Buck's Engines

Diagnostic Guide

PG-08 Diagnostics and Trouble Shooting Guide – GM Engines

Emission-Certified
Natural Gas Fuel Systems
March 2012

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Contents

List of Figures

Electromagnetic Compatibility (EMC)

All PG-08 active electronic components manufactured by the Woodward Governor Company have been developed and individually tested for electromagnetic compatibility using standardized industry methods under laboratory test conditions. Actual EMC performance may be adversely affected by the wiring harness design, wire routing, the surrounding structure, other EMC generating components, and other factors that are beyond the control of the Woodward Governor Company. It is the responsibility of the vehicle and/or application manufacturer to confirm that the overall system's EMC performance is in compliance with all standards that they wish to apply for their particular use.

Electrostatic Discharge Awareness

All electronic equipment is static-sensitive, some components more than others. To protect these components from static damage, you must take special precautions to minimize or eliminate electrostatic discharges.

Follow these precautions when working with or near the control.

1. Before doing maintenance on the electronic control, discharge the static electricity on your body to ground by touching and holding a grounded metal object (pipes, cabinets, equipment, etc.).

2. Avoid the build-up of static electricity on your body by not wearing clothing made of synthetic materials. Wear cotton or cotton-blend materials as much as possible because these do not store static electric charges as much as synthetics.

3. Keep plastic, vinyl, and Styrofoam materials (such as plastic or Styrofoam cups, cup holders, cigarette packages, cellophane wrappers, vinyl books or folders, plastic bottles, and plastic ash trays) away from the control, the modules, and the work area as much as possible.

CAUTION—ELECTROSTATIC DISCHARGE

To prevent damage to electronic components caused by improper handling, read and observe the precautions in Woodward manual 82715, *Guide for Handling and Protection of Electronic Controls, Printed Circuit Boards, and Modules*.

DIAGRAM NOTES

NOTE #1
Wire sizes are in AWG.

NOTE #2
All wire sizes are 18 AWG unless otherwise noted.

NOTE #3
All connector terminations are shown on wire side—not terminal side.

4 Refer to your CAN device documentation for proper CAN network configuration and use of termination resistor. Also refer to ISO 11898-2 for CANBus criteria and SAE J1939 protocol for standard CAN restrictions.

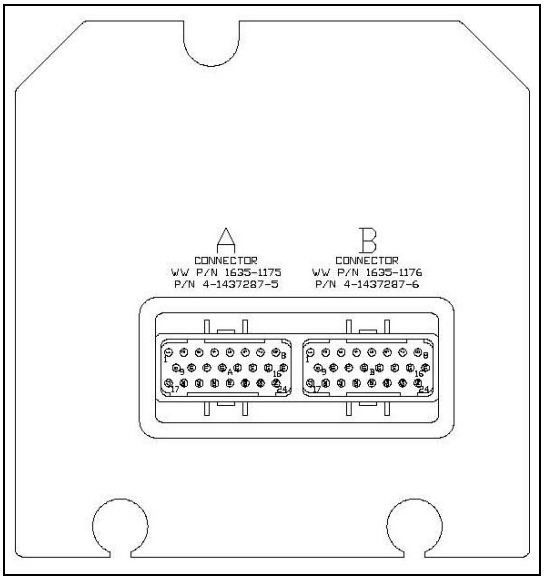
5 XDRG Pin B1 and DRVG Pins A16, B17 should not be connected in the harness.

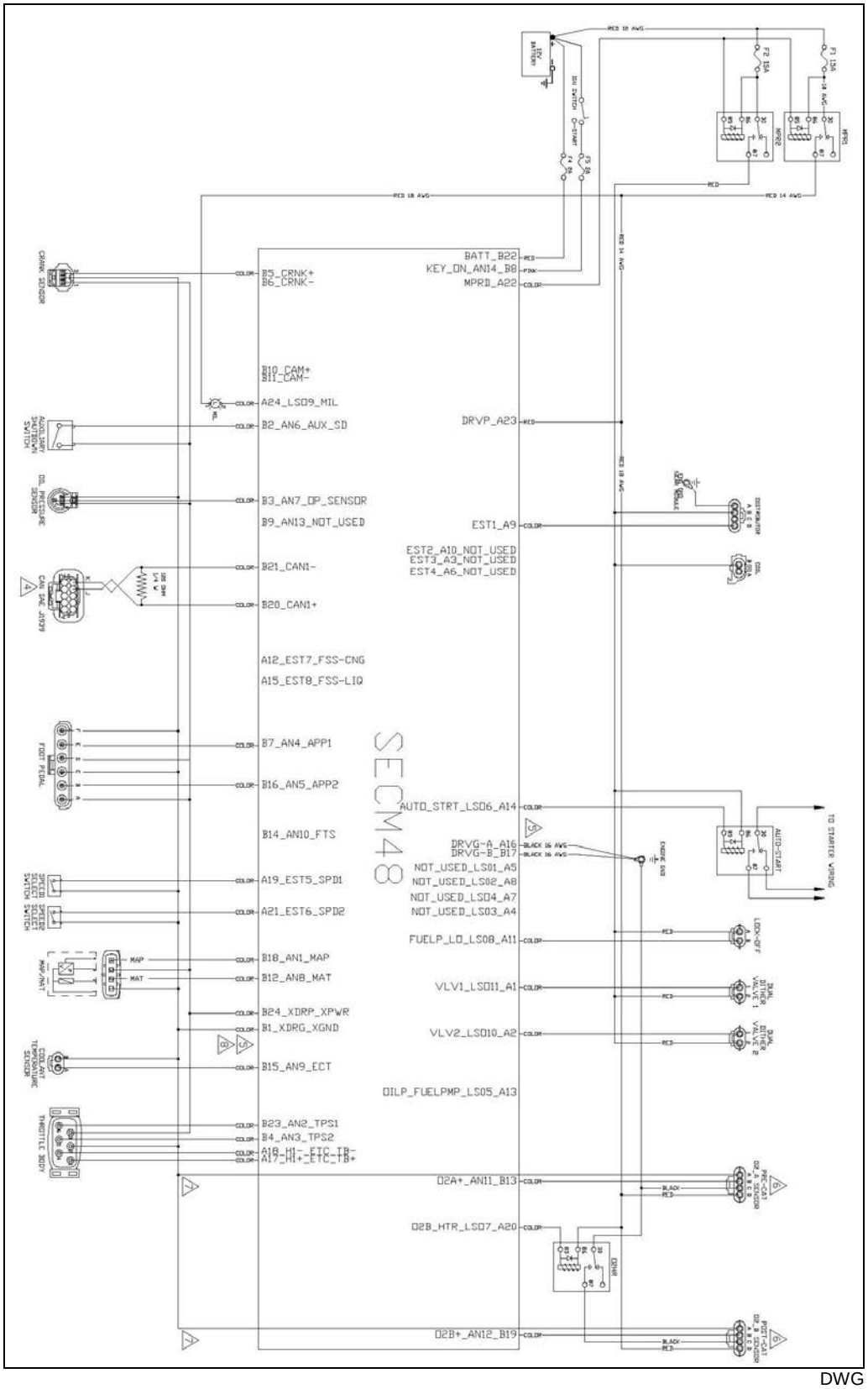
6 Pre-cat 02 sensor and post-cat 02 sensor signal ground wires must be electrically isolated from heater ground wires. Signal ground wires must go to XDRG and heater ground wires must go to DRVG.

7 Pre-cat 02 sensor and post-cat 02 sensor signal ground wire splices must be within 6” (152.4 mm) of SECM-48.

8 All XDRG wires should be routed such that the splices are as close as possible to the SECM-48.

TERMINAL CONNECTIONS





DWG NO. 9930-1095

Figure 13. SECM Wiring Diagram for GM 3.0L Natural Gas System

Chapter 6.
Basic Troubleshooting

Preliminary Checks

PG-08 systems are equipped with built-in fault diagnostics. Detected system faults can be displayed by the Malfunction Indicator Lamp (MIL) and are covered in Chapter 7, Advanced Diagnostics. However, items such as fuel level, plugged fuel lines, clogged fuel filters, and malfunctioning pressure regulators may not set a fault code and usually can be corrected with the basic troubleshooting steps described on the following pages.

If engine or drivability problems are encountered with your PG-08 system, perform the checks in this section before referring to Advanced Diagnostics.

NOTE: Locating a problem in a natural gas engine is done exactly the same as with a gasoline engine. Consider all parts of the ignition and mechanical systems as well as the fuel system.

BEFORE STARTING . . .

1. Determine that the SECM and MIL light are operating. Verify operation by keying on engine and checking for flash of MIL light.

   When the ignition key is turned on, the MIL will illuminate and remain on until the engine is started. Once the engine is started, the MIL lamp will go out unless one or more fault conditions are present. If a detected fault condition exists, the fault or faults will be stored in the memory of the small engine control module (SECM). Once an active fault occurs the MIL will illuminate and remain ON. This signals the operator that a fault has been detected by the SECM.

2. Determine that there are no diagnostic codes stored, or there is a diagnostic code but no MIL light.

VISUAL/PHYSICALCHECK
Several of the procedures call for a “Careful Visual/Physical Check” which should include:

- SECM grounds for being clean and tight
- Vacuum hoses for splits, kinks, and proper connection.
- Air leaks at throttle body mounting and intake manifold
- Exhaust system leaks
- Ignition wires for cracking, hardness, proper routing, and carbon tracking
- Wiring for pinches and cuts

Also check:

- Connections to determine that none are loose, cracked, or missing
- Fuel level in vehicle is sufficient
- Fuel is not leaking
- Battery voltage is greater than 11.5 volts
- Steering, brakes, and hydraulics are in proper condition and vehicle is safe to operate

NOTE
The Visual/Physical check is very important, as it can often correct a problem without further troubleshooting and save valuable time.

Basic Troubleshooting

Intermittents

An intermittent fault is the most difficult to troubleshoot since the MIL flashes on at random, causing uncertainty in the number of flashes or the conditions present at the time of the fault. Also, the problem may or may not fully turn “ON” the MIL light or store a code.

Therefore, the fault must be present or able to be recreated in order to locate the problem. If a fault is intermittent, use of diagnostic code charts may result in the unnecessary replacement of good components.

CORRECTIVE ACTION
Most intermittent problems are caused by faulty electrical connections or wiring. Perform careful visual/physical check for: • Poor mating of the connector halves or terminal not fully seated in the connector body (backed out) • Improperly formed or damaged terminal. All connector terminals in problem circuit should be carefully reformed or replaced to insure proper contact tension • Loose connections or broken wires • Poor terminal to wire connection crimp
If a visual/physical check does not find the cause of the problem, perform the following: (1) Drive the vehicle with a voltmeter or “Service” tool connected to a suspected circuit. Check if circuit is active and signal is reasonable. (2) Using the “Service” tool, monitor the input signal to the SECM to help detect intermittent conditions. (3) An abnormal voltage, or “Service” reading, when the problem occurs, indicates the problem may be in that circuit. (4) If the wiring and connectors check OK, and a diagnostic code was stored for a circuit having a sensor, check sensor.
An intermittent “Service Engine Soon” light with no stored diagnostic code may be caused by: • Ignition coil shortage to ground and arcing at spark plug wires or plugs • MIL light wire to ECM shorted to ground • SECM grounds (refer to SECM wiring diagrams).
Check for improper installation of electrical options such as lights, 2-way radios, accessories, etc.
EST wires should be routed away from spark plug wires, distributor wires, distributor housing, coil and generator. Wires from SECM to ignition should have a good connection.

Surges and/or Stumbles

Engine power varies under steady throttle or cruise. Feels like the vehicle speeds up and slows down with no change in the acceleration pedal.

PRELIMINARY CHECKS
Perform the visual checks as described at start of " Basic Troubleshooting" chapter. Be sure driver understands vehicle operation as explained in the operator manual.

PROBABLE CAUSE	CORRECTIVE ACTION
Oxygen sensor malfunction	The fuel management should maintain a stoichiometric air-fuel ratio under all steady state operating conditions following engine warmup. Failure of the Pre-catalyst O2 sensor should cause an O2 sensor fault that can be diagnosed with the MIL lamp or Service Tool.
Fuel system malfunction	**NOTE:** To determine if the condition is caused by a rich or lean system, the vehicle should be driven at the speed of the complaint. Monitoring pre-catalyst O2 adapts* or dither valve duty cycle will help identify problem. Check fuel supply while condition exists. Check in-line fuel filter. Replace if dirty or plugged. Check fuel pressure.
Ignition system malfunction	Check for proper ignition voltage output using spark tester. Check spark plugs. • Remove spark plugs, check for wet plugs, cracks, wear, improper gap, burned electrodes, or heavy deposits. • Repair or replace as necessary. • Check condition of distributor cap, rotor and spark plug wires (where applicable). • Check ignition timing.
Component malfunction	Check vacuum lines for kinks or leaks. Check alternator output voltage. Repair if less than 9 or more than 16 volts.
Exhaust backpressure	Check condition of exhaust system. Check backpressure before catalyst. It should be less than 3.5 psig (24.13 kPa).

(*) Refer to **Table 1** for description of gaseous O2 adapts.

Related MIL Faults:

Pre-catalyst O2 sensor errors / O2 control errors
Dither valve DC faults / EST faults / ETC faults

Engine Cranking but Will Not Start / Difficult to Start

Engine cranks OK, but does not start for a long time. Does eventually run, or may start but immediately dies.

PRELIMINARY CHECKS
Perform the visual checks as described at start of " Basic Troubleshooting" chapter. Be sure driver is using correct method to start engine as explained in operator's manual. Use "clear flood" mode during cranking by fully depressing the pedal and cranking the engine. If engine does not start, continue troubleshooting.

PROBABLE CAUSE	**CORRECTIVE ACTION**
Plugged fuel line	Remove obstruction from the fuel line. • Using caution, disconnect the fuel line (some natural gas may escape). • Clear obstruction with compressed air. • Re-connect fuel line. • Leak test.
Clogged fuel filter	Repair/replace as required. *See Chapter 3 Fuel Filter replacement.*
Faulty vapor connection between the pressure regulator and the mixer	Check connection • Verify no holes in hose. • Clamps must be tight. • Look for kinked, pinched and/or collapsed hose.
Fuel lock-off malfunction	Repair/replace fuel lock-off. *See Chapter 3 Fuel Lock-off.*
Pressure regulator malfunction	Test regulator operation and pressure. *See Chapter 5 Tests and Adjustments.*
Incorrect air/fuel or ignition/spark control	*See Chapter 7 Advanced Diagnostics.*
No crankshaft position sensor signal	Verify the crankshaft position signal is present *See Chapter 7 Advanced Diagnostics.*
SECM / control system malfunction	Check Coolant Temperature Sensor using the Service Tool; compare coolant temperature with ambient temperature on cold engine. If coolant temperature reading is 5° greater than or less than ambient air temperature on a cold engine, check resistance in coolant sensor circuit or sensor itself. Compare CTS resistance value to "Diagnostic Aids" chart at end of this section. Verify that there is no code for ETC spring check fault. Check for 0% APP during cranking. Cycle key ON and OFF and listen for throttle check (movement) on key OFF. Check for oil pressure switch faults. Check for sensor "sticking" faults. Check TPS for stuck binding or a high TPS voltage with the throttle closed.

Fuel system malfunction	Check fuel lock off: actuator should turn “ON” for 2 seconds when ignition is turned “ON”. Check fuel pressure. Check for contaminated fuel. Check lock off fuses (visually inspect). Check FTV system for proper operation.
PROBABLE CAUSE	CORRECTIVE ACTION
Ignition system malfunction	Check for proper ignition voltage output with spark tester. Check spark plugs. Remove spark plugs, check for wet plugs, cracks, wear, improper gap, burned electrodes, or heavy deposits. Repair or replace as necessary. Check for: • Moisture in distributor cap* • Bare or shorted wires • Worn distributor shaft/rotor* • Loose ignition coil ground • Pickup coil resistance and connections (*) Where present

Related MIL Faults:
ETC spring check / ETC faults / EST faults / TPS conflict
APP faults / Encoder error / MAP faults / Oil pressure faults

(continued on next page)

Engine Cranking but Will Not Start / Difficult to Start (cont’d.)

Basic Troubleshooting (cont’d.)

Lack of Power, Slow to Respond / Poor High Speed Performance / Hesitation During Acceleration

Engine delivers less than expected power. Little or no increase in speed when accelerator pedal is pushed down part way. Momentary lack of response as the accelerator is pushed down. Can occur at all vehicle speeds. Usually most severe when first trying to make vehicle move, as from a stop. May cause engine to stall.

PRELIMINARY CHECKS	
Perform the visual checks as described at start of " Basic Troubleshooting" chapter. Drive vehicle; verify problem exists. Remove air filter and check for dirt or other means of plugging. Replace if needed.	
PROBABLE CAUSE	**CORRECTIVE ACTION**
Fuel system malfunction	Check for restricted fuel filter. Check fuel supply. Check for contaminated fuel. Check for clogged fuel filter and repair or replace as required. *See Chapter 3 Fuel Filter replacement* Check for plugged fuel line and remove any obstruction from the fuel line: • Using caution, disconnect the fuel line (some natural gas may escape). • Clear obstruction with compressed air. • Re-connect fuel line. Check for faulty vapor connection between pressure regulator and mixer: • Verify that there are no holes in hose. • Observe that clamps are tight. • Look for kinked, pinched and/or collapsed hose. Monitor pre-catalyst O2 with Service Tool. Check for proper pressure regulator operation. *See Chapter 5 Test and Adjustments.* Check for proper air/fuel mixer operation.
Ignition system malfunction	Check spark advance for excessive retarded ignition timing. Use Service Tool. Check secondary voltage using an oscilloscope or a spark tester to check for a weak coil. Check spark plug condition. Check poor spark plug primary and secondary wire condition.

(continued on next page)

Lack of Power, Slow to Respond / Poor High Speed Performance Hesitation During Acceleration (cont'd.)

PROBABLE CAUSE	CORRECTIVE ACTION
Component malfunction	Check SECM grounds for cleanliness and secure connection. See SECM wiring diagrams. Check alternator output voltage. Repair if less than 9 volts or more than 16 volts. Check for clogged air filter and clean or replace as required. Check exhaust system for possible restriction. Refer to Chart T-1 on later pages. Inspect exhaust system for damaged or collapsed pipes. • Inspect muffler for heat distress or possible internal failure. • Check for possible plugged catalytic converter by comparing exhaust system backpressure on each side at engine. Check backpressure by removing Pre-catalyst O2 sensor and measuring backpressure with a gauge.
Engine mechanical	*See Engine Manufacturer's Service Manual.* Check engine valve timing and compression Check engine for correct or worn camshaft.

Related MIL Faults:

EST faults
ETC faults
ETC spring check
TPS faults
APP faults
Encoder error
Delayed Shutdown faults

Detonation / Spark Knock

A mild to severe ping, usually worse under acceleration. The engine makes sharp metallic knocks that change with throttle opening (similar to the sound of hail striking a metal roof).

PRELIMINARY CHECKS
Perform the visual checks as described at start of " Basic Troubleshooting" chapter.

PROBABLE CAUSE	CORRECTIVE ACTION
Fuel system malfunction	Check fuel pressure. To determine if the condition is caused by a rich or lean system, the vehicle should be driven at the speed of the complaint. Monitoring with the Service Tool will help identify problem.
Cooling system malfunction	Check for obvious overheating problems: • Low engine coolant • Loose water pump belt • Restricted air flow to radiator, or restricted water flow through radiator • Inoperative electric cooling fan • Correct coolant solution should be a mix of anti-freeze coolant (or equivalent) and water • High coolant temperature
Ignition system malfunction	Check ignition timing. Check spark module wiring.
Exhaust system malfunction	Check exhaust backpressure. Check for debris clogging the catalyst. Check that pre-catalyst O2 sensor is functioning.
Engine mechanical	Check for excessive oil in the combustion chamber and/or blow by from excessive PCV flow. Check combustion chambers for excessive carbon build up. Check combustion chamber pressure by performing a compression test. Check for incorrect basic engine parts such as cam, heads, pistons, etc.

Related MIL Faults:

EST faults
Encoder error
High coolant temperature faults

Backfire

Fuel ignites in intake manifold or in exhaust system, making loud popping noise.

PRELIMINARY CHECKS
Perform the visual checks as described at start of " Basic Troubleshooting" chapter. Simulate condition by reviewing operation procedure practiced by vehicle operator.

PROBABLE CAUSE	CORRECTIVE ACTION
Fuel system malfunction	Perform fuel system diagnosis check: • Check for fuel leaks • Check for MIL faults • Check for damaged components
Ignition system malfunction	Check proper ignition coil output voltage with spark tester. Check spark plugs. Remove spark plugs, check for wet plugs, cracks, wear, improper gap, burned electrodes, or heavy deposits. Repair or replace as necessary. Check spark plug wires for crossfire; also inspect distributor cap, spark plug wires and proper routing of plug wires. Check ignition timing.
Engine mechanical	Check compression: look for sticking or leaking valves. Check intake and exhaust manifold for casting flash and gasket misalignment. Refer to Engine Manufacturer's Service Manual.

Related MIL Faults: EST faults / ETC faults / Encoder error
Pre-catalyst O2 sensor faults

Dieseling, Run-on

Engine continues to run after key is turned "OFF," but runs very roughly. If engine runs smoothly, check ignition switch and adjustment.

PRELIMINARY CHECKS
Perform the visual checks as described at start of " Basic Troubleshooting" chapter.

PROBABLE CAUSE	CORRECTIVE ACTION
Fuel system malfunction	Check for fuel leaks.
Ignition switching	Make sure power to system is shut off when key is in OFF position.
Fuel lock off valve	Make sure lock off valve is closing properly.
Ignition system malfunction	Check spark advance at idle.

Related MIL Faults: EST faults / ETC faults / Pre-catalyst O2 sensor faults

Rough, Unstable, Incorrect Idle, or Stalling

Engine cranks OK, but does not start for a long time. Does eventually run, or may start but immediately dies.

PRELIMINARY CHECKS	
Perform the visual checks as described at start of " Basic Troubleshooting" chapter. Check for vacuum leaks. Check that SECM grounds are clean and tight. See SECM wiring diagram.	
PROBABLE CAUSE	**CORRECTIVE ACTION**
Fuel system malfunction	Monitor oxygen feedback to help identify the cause of the problem. If the system is running lean or if the system is running rich evaluate further i.e. dither valve duty cycle. Check for incorrect minimum idle speed that may be caused by foreign material accumulation in the throttle bore, on the throttle valve, or on the throttle shaft. The pre-catalyst oxygen (O2) sensor should respond quickly to different throttle positions. If it does not, then check the pre-catalyst O2 sensor for contamination. If the pre-catalyst O2 sensor is aged or contaminated, the SECM will not deliver correct amount of fuel, resulting in a drivability problem.
Ignition system malfunction	Check ignition system; wires, plugs, etc.
Natural gas pressure regulator malfunction	Test regulator operation and pressure. *See Chapter 5 Tests and Adjustments*
Air/fuel mixer malfunction	Check mixer.
Component malfunction	Check throttle for sticking or binding. Check PCV valve for proper operation by placing finger over inlet hole in valve end several times. Valve should snap back. If not, replace valve. Check alternator output voltage. Repair if less than 9 or more than 16 volts.
Engine mechanical	Perform a cylinder compression check. *See Engine Manufacturer's Service Manual.*

(continued on next page)

Rough, Unstable, Incorrect Idle, or Stalling (cont'd.)

PROBABLE CAUSE	CORRECTIVE ACTION
Clogged fuel filter	Repair/replace as required *See Chapter 3 Fuel Filter Replacement*
Plugged fuel line	Remove obstruction from the fuel line. • Using caution, disconnect the fuel line (some natural gas may escape). • Clear obstruction with compressed air. • Re-connect fuel line.
Fuel lock-off malfunction	Repair/replace fuel lock-off. *See Chapter 3 Fuel Lock-Off.*
Faulty vapor connection between the pressure regulator and the mixer	Check connection. • Verify no holes in hose. • Clamps must be tight. • Look for kinked, pinched and/or collapsed hose.
Vacuum leak	Check for vacuum leaks . . . • Between mixer and throttle body • Between throttle body and intake manifold • Between intake manifold and cylinder head

Related MIL Faults:

EST faults
ETC Sticking fault
Pre-catalyst adapts error

Cuts Out, Misses

Steady pulsation or jerking that follows engine speed, usually more pronounced as engine load increases, sometimes above 1500 rpm. The exhaust has a steady spitting sound at idle or low speed.

PRELIMINARY CHECKS	
Perform the visual checks as described at start of " Basic Troubleshooting" chapter.	
PROBABLE CAUSE	**CORRECTIVE ACTION**
Fuel system malfunction	Check fuel system specifically for plugged fuel filter, low pressure. Check for contaminated fuel. Check lock off intermittent connection. Check dither valve operation.
Ignition system malfunction	Check for spark on the suspected cylinder(s) using a shop oscilloscope or spark tester or equivalent. If no spark, check for intermittent operation or miss. If there is a spark, remove spark plug(s) in these cylinders and check for cracks, wear, improper gap, burned electrodes, heavy deposits. Check spark plug wires by connecting ohmmeter to ends of each wire in question. If meter reads over 30,000 ohms, replace wire(s). Visually inspect distributor cap, rotor, and wires for moisture, dust, cracks, burns, etc. Spray plug wires with fine water mist to check for shorts. Check engine ground wire for looseness or corrosion.
Component malfunction	Check for electromagnetic interference (EMI). A missing condition can be caused by EMI on the reference circuit. EMI can usually be detected by monitoring engine rpm with Service Tool. A sudden increase in rpm with little change in actual engine rpm indicates EMI is present. If problem exists, check routing of secondary wires and check distributor ground circuit. Check intake and exhaust manifolds for casting flash or gasket leaks.
Engine mechanical	Perform compression check on questionable cylinders. If compression is low, repair as necessary. Check base engine. Remove rocker covers and check for bent pushrods, worn rocker arms, broken valve springs, worn camshaft lobes, and valve timing. Repair as necessary.

Related MIL Faults:

EST faults
ETC Sticking fault

Poor Fuel Economy / Excessive Fuel Consumption
Natural Gas Exhaust Smell

Fuel economy, as measured during normal operation, is noticeably lower than expected. Also, economy is noticeably lower than what it has been in the past. Natural gas fuel smell near vehicle sets off carbon monoxide sensors.

PRELIMINARY CHECKS
Perform the visual checks as described at start of " Basic Troubleshooting" chapter. Verify operator complaint: identify operating conditions. Check operator's driving habits: Are tires at correct pressure? Are excessively heavy loads being carried? Is acceleration too much, too often? Check air cleaner element (filter) for being dirty or plugged. Visually (physically) check vacuum hoses for splits, kinks, and proper connections.

PROBABLE CAUSE	CORRECTIVE ACTION
Fuel system malfunction	Check for faulty pressure regulator. Check that dither valve duty cycle is < 15%. Check for too high natural gas pressure at mixer (> 1" positive pressure). Monitor Pre-catalyst O2 sensor with Service Tool.
Cooling system malfunction	Check engine coolant level. Check engine thermostat for faulty part (always open) or for wrong heat range.
Ignition system malfunction	Check ignition timing. Check for weak ignition and/or spark control. Check spark plugs. Remove spark plugs and check for wet plugs, cracks, wear, improper gap, burned electrodes, or heavy deposits. Repair or replace as necessary.
Component malfunction	Check for exhaust system restriction or leaks. Check induction system and crankcase for air leaks. Check for clogged air filter; clean or replace as required. Check FTV for housing cracks or obstructions; repair or replace as required. Check for vacuum leak. Check system vacuum hoses from regulator to FTV and mixer. Repair or replace as required.
Air/fuel mixer malfunction	Check mixer.
Pressure regulator malfunction / fuel pressure too high	Test regulator operation and pressure. *See Chapter 5 Tests and Adjustments.*
Engine mechanical	Check compression. *Refer to Engine Manufacturer's Service Manual.*

Related MIL Faults:

Pre-catalyst O2 sensor faults / Low side driver / Dither valve duty cycle
EST faults / Fuel adapt faults / Low coolant temperature

High Idle Speed

Engine idles above the range of 750-1000 rpm.

PRELIMINARY CHECKS
Perform the visual checks as described at start of " Basic Troubleshooting" chapter.

PROBABLE CAUSE	**CORRECTIVE ACTION**
Incorrect idle speed control	Check all hoses and gaskets for cracking, kinks, or leaks. Verify that there are no vacuum leaks. *See Chapter 7 Advanced Diagnostics & Chapter 5 Tests and Adjustments*
Throttle sticking	Replace throttle. *See Fault Code 461: ETC_Sticking*
Foot pedal sticking or incorrect pedal signal	Check pedal return spring travel for binding. Check APP function with Service Tool. Verify smooth change of APP reading with pedal movement. *See Chapter 7 Advanced Diagnostics.*
Engine mechanical	Check for vacuum hose leak. Check for PCV malfunction. Check for defective intake gasket.

Related MIL Faults:

ETC Sticking fault
Idle adapt out of range
MAP Sticking fault
MAP high value

Excessive Exhaust Emissions or Odors

Vehicle has high CO emissions.
NOTE: Excessive odors do not necessarily indicate excessive emissions.

PRELIMINARY CHECKS
Verify that no stored codes exist. If emission test shows excessive CO and HC, check items that cause vehicle to run **rich**. If emission test shows excessive NOx, check items that cause vehicle to run **lean** or too hot.

PROBABLE CAUSE	CORRECTIVE ACTION
Cooling system malfunction	If the Service Tool indicates a very high coolant temperature and the system is running *lean*: • Check engine coolant level. • Check engine thermostat for faulty part (always open) or for wrong heat range. • Check fan operation
Fuel system malfunction	If the system is running *rich*, refer to "Diagnostic Aids" chart on the next page. If the system is running *lean* refer to "Diagnostic Aids" chart on the next page. Check for properly installed fuel system components. Check fuel pressure.
Ignition system malfunction	Check ignition timing. Check spark plugs, plug wires, and ignition components.
Component malfunction	Check for vacuum leaks. Check for contamination for catalytic converter (look for the removal of fuel filler neck restrictor). Check for carbon build-up. Remove carbon with quality engine cleaner. Follow instructions on label. Check for plugged PCV valve. Check for stuck or blocked PCV hose. Check for fuel in the crankcase.

Related MIL Faults:

Low side driver
Fuel adapt faults
EST faults

Diagnostic Aids for Rich / Lean Operation

SERVICE TOOL ITEM	RICH	LEAN
Pre-catalyst O2 A/ D counts	Consistently > 250	Consistently < 170
Pre-catalyst O2 sensor switching between high and low	Always high ADC	Always low ADC
Trim valve duty cycle	> 90%	< 10%
Malfunction codes	• Pre-catalyst O2 sensor failed rich • Pre-catalyst O2 sensor high • Fuel adapts	• Pre-catalyst O2 sensor failed lean • Pre-catalyst O2 sensor low • Fuel adapts
Closed loop operation	Stuck in open loop	Stuck in open loop

RICH OPERATION

Gaseous fuel (Trim valve duty cycle>90%)

- Inspect hoses from AVV port (port on bottom of mixer) to trim valves and regulator for leaks or blockages, replace as necessary.
- Inspect in-line orifices for blockages (in wye), replace as necessary
- Check trim valves for proper operation, replace as necessary
- Check regulator out pressure, replace if out of spec
- Inspect fuel cone for damage, replace mixer assembly as necessary

LEAN OPERATION

Gaseous fuel (trim valve duty cycle<10%)

- Check for vacuum leaks, replace hoses, o-rings, and gaskets as necessary
- Check balance line for blockage, replace as necessary
- Check vapor hose for restrictions, replace as necessary
- Check trim valves for proper operation, replace as necessary
- Check regulator out pressure, replace if out of spec

Chart T-1
Restricted Exhaust System Check

Proper diagnosis for a restricted exhaust system is essential before replacement of any components. The following procedures may be used for diagnosis, depending upon engine or tool used.

CHECK AT PRE-CATALYST OXYGEN (O_2) SENSOR

1. Carefully remove pre-catalyst oxygen (O_2) sensor.
2. Install exhaust backpressure tester or equivalent in place of O_2 sensor using Snap-On P/N EEVPV311A kit and YA8661 adapter or Mac tool. See **Figure 26**.
3. After completing test described below, be sure to coat threads of O_2 sensor with anti-seize compound prior to re-installation.

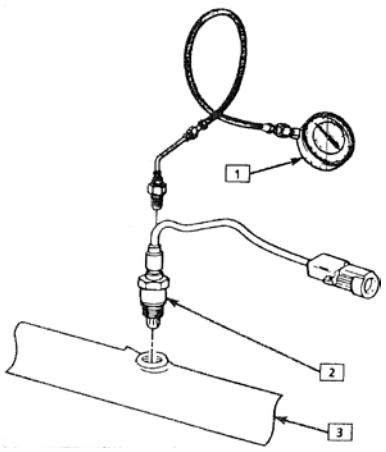


ILLUSTRATION NOTES

[1] Backpressure gage
[2] Pre-catalyst Oxygen (O_2) sensor
[3] Exhaust manifold

Courtesy of GM 1991 Service Manual for Chevrolet Camaro © 1990

Figure 26. Installing Exhaust Backpressure Tester

DIAGNOSIS:

1. With the engine idling at normal operating temperature, observe the exhaust system backpressure reading on the gage. Reading should not exceed 1.25 psig (8.61 kPa).
2. Increase engine speed to 2000 RPM and observe gage. Reading should not exceed 3 psig (20.68 kPa).
3. If the backpressure at either speed exceeds specification, a restricted exhaust system is indicated.
4. Inspect the entire exhaust system for a collapsed pipe, heat distress, or possible internal damage, split welds, or cracked pipe.
5. If there are no obvious reasons for the excessive backpressure, the catalytic converter is restricted and should be replaced using current recommended procedures.

Chapter 7.
Advanced Diagnostics

PG-08 systems are equipped with built-in fault diagnostics. Detected system faults can be displayed by the Malfunction Indicator Lamp (MIL) as Diagnostic Fault Codes (DFC) or flash codes, and viewed in detail with the use of the Service Tool software. When the ignition key is turned on, the MIL will illuminate and remain on until the engine is started. Once the engine is started, the MIL lamp will go out unless one or more fault conditions are present. If a detected fault condition exists, the fault or faults will be stored in the memory of the small engine control module (SECM). Once an active fault occurs the MIL will illuminate and remain ON. This signals the operator that a fault has been detected by the SECM.

Reading Diagnostic Fault Codes

All PG-08 fault codes are three-digit codes. See MotoService Tool Handbook. Active and stored fault codes will be displayed on the Diagnostic Service Tool.

Displaying Fault Codes (DFC) from SECM Memory

See MotoService Tool Handbook. Active and stored fault codes will be displayed on the Diagnostic Service Tool.

Clearing Fault (DFC) Codes

See MotoService Tool Handbook

CAUTION
Once the fault list is cleared it cannot be restored.

Fault Action Descriptions

Each fault detected by the SECM is stored in memory (FIFO) and has a specific action or result that takes place. Listed below are the descriptions of each fault action.

Engine Shutdown: The most severe action is an Engine Shutdown. The MIL will light and the engine will immediately shut down, stopping spark and closing the fuel lock-off solenoid valve.

Delayed Engine Shutdown: Some faults, such as low oil pressure, will cause the MIL to illuminate for 30 seconds and then shut down the engine.

Cut Fuel: Fuel flow will be turned off.

Cut Throttle: The throttle moves to its default position. The engine will run at idle but will not accelerate.

Turn on MIL: The MIL will light by an active low signal provided by the SECM, indicating a fault condition. May illuminate with no other action or may be combined with other actions, depending on which fault is active.

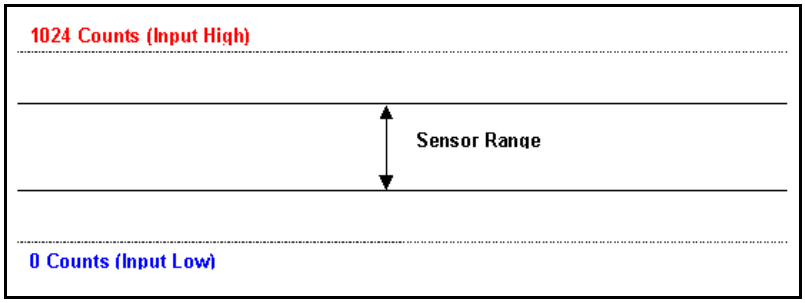
Soft Rev Limit / Medium Rev Limit / Hard Rev Limit: System will follow various sequences to bring engine speed back to acceptable levels.

Level4 Power Limit / Level3 Power Limit / Level2 Power Limit / Level1 Power Limit: The maximum engine power output will be limited to one of four possible levels. The engine power is calculated from measured engine parameters (e.g. MAP, rpm, fuel flow, etc).

Disable Gas O2 Control: In natural gas mode, closed loop correction of air fuel ratio based on the Pre-catalyst O2 sensor is disabled.

Fault List Definitions

All the analog sensors in the PG-08 system have input sensor range faults. These are the coolant temperature sensor, fuel temperature sensor, throttle position sensors, pedal position sensors, manifold pressure sensor, HEGO sensors, and intake air temperature sensor. Signals to these sensors are converted into digital counts by the SECM. A low/high range sensor fault is normally set when the converted digital counts reach the minimum of 0 or the maximum of 1024 (**1024 = 5.0 Vdc with ~ 204 counts per volt**).



Additionally, the SECM includes software to learn the actual range of the throttle position settings and throttle position sensors in order to take full advantage of the sensor range. Faults are set if the learned values are outside of the normal expected range of the sensor (e.g. APP1AdaptLoMin).

Table 1. Fault List Definitions

FAULT	DESCRIPTION	CODE
APP1AdaptHiMax	Learned full pedal end of APP1 sensor range higher than expected	641
APP1AdaptHiMin	Learned full pedal end of APP1 sensor range lower than expected	651
APP1AdaptLoMax	Learned idle end of APP1 sensor range higher than expected	661
APP1AdaptLoMin	Learned idle end of APP1 sensor range lower than expected	631
APP1RangeHigh	APP1 sensor voltage out of range high, normally set if the APP1 signal has shorted to power or the ground for the sensor has opened	621
APP1RangeLow	APP1 sensor voltage out of range low, normally set if the APP1 signal has shorted to ground, circuit has opened or sensor has failed	611
APP2AdaptHiMax	Learned full pedal end of APP2 sensor range higher than expected	642

Table 1. Fault List Definitions (cont'd.)

FAULT	DESCRIPTION	CODE
APP2AdaptHiMin	Learned full pedal value of APP_2 sensor range lower than expected	652
APP2AdaptLoMax	Learned idle value of APP_2 sensor range higher than expected	662
APP2AdaptLoMin	Learned idle value of APP_2 sensor range lower than expected	632
APP2RangeHigh	APP_2 sensor voltage out of range high, normally set if the APP_2 signal has shorted to power or the ground for the sensor has opened	622
APP2RangeLow	APP_2 sensor voltage out of range low, normally set if the APP_2 signal has shorted to ground, circuit has opened or sensor has failed	612
APP_Sensors_Conflict	APP position sensors do no not track well, intermittent connections to APP or defective pedal assembly	691
CamEdgesFault	No CAM signal when engine is known to be rotating, broken CAM sensor leads or defective CAM sensor	191
CamSyncFault	Loss of synchronization on the CAM sensor, normally due to noise on the signal or an intermittent connection on the CAM sensor	192
CrankEdgesFault	No crankshaft signal when engine is known to be rotating, broken crankshaft sensor leads or defective crank sensor	193
CrankSyncFault	Loss of synchronization on the crankshaft sensor, normally due to noise on the signal or an intermittent connection on the crankshaft sensor	194
ECTOverTempFault	Engine Coolant Temperature is High. The sensor has measured an excessive coolant temperature typically due to the engine overheating.	161
ECTRangeHigh	Engine Coolant Temperature Sensor Input is High. Normally set if coolant sensor wire has been disconnected or circuit has opened to the SECM.	151

Table 1. Fault List Definitions (cont'd.)

FAULT	DESCRIPTION	CODE
ECTRangeLow	Engine Coolant Temperature Sensor Input is Low. Normally set if the coolant sensor wire has shorted to chassis ground or the sensor has failed.	141
ECT_IR_Fault	Engine Coolant Temperature not changing as expected	171
EST1_Open	EST1 output open, possibly open EST1 signal or defective spark module	421
EST1_Short	EST1 output shorted high or low, EST1 signal shorted to ground or power or defective spark module	431
ETCSpringTest	Electronic Throttle Control Spring Return Test has Failed. The SECM will perform a safety test of the throttle return spring following engine shutdown. If this spring has become weak the throttle will fail the test and set the fault. **NOTE: Throttle assembly is not a serviceable item and can only be repaired by replacing the DV-EV throttle assembly**.	481
ETC_Open_Fault	Electronic Throttle Control Driver has failed. Normally set if either of the ETC driver signals have opened or become disconnected, electronic throttle or SECM is defective.	471
ETC_Sticking	Electronic Throttle Control is Sticking. This can occur if the throttle plate (butterfly valve) inside the throttle bore is sticking. The plate sticking can be due to some type of obstruction; a loose throttle plate or worn components shaft bearings. ***NOTE: Throttle assembly is not a serviceable item and can only be repaired by replacing the DV-EV throttle assembly.***	461
FuelSelectConflict	Conflict in fuel select signals, normally set if one or both of the fuel select signals are shorted to ground	181
FuelTempRangeHigh	Fuel Temperature Sensor Input is High. Normally set if the fuel temperature sensor wire has been disconnected or the circuit has opened to the SECM.	932
FuelTempRangeLow	Fuel Temperature Sensor Input is Low. Normally set if the fuel temperature sensor wire has shorted to chassis ground or the sensor has failed.	931
GasFuelAdaptRangeHi	In natural gas mode, system had to adapt lean more than expected	731
GasFuelAdaptRangeLo	In natural gas mode, system had to adapt rich more than expected	721
GasO2FailedLean	Pre-catalyst O_2 sensor indicates extended lean operation on natural gas	751

Table 1. Fault List Definitions (cont'd.)

FAULT	DESCRIPTION	CODE
GasO2FailedRich	Pre-catalyst O_2 sensor indicates extended rich operation on natural gas	771
GasO2NotActive	Pre-catalyst O_2 sensor inactive on natural gas, open O_2 sensor signal or heater leads, defective O_2 sensor, or defective FTVs	741
GasPostO2FailedRich	Post-catalyst O_2 sensor control on natural gas has reached rich limit and sensor still reads too lean. This could be caused by oxygen leak before or just after sensor, catalyst failure, sensor failure, or wiring/relay failure causing the sensor to not be properly heated. If any Pre-O_2 sensor faults are set, diagnose these first and after correcting these faults recheck if this fault sets.	772
GasPostO2FailedLean	Post-catalyst O_2 sensor control on natural gas has reached lean limit and sensor still reads too rich. This could be caused by catalyst failure, sensor failure, or wiring/relay failure causing the sensor to not be properly heated. If any Pre-O_2 sensor faults are set diagnose, these first and after correcting these faults recheck if this fault sets.	752
GasPostO2Inactive	Post-catalyst O_2 sensor control on natural gas has sensed the O_2 sensor is not responding as expected. If any Pre-O_2 sensor faults are set diagnose these first and after correcting these faults recheck if this fault sets. Possible causes for this fault are sensor disconnected, sensor heater failed, sensor element failed, heater relay, or SECM control of heater relay is disconnected or failed.	742
HbridgeFault_ETC	(Electronic Throttle Control Driver has Failed) Indeterminate fault on Hbridge driver for Electronic Throttle Control. Possibly either ETC+ or ETC- driver signals have been shorted to ground	491
HardOverspeed	Engine speed has exceeded the third level (3 of 3) of overspeed protection	571

Table 1. Fault List Definitions (cont'd.)

FAULT	DESCRIPTION	CODE
IATRangeHigh	Intake Air Temperature Sensor Input is High normally set if the IAT temperature sensor wire has been disconnected, the circuit has opened to the SECM, or a short to Vbatt has occurred.	381
IATRangeLow	Intake Air Temperature Sensor Input is Low normally set if the IAT temperature sensor wire has shorted to chassis ground or the sensor has failed.	371
IAT_IR_Fault	Intake Air Temperature not changing as expected	391
LSDFault_CrankDisable	Crank Disable Fault, signal has opened or shorted to ground or power or defective crank disable relay	715
LSDFault_Dither1	Dither Valve 1 Fault, signal has opened or shorted to ground or power or defective dither 1 valve	711
LSDFault_Dither2	Dither Valve 2 Fault, signal has opened or shorted to ground or power or defective dither 2 valve	712
LSDFault_LockOff	Fuel lock off Valve Fault, signal has opened or shorted to ground or power or defective Fuel lock off valve	717
LSDFault_MIL	Malfunction Indicator Lamp Fault, signal has opened or shorted to ground or power or defective MIL lamp	718
LowOilPressureFault	Low engine oil pressure	521
MAPRangeHigh	Manifold Absolute Pressure Sensor Input is High, normally set if the TMAP pressure signal wire has become shorted to power, shorted to the IAT signal, the TMAP has failed or the SECM has failed.	342
MAPRangeLow	Manifold Absolute Pressure Sensor Input is Low, normally set if the TMAP pressure signal wire has been disconnected or shorted to ground or the circuit has opened to the SECM	332
MAPTimeRangeHigh	Manifold Absolute Pressure Sensor Input is High, normally set if the TMAP pressure signal wire has become shorted to power, shorted to the IAT signal, the TMAP has failed or the SECM has failed.	341

Table 1. Fault List Definitions (cont'd.)

FAULT	DESCRIPTION	CODE
MAPTimeRangeLow	Manifold Absolute Pressure Sensor Input is Low, normally set if the TMAP pressure signal wire has been disconnected or shorted to ground or the circuit has opened to the SECM	331
MAP_IR_HI	MAP sensor indicates higher pressure than expected	351
MAP_IR_LO	MAP sensor indicates lower pressure than expected	352
MAP_STICKING	MAP sensor not changing as expected	353
MediumOverspeed	Engine speed has exceeded the second level (2 of 3) of overspeed protection	572
O2RangeHigh	Pre-catalyst O_2 sensor voltage out of range high, sensor signal shorted to power	921
O2RangeLow	Pre-catalyst O_2 sensor voltage out of range low, sensor signal shorted to ground	911
O2_PostCatRangeHigh	Post-catalyst O_2 sensor voltage out of range high, sensor signal shorted to voltage source (5V or battery)	922
O2_PostCatRangeLow	Post-catalyst O_2 sensor voltage out of range low, sensor signal shorted to ground	912
SensVoltRangeHigh	Sensor reference voltage XDRP too high	561
SensVoltRangeLow	Sensor reference voltage XDRP too low	551
ServiceFault1	Service Interval 1 has been reached	991
ServiceFault2	Service Interval 2 has been reached	992
ServiceFault3	Service Interval 3 has been reached	993
ServiceFault4	Service Interval 4 has been reached—time to replace HEGO sensors	994
ServiceFault5	Service Interval 5 has been reached	995
SoftOverspeed	Engine speed has exceeded first level (1 of 3) of overspeed protection	573
SysVoltRangeHigh	System voltage too high	541
SysVoltRangeLow	System voltage too low	531

Table 1. Fault List Definitions (cont'd.)

FAULT	DESCRIPTION	CODE
TPS1AdaptHiMax	Learned WOT value of TPS_1 sensor range higher than expected	251
TPS1AdaptHiMin	Learned WOT value of TPS_1 sensor range lower than expected	271
TPS1AdaptLoMax	Learned closed throttle value of TPS_1 sensor range higher than expected	281
TPS1AdaptLoMin	Learned closed throttle value of TPS_1 sensor range lower than expected	241
TPS1RangeHigh	TPS_1 sensor voltage out of range high, normally set if the TPS_1 signal has shorted to power or ground for the sensor has opened	231
TPS1RangeLow	TPS_1 sensor voltage out of range low, normally set if TPS_1 signal has shorted to ground, circuit has opened or sensor has failed	221
TPS2AdaptHiMax	Learned WOT value of TPS_2 sensor range higher than expected	252
TPS2AdaptHiMin	Learned WOT value of TPS_2 sensor range lower than expected	272
TPS2AdaptLoMax	Learned closed throttle value of TPS_2 sensor range higher than expected	282
TPS2AdaptLoMin	Learned closed throttle value of TPS_2 sensor range lower than expected	242
TPS2RangeHigh	TPS_2 sensor voltage out of range high, normally set if the TPS_2 signal has shorted to power or ground for the sensor has opened	232
TPS2RangeLow	TPS_2 sensor voltage out of range low, normally set if TPS_2 signal has shorted to ground, circuit has opened or sensor has failed	222
TPS_Sensors_Conflict	TPS sensors differ by more than expected amount. ***NOTE: The TPS is not a serviceable item and can only be repaired by replacing the DV-EV throttle assembly***	291

Table 2. Diagnostic Fault Codes (Flash Codes)

DFC	PROBABLE FAULT	FAULT ACTION *	CORRECTIVE ACTION FIRST CHECK
12	**NONE** Signifies the end of one pass through the fault list	NONE	None, used as end of the fault list identification
141	**ECTRangeLow** Coolant Sensor failure or shorted to GND	TurnOnMil	Check ECT sensor connector and wiring for a short to GND SECM (Signal) Pin B15 To ECT Pin A SECM (Sensor GND) Pin B1 to ECT Pin B SECM (System GND) Pin A16, B17
151	**ECTRangeHigh** Coolant sensor disconnected or open circuit	(1) TurnOnMil (2) DelayedEngine Shutdown (3) CheckEngineLight	Check if ECT sensor connector is disconnected or for an open ECT circuit SECM (Signal) Pin B15 to ECT Pin A SECM (Sensor GND) Pin B1 to ECT Pin B
161	**ECTOverTempFault** Engine coolant temperature is high. The sensor has measured an excessive coolant temperature typically due to the engine overheating.	(1) TurnOnMil (2) DelayedEngine Shutdown (3) CheckEngineLight	Check coolant system for radiator blockage, proper coolant level and for leaks in the system. Possible ECT short to GND, check ECT signal wiring SECM (Signal) Pin B15 to ECT Pin A SECM (Sensor GND) Pin B1 to ECT Pin B SECM (System GND) Pin A16, B17 Check regulator for coolant leaks
171	**ECT_IR_Fault** Engine coolant temperature not changing as expected	NONE	Check for coolant system problems, e.g. defective or stuck thermostat
181	**FuelSelectConflict** Conflict in fuel select signals, normally set if both of the fuel select signals are shorted to ground	TurnOnMil	Check fuel select switch connection for a short to GND SECM (SIGNAL) Pin A12 SECM (SIGNAL) Pin A15 SECM (Sensor GND) Pin B1
191	**CamEdgesFault** No CAM signal when engine is known to be rotating, broken crankshaft sensor leads or defective CAM sensor	NONE	Check CAM sensor connections at distributor SECM (SIGNAL) Pin B10 to distributor connector Pin B SECM (Sensor GND) Pin B1 to distributor connector Pin A SECM 5V (PWR) to distributor connector Pin C Check for defective CAM sensor in distributor housing.

(*) Fault actions shown are default values specified by the OEM.

Table 2. Diagnostic Fault Codes (Flash Codes) cont'd.

DFC	PROBABLE FAULT	FAULT ACTION *	CORRECTIVE ACTION FIRST CHECK
192	**CamSyncFault** Loss of synchronization on the CAM sensor, normally due to noise on the signal or an intermittent connection on the CAM sensor	NONE	Check CAM sensor connections at distributor SECM (SIGNAL) Pin B10 to distributor connector Pin B SECM (Sensor GND) Pin B1 to distributor connector Pin A SECM 5V (PWR) to distributor connector Pin C Check for defective CAM sensor in distributor housing
193	**CrankEdgesFault** No crankshaft signal when engine is known to be rotating, broken crankshaft sensor leads or defective crank sensor	NONE	Check Crankshaft sensor connections SECM (SIGNAL) Pin B5 to Crank sensor Pin C SECM (Sensor GND) PIN B1 to Crank sensor Pin B SECM 5V (PWR) to Crank sensor Pin A Check for defective Crank sensor
194	**CrankSyncFault** Loss of synchronization on the crankshaft sensor, normally due to noise on the signal or an intermittent connection on the crankshaft sensor	NONE	Check Crankshaft sensor connections SECM (SIGNAL) Pin B5 to Crank sensor Pin C SECM (Sensor GND) Pin B1 to Crank sensor Pin B SECM 5V (PWR) to Crank sensor Pin A Check for defective Crank sensor
221	**TPS1RangeLow** TPS_1 sensor voltage out of range low, normally set if the TPS_1 signal has shorted to ground, circuit has opened or sensor has failed	TurnOnMil	Check throttle connector connection and TPS_1 sensor for an open circuit or short to GND SECM Pin B23 (signal) to ETC Pin 6 SECM Pin B1 (sensor GND) to ETC Pin 2 SECM (system GND) Pin A16, B17
222	**TPS2RangeLow** TPS_2 sensor voltage out of range low, normally set if the TPS_2 signal has shorted to ground, circuit has opened or sensor has failed	TurnOnMil	Check throttle connector connection and TPS_2 sensor for an open circuit or short to GND SECM Pin B4 (signal) to ETC Pin 5 SECM Pin B1 (sensor GND) to ETC Pin 2 SECM (system GND) Pin A16, B17

(*) Fault actions shown are default values specified by the OEM.

Table 2. Diagnostic Fault Codes (Flash Codes) cont'd.

DFC	PROBABLE FAULT	FAULT ACTION *	CORRECTIVE ACTION FIRST CHECK
231	**TPS1RangeHigh** TPS_1 sensor voltage out of range high, normally set if the TPS_1 signal has shorted to power or the ground for the sensor has opened	TurnOnMil	Check throttle connector and TPS_1 sensor wiring for a shorted circuit SECM Pin B23 (signal) to ETC Pin 6 SECM Pin B1 (sensor GND) to ETC Pin 2
232	**TPS2RangeHigh** TPS_2 sensor voltage out of range high, normally set if the TPS_2 signal has shorted to power or the ground for the sensor has opened	TurnOnMil	Check throttle connector and TPS_1 sensor wiring for a shorted circuit SECM Pin B4 (signal) to ETC Pin 5 SECM pin B1 (sensor GND) to ETC Pin 2
241	**TPS1AdaptLoMin** Learned closed throttle value of TPS_1 sensor range lower than expected	NONE	Check the throttle connector and pins for corrosion. To check the TPS disconnect the throttle connector and measure the resistance from: TPS Pin 2 (GND) to Pin 6 (TPS_1 SIGNAL) (0.7 Ω ± 30%) TPS Pin 3 (PWR) to Pin 6 (TPS_1 SIGNAL) (1.4 Ω ± 30%)
242	**TPS2AdaptLoMin** Learned closed throttle value of TPS_2 sensor range lower than expected	NONE	Check the throttle connector and pins for corrosion. To check the TPS disconnect the throttle connector and measure the resistance from: TPS Pin 2 (GND) to Pin 5 (TPS_2 SIGNAL) (1.3K Ω ± 30%) TPS PIN 3 (PWR) to PIN 5 (TPS_2 SIGNAL) (0.6K Ω ± 30%)
251	**TPS1AdaptHiMax** Learned WOT value of TPS_1 sensor range higher than expected	NONE	N/A
252	**TPS2AdaptHiMax** Learned WOT value of TPS_2 sensor range higher than expected	NONE	N/A
271	**TPS1AdaptHiMin** Learned WOT value of TPS_1 sensor range lower than expected	NONE	N/A
272	**TPS2AdaptHiMin** Learned WOT value of TPS_2 sensor range lower than expected	NONE	N/A

(*) Fault actions shown are default values specified by the OEM.

Table 2. Diagnostic Fault Codes (Flash Codes) cont'd.

DFC	PROBABLE FAULT	FAULT ACTION *	CORRECTIVE ACTION FIRST CHECK
281	**TPS1AdaptLoMax** Learned closed throttle value of TPS_1 sensor range higher than expected	NONE	N/A
282	**TPS2AdaptLoMax** Learned closed throttle value of TPS_2 sensor range higher than expected	NONE	N/A
291	**TPS_Sensors_Conflict** TPS sensors differ by more than expected amount **NOTE:** ***The TPS is not a serviceable item and can only be repaired by replacing the DV-EV throttle assembly.***	(1) TurnOnMil (2) Engine Shutdown	Perform checks for DFCs 241 & 242
331	**MAPTimeRangeLow** Manifold Absolute Pressure sensor input is low, normally set if the TMAP pressure signal wire has been disconnected or shorted to ground or the circuit has opened to the SECM	NONE	Check TMAP connector and MAP signal wiring for an open circuit TMAP Pin 4 to SECM Pin B18 (signal) TMAP Pin 1 to SECM Pin B1 (sensor GND) TMAP Pin 3 to SECM Pin B24 (PWR) Check the MAP sensor by disconnecting the TMAP connector and measuring at the sensor: TMAP Pin 1(GND) to Pin 4 (pressure signal kPa) (2.4kΩ - 8.2kΩ) TMAP Pin 3 (PWR) to Pin 4 (pressure signal kPa) (3.4kΩ - 8.2kΩ)

(*) Fault actions shown are default values specified by the OEM.

Table 2. Diagnostic Fault Codes (Flash Codes) cont'd.

DFC	PROBABLE FAULT	FAULT ACTION *	CORRECTIVE ACTION FIRST CHECK
332	**MAPRangeLow** Manifold Absolute Pressure sensor input is low, normally set if the TMAP pressure signal wire has been disconnected or shorted to ground or the circuit has opened to the SECM	(1) TurnOnMil (2) CutThrottle	Check TMAP connector and MAP signal wiring for an open circuit TMAP Pin 4 to SECM Pin B18 (signal) TMAP Pin 1 to SECM Pin B1 (sensor GND) TMAP Pin 3 to SECM Pin B24 (PWR) Check the MAP sensor by disconnecting the TMAP connector and measuring at the sensor: TMAP Pin 1(GND) to Pin 4 (pressure signal kPa) (2.4kΩ - 8.2kΩ) TMAP Pin 3 (power) to Pin 4 (pressure signal kPa) (3.4kΩ - 8.2kΩ)
341	**MAPTimeRangeHigh** Manifold Absolute Pressure Sensor Input is High, normally set if the TMAP pressure signal wire has become shorted to power, shorted to the IAT signal, the TMAP has failed or the SECM has failed.	NONE	Check TMAP connector and MAP signal wiring for a shorted circuit TMAP Pin 4 to SECM Pin B18 (signal) TMAP Pin 1 to SECM Pin B1 (sensor GND) TMAP Pin 3 to SECM Pin B24 (PWR) Check the MAP sensor by disconnecting the TMAP connector and measuring at the sensor: TMAP Pin 1(GND) to Pin 4 (pressure signal kPa) (2.4kΩ - 8.2kΩ) TMAP Pin 3 (power) to Pin 4 (pressure signal kPa) (3.4kΩ - 8.2kΩ)
342	**MAPRangeHigh** Manifold Absolute Pressure Sensor Input is High, normally set if the TMAP pressure signal wire has become shorted to power, shorted to the IAT signal, the TMAP has failed or the SECM has failed	(1) TurnOnMil (2) CutThrottle	Check TMAP connector and MAP signal wiring for a shorted circuit TMAP Pin 4 to SECM Pin B18 (signal) TMAP Pin 1 to SECM Pin B1 (sensor GND) TMAP Pin 3 to SECM Pin B24 (PWR) Check the MAP sensor by disconnecting the TMAP connector and measuring at the sensor: TMAP Pin 1(GND) to Pin 4 (pressure signal kPa) (2.4kΩ - 8.2kΩ) TMAP Pin 3 (power) to Pin 4 (pressure signal kPa) (3.4kΩ - 8.2kΩ)

(*) Fault actions shown are default values specified by the OEM.

Table 2. Diagnostic Fault Codes (Flash Codes) cont'd.

DFC	PROBABLE FAULT	FAULT ACTION *	CORRECTIVE ACTION, FIRST CHECK
351	**MAP_IR_HI** MAP sensor indicates higher pressure than expected	NONE	Check for vacuum leaks. Check that TMAP sensor is mounted properly. Possible defective TMAP sensor.
352	**MAP_IR_LO** MAP sensor indicates lower pressure than expected	NONE	Possible defective TMAP sensor.
353	**MAP_STICKING** MAP sensor not changing as expected	NONE	Check that TMAP sensor is mounted properly. Possible defective TMAP sensor.
371	**IATRangeLow** Intake Air Temperature Sensor Input is Low normally set if the IAT temperature sensor wire has shorted to chassis ground or the sensor has failed.	TurnOnMil	Check TMAP connector and IAT signal wiring for a shorted circuit TMAP Pin 2 to SECM Pin B12 (signal) TMAP Pin 1 to SECM Pin B1 (sensor GND) To check the IAT sensor of the TMAP disconnect the TMAP connector and measure the IAT resistance Resistance is approx 2400 ohms at room temperature.
381	**IATRangeHigh** Intake Air Temperature Sensor Input is High normally set if the IAT temperature sensor wire has been disconnected or the circuit has opened to the SECM.	TurnOnMil	Check TMAP connector and IAT signal wiring for a shorted circuit TMAP Pin 2 to SECM Pin B12 (signal) TMAP Pin 1 to SECM Pin B1 (sensor GND) To check the IAT sensor of the TMAP disconnect the TMAP connector and measure the IAT resistance Resistance is approx 2400 ohms at room temperature.
391	**IAT_IR_Fault** Intake Air Temperature not changing as expected	NONE	Check connections to TMAP sensor. Check that TMAP sensor is properly mounted to manifold.
421	**EST1_Open** EST1 output open, possibly open EST1 signal or defective spark module	TurnOnMil	Check ignition module wiring and connector for open circuit SECM Pin A9 (EST1) to ignition module Pin B. Verify GND on ignition module Pin C Verify +12 Vdc on ignition module Pin A Refer to application manual for specific engine details.

(*) Fault actions shown are default values specified by the OEM.

Table 2. Diagnostic Fault Codes (Flash Codes) cont'd.

DFC	PROBABLE FAULT	FAULT ACTION *	CORRECTIVE ACTION FIRST CHECK
431	**EST1_Short** EST1 output shorted high or low, EST1 signal shorted to ground or power or defective spark module	TurnOnMil	Check ignition module wiring and connector for shorts SECM Pin A9 (EST1) to ignition module Pin B Verify GND on ignition module Pin C Verify +12 Vdc on ignition module Pin A Refer to application manual for specific engine details.
461	**ETC_Sticking** Electronic Throttle Control is sticking. This can occur if the throttle plate (butterfly valve) inside the throttle bore is sticking. The plate sticking can be due to some type of obstruction, a loose throttle plate, or worn components shaft bearings. **NOTE: *The throttle assembly is not a serviceable item and can only be repaired by replacing the DV-EV throttle assembly.***	(1) TurnOnMil (2) EngineShutdown (3) CutThrottle	Check for debris or obstructions inside the throttle body * Check throttle-plate shaft for bearing wear Check the ETC driver wiring for an open circuit SECM Pin A17 to ETC + Pin 1 SECM Pin A18 to ETC - Pin 4 Check the ETC internal motor drive by disconnecting the throttle connector and measuring the motor drive resistance at the throttle ETC Pin 1 (+DRIVER) to Pin 4 (-DRIVER) ~3.0-4.0Ω
471	**ETC_Open_Fault** Electronic Throttle Control Driver has failed, normally set if either of the ETC driver signals have opened or become disconnected, electronic throttle or SECM is defective.	NONE	Check the ETC driver wiring for an open circuit SECM Pin A17 to ETC + Pin 1 SECM Pin A18 to ETC - Pin 4 Check the ETC internal motor drive by disconnecting the throttle connector and measuring the motor drive resistance at the throttle ETC Pin 1 (+DRIVER) to Pin 4 (-DRIVER) ~3.0-4.0Ω
491	**HbridgeFault_ETC** Electronic Throttle Control Driver has failed. Indeterminate fault on Hbridge driver for electronic throttle control. Possibly either ETC+ or ETC- driver signals have been shorted to ground	TurnOnMil	Check ETC driver wiring for a shorted circuit SECM Pin A17 to ETC + Pin 1 SECM Pin A18 to ETC - Pin 4 Check the ETC internal motor drive by disconnecting the throttle connector and measuring the motor drive resistance at the throttle ETC Pin 1 (+DRIVER) to Pin 4 (-DRIVER) ~3.0-4.0Ω

(*) Fault actions shown are default values specified by the OEM.

Table 2. Diagnostic Fault Codes (Flash Codes) cont'd.

DFC	PROBABLE FAULT	FAULT ACTION *	CORRECTIVE ACTION FIRST CHECK
521	**LowOilPressureFault** Low engine oil pressure	(1) TurnOnMil (2) DelayedEngine Shutdown (3) CheckEngine Light	Check engine oil level Check electrical connection to the oil pressure switch SECM Pin B9 to Oil Pressure Switch
531	**SysVoltRangeLow** System voltage too low	TurnOnMil	Check battery voltage * Perform maintenance check on electrical connections to the battery and chassis ground * Check battery voltage during starting and when the engine is running to verify charging system and alternator function * Measure battery power at SECM with a multimeter (with key on) SECM Pin A23 (DRVP) to SECM Pin A16 (DRVG) SECM Pin A23 (DRVP) to SECM Pin B17 (DRVG)
541	**SysVoltRangeHigh** System voltage too high	TurnOnMil	Check battery and charging system voltage * Check battery voltage during starting and when the engine is running * Check voltage regulator, alternator, and charging system * Check battery and wiring for overheating and damage * Measure battery power at SECM with a multimeter (with key on) SECM Pin A23 (DRVP) to SECM Pin A16 (DRVG) SECM Pin A23 (DRVP) to SECM Pin B17 (DRVG)

(*) Fault actions shown are default values specified by the OEM.

Table 2. Diagnostic Fault Codes (Flash Codes) cont'd.

DFC	PROBABLE FAULT	FAULT ACTION *	CORRECTIVE ACTION FIRST CHECK
551	**SensVoltRangeLow** Sensor reference voltage XDRP too low	(1) TurnOnMil (2) EngineShutdown	Measure transducer power at the TMAP connector with a multimeter TMAP Pin 3 (PWR) to TMAP Pin 1 (sensor GND) Verify transducer power at the SECM with a multimeter SECM Pin B24 (PWR) to SECM Pin B1 (sensor GND) Verify transducer power at ETC with a multimeter ETC Pin 3 (PWR) to ETC Pin 2 (sensor GND) Verify transducer power to the foot pedal with a multimeter.
561	**SensVoltRangeHigh** Sensor reference voltage XDRP too high	(1) TurnOnMil (2) EngineShutdown	Measure transducer power at the TMAP connector with a multimeter TMAP Pin 3 (PWR) to TMAP Pin 1 (sensor GND) Verify transducer power at the SECM with a multimeter SECM Pin B24 (PWR) to SECM Pin B1 (sensor GND) Verify transducer power at ETC with a multimeter ETC Pin 3 (PWR) to ETC Pin 2 (sensor GND) Verify transducer power to the foot pedal with a multimeter.
571	**HardOverspeed** Engine speed has exceeded the third level (3 of 3) of overspeed protection	(1) TurnOnMil (2) HardRevLimit	Usually associated with additional ETC faults * Check for ETC Sticking or other ETC faults Verify if the lift truck was motored down a steep grade
572	**MediumOverspeed** Engine speed has exceeded the second level (2 of 3) of overspeed protection	(1) TurnOnMil (2) MediumRevLimit	Usually associated with additional ETC faults * Check for ETC Sticking or other ETC faults Verify if the vehicle was motored down a steep grade
573	**SoftOverspeed** Engine speed has exceeded the first level (1 of 3) of overspeed protection	(1) TurnOnMil (2) SoftRevLimit	Usually associated with additional ETC faults * Check for ETC Sticking or other ETC faults Verify if the vehicle was motored down a steep grade
611	**APP1RangeLow** APP_1 sensor voltage out of range low, normally set if the APP_1 signal has shorted to ground, circuit has opened or sensor has failed	(1) TurnOnMil (2) CheckEngineLight	Check foot pedal connector * Check APP_1 signal at SECM PIN B7

(*) Fault actions shown are default values specified by the OEM.

Table 2. Diagnostic Fault Codes (Flash Codes) cont'd.

DFC	PROBABLE FAULT	FAULT ACTION *	CORRECTIVE ACTION FIRST CHECK
612	**APP2RangeLow** APP_2 sensor voltage out of range low, normally set if the APP_2 signal has shorted to ground, circuit has opened or sensor has failed	TurnOnMil	Check foot pedal connector * Check APP_2 signal at SECM PIN B16
621	**APP1RangeHigh** APP_1 sensor voltage out of range high, normally set if the APP_1 signal has shorted to power or the ground for the sensor has opened	(1) TurnOnMil (2) CheckEngine Light	Check foot pedal connector * Check APP_1 signal at SECM PIN B7
622	**APP2RangeHigh** APP_2 sensor voltage out of range high, normally set if the APP_2 signal has shorted to power or the ground for the sensor has opened	TurnOnMil	Check foot pedal connector * Check APP_2 signal at SECM PIN B16
631	**APP1AdaptLoMin** Learned idle value of APP_1 sensor range lower than expected	NONE	Check APP connector and pins for corrosion * Cycle the pedal several times and check APP_1 signal at SECM Pin B7
632	**APP2AdaptLoMin** Learned idle value of APP_2 sensor range lower than expected	NONE	Check APP connector and pins for corrosion * Cycle the pedal several times and check APP_2 signal at SECM Pin B16
641	**APP1AdaptHiMax** Learned full pedal value of APP_1 sensor range higher than expected	NONE	N/A
642	**APP2AdaptHiMax** Learned full pedal value of APP_2 sensor range higher than expected	NONE	N/A
651	**APP1AdaptHiMin** Learned full pedal value of APP_1 sensor range lower than expected	NONE	N/A
652	**APP2AdaptHiMin** Learned full pedal value of APP_2 sensor range lower than expected	NONE	N/A
661	**APP1AdaptLoMax** Learned idle value of APP_1 sensor range higher than expected	NONE	N/A
662	**APP2AdaptLoMax** Learned idle value of APP_2 sensor range higher than expected	NONE	N/A

(*) Fault actions shown are default values specified by the OEM.

Table 2. Diagnostic Fault Codes (Flash Codes) cont'd.

DFC	PROBABLE FAULT	FAULT ACTION *	CORRECTIVE ACTION FIRST CHECK
691	**APP_Sensors_Conflict** APP position sensors do no not track well, intermittent connections to APP or defective pedal assembly	1) TurnOnMil (2) Level1PowerLimit	Check APP connector and pins for corrosion * Cycle the pedal several times and check APP_1 signal at SECM Pin B7 * Cycle the pedal several times and check APP_2 signal at SECM Pin B16
711	**LSDFault_Dither1** Dither Valve 1 Fault, signal has opened or shorted to ground or power or defective dither 1 valve	TurnOnMil	Check FTV_1 for an open wire or FTV connector being disconnected FTV_1 Pin 1 (signal) to SECM Pin A1 FTV_1 Pin 2 (power) to SECM (DRVP) Pin A23 Check FTV_1 for an open coil by disconnecting the FTV connector and measuring the resistance (~26Ω ± 2Ω)
712	**LSDFault_Dither2** Dither Valve 2 Fault, signal has opened or shorted to ground or power or defective dither 2 valve	TurnOnMil	Check FTV_2 for an open wire or FTV connector being disconnected or signal shorted to GND FTV_2 Pin 1 (signal) to SECM Pin A2 FTV_2 Pin 2 (power) to SECM (DRVP) Pin A23 Check FTV_2 for an open coil by disconnecting the FTV connector and measuring the resistance (~26Ω ± 2Ω)
715	**LSDFault_CrankDisable** Crank Disable Fault, signal has opened or shorted to ground or power or defective crank disable relay	NONE	N/A

(*) Fault actions shown are default values specified by the OEM.

Table 2. Diagnostic Fault Codes (Flash Codes) cont'd.

DFC	PROBABLE FAULT	FAULT ACTION *	CORRECTIVE ACTION FIRST CHECK
717	**LSDFault_LockOff** Fuel lock off Valve Fault, signal has opened or shorted to ground or power or defective Fuel lock off valve	TurnOnMil	Check fuel lock off valve for an open wire or connector being disconnected or signal shorted to GND Lockoff Pin B (signal) to SECM Pin A11 Lockoff Pin A (power) to SECM (DRVP) Pin A23 Check CSV for an open coil by disconnecting the CSV connector and measuring the resistance (~26Ω ± 3Ω)
718	**LSDFault_MIL** Malfunction Indicator Lamp Fault, signal has opened or shorted to ground or power or defective MIL lamp	NONE	Check MIL lamp for an open wire or short to GND.
721	**GasFuelAdaptRangeLo** In natural gas mode, system had to adapt rich more than expected	TurnOnMil	Check for vacuum leaks. Check fuel trim valves, e.g. leaking valve or hose Check for missing orifice(s).
731	**GasFuelAdaptRangeHi** In natural gas mode, system had to adapt lean more than expected	TurnOnMil	Check fuel trim valves, e.g. plugged valve or hose. Check for plugged orifice(s).
741	**GasO2NotActive** Pre-catalyst O_2 sensor inactive on natural gas, open O_2 sensor signal or heater leads, defective O_2 sensor	(1) TurnOnMil (2) DisableGas O2Ctrl	Check that Pre-catalyst O_2 sensor connections are OK. O_2 (signal) Pin B to SECM Pin B13 O_2 Pin C (GND) to SECM (DRVG GND) Pins A16, B17 O_2 Pin 1 (power) to SECM (DRVP + 12V) Pin A23 Verify O_2 sensor heater circuit is operating by measuring heater resistance (2.1Ω ± 0.4Ω) O_2 Pin C (GND) to Pin D (power)

(*) Fault actions shown are default values specified by the OEM.

Table 2. Diagnostic Fault Codes (Flash Codes) cont'd.

DFC	PROBABLE FAULT	FAULT ACTION *	CORRECTIVE ACTION FIRST CHECK
742	**GasPostO2NotActive** Post-catalyst O_2 sensor inactive on natural gas, open O_2 sensor signal or heater leads, defective O_2 sensor.	(1) TurnOnMil (2) DisableGasPost O2Ctrl	Check that Post-catalyst O_2 sensor connections are OK. O_2 (signal) Pin B to SECM Pin B19 O_2 Pin C (GND) to SECM (DRVG GND) Pins A16, B17 O_2 Pin D (power) to Post O_2 Heater Relay. Relay pin 87. This relay only turns on after engine has been running for some time and SECM has calculated that water condensation in exhaust has been removed by exhaust heat. Post O_2 Heater Relay has SECM (DRVP + 12V) applied to the relay coil power. The relay coil ground is controlled by SECM Pin A20 to activate the relay to flow current through the post O_2 heater. Verify O_2 sensor heater circuit is operating by measuring heater resistance ($2.1\Omega \pm 0.4\Omega$) O_2 Pin C (GND) to Pin D (power)
751	**GasO2FailedLean** Pre-catalyst O_2 sensor indicates extended lean operation on natural gas	(1) TurnOnMil (2) DisableGas O2Ctrl	Check for vacuum leaks. Check fuel trim valves, e.g. leaking valve or hose. Check for missing orifice(s).
752	**GasPostO2FailedLean** Post-catalyst O_2 sensor indicates extended lean operation on natural gas	(1) TurnOnMil (2) DisableGasPost O2Ctrl	Correct other faults that may contribute to 752 (e.g. faults pertaining to fuel trim valves, Pre-Cat O_2, Post Cat O_2 sensor) Check for vacuum leaks Check for leaks in exhaust, catalytic converter, HEGO sensors; repair leaks. Check all sensor connections (see fault 742 corrective actions).
771	**GasO2FailedRich** Pre-catalyst O_2 sensor indicates extended rich operation on natural gas	(1) TurnOnMil (2) DisableGas O2Ctrl	Check fuel trim valves, e.g. plugged valve or hose. Check for plugged orifice(s).

(*) Fault actions shown are default values specified by the OEM.

Table 2. Diagnostic Fault Codes (Flash Codes) cont'd.

DFC	PROBABLE FAULT	FAULT ACTION *	CORRECTIVE ACTION FIRST CHECK
772	**GasPostO2FailedRich** Pre-catalyst O_2 sensor indicates extended rich operation on natural gas	(1) TurnOnMil (2) DisableGasPost O2Ctrl	Correct other faults that may contribute to 772 (e.g. faults pertaining to FTVs, Pre-Cat O_2, Post Cat O_2 sensor) Look for leaks in exhaust, catalytic converter, HEGO sensors; repair leaks. Check all sensor connections (see fault 742 corrective actions).
911	**O2RangeLow** Pre-catalyst O_2 sensor voltage out of range low, sensor signal shorted to ground	(1) TurnOnMil (2) DisableGasO2Ctrl	Check if O_2 sensor installed before the catalyst is shorted to GND or sensor GND. O_2 (signal) Pin B to SECM Pin B13 SECM (DRVG GND) Pins A16, B17 SECM (sensor GND) Pin B1
912	**O2_PostCatRangeLow** Post-catalyst O_2 sensor voltage out of range low, sensor signal shorted to ground	(1) TurnOnMil (2) Disable NG Post-catalyst O2Ctrl	Check if O_2 installed after the catalyst sensor is shorted to GND or sensor GND. O_2 (signal) Pin B to SECM Pin B19 Possible sources: SECM (DRVG GND) Pins A16, B17 and SECM (sensor GND) Pin B1
921	**O2RangeHigh** Pre-catalyst O2 sensor voltage out of range high, sensor signal shorted to power	(1) TurnOnMil (2) DisableGas O2Ctrl	Check if O_2 sensor installed before catalyst is shorted to +5Vdc or battery. O_2 (signal) Pin B to SECM Pin B13 SECM (PWR) Pin B24 SECM (power) Pin A23
922	**O2_PostCatRangeHigh** Post-catalyst O_2 sensor voltage out of range low, sensor signal shorted to ground	(1) TurnOnMil (2) Disable NG Post-catalyst O2Ctrl	Check if O_2 sensor installed after catalyst is shorted to +5Vdc or battery. O_2 (signal) Pin B to SECM Pin B19 Possible voltage sources: SECM (PWR) Pin B24 and SECM (power) Pin A23

(*) Fault actions shown are default values specified by the OEM.

Table 2. Diagnostic Fault Codes (Flash Codes) cont'd.

DFC	PROBABLE FAULT	FAULT ACTION *	CORRECTIVE ACTION FIRST CHECK
931	**FuelTempRangeLow** Fuel Temperature Sensor Input is Low, normally set if the fuel temperature sensor wire has shorted to chassis ground or the sensor has failed.	TurnOnMil	Check fuel temp sensor connector and wiring for a short to GND SECM (signal) Pin B14 to FTS Pin 1 SECM (sensor GND) Pin B1 to FTS Pin 2 SECM (GND) Pin A16, B17
932	**FuelTempRangeHigh** Fuel Temperature Sensor Input is High normally set if the fuel temperature sensor wire has been disconnected or the circuit has opened to the SECM.	TurnOnMil	Check if fuel temp sensor connector is disconnected or for an open FTS circuit SECM (signal) Pin B14 to FTS Pin 1 SECM (sensor GND) Pin B1 to FTS Pin 2
991	**ServiceFault1** Service Interval 1 has been reached	NONE	Perform service procedure related to Service Interval 1 (determined by OEM)
992	**ServiceFault2** Service Interval 2 has been reached	NONE	Perform service procedure related to Service Interval 2 (determined by OEM)
993	**ServiceFault3** Service Interval 3 has been reached	NONE	Perform service procedure related to Service Interval 3 (determined by OEM)
994	**ServiceFault4** Service Interval 4 has been reached—replace HEGO sensors	TurnOnMil	Replace Pre-catalyst HEGO sensor Replace Post-catalyst HEGO sensor
995	**ServiceFault5** Service Interval 5 has been reached	TurnOnMil	Perform service procedure related to Service Interval 5 (determined by OEM)

(*) Fault actions shown are default values specified by the OEM.

Chapter 8.
Parts Description

Fuel System Components

The chart below lists the PG-08 components required for an engine operating on natural gas fuel.

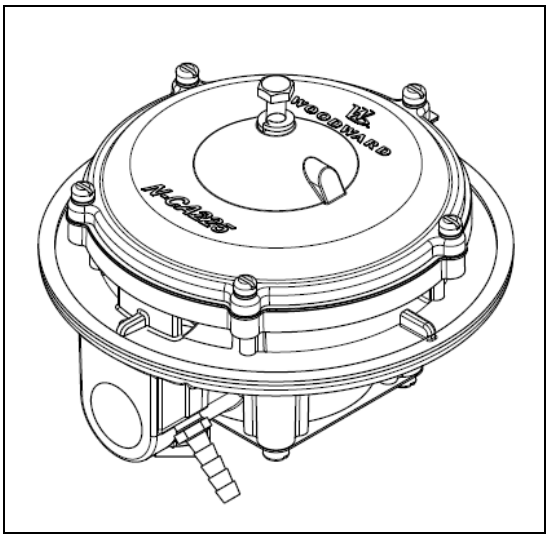
	DESCRIPTION	QTY
	Engine Control Module (SECM 48-pin)	1
	Crankshaft Position Sensor	1
	TMAP Sensor	1
	Oxygen Sensors	2
	Coolant Sensor	1
	Engine Oil Pressure Switch	1
	Fuel Trim Valves	2
	Ignition Coils	1
	Fuel Lock Off Solenoid	1
	Maxitrol R600S Regulator	1
	CA225 Mixer	1
	Throttle-DV-E5 40mm	1
	Throttle to Mixer Hose Adapter	1
	Throttle Hose	1
	Hose Clamps	2
	Wye Fitting	1
	Wye Orifice	2

CA225 Mixer

Refer to **Figure 27** exploded view on facing page.

Parts List CA225 Mixer

REF NO.	DESCRIPTION	QTY
1	Hex Head Screw, 1/4-20 x 1	1
2	Split Lockwasher, 1/4”	1
3	Fillister Head Screws, SEMS #10-24 UNC x 5/8	5
4	Mixer Cover	1
5	Air Valve Spring	1
6	Diaphragm, Fluorosilicone	1
7	Air Valve Ring	1
8	Mixer Body	1
9	Gasket, Throttle Body to Mixer	1
10	Fillister Head Screws, SEMS #12-24 x 5/8	4



Exploded View CA225 Mixer

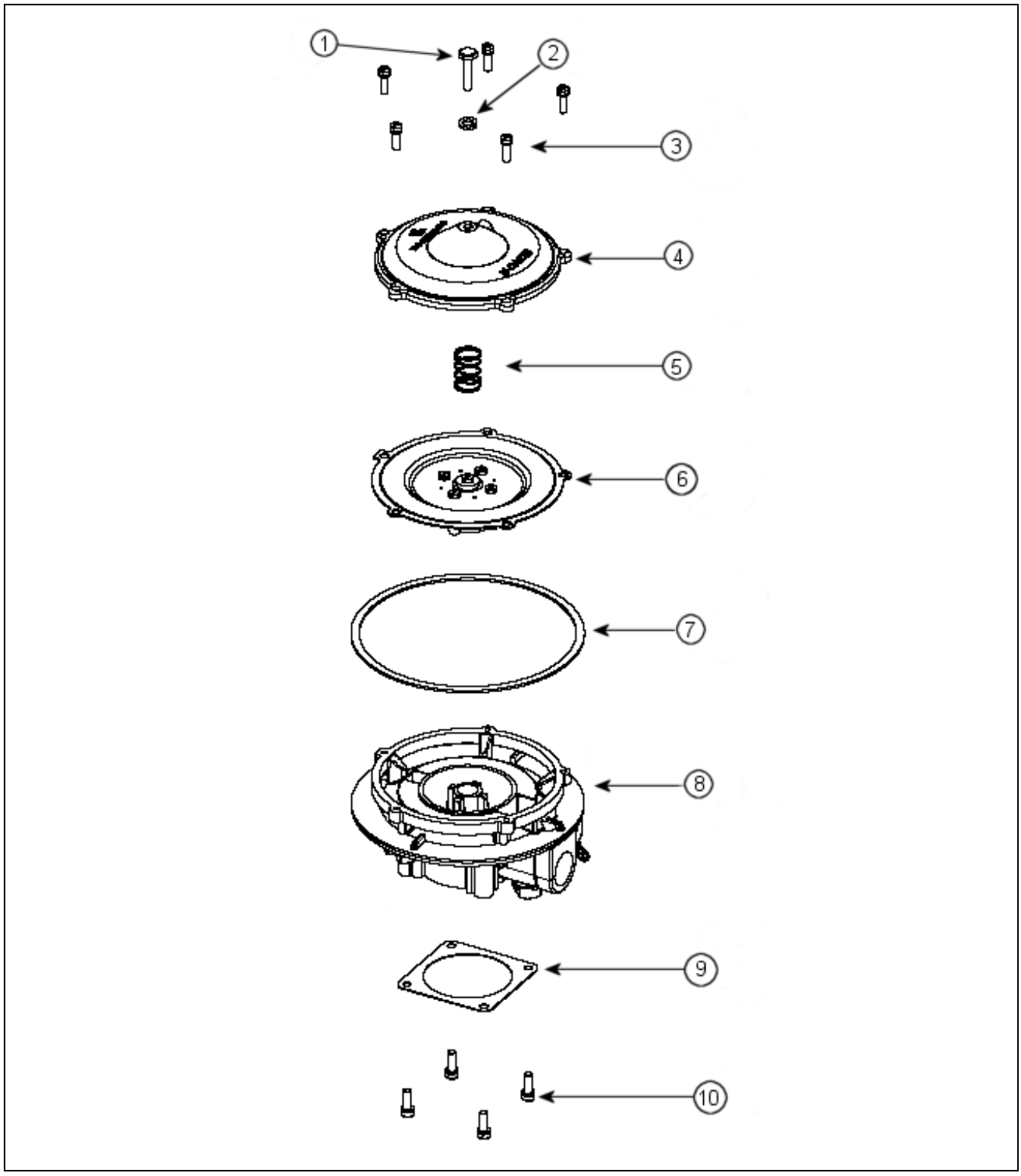
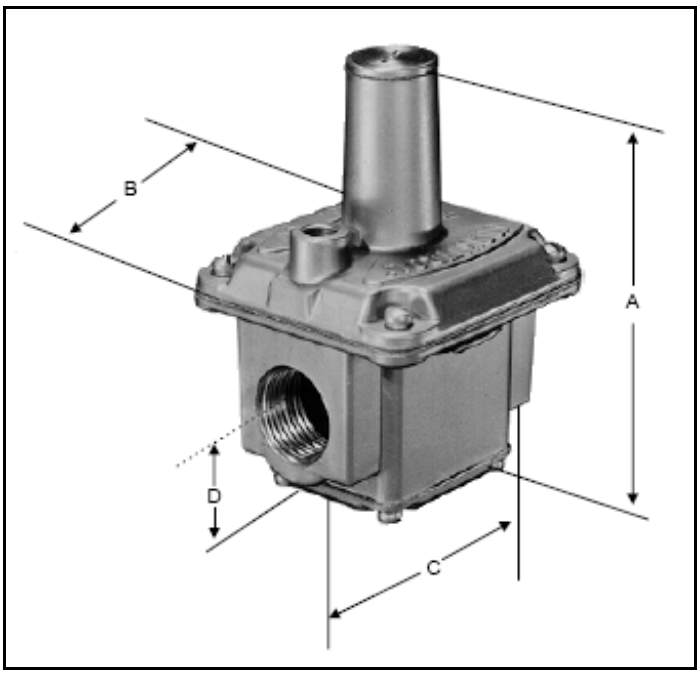


Figure 27. CA225 Mixer Exploded View

Maxitrol R600S Regulator

This R600S regulator is supplied from an outside vendor as a complete assembly. It has no servicable parts. If it tests defective, replace the entire regulator with the specified replacement assembly. The Maxitrol regulator is specifically engineered for the PG-08 system and cannot be replaced by a standard Maxtirol R600S regulator.

NOTE
The PG-08 system will malfunction if the incorrect regulator is substituted in the system. Please contact Buck's Engines' component supplier for the correct replacement part.



Swing Radius	4.32" (109.7mm)
Dimension A	5.68" (144.3mm)
Dimension B	3.88" (98.3mm)
Dimension C	4.03" (102.4mm)
Dimension D	1.46" (37.1mm)

Appendix

Abbreviations

ACFM	Actual cubic feet per minute at the specified suction conditions
AFR	Air fuel ratio
BHP	Brake horsepower
BTU	British Thermal Unit
Bi-Fuel	Able to operate on either of two fuels
CTS	Coolant temperature sensor
CNG	Compressed natural gas
Dual Fuel	Able to run simultaneously on two fuels, e.g. diesel and natural gas. Often this term is incorrectly used to describe bi-fuel operation. Spark-ignited engines are typically bi-fuel while compression ignition engines are dual-fuel.
ECM	Engine control module
FPP	Foot pedal position
FPV	Fuel primer valve
FTV	Fuel trim valve
GPM	Gallons per minute of flow
HEGO	Heated exhaust gas oxygen (sensor)
LAT	Limited-angle torque motor
MAP	Manifold absolute pressure
MAT	Manifold air temperature
MIL	Malfunction indicator lamp
MOR	Manufacturer of record for emissions certification on the engine
NG	Natural gas
NSPS	New Source Performance Standards effective in 2008 for stationary spark-ignited engines.
OEM	Original equipment manufacturer
PHI	Relative fuel-air ratio or percent of stoichiometric fuel (actual fuel-air ratio / stoichiometric fuel-air ratio)
RPM	Revolutions per minute
SECM	Small engine control module
TMAP	Temperature and manifold absolute pressure
TPS	Throttle position sensor
VDC	Voltage of direct current type
VE	Compressed natural gas
WOT	Wide open throttle

Certified Engine Troubleshooting

Types of Fuel Systems

- 3.0L, 4.3L, and 5.7L Use a dual fuel trim valve (dither valve) feedback fuel system
- 8.1L Uses a Woodward L-series trim valve feedback system

Duel Fuel Trim Components

- Maxitrol 600s regulator
- Fuel trim valves
- Throttle Body
- 225 mixer
- Vacuum wye

Maxitrol 600s regulator

Inlet fuel pressure 8 to 12 inH2O

Outlet fuel pressure 3.5 inH2O

Regulator pressure is controlled by vacuum introduced to a tee screwed into the top.

This is not field adjustable

Fuel trim valves

These control the amount of vacuum being supplied to the regulator. If you hold when the engine is running you would feel it clicking rapidly. This is providing a vacuum bias to the Maxitrol regulator

Throttle Body

The throttle body provides control of engine speed

2 verities of Woodward 225 mixers

The Non-Adjustable
It will have either a locked power valve or no power valve at all.

The adjustable
It will have a functioning power valve and idle adjusting screw

Vacuum Wyes

The Black wye will free flow

The Blue wye will have a fixed orifice in it

L-series trim valve fuel control primary components

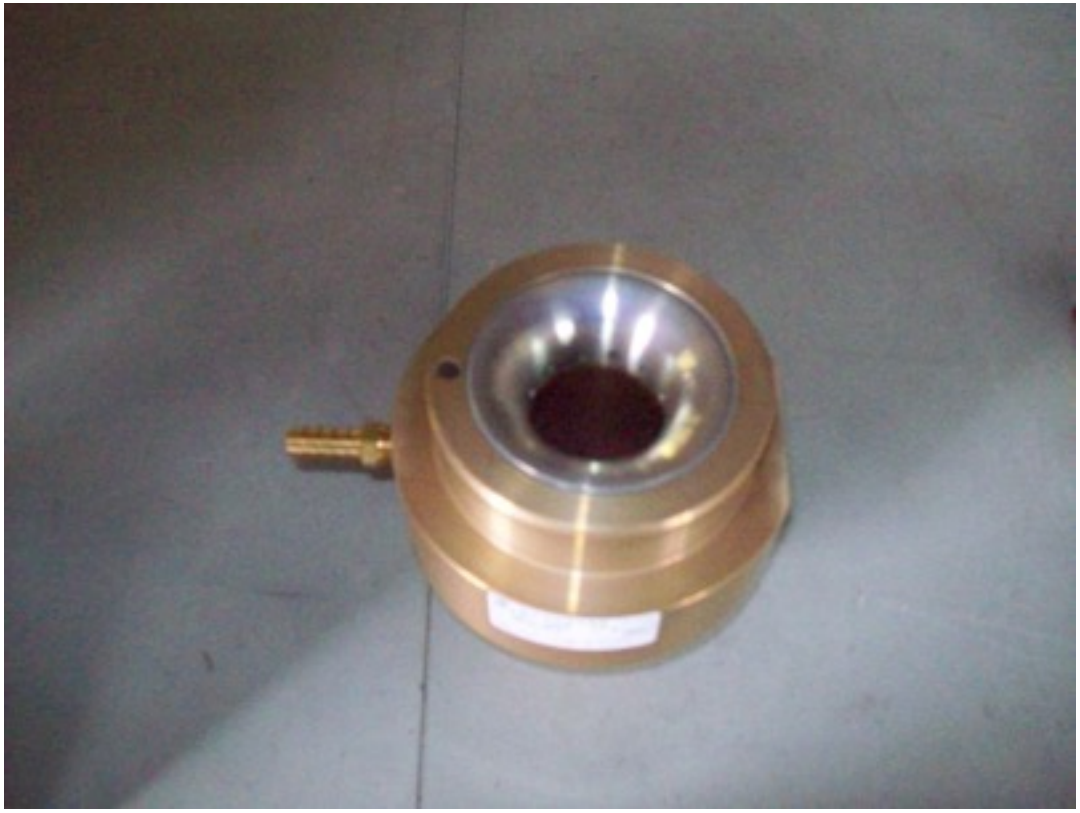
- L-Series trim valve.
- 68mm trim valve
- Maxitrol 210DZ regulator

L-Series Trim Valve

The L-Series trim valve has a flapper that opens and closes to control the amount of fuel under load. This control uses the same type of program as the L-Series governor.

68mm Venturi

The 68mm venturi has no moving parts inside of it.



Maxitrol 210DZ regulator

Inlet pressure 10 inH20

Outlet pressure .3 inH20

This regulator is considered a zero pressure. You will not feel any pressure when the lock off is opened. It is not field adjustable. Fuel is trimmed at idle by a vacuum line going to the top of the regulator

Common items to all fuel systems

- MAP sensor
- 02 Sensors
- Temperature sensor
- Oil pressure sensor

Map Sensor

The map sensor measures both engine vacuum and barometric pressure. It also measures inlet air temperature.

02 Sensor

The 02 sensors are located in the exhaust system before and after the catalyst. These are both heated sensors. The precat sensor is always on and the post cat comes on up to 3 mins after the engine starts