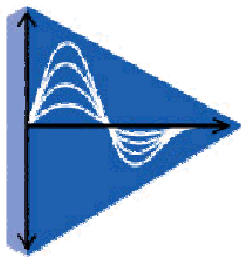


Precision Governors, LLC

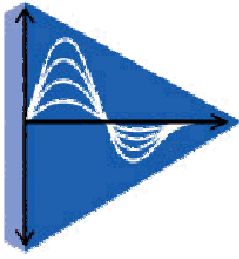
2322 Seventh Avenue, Rockford, IL 61104
phone 815.229.5300 • fax: 815.229.5342
www.precisiongovernors.com
ISO 9001 Certified



User Manual for EFI Fuel Systems



<u>Table of Contents</u>	<u>Page</u>
Contact list	3
Engine Management System Overview	4
a) ECM System components	7
b) Governed Throttle Body	8
c) Fuel Components	10
d) ECM	12
e) Engine Sensor	14
f) Cold Start Capability	15
g) Closed Loop Operation	16
Diagnostics	17
a) Summary of Diagnostic Error Codes	18
b) Description of Error Codes	19
Basic Trouble Shooting	34
Assembly Detail	37
a) Fuel Systems	38
b) ECM Connector & Harness Layout	42
Schematics	43
a) Electrical	44
b) Plumbing	48
Service Parts	50
Nomenclatures	52
Appendix	53
a) LPG Fuel System Retrofit Procedure	54



Contact List

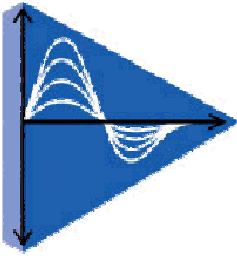
Please direct all questions and inquiries to KEM Equipment at:

KEM Equipment Inc.

Don Abel
Service and Warranty Coordinator
10800 S.W. Hermann Rd
Tualatin, OR 97062
Phone: (503) 692-5012
Fax: (503) 692-1098
Dona@kemequipment.com

Precision Governors LLC

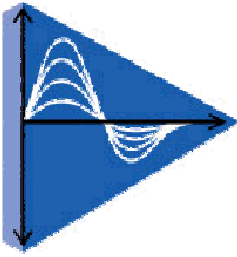
Paul Hanson
Customer Service and Repair
2322 Seventh Avenue
Rockford, IL 61104
Phone: (815) 229-5300
Fax: (815) 229-5342
phanson@precisiongovernors.com



EFI

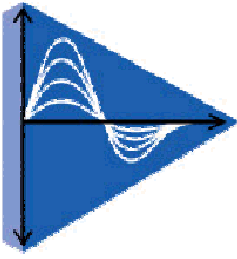
Engine Management System

Overview



EFI Fuel System

- **Integrated product design built around off-the-shelf automotive components.**
- **Certified to meet EPA/CARB 2004 off-road large spark ignition engine emission requirements.**
- **Advanced Speed governing with TPS feedback**
- **Advanced Spark ignition timing for each fuel type**



EFI System Overview

Precision/KEM Certified Engines **2004 Certified Emissions Results**

GM Engine	Fuel	Max HP	HC+NOx certified	CO certified	HC+NOx % to std	CO % to std
1.6L	Gas/LPG	45	1.96	12.35	65%	33%
3.0L	Gas/LPG	68	0.9	4.4	30%	12%
4.3L	Gas/LPG	103	0.9	13.9	30%	37%
5.7L	Gas/LPG	128	0.5	7.7	17%	21%



GM 1.6L



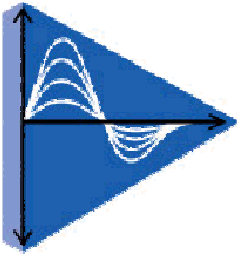
GM 4.3L



GM 3.0L



GM 5.7L



ECM System Components

- Governed Throttle body
- Fueling components



Gasoline

LP components



- ECM

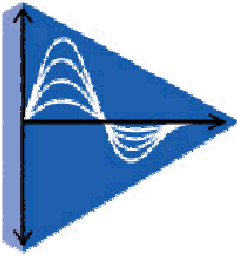


- Engine sensors



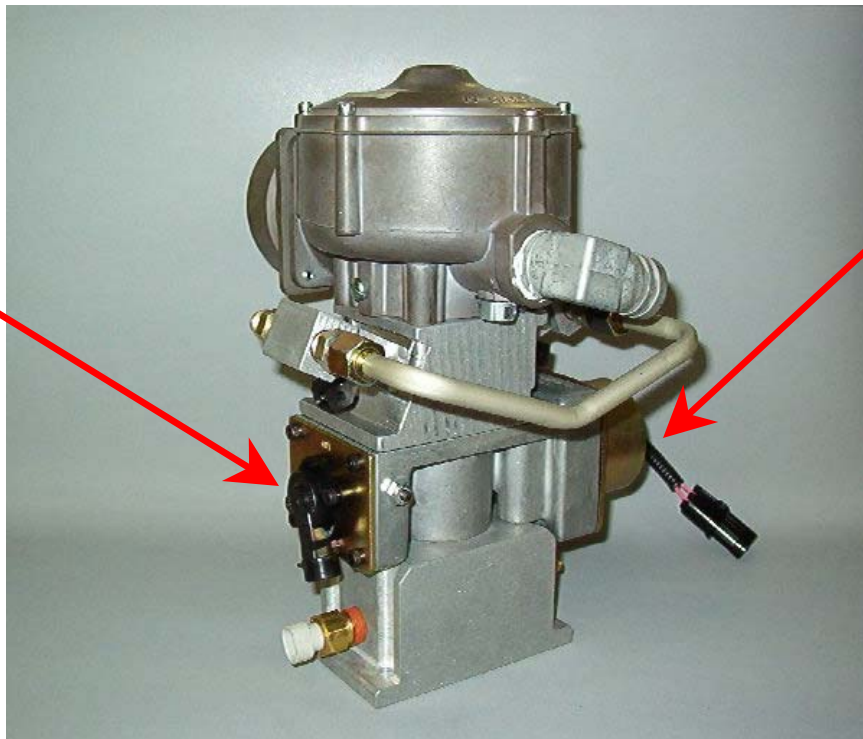
- Harness





Governed Throttle Body Dual - Fuel GM Engine

**Throttle
Position
Sensor**



*Quick
response
actuator*

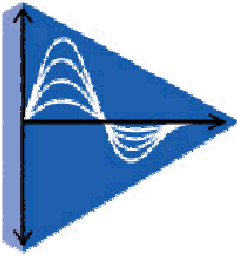
Certified On the Following GM Engines

1.6 L

3.0 L

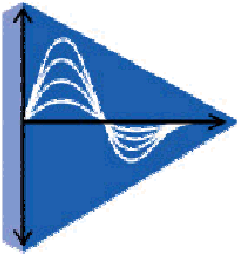
4.3 L

5.7 L



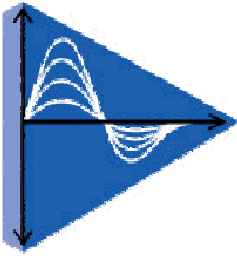
Speed Governing Modes

- **4 Discrete speeds**
- **Ramp – up / ramp – down speed select**
- **Drive by wire**
 - **Potentiometer**
 - **Foot pedal**
- **Custom plus**

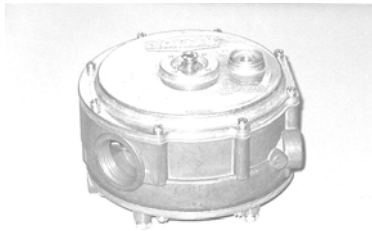


Gasoline Fuel System

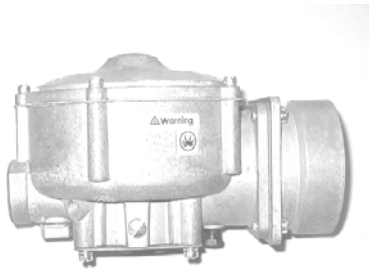
- **Siemens fuel injectors**
- **8 grams/second @ 42 psi.**
- **Throttle body fuel injection**



Gaseous Fuel System for LP, NG, & CNG

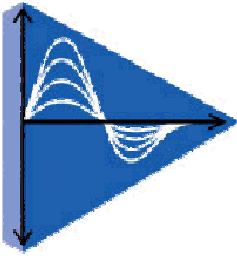


- **Use conventional gaseous fuel components for LPG and CNG**

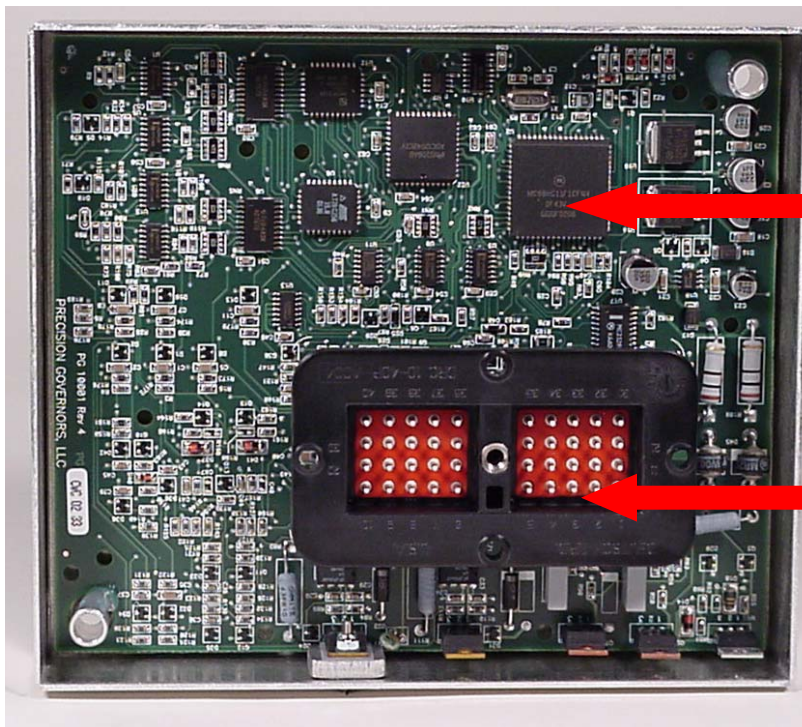


- **Lockoff valve, Vaporizer, Vacuum Valve, LP mixer**
- **Proven field reliability**
- **Avoids known problems with LP injectors**





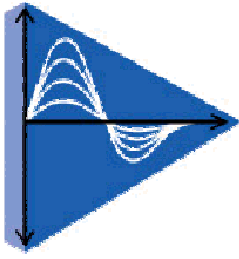
Electronic Control Module (ECM)



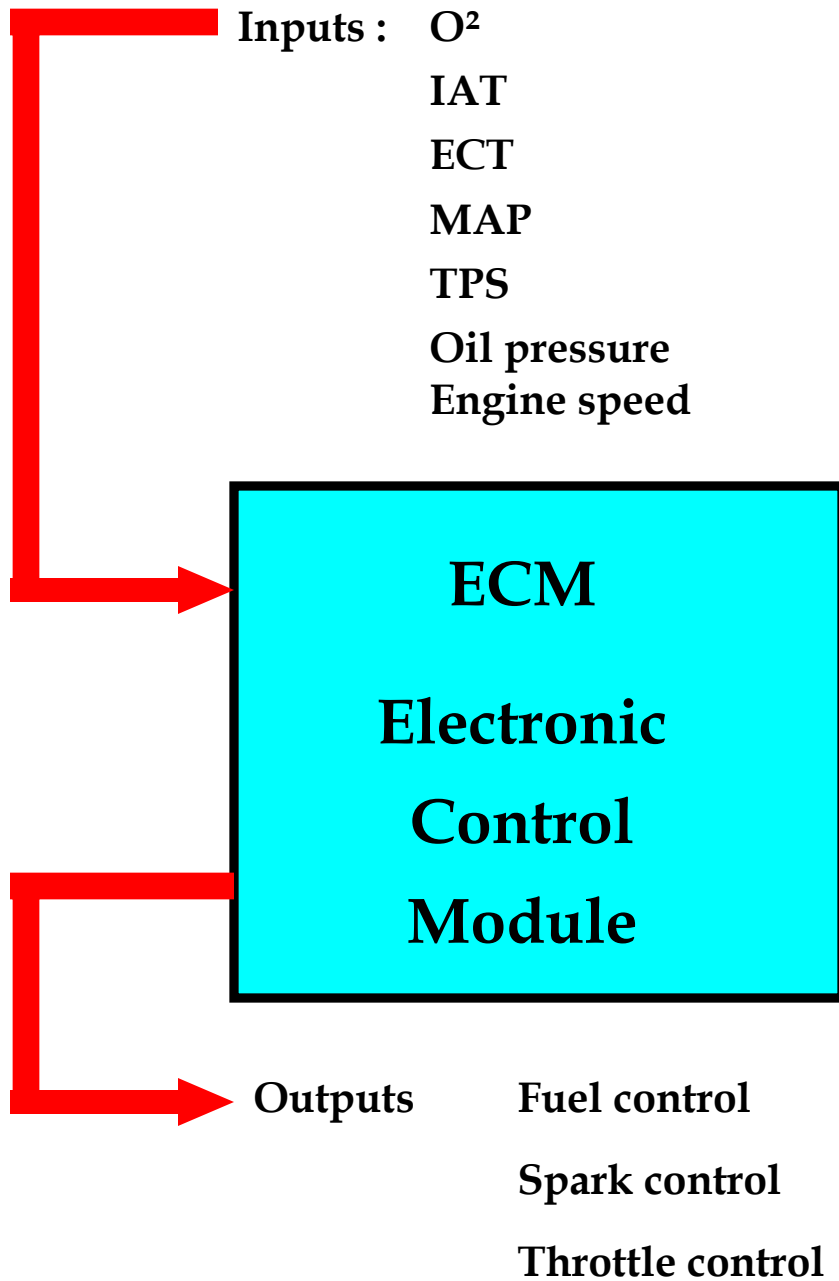
Microprocessor

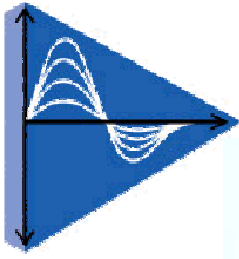
40-pin Deutsch
sealed connector

- Motorola Microprocessor controlled
- Environmental : SAE J1211-4.2
- Vibration: Mil-STD-202G at 9.2G
- Temperature Rating -40 deg to 185 deg F,
- EMI SAE J1113/21 60 VOLTS/METER
- Integral Heat sink Aluminum enclosure.
- Additional I/O capability for accessories.
- Remotely vertically mounted away from the engine.



Engine Control System





Engine Sensors

O₂ sensor

Exhaust gas emission control

MAP sensor

Engine vacuum

IAT sensor

Inlet air temperature

ECT sensor

Engine coolant temperature

Magnetic speed

Speed sensing

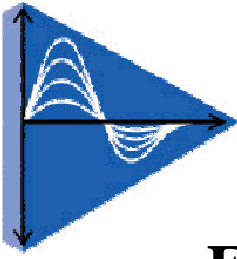
TPS

Throttle position sensor

Oil pressure sensor

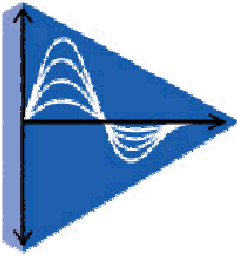
Low oil pressure shutdown





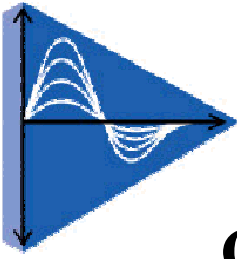
Engine Safety Shutdown Features

- **High engine coolant temperature**
 - **Programmable**
 - **Currently set at 230°F**
 - **Can be customized**
- **Low oil pressure shutdown**
- **Shuts engine down by shutting off fuel**

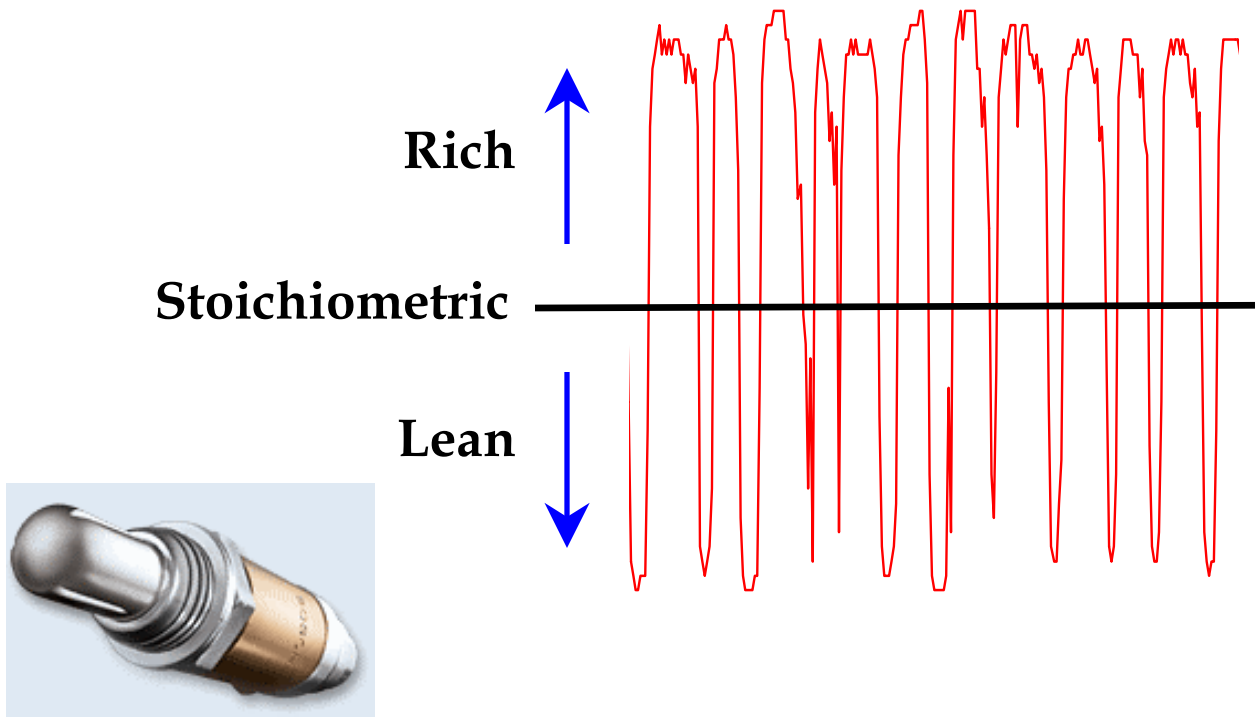


Cold Start Performance

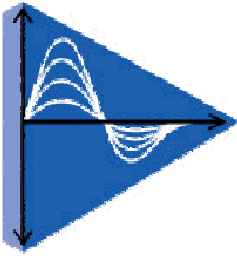
- Gasoline engines to -20°F (-30°C)
- LPG engines to 0°F (-17°C)



Closed-Loop Emissions Control

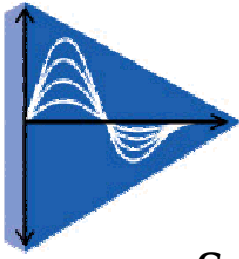


- **O₂ sensor indicates rich or lean condition**
- **Air-fuel ratio is controlled to optimize catalyst efficiency**
- **Automatic altitude compensation**



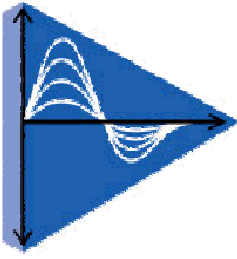
Diagnostics

- **Malfunction Indicator light (MIL) diagnostics**
- **MIL diagnostics for critical engine components including: throttle body actuator, gas injector, ECM, & all engine sensors**
- **Easy for field troubleshooting**
- **Uses simple error blink codes.**



Summary of Diagnostic Error Codes

<u>Error Codes</u>	<u>Error Description</u>
12	Diagnostic mode indicator
13	Oxygen sensor error
14	Engine coolant temp – high
15	Engine coolant temp – low
21	Throttle position sensor error
22	Throttle body actuator not responding
23	Inlet air temp sensor – low
24	Inlet air temp sensor – high
25	Electronic ignition control error
31	Drive by wire error
32	System voltage low
41	Manifold absolute pressure sensor error
43	Fuel - injector error
51	EEPROM fault
53	Oil pressure too low - fault
52	Analog to digital converter fault
61	LP solenoid relay fault
62	Fuel pump relay fault
63	Dual fuel relay fault
64	Ignition power relay output error



MIL Diagnostic Description

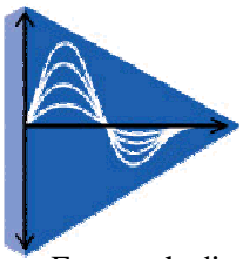
The machine's diagnostic LED is mounted in a place visible to the operator. The LED is a 2-wire device and it must be wired according to the diagram. If it is not connected correctly, the LED will not light.

Many machine or fueling problems are wiring or wiring related.

First, perform a visual inspection of the system. Unplugged, cut, or damaged connections and wires should be corrected or replaced before attempting further diagnosis.

The diagnostic LED provides a method to identify a systemic malfunction. The code format will consist of a number of blinks, a pause, a second number of blinks, then a longer pause. The first set of blinks is the 10's digit of the error code. The second set of blinks is the one's digit of the error code. After the longer pause, the next error code will be sent. At the conclusion of the error codes, a code 12 will be sent then the sequence will repeat itself.

The error codes are repeated sequentially until the malfunction is fixed or the engine has begun running. The first error code that is blinked is code 12, then all active error codes in ascending order, then it is finally concluded with a code 12 again.



Error code diagnostics below:

Code 12:

Code 12 is a special code signifying the beginning or end of the error codes.

Code 13:

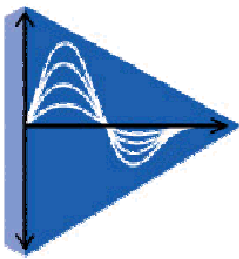
Code 13 indicates the oxygen sensor has not warmed up or has stuck rich, lean, or neutral for a period of time. Other fuel system issues can cause this; for example, incorrect fuel pressure or a leak in the MAP sensor hose.

To verify the O2 sensor wiring:

1. Verify fuses are intact.
2. Disconnect O2 sensor connector, and turn ignition power on.
3. Measure voltage across harness O2 connector pins A (-) and B (+). This should read near 0.45 volts.
4. If not. Turn off power
5. Disconnect ECM
6. Check connections shown in Table 5.

Meter mode	From	To	Desired Result	If defective
Ohms	ECM 10	Harness O2 A	$< 1 \Omega$	wire is open
Ohms	ECM 10	Harness O2 B	Open	wire is shorted
Ohms	ECM 20	Harness O2 A	$< 1 \Omega$	This wire is open
Ohms	ECM 20	Harness O2 B	Open	wire is shorted

Table 5 : Harness O2 sensor check



7. Turn on ignition power.

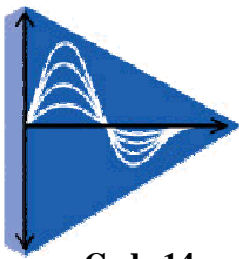
7.1. Measure the voltage across harness O2 sensor connector pins C(+) and D (-).
This This should read near the battery voltage: if not proceed to the step 7.1.1.

7.1.1. Perform the first measurements in Table 6.

Meter mode	From	To	Desired Result	If defective
Voltage	Ground	Harness O2 C	Battery voltage (10-14)	O2 C wire is open
Voltage	Battery +	Harness O2 C	< 1 volt	O2 C wire is open
Voltage	Ground	Harness O2 D	< 1 volt	O2 D wire is open
Voltage	Battery +	Harness O2 D	Battery voltage (10-14)	O2 D wire is open

Table 6 : Harness O2 heater check

7.2. If battery voltage is present from step 7.1, measure resistance between the 2 white wires on the O2 sensor. They should be between 1.5 and 3.52 ohms at room temperature. If the heater is open or shorted, replace the sensor. A warm sensor will read higher resistance than a cold sensor. If no wires are open or shorted, verify the rest of the fueling system is operating properly. If everything else checks out, replace the oxygen sensor.



Code 14: The engine coolant reads too high. It is possible to receive this code if the engine has severely overheated (above 280 ° F).

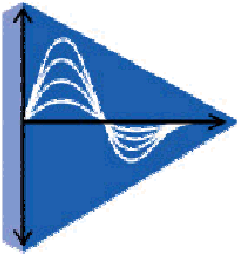
Code 15: The engine coolant reads too low. This may occur if the temperature is below - 30° F or if the CTS sensor is unplugged.

To verify the coolant temp wiring:

1. Disconnect the coolant temp sensor and measure the resistance of the coolant temperature sensor. This will vary depending on the sensor's temperature. The resistance should be within 5% of that listed in Table 7. If the sensor differs, replace the sensor.

Table 7: CTS / IAT resistance

Degrees F	CTS Resistance (Ω)	IAT Resistance (Ω)
-22	52594	51791
5	21371	21044
32	9399	12073
68	3511	3457
77	2795	2752
86	2240	2205
95	1806	1778
104	1465	1443
140	671	660
167	395	398
176	334	329
194	242	238
203	207	204
212	178	175
248	100.9	99



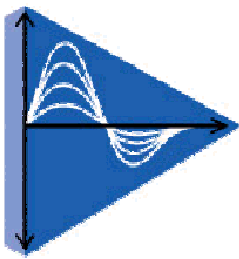
2. Turn ignition power ON.
- 2.1. Measure the voltage between CTS sensor pin A (Wh / BK) and ground. This should read near 5 volts. If it does not proceed to step 2.1.1
- 2.1.1. Turn off ignition power and disconnect the ECM .
- 2.1.2. Measure resistance from ECM pin 9 to CTS pin A. It should read less than 1 Ω . If it does not repair the wire.
- 2.1.3. Measure resistance from ECM connector pin 10 to CTS sensor pin B (Bk/Yl). It should read less than 1 Ω . If it does not repair the wire.
- 2.2. If no sensor or wiring problems are found, replace the ECM.

Code 21:

The TPS sensor is reading incorrectly. Make sure the TPS is plugged in.

To verify the TPS sensor and wiring:

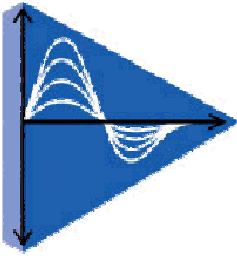
1. Disconnect the TPS sensor from the harness.
- 1.1. Measure the TPS resistance between TPS pins A and B. This should read 2.5-7.5k Ω . If it is outside this range replace the sensor.
- 1.2. Measure resistance from pin A to pin C while slowly, manually move the throttle plate. The resistance should increase smoothly without dips or spikes. If it is not smooth replace the sensor.
2. Turn ignition power ON. Measure voltage from harness TPS connector pins A (-) and B (+). This should measure 4.75 – 5.25 volts. If not proceed to step 2.1.
- 2.1. Perform the following measurements:
- 2.2. Turn ignition power OFF. Disconnect the ECM from the wiring harness. Disconnect the MAP sensor and drive-by-wire pot (if it is used and easily to disconnect). Perform the measurements in Table 8.



Meter mode	From	To	Desired Result	If defective
Ohms	ECM Harness 10	TPS A	$< 1 \Omega$	Ground wire is open
Ohms	ECM Harness 40	TPS B	$< 1 \Omega$	5 volt wire is open.
Ohms	ECM Harness 8	TPS C	$< 1 \Omega$	TPS signal wire is open
Ohms	ECM Harness 10	ECM Harness 40	Open, or $< 1000 \Omega$ if DBW pot .	5 volt wire shorted to ground
Ohms	ECM Harness 10	ECM Harness 8	Open	TPS signal shorted to ground
	ECM Harness 40	ECM Harness 8	Open	TPS signal shorted to +5 volts.

Table 8: TPS wiring troubleshooting

If all other TPS tests check out, reconnect all sensors. Measure the voltage from TPS pin C to ground while manually opening the throttle plate. The voltage should read > 0.5 volts at closed throttle and < 4.5 volts at WOT and move smoothly between closed and open throttle. If the voltage has “dead spots” or spikes, replace the TPS sensor. If the voltage is within the range and moves smoothly, replace the ECM.

**Code 22:**

The Throttle body actuator is not responding, the fault is either caused by a short circuit or the actuator is unplugged.

Code 23:

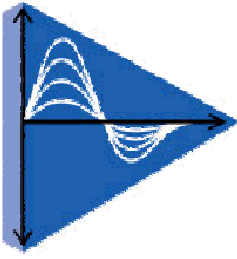
The Inlet Air temperature reads too low. This may occur if the temperature is below -40° F or if the IAT sensor is unplugged.

Code 24:

The engine coolant reads too high. While unlikely, if this sensor is above 270 ° F this code will be sent.

To Verify the Inlet Air Temperature sensor wiring:

1. Disconnect the IAT sensor and measure its resistance. This will vary depending on the sensors temperature. The resistance should be within 5% of that listed in Table 7. If the sensor differs, replace the sensor.
2. Turn ignition power ON and disconnect the IAT sensor.
 - 2.1. Measure the voltage between IAT harness sensor pin A (purple) and ground. This should read near 5 volts. If it does not proceed to step.
 - 2.1.1. Turn off ignition power and disconnect the ECM .
 - 2.1.2. Measure resistance from ECM pin 19 to IAT harness pin A. It should read less than 1 Ω . If it does not repair the wire.
 - 2.1.3. Measure resistance from ECM connector pin 10 to IAT sensor pin B (Bk/Y1). It should read less than 1 Ω . If it does not repair the wire.
 - 2.2. If no sensor or wiring problems are found, replace the ECM.



Code 31:

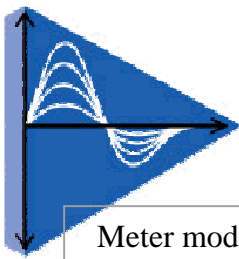
Drive by wire fault: the drive by wire voltage is too low or too high.

This code can be set in some systems if the drive by wire pot is set to one extreme or the other. First, set the pot at least 1/8 of a turn from either end. If the error code is gone, there is no problem. If the machine does not utilize the DBW device, this error can be ignored.

As the DBW device is OEM specific, the resistance values can vary depending on what device is used. Recommended potentiometer ranges are 1k Ω to 10k Ω .

To verify the DBW sensor and wiring:

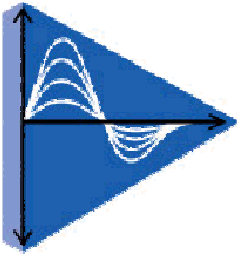
1. Turn ignition power ON. Measure voltage from harness DBW ground wire (Bk/Yl) and 5 volts (Rd/Bu). This should measure 4.75 – 5.25 volts. If not proceed to step 1.1.
 - 1.1. Turn off the ignition power, disconnect the DBW sensor from the harness, if possible, and disconnect the ECM.
 - 1.2. Measure the resistance between DBW control ground (Harness wire Bk/Yl) and supply (Harness wire RD/BU). This should read close to the pots resistance (in the range of 1k Ω to 10k Ω) however if it reads open or shorted the unit is defective.
 - 1.3. Measure the resistance from the pots ground lead to the output lead (harness GN/YL). The resistance should start low when the pot is turned to the low side and increase smoothly as the pot is turned to the high side. If the resistance does not smoothly increment or has discontinuities, replace the DBW device.
- Turn ignition power OFF. Disconnect the ECM from the wiring harness.
- Disconnect the MAP sensor and TPS. Perform the measurements in Table 9.



Meter mode	From	To	Desired Result	If defective
Ohms	ECM Harness 10	DBW GND (BK/YL)	< 1 Ω	Ground wire is open
Ohms	ECM Harness 40	DBW +5 (RD/BU)	< 1 Ω	5 volt wire is open.
Ohms	ECM Harness 8	DBW output (GN/YL)	< 1 Ω	DBW signal wire is open
Ohms	ECM Harness 10	ECM Harness 40	Open, or < 1000 Ω if DBW pot is connected	5 volt wire shorted to ground
Ohms	ECM Harness 10	ECM Harness 18	Open	TPS signal shorted to ground
	ECM Harness 40	ECM Harness 18	Open	TPS signal shorted to +5 volts.

Table 9: DBW wiring troubleshooting

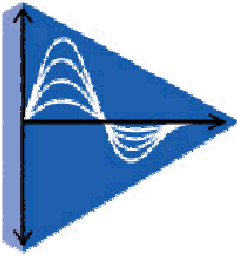
1.4 If all other DBW tests check out, reconnect all sensors. Measure the voltage from DBW output to ground while manually opening the throttle plate. The voltage should move smoothly between low speed and high speed. If the voltage has “dead spots” or spikes, replace the DBW device. If the voltage is within the range and moves smooth, replace the ECM.



Code 32: System voltage too low.

This indicates the ECM is receiving a low battery voltage measurement. Verify the battery voltage measures above 10 volts while the engine is running.

1. Measure the system (battery voltage) during normal operation. If it is below 12.5 volts the charging system should be diagnosed. Normal running battery voltage should read approximately 13 – 14.5 volts. If the battery voltage is low, the charging system or machine wiring should be diagnosed.
2. Turn ignition power off, then disconnect the ECM. Turn ignition power ON. Measure the voltage between pins ground (25 or 35) and switched power (11) and then the battery voltage. The 2 readings should be within 0.5 volts. If the readings vary considerably, proceed with step 0. Acceptable voltage drops should be less than 0.5 volts unless the machine draws current for other functions. If any wires show considerable voltage drops that wire should be inspected for damage or poor connections.
 - 2.1. Measure the voltage between battery ground (-) and ECM pin 25. This voltage should be near 0.
 - 2.2. Measure the voltage between battery ground (-) and ECM pin 35. This voltage should be near 0.
 - 2.3. With ignition power still ON, measure voltage between ECM pin 11 and battery positive. This should be near 0.

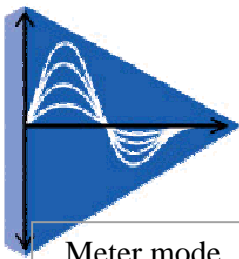


Code 41: MAP sensor system error

The MAP sensor code can be set if: map output wire is grounded, shorted to +5 volts, or if the MAP pressure does not change between key on and engine run time.

Verify:

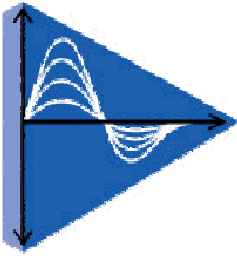
1. MAP sensor is plugged in.
2. Vacuum hose to the MAP sensor is connected properly with no leaks.
3. Disconnect MAP sensor electrical connector. Turn ignition power on.
Measure the voltage from pins A (Bk/Yl) to C (Rd/BU). This should read 4.75-5.25 volts. If it outside of this range proceed with step 3.1
- 3.1. Perform the following measurements:
- 3.2. Turn ignition power OFF. Disconnect the ECM from the wiring harness.
Disconnect the TPS sensor and drive-by-wire pot (if it us used and easily to disconnect). Perform the measurements in Table 10.



Meter mode	From	To	Desired Result	If defective
Ohms	ECM Harness 10	MAP A	< 1 Ω	Ground wire is open
Ohms	ECM Harness 40	MAP C	< 1 Ω	5 volt wire is open.
Ohms	ECM Harness 8	TPS C	< 1 Ω	TPS signal wire is open
Ohms	ECM Harness 10	ECM Harness 40	Open, or < 1000 Ω if DBW pot is connected	5 volt wire shorted to ground
Ohms	ECM Harness 10	ECM Harness 7	Open	MAP signal shorted to ground
	ECM Harness 40	ECM Harness 7	Open	MAP signal shorted to +5 volts.

Table 10: MAP wiring troubleshooting

4. If all other MAP tests check out, reconnect all sensors and turn ignition power on. Measure the voltage from MAP pin B to ground while manually applying vacuum to the vacuum fitting on the map sensor. The voltage will depend on the vacuum but should read from 0.1 volt under high vacuum to 4.7-5 volts at atmosphere pressure and sea level. If the voltage is within the range, replace the ECM.

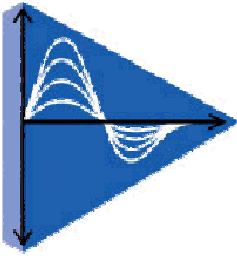


Code 43: Fuel injector error.

The fuel injector circuit is not responding properly. The circuit has an open, short, or lost power from the power relay. If the injector shows a true fault, it is unlikely the engine would run on gasoline. The injector could be turned on all the time and therefore it would squirt gasoline continuously when the ignition relay is active. This would tend to flood the engine; however, it may run depending on loading and other conditions.

Verifying Fuel injector fault:

1. Verify the ignition relay is operating properly as described in Code 64. The ignition relay provides power to the fuel injector.
2. Disconnect the fuel injector. Connect a volt meter between ground and injector pin A (Rd / Bk). Switch the ignition from off to on and verify the injector pin has battery voltage applied for the 2 second fuel pump prime time period. If this voltage is not present, continue with step. Reference 2.1.
 - 2.1. Connect voltmeter between ground and pin 87 of the ignition coil and fuel injector relay. Switch the ignition power off to on. Verify 12 volts is present at in 87 during the 2 second initial prime period. If the voltage is present, proceed with step 2.1.1.
 - 2.1.1. Recheck the ignition power relay as described in Code 64.
 - 2.2. Turn off ignition power. Measure resistance from relay pin 87 (Rd / Bk, of the ignition coil and fuel injector relay) and injector pin A (Rd / Bk). This should measure $< 1\Omega$. If the measurement is greater repair the wire.
3. Turn off the ignition power. Measure the resistance of the fuel injector. The resistance of a room temperature injector should read 1-2 Ω . Replace the injector if the resistance is considerably outside this range.
4. Disconnect the ECM from the harness. Measure the resistance from ECM harness pin 4 and injector connector pin B. This should read $< 1\Omega$. If it is greater repair the wire.
5. Measure the resistance from ECM harness pin 25 and injector connector pin B. This should read open. If it shows continuity repair a short to ground.
6. Measure the resistance from ECM pin 11 (switched battery voltage) and injector connector pin B. This should read open. If it shows continuity repair a short to battery voltage.
7. If no short is found and the injector squirts fuel during the initial prime period, replace the ECM.
8. If no short is found and the injector does not squirt fuel during the initial prime period but the engine runs normally (without flooding), investigate battery voltage and charging system malfunctions. Otherwise replace the ECM.



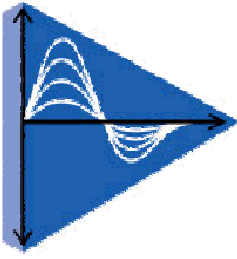
Code 53: Low oil pressure fault:

The engine has exhibited low oil pressure during run time.

The oil pressure wire has been shorted to ground or power (this input depends on how the ECM and machine is configured). The low pressure shutdown system is intended for use with a low pressure “switch” not an analog pressure sensor. If the system uses a pressure sensor it must be replaced with a switch. Some machines may also use the shutdown wire for other shutdowns such as over temperature, overload, or others as the OEM deems appropriate. Ensure these are not causing the problem.

To verify the oil pressure fault wire:

1. Disconnect oil pressure wire. Turn ignition power on. Measure the voltage present on the oil pressure wire (PU/Wh). If the voltage is less than battery voltage proceed to step. Reference 1.1.
 - 1.1. Verify the engine contains the proper level of oil.
 - 1.2. Turn ignition power off and disconnect ECM from the harness. Measure resistance from ECM pin 14 to the oil pressure shutdown terminal. This should be $< 1\Omega$. If the resistance is higher repair the wire.
 - 1.3. Measure the resistance from ECM pin 14 (oil pressure) to ECM pin 25 (ground). If this is not open the wire contains a short – repair the wire.
 - 1.4. Measure the resistance from ECM pin 14 (oil pressure) to ECM pin 11 (power). If this is not open the wire contains a short – repair the wire.
 - 1.5. To test functionality of the wire, connect the ECM and start the engine. For engines with a standard “short to ground on fault” sensor, short the wire to ground. The engine should shutdown within 15 seconds. If it fails to shutdown, perform step 1.6.
 - 1.6. For engines with a “connect to power on fault” sensor, short the shutdown wire to switched power. The engine should shutdown within 15 seconds. If it fails to shutdown, perform step 1.5.
 - 1.7. Verify the engine’s oil pressure per the engine manufacturer’s recommendations.
 - 1.7.1. If the engine oil pressure is within spec, replace the oil pressure switch (sensor).
 - 1.8. If the shutdown will not kill the engine and it is enabled in the ECM, replace the ECM.



Code 61: LP power solenoid fault:

Verify connections .

Code 62: Fuel Pump Relay fault:

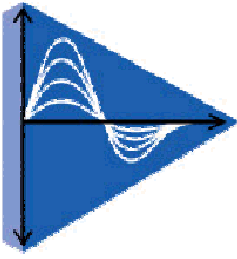
Verify connections .

Code 63: Dual fuel relay fault

Verify connections .

Code 64: Ignition power relay output error

Verify connections .



Basic Trouble Shooting Guide

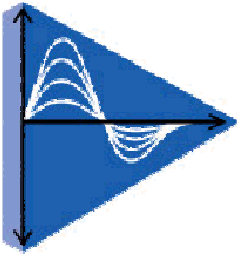
The following is a guide to the most common engine performance complaints.
The guide is used to diagnose problems that are due to worn out components and/or bad adjustments in the Fueling system.

Condition: Engine will not start (Gasoline)

Verify each item below:

Remedy for each item

Fuel Tank Level	Add Fuel
Check fuel pump. Cycle ignition switch on/off, fuel pump should run for 2 seconds.	Check wiring and fuse/relay
Use a pressure gage connected to fuel port. Verify the fuel pressure should read between 40-45 psi.	Check and or Replace fuel filter and/or And/or Fuel Pressure regulator And/or fuel pump
Fuel injector is spraying.	Check fuel injection wiring
Fuel injector is not leaking.	Replace injector o-rings or injector
Spark plugs are not fouled or wet.	Disconnect the fuel injector connectors for 15 seconds while cranking to un-flood the engine.

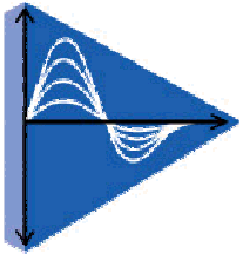


Condition: Engine runs too Rich with Gasoline

Verify each item below

Remedy for each item below

Verify vacuum leaks to the MAP sensor	Replace hose
Restricted fuel return line	Replace fuel line
LPG shut-off valve does not close	Shut-off LPG tank valve, replace/clean LPG shut-off valve
Check fuel pressure should be 40-45 psi (gasoline) at the fuel port.	Replace fuel pressure regulator
Check for bad MAP sensor	Replace with new MAP sensor
Check for a bad IAT, ECT sensor	Replace with new sensor
Check for exhaust air leaks before the O² sensor	Repair air leaks in the exhaust system
Check to see if there is excessive smoke while running.	Check and replace fouled spark plugs

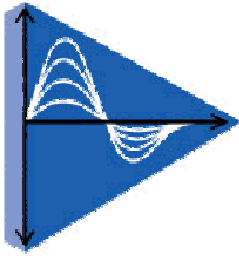


Condition: Engine runs lean or misfires on Gasoline.

Verify each item below

Remedy for each item below

Visually inspect fuel filter for restriction	Replace fuel filter
Verify the fuel pressure is 40-45 psi use gage readings from the fuel port.	Replace fuel pressure regulator
Check for clogged fuel injectors	Clean/Replace fuel injectors
Visually inspect Map sensor for hose breaks	Replace hose
Check for Bad map sensor	Replace with new MAP sensor
Check for Bad IAT sensor	Replace with new IAT sensor
Check for intake manifold air leaks	Repair all air leaks in the intake system

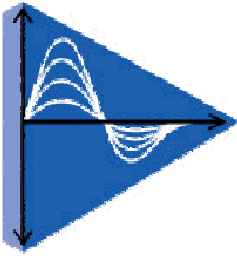


Condition: Engine runs lean or misfires on LPG.

Verify Each item below

Remedy for each item below

LPG tank level	Re-fill Tank
LPG fuel filter is not contaminated and use air pressure to verify restriction. Clogged fuel lines	Replace LPG filter Clean fuel lines
LPG pressure regulator/vaporizer is not frozen and /or icing	Check for air leaks ,purge air from coolant hoses. add coolant
Visually inspect Vacuum hose for breaks	Repair
Verify Timing with timing light	Adjust distributor timing
Verify the air filter for the vaporizer is not clogged	Replace air filter
Vaporizer primer button becomes hard to depress when the fuel is present	Replace / Clean LPG fuel lock-off

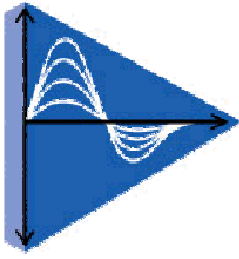


Condition: Engine runs too Rich with LPG

Verify each item below

Remedy for each item below

Verify that there is no air leaks into the vacuum port on the LPG mixer	Replace /repair hose
Check for Clogged Air Filter	Repair/Replace
Check for exhaust air leaks before the O2 sensor	Repair air leaks in the exhaust system
Verify the O2 sensor is working properly	See error code 13
Verify idle air screw is adjusted at idle Fuel trim valve will have a 50% duty cycle	Turn ccw the adjustment screw to lean out the air/fuel mixture
Faulty LPG vaporizer	Replace if LPG vapor pressure is not greater than Atm. Pressure – 2” W.C

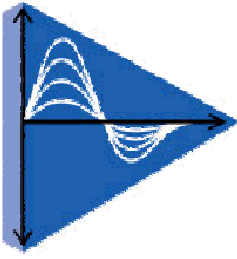


Condition: Engine will not start LPG

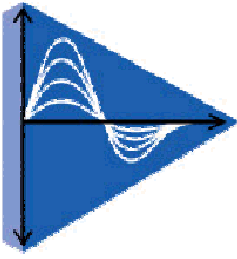
Verify each item below:

Remedy for each item

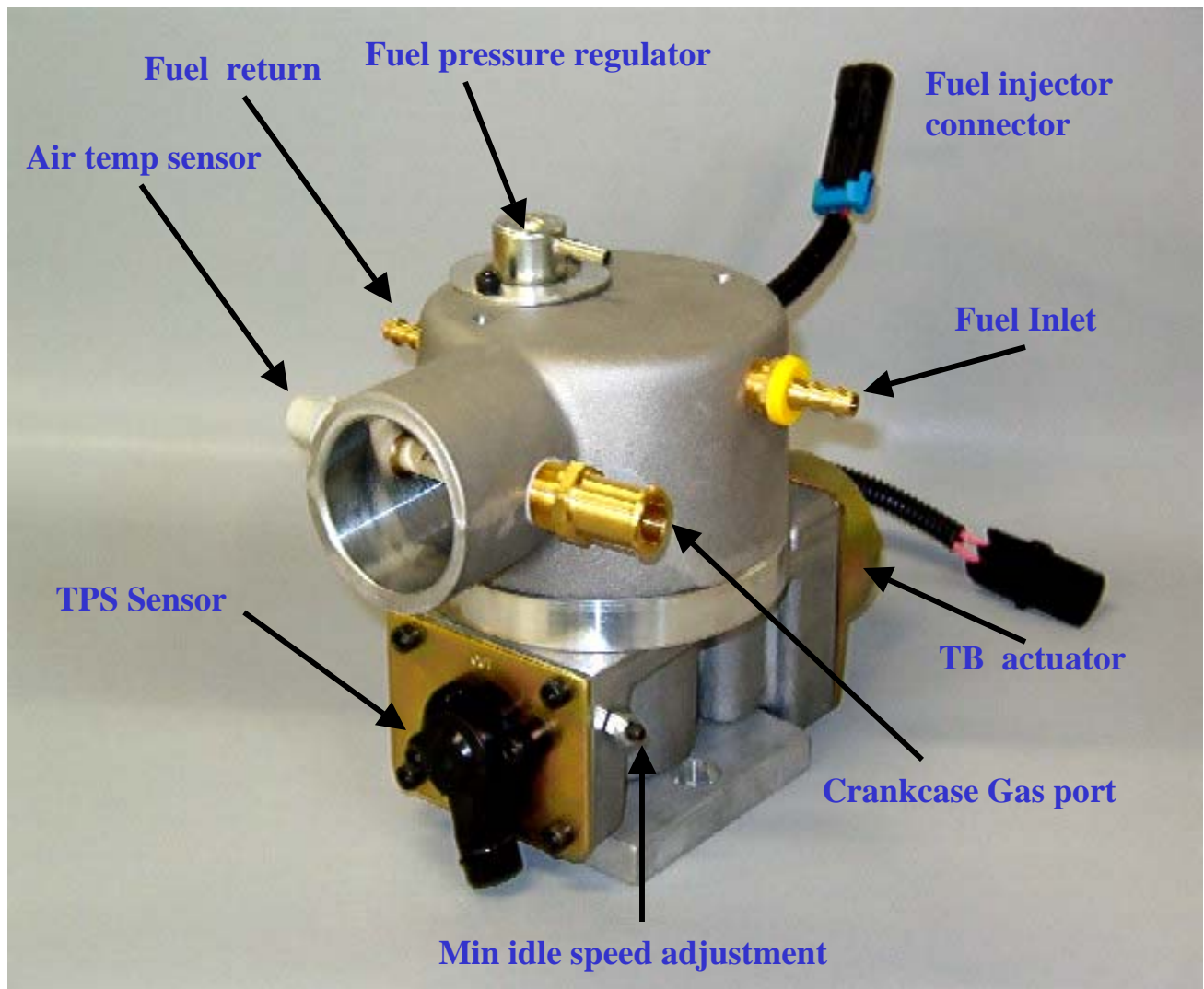
Fuel Tank Level	Add Fuel
Check fuel shut-off valve. Cycle ignition switch on/off, fuel shut off valve should click off after 2 seconds.	Check for obstruction from fuel line Check wiring and fuse/relay
Clogged fuel filter	Close liquid fuel valve Repair/replace fuel filter Open liquid fuel valve, check for leaks
fuel trim vacuum valve is stuck open	Clean valve . Check wiring
Clogged small air filter on top of the vaporizer.	Clean/Replace air filter and orifice jet
Carburetor malfunction	Check diaphragm for holes and damage Repair/Replace

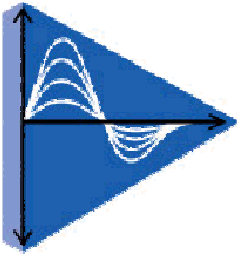


Assembly Detail

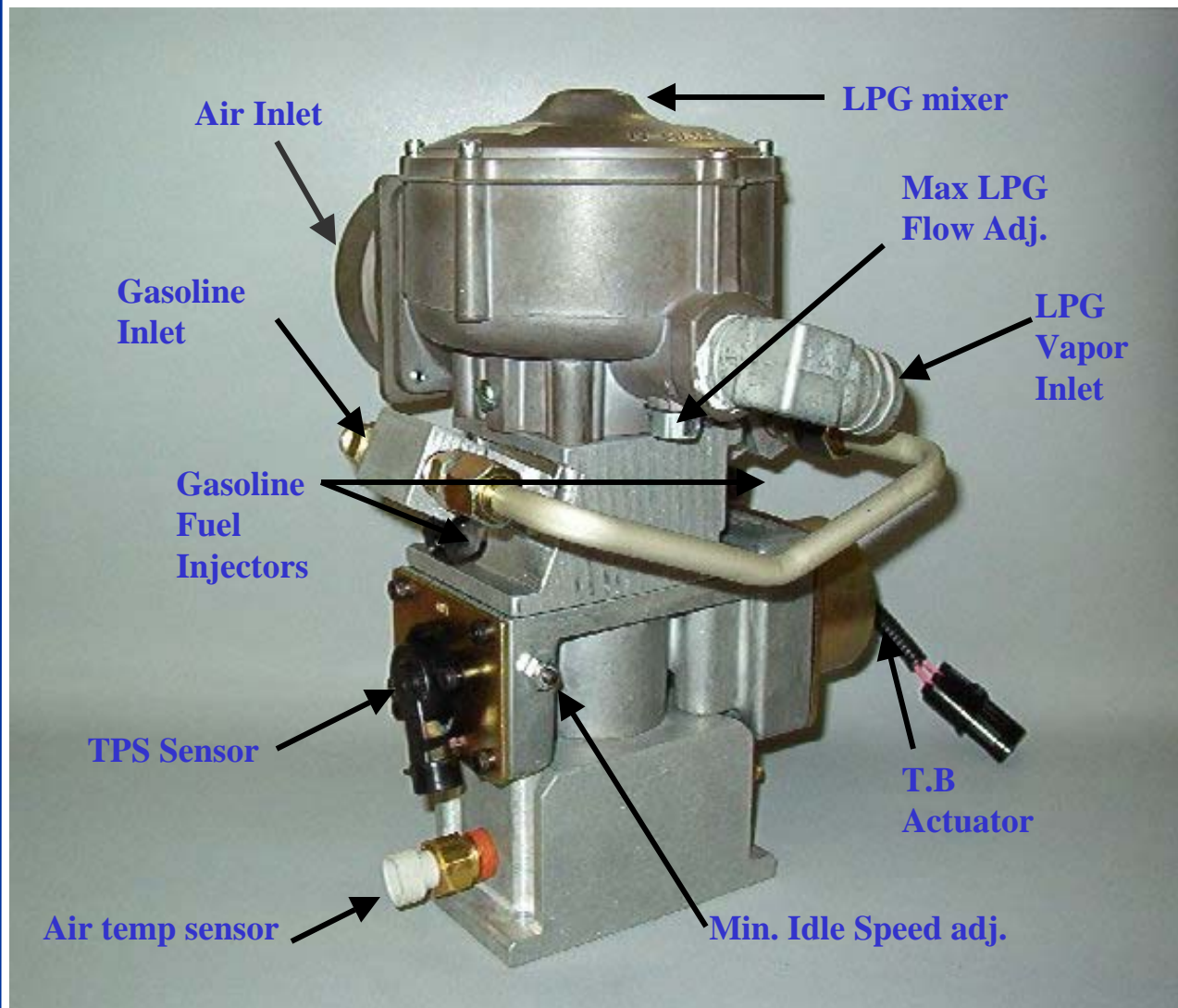


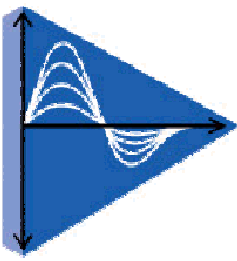
Gasoline Only Fuel Injection Detail Assembly 3.0L Engine typical





Dual Fuel System Detail Assembly 4.3L and 5.7L typical





LPG Gaseous Fuel System Assembly

4.3L and 5.7L engine typical



Coolant Hoses

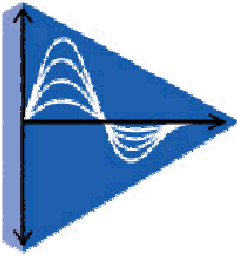
LPG Vaporizer Regulator

vacuum solenoid valve

engine vacuum pressure line

Propane vapor ports

Atmospheric pressure port

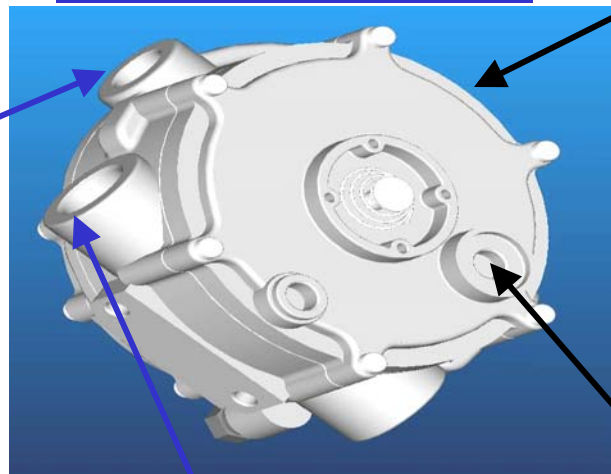


LPG Gaseous Fuel System Assembly

1.6L Engine typical

LPG Vaporizer Regulator

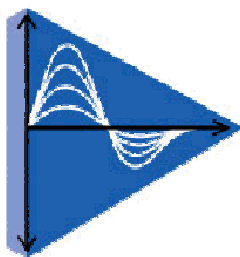
Coolant Inlet /
Outlet
Ports



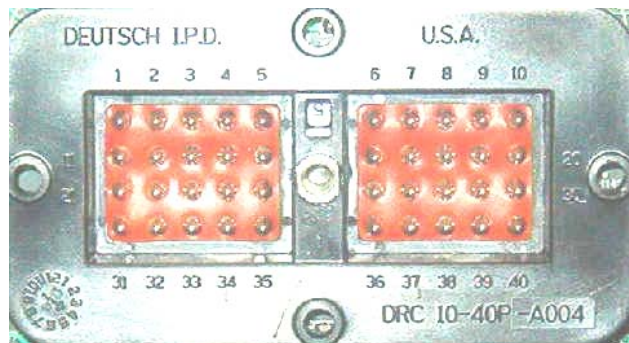
LPG inlet Port

Propane Vapor
Outlet Port

Vacuum
Reference Port



ECM Connector



Deutsch 40-Pin Connector Layout for EFI Harness

Deutsch Part Number - DRC16-40S Quantity - 1

Pin Part Number - 0462-201-16141 Quantity - 26

Functional layout

	1	2	3	4	5	6	7	8	9	10	
1	Ignition Coil B	Ignition Coil A	vacuum valve	Injector - 1	Fuel Sel.	Gov. Sel. 1	MAP - B	TPS - C	ECT - A	Analog GND	10
11	Switched Power	Battery	Tach out	Oil Pressure	Test	Gov. Sel. 2	CPS - A	DBW	IAT - A	hego-	20
21	Power-relay	NC	MIL	Fuel Relay	Power GND	Emergency-kill	CAM	Analog	knock	transmit	30
31	Actuator -pwm B	LP Shutoff	Actuator - A	Aux-out	Power GND	Dwell-out	Spark-bypass	Flash - 3	receive	5V Ref.	40
	31	32	33	34	35	36	37	38	39	40	

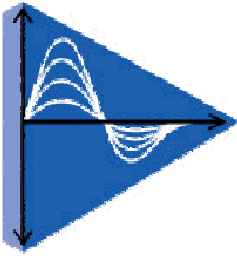
NC = No Connection

Color Layout

	1	2	3	4	5	6	7	8	9	10	
1	NC	NC	PR/YL	GR/RD	YL/RED	PINK	TAN	YL	WH/BK	BK/YL	10
11	OR	RD/YL	NC	PR/WH	NC	BR/WH	BU/WH	GR/YL	PR	BU/YL	20
21	BK/WH	NC	GR	BK/BU	BK/RD	NC	NC	NC	NC	GR	30
31	BU	BU/BK	BN	NC	BK	TN/BK	GR/WH	WH	OR/BK	RD/BU	40
	31	32	33	34	35	36	37	38	39	40	

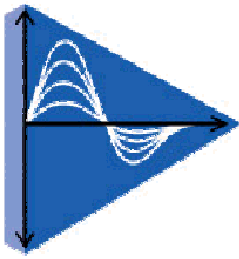
WH = WHITE RD = RED PR= PURPLE BN = BROWN OR = ORANGE GR = GREEN
BK = BLACK PK = PINK TN = TAN GY = GREY YL = YELLOW BU = BLUE

EX: WH / BK & BN = White with Black and Brown stripes



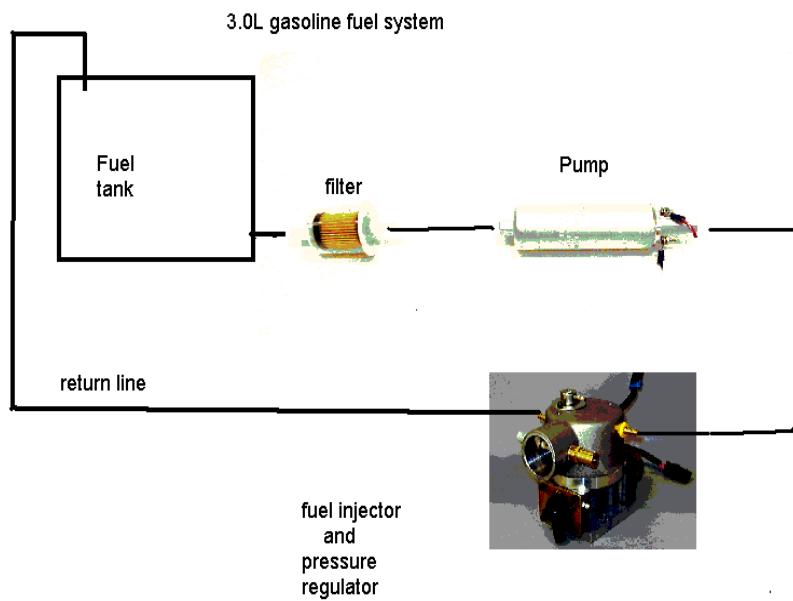
Schematics

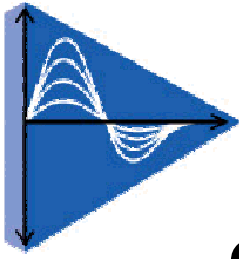




Gasoline Fuel System

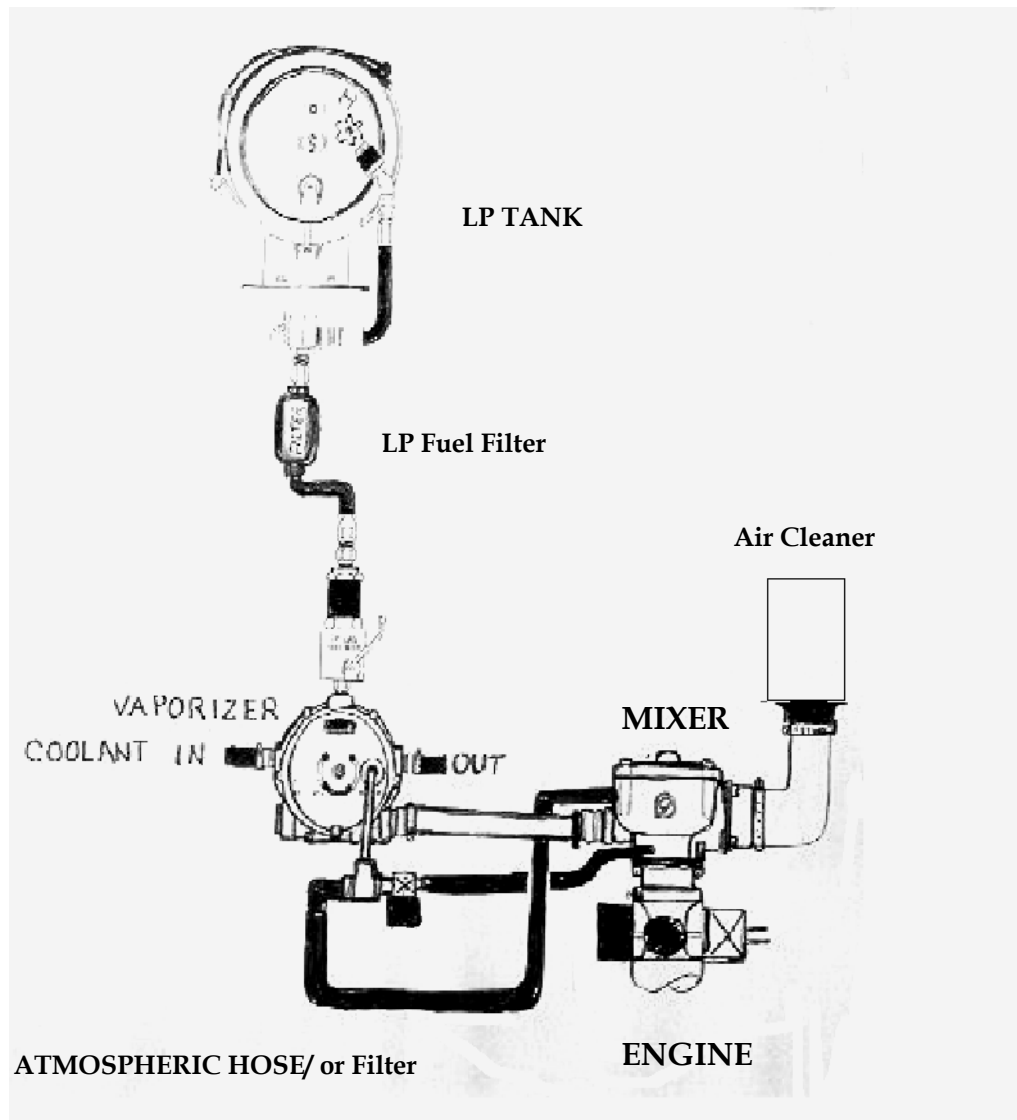
(Plumbing Schematic)

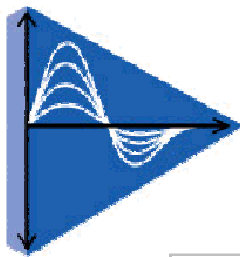




Gaseous Fuel Plumbing

(Schematic)



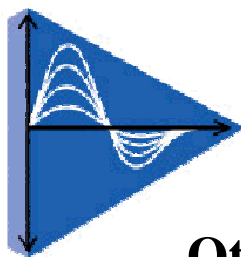


GM 3.0 LPG ONLY

Service Parts

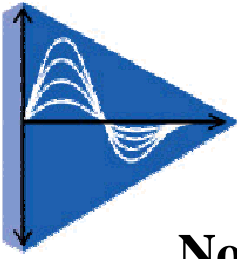
1	94050020	3.0 LP ONLY FUEL KIT
1	HE1-4A	1/8 NPT X 1/4 BARB 90 DEG
2	269HB-12-8	3/4 X 1/2 BARB 90 DEG
2'	H177	3/8 USCG FUEL HOSE
3'	3/4 "HOSE	3/4" LPG HOSE
2	#10	CLAMP
1	110FB-DC	BUSHING, 1/2M X 3/8 FM FACE MT.
1	125HBL-10-8	5/8 X 1/2 HOSE BARB
3	H200	5/8 PCV PUSH ON JIFFY HOSE
4	#08	S.S. HOSE CLAMP
1	PC7688	ACCESSORY BRACKET
2	#12	S.S. HOSE CLAMP
1	10068571	MAP SEN BRACKET
1	N00-5101	1/8 VAC FITTING
1	735-4970	VC GROMMET
2	4-1142	CERTIFICATION LABEL
1	PC7764	MIXER ADPT
1	630-1049	GROMMET
1	PC7686	MAP SEN SUPPORT BRACKET
1	2024-4	1/4 NPT X #6 90
1 *	AFC-A155	LP FILTER
1	LW05	5/16 LOCK WASHER
1	PC7762	PVC LINE RESTRICTOR
1	BHM05C075	5/16 NC X 3/4 BOLT
1	PC7771	CUSTOMER INTERFACE HARNESS
1	230404	OIL SAFETY SWITCH
1	125HLB-4-6	1/4 NPT X 3/8 BARB
1	125HBL-12-8	3/4 X 1/2 BARB
1	122-60	JET
2	BHS0420350	1/4NC X 3 1/2 BOLT
1	2059	BREATHER
1	3046	FILTER
1	211P-2	1/8 NPT PLUG
1	211P-6	3/8 NPT PLUG
1	222P-2-2	1/8F X 1/8 M ADAPTER
1	7388	HOSE

List of Service Items



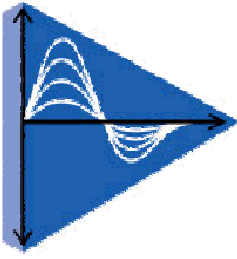
PG # 94050020 Kit

<u>Qty</u>	<u>P/N</u>	<u>Description</u>
1	PG 2560	Map Sensor
1	PG 2561	Oxygen Sensor
1	PG 2562	Coolant Temp Sensor
1	PG 2585	Autotronix Solenoid Valve
2	PG 3143	3/8-16 x 1/2 Socket Hd Cap Screw
2	PG 3206	O-Ring, EFI
13	PG 3322	Hose, Neoprene Vapor, 5/8"
1	PG 3329	Brass, 3/8 Barb x 1/8 NPT-90 Elbow
1	PG 3357	Brass, 3/8 Compression x 1/4 NPT
24	PG 3360	Hose, 3/8" – 24" Minimum
2	PG 3362	Brass, 5/8 Barb x 1/2 NPT 90 Elbow
2	PG 3363	Brass, 5/8 Barb x 3/8 NPT
2	PG 3364	Brass, 5/8 Barb x 3/8 NPT-90 Elbow
2	PG 3435	Brass, 1/8 x 1/8 NPT Male
1	PG 3436	Brass, 1/8 x 1/8 x 1/8 NPT Female
4	PG 3446	Nut, 1/4-20 Flange Hd Serrated
1	PG 3455	3/8" x 3/8" x 3/8" NPT Female
1	PG 3462	Tee Fitting, Hose 1/4"
1	PG 3464	Nolff N00-5101 1/4-28 to 1/4 I.D. Hose, Brass
1	PG 3466	Fitting, 1/8 NPT x 1/4 Barb
24	PG 3482	Hose, 3/16" Fuel Hose
2	PG 3487	1/4-20 x 3"Socket Head Cap Screw
1	PG 4089	ECM Cover
1	PG 7624	Plate, Top (LP)
1	PG 7638	Gasket, Throttle Body to Plate
1	PG 7655	EFI Malfunction Indicator Lamp Face Plate
7	PG 7656	Hose Clamp, 1/2" – 1 1/8" Clamp Dia
2	PG 7657	Hose Clamp, 1 5/16" – 3 1/4" Clamp Dia
1	PG 7663	GM 3.0L Manifold Adapter Plate
1	PG 7670	Throttle Body Assembly, 3.0
1	PG 7687	LP Lockoff Solenoid Valve for KEM
1	PG 7707	Gasket, 3.0L Intake Manifold
1	PG 7713	Nolff Mixer (CA100) w/Feedback Diaphragm
1	PG 7714	Nolff NJ – Vaporizer Regulator w/Blue Spring
1	PG 77350020	Harness, GM 3.0L LP
1	PG 9397	EFI Controller, ECM

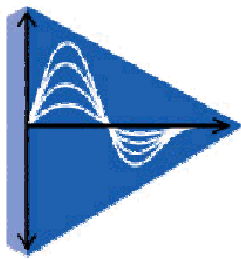


Nomenclatures typically used in EFI systems

CNG:	Compress Natural Gas
CTS:	Coolant Temperature Sensor
DBW:	Drive-by Wire
DIS:	Distributorless Ignition System
ECM:	Engine Control Module
ECT:	Engine Coolant Temperature
EFI:	Electronic Fuel Injection
ESA:	Electronic Spark Advance
GUI:	Graphical User Interface
HEGO:	Heated Exhaust Gas Oxygen (Oxygen sensor)
IAT:	Inlet Air Temperature
LED:	Light Emitting Diode
LP:	Liquid Propane/Liquid Petroleum
MAP:	Manifold Air Pressure
NG:	Natural Gas
PWM:	Pulse Width Modulated
TPS:	Throttle Position Sensor



Appendix



LPG FUEL SYSTEM RETROFIT

PROCEDURE

1. Remove the old fuel system throttle body assembly and electrical cable harness.
2. Check distributor cap and rotor.
3. Check spark plug wire, Replace if worn.
4. Check fuel lines and connectors for leaks.
5. Install the PG throttle body and mixer to the intake manifold.
6. Install the exhaust system including : the exhaust manifolds and catalytic converter (if required) and weld the O2 sensor weld boss to the exhaust manifold.
7. Verify the Spark Plugs Gap (0.030" typ.) and then install new spark plugs.
8. Install and verify the orifice hole 0.100" plug in the vacuum manifold hose to the PCV valve is correct.
9. Verify the Orifice size (0.060") to the tee adapter elbow on top port of the vaporizer is installed.
10. Install the PG electrical harness.
11. The harness should not be routed close to exhaust pipes ,or make sharp bends.
12. There should be sufficient length to flex across the stationary positions and the engine block.
13. Install Sensors:O2, map, air temp, coolant temp, oil pressure sender .
14. Assemble the throttle body inserting the gasket material and sealer between stages.
15. Install the vaporizer to the engine mount.
16. Install the LPG lock-off valve to the vaporizer.
17. Insert vacuum hoses and crank case vacuum hoses on the engine ports.
18. Check the air cleaner condition,replace if necessary.
19. The Map sensor must be connected to manifold vacuum.
20. The LPG fuel trim vacuum valve must be connected to the vacuum port at the LPG mixer.install the vapor line to the LP mixer .
21. Check vapor pressure line for leaks.
22. Assemble engine coolant hoses.
23. Connect all the sensors' connectors in place to the engine.
24. Check oil level and coolant level in engine.
25. Connect the ECM to the engine harness.
26. Unplug Actuator (if connected).
27. Start engine and warm-up with mechanical idle speed to approx. 750 rpm.
28. Adjust the minimum Air adjustment screw .
29. Tighten and lock the minimum idle speed adjustment screw..
30. Plug the connector back to the Actuator.
31. Test Throttle responsiveness and stability.
32. Verify that no exhaust leaks occurs before the O2 sensor.
33. Adjust Mixture till the O2 feedback is between 1.5 – 1.7.
34. Disconnect coolant temperature sensor. Stop Engine. Verify the error light flashes a code 15 OR the diagnostic error screen shows an error #15. This ensures the ECM is in timing check mode when the engine speed is below 1000 RPM.
35. Disconnect the actuator power.
36. Disconnect the O₂ sensor.
37. Start the engine.
38. Set engine speed to 750 RPM via idle screw.
39. Check timing is 0 degrees .
40. Do not exceed 1050 RPM when timing or it will exit timing mode.
41. Set minimum Air "Base Idle Speed"Customer Specific = 900 RPM.