651 is not set.

6.1.2 The ignition is ON or the engine is running.

6.1.3 The run/crank or powertrain relay voltage is greater than 6.0 V and reduced power is not active.

6.1.4 DTCP2120, P2122, P2123, P2125, P2127, P2128 run continuously when the above conditions are met

6.2 P2138

6.2.1 DTC P0641, P0651, P2120, P2125 are not set.

6.2.2 The ignition is ON or the engine is running.

6.2.3 The run/crank or powertrain relay voltage is greater than 6.0 V and reduced power is not active.

6.2.4 DTC P2138 runs continuously when the above conditions are met.

7 CONDITIONS FOR SETTING THE DTC

7.1 P2120

7.1.1 The APP sensor1 voltage is less than 0.46V or greater than 4.7V for greater than 0.2s.

7.2 P2122

7.2.1 The ECM detects that the APP sensor1 voltage is less than 0.46V for greater than 0.2s.

7.3 P2123

7.3.1 The ECM detects that the APP sensor1 voltage is greater than 4.75V for greater than 0.2s.

7.4 P2125

7.4.1 The APP sensor2 voltage is less than 0.32V or greater than 2.6V for greater than 0.2s.

7.5 P2127

7.5.1 The ECM detects that the APP sensor2 voltage is less than 0.32V for greater than 0.2s.

7.6 P2128

7.6.1 The ECM detects that the APP sensor2 voltage is greater than 2.6V for greater than 0.2s.

7.7 P2138

7.7.1 The voltage difference between APP sensor1 and APP sensor2 exceeds a predetermined value for greater than 1s.

8 ACTION TAKEN WHEN THE DTC SETS

8.1 DTCs P2120, P2122, P2123, P2125, P2127, P2128, and P2138 are Type A DTCs.

8.2 The control module commands the TAC system to operate in the Reduced Engine Power mode.

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

8.4 Under certain conditions the control module commands the engine OFF.

P2120, P2122, P2123, P2125, P2127, P2128, P2138 – Accelerator Pedal Position (APP) Circuit

9 CONDITIONS FOR CLEARING THE MIL/DTC

9.1 DTCsP2120, P2122, P2123, P2125, P2127, P2128, and P2138 are TypeA DTCs.

10 DIAGNOSTIC AIDS

10.1 A high resistance condition on the accelerator pedal sensor circuits could cause a DTC to set.

11 REFERENCE INFORMATION

11.1 SCHEMATIC REFERENCE

11.1.1 Engine controls schematics

11.2 CONNECTOR END VIEW REFERENCE

11.2.1 Component connector end views

11.3 ELECTRICAL INFORMATION REFERENCE

11.3.1 Circuit testing

11.3.2 Connector repairs

11.3.3 Testing for intermittent conditions and poor connections

11.3.4 Wiring repairs

11.4 DTC TYPE REFERENCE

11.4.1 Powertrain diagnostic trouble code (DTC) type definitions

11.5 SCAN TOOL REFERENCE

11.5.1 CONTROL MODULE REFERENCESfor scan tool information

12 CIRCUIT/SYSTEM VERIFICATION

12.1 Ignition ON, observe the DTC information with a scan tool. Verify that DTC P0641 or P0651 are not set.

12.1.1 If a DTC is set, refer to DTC P0641 or P0651 for further diagnosis.

12.2 Observe the scan tool APP Sensor 1 and 2 voltage parameters. Verify both of the APP sensor voltages are between 0.32–4.75 V.

P2120, P2122, P2123, P2125, P2127, P2128, P2138 – Accelerator Pedal Position (APP) Circuit

12.3 Rapidly depress the accelerator pedal from the rest position to the wide open throttle position (WOT) and release pedal. Repeat the procedure several times. DTCs P2120, P2122, P2123, P2125, P2127, P2128, or P2138 should not set.

12.4 Slowly depress the accelerator pedal to WOT and then slowly return the pedal to closed throttle. Repeat the procedure several times. DTCs P2120, P2122, P2123, P2125, P2127, P2128, or P2138 should not set.

12.5 Observe the scan tool APP sensor 1 and 2 parameter. The scan tool should display Agree.

12.6 Clear the DTCs with the scan tool. Operate the vehicle within the Conditions for Running the DTC or within the conditions that you observed from the Freeze Frame/Failure Records.

12.7 Ignition ON, observe the DTC information with a scan tool. Verify that DTC P2120 or P2125 are not the only APP sensor DTCs set.

12.7.1 If DTC P2120 or P2125 are the only DTCs set, replace the ECM.

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

13 CIRCUIT/SYSTEM TESTING

13.1 Ignition OFF, disconnect the harness connector at the accelerator pedal.

13.2 Ignition OFF for 1minute, test for less than 5Ω between the appropriate low reference circuit terminal listed below and ground.

13.2.1 APP sensor1 terminalFor4

13.2.2 APP sensor2 terminalAor5

13.2.3 If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit/connections test normal, replace the ECM.

13.3 Ignition ON, test for 4.8–5.2V between the appropriate 5V reference circuit terminal listed below and ground.

13.3.1 APP sensor1 terminalDor2

13.3.2 APP sensor2 terminalCor1

13.3.3 If less than the specified range, test the 5V reference circuit for a short to ground or open/high resistance. If the circuit/connections test normal, replace the ECM.

13.3.4 If greater than the specified range, test the 5V reference circuit for a short to voltage. If the circuit/connections test normal, replace the ECM.

13.4 Observe the scan tool APP sensor1 voltage parameter. Verify the voltage is less than 0.3V.

P2120, P2122, P2123, P2125, P2127, P2128, P2138 – Accelerator Pedal Position (APP) Circuit

13.4.1 If greater than the specified range, test the signal circuit terminalE or 3 for a short to voltage. If the circuit/connections test normal, replace the ECM.

13.5 Observe the scan tool APP sensor2 voltage parameter. Verify the voltage is less than 0.3V.

13.5.1 If greater than the specified range, test the signal circuit terminalB or 6 for a short to voltage. If the circuit/connections test normal, replace the ECM.

13.6 Connect a 3A fused jumper wire between the APP sensor1 signal circuit terminalE or 3 and the 5V reference circuit terminalC or 1. Verify the APP sensor1 voltage parameter is greater than 4.8V.

13.6.1 If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit/connections test normal, replace the ECM.

13.7 Connect a 3A fused jumper wire between the APP sensor2 signal circuit terminalB or 6 and the 5V reference circuit terminalC or 1. Verify the APP sensor2 voltage parameter is greater than 4.8V.

13.7.1 If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit/connections test normal, replace the ECM.

13.8 If all circuits/connections test normal, test or replace the Accelerator Pedal Assembly.

14 REPAIR INSTRUCTIONS

14.1 Perform the *DIAGNOSTIC REPAIR VERIFICATION*after completing the repair

14.2 Accelerator Pedal Position Sensor Replacement

14.3 Control Module References for Engine Control Module replacement, programming, and setup.

P2181 – Engine Cooling System Performance

1 DIAGNOSTIC INSTRUCTIONS

1.1 Review *STRATEGY BASED DIAGNOSIS* for an overview of the diagnostic approach.

1.2 Perform the *DIAGNOSTIC SYSTEM CHECK*prior to using this diagnostic procedure.

2 DTC DESCRIPTOR

2.1 **DTC P2181**: Engine Cooling System Performance

3 CIRCUIT/SYSTEM DESCRIPTION

The engine control module (ECM) monitors temperature difference between the engine coolant temperature (ECT) sensor and the radiator coolant temperature (RCT) sensor during a cold start-up. The purpose of this diagnostic is to analyze the engine coolant thermostat for being stuck open.

4 CONDITIONS FOR RUNNING THE DTC

4.1 DTCs P00B3, P00B4, P0101, P0102, P0103, P0112, P0113, or P0114 are not set.

4.2 The engine run time is between 70 s and 22 m.

4.3 The engine coolant temperature (ECT) sensor at start-up is between −20°C to +75°C (19 to 140°F).

4.4 The intake air temperature (IAT) sensor is between −7°C to +75°C (−4°F to +167°F).

4.5 The airflow into the engine is between 11 to 100 g/s.

4.6 The DTC runs once per ignition cycle when the above conditions are met.

5 CONDITIONS FOR SETTING THE DTC

5.1 The ECM detects the engine coolant thermostat is stuck open for 160 s.

6 ACTION TAKEN WHEN THE DTC SETS

6.1 DTC P2181 is a Type B DTC

7 CONDITIONS FOR CLEARING THE DTC

7.1 DTC P2181 is a Type B DTC

P2181 – Engine Cooling System Performance

8 DIAGNOSTIC AIDS

8.1 Insufficient vehicle interior heating is an indication of improper thermostat operation.

8.2 The scan tool Desired ECT Sensor and the ECT Sensor parameters should be within 5°C (9°F) when the engine is at operating temperature.

8.3 A resistance condition in the ECT sensor circuits may cause this DTC. This condition results in a greater voltage on the ECT sensor signal circuit, which is interpreted by the ECM as a colder ECT.

8.4 The mechanical thermostat will open at approximately 104°C (220°F). The mechanical thermostat will cycle from approximately 104°C (220°F) to approximately 98°C (208°F).

9 REFERENCE INFORMATION

9.1 SCHEMATIC REFERENCE

9.1.1 Engine controls schematics

9.2 CONNECTOR END VIEW REFERENCE

9.2.1 Component connector end views

9.3 ELECTRICAL INFORMATION REFERENCE

9.3.1 Circuit testing

9.3.2 Connector repairs

9.3.3 Testing for intermittent conditions and poor connections

9.3.4 Wiring repairs

9.4 DTC TYPE REFERENCE

9.4.1 Powertrain diagnostic trouble code (DTC) type definitions

9.5 SCAN TOOL REFERENCE

9.5.1 CONTROL MODULE REFERENCESfor scan tool information

10 CIRCUIT/SYSTEM VERIFICATION

10.1 Ignition ON, observe the DTC information with a scan tool. DTC P00B3, P00B4, P00B6, P0117, P0118, P0480, or P0481 should not be set.

10.1.1 ⇒If a DTC is set; refer to *DIAGNOSTIC TROUBLE CODE (DTC) LIST*for further diagnosis.

10.2 Verify the coolant in the radiator surge tank is at the correct level and there are no engine coolant leaks.

Note: Depending on ambient temperature, it may take up to 4 min for the temperature to increase greater than the specified value.

10.3 Increase the engine speed to 3000 RPM. Observe the scan tool ECT sensor parameter. The temperature should increase to greater than 102°C (215°F).

10.3.1 ⇒ If less than the specified value, replace the Engine Coolant Thermostat

10.4 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.

11 REPAIR INSTRUCTIONS

11.1 Perform the *DIAGNOSTIC REPAIR VERIFICATION*after completing the diagnostic procedure.

11.2 Engine Coolant Thermostat Replacement

P2270 or P2272 – Heated O2 Sensor Signal Stuck Lean Bank 1 or 2

1 DIAGNOSTIC INSTRUCTIONS

1.1 Review *STRATEGY BASED DIAGNOSIS* for an overview of the diagnostic approach.

1.2 Perform the *DIAGNOSTIC SYSTEM CHECK* prior to using this diagnostic procedure.

2 DTC DESCRIPTOR

2.1 **DTC P2270:** HO2S Signal Stuck Lean Bank 1 Sensor 2

2.2 **DTC P2272:** HO2S Signal Stuck Lean Bank 2 Sensor 2

3 DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
HO2S Signal	P0131, P0132, P0137, P0140, P0151, P0152, P0157, P0158, P1133	P0131, P0132, P0133, P0134, P0137, P013A, P013B, P013E, P013F, P0140, P0151, P0152, P0153, P0154, P0157, P0160, P1133, P1153	P0131, P0132, P0133, P0134, P0137, P013A, P013B, P013E, P013F, P0140, P0151, P0152, P0153, P0154, P0157, P0160, P1133, P1153	P0132, P0134, P0138, P0140, P0152, P0154, P0158, P0160, P1133, P1153	P0133, P0134, P013A, P013B, P013E, P013F, P0140, P0153, P0154, P0160, P1133, P1153, P2270, P2271
HO2S Low Reference	—	P0131, P0132, P0133, P0134, P0138, P013A, P013B, P013E, P013F, P0140, P0151, P0152, P0153, P0154, P0158, P0160, P1133	P0131, P0132, P0133, P0134, P0138, P013A, P013B, P013E, P013F, P0140, P0151, P0152, P0153, P0154, P0158, P0160, P1133, P1153	P0134, P0138, P0140, P0154, P0158, P0160, P1133, P1153	—

P2270 or P2272 – Heated O2 Sensor Signal Stuck Lean Bank 1 or 2

4 TYPICAL SCAN TOOL DATA

HO2S SENSOR 1 VOLTAGE CIRCUIT	Short to Ground	Open	Short to Voltage
Parameter Normal Range: 200–800 mV			
HO2S Signal	0 mV	Approximately 470 mV	Approximately 1,100 mV
HO2S Low Reference	455 mV	Approximately 450 mV	Approximately 445 mV

5 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 heat up and begin to generate a voltage within a range of 0-1,275mV. 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 1,000mV indicates a rich fuel mixture. An HO2S voltage that decreases toward 0mV 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.

6 CONDITIONS FOR RUNNING THE DTC

6.1 DTCs P0036, P0037, P0038, P0137, P0138, P0140, P0141, P0443, P0458, P0459, P2232 are not set.

6.2 The ignition1 voltage is between 10–18volts.

6.3 The engine run time is greater than 5minutes.

6.4 The engine speed is between 1,100–2,500RPM.

6.5 The engine speed is between 1,100–2,500RPM.

6.6 The mass air flow (MAF) is between 3–20g/s.

6.7 The vehicle speed is between 50–120km/h (31–75mph).

6.8 The fuel level is greater than 10percent.

6.9 The fuel system is in Closed Loop.

6.10 The catalytic converter temperature is between 550–900°C(1,022–1,652°F).

6.11 The DTCs run once per ignition cycle when the above conditions are met.

P2270 or P2272 – Heated O2 Sensor Signal Stuck Lean Bank 1 or 2

7 CONDITIONS FOR SETTING THE DTC

7.1 P2270

7.1.1 The ECM does not detect a HO2S voltage greater than 805mV before accumulated mass airflow exceeds 550grams.

7.2 P2272

7.2.1 The ECM does not detect a HO2S voltage greater than 775mV before the accumulated mass airflow exceeds 82grams.

8 ACTION TAKEN WHEN THE DTC SETS

8.1 DTCsP2270 and P2272 are TypeB DTCs.

9 CONDITIONS FOR CLEARING THE DTC

9.1 DTCs P2270 and P2272 are Type B DTCs.

10 REFERENCE INFORMATION

10.1 SCHEMATIC REFERENCE

10.1.1 Engine controls schematics

10.2 CONNECTOR END VIEW REFERENCE

10.2.1 Component connector end views

10.3 ELECTRICAL INFORMATION REFERENCE

10.3.1 Circuit testing

10.3.2 Connector repairs

10.3.3 Testing for intermittent conditions and poor connections

10.3.4 Wiring repairs

10.4 DTC TYPE REFERENCE

10.4.1 Powertrain diagnostic trouble code (DTC) type definitions

10.5 SCAN TOOL REFERENCE

10.5.1 CONTROL MODULE REFERENCESfor scan tool information

P2270 or P2272 – Heated O2 Sensor Signal Stuck Lean Bank 1 or 2

11 CIRCUIT/SYSTEM VERIFICATION

11.1 Ignition ON, observe the DTC information with a scan tool. Verify that no B52 HO2S heater DTCs are set.

11.1.1 If any B52HO2S heater DTCs are set, perform those diagnostics first. Refer to Diagnostic Trouble Code

11.2 Engine idling, move the appropriate B52HO2S2 harness connector and the engine control module (ECM) harness connector while monitoring the B52HO2S2 voltage parameter with a scan tool. Verify that the B52HO2S parameter does not change abruptly while moving the related harnesses.

11.2.1 If the B52HO2S parameter does change abruptly while moving the related harnesses repair the circuit as necessary.

11.3 Engine idling at operating temperature; observe the appropriate B52HO2S2 parameter with a scan tool. Verify the following:

11.3.1 The B52HO2S1 value should vary from below 200mV to above 800mV and respond to fueling changes.

11.3.2 The B52HO2S2 should fluctuate at less than 380mV or greater than 520mV. The values should not remain within 380mV and 520mV.

11.4 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.

12 CIRCUIT/SYSTEM TESTING

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

12.1 Ignition OFF, disconnect the harness connector at the appropriate B52HO2S.

12.2 Ignition OFF, all vehicle systems OFF, this may take up to 2minutes, test for less than 5Ω between the low reference circuit terminalA and ground.

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

12.3 Ignition ON, verify the appropriate scan tool B52HO2S parameter is approximately 450mV.

12.3.1 If less than the specified value, test the signal circuit for a short to ground. If the circuit tests normal, replace the ECM.

12.3.2 If greater than the specified value, test the signal circuit for a short to voltage. If the circuit tests normal, replace the ECM.

12.4 Ignition ON, install a 3A fused jumper wire between the signal circuit terminalB and ground. Verify the scan tool HO2S parameter is less than 60mV.

12.4.1 If greater than the specified range, test the signal circuit for an open/high resistance. If the circuits test normal, replace the ECM.

P2270 or P2272 – Heated O2 Sensor Signal Stuck Lean Bank 1 or 2

12.5 Verify none of the following conditions exist:

12.5.1 Lean fuel injectors—Refer to *FUEL INJECTOR DIAGNOSIS*

12.5.2 Lean fuel injectors—Refer to *FUEL INJECTOR DIAGNOSIS*

12.5.3 Water intrusion in the B52HO2S harness connector

12.5.4 Low fuel system pressure—Refer to *FUEL SYSTEM DIAGNOSIS*

12.5.5 Fuel that is contaminated—Refer to *ALCOHOL/CONTAMINANTS-IN-FUEL DIAGNOSIS*

12.5.6 Exhaust leaks near the B52HO2S

12.5.7 Engine vacuum leaks

12.5.8 Contaminated B52HO2S – Silicon

12.5.9 An engine mechanical condition— *SYMPTOMS - ENGINE MECHANICAL*

12.5.10 If you find any of the above conditions, repair as necessary.

12.5.11 If all circuits test normal, replace the appropriate B52 HO2S

13 REPAIR INSTRUCTIONS

CAUTION:Refer to heated oxygen sensor resistance learn reset caution

13.1 Perform the *DIAGNOSTIC REPAIR VERIFICATION*after completing the diagnostic procedure.

13.2 Heated Oxygen Sensor Replacement - Bank 1 Sensor 2

13.3 Heated Oxygen Sensor Replacement - Bank 2 Sensor 2

13.4 Control Module References for ECM replacement, setup, and programming

P2271 or P2273 – Heated O2 Sensor Signal Stuck Rich Bank 1 or Bank 2

1 DIAGNOSTIC INSTRUCTIONS

1.1 Review *STRATEGY BASED DIAGNOSIS* for an overview of the diagnostic approach.

1.2 Perform the *DIAGNOSTIC SYSTEM CHECK* prior to using this diagnostic procedure.

2 DTC DESCRIPTOR

2.1 **DTC P2271:** HO2S Signal Stuck Rich Bank 1 Sensor 2

2.2 **DTC P2273:** HO2S Signal Stuck Rich Bank 2 Sensor 2

3 DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
HO2S High Signal	P0131, P0132, P0137, P0140, P0151, P0152, P0157, P0158, P1133	P0131, P0132, P0133, P0134, P0137, P013C, P013D, P0140, P014A, P014B, P0151, P0152, P0153, P0154, P0157, P0160, P1133, P1153	P0131, P0132, P0133, P0134, P0137, P013C, P013D, P0140, P014A, P014B, P0151, P0152, P0153, P0154, P0157, P0160, P1133, P1153	P0132, P0134, P0138, P0140, P0152, P0154, P0158, P0160, P1133, P1153	P0133, P0134, P013C, P013D, P0140, P014A, P014B, P0153, P0154, P0160, P1133, P1153, P2272, P2273
HO2S Low Signal	—	P0131, P0132, P0133, P0134, P0138, P013C, P013D, P0140, P014A, P014B, P0151, P0152, P0153, P0154, P0158, P0160, P1133	P0131, P0132, P0133, P0134, P0138, P013C, P013D, P0140, P014A, P014B, P0151, P0152, P0153, P0154, P0158, P0160, P1133, P1153	P0134, P0138, P0140, P0154, P0158, P0160, P1133, P1153	—

P2271 or P2273 – Heated O2 Sensor Signal Stuck Rich Bank 1 or Bank 2

4 TYPICAL SCAN TOOL DATA

HO2S SENSOR 1 VOLTAGE CIRCUIT	Short to Ground	Open	Short to Voltage
Parameter Normal Range: 200–800 mV			
HO2S High Signal	0 mV	Approximately 470 mV	Approximately 1,100 mV
HO2S Low Signal	455 mV	Approximately 450 mV	Approximately 445 mV

5 CIRCUIT/SYSTEM DESCRIPTION

Heated oxygen sensors (HO2S) are used for fuel control and post catalyst monitoring. Each HO2S compares the oxygen content of the surrounding air with the oxygen content in the exhaust stream. The HO2S must reach operating temperature to provide an accurate voltage signal. Heating elements inside the HO2S minimize the time required for the sensors to reach operating temperature. The control module supplies the HO2S with a reference, or bias, voltage of about 450mV. When the engine is first started, the control module operates in Open Loop, ignoring the HO2S voltage signal. Once the HO2S reaches operating temperature and Closed Loop is achieved, the HO2S generates a voltage within a range of 0– 1,000mV that fluctuates above and below bias voltage. High HO2S voltage indicates a rich exhaust stream. Low HO2S voltage indicates a lean exhaust stream.

6 CONDITIONS FOR RUNNING THE DTC

6.1 Before the ECM can report DTCP2271, or P2273 failed, DTCsP013A, P013C, P013E, P014A, P2270, and P2272 must run and pass.

6.2 DTCsP0036, P0037, P0038, P0137, P0138, P0140, P0141, P0443, P0458, P0459, and P2232 are not set.

6.3 The ignition1 voltage is between 10–18volts.

6.4 The engine speed is between 500–5,000RPM.

6.5 The mass airflow (MAF) is between 3–50g/s.

6.6 The vehicle speed is between 24–132km/h(15–82mph).

6.7 The fuel level is greater than 10percent.

6.8 The fuel system is in Closed Loop.

6.9 The engine run time is equal to or more than 5minutes.

6.10 The accelerator pedal position (APP) is steady.

6.11 The torque converter clutch is TCC is applied.

6.12 The DTCs run once per ignition cycle, during decel fuel cut-off, when the above conditions are met.

P2271 or P2273 – Heated O2 Sensor Signal Stuck Rich Bank 1 or Bank 2

7 CONDITIONS FOR SETTING THE DTC

7.1 P2271

7.1.1 The ECM does not detect an HO2S voltage less than 150mV before accumulated mass airflow exceeds 550 grams.

7.2 P2273

7.3 The ECM does not detect an HO2S voltage less than 100mV before the accumulated mass airflow exceeds 76 grams.

8 ACTION TAKEN WHEN THE DTC SETS

8.1 DTCs P2271 or P2273 are Type B DTCs.

9 CONDITIONS FOR CLEARING THE DTC

9.1 DTCs P2271 or P2273 are Type B DTCs.

10 REFERENCE INFORMATION

10.1 SCHEMATIC REFERENCE

10.1.1 Engine controls schematics

10.2 CONNECTOR END VIEW REFERENCE

10.2.1 Component connector end views

10.3 ELECTRICAL INFORMATION REFERENCE

10.3.1 Circuit testing

10.3.2 Connector repairs

10.3.3 Testing for intermittent conditions and poor connections

10.3.4 Wiring repairs

10.4 DTC TYPE REFERENCE

10.4.1 Powertrain diagnostic trouble code (DTC) type definitions

10.5 SCAN TOOL REFERENCE

10.5.1 CONTROL MODULE REFERENCESfor scan tool information

P2271 or P2273 – Heated O2 Sensor Signal Stuck Rich Bank 1 or Bank 2

11 CIRCUIT/SYSTEM VERIFICATION

11.1 Ignition ON, observe the DTC information with a scan tool. Verify that no B52HO2S heater DTCs are set.

11.1.1 If any B52HO2S heater DTCs are set, perform those diagnostics first. Refer to *DIAGNOSTIC TROUBLE CODE (DTC) LIST*.

11.2 Engine idling, move the appropriate B52HO2S2 harness connector and the engine control module (ECM) harness connector while monitoring the B52HO2S 2 voltage parameter with a scan tool. Verify that the B52HO2S parameter does not change abruptly while moving the related harnesses.

11.2.1 If the B52HO2S parameter does change abruptly while moving the related harnesses repair the circuit as necessary.

11.3 Engine idling at operating temperature; observe the appropriate B52HO2S2 parameter with a scan tool. Verify the following:

11.3.1 The B52HO2S1 value should vary from below 200mV to above 800mV and respond to fueling changes.

11.3.2 The B52HO2S2 should fluctuate at less than 380mV or greater than 520mV. The values should not remain within 380mV and 520mV.

11.4 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.

12 CIRCUIT/SYSTEM TESTING

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

12.1 Ignition OFF, disconnect the harness connector at the appropriate B52 HO2S.

12.2 Ignition OFF, all vehicle systems OFF, this may take up to 2 minutes, test for less than 5 Ω between the low reference circuit terminal A and ground.

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

12.3 Ignition ON, verify the appropriate scan tool B52 HO2S parameter is approximately 450 mV.

12.3.1 If less than the specified value, test the signal circuit for a short to ground. If the circuit tests normal, replace the K20 ECM.

12.3.2 If greater than the specified value, test the signal circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.

12.4 Ignition ON, install a 3 A fused jumper wire between the signal circuit terminal B and ground. Verify the scan tool B52 HO2S parameter is less than 60 mV.

12.4.1 If greater than the specified range, test the signal circuit for an open/high resistance. If the circuits test normal, replace the K20 ECM.

12.5 Verify none of the following conditions exist:

12.5.1 Rich fuel injectors—Refer to *FUEL INJECTOR DIAGNOSIS*

12.5.2 Water intrusion in the B52 HO2S harness connector

12.5.3 High fuel system pressure—Refer to *FUEL SYSTEM DIAGNOSIS*

12.5.4 Fuel that is contaminated—Refer to *ALCOHOL/CONTAMINANTS-IN-FUEL DIAGNOSIS*

12.5.5 Fuel saturation of the evaporative emission (EVAP) canister

12.5.6 If you find any of the above conditions, repair as necessary.

12.6 If all circuits test normal, replace the appropriate B52 HO2S.

13 REPAIR INSTRUCTIONS

CAUTION: Refer to heated oxygen sensor resistance learn reset caution.

13.1 Perform the *DIAGNOSTIC REPAIR VERIFICATION*after completing the diagnostic procedure.

13.2 Heated Oxygen Sensor Replacement - Bank 1 Sensor 2

13.3 Heated Oxygen Sensor Replacement - Bank 2 Sensor 2

13.4 Control Module References for ECM replacement, setup, and programming