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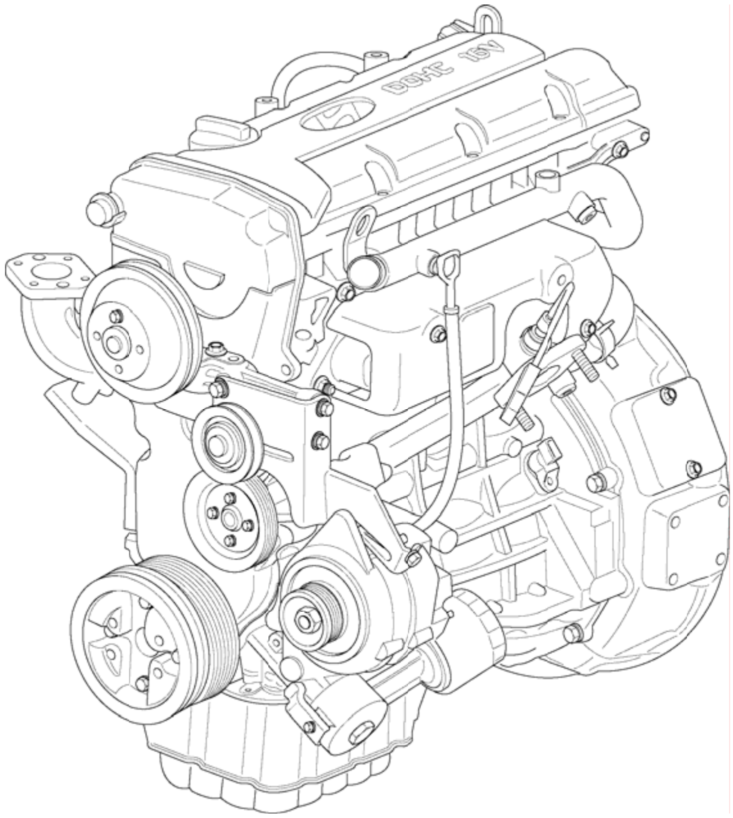
2007-2009 Emission Certified LPG & Bi-Fuel System 2.0L Engine



Service Manual

Revision A/June, 2009

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General Information

INTRODUCTION

This service manual supplement has been developed to provide the service technician with the basic understanding of the IMPCO certified fuel and emission systems for the 2.0L engine. This manual should be used in conjunction with the base engine manual and the OEM service manual when diagnosing fuel or electrical problems.

HOW TO IDENTIFY THE ENGINE YEAR

The 2.0L engine blocks have been stamped with a serial number. The number can be found on the left side of the top edge of the engine block near the exhaust manifold.

ENGINE IDENTIFICATION NUMBER

The engine identification number consists of 11 digits.

L	4	G	C	X	0	0	0	0	0	1
1	2	3	4	5	6					

1. Engine fuel
   L : LPG
2. Engine range
   4 : In line 4 cycle 4 cylinder
3. Engine development order
   G : β engine
4. Engine capacity
   C: 1975 CC (β engine)
5. Production year
   1 : 2001 2 : 2002 3 : 2003
   4 : 2004 5 : 2005 6 : 2006
6. Engine production sequence number
   000001 ~ 999999

Engine Identification Number Table

SERVICING YOUR EMISSIONS CERTIFIED ENGINE

Any maintenance and repair should be performed by trained and experienced service technicians. Proper tools and equipment should be used to prevent injury to the servicing technician and damage to the vehicle or components. Service repairs should always be performed in a safe environment and the technician should always wear protective clothing to prevent injury.

For parts or labor to be reimbursed under the IMPCO Technologies Inc. emission warranty, only work performed by IMPCO or OEM trained technicians using only IMPCO specified parts will qualify for reimbursement. Refer to the IMPCO Labor Time Guide for additional information.

For parts or labor not reimbursed under warranty, a repair shop or person of the owner's choosing may maintain, replace, or repair emission-control devices and systems. It is highly recommended that any replacement parts used for maintenance or for the repair of emission control systems be new OEM replacement parts. The use of other than genuine IMPCO replacement parts may impair the effectiveness of emission control systems, therefore, the owner should assure that such parts are warranted by their manufacturer to be equivalent to genuine IMPCO OEM parts in performance and durability.

FUEL QUALITY

LPG

Note that LPG engines are designed to operate on HD–5 or HD–10 specification LPG fuel. Fuel other than HD–5 or HD–10 may cause harm to the engine's emission control system and a warranty claim may be denied on this basis if operators can readily find the proper fuel*.

Use of any other fuel may result in your engine no longer operating in compliance with CARB or EPA emissions requirements.

*Not Applicable in the state of California.

Gasoline

IMPCO recommends the use of name brand high detergent gasoline. Gasoline is a mixture of many different hydrocarbons, including olefins, which are heavy, waxy compounds. Over time, these deposits can build up and clog the fuel injectors. The formation of these deposits is a normal consequence of engine operation, so detergents are added to high quality gasoline to help keep the injectors clean. The use of low quality low detergent gasoline may cause fuel injectors to fail. Fuel injector replacement or cleaning is expensive, and the cleaning procedure requires special equipment that may not be practical in the industrial lift truck market. Speak with your fuel supplier to verify that the fuel you are supplied contains the necessary fuel additives to keep your fuel system clean. IMPCO may deny emissions related warranty claims due to the use of low quality low detergent gasoline.

FUEL SYSTEM CAUTIONS

CAUTION

Do not smoke, carry lighted tobacco or use a lighted flame of any type when working on or near any fuel related component. Highly flammable air-fuel mixtures may be present and can be ignited causing personal injury

CAUTION

Do not allow LPG to contact the skin. LPG is stored in the fuel tank as a liquid. When LPG contacts the atmosphere, it immediately expands into a gas, resulting in a refrigeration effect that can cause severe burns to the skin.

CAUTION

Do not allow LPG to accumulate in areas below ground level such as in a service pit or underground ventilation systems. LPG is heavier than air and can displace oxygen, creating a dangerous condition

CAUTION

Do not make repairs to the LPG fuel system if you are not familiar with or trained to service LPG fuel system. Contact the dealer who sold you the vehicle to locate a repair facility with trained technicians to repair your fuel system

WARNINGS, CAUTIONS AND NOTES

This manual contains several different Warnings, Cautions, and Notes that must be observed to prevent personal injury and or damage to the vehicle, the fuel system or personal property.

A “WARNING“ is an advisement that by performing a process or procedure listed in this manual improperly may result in serious bodily injury, death and/or serious damage to the vehicle or property.

Typical Warning Label:

WARNING

Failure to heed instructions could result in death, injury, or property damage.

A “CAUTION” label or statement is used when it has been determine that by performing a process or procedure defined in the manual improperly a less severe result may occur. It could however, result in serious bodily injury, and or serious damage to the vehicle or property damage.

CAUTION

Less severe than WARNING but has the potential to cause injury or damage. Also used to notify of situations that could lead to eventual failure, injury or damage.

This caution label may also appear in area of this manual that applies to service and repair procedures which could render the fuel and emissions control system non-compliant. In addition it may also be used to indicate a failure to observe which may influence the terms of the warranty.

An "IMPORTANT" statement generally denotes a situation that requires strict adherence to the assembly, tightening, or service procedure. Failure to observe this procedure could result in an unsafe condition or improper performance of the vehicle or a component.

A "NOTE" statement applies to a specific item or procedure that is to be followed during the servicing of the vehicle or its components.

PROPER USE OF THIS SERVICE MANUAL, TOOLS AND EQUIPMENT

To reduce the potential for injury to the technician or others and to reduce damage to the vehicle during service repairs the technician should observe the following steps:

- The service procedures defined in this manual, when followed, have been found to be a safe and efficient process to repair the fuel system. In some cases special tools may be required to perform the necessary procedures to safely remove and replace a failed component.
- The installed IMPCO fuel system has been certified with the Environmental Protection Agency (EPA) and the California Air Resources Board (CARB) and complies with the regulation in effect at the time of certification. When servicing the fuel and emission control system you should follow all the recommended service and repair procedures to insure the fuel and emissions system is operating as designed and certified. Purposely or knowingly defeating or disabling any part or the fuel and emission system may be in violation of the anti-tampering provision of the EPA's Clean Air Act.
- Tools identified in this manual with the prefix "J" or "BT" can be procured through SPX in Warren, Michigan.
- Tools identified in this manual with a prefix "ITK" can be acquired through OEM Parts Distribution.

IMPORTANT
It is important to remember that there may be a combination of Metric and Imperial fasteners used in the installation of the IMPCO fuel system. Check to insure proper fit when using a socket or wrench on any fastener to prevent damage to the component being removed or injury from "slipping off" the fastener.

The IMPCO fuels system utilizes fuel lines hoses with swivel connections which attach to fixed mating connectors. You should always use a wrench of the proper size on both the swivel and fixed fitting to prevent turning of the fixed fitting. Turning of the fixed fitting may cause a "twisting" or "kinking" of the hose and may result in a restriction of the fuel line or a leak.

WARNING

Always leak check any fuel system connection after servicing! Use an electronic leak detector and/or a liquid leak detection solution. Failure to leak check could result in serious bodily injury, death, or serious property damage.

Maintenance

MAINTENANCE

The maintenance of an engine and related components are critical to its operating performance and lifespan. Industrial engines operate in environments that often include hot and cold temperatures and extreme dust. The recommended maintenance schedule is listed in this section, however, environmental operating conditions and additional installed equipment may require more frequent inspection and servicing. The owner and/or service agent should review the operating conditions of the equipment to determine the inspection and maintenance intervals.

WARNING

When performing maintenance on the engine, turn the ignition OFF and disconnect the battery negative cable to avoid injury or damage to the engine.

The engine installed in this equipment uses a serpentine drive belt configuration that drives the water pump, alternator and additional pumps or devices. It is important to note that the drive belt is an integral part of the cooling and charging system and should be inspected according to the maintenance schedule in this section. When inspecting the belts check for:

- Cracks
- Chunking of the belt
- Splits
- Material hanging loose from the belt
- Glazing, hardening

If any of these conditions exist the belt should be replaced with the recommended OEM replacement belt.

WARNING

Alcohol or Methanol based anti-freeze or plain water are not recommended for use in the cooling system at anytime.

SERPENTINE BELT SYSTEM

Serpentine belts utilize a spring-loaded tensioner to keep the belt properly adjusted. Serpentine belts should be checked according to the maintenance schedule in this section.

IMPORTANT:
The use of “belt dressing” or “anti-slipping agents” on belts is not recommended.

COOLING SYSTEM

It is important that the cooling system of the engine be maintained properly to ensure proper performance and longevity.

WARNING

Do not remove the cooling system pressure cap (radiator cap) when the engine is hot. Allow the engine to cool and then remove the cap slowly to allow pressure to vent. Hot coolant under pressure may discharge violently.

Note that the LPG vaporizer is connected to the cooling system and the fuel system may be adversely affected by low coolant levels and restricted or plugged radiator cores. Therefore, the cooling system must be maintained according to the recommend maintenance schedule in this section and also include:

- The regular removal of dust, dirt and debris from the radiator core and fan shroud.
- Inspection of coolant hoses and components for leaks, especially at the radiator hose connections. Tighten hose clamps if necessary.
- Check radiator hoses for swelling, separation, hardening, cracks or any type of deterioration. If any of these conditions exist the hose should be replaced with a recommended OEM replacement part.
- Inspect the radiator cap to ensure proper sealing.

COOLANT

Check coolant level in coolant recovery tank and add coolant as required. Add 50/50 mixture of ethylene glycol antifreeze and distilled water or coolant per engine manufacturer's instructions. Do not add plain water. Replace coolant per the recommended schedule.

IMPORTANT:
The manufacturers of the engine and fuel system do not recommend the use of "stop leak" additives to repair leaks in the cooling system. If leaks are present the radiator should be removed and repaired or replaced.

ENGINE ELECTRICAL SYSTEM MAINTNANCE

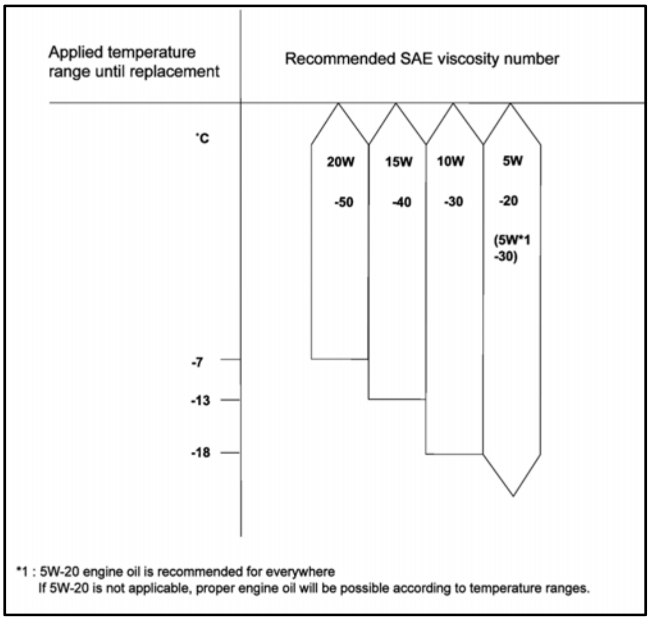
The engine's electrical system incorporates computers to control various related components. The electrical system connections and ground circuits require good connections. Follow the recommended maintenance schedule in this section to maintain optimum performance. When inspecting the electrical system check the following:

- Check Positive and Negative cables for corrosion, rubbing, chafing, burning and to ensure tight connections at both ends.
- Check battery for cracks or damage to the case and replace if necessary.
- Inspect engine wire harness for rubbing, chafing, pinching, burning, and cracks or breaks in the wiring.
- Verify that engine harness connectors are correctly locked in by pushing in and then pulling the connector halves outward.
- Inspect primary ignition coil wires for hardening, cracking, arcing, chafing, burning, separation, split boot covers.
- Check spark plug wires for hardening, cracking, chafing, arcing or burning, separation, and split boot covers.
- Replace spark plugs at the required intervals per the recommended maintenance schedule.
- Verify that all electrical components are securely mounted to the engine or chassis.
- Verify that any additional electrical services installed by the owner are properly installed in the system.
- Verify that the MIL, charging, and oil pressure lights illuminate momentarily during engine start.

ENGINE CRANKCASE OIL

OIL RECOMMENDATION

Select an engine oil that will best match the prevailing daytime temperature:



Motor oils meeting this spec receive the API (American Petroleum Institute) starburst symbol:

The recommended API classification: Above SG.

The oil capacity for the 2.0L engine including a new filter is 1.1 gallons (4.0L)

IMPORTANT:
Oils recommended by the engine manufacturer already contain a balanced additive treatment. Oils containing "solid" additives, non-detergent oils, or low quality oils are not recommended by the engine manufacturer. The supplemental additives added to the engine oil are not necessary and may be harmful. The engine and fuel system

supplier do not review, approve or recommend such products.

SYNTHETIC OILS

Synthetic oils have been available for use in industrial engines for a relatively long period of time and may offer advantages in cold and hot temperatures. However, it is not known if synthetic oils provide operational or economic benefits over conventional petroleum-based oils in industrial engines. Use of synthetic oils does not permit the extension of oil change intervals.

CHECKING/FILLING ENGINE OIL LEVEL

IMPORTANT:
Care must be taken when checking engine oil level. Oil level must be maintained between the "ADD" mark and the "FULL" mark on the dipstick. To ensure that you are not getting a false reading, make sure the following steps are taken before checking the oil level.

1. Stop engine.
2. Allow approximately five minutes for the oil to drain back into the oil pan.
3. Remove the dipstick. Wipe with a clean cloth or paper towel and reinstall. Push the dipstick all the way into the dipstick tube.
4. Remove the dipstick and note the amount of oil on the dipstick. The oil level must be between the "FULL" and "ADD" marks.

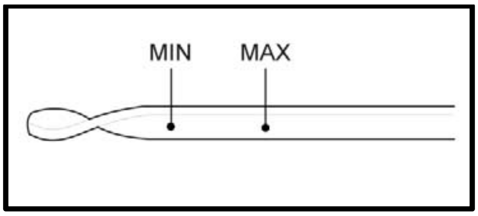


Figure 2 *Engine Oil Dip tick (Typical)*

5. If the oil level is below the "ADD" mark reinstall the dipstick into the dipstick tube and proceed to Step 6.
6. Remove the oil filler cap from the valve cover.
7. Add the required amount of oil to bring the level up to, but not over, the "FULL" mark on the dipstick Reinstall the oil filler cap to the valve rocker arm cover and wipe any excess oil clean.

CHANGING THE ENGINE OIL

IMPORTANT:
When changing the oil, always change the oil filter.

1. Start the engine and run until it reaches normal operating temperature.

CAUTION

An overfilled crankcase (oil level being too high) can cause an oil leak, a fluctuation or drop in oil pressure. When overfilled, the engine crankshafts splash and agitate the oil, causing it to aerate or foam.

IMPORTANT:
Change oil when engine is warm and the old oil flows more freely.

2. Stop engine

IMPORTANT:
Engine oil will be hot. Use protective gloves to prevent burns. Engine oil contains chemicals which may be harmful to your health. Avoid skin contact.

3. Remove drain plug and allow the oil to drain.
4. Remove and discard oil filter and its sealing ring.
5. Coat sealing ring on the new filter with clean engine oil, wipe the sealing surface on the filter mounting surface to remove any dust, dirt or debris. Tighten filter securely (follow filter manufacturer's instructions). Do not over tighten.
6. Check sealing ring on drain plug for any damage, replace if necessary, wipe plug with clean rag, wipe pan sealing surface with clean rag and re-install plug into the pan. Tighten to 25.3-32.4 ft.lbs (34.3-44.1 Nm).

IMPORTANT:
Always use a new drain plug gasket when changing the oil.

7. Fill crankcase with oil.
8. Start engine and check for oil leaks.
9. Dispose of oil and filter in a safe manner.

FUEL SYSTEM INSPECTION AND MAINTENANCE

LPG FUEL SYSTEM

The LPG fuel system installed on this industrial engine has been designed to meet the emission standard applicable for the 2007-2009 model years. To ensure compliance to these standards, follow the recommended maintenance schedule contained in this section.

INSPECTION AND MAINTENANCE OF THE FUEL STORAGE CYLINDER

The fuel storage cylinder should be inspected daily or at the beginning of each operational shift for any leaks, external damage, adequate fuel supply and to ensure the manual service valve is open. Fuel storage cylinders should always be securely mounted, inspect the securing straps or retaining devices for damage ensure that all locking devices are closed and locked. Check to ensure that the fuel storage cylinder is positioned with the locating pin in the tank collar on all horizontally mounted cylinders this will ensure the proper function of the cylinder relief valve.

When refueling or exchanging the fuel cylinder, check the quick fill valve for thread damage. Also verify O-ring is in place and inspect for cracks, chunking or separation. If damage to the o-ring is found, replace prior to filling. Check the service line quick coupler for any thread damage.

IMPORTANT:
When refueling the fuel cylinder, wipe both the female and male connection with a clean rag prior to filling to prevent dust, dirt and debris from being introduced to the fuel cylinder.

INSPECTION AND REPLACEMENT OF THE LPG FUEL FILTER

The LPG system on this emission certified engine utilizes an in-line replaceable fuel filter element. This element should be replaced, at the intervals specified in the recommended maintenance schedule. When inspecting the fuel filter check the following:

- Check for leaks at the inlet and outlet fittings, using a soapy solution or an electronic leak detector and repair if necessary.
- Check to make sure filter is securely mounted.
- Check filter housing for external damage or distortion. If damaged replace fuel filter.

REPLACING THE LPG FUEL FILTER:

1. Move the equipment to a well ventilated area and verify that sparks, ignition and any heat sources are not present.
2. Start the engine.
3. Close the LPG tank valve.
4. When the engine stalls when it runs out of fuel, turn the ignition key to the OFF position and disconnect the battery negative cable.

IMPORTANT:
A small amount of fuel may still be present in the fuel line. Use gloves and proper eye protection to prevent burns. If liquid fuel continues to flow from the connections when removed, make sure the manual valve is fully closed.

5. Slowly loosen the inlet fitting and disconnect.
6. Slowly loosen the outlet fitting and disconnect.
7. Remove the filter housing form the equipment.
8. Check for contamination.
9. Tap the opening of the filter on a clean cloth.
10. Check for debris.
11. Check canister for proper mounting direction.
12. Reinstall the filter housing to the equipment.
13. Tighten the inlet and outlet fittings to specification.
14. Open the LPG tank valve.

IMPORTANT:
The fuel cylinder manual valve contains an Excess Flow Check Valve. Open the valve slowly to prevent activating the Excess Flow Check Valve.

15. Check for leaks at the inlet and outlet fittings, and the filter housing end connection using a soapy solution or an electronic leak detector, if leaks are detected make repairs.

ELECTRONIC PRESSURE REGULATOR (EPR) MAINTENANCE AND INSPECTION

IMPORTANT:
The Electronic Pressure Regulator (EPR) components have been specifically designed and calibrated to meet the fuel system requirements of the emission certified engine.

If the EPR fails to operate or develops a leak, it should be repaired or replaced with the OEM recommended replacement parts. When inspecting the regulator check for the following items:

- Check for any fuel leaks at the inlet and outlet fittings.
- Check for any fuel leaks in the regulator body.
- Check the inlet and outlet fittings of the coolant supply lines for water leaks.
- Check the coolant supply lines for hardening, cracking, chafing or splits. If any of these conditions exist replace coolant lines.
- Check coolant supply hose clamp connections, ensure they are tight.
- Check to ensure the EPR is securely mounted and the mounting bolts are tight.
- Check EPR for external damage.
- Check EPR electrical connection to ensure the connector is seated and locked.

CHECKING/DRAINING OIL BUILD-UP IN THE ELECTRONIC PRESSURE REGULATOR

During the course of normal operation oil or "heavy ends" may build inside the secondary chamber of the Electronic Pressure Regulator (EPR). These oil and heavy ends may be a result of poor fuel quality, contamination of the fuel, or regional variation of the fuel make up. A significant build up of oil can affect the performance of the secondary diaphragm response. The Recommended Maintenance Schedule found in this section recommends that the oil be drained periodically. This is the minimum requirement to maintain the emission warranty. More frequent draining of the EPR is recommended for special situation where substandard fuel may be a problem. IMPCO recommends the EPR be drained at every engine oil change if contaminated or substandard fuel is suspected or known to have been used or in use with the emission complaint fuel system. This is known as special maintenance, and failure to follow this recommendation may be used to deny a warranty claim.

IMPORTANT:
Draining the regulator when the engine is warm will help the oils to flow freely from the regulator.

To drain the EPR, follow the steps below:

1. Move the equipment to a well ventilated area and ensure no external ignition sources are present.
2. Start the engine.
3. With the engine running close the LPG tank valve.
4. When the engine runs out of fuel turn OFF the key when the engine stops and disconnect the negative battery cable.

IMPORTANT:
A small amount of fuel may still be present in the fuel line, use gloves to prevent burns, wear proper eye protection. If liquid fuels continues to flow from the connections when loosened check to make sure the manual valve is fully closed.

5. Slowly loosen the inlet fitting and disconnect.
6. Loosen the hose clamp at the outlet hose fitting and remove the hose.
7. Remove the Retaining Pin in the LPG Temperature Sensor and remove from the EPR
8. Remove the EPR mounting bolts.
9. Place a small receptacle in the engine compartment.
10. Rotate the EPR to 90° so that the outlet fitting is pointing down into the receptacle and drain the EPR.
11. Inspect the secondary chamber for any large dried particles and remove.
12. Remove the receptacle and reinstall the EPR with the two retaining bolts and tighten to specifications.
13. Reinstall the outlet fitting and secure with the previously removed Retaining pin.
14. Reconnect the electrical connector (push in until it clicks and securely locks), then pull on the connector to ensure it is locked.
15. Connect the vacuum line.
16. Reconnect the outlet hose and secure the hose clamp.
17. Reinstall the fuel inlet line and tighten connection to specification.
18. Slowly open the LPG tank valve.

IMPORTANT:
The fuel cylinder manual valve contains an Excess Flow Check Valve. Open the manual valve slowly to prevent activating the Excess Flow Check Valve.

19. Check for leaks at the inlet and outlet fittings using a soapy solution or an electronic leak detector. If leaks are detected make repairs. Check coolant line connections to ensure no leaks are present.
20. Start engine recheck for leaks at the regulator.
21. Dispose of any drained material in safe and proper manner.

AIR FUEL MIXER/THROTTLE CONTROL DEVICE MAINTENANCE AND INSPECTION

IMPORTANT:
The Air Fuel Mixer components have been specifically designed and calibrated to meet the fuel system requirements of the emission certified engine. The mixer should not be disassembled or rebuilt. If the mixer fails to operate or develops a leak the mixer should be replaced with the OEM recommended replacement parts.

When inspecting the mixer check for the following items:

- Leaks at the inlet fitting.
- Fuel inlet hose for cracking, splitting or chaff-ing, replace if any of these condition exist.
- Ensure the mixer is securely mounted.
- Inspect air inlet hose connection and clamp. Also inspect inlet hose for cracking, splitting or chafing. Replace if any of these conditions ex-ist.
- Inspect Air cleaner element according to the Recommended Maintenance Schedule found in this section.
- Check Fuel lines for cracking, splitting or chaf-ing. Replace if any of these conditions exist.
- Verify Throttle Body return action to ensure throttle shaft is not sticking. Repair if neces-sary.
- Check for leaks at the Throttle Body and in-take manifold.

EXHAUST SYSTEM AND CATALYTIC CONVERTER INSPECTION AND MAINTENANCE

IMPORTANT:
The exhaust system on this emission certified en-gine contains a Heated Exhaust Gas Oxygen Sensor (HEGO) which provides feed back to the ECM on the amount of oxygen present in the ex-haust stream after combustion.

The measurement of oxygen in the exhaust stream is measured in voltage and sent to the ECM. The ECM then makes corrections to the fuel air ratio to ensure the proper fuel charge and optimum catalytic performance. Therefore, it is important that the exhaust connections remain secured and air tight.

IMPORTANT:
The HEGO sensor is sensitive to silicone based products. Do not use silicone sprays or hoses which are assembled using silicone lubricants. Silicone contamination can cause severe damage to the HEGO.

When inspecting the Exhaust system check the following:

- Exhaust manifold at the cylinder head for leaks and that all retaining bolts and shields (if used) are in place.
- Manifold to exhaust pipe fasteners to ensure they are tight and that there are no exhaust leaks repair if necessary.
- HEGO electrical connector to ensure connec-tor is seated and locked, check wires to ensure there is no cracking, splits chafing or "burn through." Repair if necessary.
- Exhaust pipe extension connector for leaks tighten if necessary
- Visually inspect converter to ensure muffler is securely mounted and tail pipe is properly aimed.
- Check for any leaks at the inlet and outlet of the converter.

LPG & BI-FUEL CERTIFIED ENGINE MAINTENANCE REQUIREMENTS

Perform the following maintenance on the engine at the hours indicated and at equivalent hour intervals thereafter.

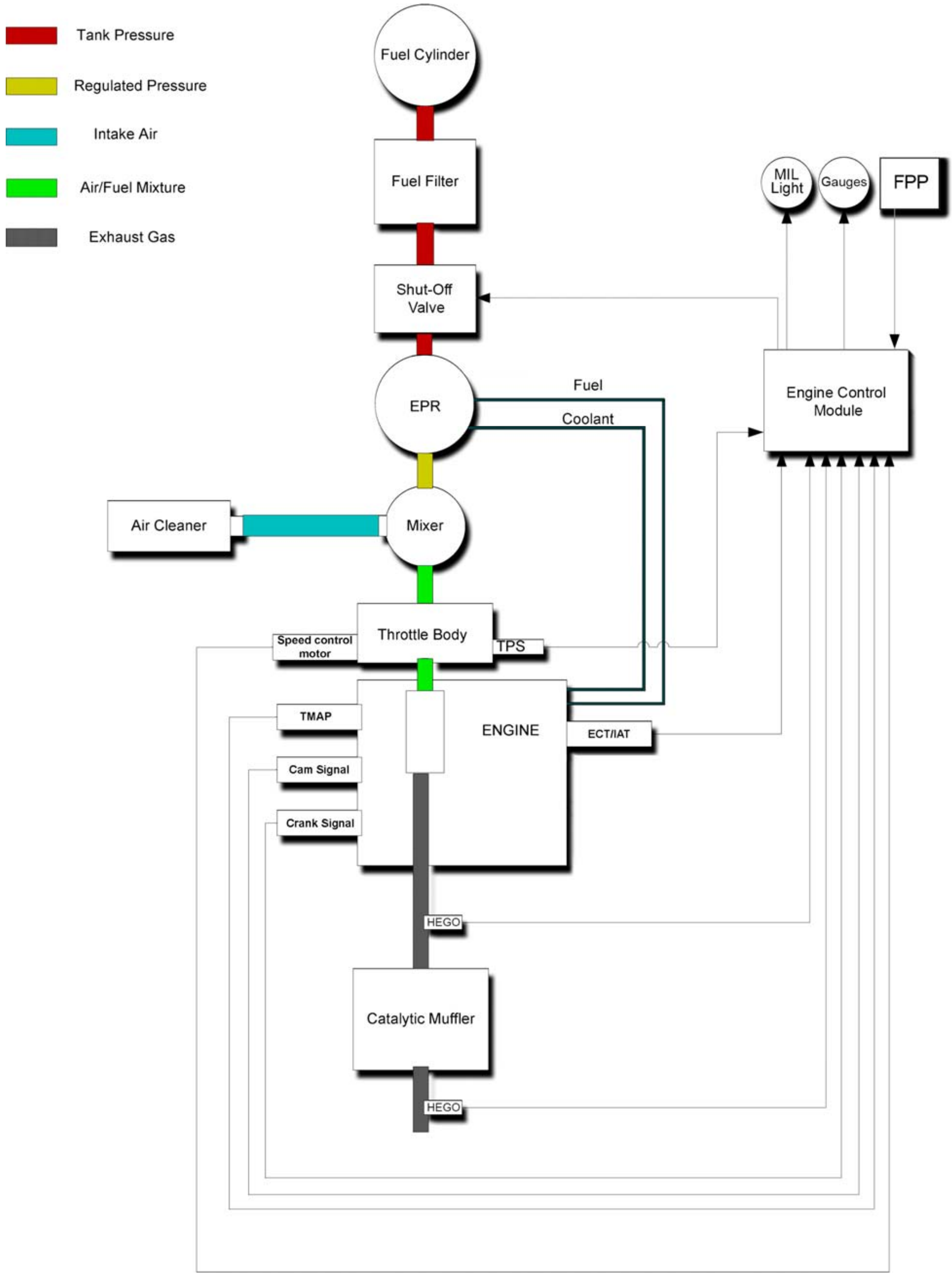
	Interval Hours									
	Daily	1000	1500	2000	2500	3000	3500	4000	4500	5000
General Maintenance Section										
Visual check for fluid leaks	X									
Check engine oil level	X									
Check coolant level	X									
Change engine oil and filter	**Every 100 hours or 60 days of operation**									
Check LPG system for leaks	Prior to any service or maintenance activity									
Inspect accessory drive belts for cracks, breaks, splits or glazing		X		X		X		X		X
Inspect electrical system wiring for cuts, abrasions or corrosion				X				X		
Inspect all vacuum lines and fittings for cracks, breaks or hardening				X				X		
Engine Coolant Section										
Clean debris from radiator core	**Every 100 hours or 60 days of operation**									
Change coolant		X		X		X		X		X
Inspect coolant hoses for cracks, swelling or deterioration		X		X		X		X		X
Engine Ignition System										
Inspect Battery case for leaks or damage		X		X		X		X		X
Inspect battery cables for damage corrosion or contamination		X		X		X		X		X
Check all electrical connector retainer locks		X		X		X		X		X
Replace spark plugs				X				X		
Fuel System Maintenance										
Inspect air cleaner	**Every 200 hours, or every 100 hours in dusty environment**									
Replace filter element	Annually, or Bi-annually in dusty environments									
Replace PCV Valve							X			
Replace inline LPG fuel filter		X		X		X		X		X
Check LPG shut off solenoid valve function				X				X		
Replace fuel filter (Bi-fuel only)		X		X		X		X		X
Inspect Shut-off Valve for leaks and closing				X				X		
Leak check fuel lines				X				X		
Check air induction for leaks				X				X		
Check manifold for vacuum leaks				X				X		
Check fuel injector s& rail for leaks (Bi-fuel only)				X				X		
Replace fuel injectors (Bi-fuel only)										X
Inspect EPR for coolant leaks	**Annually or every 2000 hours**									
Drain EPR oil build up	**Every 2500 hrs**									
Engine Exhaust System										
Inspect exhaust manifold for leaks				X				X		
Inspect exhaust piping for leaks				X				X		
Check HEGO sensor connector and wires for burns, cuts or damage				X				X		
Inspect catalyst for mechanical damage				X				X		

This maintenance schedule represents the manufacturer's recommended maintenance intervals to maintain proper engine/equipment function. Federal, State, or Local regulations may require additional or more frequent inspection or maintenance intervals than those specified above. Check with the authority having jurisdiction for details. Note that LPG engines are designed to operate on HD–5 or HD–10 specification LPG fuel. Fuel other than HD–5 or HD–10 may cause harm to the engine's emission control system and a warranty claim may be denied on this basis if operators can readily find the proper fuel. Use of any other fuel may result in your engine no longer operating in compliance with CARB or EPA emissions requirements.*

**Not Applicable in the state of California.*

LPG Fuel System

LPG FUEL SYSTEM OPERATION



DESCRIPTION AND OPERATION OF THE FUEL SYSTEMS

LPG FUEL SYSTEM

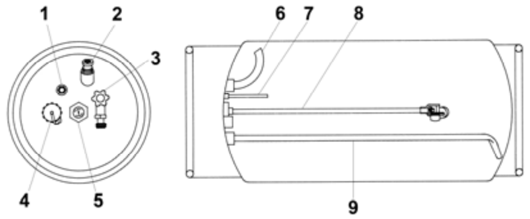
The primary components of the LPG fuel system are the Fuel Storage Tank, Electronic Pressure Regulator (EPR), Fuel Mixer, Throttle Control Device, electric Shut-Off Valve, Engine Control Module (ECM), Oxygen Sensor and a Catalytic Converter. The system operates at pressures which range from 355.60mm (14.0 inches) of water column up to 21.5 BAR (312 psi).

LPG FUEL TANK

LPG is stored in the fuel tank as a liquid. The approximate pressure of the fuel in the tank is 8.8 bar (130 psi) when the tank is full at an ambient temperature of 27° C (81°F). The boiling point, (temperature at which the liquid fuel becomes vapor) is approximately 40° C (-40° F). When the fuel changes from liquid to vapor the fuel expands and creates pressure inside the tank. When the tank service valve is opened the pressure inside the tank forces the liquid fuel out though the pickup tube located near the bottom of the fuel cylinder.

TABLE #1			
TEMPERATURE		VAPOR PRESSURE	
deg. F	deg. C	PSIG	kPa
130	54	257	1794
110	43	197	1358
100	38	172	1186
90	32	149	1027
80	27	128	883
60	16	92	637
30	-1	51	356
0	-18	24	162
-20	-29	11	74
-44	-42	propane begins to boil @ sea level	
-45	-43	0	0

Because the LPG is stored under pressure the tank is equipped with a safety valves which are normally set at 25.8 bar (375 psi) to prevent tank rupture due to over-pressurization of the cylinder. The service valve mounted in the end of the cylinder controls the flow of fuel from the tank. By turning the handle to its “open” position, fuel flows out of the tank and into the service line. The service valve is also equipped with a safety feature called an excess flow check valve. This feature reduces the flow from the service valve in the event of a rupture of the fuel line or any downstream.



Typical LPG Cylinder

1. Liquid Outage Fill Check Valve
2. Pressure Relief Valve
3. Liquid Outage Valve w/quick disconnect coupling (also referred to as the manual shut-off valve or MSV).
4. Filler Valve
5. Fuel Gauge
6. Vapor Withdrawal Tube (when applicable)
7. 80% Limiter Tube
8. Fuel Level Float
9. Liquid Withdrawal Tube

SERVICE LINE

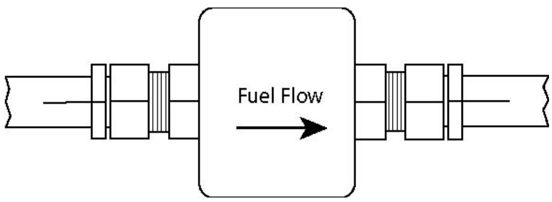
LPG flows from the fuel tank to the electric LPG Shut-Off Valve via the service line. The service line is connected to the tank utilizing a quick coupler. The other end of the service line is connected to a bulkhead connector mounted on the equipment sheet metal. This bulkhead connector allows for a safe means of passing through the equipments engine compartment sheet metal and into the engine compartment. If a bulkhead connector is used a pressure relief device is mounted in the service line or the connector itself to prevent over pressurization. The service line is made of high pressure hose with special material or possibly tubing which is compatible with the LPG fuel and should always be replaced with an OEM supplied part.

CAUTION

The bulkhead assembly should never be removed. Never run a service line through the sheet metal.

FUEL FILTER

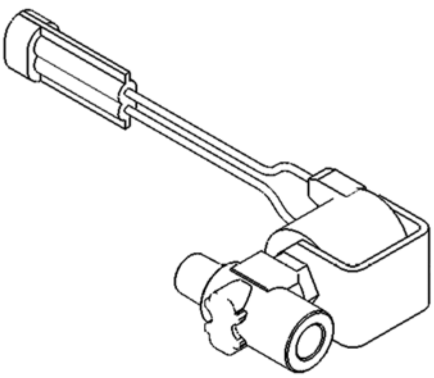
LPG, fuel like all other motor fuels is subject to contamination from outside sources. Refueling of the equipment tank and removal of the tank from the equipment can inadvertently introduce dirt and other foreign matter into the fuel system. It is therefore necessary to filter the fuel prior to entering the fuel system components downstream of the tank. An inline fuel filter has been installed in the fuel system to remove the dirt and foreign matter from the fuel, which is replaceable as a unit only. Maintenance of the filter is critical to proper operation of the fuel system and should be replaced according to the maintenance schedule or more frequently under severe operating conditions.



Inline Fuel Filter

LPG SHUT-OFF VALVE

The LPG Shut-Off Valve is an integrated assembly consisting of a 12 volt solenoid and a normally closed valve. When energized, the solenoid opens the valve and allows the LPG fuel to flow through the device. The valve opens during cranking and engine run cycles.



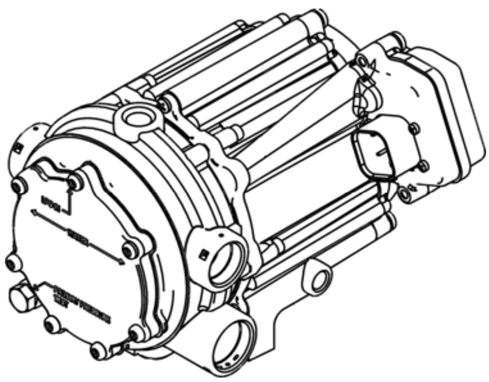
LPG Shut-Off Valve

Voltage to the LPG Shut-Off Valve is controlled by the engine control module (ECM).

ELECTRONIC PRESSURE REGULATOR (EPR)

The EPR is a combination vaporizer and pressure regulating device. The EPR functions as a negative pressure two stage regulator that is normally closed with the ability to supply additional fuel by command from the ECM. When the engine is cranking or running, a partial vacuum is created in the fuel line which connects the regulator to the mixer. This partial vacuum opens the regulator permitting fuel to flow to the mixer.

LPG fuel enters the primary port of the EPR and passes through the primary jet and into the primary/heat exchanger chamber and expands as it heats up, creating pressure inside the chamber. When the pressure increases above 10.34 kPa (3.5 psi), sufficient pressure is exerted on the primary diaphragm to cause the diaphragm plate to pivot and press against the primary valve pin, thus closing off the flow of fuel. When the engine is cranking, sufficient vacuum will be introduced into the secondary chamber from the mixer drawing the secondary diaphragm down onto the spring loaded lever and opening the secondary valve. An increase in vacuum in the secondary chamber increases the downward action on the secondary lever, causing it to open wider and permitting more fuel flow to the mixer.



Electronic Pressure Regulator

CAUTION

The EPR is an emission control device and should only be serviced by qualified technicians.

AIR FUEL MIXER

The air valve mixer is a completely self-contained air-fuel metering device. The mixer is an air valve design, utilizing a relatively constant pressure drop to draw fuel into the mixer from cranking to full load. The mixer is mounted in the air stream ahead of the throttle control device.

When the engine begins to crank it draws in air with the air valve covering the inlet, and negative pressure begins to build. This negative pressure signal is communicated to the top of the air valve chamber through 4 vacuum ports in the air valve assembly. A pressure/force imbalance begins to build across the air valve diaphragm between the air valve vacuum chamber and the atmospheric pressure below the diaphragm. The air valve vacuum spring is calibrated to generate from 101.6 mm (4.0 inches) of water column at start to as high as 355.60 mm (14.0 inches) of water column at full throttle. The vacuum being created is referred to as Air Valve Vacuum (AVV). As the air valve vacuum reaches 101.6mm (4.0 inches) of water column, the air valve begins to lift against the air valve spring. The amount of AVV generated is a direct result of the throttle position. At low engine speed the air valve vacuum and the air valve position is low thus creating a small venturi for the fuel to flow. As the engine speed increases the AVV increases and the air valve is lifted higher thus creating a much larger venturi. This air valve vacuum is communicated from the mixer venturi to the EPR secondary chamber via the low pressure fuel supply hose. As the AVV increases in the secondary chamber the secondary diaphragm is drawn further down forcing the secondary valve lever to open wider.

The mixer is equipped with a low speed mixture adjustment retained in a tamper proof housing. The mixer has been preset at the factory and should not require adjustment. In the event that the idle adjustment should need to be adjusted refer to the Fuel System Repair section of this manual.

CAUTION

The air/fuel mixer is an emission control device. Components inside the mixer are specifically calibrated to meet the engine's emissions requirements and should never be disassembled or rebuilt. If the mixer fails to function correctly, replace with an OEM replacement part.

THROTTLE CONTROL DEVICE—DRIVE BY WIRE

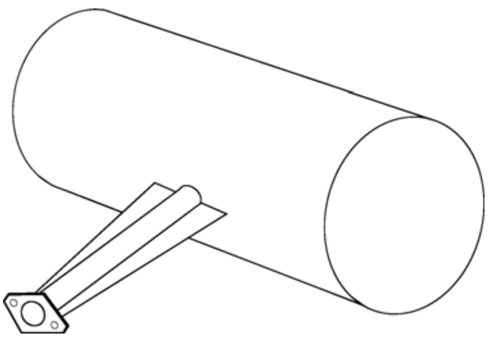
Drive By Wire Engine speed control is maintained by the amount of pressure applied to the foot pedal located in the engine compartment. In a Drive By Wire (DBW) application, there is no direct connection between the operator pedal and the throttle shaft. Speed and load control are determined by the ECM. Defaults programmed into the ECM software and throttle position sensors allow the ECM to maintain safe operating control over the engine. In a drive by wire application the Electronic Throttle Control device or throttle body assembly is connected to the intake manifold of the engine. The electronic throttle control device utilizes an electric motor connected to the throttle shaft. In addition, a Foot Pedal Position sensor (FPP) is located in the operator's compartment.

When the engine is running electrical signals are sent from the foot pedal position sensor to the engine ECM when the operator depresses or release the foot pedal. The ECM then sends an electrical signal to the motor on the electronic throttle control to increase or decrease the angle of the throttle blade thus increasing or decreasing the air/fuel charge to the engine. The electronic throttle control device incorporates two internal Throttle Position Sensors (TPS) which provide output signals to the ECM as to the location of the throttle shaft and blade. The TPS information is used by the ECM to correct for speed and load control as well as emission.

CATALYTIC CONVERTER

The Catalytic Converter is a component of the emissions system which is designed and calibrated to meet the emission standards in effect for 2007-2009 model year.

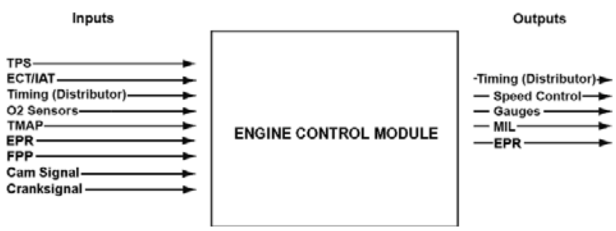
The exhaust gases pass through the honeycomb catalyst which is coated with a mixture of metals (such as platinum, palladium, and rhodium) to oxidize and reduce CO, HC and NOX emission gases.



Catalytic Converter/Muffler

ENGINE CONTROL MODULE

To obtain maximum effect from the catalyst and accurate control of the air fuel ratio, the emission certified engine is equipped with an onboard computer or Engine Control Module (ECM). The ECM is a 32 bit controller which receives input data from sensors mounted to the engine and fuel system and then outputs various signals to control engine operation.



Engine Control Module (ECM)

One specific function of the controller is to maintain a closed loop fuel control which is accomplished by use of the Heated Exhaust Gas Oxygen sensor (HEGO) mounted in the exhaust system. The HEGO sensor sends a voltage signal to the controller which then outputs signals to the EPR to change the amount of fuel being delivered from the regulator or mixer to the engine.

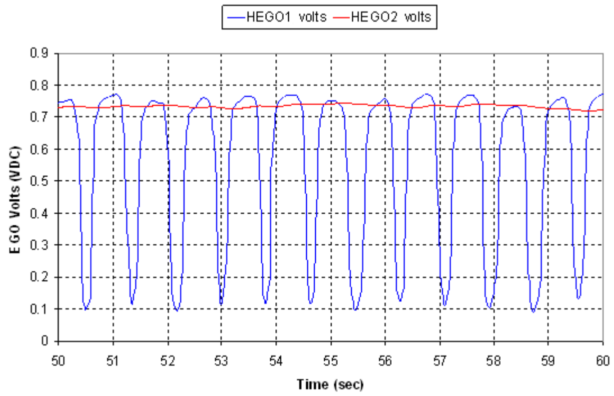
The controller also performs diagnostic functions on the fuel system and notifies the operator of engine malfunctions by turning on a Malfunction Indicator Light (MIL) mounted in the dash. Malfunctions in the system are identified by a Diagnostic Trouble Code (DTC) number. In addition to notifying the operator of the malfunction in the system, the controller also stores the information about the malfunction in its memory. A technician can than utilize a computerized diagnostic scan tool to retrieve the stored diagnostic code and by using the diagnostic charts in this manual to determine the cause of the malfunction. In the event a technician does not have the computerized diagnostic tool, the MIL light can be used to identify the diagnostic code to activate the “blink” feature and count the number of blinks to determine the diagnostic code number to locate the fault in the system.

HEATED EXHAUST GAS OXYGEN SENSORS

The Heated Exhaust Gas Oxygen (HEGO) Sensors are mounted in the exhaust system, one upstream and one downstream of the catalytic converter. The HEGO sensors are used to measure the amount of oxygen present in the exhaust stream to determine whether the fuel air ratio is to rich or to lean. It then communicates this measurement to the ECM. If the HEGO sensor signal indicates that the exhaust stream is too rich, the ECM will decrease or lean the fuel mixture during engine operation. If the mixture is too lean, the ECM will richen the mixture. If the ECM determines that a rich or lean condition is present for an extended period of time which cannot be corrected, the ECM will set a diagnostic code and turn on the MIL light in the dash.

By monitoring output from the sensor upstream and the sensor downstream of the catalytic converter, the ECM can determine the performance of the converter.

The Heat Exhaust Gas Oxygen (HEGO) Sensor

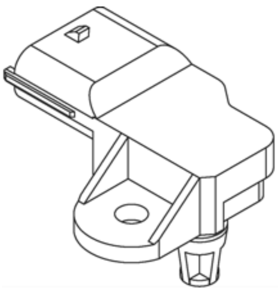


HEGO1 (upstream or before the catalytic converter) and HEGO2 (downstream) voltage output.

CAUTION

The Heated Exhaust Gas Oxygen Sensor (HEGO) is an emissions control component. In the event of a failure, the HEGO should only be replaced with the recommended OEM replacement part. The HEGO is sensitive to silicone based products and can become contaminated. Avoid using silicone sealers or air or fuel hoses treated with a silicone based lubricant.

TMAP SENSOR



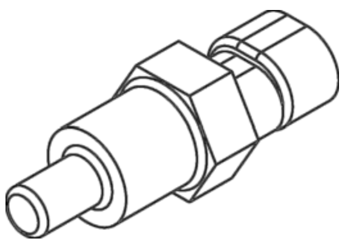
T–MAP Sensor

The Air Temperature/Manifold Absolute Pressure or TMAP sensor is a combination of two sensors:

1) A variable resistor used to monitor the difference in pressure between the intake manifold and outside or atmospheric pressure. The ECM monitors the resistance of the sensor to determine engine load (the vacuum drops when the engine is under load or at wide open throttle). When the engine is under load, the computer may alter the fuel mixture to improve performance and emissions.

2) The intake air temperature or IAT sensor is a variable resistance thermistor located in the air intake passage which measures the temperature of the incoming air. The ECM uses the resistance value to monitor incoming air temperature and calculate the engine's airflow requirement. The ECM provides a voltage divider circuit so that when the air is cool, the signal reads a higher voltage, and lower when warm. On cold starts, the ECM richens the fuel/air mixture.

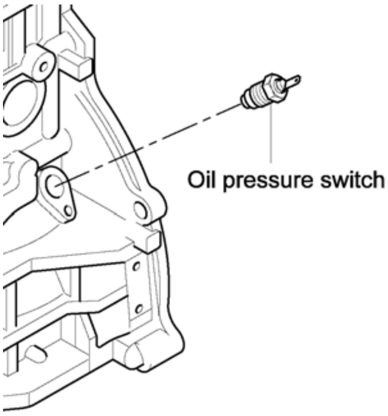
COOLANT TEMPERATURE SENSOR



ECT

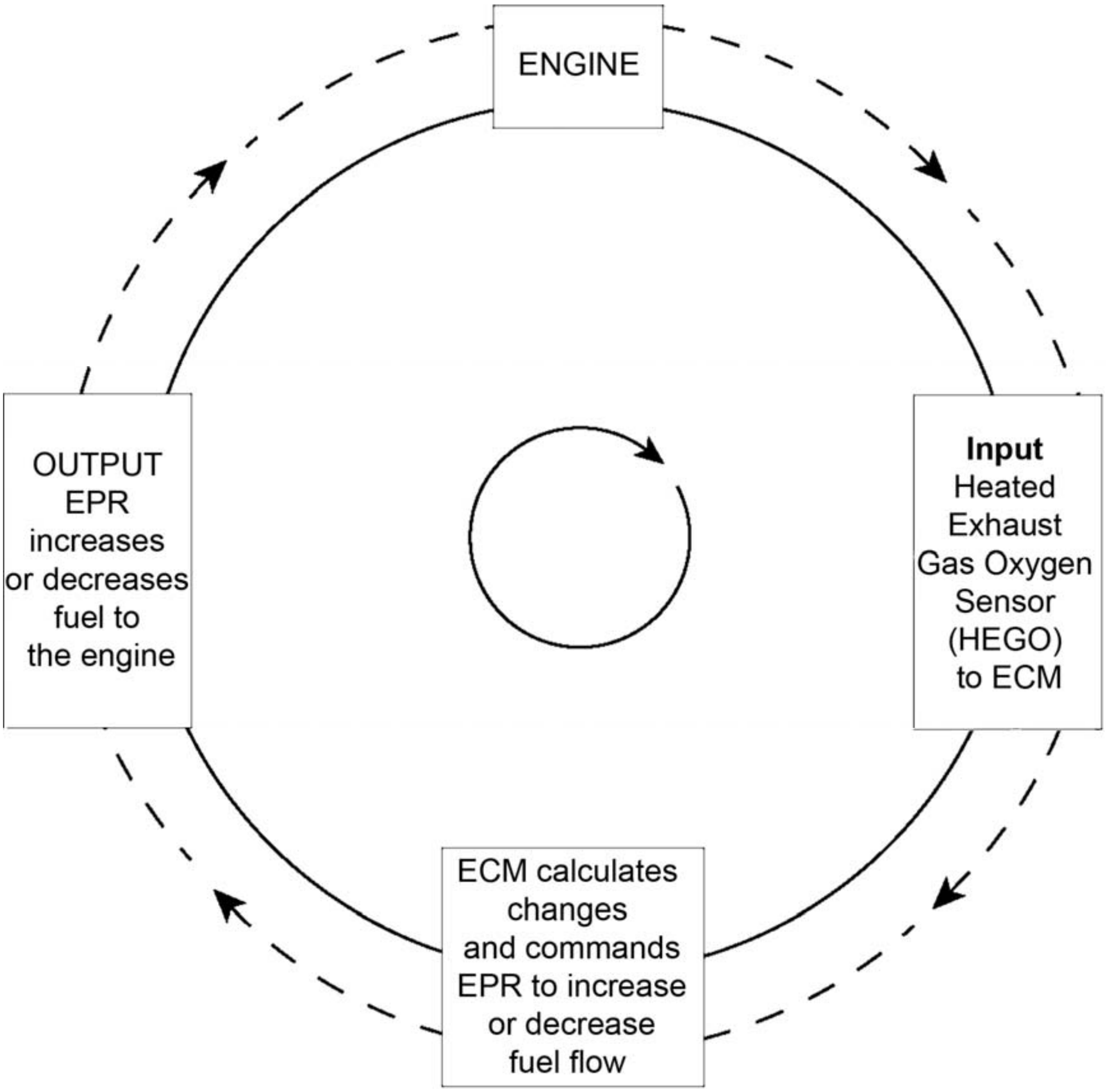
The Engine Coolant Temperature sensor or ECT is a variable resistance thermistor that changes resistance as the engine's coolant temperature changes. The sensor's output is monitored by the ECM to determine a cold start condition and to regulate various fuel and emission control functions via a closed loop emission system.

OIL PRESSURE SENDER/SWITCH



The Oil Pressure Switch is Mounted on the side of the Engine Block

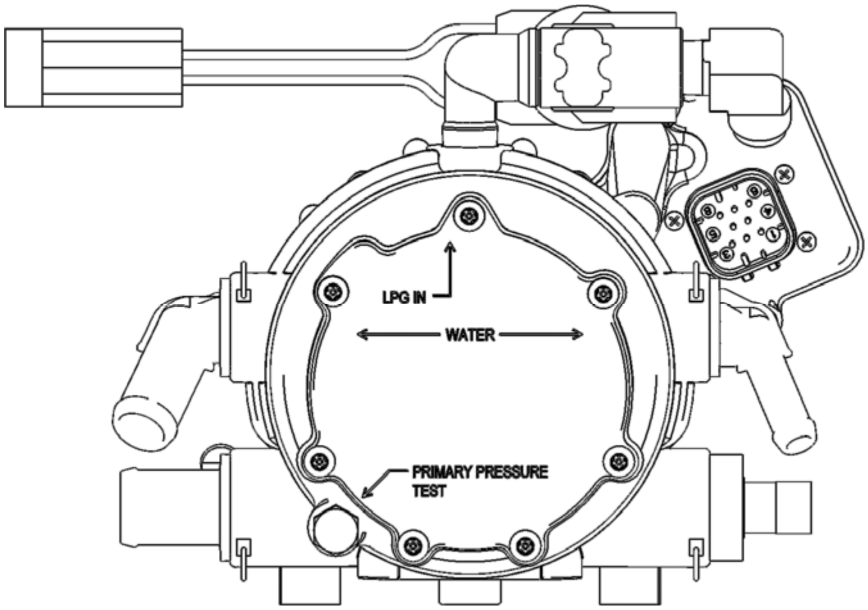
The Engine Oil Pressure switch or sender is designed to ensure adequate lubrication throughout the engine. It provides a pressure value for the oil pressure gauge and is monitored by the ECM. If the pressure drops, an MIL will occur.



LPG Closed Loop Schematic

LPG System Diagnosis

LPG FUEL SYSTEM DIAGNOSIS



The Electronic Pressure Regulator Assembly (EPR), Shown with Port Fittings and Shut-off Valve.

FUEL SYSTEM DESCRIPTION

The Engine Control Module (ECM) receives information from various engine sensors in order to control the operation of the Electronic Pressure Regulator (EPR) and Shut-Off Valve. The Shut-Off Valve solenoid prevents fuel flow unless the engine is cranking or running.

LPG is stored in the tank as a liquid and delivered under pressure of up to 21.5 BAR (312 psi). At Key ON, the EPR receives a two (2) second prime pulse from the ECM, allowing time for the LPG to flow from the tank through the fuel filter and fuel lines to the EPR. Inside of the EPR, fuel is vaporized and reduced in pressure in two stages. The first stage reduces the tank pressure to approximately 20.68 kilopascals (3.0 psi). The second stage then reduces the pressure to approximately negative 38.1 mm (1.5" of water column) when vacuum from the engine draws in fuel.

The fuel is then drawn in from the secondary chamber of the EPR by the vacuum generated by air flowing through the Mixer. This vacuum is also generates lift for the mixer air valve and is commonly referred to as air valve vacuum. Once in the mixer, the fuel is combined with air and is drawn into the engine for combustion.

DIAGNOSTIC AIDS

This procedure is intended to diagnose a vehicle operating on LPG. If the vehicle will not continue to run on LPG, refer to Hard Start for preliminary checks. Before starting this procedure, complete the following tasks to verify that liquid fuel is being delivered to the EPR:

- Inspect fuel tank to verify it has a sufficient amount of fuel.
- Verify manual shut off valve on the LPG tank is fully opened.
- Verify that the excess flow valve has not been activated.
- Inspect fuel tank to ensure it is properly mounted and rotated to the correct position.
- Inspect the hoses leading from the tank ensuring they are properly connected and do not have any kinks or damage.

TOOLS REQUIRED:

- 7/16” Open end wrench (for test port plugs)
- Test port adapter
- Straight Blade screw driver
- Needle nose pliers

DST

- Diagnostic Scan Tool (DST)

PRESSURE GAUGES

- 0-10” Water Column Gauge
- 0-10 PSI Gauge

TEST DESCRIPTION

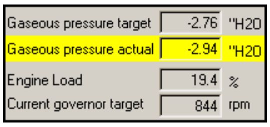
The numbers below refer to step numbers on the Diagnostic Table:

1. This step checks the base mechanical EPR output pressure by disabling all fuel control devices.
9. This step checks for proper air valve operation.
12. This determines if fuel is available from the fuel tank supply system.

LPG FUEL SYSTEM DIAGNOSTICS

Step	Action	Value(s)	Yes	No
1	Were you referred to this procedure by a DTC diagnostic Chart?		Go to Step 3	Go to Step 2
2	Connect the Diagnostic Scan Tool (DST) to the ECM Data Link Connector (DLC) and check for any DTCs. Are any DTCs present in the ECM?		Go to applicable DTC Table	Go to Step 3
3	Perform the following visual and physical preliminary checks: • Check all ECM system fuses and circuit breakers (refer to Engine Wiring Schematic). • Check the ECM grounds for being clean, tight and in their proper locations (refer to Engine Wiring Schematic). • Check the vacuum hoses for damage, splits, kinks and proper connections. • Check the fuel system for any type of leak or restriction from the supply tank to the mixer. • Check for air leaks at all mounting areas of the intake manifold sealing surfaces. • Check for proper installation of the mixer assembly. • Check for air leaks at the mixer assembly and all intake ducting between intake manifold and air cleaner. • Check air cleaner and all vehicle intake ducting for restrictions. • Check exhaust system for flow obstructions or leaks. Check the ignition wires for the following conditions: • Cracking or hardening • Proper routing • Bare or shorted wires • Carbon tracking Check the wiring harness for the following conditions: • Proper connections • Pinches • Cuts or abrasions Were any faulty conditions found in the preliminary checks?		Correct the faulty condition and Go to Step 20	Go to Step 4
4	Does the vehicle start and run?		Go to Step 9	Go to Step 5
5	Check the fuel system for the following conditions: • Verify the LPG fuel tank is at least ¼ full. • Verify the manual fuel shut-off valve is open and operating correctly. • Verify the high-flow valve has not tripped. • Verify the quick disconnect is fully engaged and there are no kinks or obstructions in the high pressure LPG supply hose. • Verify the LPG fuel filter is clean and unobstructed. Were any faulty conditions found in the fuel supply system?		Correct the faulty condition and Go to Step 20	Go to Step 6

Step	Action	Value(s)	Yes	No
6	• Connect a calibrated 0-5" PSI pressure gauge to the primary pressure test port of the EPR. • Make sure the manual shut-off valve is open and turn the ignition to ON. • Crank the engine and observe the pressure gauge. Does the pressure gauge indicate the proper primary fuel pressure?	2.0 – 4.0 PSI	Go to Step 7	If NO pressure was indicated, Go to Step 14 If LOW or HIGH pressure was indicated, Go to Step 15
7	LPG is a gaseous fuel and requires higher secondary ignition voltages than gasoline fueled engines. Check the ignition system for proper ignition secondary voltage output with J 26792 or equivalent. Remove the spark plugs and check for the following: • Correct plug type for LPG application. • Wet electrodes (oil fouling) • Cracks • Wear • Improper gap • Burned electrodes • Heavy deposits Were any faulty conditions found in the ignition system check?		Correct the faulty condition and Go to Step 20	Go to Step 8
8	Perform a leak-down test on the engine. Are all cylinder leak-down test results within specification?	<10% leakage	Go to Step 12	Repair the engine as necessary and Go to Step 20
9	• Turn OFF the manual fuel shut-off valve. • Start the engine and let it run until it dies. • Remove the LPG Temperature Sensor from the EPR (DO NOT disconnect the electrical connector). • Inspect the inside of the low-pressure fuel supply hose for heavy-end deposits. Are there any deposits built-up in the low-pressure fuel supply hose?		Go to Step 16	Go to Step 10

Step	Action	Values	Yes	No
10	• Insert the Secondary Pressure Test Adapter into the EPR port from which you removed the LPG Temp Sensor. • Connect a CALIBRATED 0-10" water column (WC) vacuum gauge or manometer to the secondary pressure test port of the EPR. • Connect the DST to the vehicle DLC connector and open the GCP Display software. • Turn the manual shut-off valve ON. Start the engine and allow it to reach operating temperature. Compare the gauge secondary pressure reading to the actual pressure on the DST Faults Screen.  (Sample Only – Readings will vary) Is the gauge secondary pressure within the specified percentage of the actual pressure indicated on the DST Faults Screen?	+/-0.75" WC	Go to Step 19	Go to Step 11
11	With the engine still running: • Disconnect the EPR electrical connector. NOTE: This action will cause a DTC to be set turning ON the MIL. • With the engine idling, observe the pressure reading on the secondary pressure test port gauge. Is the pressure reading within specifications?	-1.0" to -2.0" WC	Go to Step 15	Go to Step 13
12	• Turn OFF the manual shut-off valve and let the engine run until it dies. • Turn the ignition OFF. • Remove the Air induction hose from the mixer. • Crank the engine and observe the air valve for movement while the engine is cranking. NOTE: At cranking speeds, the air valve movement will be minimal. Is there movement in the air valve when the engine is cranking?		Go to Step 14	Go to Step 13
13	Replace the mixer assembly (refer to Fuel Mixer Replacement). Is the action complete?		Go to Step 20	NA
14	• If turned OFF, turn ON the manual shut-off valve. • Disconnect the Lock-off valve electrical connector. • Apply 12V to the lock-off valve terminals and observe the pressure gauge. Does the pressure gauge indicate pressure?	Above 1.0 PSI	Go to Step 17	Go to Step 18
15	Repair or replace the EPR (refer to EPR Repair Instructions). Is the action complete?		Go to Step 20	NA

Step	Action	Values	Yes	No
16	Inspect the following for heavy-end deposits: • Electronic Pressure Regulator. Inspect, clean and/or repair as necessary (refer to EPR Repair Instructions). • Inspect the diaphragm through the Mixer air inlet for any deposits or contaminants. <u>DO NOT disassemble the Mixer.</u> The Mixer is calibrated and disassembly may alter its calibration and adversely affect engine performance and/or emissions. Are all actions complete?		Go to Step 20	NA
17	Replace the ECM. Is the action complete?		Go to Step 20	NA
18	Replace the Lock-off Valve. Is the action complete?		Go to Step 20	NA
19	System working correctly at this time. Vehicle may have intermittent electrical connection conditions. • Return vehicle to original condition (but leave the diagnostic equipment connected). • Start the engine and wiggle test the harness while observing the DST Faults Screen and the pressure gauge readings. • Repair any conditions encountered. Is the action complete?		Go to Step 20	NA
20	• Clear any active or historic DTCs (DST Service or Faults Screen). • Clear Adaptive from memory (DST Service Screen). • Return the vehicle to original condition. • Operate the vehicle under all load and driving conditions for at least 10 minutes. • Park the vehicle with the engine running and connect the DST to the vehicle's DLC connector. • Open the GCP software and switch to the Faults Screen. • Let the vehicle idle with no load for at least 30 seconds and observe the Adaptive 1 fuel correction. Did the Adaptive 1 fuel correction remain within the specified values?	-15% to +15%	Go to Step 21	Go to Step 24
21	With engine still idling, apply a load with the hydraulic system for at least 10 seconds and observe the Adaptive 1 value. Did the Adaptive 1 fuel correction remain within the specified values?	-15% to +15%	Go to Step 22	Go to Step 24
22	Raise the engine rpms to 75-90% of maximum full governed speed with no load for at least 10 seconds and observe the Adaptive 1 fuel correction. Did the Adaptive 1 fuel correction remain within the specified values?	-15% to +15%	Go to Step 23	Go to Step 24
23	• With the engine still running at 75-90% of full governed speed, apply a moderate load with the hydraulic system. • Observe the Adaptive 1 fuel correction. Did the Adaptive 1 fuel correction remain within the specified values?	-15% to +15%	Go to Step 29	Go to Step 24
24	Was the Adaptive 1 fuel correction less than-15%?		Go to Step 26	Go to Step 25

Step	Action	Values	Yes	No
25	Was the Adaptive 1 fuel correction more than +15%?		Go to Step 27	NA
26	Engine is running RICH (system is trying to compensate by decreasing the amount of fuel). Check the following for any condition which may cause the engine to run RICH: • Ignition system (See Step 7). • Air cleaner and intake system (including vehicle intake ducting) for airflow obstructions. • Exhaust system for flow obstructions. • HEGO 1 for correct switching characteristics. Are all actions complete?		Go to Step 28	NA
27	Engine is running LEAN (system is trying to compensate by increasing the amount of fuel). Check the following for any condition which may cause the engine to run LEAN: • Intake manifold for leaks. • All throttle body and mixer gaskets or o-rings for leaks. • All vacuum hoses and fittings for leaks. • Exhaust system for leaks NOTE: Exhaust system leaks allow for excess O_2 to dilute the HEGO sensors giving a false reading. Engine may exhibit signs of a rich running condition but the Adaptive 1 corrections will indicate an excessive positive fuel adjustment. • HEGO 1 for correct switching characteristics. Are all actions complete?		Go to Step 28	NA
28	Repeat Step 20.		NA	NA
29	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability Does the engine operate normally with no stored codes? Remove all diagnostic equipment and return vehicle to original condition. Return vehicle to customer.		NA	NA

ADDITIONAL STEPS

Step	Action	Value(s)	Yes	No
1	1. Perform the On-Board Diagnostic (OBD) System check. Are any DTCs present in the ECM?		Go to Ap-plicable DTC Ta-ble	Go to Step 2
2	Has the Fuel system diagnosis been performed?		Go to Step 3	Go to Fuel system Diagno-sis
3	1. Replace the Engine Control Unit (ECM). Refer to Engine Control Unit (ECM) replacement. Is this action complete?		Go to Step 5	Go to Step 4
4	1. Repair the open or damaged circuit. Is this action complete?		Go to Step 5	Go to Step 8
5	1. Return the fuel system to normal operating condition. 2. Observe the Adaptive 1 fuel correction. 3. Raise the engine speed to approximately 2500 rpm. Is the Adaptive 1 fuel correction within the specified range at idle and 2500 rpms?	-15 to +15	Go to Step 9	Go to Step 6
6	1. Check all vacuum hoses and mixer connections for lea-kage. Was a problem found?		Go to Step 5	Go to Step 7
7	1. Replace Mixer. Is this action complete?		Go to Step 5	Go to Step 9
8	1. The fuel control system is operating normally. Refer to Symptoms Diagnosis 1. Disconnect all test equipment 2. 2. If you were sent to this routine by another diagnostic chart, retune to the previous diagnostic procedure. Is this action complete?		System OK	
9	1. Disconnect all test equipment 2. Start the engine 3. Using a liquid leak detection solution leak check any fuel system repairs made. Is this action complete?		System OK	

LPG Symptom Diagnostics

LPG SYMPTOM DIAGNOSTICS

<table>
<tr><th>Checks</th><th>Action</th></tr>
<tr><td>Before Using This Section</td><td>Before using this section, you should have performed On Board Diagnostic (OBD) Check and determined that:

1. The ECM and MIL are operating correctly.
2. There are no Diagnostic Trouble Codes (DTCs) stored, or a DTC exists but without a MIL.

Several of the following symptom procedures call for a careful visual and physical check. These checks are very important as they can lead to prompt diagnosis and correction of a problem.</td></tr>
<tr><td>LPG Fuel System Check</td><td>1. Verify the customer complaint.
2. Locate the correct symptom table.
3. Check the items indicated under that symptom.
4. Operate the vehicle under the conditions the symptom occurs. Verify HEGO switching between lean and rich. IMPORTANT! Normal HEGO switching indicates the LPG fuel system is in closed loop and operating correctly at that time.
5. Take a data snapshot using the DST under the condition that the symptom occurs to review at a later time.</td></tr>
<tr><td>Visual and Physical Checks</td><td>• Check all ECM system fuses and circuit breakers.
• Check the ECM ground for being clean, tight and in its proper location.
• Check the vacuum hoses for splits, kinks and proper connections.
• Check thoroughly for any type of leak or restriction.
• Check for air leaks at all the mounting areas of the intake manifold sealing surfaces.
• Check for proper installation of the mixer assembly.
• Check for air leaks at the mixer assembly.

Check the ignition wires for the following conditions:
• Cracking
• Hardening
• Proper routing
• Carbon tracking.

• Check the wiring for the following items: proper connections, pinches or cuts.
• The following symptom tables contain groups of possible causes for each symptom. The order of these procedures is not important. If the DST readings do not indicate a problem, then proceed in a logical order, easiest to check or most likely to cause the problem.</td></tr>
</table>

INTERMITTENT

<table>
<tr><th>Checks</th><th>Action</th></tr>
<tr><td colspan="2">DEFINITION: The problem may or may not turn ON the (MIL) or store a Diagnostic Trouble Code (DTC).</td></tr>
<tr><td>Preliminary Checks</td><td>Do not use the DTC tables. If a fault is an intermittent, the use of the DTC tables with this condition may result in the replacement of good parts.</td></tr>
<tr><td>Faulty Electrical Connections or Wiring</td><td>Faulty electrical connections or wiring can cause most intermittent problems. Check the suspected circuit for the following conditions:

• Faulty fuse or circuit breaker, connectors poorly mated, terminals not fully seated in the connector (backed out). Terminals not properly formed or damaged.
• Wire terminals poorly connected.
• Terminal tension is insufficient.
• Carefully remove all the connector terminals in the problem circuit in order to ensure the proper contact tension.
• If necessary, replace all the connector terminals in the problem circuit in order to ensure the proper contact tension (except those noted as “Not Serviceable”). See section Wiring Schematics.
• Checking for poor terminal to wire connections requires removing the terminal from the connector body.</td></tr>
<tr><td>Operational Test</td><td>If a visual and physical check does not locate the cause of the problem, operate the vehicle with the DST connected. When the problem occurs, an abnormal voltage or scan reading indicates a problem circuit.</td></tr>
<tr><td>Intermittent MIL Illumination</td><td>The following components can cause intermittent MIL and no DTC(s):

• A defective relay.
• Switch that can cause electrical system interference. Normally, the problem will occur when the faulty component is operating.
• The improper installation of add on electrical devices, such as lights, 2-way radios, electric motors, etc.
• The ignition secondary voltage shorted to a ground.
• The MIL circuit or the Diagnostic Test Terminal intermittently shorted to ground.
• The MIL wire grounds.</td></tr>
<tr><td>Loss of DTC Memory</td><td>To check for the loss of the DTC Memory:

1. Disconnect the TMAP sensor.
2. Idle the engine until the MIL illuminates.
3. The ECM should store a TMAP DTC which should remain in the memory when the ignition is turned OFF. If the TMAP DTC does not store and remain, the ECM is faulty.</td></tr>
</table>

NO START

<table>
<tr><th>Checks</th><th>Action</th></tr>
<tr><td colspan="2">DEFINITION: The engine cranks OK but does not start.</td></tr>
<tr><td>Preliminary Checks</td><td>None</td></tr>
<tr><td>ECM Checks</td><td>Use the DST to :
• Check for proper communication with both the ECM
• Check all system fuses engine fuse holder. Refer to Engine Controls Schematics.
• Check battery power, ignition power and ground circuits to the ECM. Refer to Engine Control Schematics. Verify voltage and/or continuity for each.</td></tr>
<tr><td>Sensor Checks</td><td>• Check the TMAP sensor.
• Check the cam angle sensor for output (RPM).</td></tr>
<tr><td>Fuel System Checks</td><td>Important: A closed LPG manual fuel shut off valve will create a no start condition.

• Check for air intake system leakage between the mixer and the throttle body. Verify proper operation of the low pressure lock-off solenoids.
• Verify proper operation of the fuel control solenoids.
• Check the fuel system pressures.
• Refer to the LPG Fuel System Diagnosis.
• Check for proper mixer air valve operation.</td></tr>
<tr><td>Ignition System Checks</td><td>Note: LPG being a gaseous fuel requires higher secondary ignition system voltages for the equivalent gasoline operating conditions.

1. Check for the proper ignition voltage output with J 26792 or the equivalent.
2. Verify that the spark plugs are correct for use with LPG.

Check the spark plugs for the following conditions:
• Wet plugs.
• Cracks.
• Wear.
• Improper gap.
• Burned electrodes.
• Heavy deposits.
• Check for bare or shorted ignition wires.
• Check for loose primary ignition coil wire connections.</td></tr>
</table>

NO START

Checks	Action
Engine Mechanical Checks	**Important:** The LPG Fuel system is more sensitive to intake manifold leakage than the gasoline fuel system. Check for the following: • Vacuum leaks. • Improper valve timing. • Low compression. • Improper valve clearance. • Worn rocker arms. • Broken or weak valve springs. Worn camshaft lobes.
Exhaust System Checks	Check the exhaust system for a possible restriction: • Inspect the exhaust system for damaged or collapsed pipes: • Inspect the muffler for signs of heat distress or for possible internal failure. • Check for possible plugged catalytic converter. Refer to *Restricted Exhaust System Diagnosis.*

HARD START

<table>
<tr><th>Checks</th><th>Action</th></tr>
<tr><td colspan="2">DEFINITION: The engine cranks OK, but does not start for a long time. The engine does eventually run, or may start but immediately dies.</td></tr>
<tr><td>Preliminary Checks</td><td>Make sure the vehicle’s operator is using the correct starting procedure.</td></tr>
<tr><td>Sensor Checks</td><td>• Check the Engine Coolant Temperature sensor with the DST. Compare the engine coolant temperature with the ambient air temperature on a cold engine. If the coolant temperature reading is more than 10 degrees greater or less than the ambient air temperature on a cold engine, check for high resistance in the coolant sensor circuit. Check the cam angle sensor.
• Check the Throttle Position (TPS) and Foot Pedal Position (FPP) sensor connections.</td></tr>
<tr><td>Fuel System Checks</td><td>Important: A closed LPG manual fuel shut off valve will create an extended crank OR no start condition.

• Verify the excess flow valve is not tripped or that the LPG tank valve is not closed.

Check mixer assembly for proper installation and leakage.
• Verify proper operation of the low pressure lock-off solenoid.
• Verify proper operation of the EPR.
• Check for air intake system leakage between the mixer and the throttle body. Check the fuel system pressures. Refer to the Fuel System Diagnosis.</td></tr>
<tr><td>Ignition System Checks</td><td>Note: LPG being a gaseous fuel requires higher secondary ignition system voltages for the equivalent gasoline operating conditions.

• Check for the proper ignition voltage output with J 26792 or the equivalent.
• Verify that the spark plugs are the correct type and properly gapped.

Check the spark plugs for the following conditions:
• Wet plugs.
• Cracks.
• Wear.
• Burned electrodes.
• Heavy deposits
• Check for bare or shorted ignition wires.
• Check for moisture in the distributor cap.
• Check for loose primary ignition coil wire connections.

Important:

1. If the engine starts but then immediately stalls, check the cam angle sensor.
2. Check for improper gap, debris or faulty connections.</td></tr>
</table>

HARD START

Checks	Action
Engine Mechanical Checks	**Important:** The LPG Fuel system is more sensitive to intake manifold leakage than the gasoline fuel supply system. Check for the following: • Vacuum leaks • Improper valve timing • Low compression • Improper valve clearance. • Worn rocker arms • Broken or weak valve springs • Worn camshaft lobes. Check the intake and exhaust manifolds for casting flash.
Exhaust System Checks	Check the exhaust system for a possible restriction: • Inspect the exhaust system for damaged or collapsed pipes. • Inspect the muffler for signs of heat distress or for possible internal failure. Check for possible plugged catalytic converter. Refer to *Restricted Exhaust System Diagnosis.*

CUTS OUT, MISSES

<table>
<tr><th>Checks</th><th>Action</th></tr>
<tr><td colspan="2">DEFINITION: A surging or jerking that follows engine speed, usually more pronounced as the engine load increases, but normally felt below 1500 RPM. The exhaust has a steady spitting sound at idle, low speed, or hard acceleration for the fuel starvation that can cause the engine to cut-out.</td></tr>
<tr><td>Preliminary Checks</td><td>None</td></tr>
<tr><td>Ignition System Checks</td><td>1. Start the engine.
2. Check for proper ignition output voltage with spark tester J 26792.
3. Check for a cylinder misfire.
4. Verify that the spark plugs are the correct type and properly gapped.

Remove the spark plugs and check for the following conditions:

• Insulation cracks.
• Wear.
• Improper gap.
• Burned electrodes.
• Heavy deposits.

Visually/Physically inspect the secondary ignition for the following:

• Ignition wires for arcing and proper routing.
• Cross-firing.
• Primary ignition coil wires for cracks or carbon tracking</td></tr>
<tr><td>Engine Mechanical Checks</td><td>Perform a cylinder compression check. Check the engine for the following:

• Improper valve timing.
• Improper valve clearance.
• Worn rocker arms.
• Worn camshaft lobes.
• Broken or weak valve springs.
• Check the intake and exhaust manifold passages for casting flash.</td></tr>
<tr><td>Fuel System Checks</td><td>Check the fuel system:

• Plugged fuel filter.
• Low fuel pressure, etc. Refer to LPG Fuel System Diagnosis.
• Check the condition of the wiring to the low pressure lock-off solenoid.</td></tr>
<tr><td>Additional Check</td><td>Check for Electromagnetic Interference (EMI), which may cause a misfire condition. Using the DST, monitor the engine RPM and note sudden increases in rpms displayed on the scan tool but with little change in the actual engine rpm. If this condition exists, EMI may be present. Check the routing of the secondary wires and the ground circuit.</td></tr>
</table>

HESITATION, SAG, STUMBLE

<table>
<tr><th>Checks</th><th>Action</th></tr>
<tr><td colspan="2">DEFINITION: The vehicle has a momentary lack of response when depressing the accelerator. The condition can occur at any vehicle speed. The condition may cause the engine to stall if it’s severe enough.</td></tr>
<tr><td>Preliminary Checks</td><td>None.</td></tr>
<tr><td>Fuel System Checks</td><td>• Check the fuel pressure. Refer to LPG Fuel System Diagnosis.
• Check for low fuel pressure during a moderate or full throttle acceleration. If the fuel pressure drops below specification, there is possibly a faulty low pressure regulator or a restriction in the fuel system.
• Check the TMAP sensor response and accuracy.
• Check Shut-Off electrical connection.
• Check the mixer air valve for sticking or binding.
• Check the mixer assembly for proper installation and leakage. Check the EPR.</td></tr>
<tr><td>Ignition System Checks</td><td>Note: LPG being a gaseous fuel requires higher secondary ignition system voltages for the equivalent gasoline operating conditions. If a problem is reported on LPG and not gasoline, do not discount the possibility of a LPG only ignition system failure and test the system accordingly.

• Check for the proper ignition voltage output with J 26792 or the equivalent. Verify that the spark plugs are the correct type and properly gapped.
• Check for faulty spark plug wires.
• Check for fouled spark plugs.</td></tr>
<tr><td>Additional Check</td><td>• Check for manifold vacuum or air induction system leaks.
• Check the alternator output voltage.</td></tr>
</table>

BACKFIRE

Checks	Action
DEFINITION: *The fuel ignites in the intake manifold, or in the exhaust system, making a loud popping noise.*	
Preliminary Check	None.
Ignition System Checks	**Important! LPG, being a gaseous fuel, requires higher secondary ignition system voltages for the equivalent gasoline operating conditions. The ignition system must be maintained in peak condition to prevent backfire.** • Check for the proper primary ignition coil wire output voltage using the spark tester *J26792* or the equivalent. • Check the spark plug wires by connecting an ohmmeter to the ends of each wire in question. If the meter reads over 30,000 ohms, replace the wires. • Check the connection at primary ignition coil wire. • Check for deteriorated spark plug wire insulation. Remove the plugs and inspect them for the following conditions: • Wet plugs. • Cracks. • Wear. • Improper gap. • Burned electrodes. • Heavy deposits.
Engine Mechanical Check	**Important! The LPG Fuel system is more sensitive to intake manifold leakage than a gasoline fuel supply system.** Check the engine for the following: • Improper valve timing. • Engine compression. • Manifold vacuum leaks. • Intake manifold gaskets. • Sticking or leaking valves. • Exhaust system leakage. • Check the intake and exhaust system for casting flash or other restrictions.
Fuel System Checks	Perform a fuel system diagnosis. Refer to *LPG Fuel System Diagnosis*.

LACK OF POWER, SLUGGISHNESS, OR SPONGINESS

Checks	Action
DEFINITION: *The engine delivers less than expected power. There is little or no increase in speed when partially applying the accelerator pedal.*	
Preliminary Checks	• Refer to the *LPG Fuel system OBD System Check.* • Compare the customer's vehicle with a similar unit to verify customer has an actual problem. *Do not compare the power output of the vehicle operating on LPG to a vehicle operating on gasoline as the fuels do have different drive feel characteristics.* • Remove the air filter and check for dirt or restriction. • Check the vehicle transmission. • Refer to the OEM transmission diagnostics.
Fuel System Checks	• Check for a restricted fuel filter, contaminated fuel, or improper fuel pressure. Refer to *LPG Fuel System Diagnosis*. • Check for the proper ignition output voltage with the spark tester *J 26792* or the equivalent. • Check for proper installation of the mixer assembly. Check all air inlet ducts for condition and proper installation. • Check for fuel leaks between the EPR and the mixer. • Verify that the LPG tank valve is fully open. • Verify that liquid fuel (not vapor) is being delivered to the EPR.
Sensor Checks	• Check the Heated Exhaust Gas Oxygen Sensors (HEGO) for contamination and performance. • Check for proper operation of the TMAP sensor. • Check for proper operation of the TPS and FPP sensors.
Exhaust System Checks	Check the exhaust system for a possible restriction: • Inspect the exhaust system for damaged or collapsed pipes. • Inspect the muffler for signs of heat distress or for possible internal failure. • Check for possible plugged catalytic converter.
Engine Mechanical Check	Check the engine for the following: • Engine compression. • Valve timing. • Improper or worn camshaft. • Refer to *Engine Mechanical* in the Service Manual.
Additional Check	• Check the ECM grounds for being clean, tight, and in their proper locations. • Check the alternator output voltage. If all procedures have been completed and no malfunction has been found, review and inspect the following items: • Visually and physically, inspect all electrical connections within the suspected circuit and/or systems. • Check the DST data.

POOR FUEL ECONOMY

Checks	Action
DEFINITION: *Fuel economy, as measured by refueling records, is noticeably lower than expected. Also, the economy is noticeably lower than it was on this vehicle at one time, as previously shown by refueling records.*	
Preliminary Checks	• Check the air cleaner element (filter) for dirt or being plugged. • Visually check the vacuum hoses for splits, kinks, and proper connections. • Properly inflated tires. Check the operators driving habits for the following: • Excessive idling or stop and go driving. • Carrying of very heavy loads. • Rapid acceleration. • Suggest to the owner to fill the fuel tank and to recheck the fuel economy and/or suggest that a different operator use the equipment and record the results.
Fuel System Checks	• Check the EPR fuel pressure. Refer to *LPG Fuel System Diagnosis*. • Check the fuel system for leakage.
Sensor Checks	• Check the TMAP sensor.
Ignition System Checks	Verify that the spark plugs are the correct type and properly gapped. Remove the plugs and inspect them for the following conditions: • Wet plugs. • Cracks. • Wear. • Improper gap. • Burned electrodes. • Heavy deposits. Check the ignition wires for the following items: • Cracking. • Hardness. Proper connections.
Cooling System Checks	Check the engine thermostat to see if it is stuck open or for the wrong heat range.
Additional Check	• Check the transmission shift pattern. • Refer to the OEM Transmission Controls section the Service Manual. • Check for dragging brakes.

ROUGH, UNSTABLE, OR INCORRECT IDLE, STALLING

Checks	Action
DEFINITION: *The engine runs unevenly at idle. If severe enough, the engine or vehicle may shake. The engine idle speed may vary in RPM. Either condition may be severe enough to stall the engine.*	
Preliminary Check	None.
Sensor Checks	Check the Heated Exhaust Gas Oxygen Sensors (HEGO) performance: • Check for silicone contamination from fuel or improperly used sealant. If contaminated, the sensor may have a white powdery coating result in a high but false signal voltage (rich exhaust indication). The ECM will reduce the amount of fuel delivered to the engine causing a severe drivability problem. Check the Temperature Manifold Absolute Pressure (TMAP) sensor response and accuracy.
Fuel System Checks	• Check for rich or lean symptom that causes the condition. • Drive the vehicle at the speed of the complaint. • Monitoring the oxygen sensors will help identify the problem. • Check for a sticking mixer air valve. • Verify proper operation of the EPR. • Perform a cylinder compression test. Refer to *Engine Mechanical* in the Service Manual. • Check the EPR fuel pressure. Refer to the *LPG Fuel System Diagnosis*. • Check mixer assembly for proper installation and connection.
Ignition System Checks	• Check for the proper ignition output voltage using the spark tester *J26792* or the equivalent. • Verify that the spark plugs are the correct type and properly gapped. Remove the plugs and inspect them for the following conditions: • Wet plugs. • Cracks. • Wear. • Improper gap. • Burned electrodes. • Blistered insulators. • Heavy deposits. Check the spark plug wires by connecting an ohmmeter to the ends of each wire in question. If the meter reads over 30,000 ohms, replace the wires.
Additional Checks	**Important:** The LPG Fuel system is more sensitive to intake manifold leakage than the gasoline fuel supply system. • Check for vacuum leaks. Vacuum leaks can cause a higher than normal idle and low throttle angle control command. • Check the ECM grounds for being clean, tight, and in their proper locations. Check the battery cables and ground straps. They should be clean and secure. Erratic voltage may cause all sensor readings to be skewed resulting in poor idle quality.

ROUGH, UNSTABLE, OR INCORRECT IDLE, STALLING

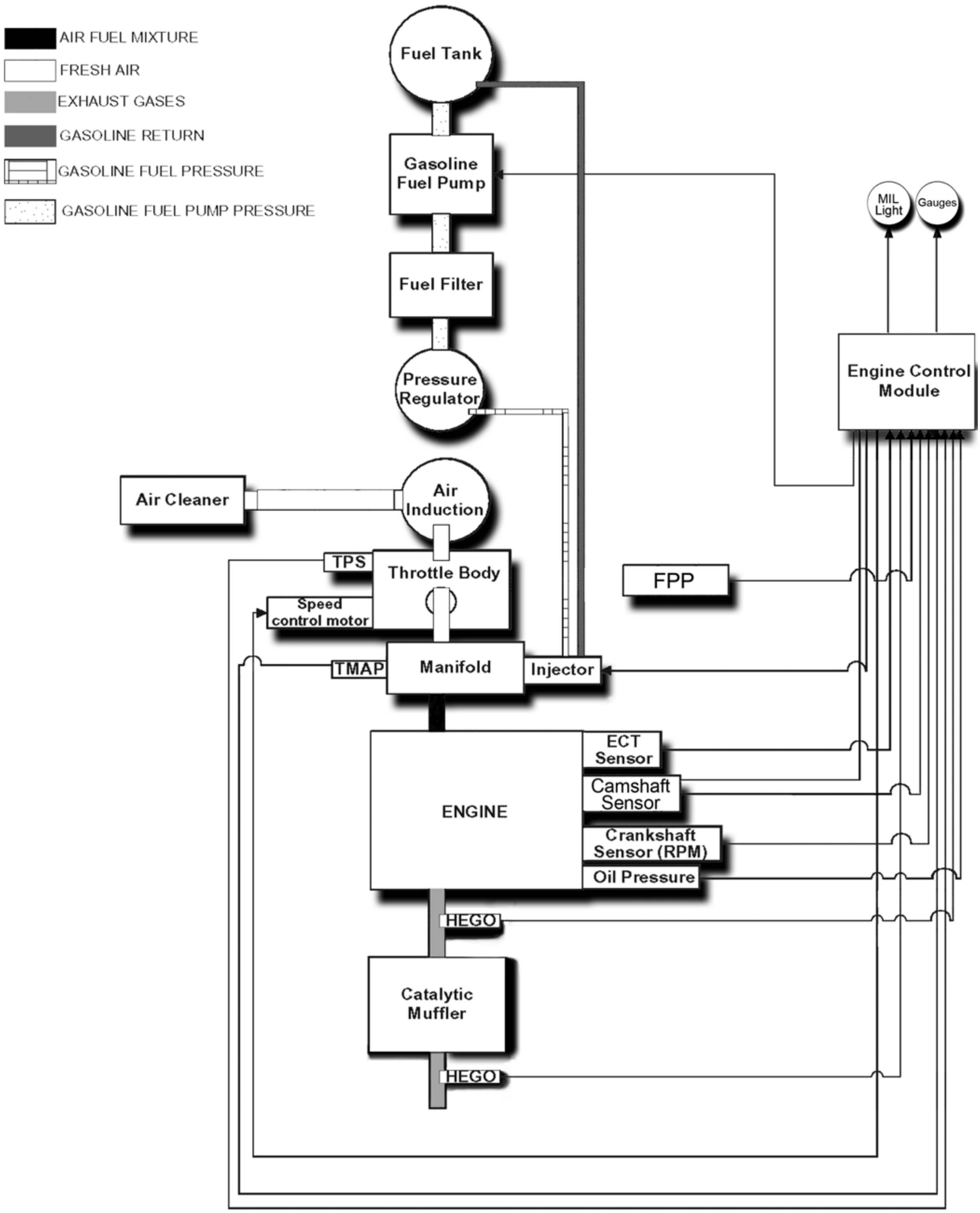
Checks	Action
Engine Mechanical Check	Check the engine for: • Broken motor mounts. • Improper valve timing. • Low compression. • Improper valve clearance. • Worn rocker arms. • Broken or weak valve springs. • Worn camshaft lobes.

SURGES/CHUGGLES

Checks	Action
DEFINITION: *The engine has a power variation under a steady throttle or cruise. The vehicle feels as if it speeds up and slows down with no change in the accelerator pedal.*	
Preliminary Checks	None.
Sensor Checks	Check the Heated Exhaust Gas Oxygen Sensors (HEGO) performance.
Fuel System Checks	• Check for Rich or Lean symptom that causes the condition. • Drive the vehicle at the speed of the complaint. Monitoring the oxygen sensors will help identify the problem. • Check the fuel pressure while the condition exists. Refer to *LPG Fuel System Diagnosis.* • Verify proper fuel control solenoid operation. • Verify that the LPG tank valve is fully open. • Check the in-line fuel filter for restrictions.
Ignition System Checks	• Check for the proper ignition output voltage using the spark tester J26792 or the equivalent. • Verify that the spark plugs are the correct type and properly gapped. Remove the plugs and inspect them for the following conditions: • Wet plugs. • Cracks. • Wear. • Improper gap. • Burned electrodes. • Heavy deposits. Check the Crankshaft Position (CKP) Sensor.
Additional Check	• Check the ECM grounds for being clean, tight, and in their proper locations. • Check the generator output voltage. • Check the vacuum hoses for kinks or leaks. • Check Transmission

Gasoline Fuel System

GAS FUEL SYSTEM OPERATION



GASOLINE MULTIPORT FUEL INJECTION SYSTEM (MFI)

The primary components of the Gasoline Multiport Fuel Injection (MFI) fuel system are the gasoline fuel tank, electric fuel pump, fuel filter, fuel rails, fuel pressure regulator, fuel injectors, O2 sensors, engine control module and a catalytic converter.

GASOLINE FUEL STORAGE TANK

The gasoline fuel storage tank location may vary on equipment applications. The fuel tank may be integrated into the chassis frame or may be a standalone vessel mounted on the equipment. For precise location for the equipment application refer to the OEMs vehicle manual.

GASOLINE FUEL PUMP

The gasoline is drawn into the fuel system from the fuel tank by a 12 volt electric fuel pump. Depending on the vehicle application, the fuel pump may be mounted in the fuel tank or as a standalone component. In both cases, the fuel pump will receive a signal from the ECM at Key ON to prime the fuel system for a several seconds prior to start. Priming of the fuel system provides for a quicker start, when the engine begins to crank.

CAUTION

The fuel pump is an emission control component. If the fuel pump fails to operate, replace only with an OEM replacement part. The fuel pump is calibrated to supply the correct amount of fuel to the injectors. Replacing the pump with anything other than the recommended OEM replacement pump could cause damage to the fuel system and/or fuel tank.

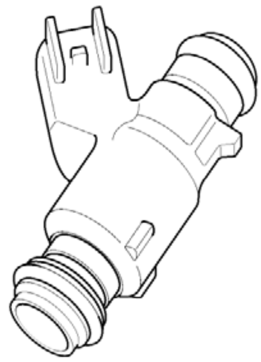
FUEL FILTER

The fuel is drawn into the fuel pump and then through the fuel filter to trap and remove small particles and prevent injectors from becoming damaged. Maintenance of the fuel filter is required as indicated in the Recommended Maintenance Schedule. A more frequent replacement of the filter may be required if the equipment operates in a dusty or dirty environment.

FUEL METERING BODY AND PRESSURE REGULATOR

The gas flows from the fuel filter to the fuel pressure regulator block. Regulated fuel is then sent to the fuel inlet pipe and through the fuel metering body to the injectors. Excess fuel is returned to the fuel tank for recirculation. The fuel pressure regulator has no adjustments and is integrated into the fuel block assembly. The fuel inlet pipe contains a Schrader valve which is utilized to test the regulated pressure of the fuel system.

FUEL INJECTOR



Gasoline Fuel Injector

The fuel pressure is maintained on the top of the injector by the fuel pressure regulator. The injector is fed a “pulse” signal through the wire harness which causes the injector to open. The ECM controls the opening and duration of the injector. During lower RPM operation the injector signals or “pulses” are shorter than when the engine is operating at higher rpms. The certified engine has been calibrated to deliver the precise amount of fuel for optimum performance and emission control.

THROTTLE CONTROL DEVICE—DRIVE BY WIRE

Drive By Wire Engine speed control is maintained by the amount of pressure applied to the foot pedal located in the engine compartment. In a Drive By

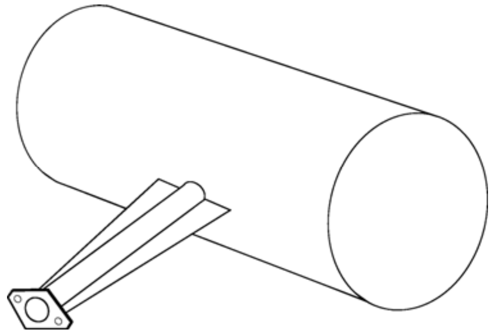
Wire (DBW) application, there is no direct mechanical connection between the operator pedal and the throttle shaft. Speed and load control are determined by the ECM. Defaults programmed into the ECM software and throttle position sensors allow the ECM to maintain safe operating control over the engine. In a drive by wire application the Electronic Throttle Control device or throttle body assembly is connected to the intake manifold of the engine. The electronic throttle control device utilizes an electric motor connected to the throttle shaft. In addition, a Foot Pedal Position sensor (FPP) is located in the operator's compartment.

When the engine is running electrical signals are sent from the foot pedal position sensor to the engine ECM when the operator depresses or release the foot pedal. The ECM then sends an electrical signal to the motor on the electronic throttle control to increase or decrease the angle of the throttle blade thus increasing or decreasing the air/fuel charge to the engine. The electronic throttle control device incorporates two internal Throttle Position Sensors (TPS) which provide output signals to the ECM as to the location of the throttle shaft and blade. The TPS information is used by the ECM to correct for speed and load control as well as emission.

THREE-WAY CATALYTIC CONVERTER

The Catalytic Converter is a component of the emissions system which is designed and calibrated to meet the emission standards in effect for 2007-2009.

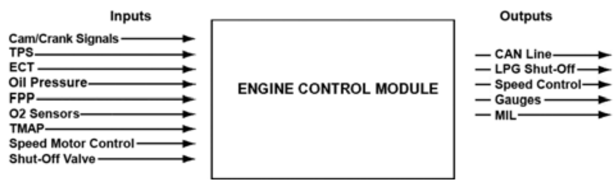
The exhaust gases pass through the honeycomb catalyst which is coated with a mixture of metals (such as platinum, palladium, and rhodium) to oxidize and reduce CO, HC and NOX emission gases.



Three-Way Catalytic Converter

ENGINE CONTROL MODULE

To obtain maximum effect from the catalyst and accurate control of the air fuel ratio, the emission certified engine is equipped with an onboard computer or Engine Control Module (ECM). The ECM receives input data from sensors mounted to the engine and fuel system and then outputs various signals to control engine operation.



Engine Control Module (ECM) Inputs & Outputs

One specific function of the controller is to maintain a closed loop fuel control which is accomplished by use of the Heated Exhaust Gas Oxygen sensor (HEGO) mounted in the exhaust system. The HEGO sensor sends a voltage signal to the controller which then outputs signals to change the amount of fuel being delivered from the regulator or mixer to the engine.

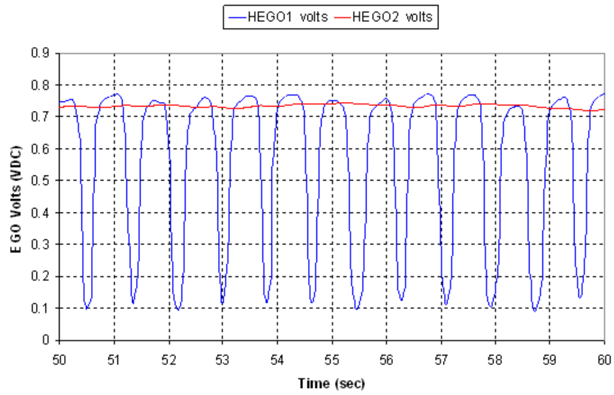
The controller also performs diagnostic functions on the fuel system and notifies the operator of engine malfunctions by turning on a Malfunction Indicator Light (MIL) mounted in the dash. Malfunctions in the system are identified by a Diagnostic Trouble Code (DTC) number. In addition to notifying the operator of the malfunction in the system, the controller also stores the information about the malfunction in its memory. A technician can than utilize a computerized diagnostic scan tool to retrieve the stored diagnostic code and by using the diagnostic charts in this manual to determine the cause of the malfunction. In the event a technician does not have the computerized diagnostic tool, the MIL light can be used to identify the diagnostic code to activate the "blink" feature and count the number of blinks to determine the diagnostic code number to locate the fault in the system.

HEATED EXHAUST GAS OXYGEN SENSORS

The Heated Exhaust Gas Oxygen (HEGO) Sensors are mounted in the exhaust system, one upstream and one downstream of the catalytic converter. The HEGO sensors are used to measure the amount of oxygen present in the exhaust stream to determine whether the fuel air ratio is to rich or to lean. It then communicates this measurement to the ECM. If the HEGO sensor signal indicates that the exhaust stream is too rich, the ECM will decrease or lean the fuel mixture during engine operation. If the mixture is too lean, the ECM will richen the mixture. If the ECM determines that a rich or lean condition is present for an extended period of time which cannot be corrected, the ECM will set a diagnostic code and turn on the MIL light in the dash.

By monitoring output from the sensor upstream and the sensor downstream of the catalytic converter, the ECM can determine the performance of the converter.

The Heat Exhaust Gas Oxygen (HEGO) Sensor

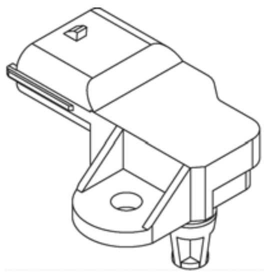


HEGO1 (upstream or before the catalytic converter) and HEGO2 (downstream) voltage output.

CAUTION

The Heated Exhaust Gas Oxygen Sensor (HEGO) is an emissions control component. In the event of a failure, the HEGO should only be replaced with the recommended OEM replacement part. The HEGO is sensitive to silicone based products and can become contaminated. Avoid using silicone sealers or air or fuel hoses treated with a silicone based lubricant.

TMAP SENSOR



T–MAP Sensor

The Air Temperature/Manifold Absolute Pressure or TMAP sensor is a combination of two sensors:

1) A variable resistor used to monitor the difference in pressure between the intake manifold and outside or atmospheric pressure. The ECM monitors the resistance of the sensor to

determine engine load (the vacuum drops when the engine is under load or at wide open throttle). When the engine is under load, the computer may alter the fuel mixture to improve performance and emissions.

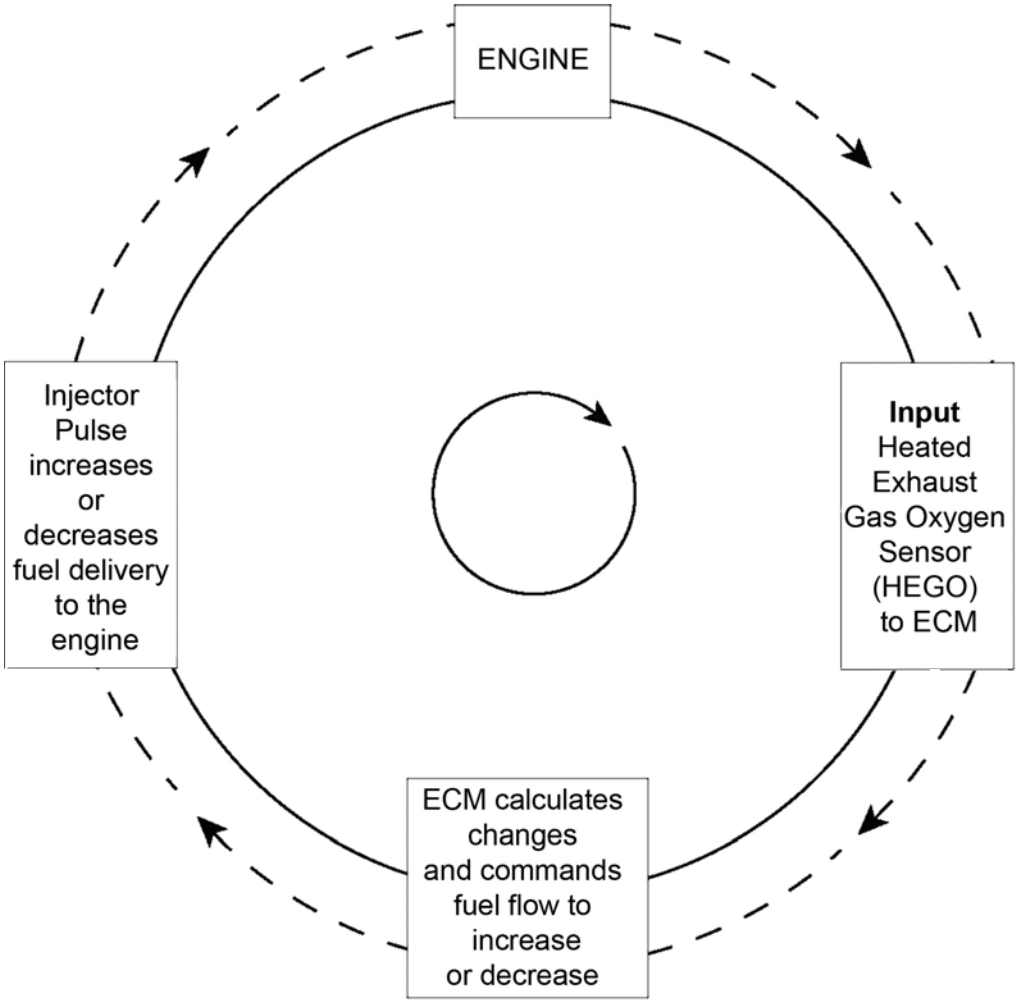
2) The intake air temperature or IAT sensor is a variable resistance thermistor located in the air intake passage which measures the temperature of the incoming air. The ECM uses the resistance value to monitor incoming air temperature and calculate the engine's airflow requirement. The ECM provides a voltage divider circuit so that when the air is cool, the signal reads a higher voltage, and lower when warm. On cold starts, the ECM richens the fuel/air mixture.

COOLANT TEMPERATURE SENSOR

The Engine Coolant Temperature sensor or ECT is a variable resistance thermistor that changes resistance as the engine's coolant temperature changes. The sensor's output is monitored by the ECM to determine a cold start condition and to regulate various fuel and emission control functions via a closed loop emission system.

OIL PRESSURE SENSOR

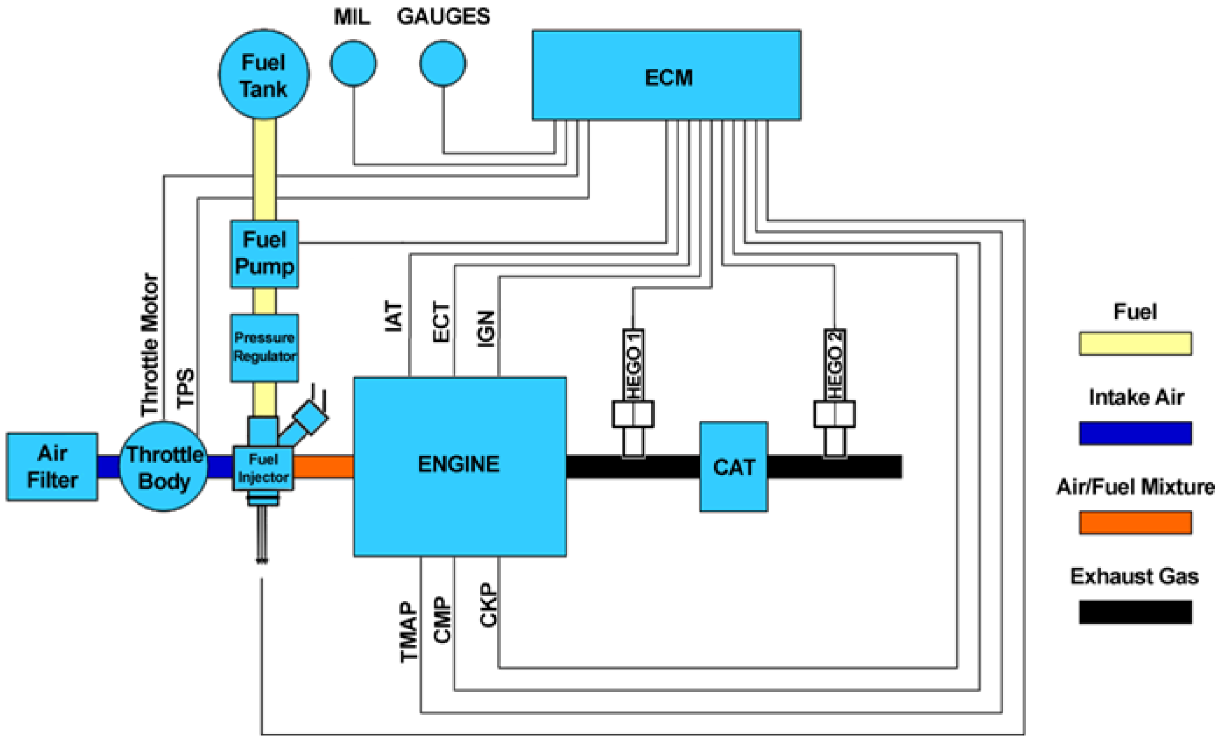
The Engine Oil Pressure Sensor is designed to ensure adequate lubrication throughout the engine. It provides a pressure value for the oil that is monitored by the ECM. If the pressure drops, a DTC will occur and the engine will shut down.



Gasoline Closed Loop Control Schematic

Gasoline System Diagnosis

GASOLINE SYSTEM DIAGNOSIS



Gasoline Injection Systems

FUEL SYSTEM DESCRIPTION

The Engine Control Module (ECM) receives information from various engine sensors in order to control the operation of the fuel injectors. The electric fuel pump prevents fuel flow unless the engine is cranking or running. During Key ON, the electric fuel pump receives a short prime cycle from the ECM which allows gasoline to flow from the tank through fuel filter and fuel lines to the pressure regulator before it reaches the fuel injector. With the Ignition ON engine OFF and fuel pump running, the pressure should be TBD-TBD kPa (TBD-TBD psi). At idle, manifold pressure is much lower than atmospheric pressure, which creates a high vacuum. This vacuum will offset the pressure regulator diaphragm, resulting in a lower fuel pressure. Fuel pressure at idle will vary somewhat depending on barometric pressure but should be approximately 69 kPa (10 psi) less than the ignition ON engine OFF pressure. Unused fuel is returned to the fuel tank by a separate return fuel line. The fuel pump pressure test port is located on the fuel rail.

DIAGNOSTIC AIDS

This procedure is intended to diagnose a vehicle operating on Gasoline. If the vehicle will not continue to run on Gasoline, refer to *Hard Start* section for preliminary checks. Before starting this procedure, verify that the vehicle has a sufficient quantity of fuel.

TOOLS REQUIRED:

- J 34730-1 or equivalent
- J 37287 or equivalent

DIAGNOSTIC SCAN TOOL

- Diagnostic Scan Tool Software (DST).

TEST DESCRIPTION

The numbers below refer to step numbers in the diagnostic table.

4. Connect fuel pressure gage (Refer to the *Fuel Injection Pressure Tester Owner's Manual* supplied in the IMPCO Test Kit for instructions on relieving gasoline fuel pressure for fuel systems without a Schrader valve or test port. Wrap a shop towel around the fuel connection to absorb any small amount of fuel leakage that may occur when installing the gage. With ignition ON engine OFF and the fuel pump running, pressure should be TBD-TBD kPa (TBD-TBD psi).

6. When the engine is idling, manifold pressure is low (High Vacuum) and is applied to the pressure regulator diaphragm. This vacuum will offset spring pressure and result in a lower pressure. Fuel pressure at idle will vary somewhat depending on barometric pressure but should be less than the pressure noted in step 4.

11. Fuel pressure that drops off during acceleration or cruise may cause a lean condition and result in a loss of power, surging or misfire. This condition can be diagnosed using the Diagnostic Scan Tool. If the fuel in the system is very lean the Heated Exhaust Gas Oxygen (HEGO) will stop toggling and output voltage may drop below 100 mV and stay low during the lean condition.

14. Fuel pressure below TBD-TBD kPa (TBD-TBD psi) under full load may cause a lean condition and may set a DTC. Drivability conditions can include hard starting when cold, hesitation, and lack of power or misfire.

15. Restricting the fuel return pipe may cause the fuel pressure to build above the regulated pressure and permanently damage the pressure regulator. With battery voltage applied to the pump, pressure should rise above TBD-TBD kPa (TBD-TBD psi) as the valve in the return pipe is partially closed.

NOTICE: Do not allow the pressure to exceed TBD kPa (TBD psi) as damage to the fuel pressure regulator may result.

17. Fuel pressure above **TBD kPa (TBD psi)** may cause a rich starting condition, followed by black smoke and a strong fuel odor in the exhaust.

18. This test is to determine if the high fuel pressure is due to a restricted fuel return pipe or a faulty fuel pressure regulator.

21. The pressure regulator may be fitted with a screen which is designed to trap contaminants introduced during engine assembly. If dirty it can be removed and cleaned if required.

23. A system that does not hold pressure is caused by one of the following:
    - Leaking fuel pump check
    - Leaking fuel feed hose
    - Leaking valve/seat within the pressure regulator
    - Leaking injector/fuel metering block assembly.

26. A leaking injector can best be determined by checking for a fouled or saturated spark plug(s). If a leaking injector cannot be determined by a fouled or saturated plug the following procedure should be used.
    - Remove the fuel metering body but leave the lines connected.
    - Inspect the injector tips for leakage under pressure.

GASOLINE FUEL SYSTEM DIAGNOSTIC CHART

Step	Action	Value(s)	Yes	No
1	Did you perform the On Board (OBD) System Check?	-	Go to Step (2)	Go to OBD System Check Section
2	Important: Inspect the fuel system for damage or external leaks before proceeding with this diagnostic. • Turn ON the ignition, with the engine OFF. • Command the fuel pump ON with the DST or fuel pump test circuit. Does the fuel pump operate?		Go to Step (3)	Check all system power fuses and power relay circuit. Refer to wiring harness schematic.
3	Important: Verify that adequate fuel is in the fuel tank before proceeding with this diagnostic. • Turn OFF the ignition. • Turn OFF all accessories. • Install the fuel pressure gage. • Turn ON the ignition, with the engine OFF. (The fuel pump relay may need to be commanded ON a few times in order to obtain the highest possible fuel pressure) • DO NOT start the engine. • Command the fuel pump ON with the DST or fuel pump test circuit. • Observe the fuel pressure gage with the fuel pump commanded ON. Is the fuel pressure within the specified range?	TBD-TBD kPa (TBD-TBD psi)	Go to Step (4)	Go to Step (10)
4	Important: The fuel pressure may vary slightly when the fuel pump stops operating. After the fuel pump stops operating, the fuel pressure should stabilize and remain constant. • Monitor the fuel pressure gage for 1 minute. Does the fuel pressure decrease by more than the specified value?	TBD-TBD kPa (TBD-TBD psi)	Go to Step (8)	Go to Step (5)
5	• Relieve the fuel pressure to the first specified value. • Monitor the fuel pressure gage for 5 minutes. Does the fuel pressure decrease by more than the second specified value?	TBD-TBD kPa (TBD-TBD psi)	Go to Step (22)	Go to Step (6)
6	• Turn ON the ignition, with the engine OFF • Monitor the fuel pressure gauge • Start the engine Does the fuel pressure decrease by the specified value when the engine is started?	TBD-TBD kPa (TBD-TBD psi)	Go to Step (7)	Go to Step (21)

Step	Action	Value(s)	Yes	No
7	• Operate the vehicle within the conditions of the customer concern. • Monitor the adaptive parameters with the DST Do any of the DST readings indicate a lean condition?		Go to Step (15)	Refer to the symptom diagnostic charts
8	• Turn OFF the ignition. • Relieve the fuel pressure. Refer to the fuel pressure relief procedure. • Drain any remaining fuel into an approved gasoline container. • Install the J 37287 Fuel Line Shut-Off Adapters between the rear fuel pipes and the chassis fuel pipes. • Open the valves on the fuel pipe shut-off adapters. • Turn ON the ignition, with the engine OFF. • Command the fuel pump relay ON with the DST or fuel pump test circuit. • Bleed the air from the fuel pressure gage. • Command the fuel pump relay ON and then OFF with the DST or fuel pump test circuit. • Close the fuel feed pipe shut-off valve. • Monitor the fuel pressure gage for 1 minute. Does the fuel pressure remain constant?		Go to Step (17)	Go to Step (9)
9	• Turn OFF the ignition. • Open the fuel feed pipe shut-off valve. • Turn ON the ignition, with the engine OFF. • Command the fuel pump relay ON and then OFF with the DST or fuel pump test circuit. • Close the fuel return pipe shut-off valve. • Monitor the fuel pressure gage for 1 minute. Does the fuel pressure remain constant?		Go to Step (21)	Go to Step (18)
10	Is the fuel pressure more than the specified value?	TBD kPa (TBD psi)	Go to Step (12)	Go to Step (11)
11	Is the fuel pressure more than the specified value?	TBD kPa (TBD psi)	Go to Step (14)	Go to Step (15)
12	• Turn OFF the ignition. • Relieve the fuel pressure. Refer to the fuel pressure relief procedure • Disconnect the rear fuel return pipe from the chassis pipe. • Attach a length of flexible hose to the chassis fuel pipe. • Place the open end of the flexible fuel hose into an approved gasoline container. • Turn ON the ignition, with the engine OFF. • Monitor the fuel pressure gage while the fuel pump is operating. Is the fuel pressure within the specified range?	TBD kPa (TBD psi)	Go to Step (20)	Go to Step (13)

Step	Action	Value(s)	Yes	No
13	• Inspect the engine fuel return pipe and the chassis fuel return pipe for a restriction. Did you find and correct the condition?		Go to Step (23)	Go to Step (21)
14	• Turn OFF the ignition. • Relieve the fuel pressure. Refer to Fuel Pressure Relief Procedure. • Disconnect the rear fuel return pipe from the chassis pipe. • Install the J 37287 between the rear fuel return pipe and the chassis fuel pipe. • Open the valve in the fuel pipe shut-off adapter. Turn ON the ignition, with the engine OFF. • Bleed the air from the fuel pressure gage. Monitor the fuel pressure gage. **Caution**: DO NOT allow the fuel pressure to exceed TBD kPa (TBD psi). Excessive pressure may damage the fuel system. • Command the fuel pump relay ON with the DST or fuel pump test circuit. • Slowly close the valve in the fuel return pipe shut-off adapter, while the fuel pump is operating. Does the fuel pressure increase to more than the specified value?	TBD kPa (TBD psi)	Go to Step (21)	Go to Step (15)
15	Inspect the following components for a restriction: • The fuel filter • The fuel feed pipe Did you find and correct the condition?		Go to Step (23)	Go to Step (16)
16	• Inspect the wiring harness connectors and ground circuits of the fuel pump for poor connections. Refer to system wiring schematic Did you find and correct the condition?		Go to Step (23)	Go to Step (17)
17	• Remove the fuel sender assembly if the pump is located inside the fuel tank. • Inspect the following items: • The fuel pump flex hose for damage • The in-tank fuel pump harness connectors for poor connections • The fuel strainer or external filter for a restriction. • The fuel tank for contaminants Did you find and correct the condition?		Go to Step (23)	Go to Step (22)

Step	Action	Value(s)	Yes	No
18	• Open the fuel return pipe shut-off valve. • Remove the upper intake manifold. Install the engine compartment fuel feed and fuel return pipes to the fuel meter body. • Turn ON the ignition, with the engine OFF. • Inspect for a fuel leak from the fuel pressure regulator. Is the fuel pressure regulator leaking fuel?		Go to Step (21)	Go to Step (19)
19	• Remove the fuel injectors from the intake manifold in order to isolate the leaking fuel injector. Did you complete the replacement?		Go to Step (23)	-
20	• Repair the restricted fuel return pipe between the chassis fuel pipe and the fuel tank. Did you complete the repair?		Go to Step (23)	-
21	• Inspect for a missing or damaged O-ring seal before replacing the fuel pressure regulator. If the O-ring seal is not missing or damaged, replace the fuel pressure regulator. Did you complete the replacement?		Go to Step (23)	-
22	• Replace the fuel sender assembly or external fuel pump if so equipped. Did you complete the replacement?		Go to Step (23)	-
23	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and drivability Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

Gasoline Symptom Diagnostics

GAS SYMPTOM DIAGNOSTICS

<table>
<tr><th>Checks</th><th>Action</th></tr>
<tr><td>Before Using This Section</td><td>Before using this section, you should have performed On Board Diagnostic Check and determined that:

1. The ECM and MIL are operating correctly.
2. There are no Diagnostic Trouble Codes (DTCs) stored, or a DTC exists but without a MIL.

Several of the following symptom procedures call for a careful visual and physical check. These checks are very important as they can lead to prompt diagnosis and correction of a problem.</td></tr>
<tr><td>Fuel System Check</td><td>1. Verify the customer complaint.
2. Locate the correct symptom table.
3. Check the items indicated under that symptom.
4. Operate the vehicle under the conditions the symptom occurs. Verify HEGO switching between lean and rich. IMPORTANT! Normal HEGO switching indicates the fuel system is in closed loop and operating correctly at that time.
5. Use the DST to take a “snapshot” under the condition that the symptom occurs. Go to Engine Scan Tool Data List to verify normal sensor values and parameters.</td></tr>
<tr><td>Visual Checks</td><td>• Check all ECM system fuses and circuit breakers.
• Check the ECM ground for being clean, tight and in its proper location.
• Check the vacuum hoses for splits, kinks and proper connections.
• Check thoroughly for any type of leak or restriction.
• Check for air leaks at all the mounting areas of the intake manifold sealing surfaces.

Check the ignition wires for the following conditions:
• Cracking.
• Hardening.
• Proper routing.
• Carbon tracking.

Check the wiring for the following items:
• Proper connections
• Pinches or cuts.

The following symptom tables contain groups of possible causes for each symptom. The order of these procedures is not important. If the scan tool readings do not indicate the problems, then proceed in a logical order, easiest to check or most likely to cause the problem.</td></tr>
</table>

INTERMITTENT

Checks	Action
DEFINITION: *The problem may or may not turn ON the MIL or store a Diagnostic Trouble Code (DTC).*	
Preliminary Checks	Do not use the DTC tables. If a fault is an intermittent, the use of the DTC tables may result in the replacement of good parts.
Faulty Electrical Connections or Wiring	Faulty electrical connections or wiring can cause most intermittent problems. Check the suspected circuit for the following conditions: • Faulty fuse or circuit breaker, connectors poorly mated, terminals not fully seated in the connector (backed out). Terminals not properly formed or damaged. • Wire terminals poorly connected. • Terminal tension is not adequate. • Carefully remove all the connector terminals in the problem circuit in order to ensure the proper contact tension. • If necessary, replace all the connector terminals in the problem circuit in order to ensure the proper contact tension (except those noted as "Not Serviceable"). See section *Wiring Schematics*. • Checking for poor terminal to wire connections requires removing the terminal from the connector body.
Operational Test	If a visual and physical check does not locate the cause of the problem, drive the vehicle with a scan tool. When the problem occurs, an abnormal voltage or scan reading indicates a problem circuit.
Intermittent MIL Illumination	The following components can cause intermittent MIL illumination and no DTC(s): • A defective relay. • Switch that can cause electrical system interference. Normally, the problem will occur when the faulty component is operating. • The improper installation of add on electrical devices, such as lights, 2-way radios, electric motors, etc. • The ignition secondary voltage shorted to a ground. • The MIL circuit or the Diagnostic Test Terminal intermittently shorted to ground. • The MIL wire grounds.
Loss of DTC Memory	To check for the loss of the DTC Memory: 1. Disconnect the MAP sensor. 2. Idle the engine until the MIL illuminates. 3. The ECM should store a MAP DTC which should remain in the memory when the ignition is turned OFF. If the MAP DTC does not store and remain, the ECM is faulty.

NO START

Checks	Action
DEFINITION: *The engine cranks OK but does not start.*	
Preliminary Checks	None.
ECM Checks	Using the DST: • Check for proper communication with both the ECM • Check all system fuses located in the engine fuse holder. Refer to *Engine Controls Schematics.* • Check battery power, ignition power and ground circuits to the ECM. Refer to *Engine Control Schematics.* Verify voltage and/or continuity for each.
Sensor Checks	• Check the MAP sensor. • Check cam angle sensor (RPM).
Fuel System Checks	• Check for fuel pump electrical circuit. • Verify proper fuel pump pressure. • Verify proper Fuel rail pressure. • Check the in-line fuel filter for restrictions. • Check electrical connections of fuel injectors. • Refer to the *Gasoline Fuel System Diagnosis*.
Ignition System Checks	• Check for the proper ignition voltage output with *J 26792* or the equivalent. • Verify that the spark plugs are the correct type and properly gapped. • Check the spark plugs for the following conditions: • Wet plugs. • Cracks. • Wear. • Improper gap. • Burned electrodes. • Heavy deposits. • Check for bare or shorted ignition wires. • Check for loose primary ignition coil wire connections.
Engine Mechanical Checks	Check for the following: • Improper valve timing. • Low compression. • Improper valve clearance. • Worn rocker arms. • Broken or weak valve springs. • Worn camshaft lobes.
Exhaust System Checks	Check the exhaust system for a possible restriction: • Inspect the exhaust system for damaged or collapsed pipes. • Inspect the catalytic converter and muffler for signs of heat distress or for possible internal failure. • Check for possible plugged catalytic converter. Refer to *Restricted Exhaust System Diagnosis.*

HARD START

<table>
<tr><th>Checks</th><th>Action</th></tr>
<tr><td colspan="2">DEFINITION: The engine cranks OK, but does not start for a long time. The engine does eventually run, or may start but immediately dies.</td></tr>
<tr><td>Preliminary Checks</td><td>Make sure the vehicle’s operator is using the correct starting procedure.</td></tr>
<tr><td>Sensor Checks</td><td>Check the Engine Coolant Temperature sensor with the scan tool. Compare the engine coolant temperature with the ambient air temperature on a cold engine. If the coolant temperature reading is more than 10 degrees greater or less than the ambient air temperature on a cold engine, check for high resistance in the coolant sensor circuit. Check the Crankshaft Position (CKP) sensor.
Check the Throttle Position Sensor (TPS) and Foot Pedal Position (FPP) sensors.</td></tr>
<tr><td>Fuel System Checks</td><td>Check for fuel pump electrical circuit.
Verify proper fuel pump pressure.
Verify proper fuel rail pressure.
Check the in-line fuel filter for restrictions.
Refer to the Gasoline Fuel System Diagnosis.</td></tr>
<tr><td>Ignition System Checks</td><td>Check for the proper ignition voltage output with J 26792 or the equivalent.
Verify that the spark plugs are the correct type and properly gapped.

Check the spark plugs for the following conditions:
Wet plugs.
Cracks.
Wear.
Burned electrodes.
Heavy deposits.
Check for bare or shorted ignition wires.
Check for moisture in the distributor cap.
Check for loose primary ignition coil wire connections.
Important:
If the engine starts but then immediately stalls, check the Crankshaft Position (CKP) sensor.
Check for improper gap, debris or faulty connections.</td></tr>
<tr><td>Engine Mechanical Checks</td><td>Check for the following:
Vacuum leaks.
Improper valve timing.
Low compression.
Worn rocker arms.
Broken or weak valve springs.
Worn camshaft lobes.
Check the intake and exhaust manifolds for casting flash.</td></tr>
</table>

HARD START

Checks	Action
Exhaust System Checks	Check the exhaust system for a possible restriction: • Inspect the exhaust system for damaged or collapsed pipes. • Inspect the muffler for signs of heat distress or for possible internal failure. • Check for possible plugged catalytic converter. Refer to *Restricted Exhaust System Diagnosis.*

CUTS OUT, MISSES

Checks	Action
***DEFINITION**: A surging or jerking that follows engine speed, usually more pronounced as the engine load increases, but normally felt below 1500 RPM. The exhaust has a steady spitting sound at idle, low speed, or hard acceleration for the fuel starvation that can cause the engine to cut-out.*	
Preliminary Checks	None.
Ignition System Checks	• Start the engine. • Check for proper ignition output voltage with spark tester J 26792. • Verify that the spark plugs are the correct type and properly gapped • Check for a cylinder misfire. Remove the spark plugs in these cylinders and check for the following conditions: • Insulation cracks. • Wear. • Improper gap. • Burned electrodes. • Heavy deposits. Visually/Physically inspect the secondary ignition for the following: • Ignition wires for arcing and proper routing. • Cross-firing. • Primary ignition coil wires for cracks or carbon tracking.
Engine Mechanical Checks	• Perform a cylinder compression check. Check the engine for the following: • Improper valve timing. • Worn rocker arms. • Worn camshaft lobes. • Broken or weak valve springs. • Check the intake and exhaust manifold passages for casting flash.
Fuel System Checks	Check the fuel system: • Check the in-line fuel filter for restrictions. • Low fuel pressure, etc. Refer to *Gas Fuel System Diagnosis*.
Additional Check	• Check for Electromagnetic Interference (EMI), which may cause a missing condition. • Using a scan tool, monitor the engine RPM and note sudden increases in rpms is displayed on the scan tool but with little change in the actual engine RPM. If this condition exists, EMI may be present. • Check the routing of the secondary wires and the ground circuit.

HESITATION, SAG, STUMBLE

Checks	Action
DEFINITION: *The vehicle has a momentary lack of response when depressing the accelerator. The condition can occur at any vehicle speed. The condition may cause the engine to stall if it's severe enough.*	
Preliminary Checks	None.
Fuel System Checks	• Check for fuel pump electrical circuit. • Verify proper fuel pump pressure. • Verify proper fuel rail pressure. • Check the in-line fuel filter for restrictions. • Refer to the *Gasoline Fuel System Diagnosis*. • Check electrical connections of fuel injectors.
Ignition System Checks	• Check for the proper ignition voltage output with *J 26792* or the equivalent. Remove Spark Plugs: • Verify that the spark plugs are the correct type and properly gapped. • Check for fouled spark plugs. • Wear. • Improper gap. • Burned electrodes. • Heavy deposits. Visually/Physically inspect the secondary ignition for the following: • Ignition wires for arcing and proper routing. • Cross-firing. • Insulation cracks. • Primary ignition coil wires for cracks or carbon tracking.
Additional Check	• Check for manifold vacuum or air induction system leaks. • Check the generator output voltage.

BACKFIRE

<table>
<tr><th>Checks</th><th>Action</th></tr>
<tr><td colspan="2">DEFINITION: The fuel ignites in the intake manifold, or in the exhaust system, making a loud popping noise.</td></tr>
<tr><td>Preliminary Check</td><td>None.</td></tr>
<tr><td>Ignition System Checks</td><td>Check for the proper primary ignition coil wire output voltage using the spark tester J26792 or the equivalent.
Check the spark plug wires by connecting an ohmmeter to the ends of each wire in question. If the meter reads over 30,000 ohms, replace the wires.
Check the connection at primary ignition coil wire.
Check for deteriorated spark plug wire insulation.
Check the spark plugs.
Remove the plugs and inspect them for the following conditions:
Wet plugs.
Cracks.
Wear.
Improper gap.
Burned electrodes.
Heavy deposits.</td></tr>
<tr><td>Engine Mechanical Check</td><td>Check the engine for the following:
Improper valve timing.
Engine compression.
Manifold vacuum leaks.
Intake manifold gaskets.
Sticking or leaking valves.
Exhaust system leakage.
Check the intake and exhaust system for casting flash or other restrictions.</td></tr>
<tr><td>Fuel System Checks</td><td>Perform a fuel system diagnosis. Refer to Gas Fuel System Diagnosis.</td></tr>
</table>

LACK OF POWER, SLUGGISHNESS, OR SPONGINESS

Checks	Action
DEFINITION: *The engine delivers less than expected power. There is little or no increase in speed when partially applying the accelerator pedal.*	
Preliminary Checks	• Refer to the *Gas Fuel system OBD System Check.* • Compare the customer's vehicle with a similar unit to verify customer has an actual problem. *Do not compare the power output of the vehicle operating on gas to a vehicle operating on LPG as the fuels do have different drive feel characteristics.* • Remove the air filter and check for dirt or restriction. • Check the vehicle transmission. • Refer to the OEM transmission diagnostics.
Fuel System Checks	• Check the in-line fuel filter for restrictions, contaminated fuel, or improper fuel pressure. Refer to *Gas Fuel System Diagnosis*. • Check for fuel pump electrical circuit. • Verify proper fuel pump pressure. • Verify proper fuel rail pressure.
Sensor Checks	• Check the Heated Exhaust Gas Oxygen Sensor (HEGO) for contamination and performance. • Check for proper operation of the MAP sensor. • Check for proper operation of the TPS and FPP sensors.
Exhaust System Checks	Check the exhaust system for a possible restriction: • Inspect the exhaust system for damaged or collapsed pipes. • Inspect the muffler for signs of heat distress or for possible internal failure. • Check for possible plugged catalytic converter.
Engine Mechanical Check	Check the engine for the following: • Engine compression. • Valve timing. • Improper or worn camshaft. • Refer to *Engine Mechanical* in the Service Manual. • Check for the proper ignition output voltage with the spark tester *J 26792* or the equivalent. • Check electrical connections of fuel injectors.
Additional Check	• Check the ECM grounds for being clean, tight, and in their proper locations. • Check the generator output voltage. If all procedures have been completed and no malfunction has been found, review and inspect the following items: • Visually and physically, inspect all electrical connections within the suspected circuit and/or systems. • Check DST data.

POOR FUEL ECONOMY

Checks	Action
DEFINITION: *Fuel economy, as measured by refueling records, is noticeably lower than expected. Also, the economy is noticeably lower than it was on this vehicle at one time, as previously shown by refueling records.*	
Preliminary Checks	• Check the air cleaner element (filter) for dirt or being plugged. • Visually check the vacuum hoses for splits, kinks, and proper connections. • Check for properly inflated tires. Check the operators driving habits for the following: • Excessive idling or stop and go driving. • Carrying of very heavy loads. • Rapid acceleration. • Suggest to the owner to fill the fuel tank and to recheck the fuel economy and/or suggest that a different operator use the equipment and record the results.
Fuel System Checks	• Refer to *Gas Fuel System Diagnosis*. • Check the fuel system for leakage.
Sensor Checks	• Check the MAP sensor.
Ignition System Checks	Remove the plugs and inspect them for the following conditions: • Verify that the spark plugs are the correct type and properly gapped. • Wet plugs. • Cracks. • Wear. • Improper gap. • Burned electrodes. • Heavy deposits. Check the ignition wires for the following items: • Cracking. • Hardness. • Proper connections.
Cooling System Checks	Check the engine thermostat to see if it is stuck open or for the wrong heat range.
Additional Check	• Check the transmission shift pattern. • Refer to the OEM Transmission Controls section the Service Manual. • Check for dragging brakes.

ROUGH, UNSTABLE, OR INCORRECT IDLE, STALLING

Checks	Action
DEFINITION: *The engine runs unevenly at idle. If severe enough, the engine or vehicle may shake. The engine idle speed may vary in RPM. Either condition may be severe enough to stall the engine.*	
Preliminary Check	None.
Sensor Checks	Check the Heated Exhaust Gas Oxygen Sensors (HEGO) performance: • Check for silicone contamination from fuel or improperly used sealant. If contaminated, the sensor may have a white powdery coating result in a high but false signal voltage (rich exhaust indication). The ECM will reduce the amount of fuel delivered to the engine causing a severe drivability problem. • Check the Manifold Absolute Pressure (MAP) sensor response and accuracy.
Fuel System Checks	• Check for rich or lean symptom that causes the condition. • Drive the vehicle at the speed of the complaint. • Monitoring the oxygen sensors will help identify the problem. • Check the in-line fuel filter for restrictions. • Refer to the *Gas Fuel System Diagnosis*.
Ignition System Checks	• Check for the proper ignition output voltage using the spark tester *J26792* or the equivalent. Remove the plugs and inspect them for the following conditions: • Verify that the spark plugs are the correct type and properly gapped • Wet plugs. • Cracks. • Wear. • Improper gap. • Burned electrodes. • Blistered insulators. • Heavy deposits. • Check the spark plug wires by connecting an ohmmeter to the ends of each wire in question. If the meter reads over 30,000 ohms, replace the wires.
Additional Checks	• Check for vacuum leaks. Vacuum leaks can cause a higher than normal idle and low throttle angle control command. • Check the ECM grounds for being clean, tight, and in their proper locations. Check the battery cables and ground straps. They should be clean and secure. Erratic voltage may cause all sensor readings to be skewed resulting in poor idle quality.
Engine Mechanical Check	Check the engine for: • Broken motor mounts. • Improper valve timing. • Improper valve clearance. • Low compression. • Worn rocker arms. • Broken or weak valve springs. • Worn camshaft lobes.

SURGES/CHUGGLES

Checks	Action
DEFINITION: *The engine has a power variation under a steady throttle or cruise. The vehicle feels as if it speeds up and slows down with no change in the accelerator pedal.*	
Preliminary Checks	None.
Sensor Checks	Check the Heated Exhaust Gas Oxygen Sensors (HEGO) performance.
Fuel System Checks	• Check for Rich or Lean symptom that causes the condition. • Drive the vehicle at the speed of the complaint. Monitoring the oxygen sensors will help identify the problem. • Check the fuel pressure while the condition exists. Refer to *Gas Fuel System Diagnosis.* • Check the in-line fuel filter for restrictions.
Ignition System Checks	• Check for the proper ignition output voltage using the spark tester J26792 or the equivalent. • Verify that the spark plugs are the correct type and properly gapped. Remove the plugs and inspect them for the following conditions: • Wet plugs. • Cracks. • Wear. • Improper gap. • Burned electrodes. • Heavy deposits. • Check the Crankshaft Position (CKP) sensor.
Additional Check	• Check the ECM grounds for being clean, tight, and in their proper locations. • Check the generator output voltage. • Check the vacuum hoses for kinks or leaks. • Check Transmission .

Electrical Section

Diagnostic Scan Tool

CONTENTS

- Installation of the DST package to a personal computer (PC).
- Software login and password functionality.
- DST service pages.
- Updating the ECM calibration using a MOT file.
- DTC pages.

Examples and snapshots used in this manual are based off of the initial DST tool release as of July, 2007. This tool is frequently updated and the illustrations may vary depending on the changes included in any updated DST display Interface. Terms, names and descriptions of parts and servicing procedures will be updated based on trade, brand, or common description to more accurately describe the part or service procedure.

DST INSTALLATION INSTRUCTIONS

Before installing the DST software, please be sure your computer meets the minimum system requirements.

Supported operating systems are:

- Windows Vista (32-Bit)
- Windows XP (32-Bit)
- Windows 2000

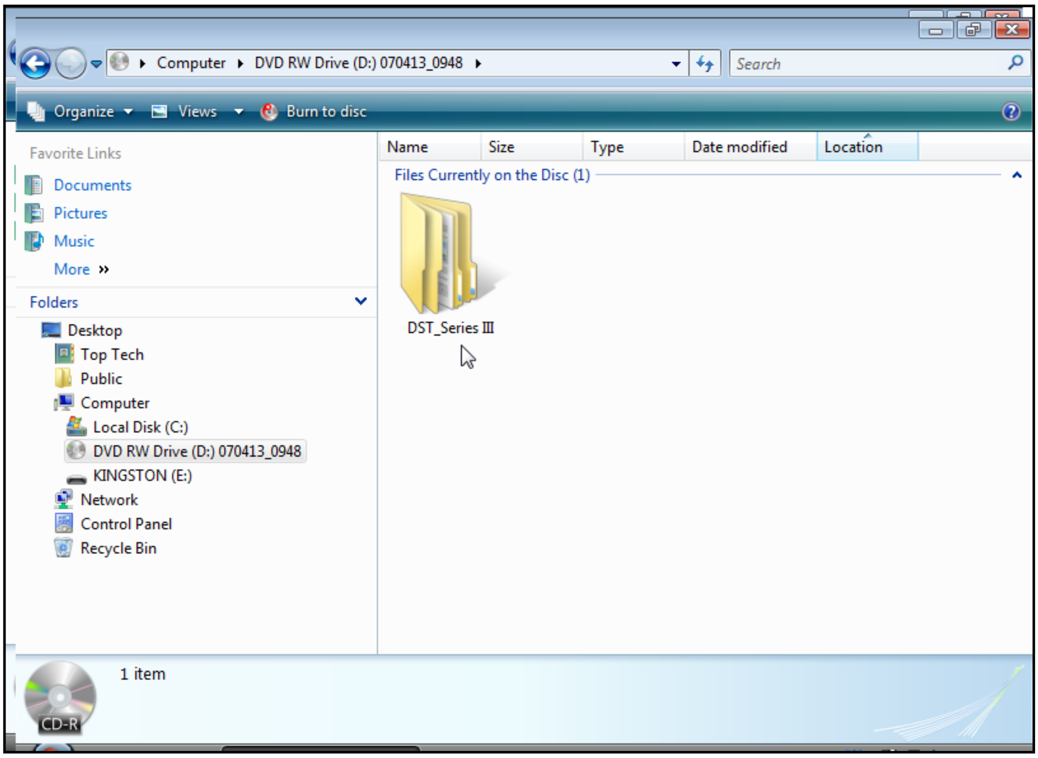
Minimum processor speed:

- Pentium II 450 MHz
- Pentium III 1.0 GHz for Windows Vista

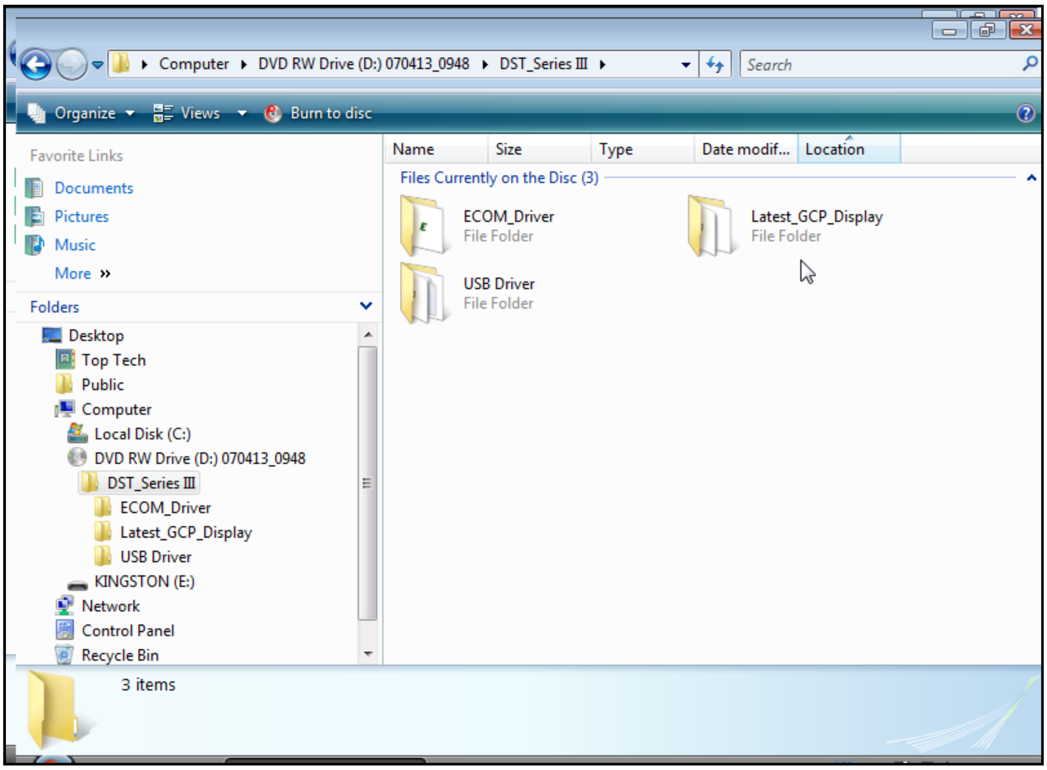
Minimum RAM requirement:

- Windows Vista 512 MB
- Windows XP 256 MB
- Windows 2000 128 MB

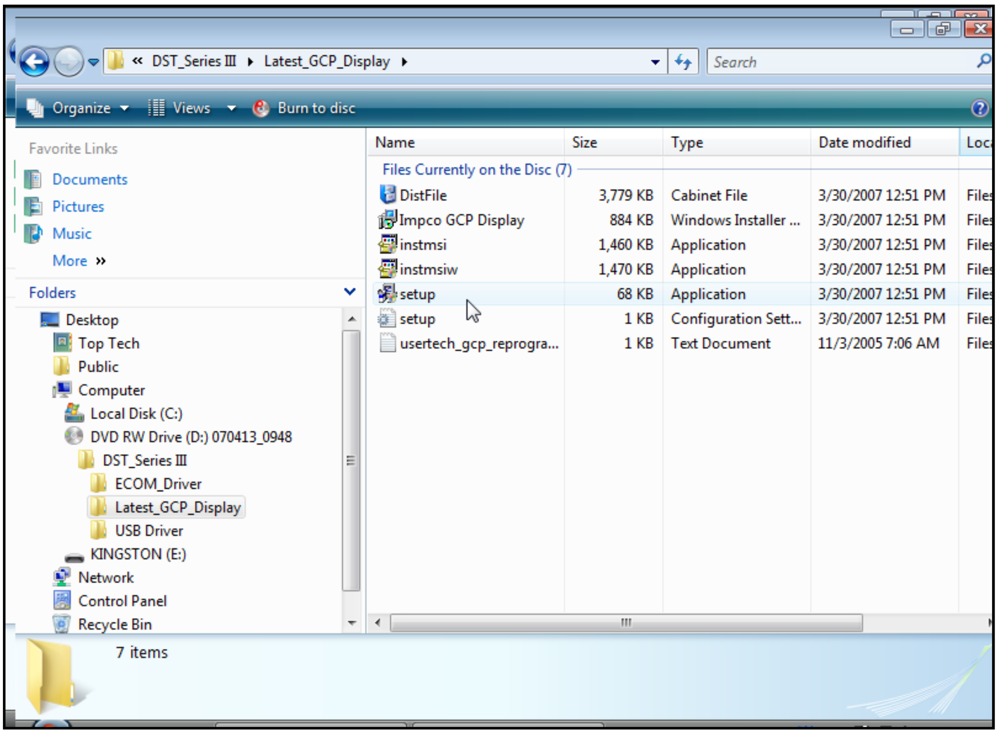
* At least one available RS232 serial or USB port.
* ECOM cable supports USB port only.



- Open the DST_Series III folder

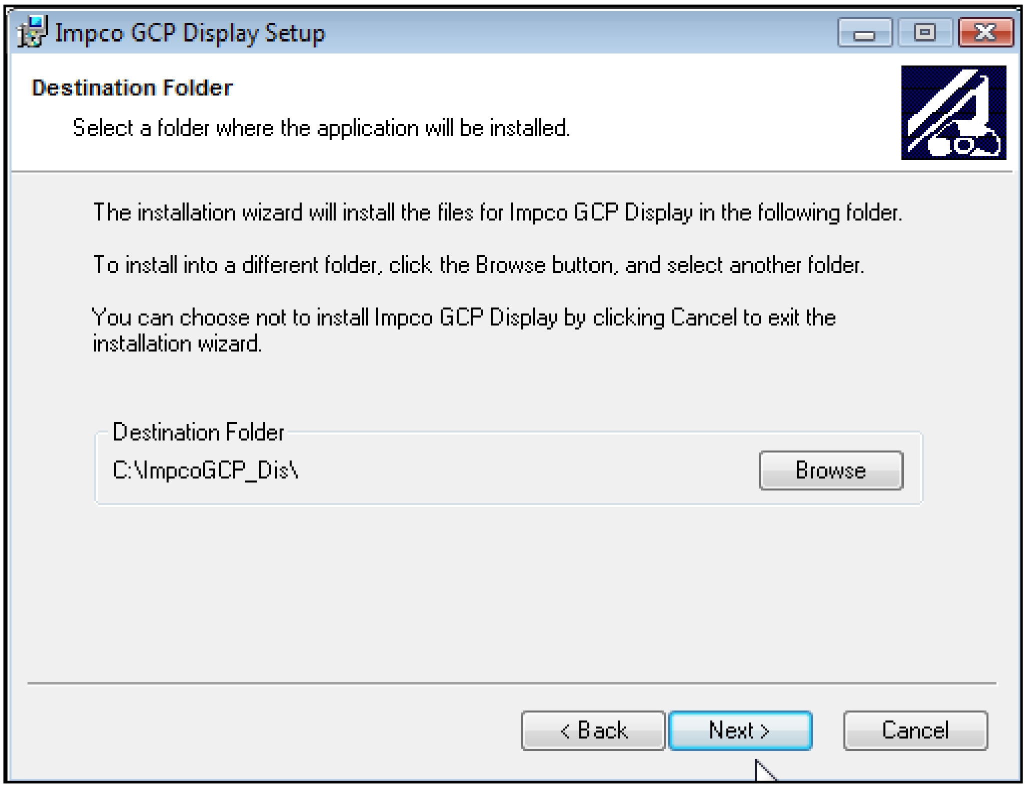


- Open the Latest_GCP_Display folder

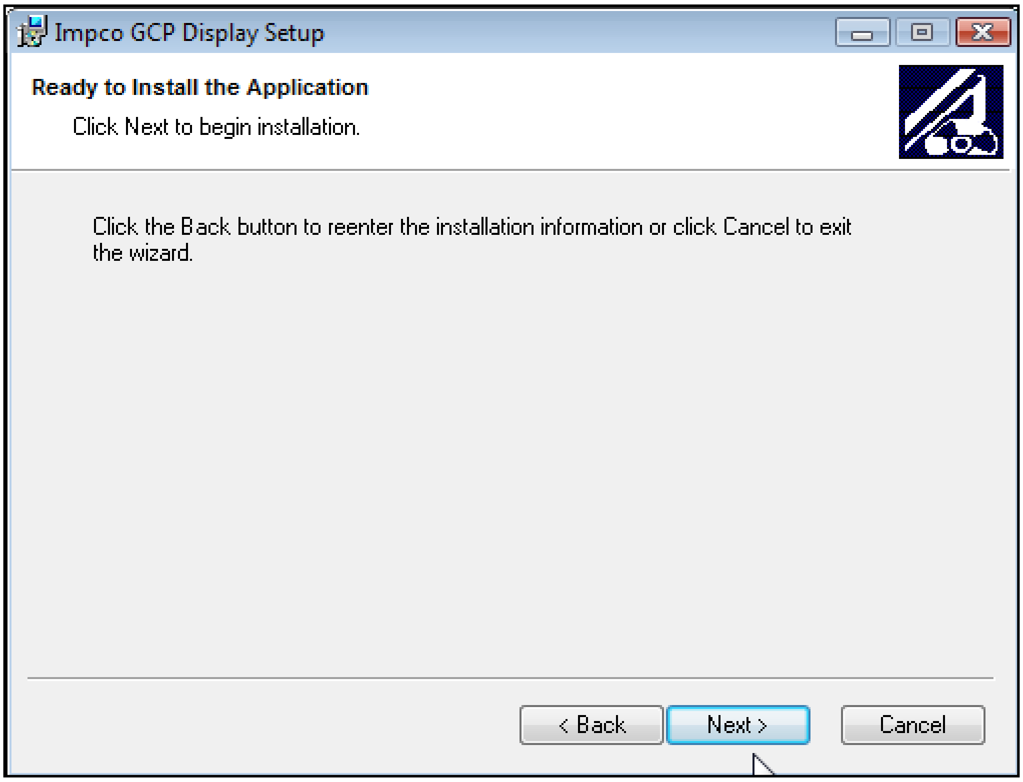


- Double click on “setup.exe” (application file) to start the windows installer. If a previous version of the GCP software is installed, the uninstaller may remove the previous version and exit. You will be required to start the installer again to install the new version.

- Click “Next” to continue

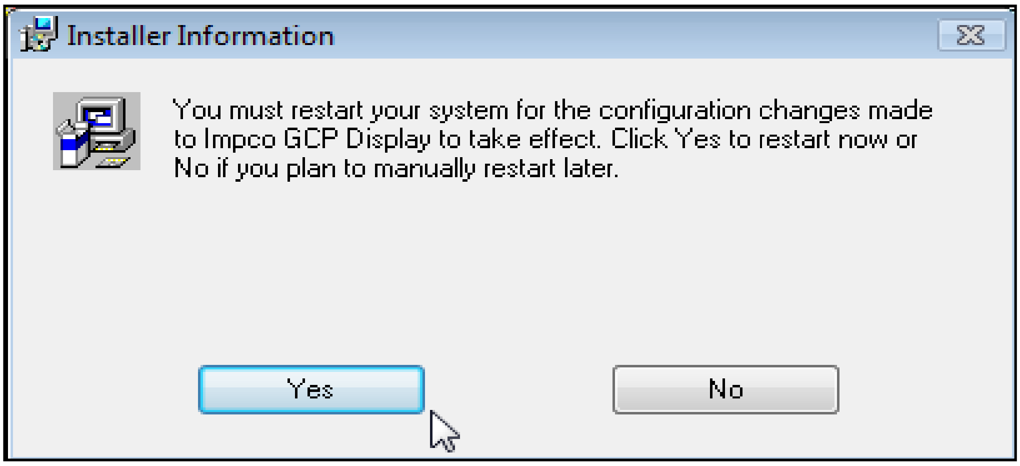


- Click "Next" to continue

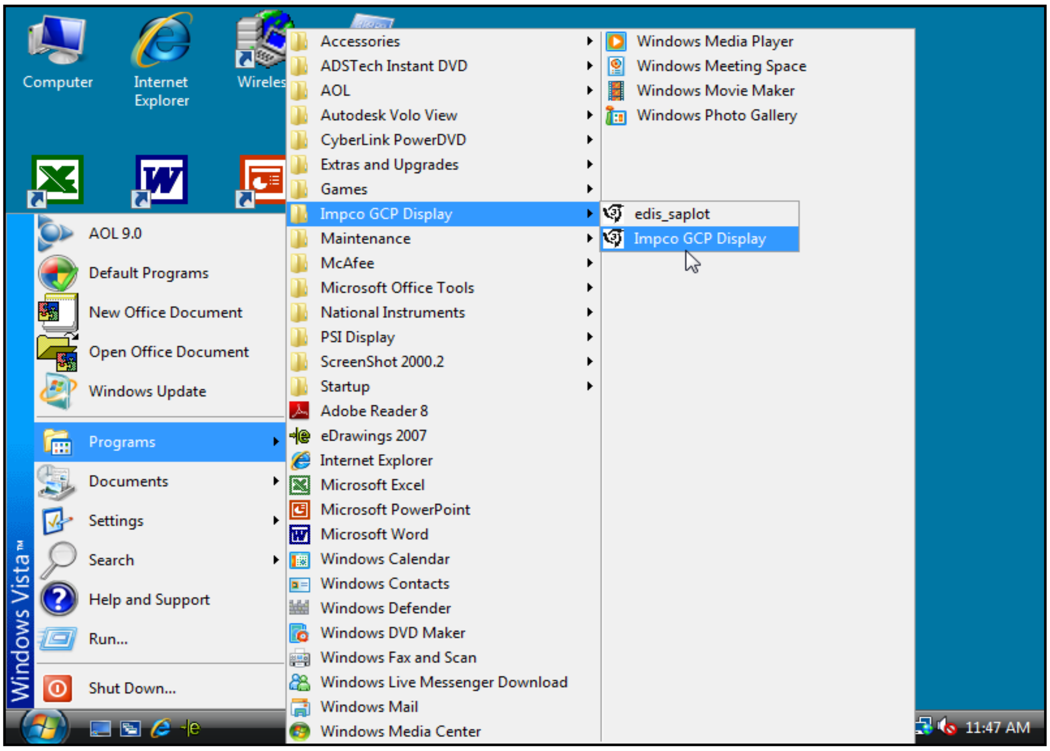


- Click "Next" to continue

- Click the “Finish” box to complete the installation.



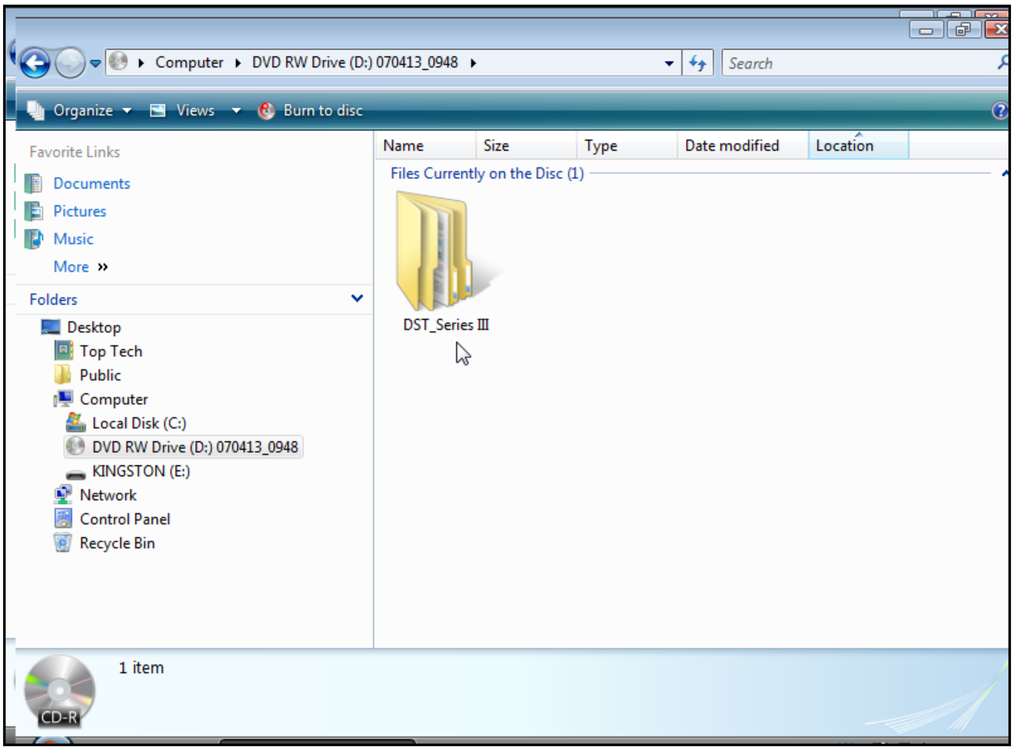
- Click “Yes” to restart your computer



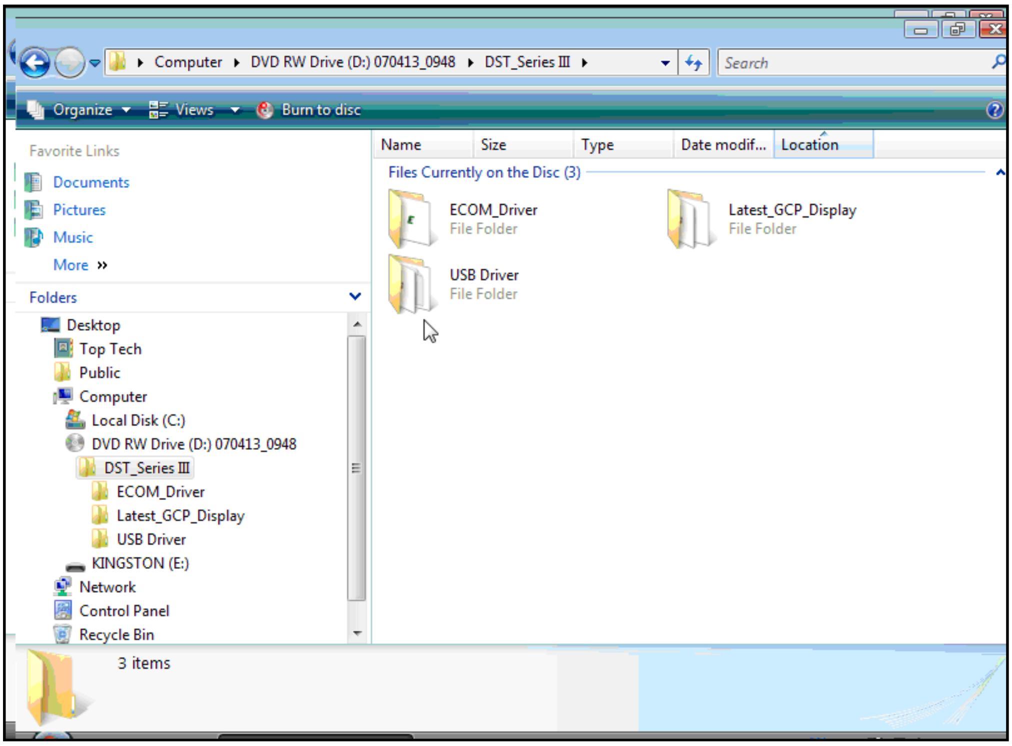
- Once installed, the software can be accessed from Start Menu →Programs → Impco GCP Display → Impco GCP Display

INSTALLING THE USB ADAPTER DRIVER

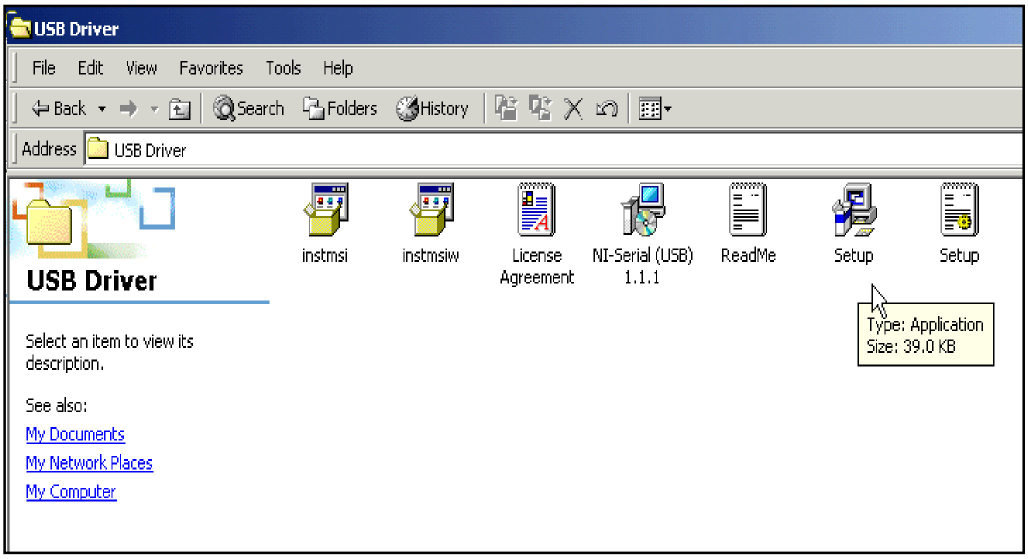
If your computer does not have an RS232 serial port you will need to install the USB adapter driver. You do not need to install this driver if you plan to use the ECOM DLC cable.



- Open the DST_Series III folder



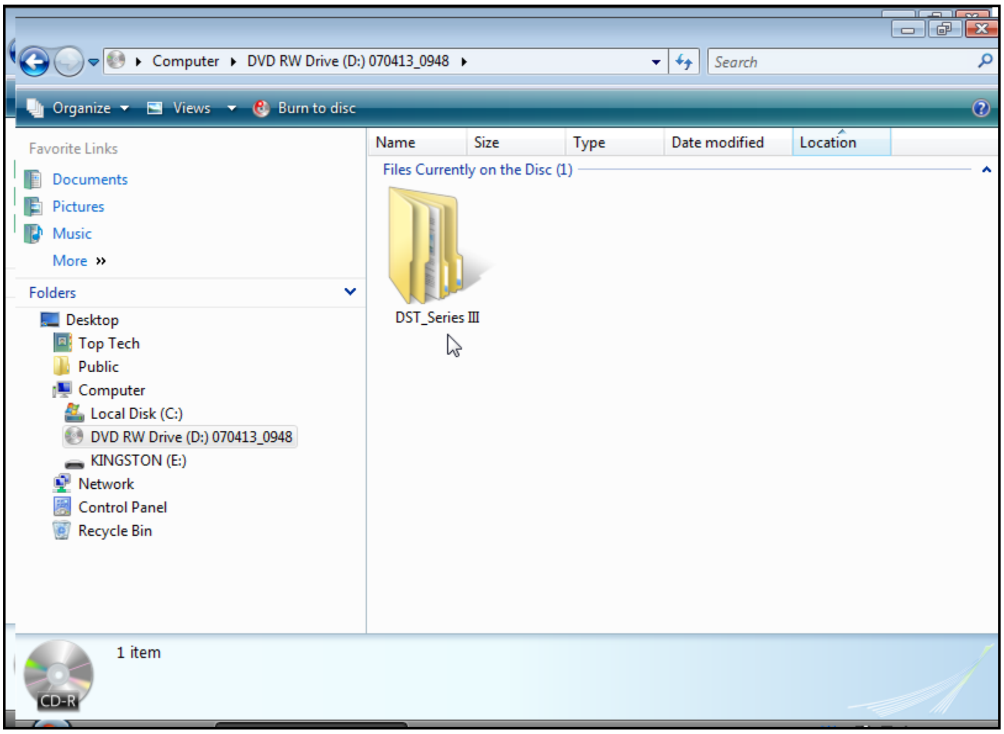
- Open the “USB Driver” folder



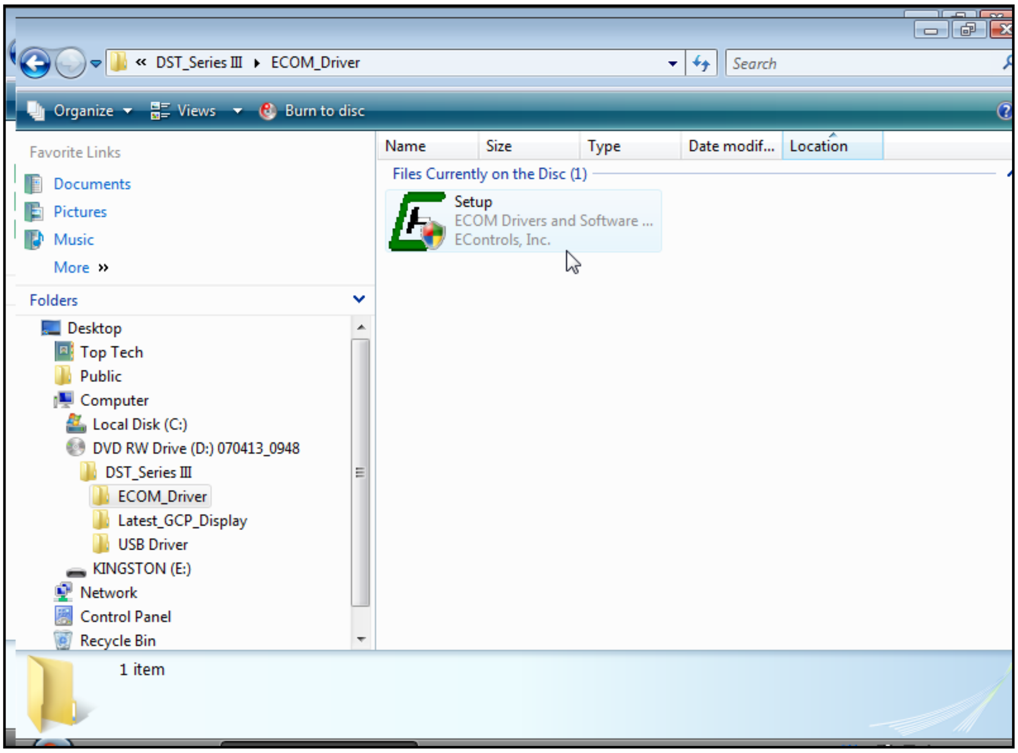
- Double click on “setup.exe” (application file) and follow the on screen prompts.

Installing the ECOM DLC cable driver

The ECOM USB cable is designed to replace both the serial DLC and the USB adapter cables. It also provides communication to the ECM on the CAN line for systems that are CAN enabled. It requires the installation of the ECOM driver and is compatible with the series II and series III DST software programs.

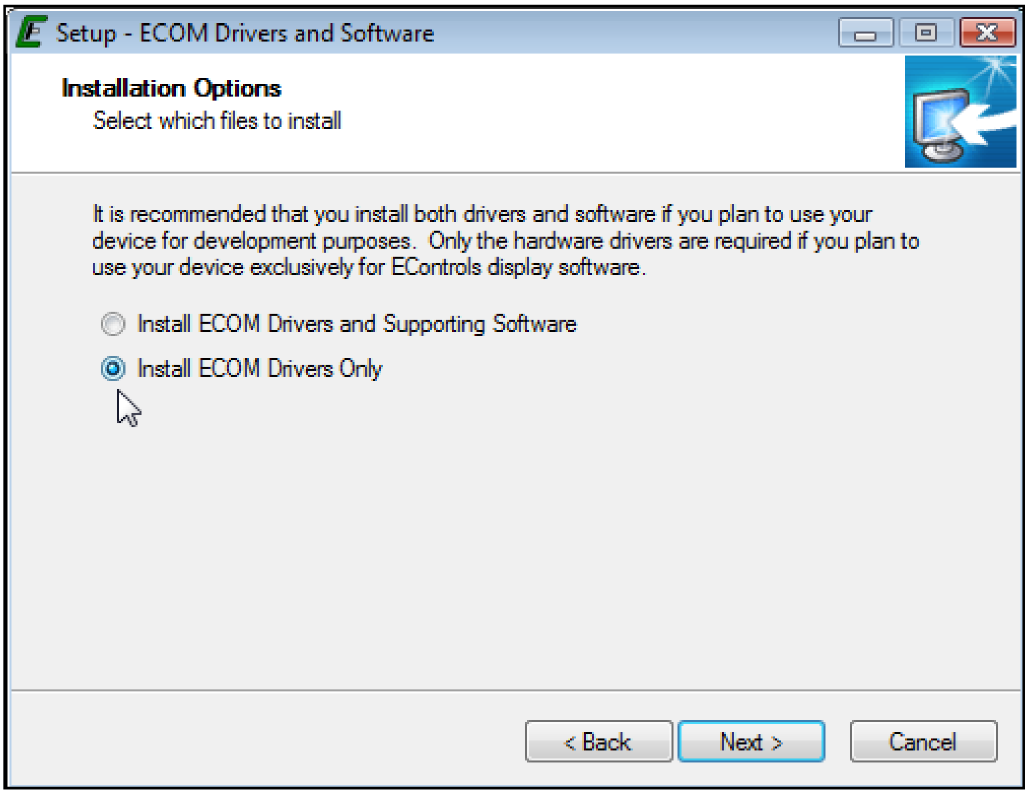


- Open the DST_Series III folder



- Double click on “setup.exe” (application file).

- Click “Next” to continue



- Select install ECOM drivers only. Click “Next” and follow the on screen prompts.

PASSWORD LOGIN

Figure 1 shows the password dialog box, which is displayed when a software session begins. Login can be accomplished in two ways.

1. Enter an “All S/N Password” which is a password applicable to all ECMs of a given original equipment manufacturer (OEM).

2. Enter a “Single S/N Password” and corresponding ECM serial number for a single ECM. A Single Serial Number password is unique to a specific ECM serial number and permits authorized service personnel to make changes or view information for a specific ECM.

3. In most instances the top “all” serial number boxes should be used for password entry. In this case, do not check the single serial number box. Each password is a 16-character alpha-numeric string specific to each Spectrum customer and determines which pages and variables are visible through the software. Passwords are assigned by the OEM support group and may change periodically. Check the “save password” box to automatically retain the password for future use.

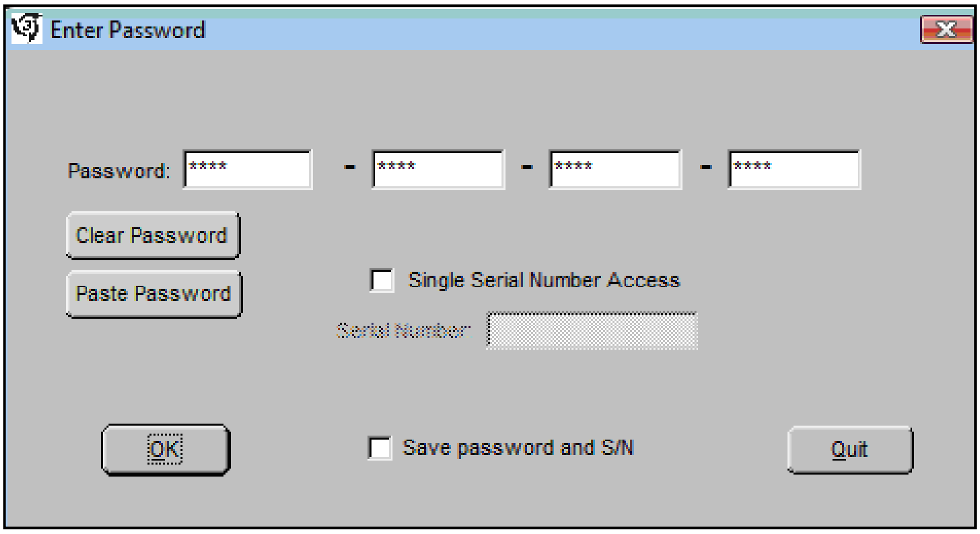


Figure 1: Populated Password Dialog Box

PASSWORD DIALOG BOX FUNCTIONS

- **Clear Password Button** Erases the current password from the password field.
- **Paste Password Button Allows** the user to copy a 16-character string from any word processor and paste the string in the password field.
- **Single Serial Number Access Checkbox** Tells the software that the password is applicable for single serial number access.
- **Serial Number Field** Only applicable when Single Serial Number Access Checkbox is checked. The entry field must be populated for the 6-digit serial number for which the Single Serial Number Access password applies (NOTE: Leading zeros included in the serial number are not required).
- **Save Password and S/N Checkbox** Retains the password, and serial number (if applicable) for the next software session.

Should an invalid password be entered, the error prompt shown in figure (2) will be displayed and the software will not load. This prompt signifies the following:

- The All S/N password is invalid.
- The Single S/N password is incorrect for the Single Serial Number entered.
- An All S/N password is entered for Single Serial Number use.
- The Single Serial Number password is valid; however, the Single Serial Number Access Checkbox is not checked.

Figure 2: Password Error Prompt

If the Single S/N password entered is correct for the software but does not match the entered S/N of the targeted ECM, the prompt in Figure 3 will be displayed.

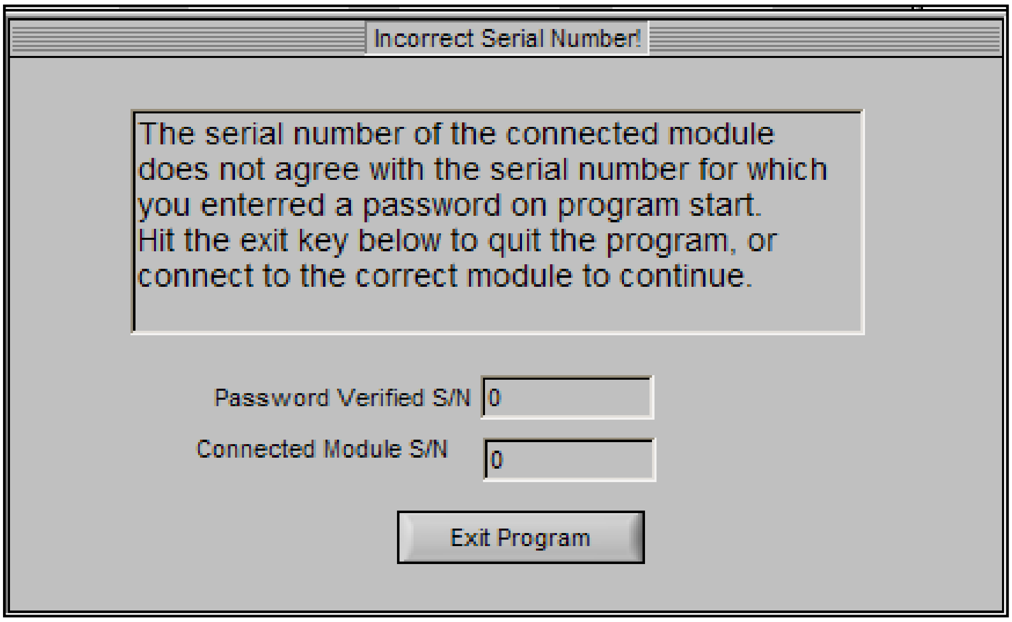


Figure 3: Incorrect Serial Number Message

Figure 4 shows the communication status if a valid software password is entered when attempting to connect to an ECM with a different key. In this instance the software will load but will not connect to the target (ECM).

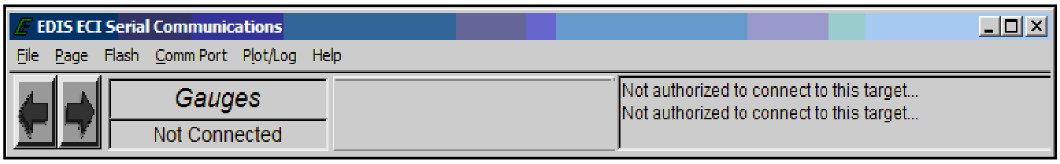
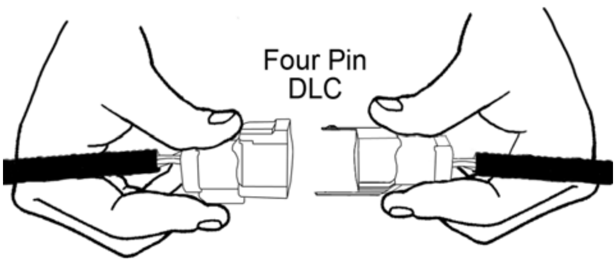


Figure 4: Not Authorized to Connect Message

In the event you receive this error message call your OEM support group for more information.

CONNECTING THE PC TO THE SPECTRUM FUEL SYSTEM



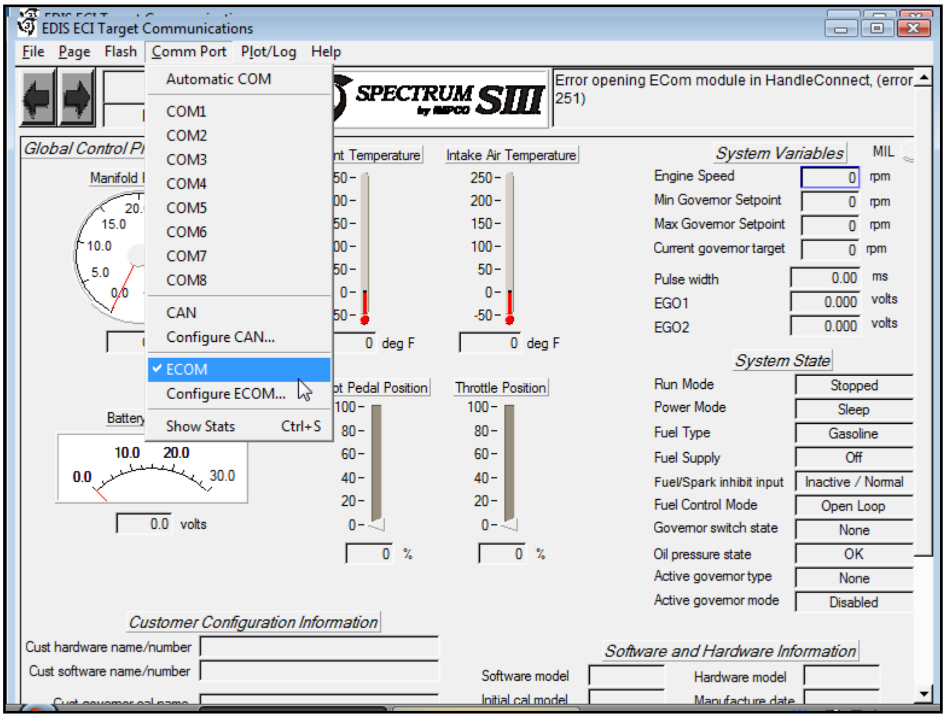
Connecting the DST cable

A laptop computer, with the diagnostic cable and software is the required tool for performing proper diagnostic testing of the Spectrum fuel system. It is also used to monitor sensor and actuator values and to read and clear Diagnostic Trouble codes. The DST software also performs several special tests.

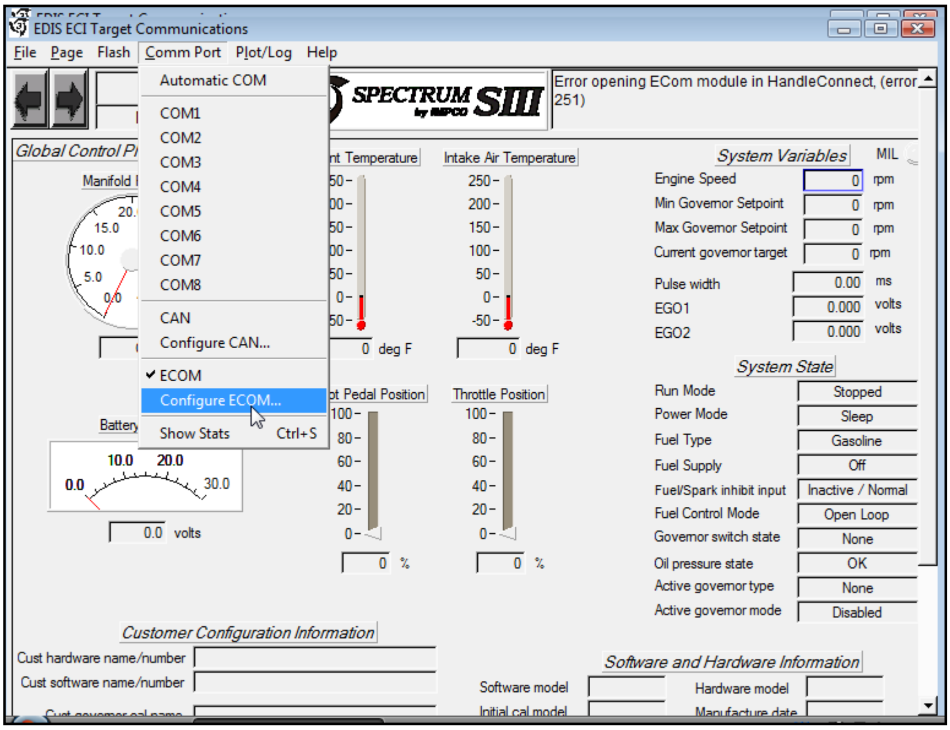
- Connect the system diagnostic cable to the RS232 port on the back of the computer. If you do not have a RS232 port, use the USB to RS232 adapter supplied in the IMPCO ITK test kit. Be sure to install the USB driver to enable the USB adapter for use with your computer.
- Connect the diagnostic cable to the DLC (diagnostic link connector) labeled in the electrical schematic. The DLC is located on the engine harness. The new 8 pin DLC requires the use of the 4 to 8 pin adapter included in the late model ITK test kits.
- Turn the computer ON.
- Start Windows.
- From the start menu select Programs → Impco GCP Display → Impco GCP Display
- Place the ignition key in the ON position.

Within several seconds the system Gauge screen should now appear and a green banner in the upper left hand will read “Connected.”

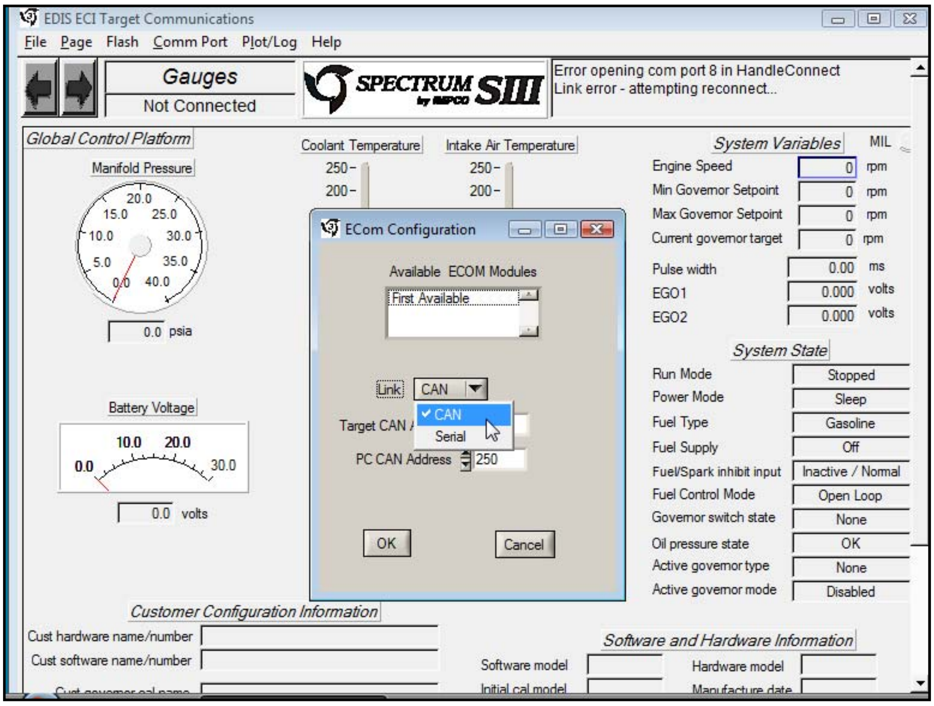
- **Connecting to the PC using the ECOM cable**



- To connect using the ECOM cable you must select ECOM from the COM Port drop down menu.

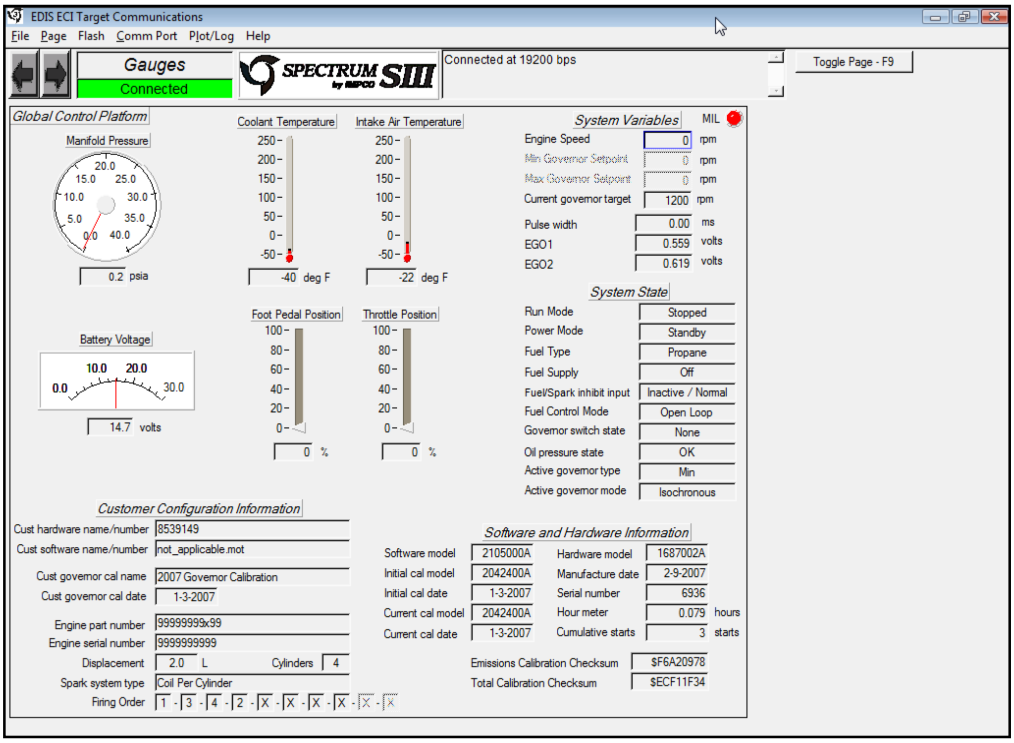


- You will now need to configure the ECOM communication protocol.



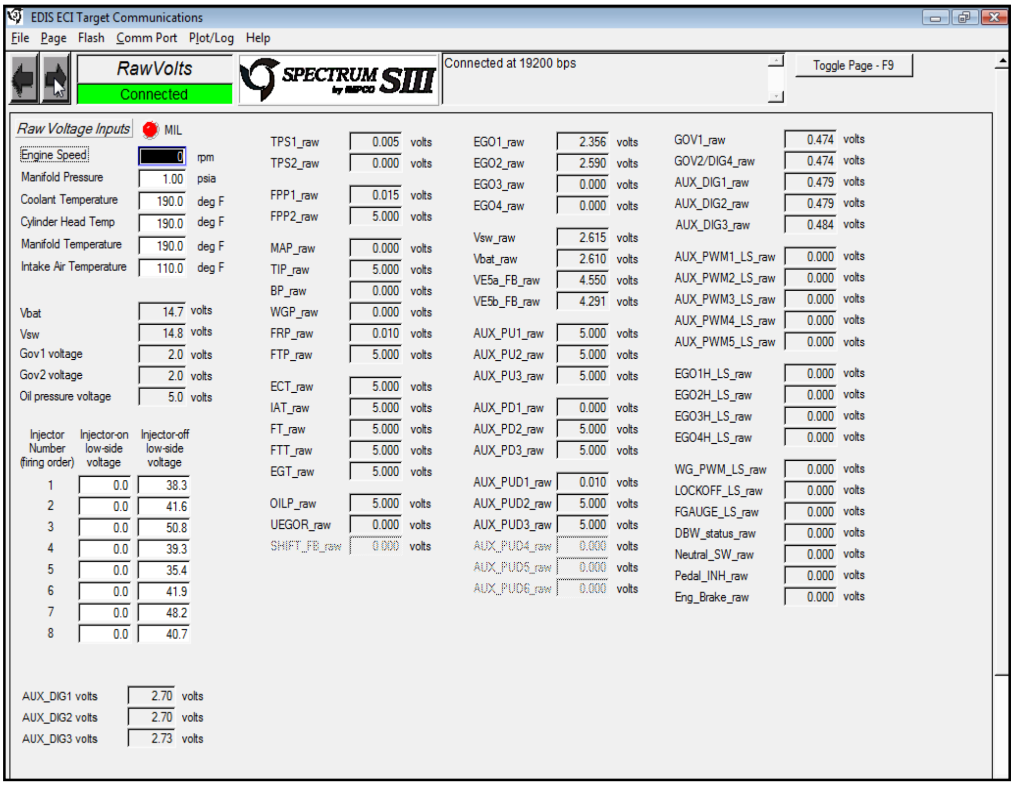
- Select the CAN for systems with CAN enabled or serial for all others. Then select OK. You are now ready to connect using the ECOM USB DLC cable.

DST SERVICE PAGES



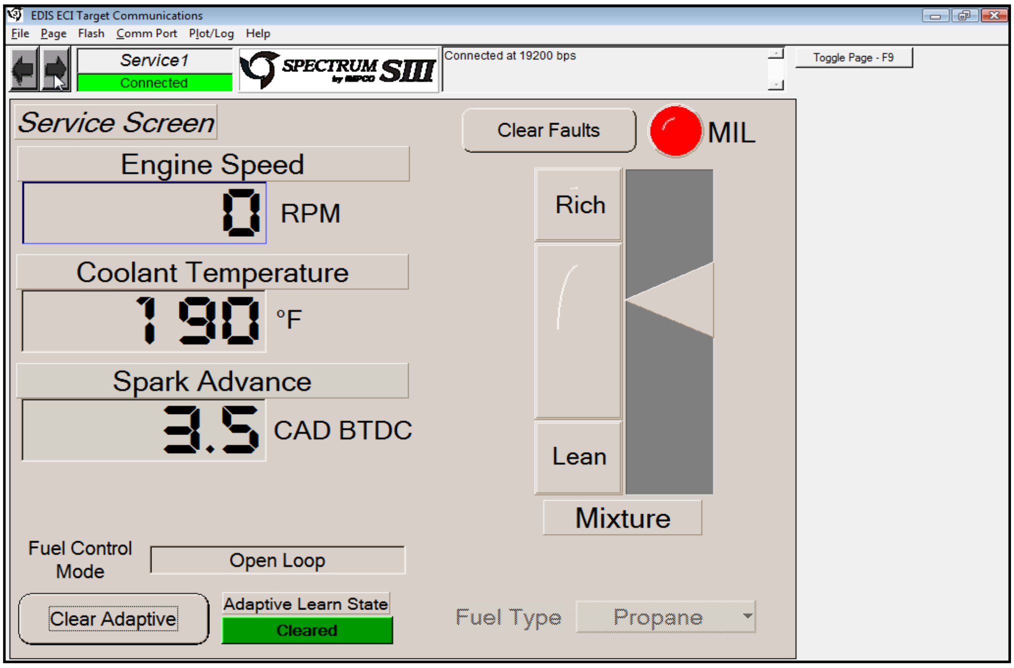
Gauge Page

Provides system data in large easy to read displays. Displays ECM configuration information for the ECM software, hardware, serial numbers and calibration dates.



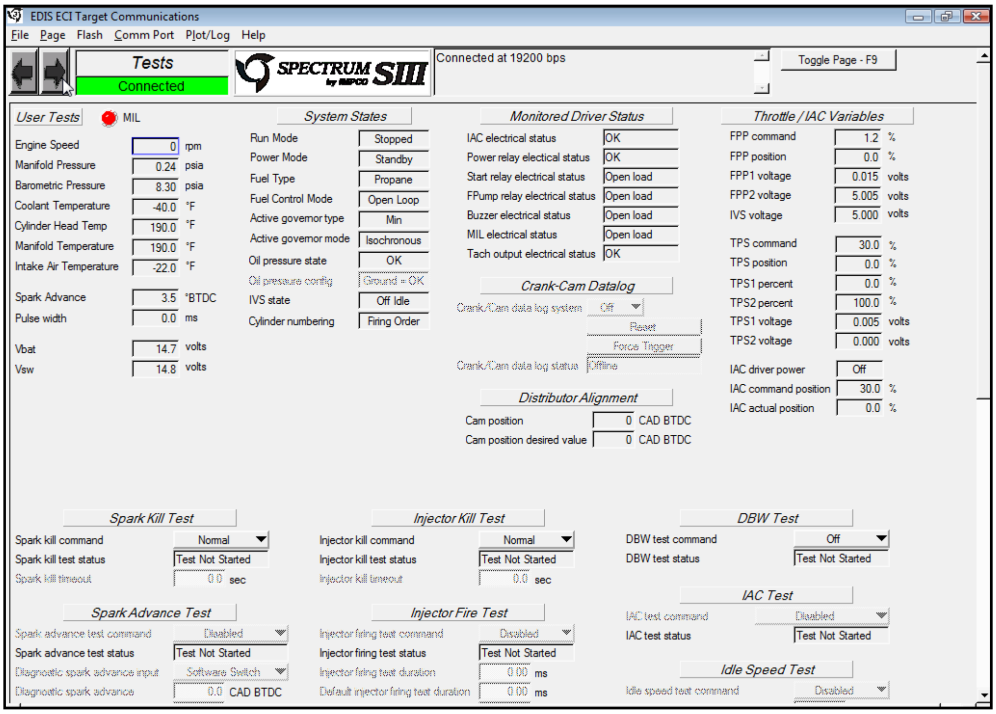
Raw Volts Page

The raw volts page displays the sensor inputs and outputs in a raw voltage format. This page is most commonly used to check values in the diagnostic trouble shooting charts.



Service 1

The Service 1 screen is used to clear the adaptive learn, shows the MIL status and provides a display for rpm, coolant temperature and spark advance. It also provides a large display to monitor the closed loop mixture control.



Tests Page

Provides diagnostic information voltages and sensor outputs and includes diagnostic engine tools such as spark and injector kill controls. Please note that not all features are available for all applications. The disabled item menus are grayed out or rendered inoperative.

SPARK KILL

The spark kill mode allows the technician to disable the ignition on individual cylinders. If the Spark Kill diagnostic mode is selected with the engine running below 1000 rpm, the minimum throttle command will lock into the position it was in when the test mode was entered. If the Spark System Test mode is selected with the engine running above 1000 rpm, the throttle will continue to operate normally. Disabling Ignition Outputs to disable the ignition system for an individual cylinder, use the mouse to highlight the "Spark Kill" button and select the desired primary ignition coil wire. The spark output can be re-enabled by using the mouse to highlight the "Spark Kill" button and selecting "Normal." If the engine is running below 1000 rpm, the spark output will stay disabled for 15 seconds and then re-set. If the engine is running above 1000 rpm, the spark output will stay disabled for 5 seconds and then re-set. This test mode has a timeout of 10 minutes. Record the rpm drop related to each spark output disabled. The spark outputs are arranged in the order which the engine fires, not by cylinder number.

INJECTOR KILL

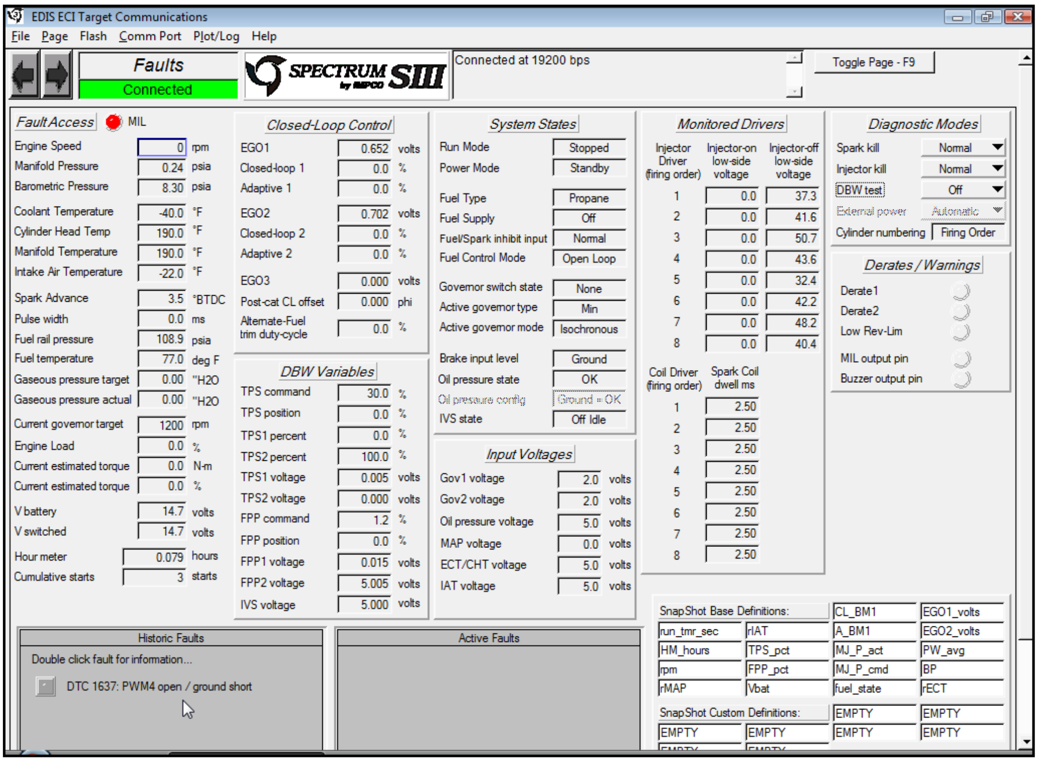
The Injector Kill mode is used to disable individual fuel injectors. If the Injector Kill mode is selected with the engine running below 1000 rpm, the minimum throttle command will lock into the position it was in when the test mode was entered. If the Injector Kill mode is selected with the engine running above 1000 rpm, the throttle will continue to operate normally. To disable an injector, use the mouse to select the desired injector. The word “Normal” will change to the Injector you have selected. The injector driver can be re-enabled by selecting again. If the engine is running below 1000 rpm, the injector driver will stay disabled for 15 seconds and then re-set. If the engine is running above 1000 rpm, the injector driver will stay disabled for 5 seconds and then re-set. Record the change in rpm while each driver is disabled.

DBW TEST MODE

The DBW (Drive by Wire) test mode allows the technician to control the throttle directly with the foot pedal or throttle input and is used during the diagnostic routines specified for FPP and TPS for Spectrum systems that use DBW control. FPP position displays the current position of the foot pedal as a percentage. FPP volts display the voltage which the ECM is reading from the FPP sensor. TPS Command displays the commanded throttle position expressed as a percentage, which is being sent to the throttle. TPS Position is the actual percent of throttle opening being sent to the ECM from the throttle. TPS volts display the actual TPS signal voltage the ECM is receiving from the throttle. To select this test mode the engine must be off and the key must be in the ON position.

EXTERNAL POWER TEST

The external power test manually activates relays (relay power, fuel pump, and drive-by wire power) controlled by the ECM while the engine is in the “Stopped” or “Running” states. Reverts to normal operation if “Automatic” state is selected or ignition voltage is cycled from high to low.



Faults Page

Stores DTC codes that may have occurred in the past (Historic Faults) or current set codes (Active Faults). Includes useful system voltages and sensor readings used while working with the fuel and emission trouble shooting charts. Shows power derate mode status. To erase a historic DTC code, double click on the code with the left mouse button. Then choose to “Clear All Faults.”

PLOT/LOG MENU FUNCTIONS

The Plot/Log menu allows the user to graphically plot or numerically log variables that have been tagged for plotting/logging. To plot or log variables, a tag must be assigned to each variable of interest. A variable is tagged for plotting/logging through a single right-mouse click in the variable’s vicinity. Once a variable has been tagged for plotting/logging, it is highlighted in green.

Figure 5 shows an example of variables that have been tagged. A maximum of twenty (20) variables may be tagged for logging and a maximum of ten (10) variables may be tagged for plotting. The maximum achievable sample frequency/minimum period is dependent on the number of variables tagged.

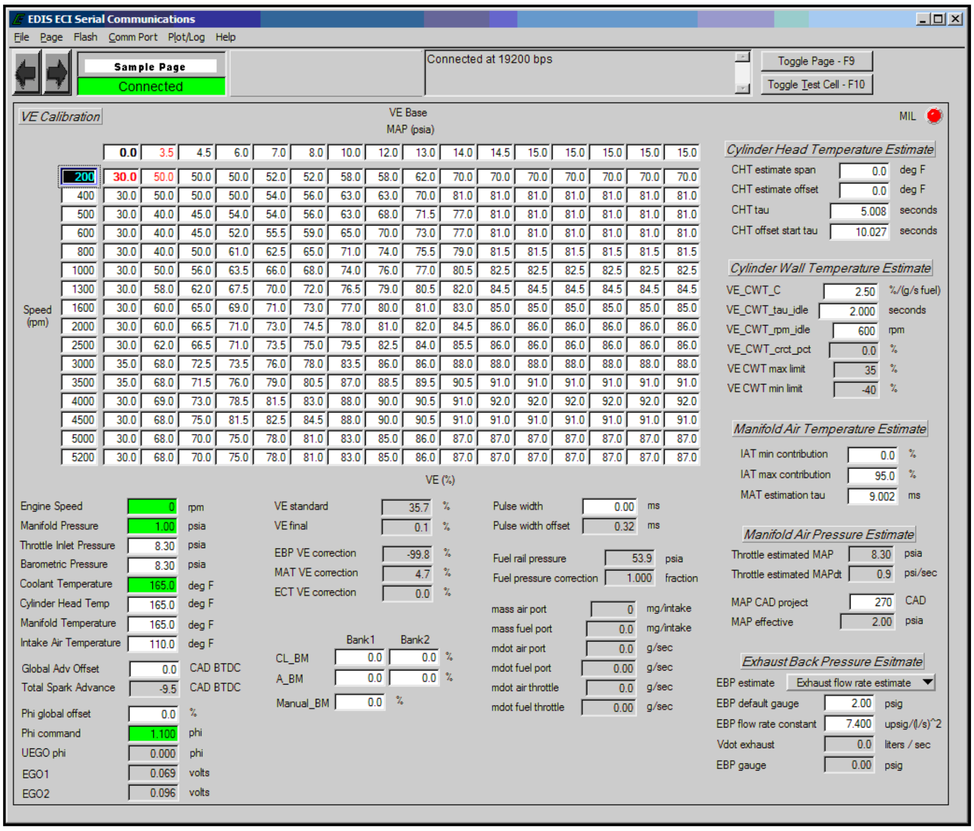


Figure 5: Tagged Variables for Plot/Log

Once the variables have been tagged as highlighted by the green color fill, select the “Plot/Log” function in the top menu bar as shown below in figure 6.

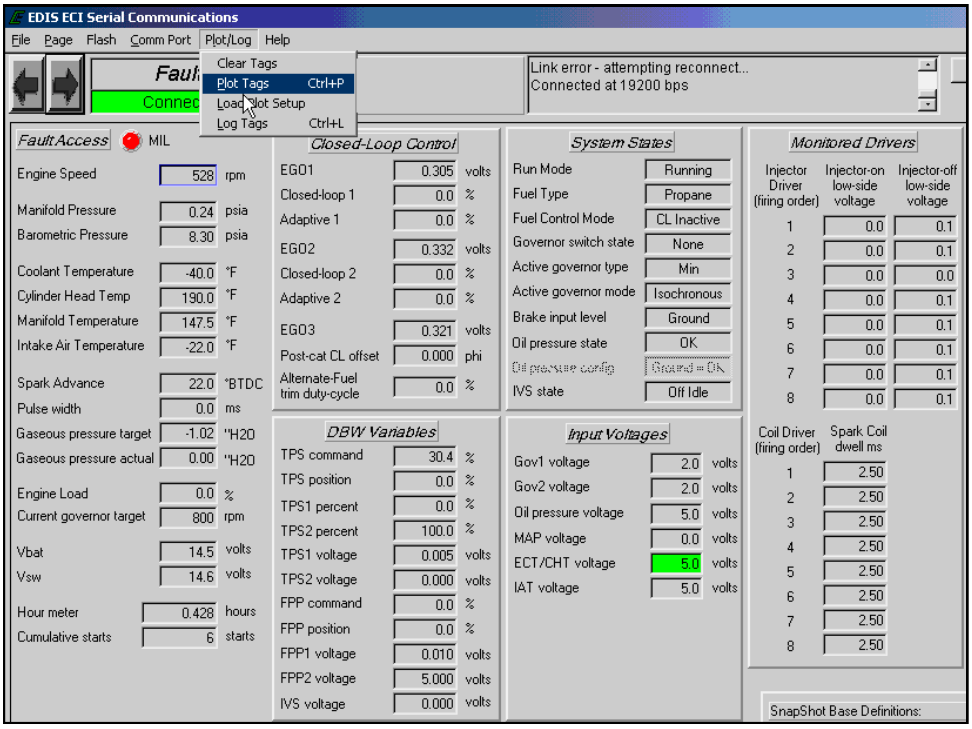


Figure 6

- Select “Plot Tags” to open the snapshot window

Other functions available from the Plot/Log menu include:

- ***Clear Tags***: Releases all plot/log variables.
- ***Plot Tags (Ctrl + P, or P)***: Graphically plot all tagged variables.
- ***Load Plot Setup***: Loads and tags variables for plotting/logging that have been stored in a plot file (.plt).
- ***Log Tags (Ctrl + L)***: Numerically log all variables that have been tagged for plotting/logging.

Once the Plot Tags menu item has been selected, tagged variables are graphically plotted in a strip chart interface. An example of a plot is shown in Figure 7. Capabilities of the plotter are outlined in Table 1.

***Start/Stop* Button**	**Start or stop plotting of selected variables**
Save Button	Save plotted data displayed in the plot to a comma-separated value file (CSV) on the PC hard drive. Format must not be altered if the *Load* function is to be used.
Snapshot Button	Convert the plot into a snapshot that may be panned, zoomed, scrolled, **and** saved
Close Button	Close the DST Plot interface
Load Setup Button	Load tags from a previously saved plot (.plt) file to allow for similar plots and logs to be generated
Load Plot Button	Load a previously saved plot from the PC into the DST Plot interface
Variable Selector Menu	Selects the active variable for axis scaling
Single Shot Acquisition Checkbox*	When checked, this does not allow the plot to scroll past the ‘Time Interval’ thereby preserving plotted data for post-processing.
Exclusive Serial Use Checkbox*	When checked, this allows exclusive serial communication for the plot variables. Other variables on the active page are not updated.
Min Y Value Field*	Specify the minimum Y-axis scaling for the active variable
Max Y Value Field*	Specify the maximum Y-axis scaling for the active variable
Sample Interval (ms) Field*	Define the sample period for recording and display *Frequency (Hz.) = 1000/Sample Interval (ms)*
Time Interval (s) Field*	Defines the total sample acquisition time for the plot.
*Accessible only when plotter is not running.	

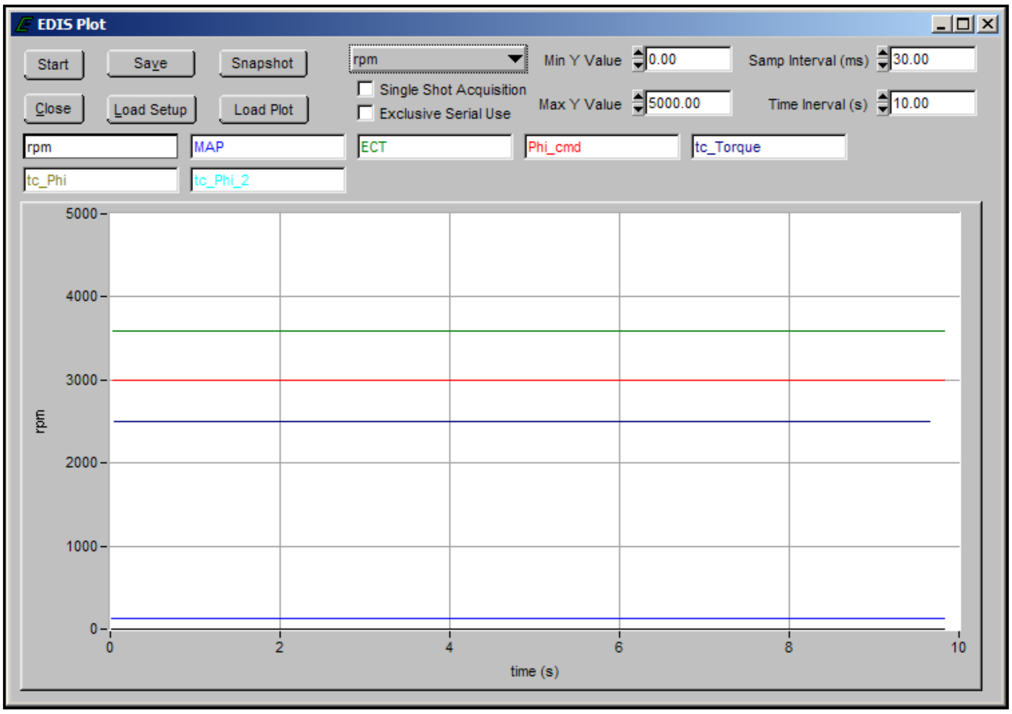


Figure 7: DST Plot

- Click on the "Start" button to start the DST plot function.
- Click on the variable selector button to view selected sensors

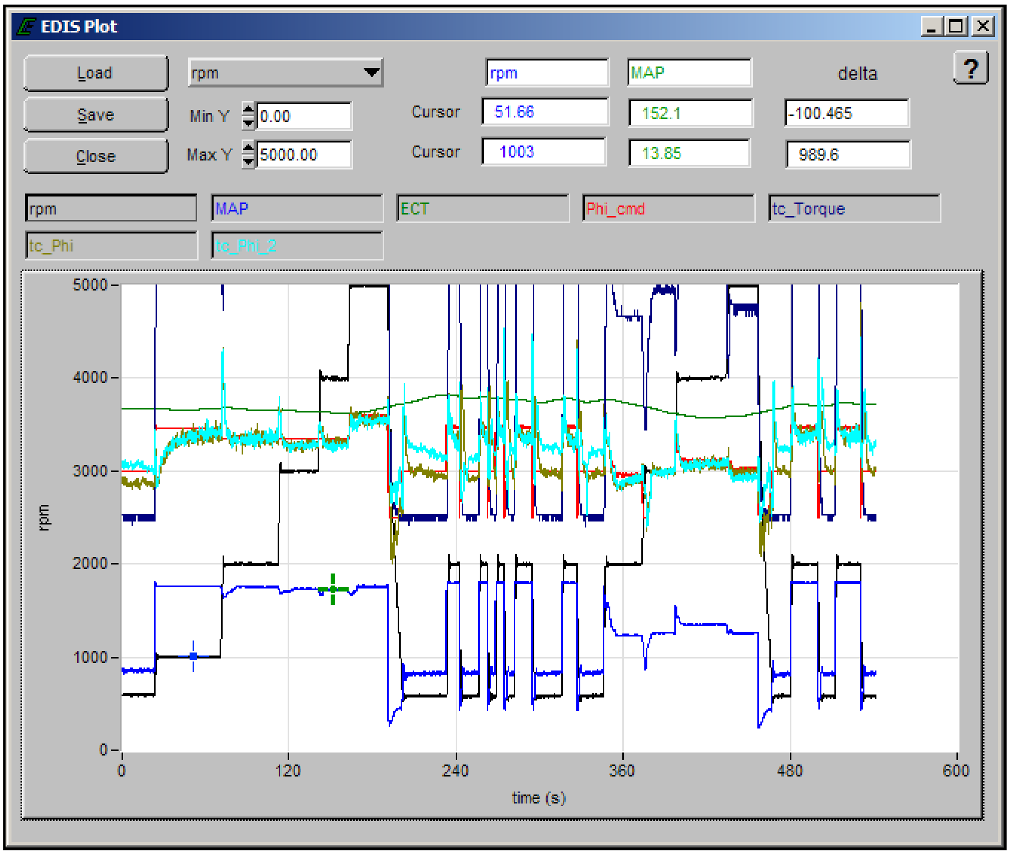
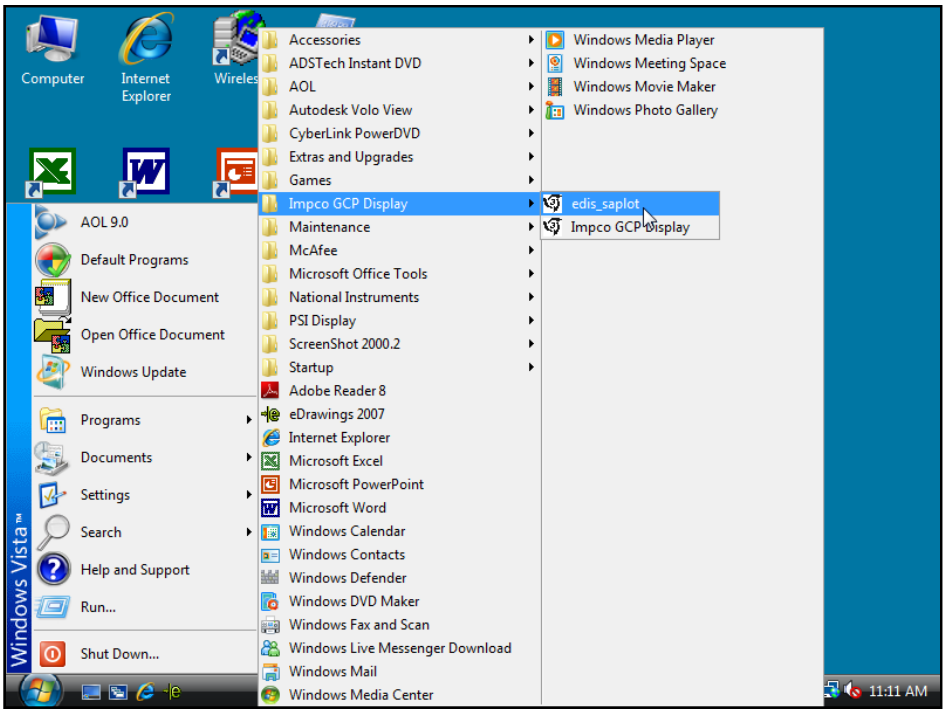


Figure 8: DST Plot Snapshot

- Click on the "Save" button to save the snapshot as a file. To replay the saved file, open the edis_saplot program from the windows start menu.



- Start Menu → Programs → Impco GCP Display → edis_saplot

DST PLOT INTERFACE FUNCTIONS

A graphic tool incorporated in the plotter is the snapshot function. This function allows data collected in a plot to be transferred into a second window for quick graphical post-processing. The snapshot allows the user to zoom in/out, pan left/right, and move cursors along the signal traces to measure the variable values in virtual real-time. An example of a snapshot is shown in Figure 8. Any CSV file in plot format (.plt) may be loaded into the snapshot. Table 2 outlines the available hot key functions of the snapshot screen.

SNAPSHOT HOT KEY FUNCTIONS

Command	Function
<Single, left-click on trace>	Snap closest cursor to data
<Ctrl + Up/Down Arrows>	Move/pan plot along y axis
<Ctrl + Left/Right Arrows>	Move/pan plot along t axis
<Ctrl+Shift + Up/Down Arrows>	Zoom plot in and out in y axis
<Ctrl+Shift + Left/Right Arrows>	Zoom plot in and out in t axis
<Ctrl + Home>	Resize plot to default settings
<Ctrl + Page Up>	Zoom out by 10%
<Ctrl + Page Down>	Zoom in by 10%
<Page Up>	Toggle to previous cursor
<Page Down>	Toggle to next cursor
<Left/Right Arrow>	Follow selected data along trace
<Up/Down Arrow>	Follow selected data along trace
<Shift + Left/Right Arrow>	Move 10 points along trace
<Shift + Up/Down Arrow>	Move 10 points along trace
<Home>	Go to first visible point on current plot
<End>	Advance to last visible point on current plot
<Shift + Up/Down Arrow>	Toggle between traces/variables

Table 1

DST LOGGER

Another data capture function incorporated in the software is the DST logger. This tool serves as a PC data logger for any variable available in the ECM through the interface software. Figure 9 shows the interface display for configuring the DST Log. The interface allows the user to create the filename, set the sample rate for acquisition, set the time interval for sampling, and display the progress of acquisition. A maximum of twenty (20) variables may be tagged for the log. The amount of data stored is only limited by available PC RAM. The resulting text file may then be viewed by any standard Windows text editor/reader program. To create a log file select the "Log Tags" in the drop down menu as shown in figure 6.

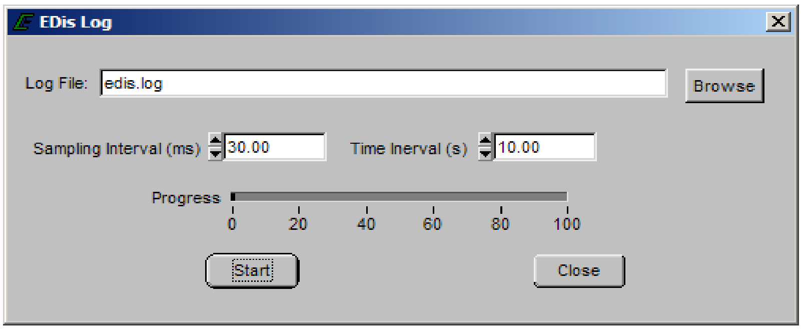
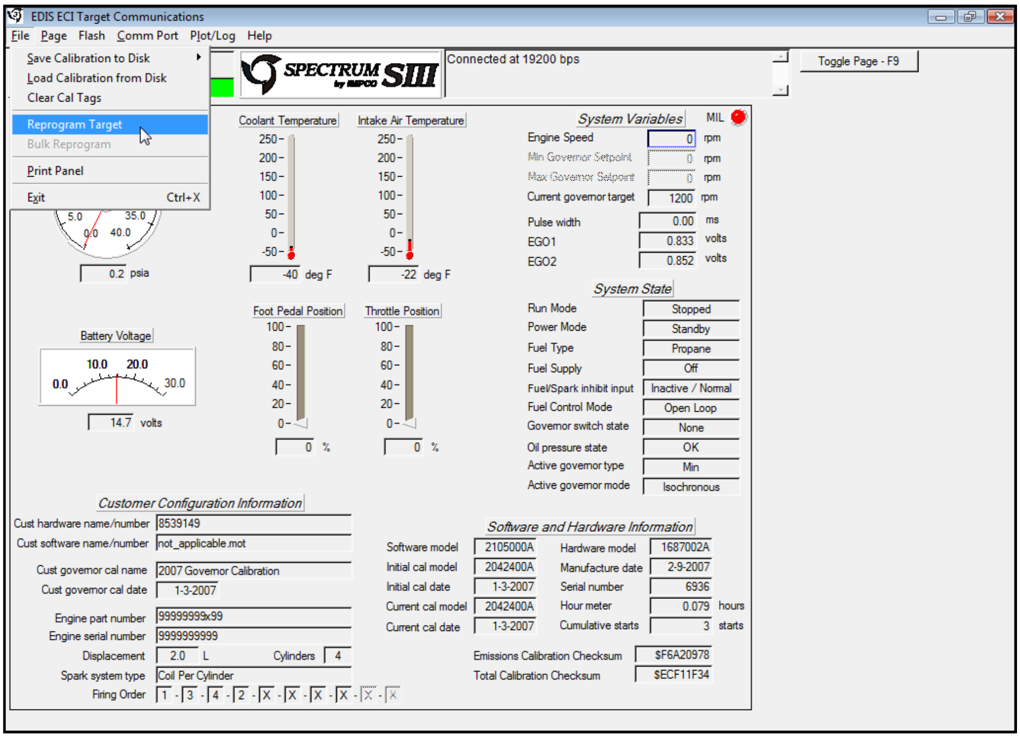


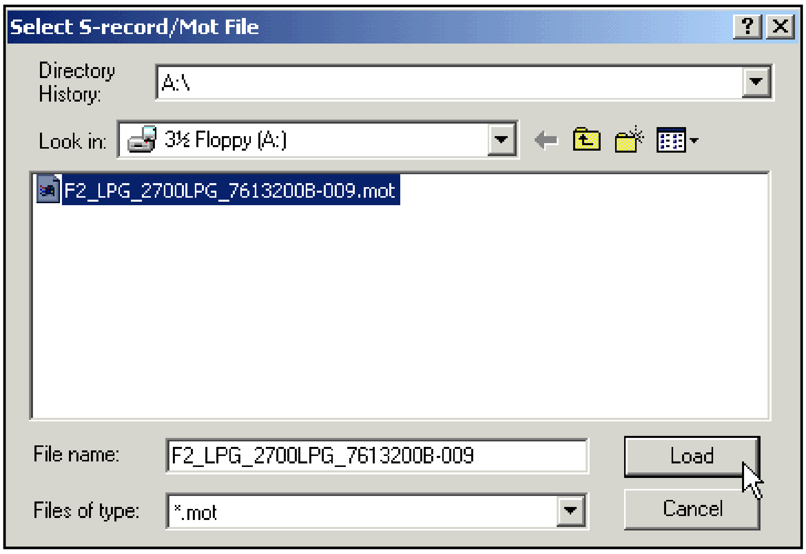
Figure 9: DST Log Interface

REPROGRAMMING THE ECM

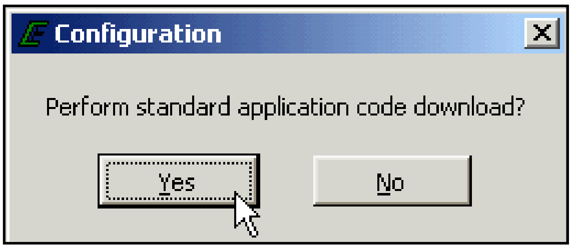
New software upgrades may become available for in field applications. ECM software upgrades are possible using the DST. Updates are released to service in MOT files (A MOT file has an extension .mot and is a binary S-record file that contains the full calibration and embedded software algorithms). The MOT file is the one file necessary to completely configure or update an existing ECM. The MOT may be supplied on a floppy disk, CD ROM or downloaded from the OEM service network. To update the ECM calibration follow the instructions listed on the next three pages.



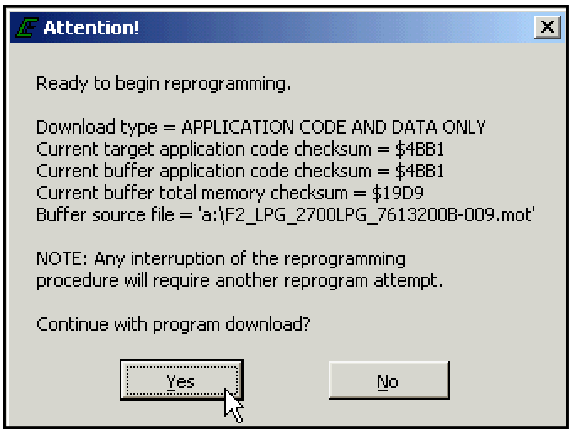
- Turn the ignition key to the ON position.
- Verify the DST is "connected" to the ECM.
- From the "File" menu select "Reprogram target."



- Navigate to the media where you have stored the MOT file. In the example above the MOT file was stored on the on the floppy (A) drive.
- Highlight the correct .mot file using the left mouse button.
- Click on "Load."



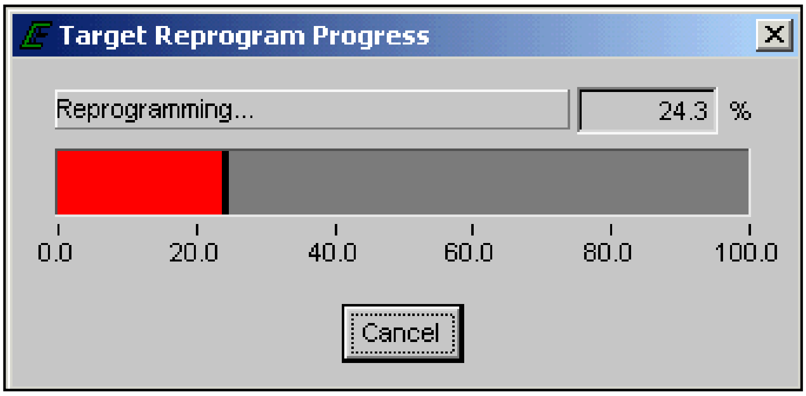
- Click “Yes” to continue.



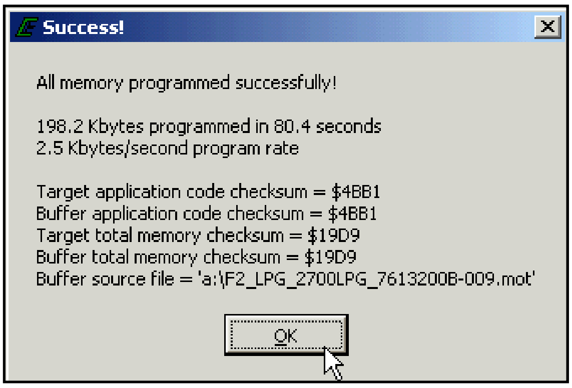
- Click the “Yes” box to continue with the update. Refrain from using other functions on the computer while the download takes place.

CAUTION

Do not disconnect the DLC, remove power or use the PC for any other function during this process. Any interruption during this reprogram process may render the ECM non-programmable in the field.



The status bar shows the update process.



Message is displayed confirming the update was successful.

MALFUNCTION INDICATOR LAMP (MIL)

The Spectrum Fuel system has built-in diagnostics for system trouble shooting. The system has a dash mounted malfunction indicator lamp (MIL) that provides indications of an emissions related problem. Most engine control system related problems that affect emissions or drivability of the vehicle will set a (DTC) diagnostic trouble code and illuminate the MIL.

The MIL serves as notification to the operator of a problem related to the emission control system so the driver can arrange for service as soon as possible. It will also display DTCs that have been stored due to a system malfunction.

The MIL should illuminate when the key is in the ON position and the engine is not running. This feature verifies that the lamp is in proper working order. If the MIL does not illuminate with the vehicle key ON/engine OFF, repair it as soon as possible. Once the engine is in start or run mode, the MIL should turn off. If the lamp remains on while the engine is in the start or run mode a diagnostic trouble code may be set.

The MIL will be turned OFF after three (3) consecutive run cycles or by clearing the active code with the Diagnostic Scan Tool (DST).

SPECTRUM DIAGNOSTIC TROUBLE CODES (DTC)

Diagnostic Trouble Codes are set when the Spectrum ECM (Engine control module) runs a diagnostic self test and the test fails. When a DTC is set, the ECM will illuminate the MIL on the instrument panel and also save the DTC in memory. The ECM will continue to run the self test. If the system continues to fail the test, the lamp will stay illuminated and the DTC is stored as an active DTC. If the self test runs and passes, the DTC will be stored as historic DTC. All DTCs are stored as historic faults until they are cleared. Most DTCs will automatically clear from memory if the DTC does not reset within 50 to 100 consecutive engine run cycles.

While a Diagnostic Trouble Code is current for a sensor, the ECM may assign a default “limp home” value and use that value in its control algorithms. All of the system diagnostic self-tests run continuously during normal vehicle operation.

The Diagnostic Trouble Codes can be read by using either the MIL lamp or a laptop computer. Diagnostic Trouble Codes can be cleared from memory with a laptop computer, or by turning the ignition key to the OFF position and removing the ECM power fuse or battery cable for at least 15 seconds.

If more than one DTC is detected, start the diagnostic repair with the lowest DTC number set. Diagnose each problem to correction unless directed to do otherwise by the diagnostic chart. The DTCs are numbered in order of importance. Both DTC 112 and DTC122 pertain to the oxygen sensor, so it is possible that a repair that corrects DTC 112 may also correct the problem causing the DTC 122.

Diagnostic test charts contained in this manual refer to the DST to be connected and in the “System Data Mode.” This simply means that the DST is connected and communicating with the PC. In some instances the chart will call out a special test mode. An example of this would be instructions for the DST to be connected and in the DBW (drive by wire) mode. Always be sure to follow the special instructions to avoid a false diagnosis of fuel system components.

DLC COMMUNICATION ERROR

The ECM 5 volt reference circuit powers the Spectrum diagnostic link cable. In the event that the 5 volt reference signal is open or shorted to ground, you will not be able to connect to the system. If you are unable to connect, follow the quick checks listed below:

Be sure you are using the correct password and latest software for the system you are connecting to.

Check the ECM system power and ground circuits. Refer to DTC 562 for the power schematic. Also check for +12 volts switched power at ECM pin 45 with the ignition key ON.

Check for power at the DLC connector for + 5 volts between pin 1 and pin 2 with the ignition key in the ON position.

You may still be able to retrieve a code using the blink code function if none of the above recommendations prove useful. In the event of a 5 volt reference signal malfunction, DTC 642 or DTC 643 should set. If you find one of these codes using the blink code function, follow the DTC diagnostic chart recommendations for that specific DTC.

BLINK CODE FUNCTION

Although the DST is considered a required tool to access the DTC codes, codes may be retrieved without a laptop computer using the blink code function. To enable this function follow the steps below:

- Jump pins A and D at the DLC connector.

- Turn the ignition key to the on position

- The system will now enter the self diagnostic blink code mode. Be ready with pen and paper to write down any codes that may be stored.

- The ECM will flash the MIL indicator with a pause between represented numbers that represent DTC codes. The sequence starts with code 1654. Code 1654 confirms the system has entered the blink code mode. The ECM will flash code 1654 (3) times before displaying the actual DTC code that may be set.

  Example:

  <u>One short blink</u> (pause) <u>six short blinks</u> (pause) <u>five short blinks</u> (pause) <u>four short blinks.</u>

- If no DTC codes are found, the ECM will continue to flash 1654 only. This means no stored DTC codes were found.

- If one of the numbers in the DTC code is zero (0), no flash will occur to represent the zero value—it will be represented as a short pause.

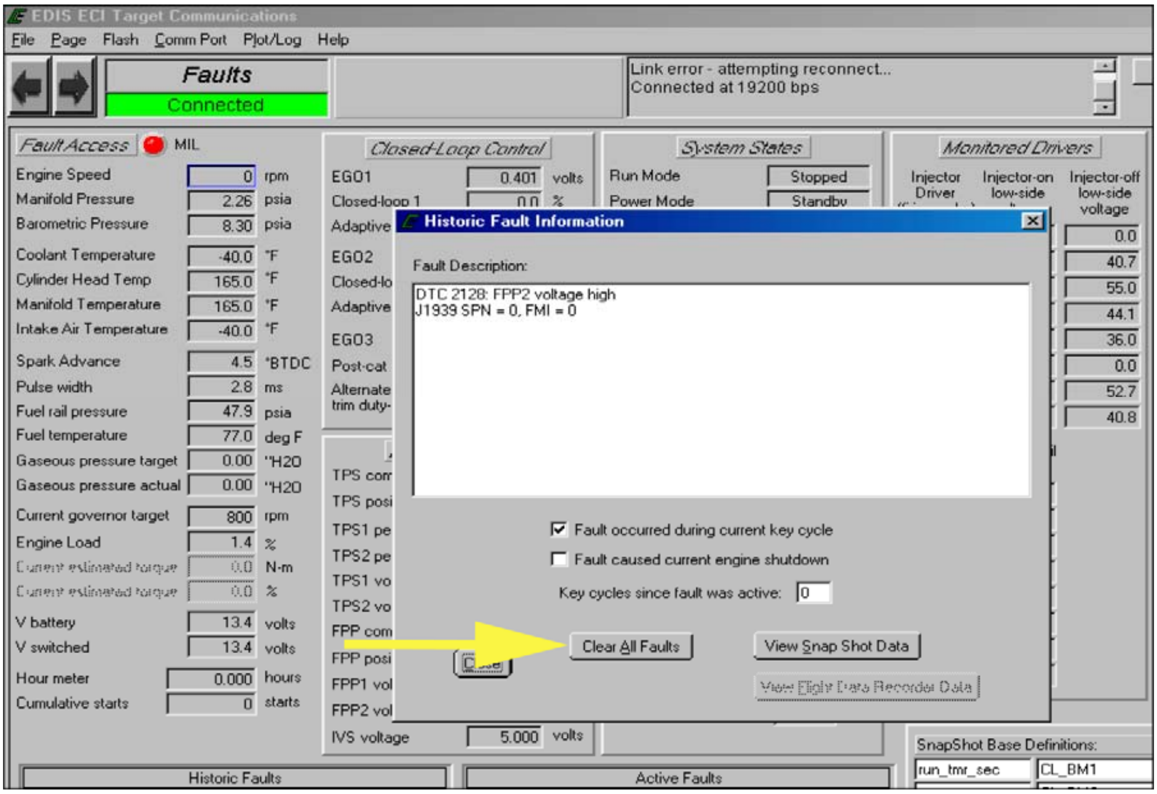


Diagram 1

When using the DST program to clear a DTC, always select the “Clear All Faults” function to immediately turn the MIL OFF after a successful repair (as shown in diagram 1 above).

INTERMITTENT PROBLEMS

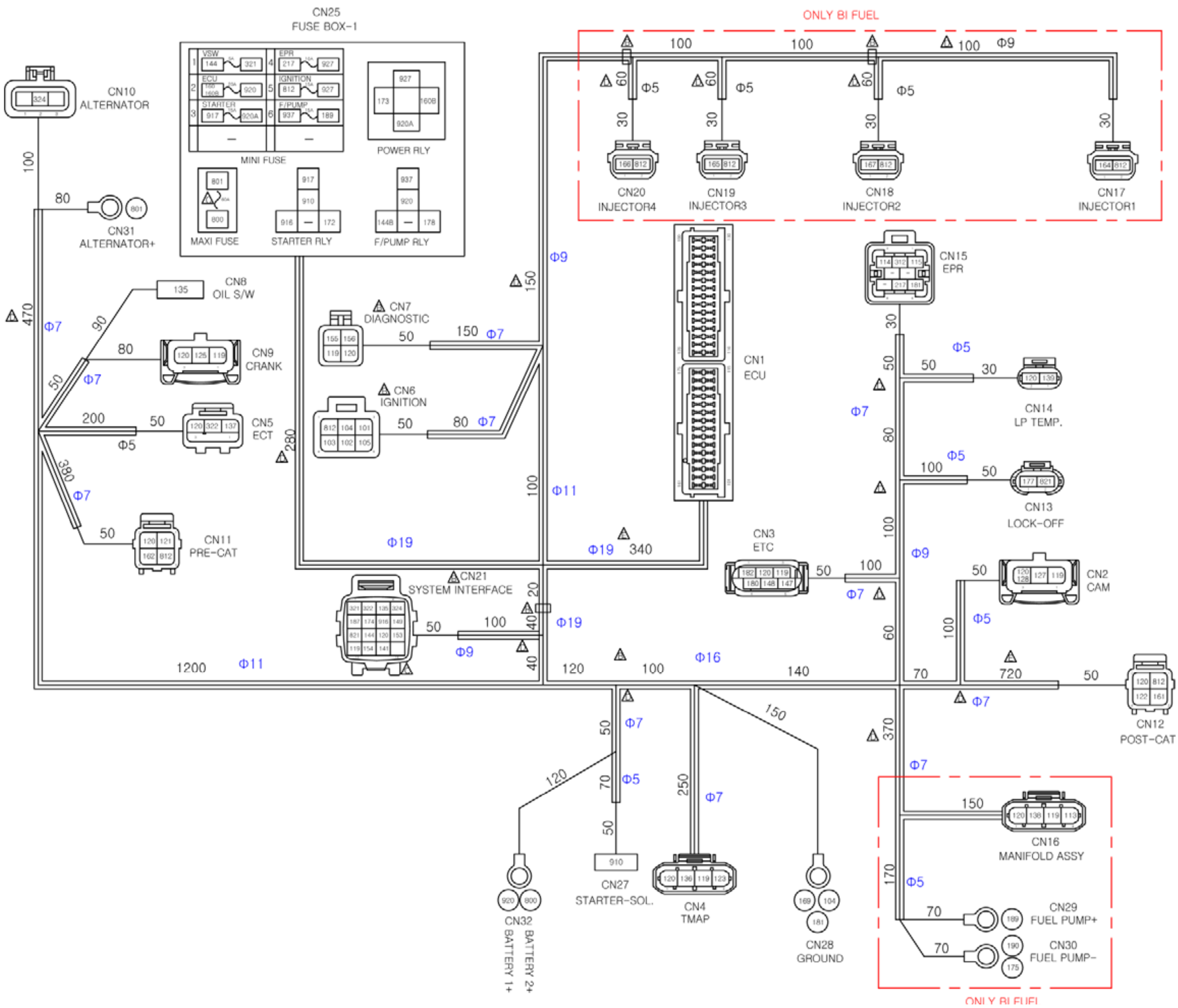
Intermittent fuel system problems can prove to be the most challenging to repair. It is most important to remember when looking to find the cause of these problems, to operate the system in the condition when and where the problem occurs. An example of this would be, if the DST showed a lean fuel mixture at full load, one of the first things to look at would be the fuel pressure. The fuel pressure would need to be monitored while the machine is operating at full load, not at idle because the leaning effect does not occur at idle. Electrical problems should be treated the same way. One excellent tool for finding intermittent electrical problems is the DST plot/log function. Set up the plot for the code that sets. An example of this would be if an intermittent IAT code set, tag the IAT voltage and watch the plot. While watching the plot, agitate the electrical wire connection at the sensor and ECM connector. The resolution of the plot screen is such that you will be able to see any unstable voltages that you would otherwise not see with a standard DVOM.

Caution should be used when pressure washing the under hood of any electrical system. Avoid direct pressure spray on the system electrical connectors. They are splash proof, but if water is sprayed directly at the connector moisture can become trapped behind the connector seal and cause serious system problems.

Extra care must be taken when probing electrical pins and terminals. Do not bend or spread these terminals as this can also be a source of intermittent problems cause by improper handling of these connectors.

Engine Wire Schematic

HHI 2007-2009 Emission Certified LPG & Bi-Fuel System 2.0L Engine



HHI 2007-2009 Emission Certified LPG & Bi-Fuel System 2.0L Engine

Connector Number (CN)	Description	Type	Manufacturer	Manufacturer Number	Remarks
1	ECM	Female 90P	FCI	900901-00	Gold Pin
2	CAM	Female 3P	AMP	85205-3	
3	Electronic Throttle Control	Female 6P	AMP	1-967616-1	
4	TMAP	Female 4P	AMP	368162-1	
5	ECT	Female 3P	KUM	KBP016-0327	
6	Ignition	Female 6P	KUM	PB625-06027	
7	Diagnostic	Female 4P	Weather Pack	12015798	Male: 12015024
8	OIL Switch	Female 1P	AMP	172320-2	Rubber Cover
9	Crank	Female 3P	AMP	85205-3	
10	Alternator	Female 3P	Sumitomo	6189-0443	
11	HEGO 1	Female 4P	AMP	174257-2	
12	HEGO 2	Male 4P	AMP	12160825	
13	Shut-Off	Female 2P	AMP	282080-1	
14	LP Temp	Female 2P	Packard	12162197	12162195
15	EPR	Female 8P	AMP	776286-1	Gold Pin
16	Manifold Assy	Female 4P	AMP	368162-1	
17	Injector 1	Female 2P	KET	MG641152	KUM- PU465-02127
18	Injector 2	Female 2P	KET	MG641152	KUM- PU465-02127
19	Injector 3	Female 2P	KET	MG641152	KUM- PU465-02127
20	Injector 4	Female 2P	KET	MG641152	KUM- PU465-02127
21	System Interf.	Female 16P	AMP	368047-1	
22	Starter Solenoid	10/20A	DECO	95225-38050	
23	Power	30A	DECO	95225-38050	ISO Micro Relay
24	Fuel Pump	10/20A	DECO	95225-38050	ISO Mini Relay
25	Fuse 1	5A	Pacific	95225-38050	ISO Micro Relay
26	Maxi-Fuse	60A	Little		Des-Fuse Box
	Fuse 2	20A	Pacific	Mini Fuse	Des-Fuse Box
	Fuse 3	15A	Pacific	Mini Fuse	Des-Fuse Box
	Fuse 4	10A	Pacific	Mini Fuse	Des-Fuse Box
	Fuse 5	15A	Pacific	Mini Fuse	Des-Fuse Box
	Fuse 6	15A	Pacific	Mini Fuse	Des-Fuse Box
27	Starter Solenoid	Femail 1P	AMP	172320-2	
28	Ground	10mm Ring			
29	Fuel Pump+	4mm Ring			
30	Fuel Pump-	5mm Ring			
31	Alternator+	8mm Ring			
32	Battery+	8mm Ring			Battery 1 & 2

Engine Wire Harness Repair

ON-VEHICLE SERVICE
WIRE HARNESS REPAIR

The ECM harness electrically connects the ECM to a various components in both the engine and passenger compartments.

Wire harnesses should be replaced with proper part number harnesses. When wires are spliced into a harness, use wire with high temperature insulation only.

Low current and voltage levels are used in the system, so it is important that the best possible bond at all wire splices be made by soldering the splices.

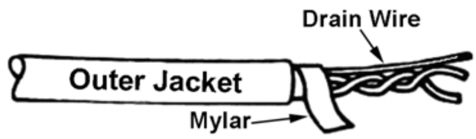
CONNECTORS AND TERMINALS

Use care when probing a connector or replacing terminals in them to prevent shorting opposite terminals and damage certain components. Always use jumper wires between connectors, for circuit checking. Do not probe through the Weather-Pack seals with oversized wire probes. Use tachometer adapter J 35812 (or equivalent) which provides an easy hook up of the tach lead. The connector test adapter kit J 35616 (or equivalent), contains an assortment of flexible connectors used to probe terminals during diagnosis. Fuse remover and test tool BT 8616, or equivalent, is used for removing a fuse and to adapt fuse holder, with a meter, for diagnosis. Do not solder oxygen sensor wire terminals as these wire ends are used for the sensors oxygen reference.

Open circuits are often difficult to locate by sight due to dirt, oxidation, or terminal misalignment. Merely wiggling a connector on a sensor, or in the wiring harness, may correct the open circuit condition. This should always be considered, when an open circuit, or failed sensor is indicated. Intermittent problems may also be caused by oxidized or loose connections.

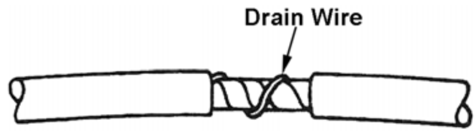
Before making a connector repair, be certain of the type of connector. Weather-Pack and Compact Three connectors look similar, but are serviced differently.

REPAIRING TWISTED/SHIELDED CABLE

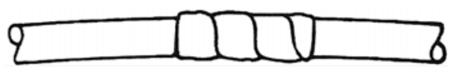


1. Remove outer jacket
2. Unwrap aluminum/Mylar tape. Do not remove Mylar.

3. Untwist conductors, strip insulation as necessary.



4. Splice wire using splice clips and rosin core solder. Wrap each splice to insulate.
5. Wrap with Mylar and drain wire (uninsulated) wire.

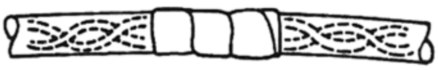


6. Tape over entire juncture and secure.

REPAIRING TWISTED LEADS

1. Locate Damaged Wire.
2. Remove insulation as required.

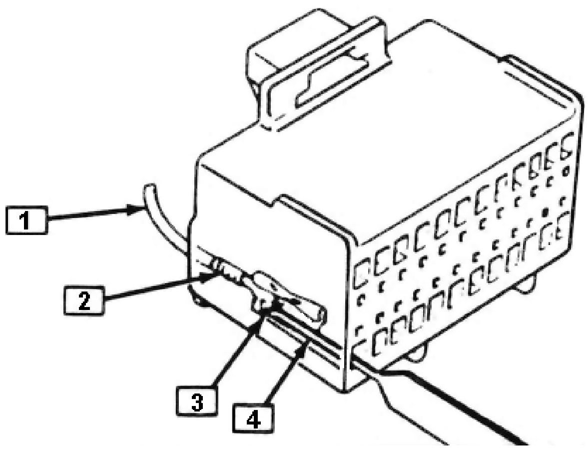
3. Splice two wires together suing splice clips and rosin core solder.



4. Cover splice with tape to insulated from other wires.
5. Retwist as before and tape with electrical tape and hold in place.

MICRO-PACK

Refer to Figure 2 and repair procedure for replacement of a Micro-Pack terminal.

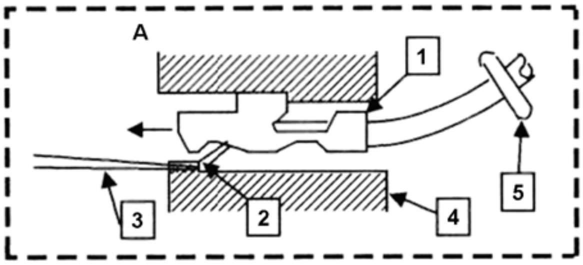


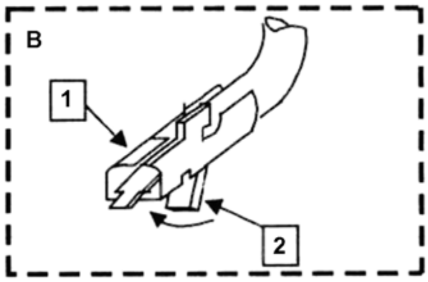
Micropack Connector

1. Cable
2. Terminal
3. Locking Tang
4. Tool J33095/BT8234-A

METRI-PACK

Some connectors use terminals called Metri-Pack Series 150. They are also called “Pull-To-Seat” terminals because of the method of installation. The wire is inserted through the seal and connector, the terminal is crimped on the wire and then pulled back into the connector to seat it in place.





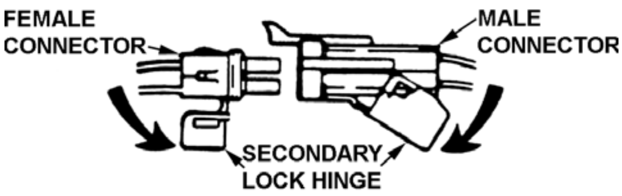
Metri-Pack Series 150 Terminal Removal

1. Slide the seal back on the wire.
2. Insert tool BT-8518, or J 35689, or equivalent, as shown in insert “A” and “B” to release the terminal locking tab (2).
3. Push the wire and terminal out through the connector. If reusing the terminal, reshape the locking tab (2).

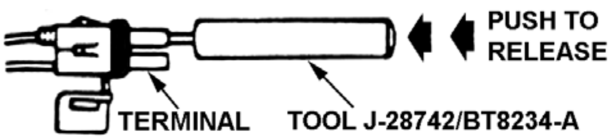
WEATHER-PACK

A Weather-Pack connector can be identified by a rubber seal, at the rear of the connector. The connector is used in the engine compartment to protect against moisture and dirt that may oxidize and/or corrode the terminals. Given the low voltage and current levels found in the electronic system, this protection is necessary to ensure a good connection.

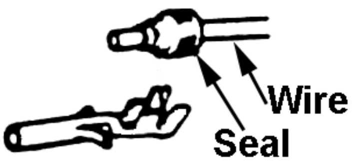
WEATHER-PACK TERMINAL REPAIR



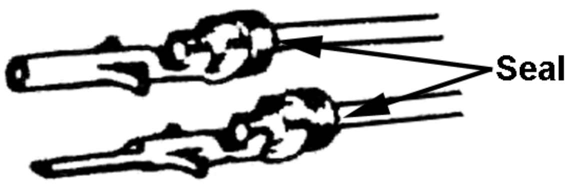
1. Open secondary lock hinge on connector.



2. Remove terminal using tool.



3. Cut wire immediately behind cable seal



4. Replace terminal.
   a. Slip new seal onto wire
   b. Strip 5 mm (.2”) of insulation from wire.
   c. Crimp terminal over wire and seal.
5. Push terminal and connector and engage locking tangs.
6. Close secondary lock hinge.

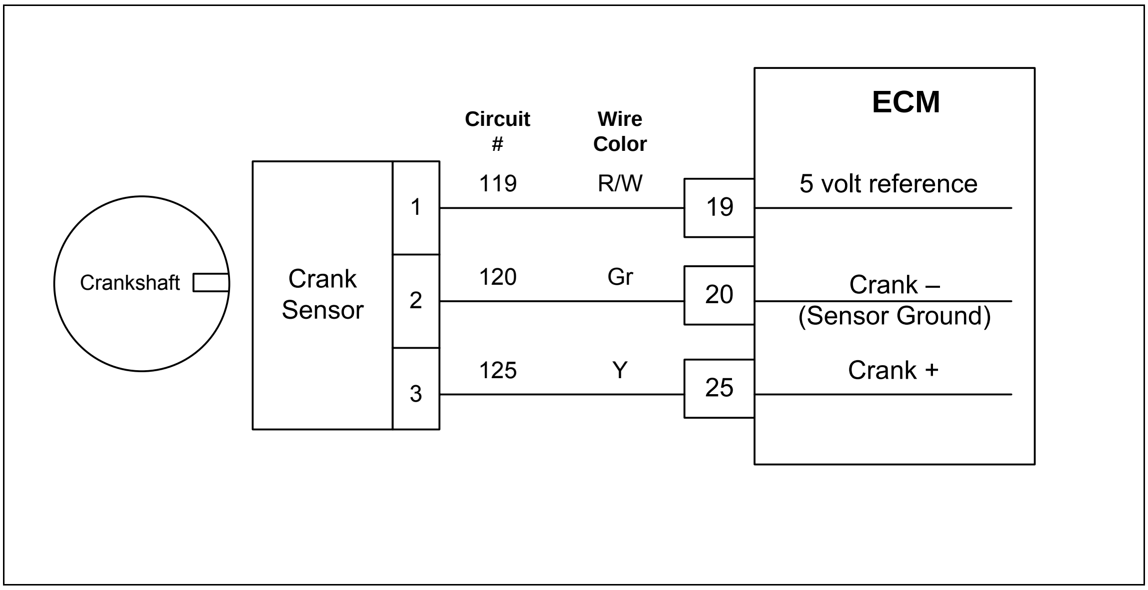
Use tool J M28742, or BT8234-A or equivalent to remove the pin and sleeve terminals. If the removal is attempted with an ordinary pick, there is a good chance that the terminal will be bent, or deformed. Unlike standard blade type terminals, these terminals cannot be straightened once they are bent.

Verify that the connectors are properly seated and all of the sealing rings in place, when connecting leads. The hinge type flap provides a backup, or secondary locking feature for the connector. They are used to improve the connector reliability by retaining the terminals, if the small terminal lock tabs are not positioned properly.

Weather-Pack connections cannot be replaced with standard connections. Additional instructions are provided with Weather-Pack connector and terminal packages.

Diagnostic Trouble Codes (DTCs)

DTC 16-Never Crank Synced at Start



Conditions for setting the DTC

- Crankshaft Position sensor
- Check Condition-Engine cranking
- Fault Condition-Cranking rpm above 90 and more than 4 cranking revolutions without synchronization
- MIL Command-ON

Circuit Description

The Crankshaft position sensor is a 5 volt powered sensor mounted in the engine block. A pulse wheel located on the crankshaft is used to measure engine rpm and its signal is used to synchronize the ignition and fuel systems. This fault will set

Diagnostic Aid

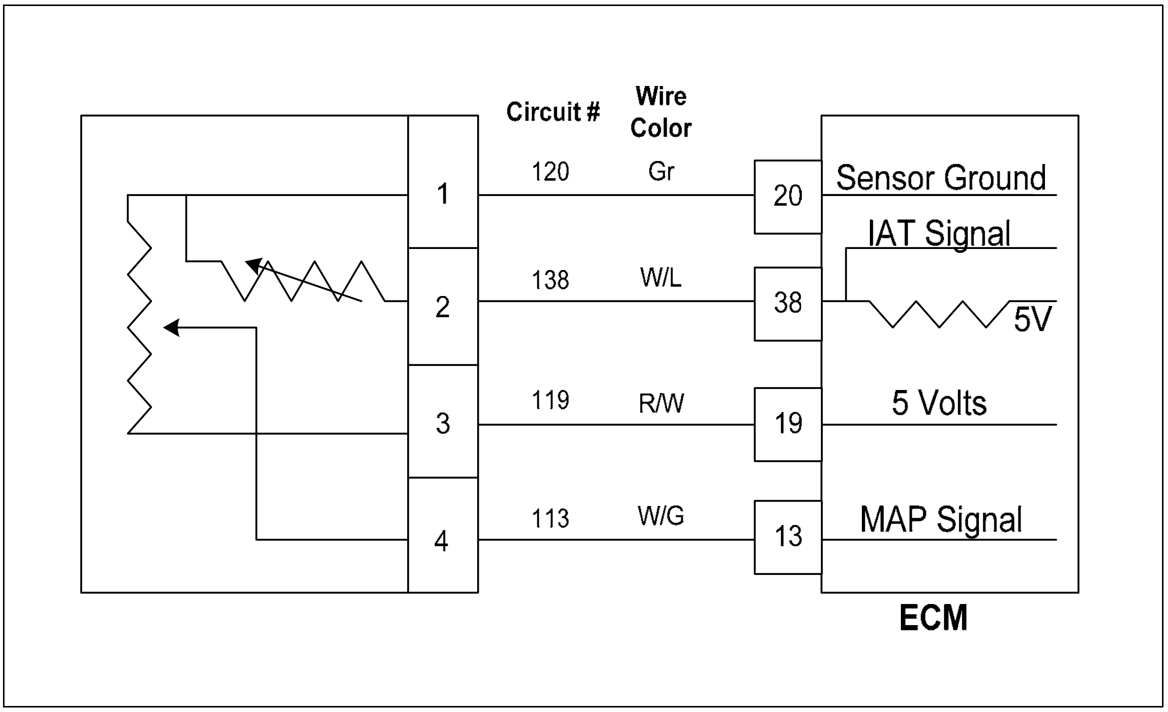
Reversed sensor wires, poor wire connections or faulty system ground are most frequently the cause of this code set.

DTC 16-Never Crank Synced at Start

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?		Go to Step (2)	Go to OBD System Check Section
2	• Check that the ECM ground terminal CN28 is clean, tight and in the proper location. Are the ground terminals clean and tight?		Go to Step (3)	Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.
3	• Key On, Engine OFF • Disconnect the CKP (Crankshaft position) Sensor connector CN9 • Using A DVOM check for voltage at the CKP sensor connector circuit 119 and engine ground Do you have voltage?	5.0 volts	Go to Step (4)	Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.
4	• Key OFF • Disconnect ECM connector CN1 • Using a DVOM check for continuity on the crank signal circuit 125 between CKP connector CN9 and ECM connector CN1 Do you have continuity between them?		Go to Step (5)	Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.
5	• Using a DVOM check for continuity on the sensor ground circuit 120 between CKP connector and ECM connector. Do you have continuity between them?		Go to Step (6)	Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.
6	• Inspect the CKP connector CN9 terminals for damage, corrosion or contamination. Did you find a problem?		Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to Step (7)
7	• Inspect the ECM connector CN1 terminals for damage, corrosion or contamination. Did you find a problem?		Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to Step (8)

Step	Action	Value(s)	Yes	No
8	• Replace CKP sensor Is the replacement complete?		Go to Step (10)	-
9	• Replace ECM Is the replacement complete?		Go to Step (11)	-
10	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-16 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to Step (9)
11	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-16 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 92-FRP High Voltage (Bi-fuel/Gasoline Only)



Conditions for Setting the DTC

- Fuel pressure check
- Check condition-engine running
- Fault Condition-FP voltage greater than 4.80 volts
- MIL-On
- Adaptive-disabled

Circuit Description

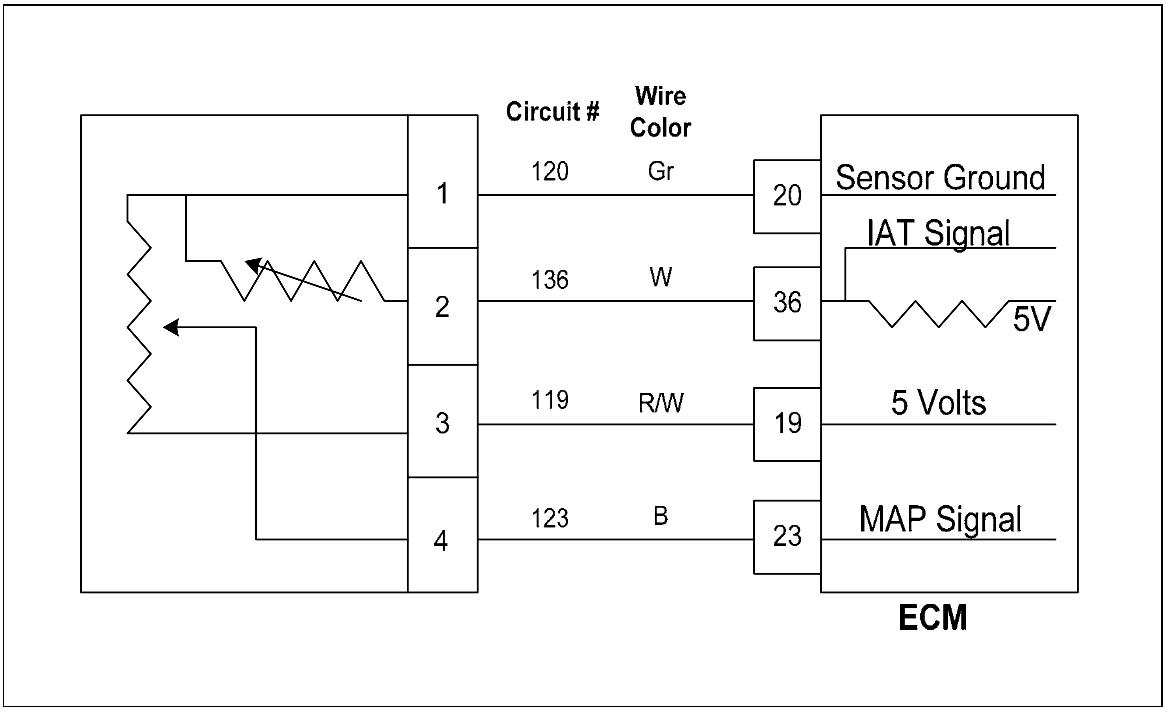
The FRP (fuel rail pressure) sensor is a combined temperature and pressure sensor located in the gasoline delivery system that provides accurate gasoline supply information to the ECM. It is used to measure the temperature and pressure of the supplied fuel. This reading is used in conjunction with other inputs to insure the proper amount of fuel is delivered to the engine for the operating conditions. This fault will set if the gasoline pressure sensor voltage exceeds 4.80 volts. The adaptive Learn will be disabled and the MIL command is on.

DTC 92-FRP High Voltage (Bi-fuel/Gasoline Only)

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?		Go to Step (2)	Go to OBD System Check Section
2	• Key ON • DST (Diagnostic Scan Tool) open in System Data Mode Does DST display FRP (Fuel Pressure) voltage greater than 4.80 volts?	Greater than 4.80 volts	Go to Step (3)	Intermittent problem Go to Intermittent section
3	• Key OFF • Disconnect the FRP sensor connector CN16 and jump circuits 120 and 113 • Key ON Does the DST display FRT voltage less than 0.10 volts?	Less than 0.10 volts	Go to Step (4)	Go to Step (6)
4	• Check wire harness and FRP sensor connector for damage corrosion or contamination Any problems found?		Repair the circuit as necessary. See wire harness repair section.	Go to Step (5)
5	• Replace FRP sensor. Is the replacement complete?		Go to Step (11)	
6	• Key OFF • Jump FRP sensor connector CN16 signal circuit 113 to engine ground • Key ON Does the DST display FRP voltage less than 0.10 volts?	Less than 0.10 volts	Go to Step (8)	Go to Step (7)
7	• Key OFF • Disconnect the ECM wire harness connector CN1 • Check for continuity on FRP signal circuit 113 between FRP sensor connector CN16 and ECM connector CN1 Do you have continuity between them?		Go to Step (9)	Repair the circuit as necessary. See wire harness repair section

Step	Action	Value(s)	Yes	No
8	• Key OFF • Disconnect the ECM wire harness connector CN1 • Check for continuity on the sensor ground circuit 120 between FRP sensor connector CN16 and ECM connector CN1 Do you have continuity between them?		Go to Step (9)	Repair the circuit as necessary. See wire harness repair section.
9	• Re-check wire harness and FRP sensor connector for damage corrosion or contamination. Any problems found?		Repair the circuit as necessary. See wire harness repair section.	Go to Step (10)
10	• Replace the ECM. Is the replacement complete?		Go to Step (11)	
11	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature. • Observe the MIL. • Observe engine performance and driveability. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 107-TMAP Low Voltage



Conditions for Setting the DTC

- Manifold Absolute Pressure Sensor
- Check Condition-Engine cranking or running
- Fault Condition-MAP voltage less than 0.050 with throttle position greater than 5.0% and engine RPM less than 4000
- MIL-ON
- Adaptive-Disabled

Circuit Description

The Manifold Absolute Pressure sensor is a pressure transducer connected to the intake manifold. It is used to measure the pressure of air in the intake manifold. This reading is used in conjunction with other inputs to estimate the airflow rate to the engine, which determines the fuel flow rate. This fault will set if the MAP voltage is less than 0.050 with TPS greater than 5.0% and engine RPM less than 4000. The adaptive Learn is disabled during this fault and the MIL command is on.

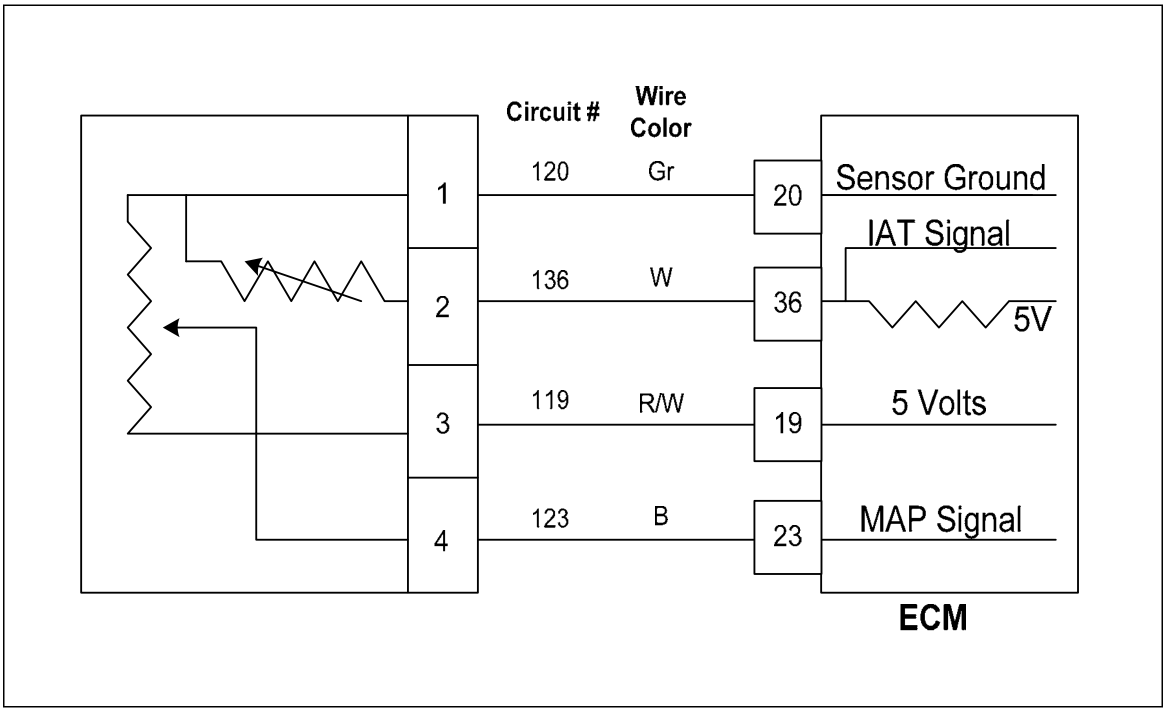
DTC 107-MAP Low Voltage

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?	-	Go to Step (2)	Go to OBD System Check Section
2	• Key On, Engine running. • DSC (Diagnostic Scan Tool) connected in System Data Mode Does DST display MAP voltage of 0.050 or less with the engine running with TPS above 5.0%?		Go to Step (3)	Intermittent problem Go to Intermittent section
3	• Key OFF • Disconnect the MAP sensor connector CN4 • Jump the 5 volt reference circuit 119 and MAP signal circuit 123 together • Key ON Does the DST display MAP voltage of 4.50 volts or greater?		Go to Step (4)	Go to Step (8)
4	• Inspect MAP connector and pins for corrosion, contamination or mechanical damage Any problems found?		Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to Step (5)
5	• Key OFF • Disconnect ECM connector CN1 • Check for continuity on MAP signal circuit 123 between MAP sensor connector CN4 and ECM connector CN1. Do you have continuity between them?		Go to Step (6)	Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.
6	• Check for continuity on 5 volts supply circuit 119 between MAP sensor connector CN4 and ECM connector CN1. Do you have continuity between them?		Go to Step (7)	Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.

Step	Action	Value(s)	Yes	No
7	• Check for continuity on MAP sensor ground circuit 120 between MAP sensor connector CN4 and ECM connector CN1 Do you have continuity between them?		Go to Step (17)	Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.
8	• Probe MAP signal circuit 119 on MAP connector CN4 with a test light connected to battery voltage Does the DST display MAP voltage of 4.0 or greater?		Go to Step (9)	Go to Step (13)
9	• Key OFF • Disconnect ECM connector • Check for continuity on 5 volts supply circuit 119 between MAP sensor connector CN4 and ECM connector CN1 Do you have continuity between them?		Go to Step (10)	Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.
10	• Check for continuity between MAP sensor connector CN4 5 volt reference circuit 119 and engine ground Do you have continuity?		Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to Step (11)
11	• Inspect ECM and MAP wire harness connector and terminals for corrosion, contamination or mechanical damage Any problems found?		Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to Step (16)
12	• Replace ECM. Refer to ECM replacement in the Engine Controls Section. Is the replacement complete?		Go to Step (17)	-
13	• Disconnect ECM connector • Check for continuity on the MAP signal circuit 123 between MAP sensor connector CN4 and ECM connector CN1 Do you have continuity between them?		Go to Step (14)	Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.

Step	Action	Value(s)	Yes	No
14	• Check for continuity between MAP sensor connector CN4 signal circuit 123 and engine ground Do you have continuity?		Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to Step (15)
15	• Inspect ECM connector and wire harness connector terminals for corrosion, contamination or mechanical damage Any problems found?		Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to Step (16)
16	• Replace ECM. Refer to ECM replacement in the Engine Controls Section. Is the replacement complete?		Go to Step (18)	-
17	• Replace MAP sensor Is the replacement complete?		Go to Step (18)	-
18	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-107 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 108-MAP High Pressure



Conditions for Setting the DTC

- MAP pressure check
- Check condition-engine running
- Fault Condition-MAP greater than 16.00 psia with TPS less than 3.0% and RPM greater than 1000
- MIL-On
- Adaptive-disabled

Circuit Description

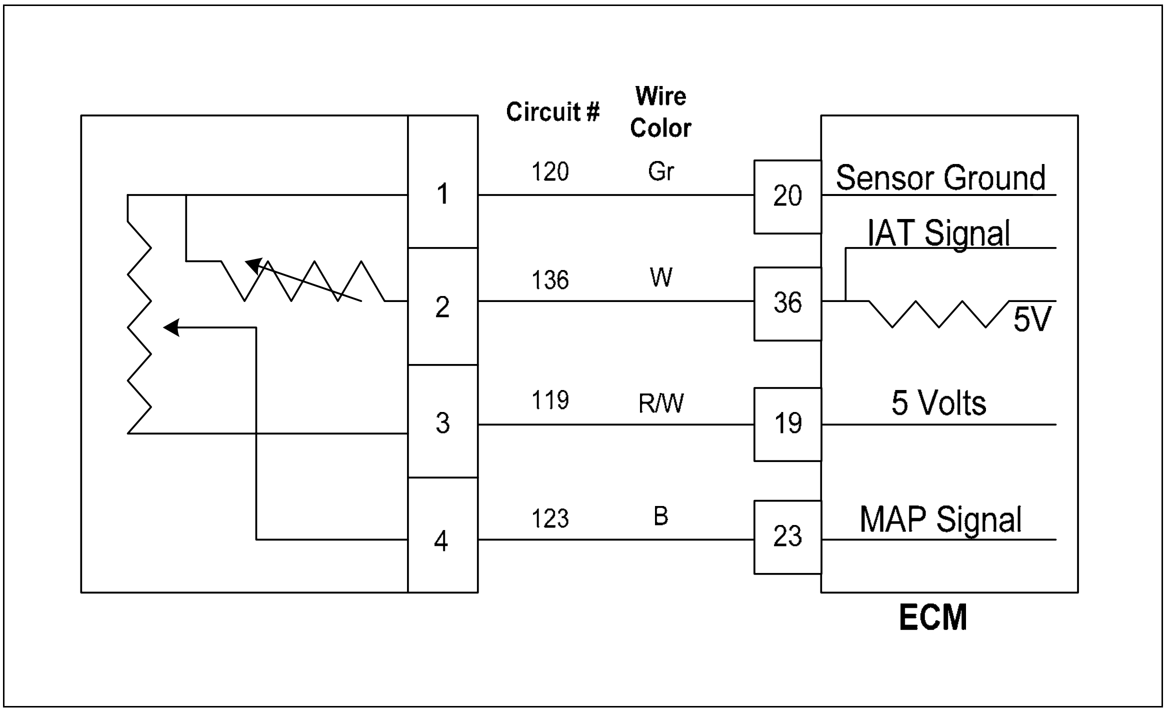
The Manifold Absolute Pressure sensor is a pressure transducer connected to the intake manifold. It is used to measure the pressure of air in the intake manifold. This reading is used in conjunction with other inputs to estimate the airflow rate to the engine, which determines the fuel flow rate. This fault will set if the MAP pressure is greater than 16.00 psia with TPS greater than 3.0% and engine rpm greater than 1000. The adaptive Learn will be disabled and the MIL command is on.

DTC 108-MAP High Pressure

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?	-	Go to Step (2)	Go to OBD System Check Section
2	• Key On, Engine running at full operating temperature. • DST (Diagnostic Scan Tool) connected in the System Data Mode Does DST display MAP pressure of 16.00 psia or greater with the engine running above 1000 RPM and a TPS value less than 3.0%?		Go to Step (3)	Intermittent problem Go to Intermittent section
3	• Key OFF • Disconnect the MAP sensor connector CN4 • Key ON Does the DST display MAP pressure less than 0.05 psia?		Go to Step (4)	Go to Step (6)
4	• Probe MAP connector CN4 ground circuit 120 with a test light connected to battery voltage. Does the test light come on?		Go to Step (5)	Go to Step (8)
5	• Check MAP mechanical vacuum connection for correct mounting or possible damage causing vacuum leakage. Is the MAP sensor mechanical connection OK?		Go to Step (6)	Go to Step (10)
6	• Key OFF • Disconnect ECM connector CN1 and inspect terminals for damage corrosion or contamination. Is the connection OK?		Go to Step (7)	Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.
7	• Replace MAP sensor Is the repair complete?		Go to Step (11)	

Step	Action	Value(s)	Yes	No
8	• Disconnect ECM connector C001 • Check for continuity on sensor ground circuit 120 between MAP sensor connector CN4 and ECM connector CN1 Do you have continuity between them?		Go to Step (9)	Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.
9	• Replace ECM. Refer to ECM replacement in the Engine Controls Section. Is the replacement complete?		Go to Step (11)	-
10	• Correct MAP mechanical connection Has the MAP mechanical connection problem been corrected?		Go to Step (11)	-
11	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-108 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 111-IAT Higher Than Expected 1



Conditions for Setting the DTC

- Intake Air Temperature
- Check Condition-Engine Running
- Fault Condition-Intake Air Temperature greater than 200 degrees F. with engine rpm greater than 1000
- MIL-On
- Adaptive-Disabled during active fault
- Power derate level 1

Circuit Description

The TMAP is a combined IAT (Intake Air Temperature) and MAP (Manifold Absolute Pressure) sensor. A temperature sensitive resistor is used in the TMAP located in the intake manifold of the engine. It is used to monitor incoming air temperature, and the output in conjunction with other sensors is used to determine the airflow to the engine. The ECM provides a voltage divider circuit so that when the air is cool, the signal reads higher voltage, and lower when warm. This fault will set if the Intake Air Temperature is greater than 200 degrees F. with engine speed greater than 1000 rpm. Power derate level one will be in force and effect limiting maximum power output.

Diagnostic Aid

This fault will set when inlet air is much hotter than normal. The most common cause of high inlet air temperature is a problem with the inlet air system. Ensure that the air inlet is not obstructed, modified or damaged. Inspect the air inlet system for cracks or breaks that may allow unwanted under hood air in to the air inlet system.

DTC 111-IAT Higher Than Expected 1

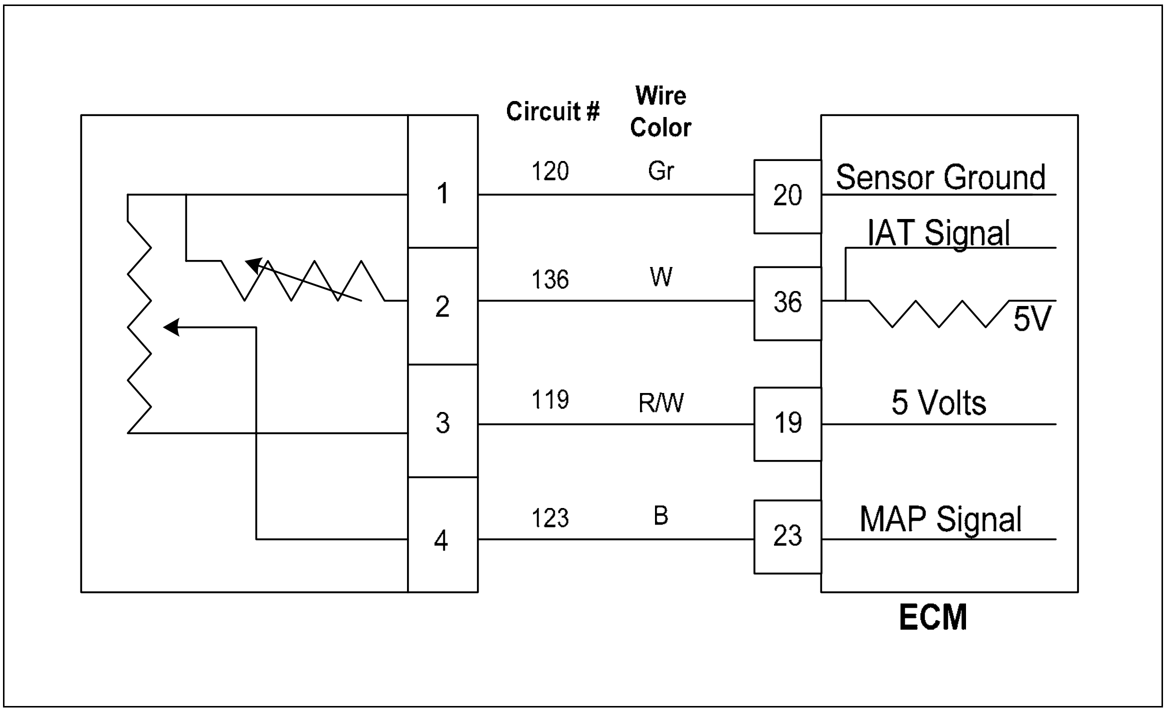
Diagnostic Aid

- This fault will set when inlet air is much hotter than normal. The most common cause of high inlet air temperature is a problem with the inlet air system. Ensure that the air inlet is not obstructed, modified or damaged.

- Inspect the air inlet system for cracks or breaks that may allow unwanted under hood air in to the air inlet system

- If none of the above can be found, follow the diagnostic steps for **DTC 112-IAT Low Voltage**

DTC 112-IAT Low Voltage



Conditions for Setting the DTC

- Intake Air Temperature
- Check Condition Engine Cranking or Running
- Fault Condition-IAT Sensor Voltage less than 0.050
- MIL-On during active fault
- Adaptive-Disabled during active fault

Circuit Description

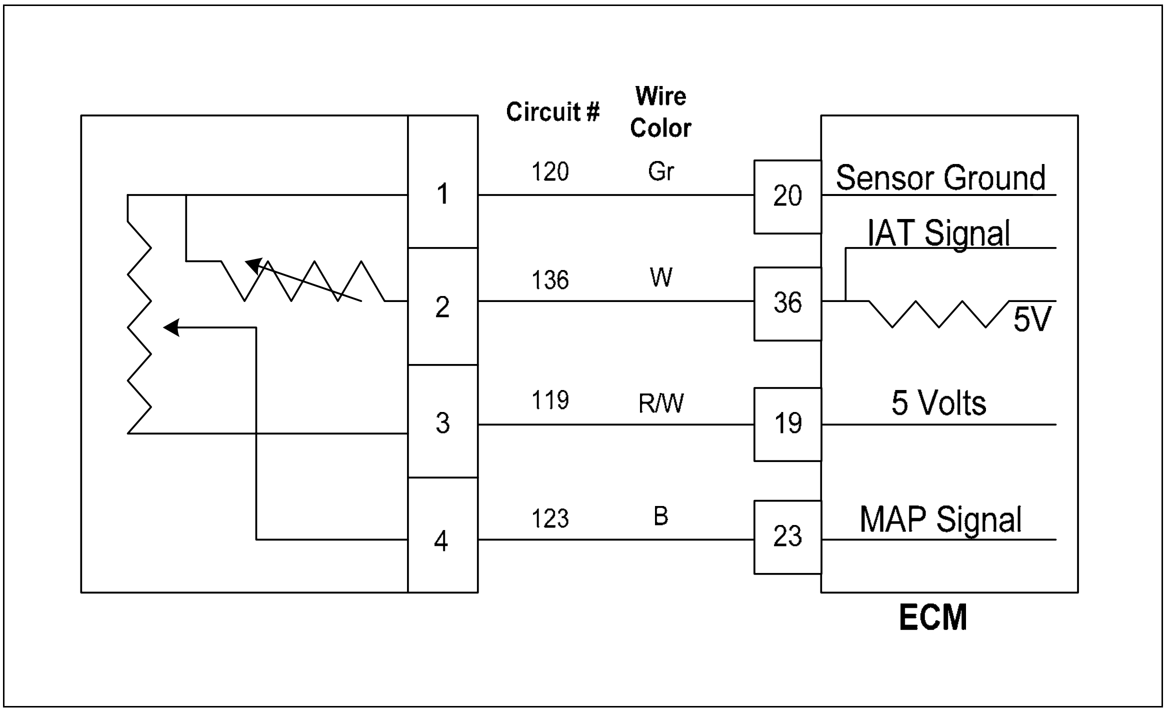
The TMAP is a combined IAT (Intake Air Temperature) and MAP (Manifold Absolute Pressure) sensor. A temperature sensitive resistor is used in the TMAP located in the intake manifold of the engine. It is used to monitor incoming air temperature, and the output in conjunction with other sensors is used to determine the airflow to the engine. The ECM provides a voltage divider circuit so that when the air is cool the signal reads higher voltage, and lower when warm. This fault will set if the signal voltage is less than 0.050 volts for 1 second anytime the engine is cranking or running. The ECM will use the default value for the IAT sensor in the event of this fault.

DTC 112-IAT Voltage Low

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?		Go to Step (2)	Go to OBD System Check Section
2	• Key On • DST (Diagnostic Scan Tool) connected in System Data Mode Does DST display IAT voltage of 0.050 or less?		Go to Step (3)	Intermittent problem Go to Intermittent section
3	• Key Off • Disconnect the TMAP sensor connector CN4 • Key ON Does the DST display IAT voltage of 4.90 volts or greater?		Go to Step (4)	Go to Step (5)
4	• Replace TMAP sensor. Is the replacement complete?		Go to Step (9)	
5	• Key OFF • Disconnect ECM wire harness connector CN1 • Check for continuity between TMAP sensor connector CN4 circuit 120 and TMAP sensor connector CN4 IAT circuit 136 Do you have continuity between them?		Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to Step (6)
6	• Check for continuity between TMAP sensor connector CN4 IAT circuit 136 and engine ground. Do you have continuity?		Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to Step (7)

Step	Action	Value(s)	Yes	No
7	• Replace ECM. Refer to ECM replacement in the Engine Controls Section. Is the replacement complete?		Go to Step (8)	
8	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-112 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 113-IAT Voltage High



Conditions for Setting the DTC

- Intake Air Temperature
- Check Condition-Engine Running
- Fault Condition-IAT Sensor Voltage greater than 4.95 volts
- Adaptive-Disabled during active fault

Circuit Description

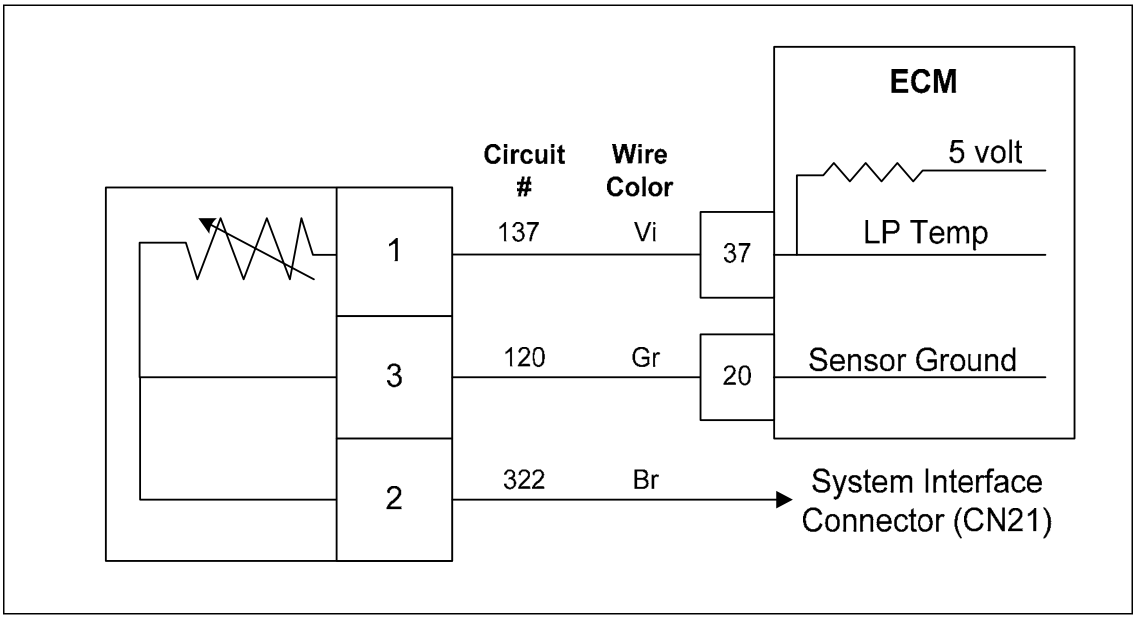
The TMAP is a combined IAT (Intake Air Temperature) and MAP (Manifold Absolute Pressure) sensor. A temperature sensitive resistor is used in the TMAP located in the intake manifold of the engine. It is used to monitor incoming air temperature, and the output in conjunction with other sensors is used to determine the airflow to the engine. The ECM provides a voltage divider circuit so that when the air is cool, the signal reads higher voltage, and lower when warm. This fault will set if the signal voltage is greater than 4.950 volts anytime the engine is running. The ECM will use a default value for the IAT sensor in the event of this fault.

DTC 113-IAT Voltage High

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?	-	Go to Step (2)	Go to OBD System Check Section
2	• Key On • DST (Diagnostic Scan Tool) connected in System Data Mode Does DST display IAT voltage of 4.950 or greater?		Go to Step (3)	Intermittent problem Go to Intermittent section
3	• Key Off • Disconnect the TMAP sensor connector CN4 and jump pins 1 and 2 together • Key On Does the DST display IAT voltage of 0.10 volts or less?	0.10 volts or less	Go to Step (9)	Go to Step (4)
4	• Key OFF • Jump TMAP sensor connector CN4 signal circuit 136 to engine ground • Key ON Does DST display IAT voltage of 0.10 volts or less?	0.10 volts or less	Go to Step (7)	Go to Step (6)
5	• Replace TMAP sensor. Is the replacement complete?		Go to Step (11)	
6	• Key OFF • Disconnect the ECM wire harness connector C001. • Check for continuity between TMAP sensor connector CN4 signal circuit 136 and ECM connector CN1 IAT circuit 136. Do you have continuity between them?		Go to Step (10)	Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.
7	• Check for continuity between TMAP sensor connector CN4 ground circuit 120 and ECM connector CN1 ground circuit 120 Do you have continuity between them?		Go to Step (10)	Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.

Step	Action	Value(s)	Yes	No
8	• Replace the ECM. Is the replacement complete?		Go to Step (11)	
9	• Re-check wire harness and TMAP sensor connector for damage corrosion or contamination Any problems found?		Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical	Go to Step (5)
10	• Re-check wire harness and TMAP sensor connectors for damage corrosion or contamination Any problems found?		Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical	Go to Step (8)
11	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-113 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 116-ECT/CHT Higher Than Expected 1



Conditions for Setting the DTC

- Engine Coolant Temperature
- Check Condition-Engine Running
- Fault Condition-ECT greater than 230 F
- MIL-On during active fault
- Power derate 1 in effect

Circuit Description

The ECT (Engine Coolant Temperature) sensor is a temperature sensitive resistor located in the engine coolant passage. It is used for the engine airflow calculation, gasoline cold enrichment and to enable other temperature dependant features. The ECM provides a voltage divider circuit so that when the coolant is cool, the signal reads higher voltage, and lower when warm. This fault will set if the coolant temperature reading exceeds 230 degrees F and engine RPM is greater than 500 for 30 seconds. Power derate level 1 will go into effect in an attempt to bring the temperature down.

ECT Sensor Resistance Scaling	
Temp(deg F)	Ohms ±10%
248.0	116
230.0	147
212.0	188
200.0	220
185.0	275
176.0	322
160.0	420
140.0	587
120.0	825
104.0	1,148
85.0	1,700
68.0	2,450
45.0	4,100
32.0	5,790
-4.0	15,480
-40.0	48,140

DTC 116-ECT/CHT Higher Than Expected 1

Diagnostic Aid

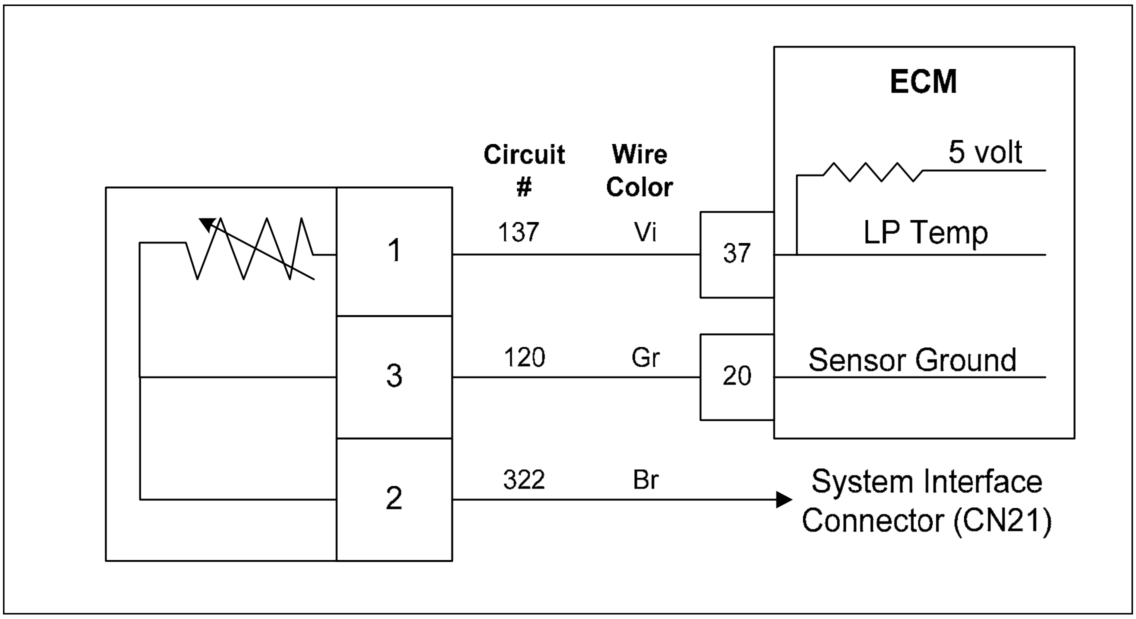
- Thoroughly inspect the entire cooling system and for any signs of coolant leakage including: coolant lines and hoses, water pump, engine block, radiator, etc.

- Insure the radiator cap is in good repair and maintaining suitable cooling system pressure.

- Compare the ECM measured temperature value with an analog temperature measurement (IR temperature measurement, thermometer, etc.) if possible.

- If no problems are found continue with DTC 117 ECT low voltage diagnostic

DTC 117-ECT/CHT-Low Voltage



Conditions for Setting the DTC

- Engine Coolant Temperature
- Check Condition-Engine Running
- Fault Condition-ECT sensor voltage less than 0.10
- MIL-On during active fault
- Adaptive-Disabled during active fault

Circuit Description

The ECT (Engine Coolant Temperature) sensor is a temperature sensitive resistor located in the engine coolant passage. It is used for the engine airflow calculation, gasoline cold enrichment and to enable other temperature dependant features. The ECM provides a voltage divider circuit so that when the coolant is cool, the signal reads higher voltage, and lower when warm. This fault will set if the signal voltage is less than 0.10 volts anytime the engine is running. The ECM will use a default value for the ECT sensor in the event of this fault.

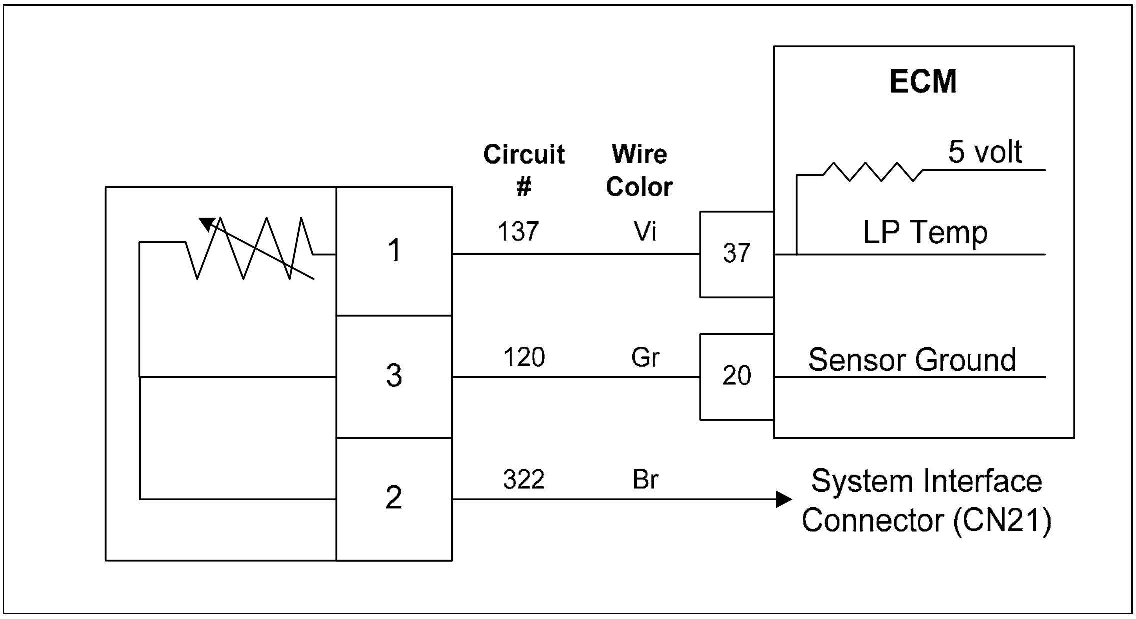
ECT Sensor Resistance Scaling	
Temp(deg F)	Ohms ±10%
248.0	116
230.0	147
212.0	188
200.0	220
185.0	275
176.0	322
160.0	420
140.0	587
120.0	825
104.0	1,148
85.0	1,700
68.0	2,450
45.0	4,100
32.0	5,790
-4.0	15,480
-40.0	48,140

DTC 117-ECT/CHT Low Voltage

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?		Go to Step (2)	Go to OBD System Check Section
2	• Key On • DST (Diagnostic Scan Tool) connected in System Data Mode Does DST display ECT voltage of 0.10 or less?		Go to Step (3)	Intermittent problem Go to Intermittent section
3	• Key Off • Disconnect the ECT wire harness connector CN5 • Key ON Does the DST display ECT voltage of 4.90 volts or greater?		Go to Step (4)	Go to Step (5)
4	Replace ECT sensor. Is the replacement complete?		Go to Step (8)	
5	• Key OFF • Disconnect ECM wire harness connector CN1 • Check for continuity between ECT sensor connector CN5 signal circuit 137 and sensor ground circuit 120 Do you have continuity between them?		Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to Step (6)
6	• Check for continuity between ECT sensor connector CN5 signal circuit 137 and engine ground. Do you have continuity?		Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to Step (7)

Step	Action	Value(s)	Yes	No
7	• Replace ECM. Refer to ECM replacement in the Engine Controls Section. Is the replacement complete?		Go to Step (8)	
8	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-117 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 118-ECT/CHT High Voltage



Conditions for Setting the DTC

- Engine Coolant Temperature
- Check Condition-Engine Running
- Fault Condition-ECT sensor voltage exceeds 4.90 volts
- MIL-On during active fault
- Adaptive-Disabled

Circuit Description

The ECT (Engine Coolant Temperature) sensor is a temperature sensitive resistor located in the engine coolant passage. It is used for the engine airflow calculation, gasoline cold enrichment and to enable other temperature dependant features. The ECM provides a voltage divider circuit so that when the coolant is cool, the signal reads higher voltage, and lower when warm. This fault will set if the signal voltage is greater than 4.90 volts anytime the engine is running. The ECM will use a default value for the ECT sensor in the event of this fault.

ECT Sensor Resistance Scaling	
Temp(deg F)	Ohms ±10%
248.0	116
230.0	147
212.0	188
200.0	220
185.0	275
176.0	322
160.0	420
140.0	587
120.0	825
104.0	1,148
85.0	1,700
68.0	2,450
45.0	4,100
32.0	5,790
-4.0	15,480
-40.0	48,140

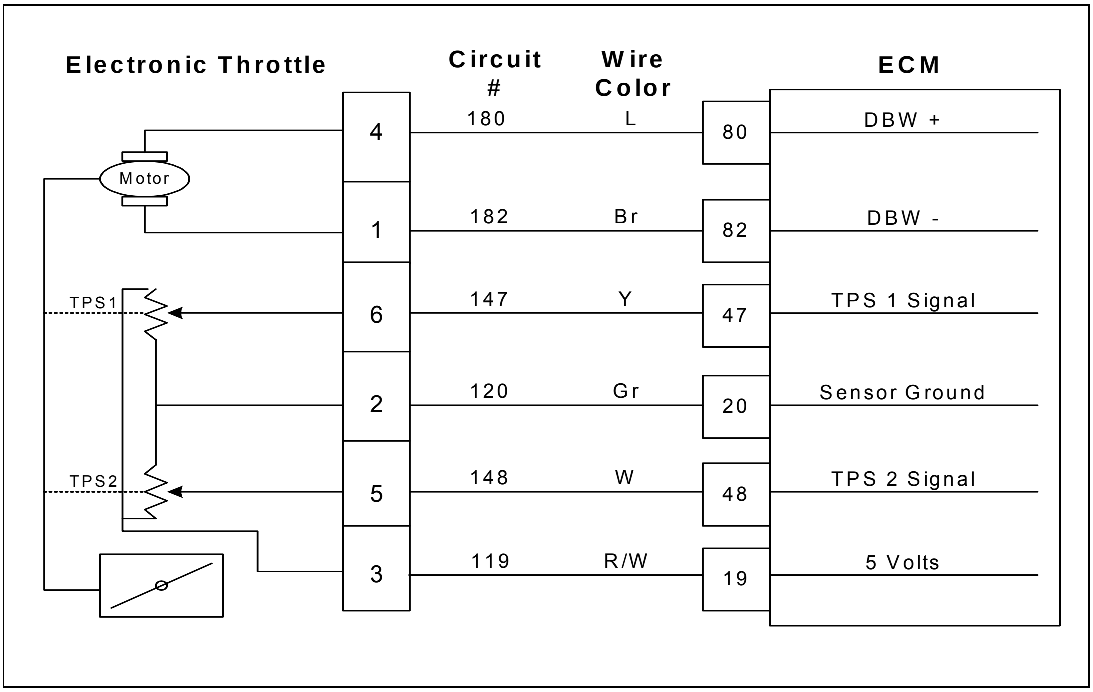
DTC 118-ECT/CHT Voltage High

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?		Go to Step (2)	Go to OBD System Check Section
2	• Key On • DST (Diagnostic Scan Tool) connected in System Data Mode Does DST display ECT voltage of 4.90 or greater?		Go to Step (3)	Intermittent problem Go to Intermittent section
3	• Key Off • Disconnect the ECT sensor connector CN5 and Jump circuits 120 and 137 together • Key On Does the DST display ECT voltage of 0.10 volts or less?	0.10 volts or less	Go to Step (4)	Go to Step (8)
4	• Read the ECT voltage on the DST and compare the reading at a known temperature to the chart. Is the resistance value correct?	See resistance chart vs. temperature in the DTC 118 circuit description	Go to Step (6)	Go to Step (5)
5	• Replace ECT sensor Is the replacement complete?		Go to Step (14)	
6	• Inspect the ECT wire harness connector terminals for damage, corrosion or contamination Did you find a problem?		Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to Step (7)
7	• Key OFF • Disconnect ECM wire harness connector CN1 • Inspect ECM connector CN1 circuits 120 and 137 for damage corrosion or contamination Did you find a problem?		Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Intermittent problem Go to Intermittent section

Step	Action	Value(s)	Yes	No
8	• Jump the ECT connector CN5 signal circuit 137 at the ECT connector to engine ground Does DST display ECT voltage of 0.10 or less?		Go to Step (9)	Go to Step (12)
9	• Key OFF • Disconnect ECM wire harness connector • Using a DVOM check for continuity on ground circuit 120 between ECT connector CN5 and ECM connector CN1 Do you have continuity between them?		Go to Step (10)	Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.
10	• Inspect ECM connector CN1 circuits 120 and 137 for damage, corrosion or contamination Did you find a problem?		Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to Step (11)
11	• Replace ECM Is the replacement complete?		Go to Step (14)	
12	• Key OFF • Disconnect ECM wire harness connector CN1 • Using a DVOM check for continuity on ECT signal circuit 137 between ECT connector CN5 and ECM connector CN1 Do you have continuity between them?		Go to Step (13)	Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.
13	• Inspect ECM connector CN1 circuit 120 and 137 for damage, corrosion or contamination Did you find a problem?		Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to Step (11)

Step	Action	Value(s)	Yes	No
14	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-118 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 121-TPS 1 Lower Than TPS 2



Conditions for Setting the DTC

- Throttle Position Sensor 1 & 2
- Check Condition-Key On
- Fault Condition-TPS 1 20% lower than TPS 2
- MIL-On for remainder of key on cycle
- Engine shutdown

Circuit description

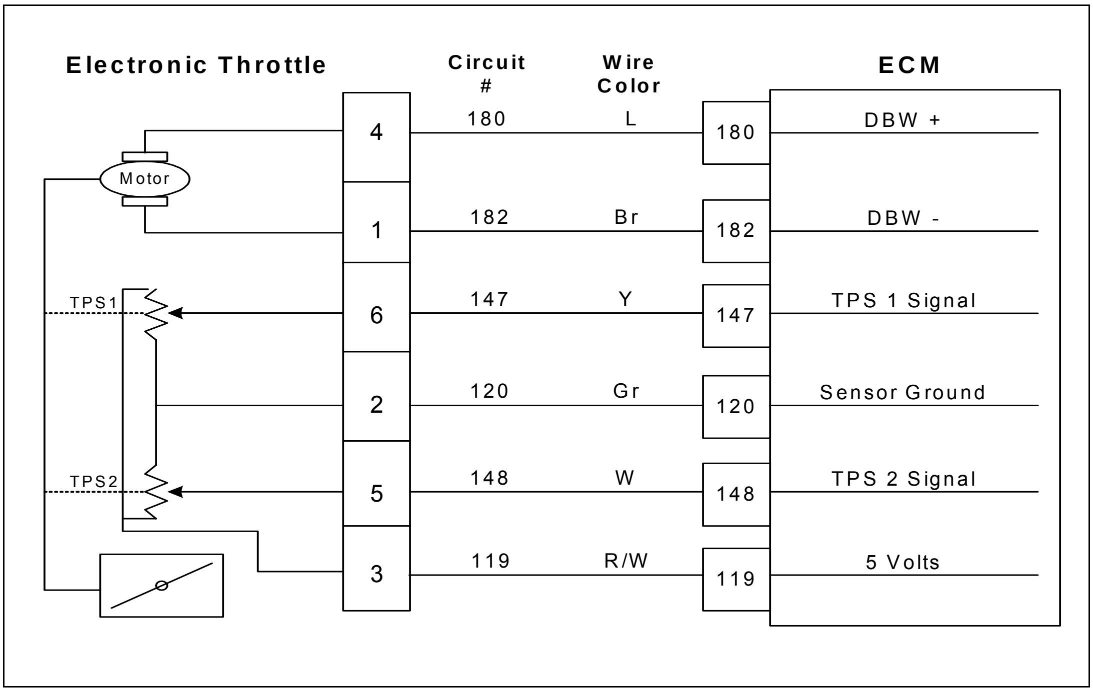
Dual throttle Position Sensors are used within the throttle that use variable resistors to determine signal voltage based on throttle plate position. TPS 1 will read low voltage when closed and TPS 2 will read high voltage when closed. The TPS 1 and TPS 2 percentages are calculated from these voltages. Although the voltages are different, the calculated values for the throttle position percentages should be very close to the same. The TPS values are used by the ECM to determine if the throttle is opening as commanded. This fault will set if TPS 1 is 20% (or more) lower than TPS 2. At this point the throttle is considered to be out of specification, or there is a problem with the TPS signal circuit. The MIL command is on and the engine will shutdown.

DTC 121-TPS 1 Lower Than TPS 2

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?		Go to Step (2)	Go to OBD System Check Section
2	• Key ON, Engine OFF • DST (Diagnostic Scan Tool) connected in System Data Mode Does the DST display more than a 20% difference between TPS 1 and TPS 2 voltage?		Go to Step (3)	Intermittent problem Go to Intermittent section
3	• Key OFF • Disconnect electronic throttle connector CN3 • Key ON • Change DST mode to DBW (drive by wire) test mode Is the voltage for TPS 1 less than 0.1 volts?		Go to Step (5)	Go to Step (4)
4	• Key OFF • Disconnect ECM wiring harness connector CN1 • Key ON • Using a DVOM check for voltage between ECM connector CN1 TPS 1 signal circuit 147 and engine ground Do you have voltage?		Repair the TPS 1 circuit shorted to voltage as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to Step (9)
5	• Jump TPS 1 signal circuit 147 to the 5 volt reference circuit 119 at connector CN3 Does DST display TPS 1 voltage over 4.90 volts?		Go to Step (6)	Go to Step (8)
6	• Inspect wire terminals at throttle connector for damage corrosion or contamination Any problems found?		Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to Step (7)
7	• Replace the electronic throttle assembly Is the replacement complete?		Go to Step (12)	

Step	Action	Value(s)	Yes	No
8	• Key OFF • Disconnect ECM wire harness connector CN1 • Using a DVOM check for continuity on the TPS 1 circuit 147 between throttle connector CN3 and ECM connector CN1 Do you have continuity between them?		Go to Step (9)	Repair the open circuit as necessary. Refer to Wiring Repairs in Engine Electrical.
9	• Using a DVOM check for continuity on sensor ground circuit 120 between throttle connector CN3 and ECM connector CN1 Do you have continuity between them?		Go to Step (10)	Repair the open circuit as necessary. Refer to Wiring Repairs in Engine Electrical.
10	• Inspect ECM connector terminals for damage corrosion or contamination. Any problems found?		Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical	Go to Step (11)
11	• Replace ECM Is the replacement complete?		Go to Step (12)	
12	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-121 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 122-TPS 1 Signal Voltage Low



Conditions for Setting the DTC

- Throttle Position Sensor 1
- Check Condition-Cranking or Running
- Fault Condition-TPS sensor less than 0.200 volts
- MIL-On during active fault
- Engine shutdown

Circuit Description

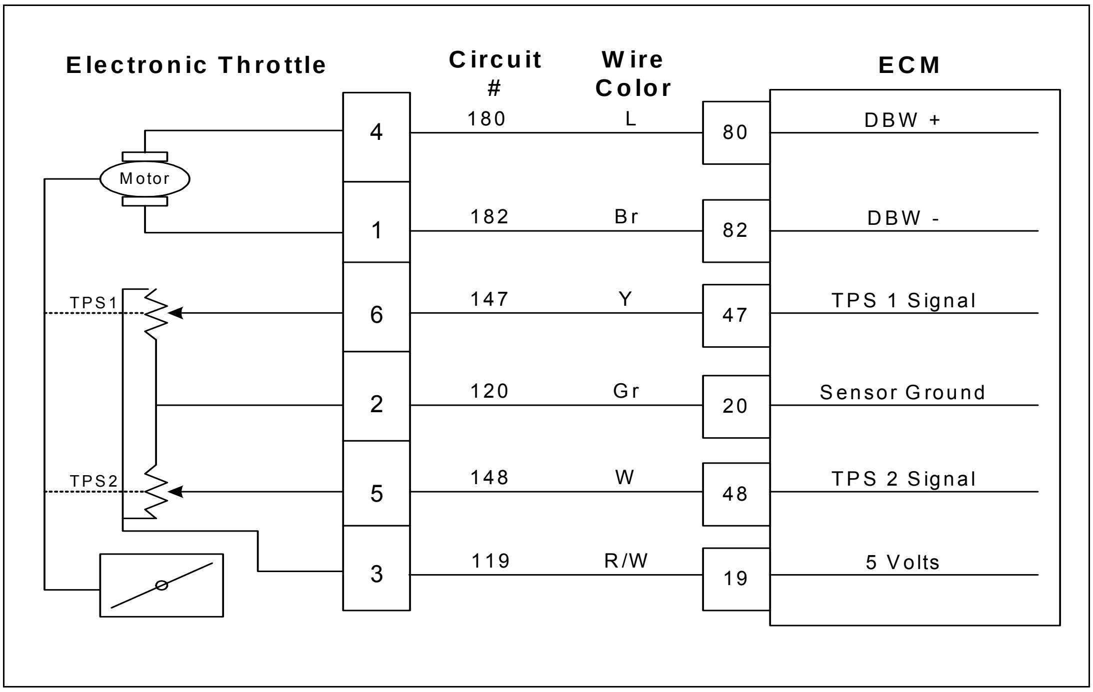
Dual throttle Position Sensors are used within the throttle that use variable resistors to determine signal voltage based on throttle plate position. TPS1 will read lower voltage when closed and TPS2 will read higher voltage when closed. The TPS1 and TPS2 percentages are calculated from these voltages. Although the voltages are different, the calculated values for the throttle position percentages should be very close to the same. The TPS values are used by the ECM to determine if the throttle is opening as commanded. The TPS is not serviceable and in the event of a failure the electronic throttle assembly must be replaced. This fault will set if the TPS 1 voltage is less than 0.200 volts. The MIL command is ON and the engine will shut down.

DTC 122-TPS 1 Signal Voltage Low

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?	-	Go to Step (2)	Go to OBD System Check Section
2	• Key ON, Engine OFF • DST (Diagnostic Scan Tool) connected in DBW (Drive by Wire) throttle test mode Does the DST display TPS 1 voltage of 0.200 volts or less with the throttle closed?		Go to Step (4)	Go to Step (3)
3	• Slowly depress Foot Pedal while observing TPS 1 voltage Does TPS 1 voltage ever fall below 0.200 volts?		Go to Step (4)	Intermittent problem Go to Intermittent section
4	• Key OFF • Disconnect the electronic throttle connector CN3 • Jump the 5 volt reference circuit 119 and TPS 1 signal circuit 147 together at the throttle connector CN3 • Key ON Does DST display TPS 1 voltage of 4.0 volts or greater?		Go to Step (7)	Go to Step (5)
5	• Key OFF • Disconnect ECM wire harness connector CN1 • Using a DVOM check continuity on the TPS 1 circuit 147 between the electronic throttle connector CN3 and ECM connector CN1 Do have continuity between them?		Go to Step (6)	Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.
6	• Replace ECM Is the replacement complete?		Go to Step (9)	-
7	• Inspect the throttle wire harness connector terminals for damage, corrosion or contamination Did you find a problem?		Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to Step (8)
8	• Replace the electronic throttle Is the replacement complete?		Go to Step (9)	-

Step	Action	Value(s)	Yes	No
9	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-122 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 123-TPS 1 Signal Voltage High



Conditions for Setting the DTC

- Throttle Position Sensor 1
- Check Condition-Cranking or Running
- Fault Condition-TPS sensor voltage exceeds 4.800 volts
- MIL-On during active fault
- Engine shutdown

Circuit Description

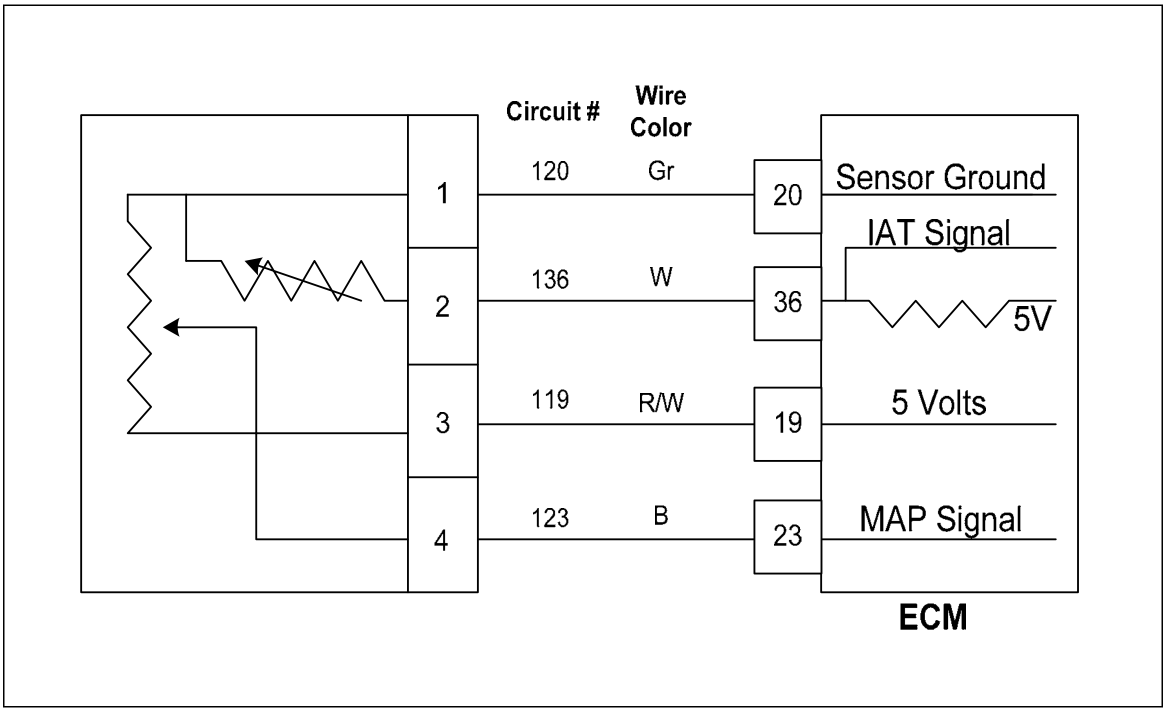
Dual throttle Position Sensors are used within the throttle that use variable resistors to determine signal voltage based on throttle plate position. TPS1 will read lower voltage when closed and TPS2 will read higher voltage when closed. The TPS1 and TPS2 percentages are calculated from these voltages. Although the voltages are different, the calculated values for the throttle position percentages should be very close to the same. The TPS values are used by the ECM to determine if the throttle is opening as commanded. The TPS is not serviceable and in the event of a failure the electronic throttle assembly must be replaced. This fault will set if the TPS 1 voltage exceeds 4.800 volts. The MIL command is ON and the engine will shut down.

DTC 123-TPS 1 Signal Voltage High

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?	-	Go to Step (2)	Go to OBD System Check Section
2	• Key ON, Engine OFF • DST (Diagnostic Scan Tool) connected Does the DST display TPS 1 voltage of 4.800 volts or greater with the throttle closed?		Go to Step (4)	Go to Step (3)
3	• Slowly depress Foot Pedal while observing TPS 1 voltage Does TPS 1 voltage ever exceed 4.800 volts?		Go to Step (4)	Intermittent problem Go to Intermittent section
4	• Key OFF • Disconnect electronic throttle connector C017 • Key ON Does DST display TPS 1 voltage less than 0.2 volts?		Go to Step (7)	Go to Step (5)
5	• Key OFF • Disconnect ECM wire harness connector CN1 • Key ON • Using a DVOM check for voltage between TPS 1 signal circuit 147 at the ECM connector CN1 and engine ground Do you have voltage?		Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to Step (6)
6	• Replace ECM Is the replacement complete?		Go to Step (11)	-
7	• Back probe sensor ground circuit at the ECM side of the wire harness circuit 120 with a test light connected to battery voltage Does the test light come on?		Go to Step (8)	Go to Step (10)
8	• Inspect the electronic throttle connector terminals for damage, corrosion or contamination Did you find a problem?		Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to Step (9)
9	• Replace the electronic throttle Is the replacement complete?		Go to Step (11)	-

Step	Action	Value(s)	Yes	No
10	• Key OFF • Disconnect ECM connector C001 • Using a DVOM check for continuity on the sensor ground circuit 120 between the electronic throttle connector CN3 and ECM connector CN1. Do have continuity between them?		Go to Step (6)	Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.
11	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-123 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 127-IAT Higher Than Expected 2



Conditions for Setting the DTC

- Intake Air Temperature
- Check Condition-Engine Running
- Fault Condition-Intake Air Temperature greater than 210 degrees F. with engine speed greater than 1000 rpm
- MIL-On for active fault
- Engine Shut Down

Circuit Description

The TMAP is a combined IAT (Intake Air Temperature) and MAP (Manifold Absolute Pressure) sensor. A temperature sensitive resistor is used in the TMAP located in the intake manifold of the engine. It is used to monitor incoming air temperature, and the output in conjunction with other sensors is used to determine the airflow to the engine. The ECM provides a voltage divider circuit so that when the air is cool, the signal reads a higher voltage, and lower when warm. This fault will set if the Intake Air Temperature is greater than 210 degrees F. with engine speed greater than 1000 rpm. The MIL light command is on during this active fault and the engine will shut down.

DTC 127-IAT Higher Than Expected 2

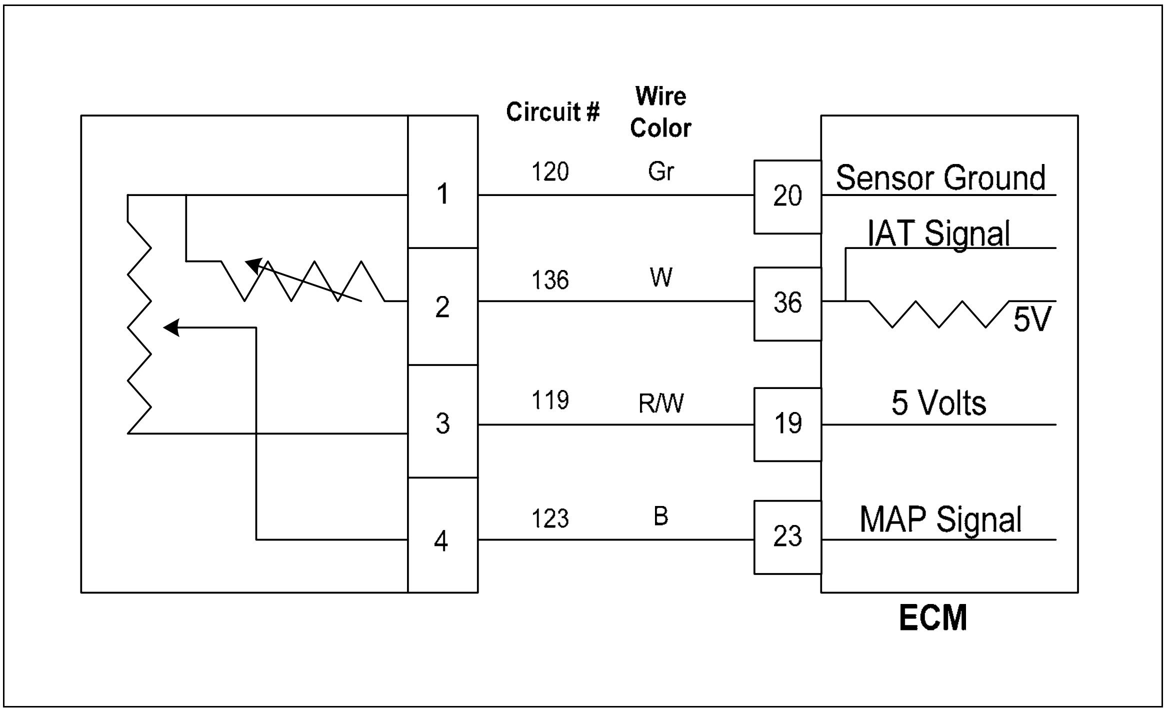
Diagnostic Aid

- This fault will set when inlet air is much hotter than normal. The most common cause of high inlet air temperature is a problem with the inlet air system. Ensure that the air inlet is not obstructed, modified or damaged.

- Inspect the air inlet system for cracks or breaks that may allow unwanted under hood air in to the air inlet system

* If none of the above can be found, follow the diagnostic steps for **DTC 112-IAT Low Voltage.**

DTC 129-BP Low Pressure



Conditions for Setting the DTC

- Barometric Pressure
- Check Condition-Key On
- Fault Condition-BP less than 8.30 psia
- MIL-On for active fault
- Adaptive-Disabled

Circuit Description

The BP (Barometric Pressure) is estimated from the TMAP sensor. The barometric pressure value is used for fuel and airflow calculations. This fault sets in the event the BP value is out of the normal range.

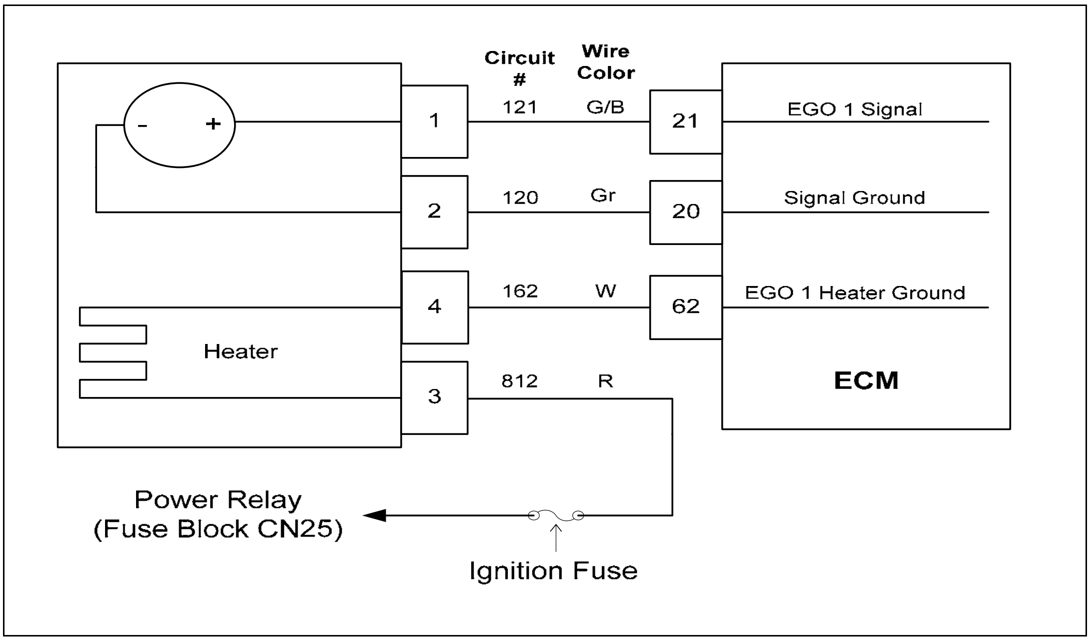
DTC 129-BP Low Pressure

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?	-	Go to Step (2)	Go to OBD System Check Section
2	• Key On. • DST (Diagnostic Scan Tool) connected in System Data Mode Does DST display BP pressure of 8.30 psia or less?		Go to Step (3)	Intermittent problem Go to Intermittent section
3	• Key OFF • Disconnect the TMAP sensor connector CN4 • Jump the 5 volt reference circuit 119 and MAP signal circuit 123 together • Key ON Does the DST display BP pressure of 16.00 psia or greater?		Go to Step (4)	Go to Step (8)
4	• Inspect TMAP connector and wire harness connector terminals for corrosion, contamination or mechanical damage Any problems found?		Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to Step (5)
5	• Key OFF • Disconnect ECM connector CN1 • Check for continuity between TMAP sensor connector CN4 circuit 123 and ECM connector CN1 circuit 123 Do you have continuity between them?		Go to Step (6)	Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.
6	• Check for continuity on the 5 volt supply circuit 119 between TMAP sensor connector CN4 and ECM connector CN1 Do you have continuity between them?		Go to Step (7)	Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.
7	• Check for continuity on the sensor ground circuit 120 between TMAP sensor connector CN4 and ECM connector CN1 Do you have continuity between them?		Go to Step (17)	Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.

Step	Action	Value(s)	Yes	No
8	• Probe TMAP connector signal circuit 123 with a test light connected to battery voltage Does the DST display BP pressure of 16.00 psia or greater?		Go to Step (9)	Go to Step (13)
9	• Key OFF • Disconnect ECM connector CN1 • Check for continuity on the 5 volt supply circuit 119 between TMAP sensor connector CN4 and ECM connector CN1 Do you have continuity between them?		Go to Step (10)	Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.
10	• Check for continuity between TMAP sensor connector 5 volt reference circuit 119 and engine ground Do you have continuity?		Repair the open ground circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to Step (11)
11	• Inspect TMAP and ECM connector pins for corrosion, contamination or mechanical damage Any problems found?		Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to Step (16)
12	• Replace ECM. Refer to ECM replacement in the Engine Controls Section. Is the replacement complete?		Go to Step(17)	-
13	• Disconnect ECM connector CN1 • Check for continuity between TMAP sensor connector CN4 circuit 123 and ECM connector CN1 circuit 123 Do you have continuity between them?		Go to Step (14)	Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.
14	• Check for continuity between TMAP sensor connector CN4 MAP circuit 123 and engine ground Do you have continuity?		Repair the open ground circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to Step (15)

Step	Action	Value(s)	Yes	No
15	• Inspect ECM connector and wire harness connector pins for corrosion, contamination or mechanical damage Any problems found?		Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to Step (16)
16	• Replace ECM. Refer to ECM replacement in the Engine Controls Section. Is the replacement complete?		Go to Step (18)	-
17	• Replace TMAP sensor Is the replacement complete?		Go to Step (18)	-
18	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-129 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 134-EGO 1 Open/Inactive



Conditions for Setting the DTC

- Heated Oxygen Sensor
- Check condition-Engine running
- Fault condition-EGO 1 pre catalyst persistently cold for more than 55 seconds
- MIL-On during active fault
- Adaptive-Disabled during active fault
- Closed Loop-Disabled during active fault

Circuit Description

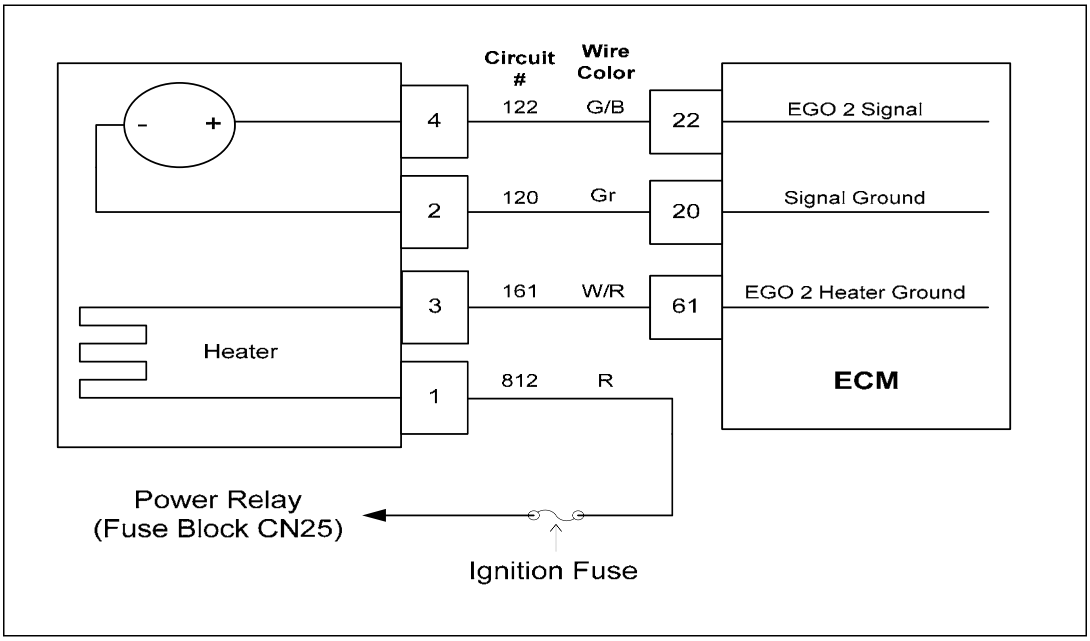
The EGO 1 sensor is used to determine if the fuel flow to the engine is correct by measuring the oxygen content in the exhaust gas. The ECM uses this information to correct the fuel flow with the Closed Loop multiplier and the Adaptive multiplier. This fault will set if EGO 1 is cold, non-responsive, or inactive for more than 55 seconds.

DTC 134-EGO 1 Open/Inactive

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?		Go to Step (2)	Go to OBD System Check Section
2	• Key ON, Engine Running • DST (Diagnostic Scan Tool) connected in System Data Mode • Run engine to full operating temperature and then idle for a minimum of 1 minute Does DST display EGO 1 voltage fixed between 0.40 and 0.50 volts after at least 1 minute of idle run time?		Go to Step (3)	Intermittent problem. See Electrical Section Intermittent Electrical Diagnosis
3	• Key OFF • Disconnect EGO 1 connector CN11 • Key ON • Using a DVOM check for voltage at the EGO 1 connector CN11 between circuits 812 and 162 **(Check must be made within 30 seconds or before power relay shuts down)** Do you have voltage?		Go to Step (8)	Go To Step (4)
4	• Key OFF • Using a DVOM check for voltage between EGO 1 connector CN11 circuit 812 and engine ground • Key ON **(Check must be made within 30 seconds or before power relay shuts down)** Do you have voltage?	System Voltage	Go to Step (5)	Repair system power relay open circuit
5	• Disconnect ECM connector CN1 • Using a DVOM check for continuity on EGO heater 1 circuit 162 between EGO 1 connector CN11 and ECM connector CN1 Do you have continuity?		Go to Step (6)	Repair open heater ground circuit

Step	Action	Value(s)	Yes	No
6	• Inspect wire harness connector CN5 pins and CN1 pins for damage, corrosion or contamination Did you find a problem?		Correct the problem as required see Electrical Section wire harness repair	Go to Step (7)
7	• Replace ECM Is the replacement complete?		Go to Step (11)	-
8	• Key OFF • Disconnect ECM wire harness connector CN1 • Using a DVOM check for continuity between EGO 1 connector circuit 121 and ECM connector circuit 121 Do you have continuity?		Go to Step (9)	Repair open EGO 1 circuit
9	• Using a DVOM check for continuity on the sensor ground circuit 120 between EGO 1 connector CN5 and ECM connector CN1 Do you have continuity?		Go to Step (10)	Repair open EGO 1 signal ground
10	• Replace EGO 1 sensor Is the replacement complete?		Go to Step (11)	-
11	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-134 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 154-EGO 2 Open/Inactive



Conditions for Setting the DTC

- Heated Oxygen Sensor
- Check condition-Engine running
- Fault condition-EGO 2 post catalyst sensor cold persistently more than 55 seconds
- MIL-On during active fault
- Adaptive-Disabled during active fault
- Closed Loop-Disabled during active fault

Circuit Description

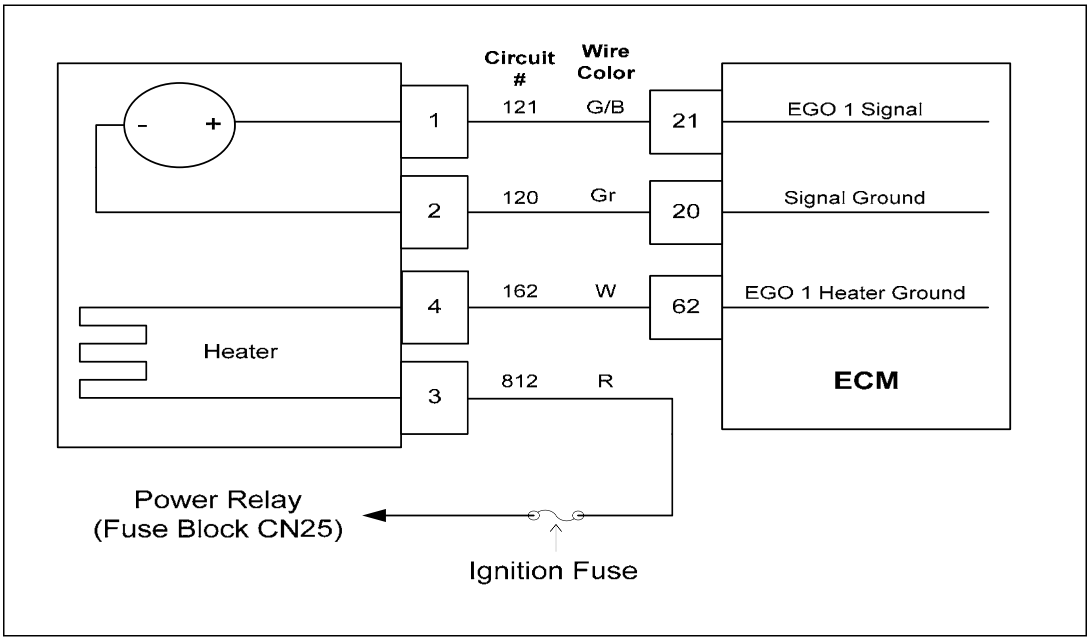
The EGO 2 sensor is used to optimize transient fuel mixture control. This fault will set if EGO 2 post catalyst sensor is cold, non-responsive, or inactive for more than 55 seconds.

DTC 154-EGO 2 Open/Inactive

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?	-	Go to Step (2)	Go to OBD System Check Section
2	• Key ON, Engine Running • DST (Diagnostic Scan Tool) connected in System Data Mode • Run engine to full operating temperature and then idle for a minimum of 1 minute. Does DST display EGO 2 voltage fixed between 0.4 and 0.5 volts after at least 1 minute of idle run time?		Go to Step (3)	Intermittent problem. See Electrical Section Intermittent Electrical Diagnosis
3	• Key OFF • Disconnect EGO 2 connector CN12 • Key ON • Using a DVOM check for voltage between EGO 2 connector CN12 circuits 812 and 161 **(Check must be made within 30 seconds or before power relay shuts down)** Do you have voltage?		Go to Step (8)	Go To Step (4)
4	• Key OFF • Using a DVOM check for voltage between EGO 2 connector CN12 circuit 812 and engine ground • Key ON **(Check must be made within 30 seconds or before power relay shuts down)** Do you have voltage?	System Voltage	Go to Step (5)	Repair system power relay open circuit
5	• Disconnect ECM connector CN1 • Using a DVOM check for continuity EGO heater 2 circuit 161 between EGO 2 connector CN12 and ECM connector CN1 Do you have continuity?		Go to Step (6)	Repair open heater ground circuit
6	• Inspect EGO 2 connector and ECM pins for damage, corrosion or contamination Did You find a problem?		Correct the problem as required see Electrical Section wire harness repair	Go to Step (7)

Step	Action	Value(s)	Yes	No
7	• Replace ECM Is the replacement complete?		Go to Step (11)	-
8	• Key OFF • Disconnect ECM wire harness connector CN1 • Using a DVOM check for continuity on circuit 122 between EGO 2 connector CN12 and ECM connector CN1 Do you have continuity?		Go to Step (9)	Repair open EGO 2 circuit
9	• Using a DVOM check for continuity on the sensor ground circuit 120 between EGO 2 and ECM connector Do you have continuity?		Go to Step (10)	Repair open EGO 2 signal ground
10	• Replace EGO 2 sensor Is the replacement complete?		Go to Step (11)	-
11	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-154 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 171-Adaptive Learn High (Bi-Fuel/Gasoline Only)



Conditions for Setting the DTC

- Heated Oxygen Sensor
- Check Condition-Engine Running
- Fault Condition-Adaptive multiplier out of range greater than 30%
- MIL-On

Circuit Description

The EGO 1 sensor is used to determine if the fuel flow to the engine is correct by measuring the oxygen content in the exhaust gas. The ECM uses this information to correct the fuel flow with the Closed Loop multiplier and Adaptive multiplier. This fault will set if the adaptive multiplier exceeds the limits of normal operation. Always run the fuel system diagnostic checks before using the following diagnostic chart.

Diagnostic Aid

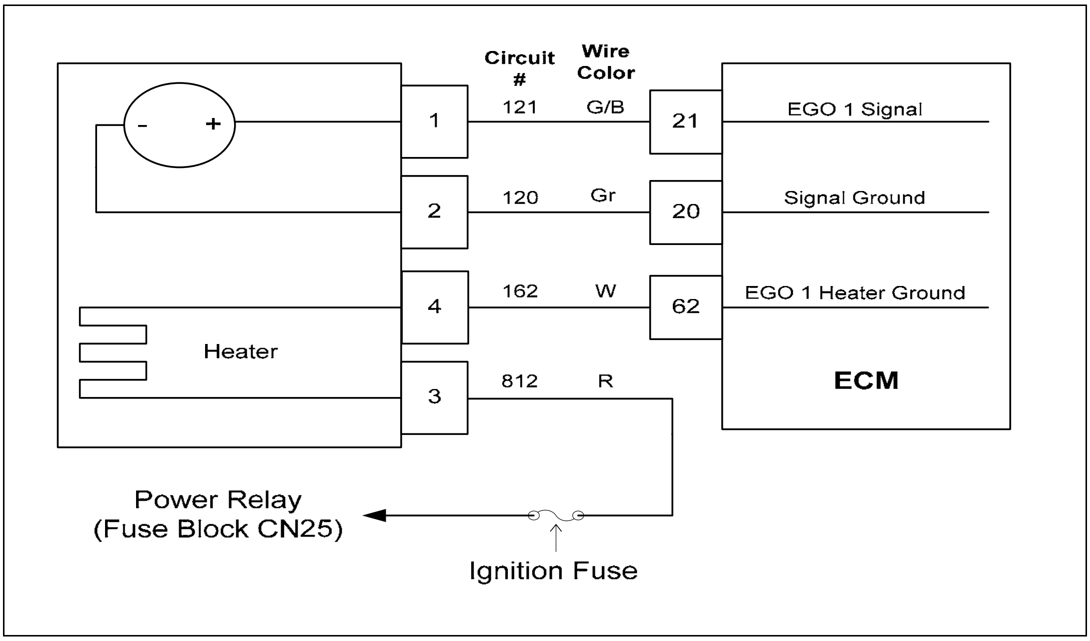
Oxygen Sensor Wire Heated Oxygen sensor wires may be mis-routed and contacting the exhaust manifold.
Vacuum Leaks Vacuum leaks and crankcase leaks can cause a lean condition at especially at light load.
Fuel Injectors The system may be lean due to contaminated or faulty fuel injectors
Fuel Pressure Low fuel pressure, faulty fuel regulator or contaminated fuel filter can cause fuel the system to run lean
Exhaust Leaks If there is an exhaust leak, outside air can be pulled into the exhaust and past the 02 sensor causing a false lean condition.
Fuel Quality Contaminated or spoiled fuel can cause the fuel system to be lean.
Ground Problem ECM grounds must be clean, tight and in the proper location.

DTC 171-Adaptive Learn High (Bi-Fuel/Gasoline Only)

Step	Action	Value(s)	Yes	No
1	• Perform the On-Board (OBD) System Check? Are any other DTCs present?		Go to Step (3)	Go to Step (2)
2	Visually and physically check the following items: • The air intake duct for being collapsed or restricted • The air filter for being plugged • System power fuses are good and in the proper location • The EGO 1 sensor installed securely and the wire leads not contacting the exhaust manifold or ignition wires • ECM grounds must be clean and tight. Refer to Engine Electrical Power and Ground Distribution • Fuel System Diagnostics. Refer to Fuel System Diagnostics Was a repair made?		Go to Step (9)	Go to Step (4)
3	• Diagnose any other DTC codes before proceeding with this chart. Always repair existing codes starting with the lowest numerical code set first. Have any other DTC codes been detected, diagnosed and repaired?		Go to Step (9)	Go to Step (4)
4	• Disconnect EGO1 connector CN11 • Using a DVOM check for voltage between EGO 1 connector circuit 812 pin B and engine ground • Key ON (CHECK MUST BE MADE WITHIN 30 SECONDS OR BEFORE POWER RELAY SHUTS DOWN) Do you have voltage?	System voltage	Go to Step (5)	Repair the open EGO power circuit as necessary. Refer to Wiring Repairs in Engine Electrical.
5	• Key OFF • Disconnect EGO 1 sensor wire harness connector CN11 • Disconnect ECM wire harness connector CN1 • Key ON • Using a high impedance DVOM check for continuity between EGO 1 connector signal circuit 121 and engine ground Do you have continuity?		Repair the shorted circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to Step (6)

Step	Action	Value(s)	Yes	No
6	• Using a high impedance DVOM check for continuity between EGO 1 connector signal ground circuit 120 and EGO 1 signal circuit 121 Do you have continuity?		Repair the shorted circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to Step (7)
7	• Using a high impedance DVOM check for continuity between EGO 1 heater ground circuit 162 and ECM connector CN1 circuit 162 Do you have continuity?		Go to Step (8)	Repair the open EGO heater ground
8	• Replace EGO 1 sensor Is the replacement complete?		Go to Step (9)	-
9	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-171 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 172-Adaptive Learn Low Gasoline (Bi-Fuel/Gasoline Only)



Conditions for Setting the DTC

- Heated Oxygen Sensor
- Check Condition-Engine Running
- Fault Condition-Adaptive multiplier out of range greater than 30%
- MIL-On

Circuit Description

The EGO 1 sensor is used to determine if the fuel flow to the engine is correct by measuring the oxygen content in the exhaust gas. The ECM uses this information to correct the fuel flow with the Closed Loop multiplier and Adaptive multiplier. This fault will set if the adaptive multiplier exceeds the limits of normal operation. Always run the fuel system diagnostic checks before using the following diagnostic chart.

Diagnostic Aid

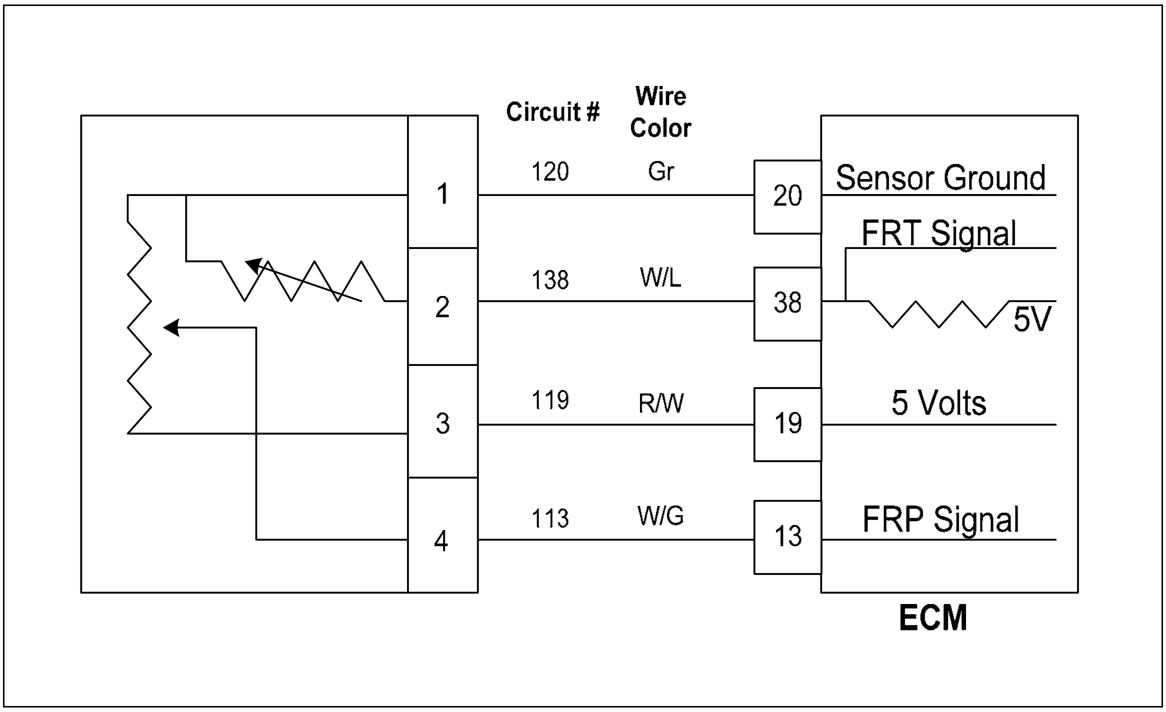
Fuel System The system will be rich if an injector fails to close properly. High fuel pressure due to a faulty fuel regulator or obstructed fuel return line will cause the system to run rich.
Ignition noise Open or poor ground circuit to or in the ignition system or ECM wiring may cause EMI (Electromagnetic interference). This noise could be interpreted by the ECM as ignition pulses or voltage across the oxygen sensor input causing the system to run rich.
MAP Sensor A higher manifold pressure than normal can cause the system to run rich. Temporarily disconnecting the MAP Sensor will allow the ECM to set a default value for MAP and is a good way to quickly eliminate this as a problem.
IAT Sensor Check for a shifted sensor that could cause the ECM to sense lower than actual temperature of incoming air. This can cause a rich exhaust condition.
ECT Sensor Check for a “skewed” sensor that could cause the ECM to sense engine temperature colder than it actually is. This can also cause a rich exhaust condition.

DTC 172-Adaptive Learn Low Gasoline (Bi-Fuel/Gasoline Only)

Step	Action	Value(s)	Yes	No
1	• Perform the On-Board (OBD) System Check? Are any other DTCs present?		Go to Step (3)	Go to Step (2)
2	Visually and physically check the following items: • The air intake duct for being collapsed or restricted • The air filter for being plugged • The EGO sensor is installed securely and the wire leads not damaged or contacting the secondary ignition wires • ECM grounds for being clean and tight. • Fuel system diagnostic checks Was a repair made?		Go to Step (6)	Go to Step (4)
3	• Diagnose any other DTC codes before proceeding with this chart. Have any other DTC codes been detected, diagnosed and repaired?		Go to Step (6)	Go to Step (4)
4	• Key OFF • Disconnect EGO sensor wire harness connector CN11 • Disconnect ECM wire harness connector CN1 • Key ON • Using a DVOM check for voltage at EGO 1 connector CN11 signal circuit 121 and engine ground Do you have voltage?		Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to Step (5)
5	• Replace EGO sensor Is the replacement complete?		Go to Step (6)	-

Step	Action	Value(s)	Yes	No
6	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-172 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 182-FRT Voltage Low (Gasoline/Bi-Fuel Only)



Conditions for Setting the DTC

- Fuel Rail Temperature
- Check Condition-Engine Running
- Fault Condition-FT sensor voltage less than 0.050 volts
- MIL-On
- Adaptive-Disabled

Circuit Description

The FRT (Fuel Rail Temperature) sensor is a temperature sensitive resistor located near the fuel outlet of the electronic pressure regulator. It is used to help determine fuel charge density for accurate fuel mixture control. The ECM provides a voltage divider circuit so that when the sensor is cool the signal reads a higher voltage, and lower when warm. This fault will set if the signal voltage is less than 0.050 volts anytime the engine is running.

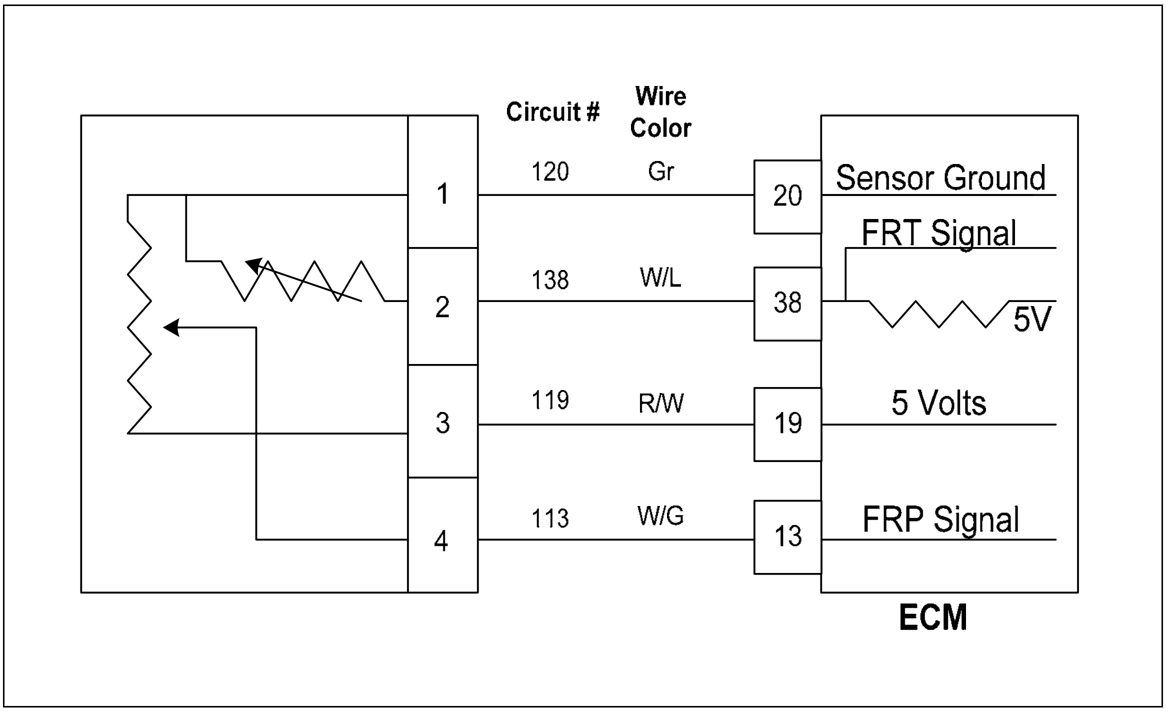
Rail Sensor Temp		Resistance in Ohms
Degrees °C	Degrees °F	(± 6%)
-40	-40	48153
-20	-4	15614
0	32	5887
20	68	2510
40	104	2000
60	140	612
70	158	446
80	176	330
100	212	186
120	248	110
130	266	85.45

DTC 182-FRT Voltage Low (Gasoline/Bi-Fuel Only)

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?		Go to Step (2)	Go to OBD System Check Section
2	• Key On • DST (Diagnostic Scan Tool) connected in System Data Mode Does DST display FT voltage of 0.050 or less?		Go to Step (3)	Intermittent problem Go to Intermittent section
3	• Key Off • Disconnect the FT wire harness connector CN16 • Key ON Does the DST display FT voltage of 4.90 volts or greater?		Go to Step (4)	Go to Step (5)
4	• Replace FT sensor. Is the replacement complete?		Go to Step (8)	
5	• Key OFF • Disconnect ECM wire harness connector CN1 • Check for continuity between fuel temperature sensor connector CN16 circuits 120 and 138 Do you have continuity between them?		Repair the shorted circuit as required. See Repairs in Engine Electrical.	Go to Step (6)
6	• Check for continuity between the fuel temperature sensor connector signal circuit 138 and engine ground. Do you have continuity?		Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to Step (7)

Step	Action	Value(s)	Yes	No
7	• Replace ECM. Refer to ECM replacement in the Engine Controls Section. Is the replacement complete?	–	Go to Step (8)	–
8	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-182 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 183-FRT Voltage High (Gasoline/Bi-Fuel Only)



Conditions for Setting the DTC

- Fuel Rail Temperature
- Check Condition-Engine Running
- Fault Condition-FT sensor voltage exceeds 4.90
- MIL-On
- Adaptive-Disabled during active fault

Circuit Description

The FRT (Fuel Rail Temperature) sensor is a temperature sensitive resistor located in the gasoline supply line. It is used to help determine fuel charge density for accurate fuel mixture control. The ECM provides a voltage divider circuit so that when the sensor is cool the signal reads a higher voltage, and lower when warm. This fault will set if the signal voltage is greater than 4.90 volts anytime the engine is running.

Rail Sensor Temp		Resistance in Ohms (± 6%)
Degrees °C	Degrees °F	
-40	-40	48153
-20	-4	15614
0	32	5887
20	68	2510
40	104	2000
60	140	612
70	158	446
80	176	330
100	212	186
120	248	110
130	266	85.45

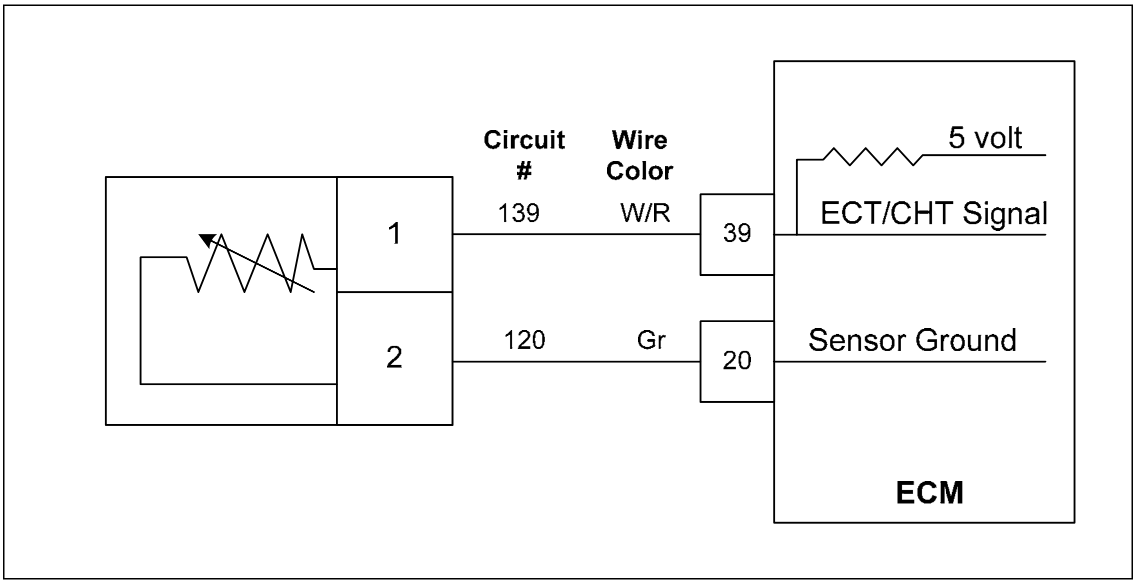
DTC 183-FT Voltage High (Gasoline/Bi-Fuel Only)

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?	-	Go to Step (2)	Go to OBD System Check Section
2	• Key On • DST (Diagnostic Scan Tool) connected in System Data Mode Does DST display FT voltage of 4.90 or greater?		Go to Step (3)	Intermittent problem Go to Intermittent section
3	• Key Off • Disconnect the FT sensor connector CN16 and jump connector circuits 120 and 138 • Key On Does the DST display FT voltage of 0.05 volts or less?		Go to Step (4)	Go to Step (8)
4	• Using a DVOM check the resistance between the two terminals of the FT sensor and compare the resistance reading to the chart Is the resistance value correct?	See temperature vs. resistance chart in the DTC 183 schematic page.	Go to Step (6)	Go to Step (5)
5	• Replace FT sensor Is the replacement complete?		Go to Step (14)	-
6	• Inspect the FT sensor connector terminals for damage, corrosion or contamination Did you find a problem?		Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to Step (7)
7	• Key OFF • Disconnect ECM wire harness connector CN1 • Inspect ECM connector pins for damage corrosion or contamination Did you find a problem?		Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Intermittent problem Go to Intermittent section

Step	Action	Value(s)	Yes	No
8	• Jump the fuel temperature sensor connector signal circuit 138 to engine ground Does DST display FT voltage of 0.05 or less?		Go to Step (9)	Go to Step (12)
9	• Key OFF • Disconnect ECM wire harness connector CN1 • Using a DVOM check for continuity on the sensor ground circuit 120 between fuel temperature sensor and ECM connector Do you have continuity between them?		Go to Step (10)	Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.
10	• Inspect ECM connector pins for damage, corrosion or contamination Did you find a problem?		Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to Step (11)

Step	Action	Value(s)	Yes	No
11	• Replace ECM Is the replacement complete?		Go to Step (14)	-
12	• Key OFF • Disconnect ECM wire harness connector CN1 • Using a DVOM check for continuity between the fuel temperature connector CN16 signal circuit 138 and ECM connector circuit 138 Do you have continuity between them?		Go to Step (13)	Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.
13	• Inspect ECM connector pins for damage, corrosion or contamination Did you find a problem?		Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to Step (11)
14	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-183 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 187-LP Temp Voltage Low



Conditions for Setting the DTC

- LP Temperature
- Check Condition-Engine Running
- Fault Condition-FT sensor voltage less than 0.050 volts
- MIL-On
- Adaptive-Disabled

Circuit Description

The LP Temp (Fuel Temperature) sensor is a temperature sensitive resistor located near the fuel outlet of the electronic pressure regulator. It is used to help determine fuel charge density for accurate fuel mixture control. The ECM provides a voltage divider circuit so that when the sensor is cool the signal reads a higher voltage, and lower when warm. This fault will set if the signal voltage is less than 0.050 volts anytime the engine is running.

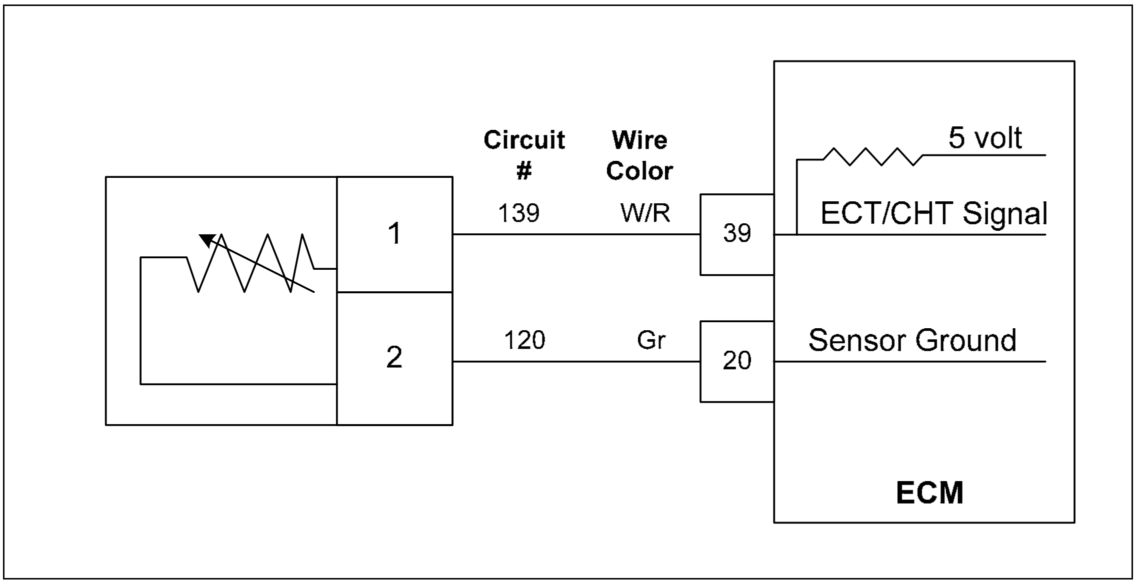
LP Sensor Temperature Degrees F.	Resistance in Ohms (± 10%)
-40	100,700
-20	28,680
0	9,420
20	3,520
40	1,459
60	667
70	467
80	332
100	177
120	100
130	77

DTC 187-LP Temp Voltage Low

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?		Go to Step (2)	Go to OBD System Check Section
2	• Key On • DST (Diagnostic Scan Tool) connected in System Data Mode Does DST display FT voltage of 0.050 or less?		Go to Step (3)	Intermittent problem Go to Intermittent section
3	• Key Off • Disconnect the FT wire harness connector CN14 • Key ON Does the DST display FT voltage of 4.90 volts or greater?		Go to Step (4)	Go to Step (5)
4	• Replace FT sensor. Is the replacement complete?		Go to Step (8)	
5	• Key OFF • Disconnect ECM wire harness connector CN1 • Check for continuity between fuel temperature sensor connector CN14 circuits 120 and 139 Do you have continuity between them?		Repair the shorted circuit as required. See Repairs in Engine Electrical.	Go to Step (6)
6	• Check for continuity between the fuel temperature sensor connector signal circuit 139 and engine ground. Do you have continuity?		Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to Step (7)

Step	Action	Value(s)	Yes	No
7	• Replace ECM. Refer to ECM replacement in the Engine Controls Section. Is the replacement complete?	–	Go to Step (8)	–
8	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-187 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 188-LP Temp Voltage High



Conditions for Setting the DTC

- LP Temperature
- Check Condition-Engine Running
- Fault Condition-FT sensor voltage exceeds 4.90
- MIL-On
- Adaptive-Disabled during active fault

Circuit Description

The LP Temp (Fuel Temperature) sensor is a temperature sensitive resistor located near the fuel outlet of the electronic pressure regulator. It is used to help determine fuel charge density for accurate fuel mixture control. The ECM provides a voltage divider circuit so that when the sensor is cool the signal reads a higher voltage, and lower when warm. This fault will set if the signal voltage is greater than 4.90 volts anytime the engine is running.

Sensor Temperature Degrees F.	Resistance in Ohms (± 10%)
-40	100,700
-20	28,680
0	9,420
20	3,520
40	1,459
60	667
70	467
80	332
100	177
120	100
130	77

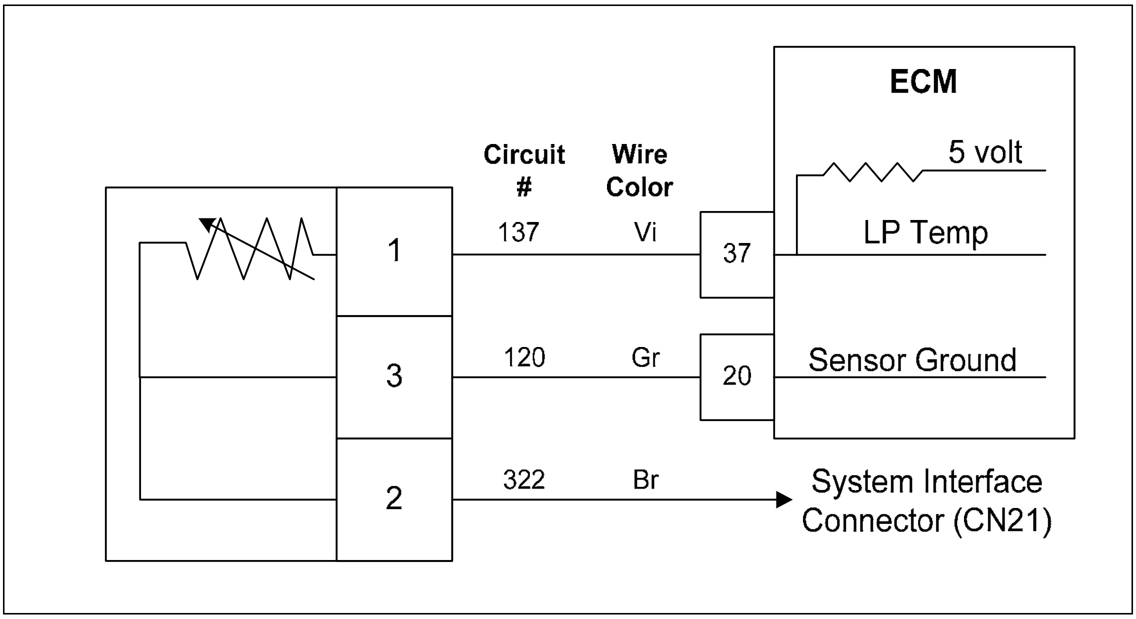
DTC 188-LP Temp Voltage High

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?	-	Go to Step (2)	Go to OBD System Check Section
2	• Key On • DST (Diagnostic Scan Tool) connected in System Data Mode Does DST display FT voltage of 4.90 or greater?		Go to Step (3)	Intermittent problem Go to Intermittent section
3	• Key Off • Disconnect the FT sensor connector CN14 and jump connector circuits 120 and 139 • Key On Does the DST display FT voltage of 0.05 volts or less?		Go to Step (4)	Go to Step (8)
4	• Using a DVOM check the resistance between the two terminals of the FT sensor and compare the resistance reading to the chart Is the resistance value correct?	See temperature vs. resistance chart in the DTC 188 schematic page.	Go to Step (6)	Go to Step (5)
5	• Replace FT sensor Is the replacement complete?		Go to Step (14)	-
6	• Inspect the FT sensor connector terminals for damage, corrosion or contamination Did you find a problem?		Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to Step (7)
7	• Key OFF • Disconnect ECM wire harness connector CN1 • Inspect ECM connector pins for damage corrosion or contamination Did you find a problem?		Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Intermittent problem Go to Intermittent section

Step	Action	Value(s)	Yes	No
8	• Jump the fuel temperature sensor connector signal circuit 139 to engine ground Does DST display FT voltage of 0.05 or less?		Go to Step (9)	Go to Step (12)
9	• Key OFF • Disconnect ECM wire harness connector CN1 • Using a DVOM check for continuity on the sensor ground circuit 120 between fuel temperature sensor and ECM connector Do you have continuity between them?		Go to Step (10)	Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.
10	• Inspect ECM connector pins for damage, corrosion or contamination Did you find a problem?		Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to Step (11)

Step	Action	Value(s)	Yes	No
11	• Replace ECM Is the replacement complete?		Go to Step (14)	-
12	• Key OFF • Disconnect ECM wire harness connector CN1 • Using a DVOM check for continuity between the fuel temperature connector CN14 signal circuit 139 and ECM connector circuit 139 Do you have continuity between them?		Go to Step (13)	Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.
13	• Inspect ECM connector pins for damage, corrosion or contamination Did you find a problem?		Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to Step (11)
14	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-188 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 217-ECT/CHT Higher Than Expected 2



Conditions for Setting the DTC

- Engine Coolant Temperature
- Check Condition-Engine Running
- Fault Condition-ECT greater than 248 F
- MIL-On during active fault
- Engine shutdown
-

ECT Sensor Resistance Scaling	
Temp(deg F)	Ohms ±10%
248.0	116
230.0	147
212.0	188
200.0	220
185.0	275
176.0	322
160.0	420
140.0	587
120.0	825
104.0	1,148
85.0	1,700
68.0	2,450
45.0	4,100
32.0	5,790
-4.0	15,480
-40.0	48,140

Circuit Description

The ECT (Engine Coolant Temperature) sensor is a temperature sensitive resistor located in the engine coolant passage. It is used for the engine airflow calculation, gasoline cold enrichment and to enable other temperature dependant features. The ECM provides a voltage divider circuit so that when the coolant is cool, the signal reads higher voltage, and lower when warm. This fault will set if the coolant temperature reading exceeds 248 degrees F and engine RPM is greater than 500 for 10 seconds. The engine will shut down upon fault activation.

DTC 217-ECT/CHT Higher Than Expected 2

Diagnostic Aid

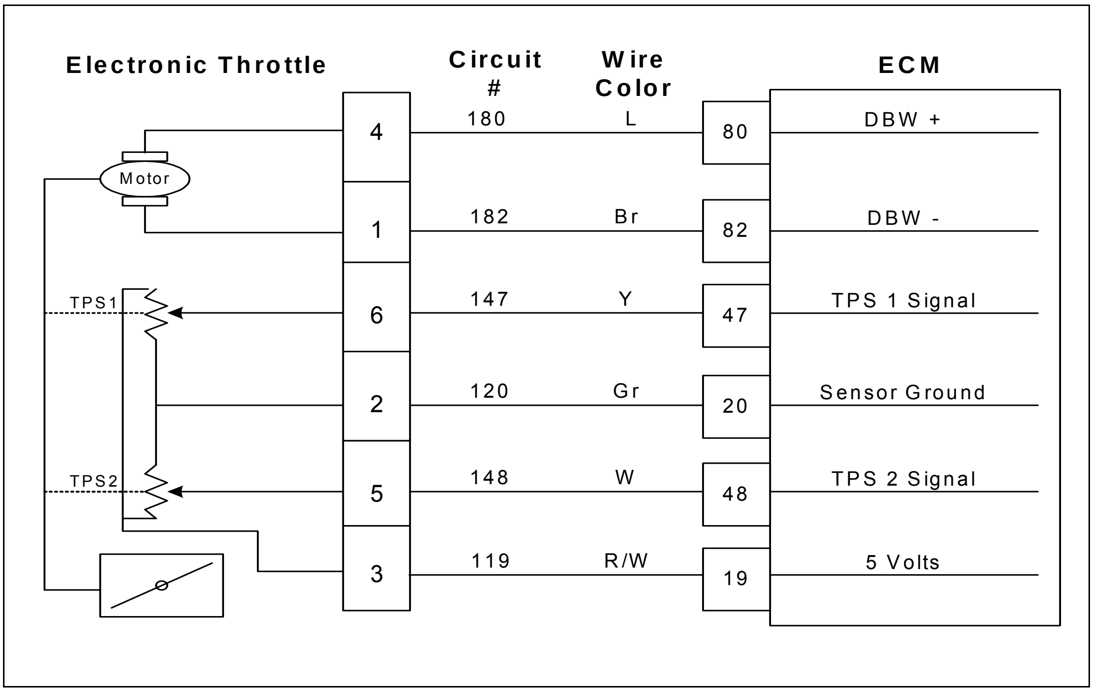
- Thoroughly inspect the entire cooling system and for any signs of coolant leakage including: coolant lines and hoses, water pump, engine block, radiator, etc.

- Insure the radiator cap is in good repair and maintaining suitable cooling system pressure.

- Compare the ECM measured temperature value with an analog temperature measurement (IR temperature measurement, thermometer, etc.) if possible.

- If no problems are found continue with DTC 117 ECT low voltage diagnostic

DTC 219-Max Govern Speed Override



Conditions for Setting the DTC

- Max Govern Speed Override
- Check Condition-Engine Running
- Fault Condition-Engine rpm greater than 3900
- MIL-On during active fault

Circuit description

This fault will set anytime the engine rpm exceeds 3900. The MIL command is ON during this active fault

Diagnostic Aid

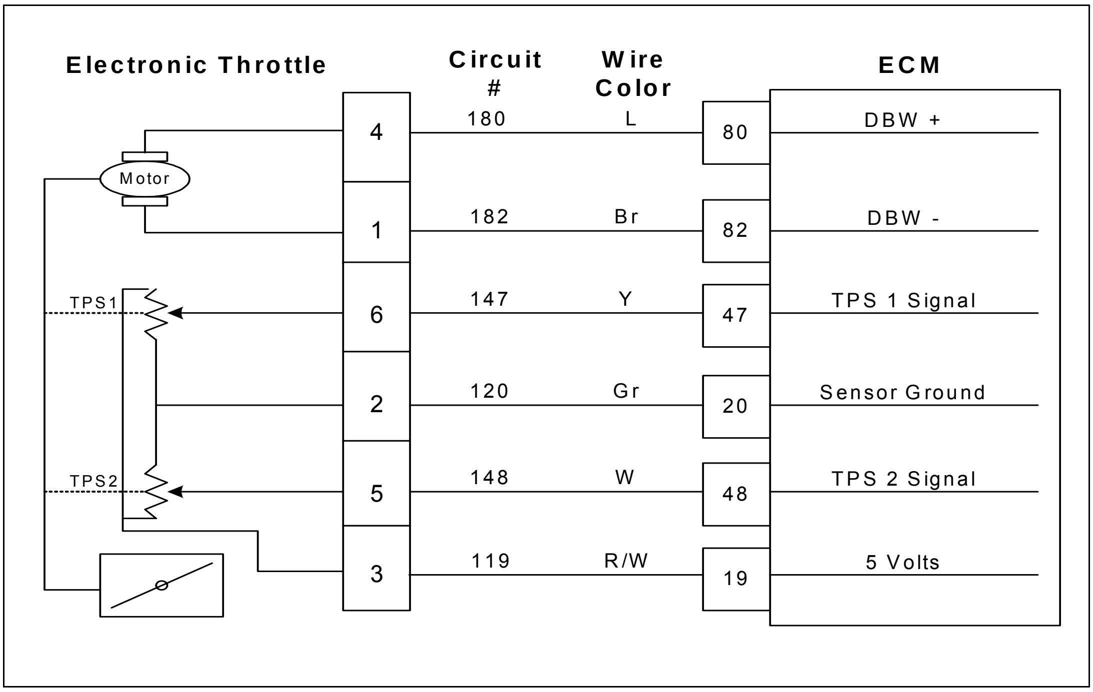
Check for other stored DTC codes before using the following DTC chart for this code set. Always diagnose and repair any existing codes starting with the lowest numerical code first.

DTC 219-Max Govern Speed Override

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?		Go to Step (2)	Go to OBD System Check Section
2	• Key ON, Engine OFF • DST connected Are any other DTC codes present with DTC 219?		Go to Step (3)	Go to Step (4)
3	• Diagnose and repair any other DTC codes stored before proceeding with this chart. Have any other DTC codes been diagnosed and repaired?		Go to Step (4)	
4	• Check the service part number on the ECM to ensure the correct calibration is in use Is the Service Part Number Correct?		Go to Step (6)	Go to Step (5)
5	• Replace ECM with correct service part number Is the replacement complete?		Go to Step (9)	
6	• Check the mechanical operation of the throttle Is the mechanical operation of the throttle OK?		Go to Step (8)	Go to Step (7)
7	• Correct mechanical operation of the throttle. Refer to Engine & Component section Has the mechanical operation of the throttle been corrected?		Go to Step (9)	
8	• Check engine for large manifold vacuum leaks. Refer to Symptom Diagnostic section Did you find and correct the vacuum leak?		Go to Step (9)	Go to OBD System Check Section

Step	Action	Value(s)	Yes	No
9	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-219 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 221-TPS 1 Higher Than TPS 2



Conditions for Setting the DTC

- Throttle Position Sensor 1 & 2
- Check Condition-Key On
- Fault Condition-TPS 1 20% higher than TPS2
- MIL-On for remainder of key on cycle
- Engine shutdown

Circuit Description

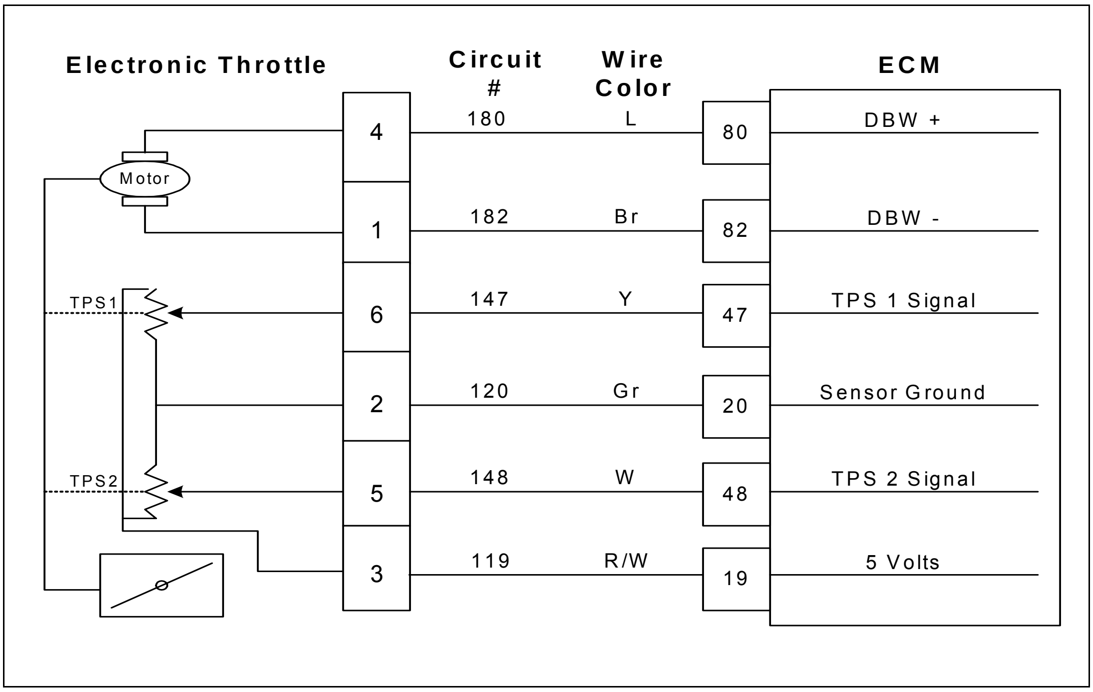
Dual throttle Position Sensors are used within the throttle that use variable resistors to determine signal voltage based on throttle plate position. TPS 1 will read lower voltage when closed and TPS 2 will read higher voltage when closed. The TPS 1 and TPS 2 percentages are calculated from these voltages. Although the voltages are different, the calculated values for the throttle position percentages should be very close to the same. The TPS values are used by the ECM to determine if the throttle is opening as commanded. The TPS is not serviceable and in the event of a failure the electronic throttle assembly must be replaced. This fault will set if TPS 1 is 20% (or more) higher than TPS 2. At this point the throttle is considered to be out of specification, or there is a problem with the TPS signal circuit. The MIL command is ON and the engine will shutdown.

DTC 221-TPS 1 Higher Than TPS 2

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?		Go to Step (2)	Go to OBD System Check Section
2	• Key ON, Engine OFF • DST (Diagnostic Scan Tool) connected in System Data Mode Does the DST display more than a 20% difference between TPS 1 and TPS 2?		Go to Step (3)	Intermittent problem Go to Intermittent section
3	• Key OFF • Disconnect electronic throttle connector CN3 • Key ON • Change DST mode to DBW (drive by wire) test mode Is the voltage for TPS 1 less than 0.1 volts?		Go to Step (5)	Go to Step (4)
4	• Key OFF • Disconnect ECM wiring harness connector CN1 • Key ON • Using a DVOM check for voltage between ECM connector TPS 1 signal circuit 148 and engine ground Do you have voltage?		Repair the TPS 1 circuit shorted to voltage as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to Step (9)
5	• Jump TPS 1 signal circuit 147 to the 5 volt reference circuit 119 at connector CN3 Does DST display TPS 1 voltage over 4.900 volts		Go to Step (6)	Go to Step (8)
6	• Inspect wire terminals at throttle connector for damage corrosion or contamination Any problems found?		Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to Step (7)
7	• Replace the electronic Throttle Is the replacement complete?		Go to Step (12)	

Step	Action	Value(s)	Yes	No
8	• Key OFF • Disconnect ECM wire harness connector CN1 • Using a DVOM check for continuity between throttle connector CN3 TPS 1 signal circuit 147 and ECM connector CN1 circuit 147 Do you have continuity between them?		Go to Step (9)	Repair the open circuit as necessary. Refer to Wiring Repairs in Engine Electrical.
9	• Using a DVOM check for continuity on the ground circuit 120 between throttle connector CN3 and ECM connector CN1 Do you have continuity between them?		Go to Step (10)	Repair the open circuit as necessary. Refer to Wiring Repairs in Engine Electrical.
10	• Inspect ECM connector terminals for damage corrosion or contamination. Any problems found?		Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical	Go to Step (11)
11	• Replace ECM Is the replacement complete?		Go to Step (12)	-
12	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-221 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 222-TPS 2 Signal Voltage Low



Conditions for Setting the DTC

- Throttle Position Sensor 2
- Check Condition-Cranking or Running
- Fault Condition-TPS 2 sensor voltage less than 0.200 volts
- MIL-ON during active fault
- Engine shutdown

Circuit Description

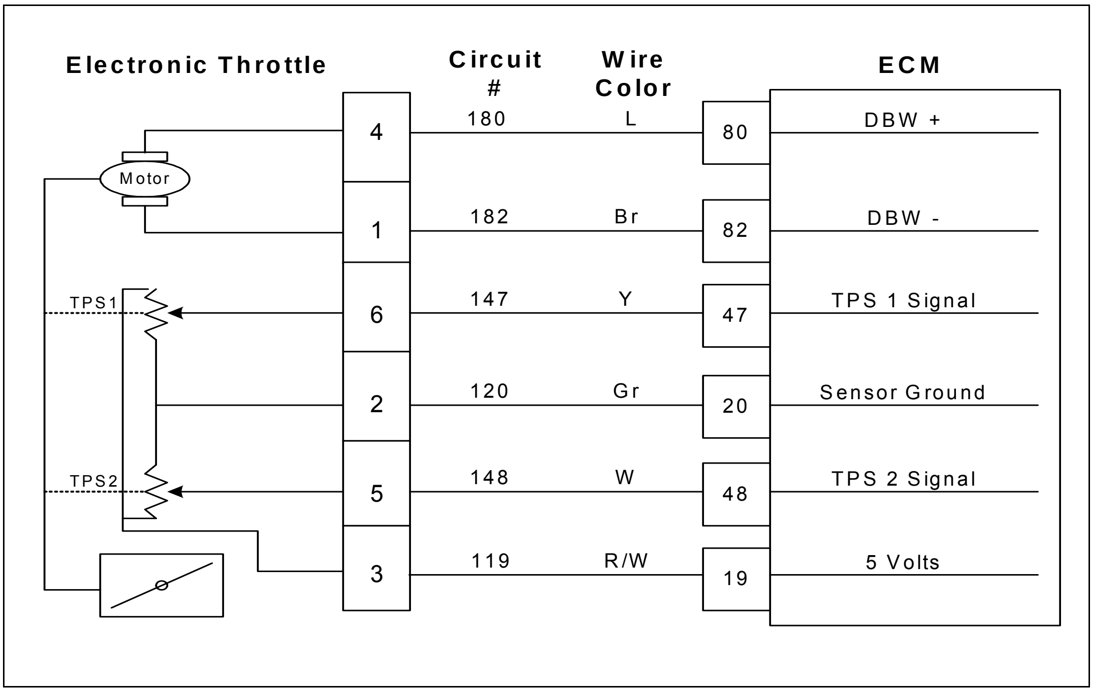
Dual throttle Position Sensors are used within the throttle that use variable resistors to determine signal voltage based on throttle plate position.TPS1 will read lower voltage when closed and TPS2 will read higher voltage when closed. The TPS1 and TPS2 percentages are calculated from these voltages. Although the voltages are different, the calculated values for the throttle position percentages should be very close to the same. The TPS values are used by the ECM to determine if the throttle is opening as commanded. The TPS is not serviceable and in the event of a failure the electronic throttle assembly must be replaced. This fault will set if the TPS 2 voltage is less than 0.200 volts. The MIL command is ON and the engine will shutdown.

DTC 222-TPS 2 Signal Voltage Low

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?	-	Go to Step (2)	Go to OBD System Check Section
2	• Key ON, Engine OFF • DST (Diagnostic Scan Tool) connected in DBW (Drive by Wire) throttle test mode Does the DST display TPS 2 voltage of 0.200 volts or less with the throttle closed		Go to Step (4)	Go to Step (3)
3	• Slowly depress Foot Pedal while observing TPS 2 voltage Does TPS 2 voltage ever fall below 0.200 volts?		Go to Step (4)	Intermittent problem Go to Intermittent section
4	• Key OFF • Disconnect electronic throttle connector CN3 • Jumper the 5 volt reference circuit 119 and TPS 2 signal circuit 148 together at the throttle connector CN3 • Key ON Does DST display TPS 2 voltage of 4.0 volts or greater?		Go to Step (7)	Go to Step (5)
5	• Key OFF • Disconnect ECM wire harness connector CN1 • Using a DVOM check continuity on the TPS 2 signal circuit 148 between TPS 2 connector CN3 and ECM connector CN1 Do have continuity between them?		Go to Step (6)	Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.
6	• Replace ECM Is the replacement complete?		Go to Step (9)	
7	• Inspect the electronic throttle wire harness connector terminals for damage, corrosion or contamination Did you find a problem?		Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to Step (8)
8	• Replace the electronic throttle Is the replacement complete?		Go to Step (9)	-

Step	Action	Value(s)	Yes	No
9	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-222 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 223-TPS 2 Signal Voltage High



Conditions for Setting the DTC

- Throttle Position Sensor 2
- Check Condition-Cranking or Running
- Fault Condition-TPS 2 sensor exceeds 4.800 volts
- MIL-On during active fault
- Engine shutdown

Circuit Description

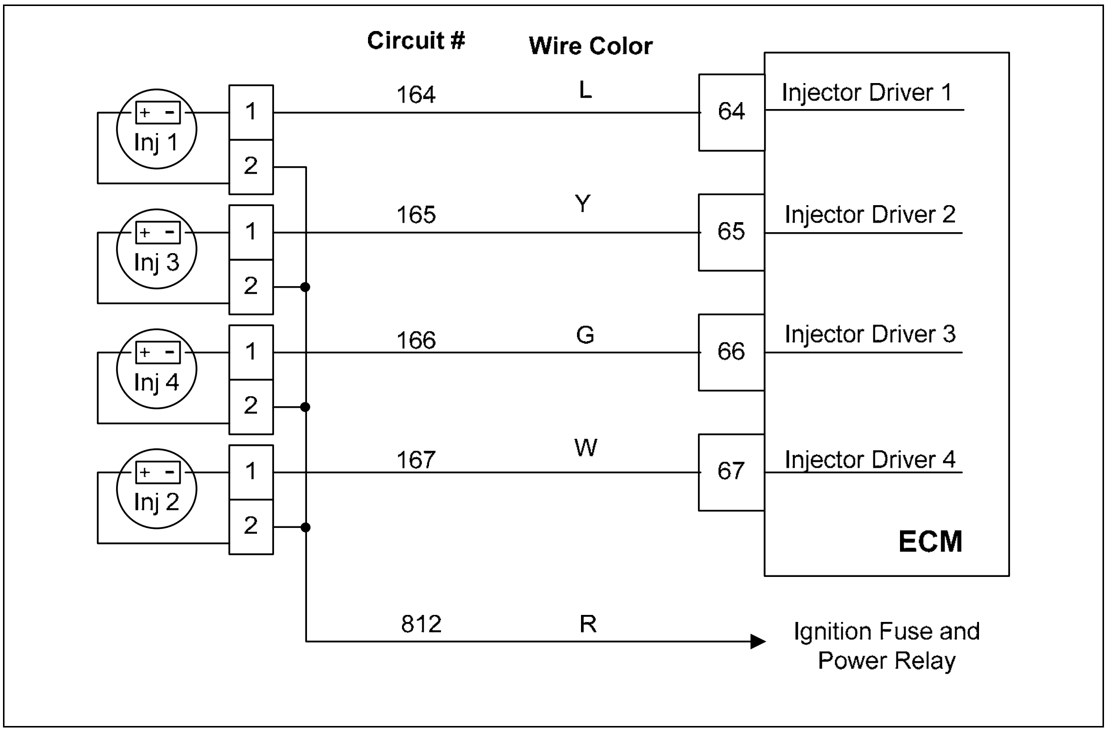
Dual throttle Position Sensors are used within the throttle that use variable resistors to determine signal voltage based on throttle plate position.TPS1 will read lower voltage when closed and TPS2 will read higher voltage when closed. The TPS1 and TPS2 percentages are calculated from these voltages. Although the voltages are different, the calculated values for the throttle position percentages should be very close to the same. The TPS values are used by the ECM to determine if the throttle is opening as commanded. The TPS is not serviceable and in the event of a failure the electronic throttle assembly must be replaced. This fault will set if the TPS 2 voltage is greater than 4.800 volts. The MIL command is ON and the engine will shutdown.

DTC 223-TPS 2 Signal Voltage High

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?	-	Go to Step (2)	Go to OBD System Check Section
2	• Key ON, Engine OFF • DST (Diagnostic Scan Tool) connected in DBW (Drive by Wire) throttle test mode Does the DST display TPS 2 voltage of 4.800 volts or greater with the throttle closed?		Go to Step (4)	Go to Step (3)
3	• Slowly depress Foot Pedal while observing TPS 2 voltage Does TPS 2 voltage ever exceed 4.800 volts?		Go to Step (4)	Intermittent problem Go to Intermittent section
4	• Key OFF • Disconnect electronic throttle connector CN3 • Key ON Does DST display TPS 2 voltage less than 0.2 volts?		Go to Step (7)	Go to Step (5)
5	• Key OFF • Disconnect ECM wire harness connector CN1 • Key ON • Using a DVOM check for voltage between electronic throttle connector TPS 2 signal circuit 148 and engine ground Do you have voltage?		Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to Step (6)
6	• Replace ECM Is the replacement complete?		Go to Step (11)	
7	• Probe sensor ground circuit at the ECM side of the wire harness circuit 120 with a test light connected to battery voltage Does the test light come on?		Go to Step (8)	Go to Step (10)
8	• Inspect the electronic throttle wire harness connector and terminals for damage, corrosion or contamination Did you find a problem?		Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to Step (9)
9	• Replace electronic throttle Is the replacement complete?		Go to Step (11)	-

Step	Action	Value(s)	Yes	No
10	• Key OFF • Disconnect ECM connector CN1 • Using a DVOM check for continuity on the sensor ground circuit 120 between throttle connector CN3 and ECM connector CN1 Do have continuity between them?		Go to Step (6)	Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.
11	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-223 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 261 Injector Driver 1 Open or Low Side Short to Ground



Conditions for Setting the DTC

- Injector loop open or low side short to ground
- Check Condition-key on and engine running
- Fault Condition-System voltage greater than 9 volts and injector low side less than 4.0 volts for 10 injector firings
- MIL-On for active fault
- Adaptive-Disabled
- Closed Loop-Disabled

Circuit Description

System battery voltage is supplied to each fuel injector. The ECM controls each fuel injector by providing a ground signal to pulse the injector ON. This fault will set if the ECM detects low feedback voltage at the injector driver circuit while the injector drive circuit is in the off-state and battery voltage is greater than 9 volts.

Diagnostic Aid

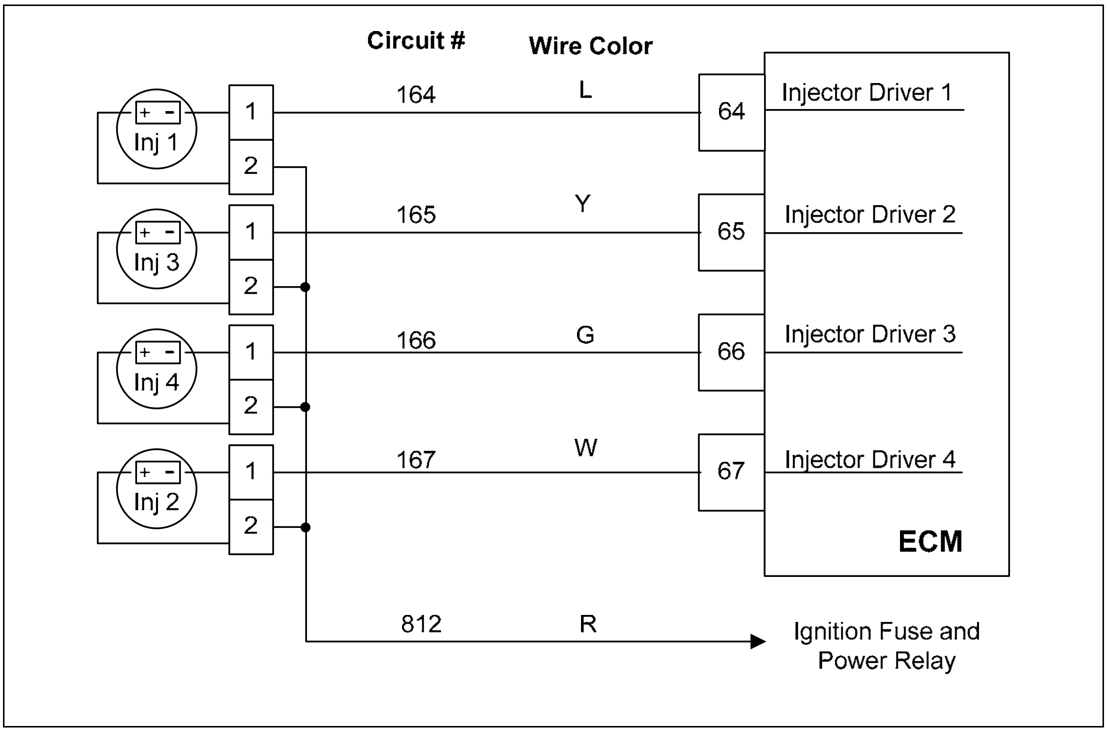
Injector coil resistance will increase as the temperature of the injector increases. Injector drivers at the ECM are numbered in sequence order and injectors by cylinder number.

DTC 261 Injector Driver 1 Open or Low Side Short to Ground

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?		Go to Step (2)	Go to OBD System Check Section
2	• Key On, Engine Running • DST (Diagnostic Scan Tool) connected in System Data Mode • Clear System DTC 261 Does DTC 261 reset with the engine idling?		Go to Step (3)	Intermittent problem. Go to Intermittent electrical section
3	• Key OFF • Disconnect the injector interface connector CN17 • Using a high impedance DVOM, measure the resistance between the fuel injector pins at the fuel metering body at an ambient temperature of 50 to 90 degrees F. Does the DVOM display a resistance value of 20 ohms or less?	20 ohms or less	Go to Step (5)	Go to Step (4)
4	• Replace the Fuel Injector Is the replacement complete?		Go to Step (8)	
5	• Disconnect the injector interface connector CN17 • Disconnect the ECM connector CN1 • Using a DVOM measure the resistance at connector CN17 between the injector control circuit 164 and engine ground Does the DVOM display a resistance of 5 Ohms or less?	5 Ohms or less	Repair the shorted to ground injector control circuit. See wire harness repair section	Go to Step (6)
6	• Using a DVOM check for continuity on the injector control circuit 164 between the injector connector CN17 and the ECM connector CN1 Do you have continuity between them?		Go to Step (7)	Repair the open injector control circuit. See wire harness repair section

Step	Action	Value(s)	Yes	No
7	• Replace the ECM. Is the replacement complete?		Go to Step (8)	
8	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-261 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 262-Injector Driver 1 Coil Shorted



Conditions for Setting the DTC

- Injector coil shorted
- Check Condition-key on and engine running
- Fault Condition-Battery voltage at ECM less than16 volts and injector on state low side greater than 4 volts for 10 injector firings
- MIL-On
- Adaptive-Disabled
- Closed Loop-Disabled

Circuit Description

System battery voltage is supplied to each fuel injector. The ECM controls each fuel injector by providing ground to pulse the injector. This fault will set if the ECM detects high feedback voltage at the injector while the injector drive circuit is in the off-state with system battery voltage less than 16 volts.

Diagnostic Aid

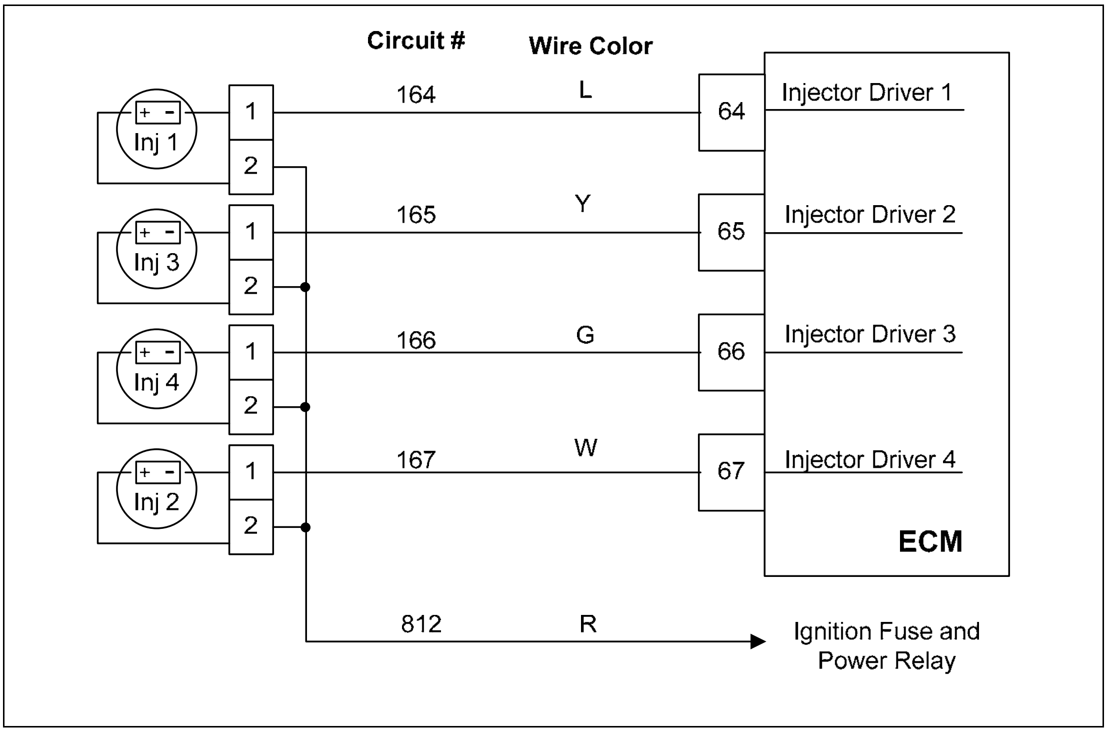
Injector coil resistance will increase as the temperature of the injector increases. Injector drivers at the ECM are numbered in sequence order and injectors by cylinder number.

DTC 262-Injector Driver 1 Coil Shorted

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?		Go to Step (2)	Go to OBD System Check Section
2	• Key On, Engine Running • DST (Diagnostic Scan Tool) connected in System Data Mode • Clear System DTC 262 Does DTC 262 reset with the engine idling?		Go to Step (3)	Intermittent problem Go to Intermittent section
3	• Key OFF • Disconnect the injector interface connector CN17 • Using a high impedance DVOM, measure the resistance between the fuel injector pins at the fuel metering body at an ambient temperature of 50 to 90 degrees F. Does the DVOM display a resistance value of 5 ohms or more?	Greater than 5.0 Ohms	Go to Step (5)	Go to Step (4)
4	• Replace the Fuel Injector Is the replacement complete?		Go to Step (8)	
5	• Disconnect the ECM wire harness connector CN1 • Key ON • Using a DVOM check for voltage between the ECM connector CN1 injector control circuit 164 and engine ground Does the DVOM display voltage?		Repair the shorted to voltage injector driver circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to Step (6)
6	• Replace the ECM Is the replacement complete?		Go to Step (7)	

Step	Action	Value(s)	Yes	No
7	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC262 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD system check

DTC 264-Injector Driver 2 Open or Low Side Short to Ground



Conditions for Setting the DTC

- Injector loop open or low side short to ground
- Check Condition-key on and engine running
- Fault Condition-System voltage greater than 9 volts and injector low side less than 4.0 volts for 10 injector firings
- MIL-On for active fault
- Adaptive-Disabled
- Closed Loop-Disabled

Circuit Description

System battery voltage is supplied to each fuel injector. The ECM controls each fuel injector by providing a ground signal to pulse the injector ON. This fault will set if the ECM detects low feedback voltage at the injector driver circuit while the injector drive circuit is in the off-state and battery voltage is greater than 9 volts.

Diagnostic Aid

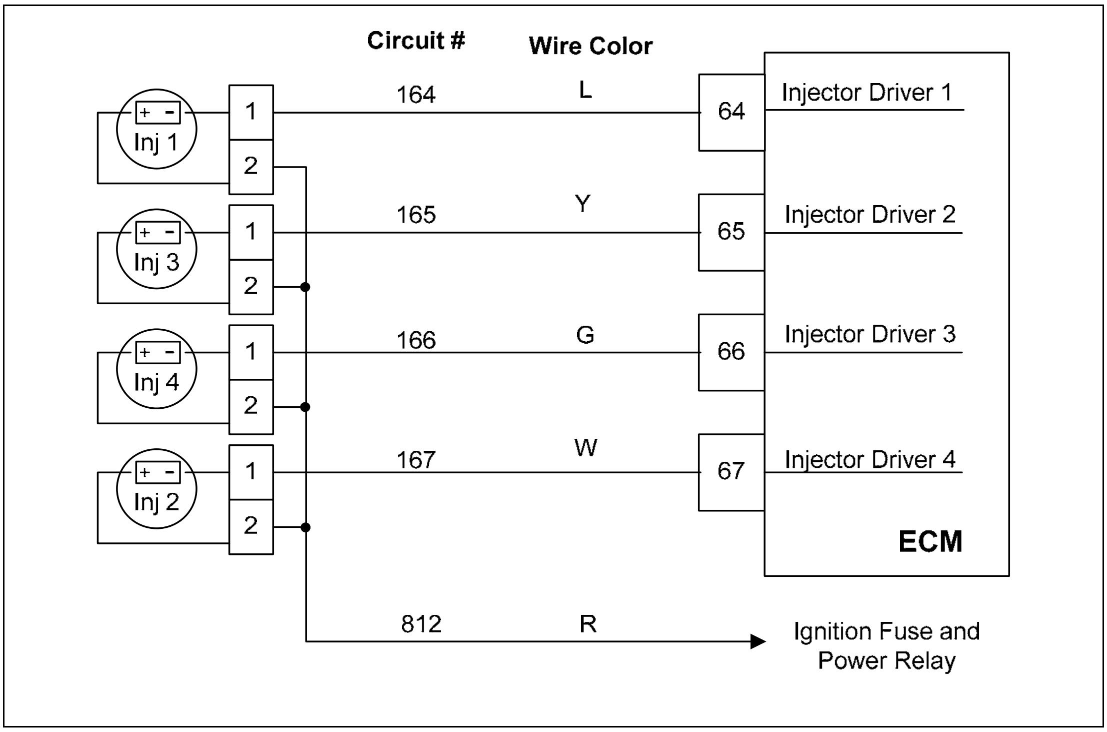
Injector coil resistance will increase as the temperature of the injector increases. Injector drivers at the ECM are numbered in sequence order and injectors by cylinder number.

DTC 264-Injector Driver 2 Open or Low Side Short to Ground

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?		Go to Step (2)	Go to OBD System Check Section
2	• Key On, Engine Running • DST (Diagnostic Scan Tool) connected in system data mode • Clear System DTC 264 Does DTC 264 reset with the engine idling?		Go to Step (3)	Intermittent problem. Go to Intermittent electrical section
3	• Key OFF • Disconnect the injector interface connector CN18 • Using a high impedance DVOM, measure the resistance between the fuel injector pins at the fuel metering body at an ambient temperature of 50 to 90 degrees F Does the DVOM display a resistance value of 20 ohms or less?	20 ohms or less	Go to Step (5)	Go to Step (4)
4	• Replace the Fuel Injector Is the replacement complete?		Go to Step (8)	
5	• Disconnect the injector interface connector CN18 • Disconnect the ECM connector CN1 • Using a DVOM measure the resistance between the injector control circuit 167 at the injector connector CN18 and engine ground Does the DVOM display a resistance of 5 Ohms or less?	5 Ohms or less	Repair the shorted to ground injector control circuit. See wire harness repair section	Go to Step (6)
6	• Using a DVOM check for continuity on the injector control circuit between the CN18 connector and the ECM connector CN1 Do you have continuity between them?		Go to Step (7)	Repair the open injector control circuit. See wire harness repair section

Step	Action	Value(s)	Yes	No
7	• Replace the ECM. Is the replacement complete?		Go to Step (8)	
8	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-264 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 265-Injector Driver 2 Coil Shorted



Conditions for Setting the DTC

- Injector coil shorted
- Check Condition-key on and engine running
- Fault Condition-Battery voltage at ECM less than16 volts and injector on state low side greater than 4 volts for 10 injector firings
- MIL-On
- Adaptive-Disabled
- Closed Loop-Disabled

Circuit Description

System battery voltage is supplied to each fuel injector. The ECM controls each fuel injector by providing ground to pulse the injector. This fault will set if the ECM detects high feedback voltage at the injector while the injector drive circuit is in the off-state with system battery voltage less than 16 volts.

Diagnostic Aid

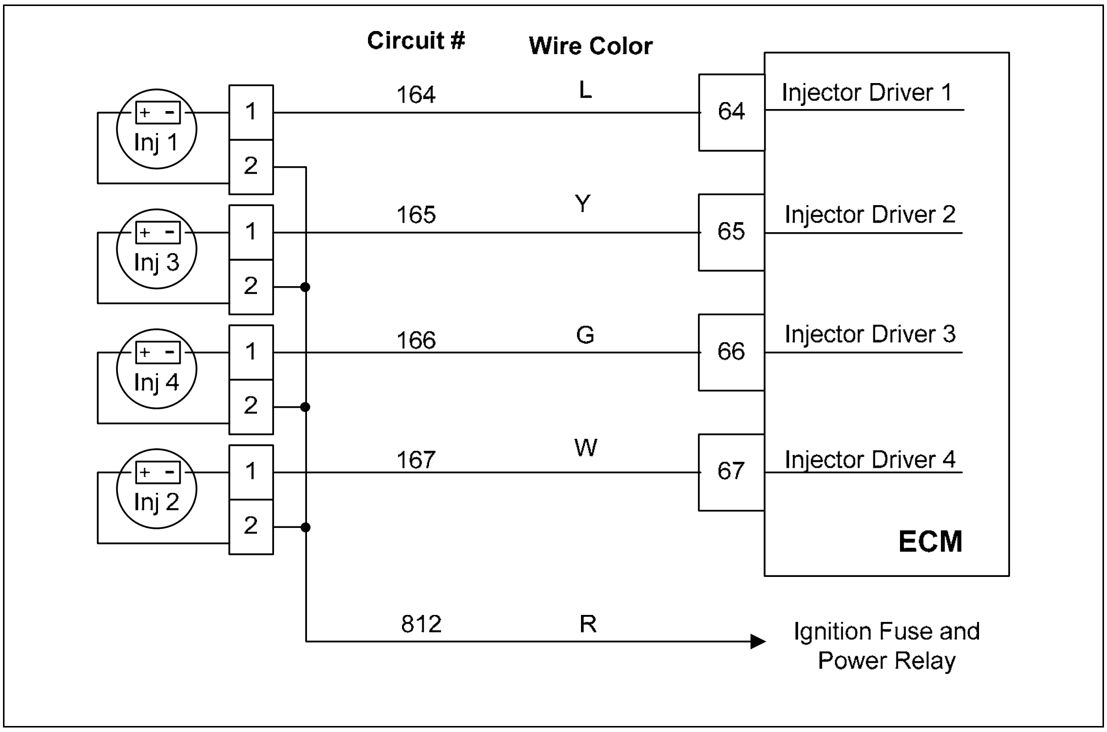
Injector coil resistance will increase as the temperature of the injector increases. Injector drivers at the ECM are numbered in sequence order and injectors by cylinder number.

DTC 265-Injector Driver 2 Coil Shorted

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?		Go to Step (2)	Go to OBD System Check Section
2	• Key On, Engine Running • DST (Diagnostic Scan Tool) connected in System Data Mode • Clear System DTC 265 Does DTC 265 reset with the engine idling?		Go to Step (3)	Intermittent problem Go to Intermittent section
3	• Key OFF • Disconnect the injector interface connector CN18 • Using a high impedance DVOM, measure the resistance between the fuel injector pins at the fuel metering body at an ambient temperature of 50 to 90 degrees F. Does the DVOM display a resistance value of 5 ohms or more?	Greater than 5.0 Ohms	Go to Step (5)	Go to Step (4)
4	• Replace the Fuel Injector Is the replacement complete?		Go to Step (8)	
5	• Disconnect the ECM wire harness connector CN1 • Key ON • Using a DVOM check for voltage between the ECM connector circuit167 and engine ground Does the DVOM display voltage?		Repair the shorted to voltage injector driver circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to Step (6)
6	• Replace the ECM Is the replacement complete?		Go to Step (7)	

Step	Action	Value(s)	Yes	No
7	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC265 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD system check

DTC 267-Injector Driver 3 Open or Low Side Short to Ground



Conditions for Setting the DTC

- Injector loop open or low side short to ground
- Check Condition-key on and engine running
- Fault Condition-System voltage greater than 9 volts and injector low side less than 4.0 volts for 10 injector firings
- MIL-On for active fault
- Adaptive-Disabled
- Closed Loop-Disabled

Circuit Description

System battery voltage is supplied to each fuel injector. The ECM controls each fuel injector by providing a ground signal to pulse the injector ON. This fault will set if the ECM detects low feedback voltage at the injector driver circuit while the injector drive circuit is in the off-state and battery voltage is greater than 9 volts.

Diagnostic Aid

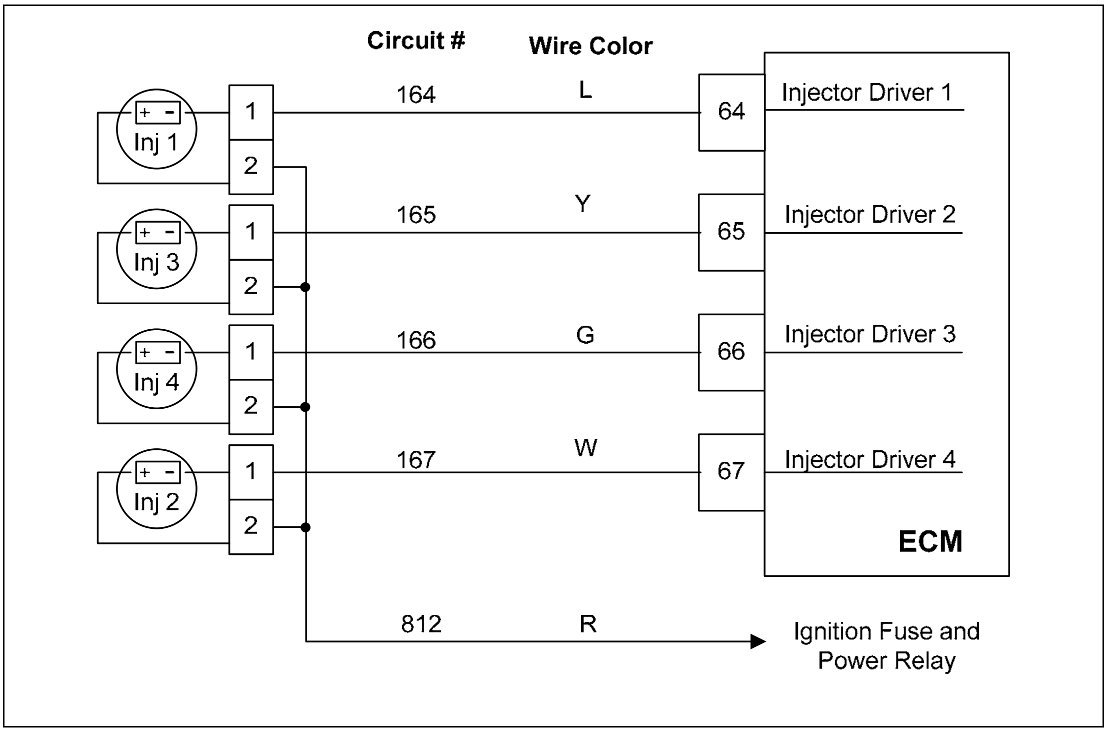
Injector coil resistance will increase as the temperature of the injector increases. Injector drivers at the ECM are numbered in sequence order and injectors by cylinder number.

DTC 267-Injector Driver 3 Open or Low Side Short to Ground

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?		Go to Step (2)	Go to OBD System Check Section
2	• Key On, Engine Running • DST (Diagnostic Scan Tool) connected in system data mode • Clear System DTC 267 Does DTC 267 reset with the engine idling?		Go to Step (3)	Intermittent problem. Go to Intermittent electrical section
3	• Key OFF • Disconnect the injector interface connector CN19. • Using a high impedance DVOM, measure the resistance between the fuel injector pins at the fuel metering body at an ambient temperature of 50 to 90 degrees F. Does the DVOM display a resistance value of 20 ohms or less?	20 ohms or less	Go to Step (5)	Go to Step (4)
4	• Replace the Fuel Injector Is the replacement complete?		Go to Step (8)	
5	• Disconnect the ECM connector CN1 • Using a DVOM measure the resistance between the injector connector control circuit 165 and engine ground Does the DVOM display a resistance of 5 Ohms or less?	5 Ohms or less	Repair the shorted to ground injector control circuit. See wire harness repair section	Go to Step (6)
6	• Using a DVOM check for continuity between the CN19 connector injector control pin and the ECM injector driver pin Do you have continuity between them?		Go to Step (7)	Repair the open injector control circuit. See wire harness repair section

Step	Action	Value(s)	Yes	No
7	• Replace the ECM. Is the replacement complete?		Go to Step (8)	
8	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-267 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 268-Injector Driver 3 Coil Shorted



Conditions for Setting the DTC

- Injector coil shorted
- Check Condition-key on and engine running
- Fault Condition-Battery voltage at ECM less than16 volts and injector on state low side greater than 4 volts for 10 injector firings
- MIL-On
- Adaptive-Disabled
- Closed Loop-Disabled

Circuit Description

System battery voltage is supplied to each fuel injector. The ECM controls each fuel injector by providing ground to pulse the injector. This fault will set if the ECM detects high feedback voltage at the injector while the injector drive circuit is in the off-state with system battery voltage less than 16 volts.

Diagnostic Aid

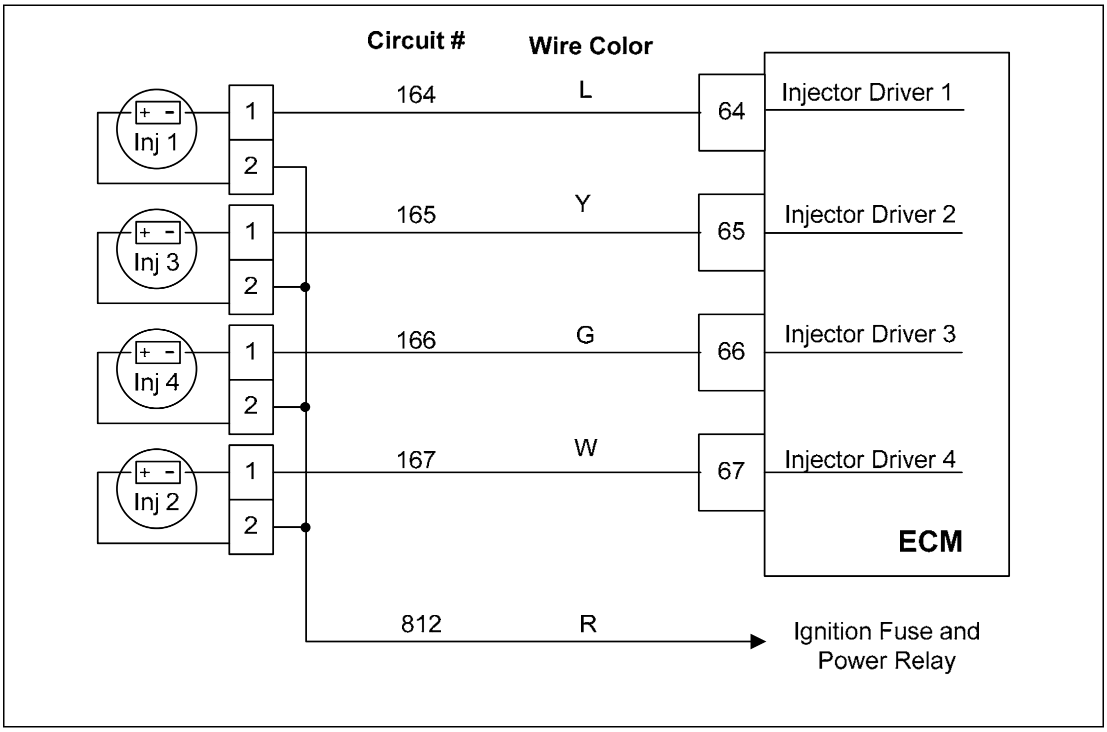
Injector coil resistance will increase as the temperature of the injector increases. Injector drivers at the ECM are numbered in sequence order and injectors by cylinder number.

DTC 268-Injector Driver 3 Coil Shorted

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?		Go to Step (2)	Go to OBD System Check Section
2	• Key On, Engine Running • DST (Diagnostic Scan Tool) connected in System Data Mode • Clear System DTC 268 Does DTC 268 reset with the engine idling?		Go to Step (3)	Intermittent problem Go to Intermittent section
3	• Key OFF • Disconnect the injector interface connector CN19 • Using a high impedance DVOM, measure the resistance between the fuel injector pins at the fuel metering body at an ambient temperature of 50 to 90 degrees F. Does the DVOM display a resistance value of 5 ohms or more?	Greater than 5.0 Ohms	Go to Step (5)	Go to Step (4)
4	• Replace the Fuel Injector Is the replacement complete?		Go to Step (8)	
5	• Disconnect the ECM wire harness connector CN1 • Key ON • Using a DVOM check for voltage between the ECM connector CN1 injector control circuit 165 and engine ground Does the DVOM display voltage?		Repair the shorted to voltage injector driver circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to Step (6)
6	• Replace the ECM Is the replacement complete?		Go to Step (7)	

Step	Action	Value(s)	Yes	No
7	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC268 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD system check

DTC 270-Injector Driver 4 Open or Low Side Short to Ground



Conditions for Setting the DTC

- Injector loop open or low side short to ground
- Check Condition-key on and engine running
- Fault Condition-System voltage greater than 9 volts and injector low side less than 4.0 volts for 10 injector firings
- MIL-On for active fault
- Adaptive-Disabled
- Closed Loop-Disabled

Circuit Description

System battery voltage is supplied to each fuel injector. The ECM controls each fuel injector by providing a ground signal to pulse the injector ON. This fault will set if the ECM detects low feedback voltage at the injector driver circuit while the injector drive circuit is in the off-state and battery voltage is greater than 9 volts.

Diagnostic Aid

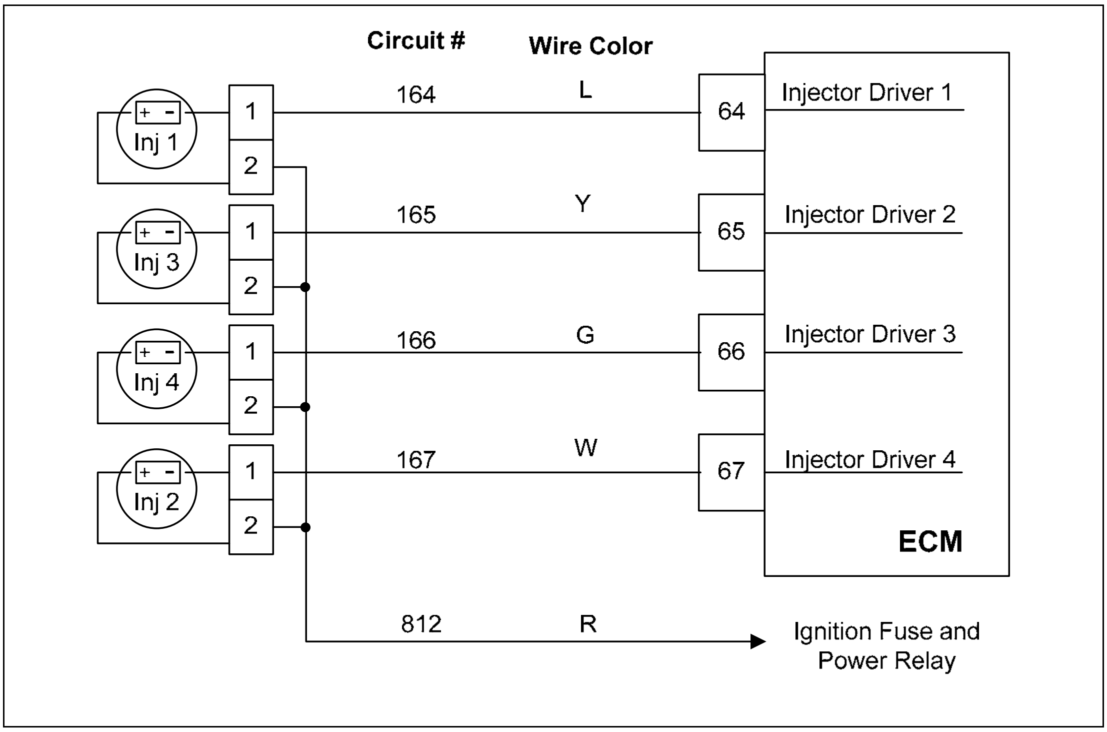
Injector coil resistance will increase as the temperature of the injector increases. Injector drivers at the ECM are numbered in sequence order and injectors by cylinder number.

DTC 270-Injector Driver 4 Open or Low Side Short to Ground

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?		Go to Step (2)	Go to OBD System Check Section
2	• Key On, Engine Running • DST (Diagnostic Scan Tool) connected in System Data Mode • Clear System DTC 270 Does DTC 270 reset with the engine idling?		Go to Step (3)	Intermittent problem. Go to Intermittent electrical section
3	• Key OFF • Disconnect the injector interface connector C20. • Using a high impedance DVOM, measure the resistance between the fuel injector pins at the fuel metering body at an ambient temperature of 50 to 90 degrees F. Does the DVOM display a resistance value of 20 ohms or less?	20 ohms or less	Go to Step (5)	Go to Step (4)
4	• Replace the Fuel Injector Is the replacement complete?		Go to Step (8)	
5	• Disconnect the injector interface connector CN20 • Disconnect the ECM connector CN1 • Using a DVOM measure the resistance between the injector control circuit 166 and engine ground Does the DVOM display a resistance of 5 Ohms or less?	5 Ohms or less	Repair the shorted to ground injector control circuit. See wire harness repair section	Go to Step (6)
6	• Using a DVOM check for continuity on the injector control circuit 166 between the CN20 connector and the ECM connector CN1 Do you have continuity between them?		Go to Step (7)	Repair the open injector control circuit. See wire harness repair section

Step	Action	Value(s)	Yes	No
7	• Replace the ECM. Is the replacement complete?		Go to Step (8)	
8	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-270 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 271-Injector Driver 4 Coil Shorted



Conditions for Setting the DTC

- Injector coil shorted
- Check Condition-key on and engine running
- Fault Condition-Battery voltage at ECM less than 16 volts and injector on state low side greater than 4 volts for 10 injector firings
- MIL-On
- Adaptive-Disabled
- Closed Loop-Disabled

Circuit Description

System battery voltage is supplied to each fuel injector. The ECM controls each fuel injector by providing ground to pulse the injector. This fault will set if the ECM detects high feedback voltage at the injector while the injector drive circuit is in the off-state with system battery voltage less than 16 volts.

Diagnostic Aid

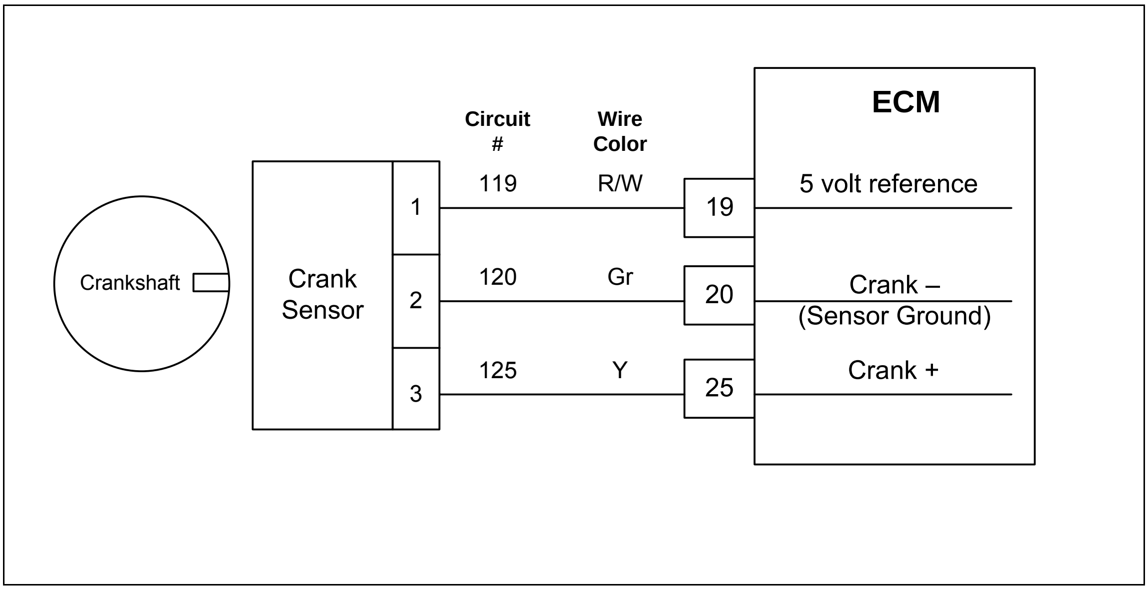
Injector coil resistance will increase as the temperature of the injector increases. Injector drivers at the ECM are numbered in sequence order and injectors by cylinder number.

DTC 271-Injector Driver 4 Coil Shorted

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?		Go to Step (2)	Go to OBD System Check Section
2	• Key On, Engine Running • DST (Diagnostic Scan Tool) connected in System Data Mode • Clear System DTC 271 Does DTC 271 reset with the engine idling?		Go to Step (3)	Intermittent problem Go to Intermittent section
3	• Key OFF • Disconnect the injector interface connector CN20 • Using a high impedance DVOM, measure the resistance between the fuel injector pins at the fuel metering body at an ambient temperature of 50 to 90 degrees F. Does the DVOM display a resistance value of 5 ohms or more?	Greater than 5.0 Ohms	Go to Step (5)	Go to Step (4)
4	• Replace the Fuel Injector Is the replacement complete?		Go to Step (8)	
5	• Disconnect the ECM wire harness connector CN1 • Key ON • Using a DVOM check for voltage between the ECM connector CN1 injector control circuit 166 and engine ground Does the DVOM display voltage?		Repair the shorted to voltage injector driver circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to Step (6)
6	• Replace the ECM Is the replacement complete?		Go to Step (7)	

Step	Action	Value(s)	Yes	No
7	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC271 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD system check

DTC 336-Crank Sync Noise



Conditions for setting the DTC

- Crankshaft Position sensor
- Check Condition Engine running
- Fault Condition 1 invalid crank re-sync in less than 800 ms
- MIL On during active fault
- Adaptive Disabled

Circuit Description

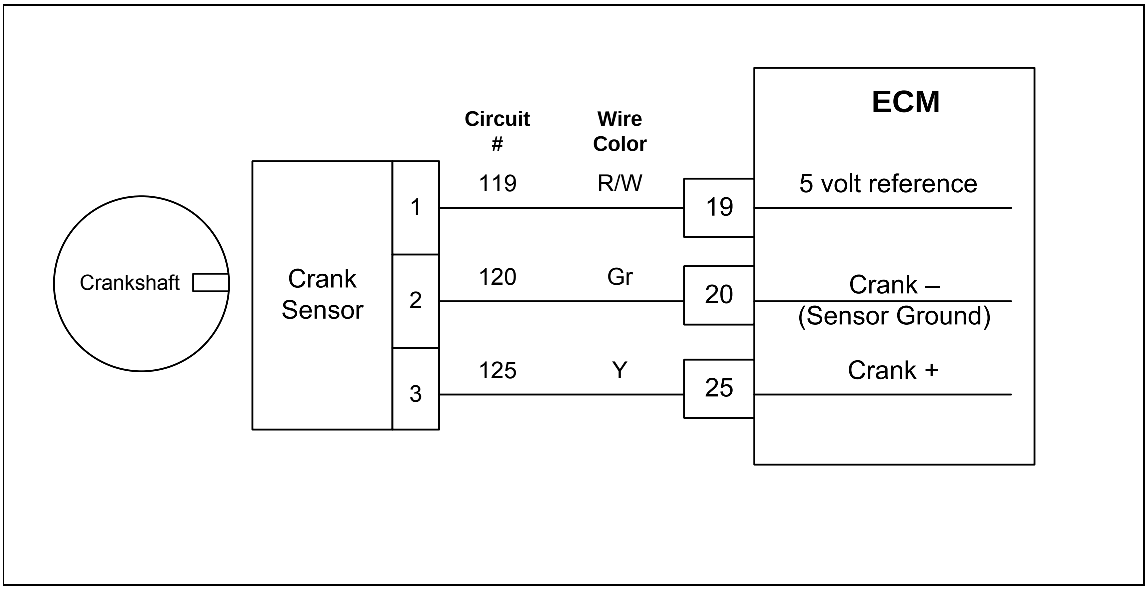
The Crankshaft position sensor is a 5 volt powered sensor mounted to the lower front engine block. A pulse wheel located on the crankshaft is used to measure engine rpm and its signal is used to synchronize the ignition and fuel systems. This fault will set If no signal is present for 800ms or longer.

DTC 336-Crank Sync Noise

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?		Go to Step (2)	Go to OBD System Check Section
2	• Check that the ECM ground terminal CN28 is clean, tight and in the proper location Are the ground terminals clean and tight?		Go to Step (3)	Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.
3	• Key On, Engine OFF • Disconnect the CKP (Crankshaft position) Sensor connector CN9 • Using A DVOM check for voltage at the CKP sensor connector CN9 circuit 119 pin A and engine ground Do you have voltage?	5.0 volts	Go to Step (4)	Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.
4	• Key OFF • Disconnect ECM connector CN1 • Using a DVOM check for continuity between CKP connector circuit 125 and ECM connector circuit 125 Do you have continuity between them?		Go to Step (5)	Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.
5	• Using a DVOM check for continuity on sensor ground circuit 120 between CKP connector CN9 and ECM connector CN1 Do you have continuity between them?		Go to Step (6)	Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.
6	• Inspect the CKP connector CN9 terminals for damage, corrosion or contamination Did you find a problem?		Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to Step (7)
7	• Inspect the ECM connector CN1 terminals for damage, corrosion or contamination Did you find a problem?		Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to Step (8)

Step	Action	Value(s)	Yes	No
8	• Replace CKP sensor Is the replacement complete?		Go to Step (10)	
9	• Replace ECM Is the replacement complete?		Go to Step (11)	
10	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-336 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to Step (9)
11	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-336 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 337-Crank Loss



Conditions for setting the DTC

- Crankshaft position sensor
- Check Condition Engine cranking
- Fault Condition 6 cam pulse signals without crankshaft activity
- MIL On during active fault
- Adaptive Disabled

Circuit Description

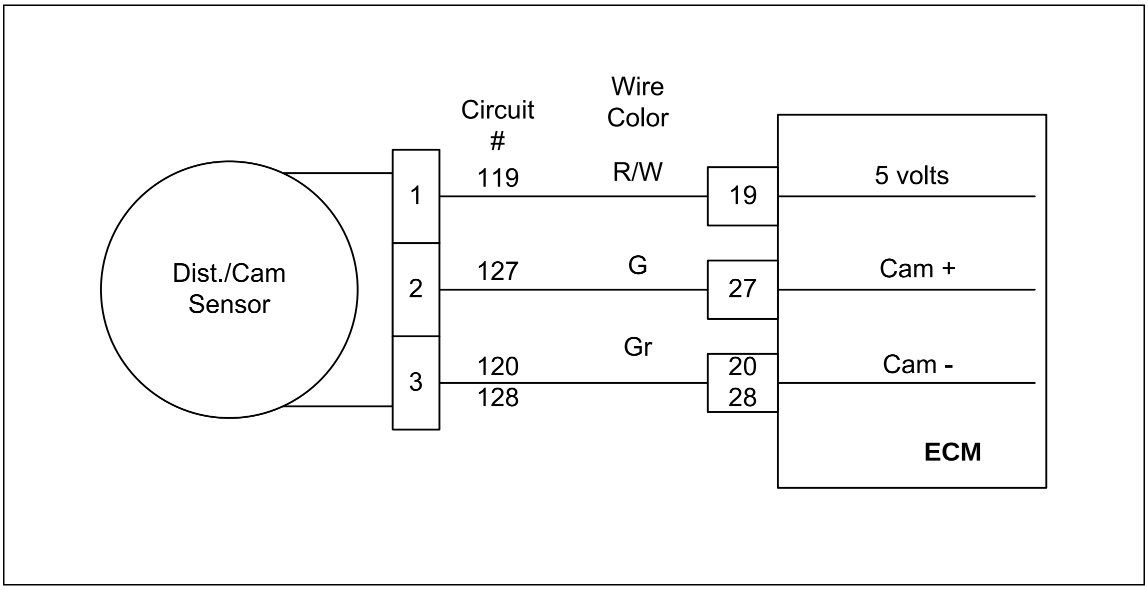
The Crankshaft position sensor is a 5 volt powered sensor mounted to the lower front engine block. A pulse wheel located on the crankshaft is used to measure engine rpm and its signal is used to synchronize the ignition and fuel systems. The ECM must see a valid Crankshaft position signal while cranking. If no crankshaft signal is present for 6 cam pulses this fault will set.

DTC 337-Crank Loss

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?		Go to Step (2)	Go to OBD System Check Section
2	• Check that the ECM ground terminal CN28 is clean, tight and in the proper location Are the ground terminals clean and tight?		Go to Step (3)	Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.
3	• Key OFF • Disconnect the CKP (Crankshaft Position) Sensor connector CN9 • Using A DVOM check for voltage at the CKP sensor connector CN9 circuit 119 and engine ground (**CHECK THIS BEFORE THE POWER RELAY SHUTS OFF**) Do you have voltage?	5.0 volts	Go to Step (4)	Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.
4	• Key OFF • Disconnect ECM connector CN1 • Using a DVOM check for continuity on crank signal circuit 125 between CKP connector and ECM connector Do you have continuity between them?		Go to Step (5)	Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.
5	• Using a DVOM check for continuity on the sensor ground circuit 120 between CKP connector CN9 and ECM connector CN1 Do you have continuity between them?		Go to Step (6)	Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.
6	• Inspect the CKP connector CN9 terminals for damage, corrosion or contamination Did you find a problem?		Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to Step (7)

Step	Action	Value(s)	Yes	No
7	• Inspect the ECM connector CN1 for damage, corrosion or contamination Did you find a problem		Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to Step (8)
8	• Replace the CKP sensor Is the replacement complete?		Go to Step (10)	
9	• Replace ECM Is the replacement complete?		Go to Step (11)	
10	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-337 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to Step (9)
11	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-337 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 341-Camshaft Sensor Sync Noise



Conditions for Setting the DTC

- Camshaft position sensor
- Check Condition-Cranking or Running
- Fault Condition 1 invalid cam re-sync in 700ms or less
- Adaptive learn disabled
- MIL-On

Circuit Description

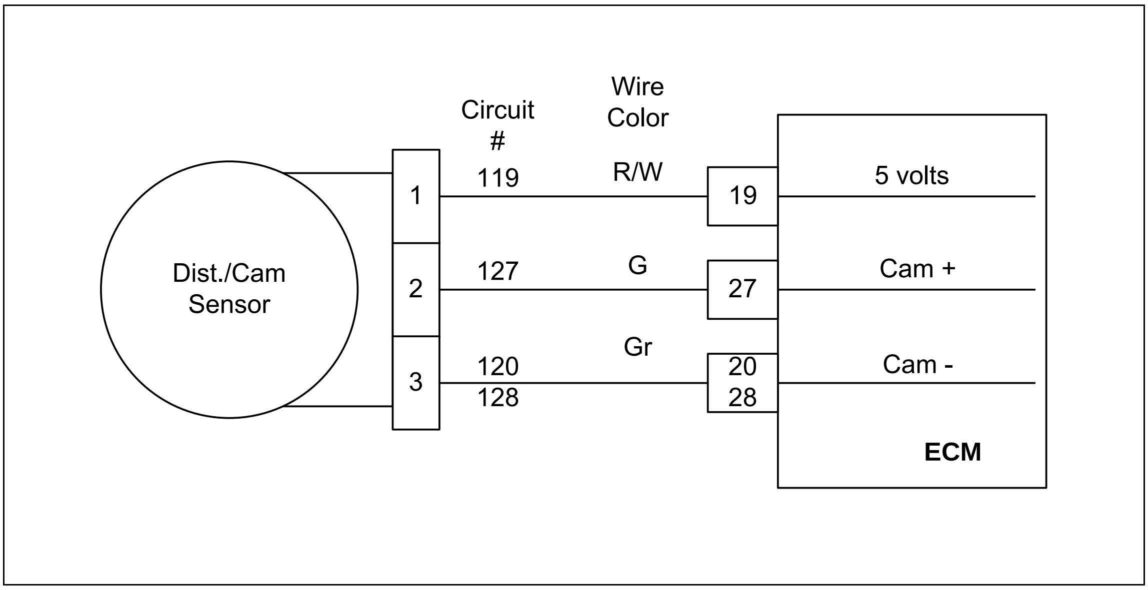
The CMP (Camshaft Position Sensor) is used to synchronize the fuel and ignition systems. This fault will set if the ECM detects erroneous pulses from the camshaft position sensor causing invalid cam re-sync.

DTC 341-Camshaft Sensor Sync Noise

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?		Go to Step (2)	Go to OBD System Check Section
2	• Check that the ECM ground terminal CN28 is clean, tight and in the proper location Are the ground terminals clean and tight?		Go to Step (3)	Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.
3	• Key OFF • Disconnect the CMP (Camshaft position) Sensor connector CN2 • Using A DVOM check for voltage at the CMP sensor connector CN2 circuit 119 and engine ground Do you have voltage?	5.0 volts	Go to Step (4)	Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.
4	• Key OFF • Disconnect ECM connector CN1 • Using a DVOM check for continuity on the CMP signal circuit 127 between CMP connector CN2 and ECM connector CN1 Do you have continuity between them?		Go to Step (5)	Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.
5	• Using a DVOM check for continuity on the sensor ground circuit 120 between CMP connector CN2 and ECM connector CN1 Do you have continuity between them?		Go to Step (6)	Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.
6	• Inspect the CMP connector terminals for damage, corrosion or contamination Did you find a problem?		Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to Step (7)
7	• Inspect the ECM connector CN1 for damage, corrosion or contamination Did you find a problem		Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to Step (8)

Step	Action	Value(s)	Yes	No
8	• Replace CMP sensor Is the replacement complete?		Go to Step (10)	-
9	• Replace ECM Is the replacement complete?		Go to Step (11)	-
10	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-341 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to Step (9)
11	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-341 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 342-Camshaft Sensor Loss



Conditions for Setting the DTC

- CMP (Camshaft Position Sensor)
- Check Condition-Engine Cranking or Running
- Fault Condition-No cam pulse in 2.5 cycles with engine speed greater than 1000 rpm
- MIL-On for active fault
- Adaptive-Disabled

Circuit Description

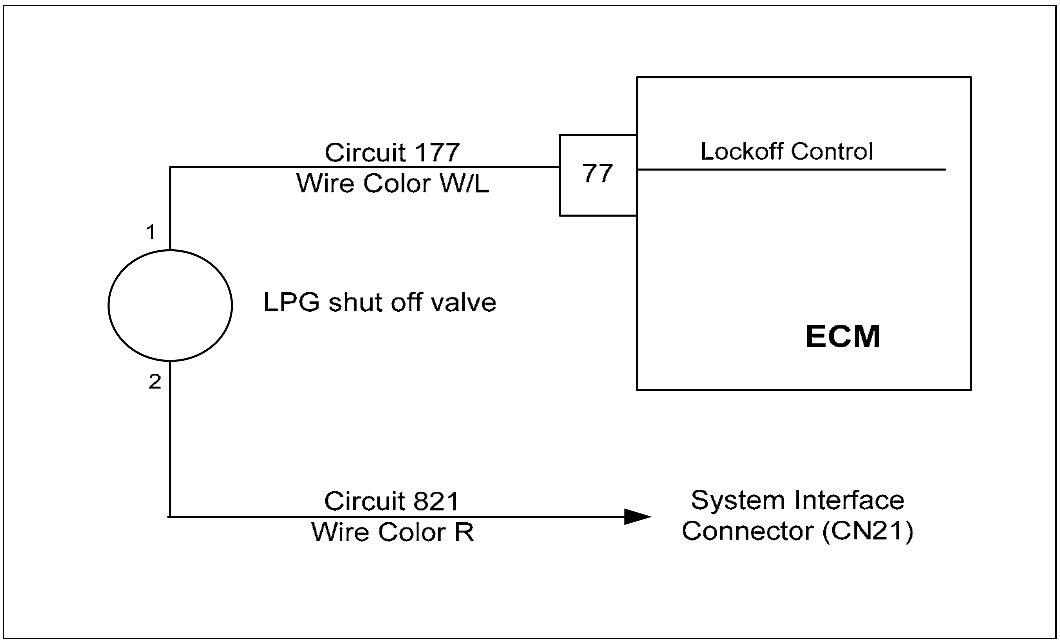
The CMP (Camshaft Position Sensor) is used to synchronize the fuel and ignition systems. This fault will set if the ECM does not detect a cam pulse in 2.5 engine cycles whenever the engine is greater than 1000 rpm. The engine may not run with this fault present.

DTC 342-Camshaft Sensor Loss

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?		Go to Step (2)	Go to OBD System Check Section
2	• Check that the ECM ground terminal CN28 is clean, tight and in the proper location Is the ground terminal clean tight and in the proper location?		Go to Step (3)	Repair the circuit as necessary. Refer to wiring harness repair section.
3	• Key OFF • Disconnect the CMP (Camshaft Position) Sensor connector CN2 • Key ON • Using A DVOM check for voltage between CMP sensor connector circuit 119 and engine ground (**RUN THIS VOLTAGE CHECK BEFORE THE POWER RELAY SHUTS OFF**) Do you have voltage?	5.0 volts	Go to Step (4)	Repair the circuit as necessary. Refer to wiring harness repair section.
4	• Key OFF • Disconnect ECM connector CN1 • Using a DVOM check for continuity on the CMP signal circuit 127 between CMP connector CN2 and ECM connector CN1 Do you have continuity between them?		Go to Step (5)	Repair the circuit as necessary. Refer to wiring harness repair section.
5	• Using a DVOM check for continuity on the sensor ground circuit between CMP connector CN2 and ECM connector CN1 Do you have continuity between them?		Go to Step (6)	Repair the circuit as necessary. Refer to wiring harness repair section.
6	• Inspect the CMP connector CN2 terminals for damage, corrosion or contamination Did you find a problem?		Repair the circuit as necessary. Refer to wiring harness repair section.	Go to Step (7)

Step	Action	Value(s)	Yes	No
7	• Inspect the ECM connector terminals for damage, corrosion or contamination Did you find a problem?		Repair the circuit as necessary. Refer to wiring harness repair section.	Go to Step (8)
8	• Replace the CMP. Is the replacement complete?		Go to Step (10)	
9	• Replace ECM Is the replacement complete?		Go to Step (11)	
10	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-342 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to Step (9)
11	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-342 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 359-Fuel Run-out Longer Than Expected



Conditions for Setting the DTC

- LPG shut off valve
- Check Condition Key OFF
- Fault Condition Engine run down time greater than 20 seconds
- MIL-On

Circuit Description

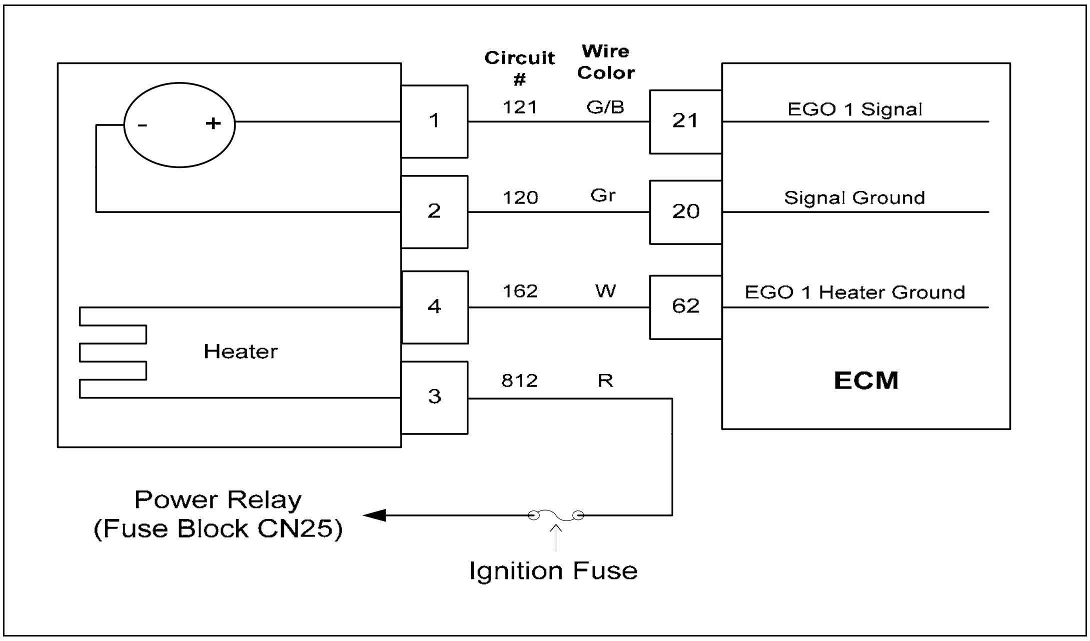
The LPG shut off valve is supplied system battery power from the VSW fused source. The ECM then provides a path to ground to turn the valve on. This fault will set in the event the engine continues to run for more than 20 seconds after the key is turned off.
This fault indicates a possible problem with the electric LPG shut off solenoid.

DTC 359-Fuel Run-out Longer Than Expected

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?	-	Go to Step (2)	
2	• Disconnect the LPG shut off solenoid connector CN13 • Using a DVOM check for power across terminals (circuits 177 and 821) while cranking the engine, then turn the key to the OFF position. Did the voltage immediately turn OFF with the Key cycle?	System Voltage	Go to Step (3)	Go to Step (5)
3	• Unplug the LPG Shut-off valve electrical connector. • Start the engine and let it idle until the engine stops. (THIS MAY TAKE SEVERAL MINUTES) Did the engine ever stop?		Intermittent problem. See intermittent problems in the electrical section of this manual.	Go to Step (4)
4	• Replace the LPG shut off valve. Is the replacement complete?		Go to Step (8)	–
5	• Key OFF • Disconnect the ECM wire harness connector CN1 • Using a DVOM check for continuity between circuit 177 and engine ground Do you have continuity?		Repair the LPG solenoid control short to ground	Go to Step (6)
6	• Inspect the ECM wire harness and connector for damage corrosion or contamination Did you find a problem?		Correct the problem as required. See wire harness repair.	Go to Step (7)
7	• Replace the ECM Is the replacement complete?		Go to Step (8)	–

Step	Action	Value(s)	Yes	No
8	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and drivability • After operating the engine within the test parameters of DTC-359 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 420-Catalyst Monitor Test (Bi-Fuel/Gasoline Only)



Conditions for Setting the DTC

- Heated Oxygen Sensor
- Check condition Engine running
- Fault condition Catalyst monitor test failed
- MIL On during active fault
- Adaptive Disabled during active fault
- Closed Loop Disabled during active fault

Circuit Description

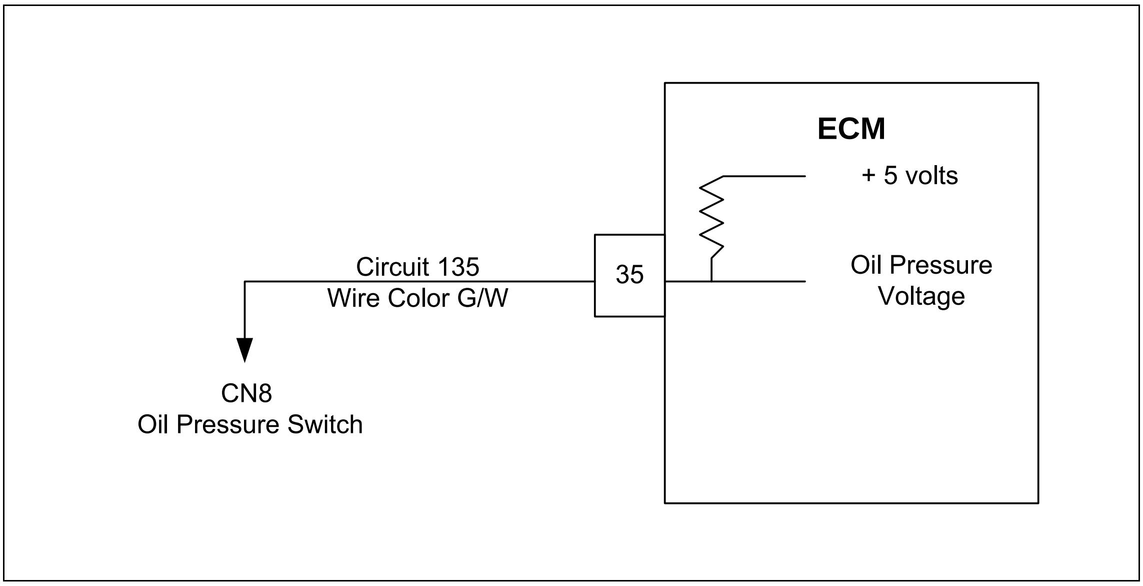
The catalyst monitor test is run under certain operating conditions to determine if the catalyst is functioning correctly. If the test is failed the fault will set letting the operator know the catalyst is not functioning as intended. Closed loop operation and adaptive learn capabilities are disabled upon activation of this fault.

DTC 420-Catalyst Monitor Test (Bi-Fuel/Gasoline Only)

Diagnostic Aid

- Inspect the exhaust system for visual signs of damage, leaks, or modification and repair if necessary.
- Insure the pre catalyst and post catalyst oxygen sensors are mounted correctly and wiring is not damaged, melted, or corroded and repair if necessary.
- If none of the above problems are found replace the catalyst.

DTC 524-Oil Pressure Low



Conditions for Setting the DTC

- Engine Oil Pressure low
- Check Condition-Engine running for 20 seconds or more with engine speed greater than 600 rpm
- Fault Condition Open pressure switch circuit voltage equal to or greater than 2.50 volts
- MIL-On
- Engine Shut Down

Circuit Description

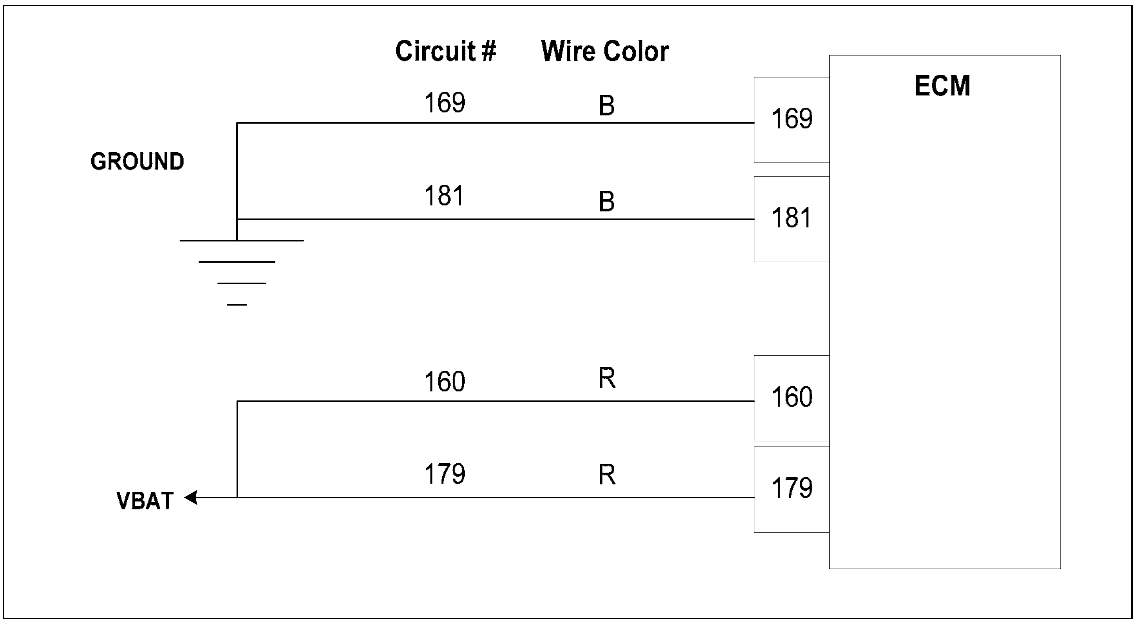
The Oil Pressure Switch is used to communicate a low oil pressure condition to the ECM. Engine damage can occur if the engine is operated with low oil pressure. The ECM uses an analog voltage input with an internal voltage reference. If the oil pressure circuit is grounded, the input voltage will be near zero. If it is open, the input will be near 2.00 volts. The pressure switch is normally open. This fault will set if the switch remains open with the engine running. The MIL command is ON and the engine will shut down in the event of this fault to help prevent possible engine damage.

DTC 524-Oil Pressure Low

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?		Go to Step (2)	Go to OBD System Check Section
2	• Verify that the engine has oil pressure using a mechanical oil pressure gauge before proceeding. Does the engine have oil pressure above 5 psi?		Go to Step (3)	Repair faulty Oiling System
3	• Key On, Engine Running DST connected in System Data Mode • Clear DTC 524 • Warm the engine by idling until the ECT temperature is above 160 degrees F. and has been running for at least 20 seconds or more • Increase engine speed above 600 RPM Does DTC 524 reset and cause the engine to shut down?		Go to Step (4)	Intermittent problem Go to Intermittent section
4	• Key OFF • Disconnect the oil pressure switch harness connector CN8 and ground it to a good engine ground • Clear DTC 524 • Start engine, let idle for at least one minute with ECT over 160 degrees F. • Increase engine speed above 600 RPM Does DTC 524 reset?		Go to Step (6)	Go to Step (5)
5	• Replace oil pressure switch Is the replacement complete?		Go to Step (9)	
6	• Key OFF • Disconnect ECM harness connector CN1 • Leave the oil pressure switch connector grounded to a good engine ground • Using a DVOM check for continuity between oil pressure switch connector CN1 and engine ground. Do you have continuity between them?		Go to Step (7)	Repair the open oil pressure switch circuit as necessary. Refer to Wiring Repairs in Engine Electrical.

Step	Action	Value(s)	Yes	No
7	• Inspect the oil pressure switch connector terminal and ECM connector for damage corrosion or contamination Did you find a problem?		Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to Step (8)
8	• Replace ECM Is the replacement complete?		Go to Step (9)	-
9	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-524 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 562-System Voltage Low



Conditions for Setting the DTC

- System Voltage to ECM
- Check Condition-Key on with engine speed greater than 1000 RPM
- Fault Condition-Battery voltage at ECM less than 9.0
- MIL-On for active fault
- Adaptive-Disabled

Circuit Description

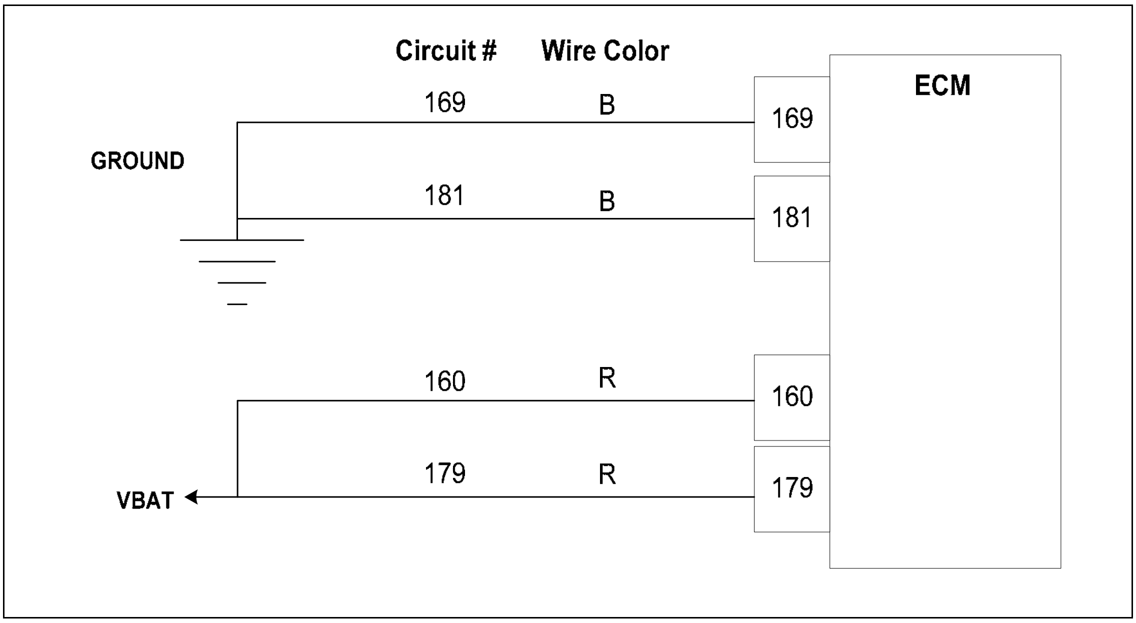
The battery voltage powers the ECM and must be measured to correctly to properly operate injector drivers, solenoid valves and ignition coils. This fault will set if the ECM detects system voltage less than 9.0 volts while the alternator should be charging. The adaptive learn is disabled during this fault.

DTC 562 System Voltage Low

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?		Go to Step (2)	Go to OBD System Check Section
2	• Key On, Engine Running • DST (Diagnostic Scan Tool) connected in System Data Mode Does DST display system voltage greater than 9.0 volts?		Intermittent problem Go to Engine Electrical Intermittent section	Go to Step (3)
3	• Check battery condition Is it OK?		Go to Step (4)	Replace Battery
4	• Check charging system Is it OK?		Go to Step (5)	Repair charging System
5	• Key OFF • Disconnect the ECM connector CN1 • Using a DVOM check the voltage between ECM connector CN1 circuits 160 and 179 and engine ground Is the voltage greater than for each pin 9.0 volts?		Repair ECM Ground circuit. Go to Power and Ground section in engine Electrical	Go to Step (6)
6	• Using a DVOM check voltage between battery positive and ECM connector CN1 circuits 169 and 181 Is the voltage greater than 9.0 volts?		Repair ECM power circuit. Go to Power and Ground section in engine Electrical	Go to Step (7)
7	• Replace ECM Is the replacement complete?		Go to Step (8)	

Step	Action	Value(s)	Yes	No
8	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-562 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 563-System Voltage High



Conditions for Setting the DTC

- System Voltage to ECM
- Check Condition-Cranking or Running
- Fault Condition-System battery voltage at ECM greater than 16 volts
- MIL-On for active fault
- Adaptive-Disabled

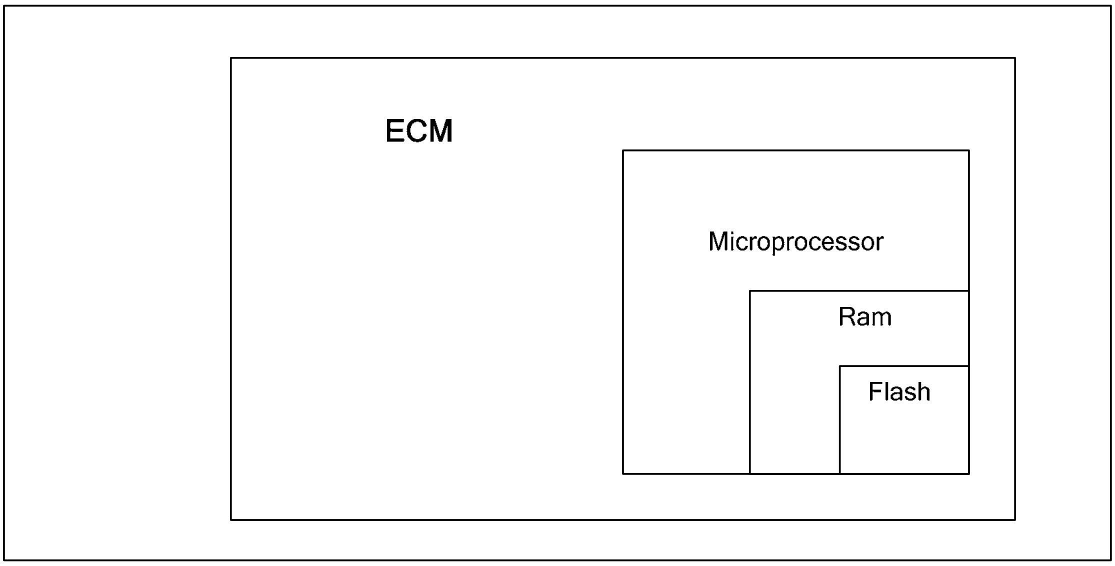
Circuit Description

The battery voltage powers the ECM and must be measured to correctly operate injector drivers, trim valves and ignition coils. This fault will set if the ECM detects voltage greater than 16 volts anytime the engine is cranking or running. The adaptive learn function is disabled during this fault. The ECM will shut down with internal protection if the system voltage ever exceeds 26 volts.

DTC 563-System Voltage High

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?		Go to Step (2)	Go to OBD System Check Section
2	• Key On, Engine Running • DST (Diagnostic Scan Tool) connected in System Data Mode • Run engine greater than 1000 rpm Does DST display system voltage greater than 16 volts?		Go To Step (3)	Intermittent problem Go to Engine Electrical Intermittent section
3	• Check voltage at battery terminals with DVOM with engine speed greater than 1000 rpm Is it greater than 16 volts?		Go to Step (4)	Go to Step (5)
4	• Repair the charging system Has the charging system been repaired?		Go to Step (6)	
5	• Replace ECM Is the replacement complete?		Go to Step (6)	
6	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-563 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 601-Flash Checksum Invalid



Conditions for Setting the DTC

- Engine Control Module
- Check Condition Key on
- Fault Condition Internal microprocessor error
- MIL On
- Adaptive Disabled for the remainder of the key-ON cycle
- Power Derate level 2

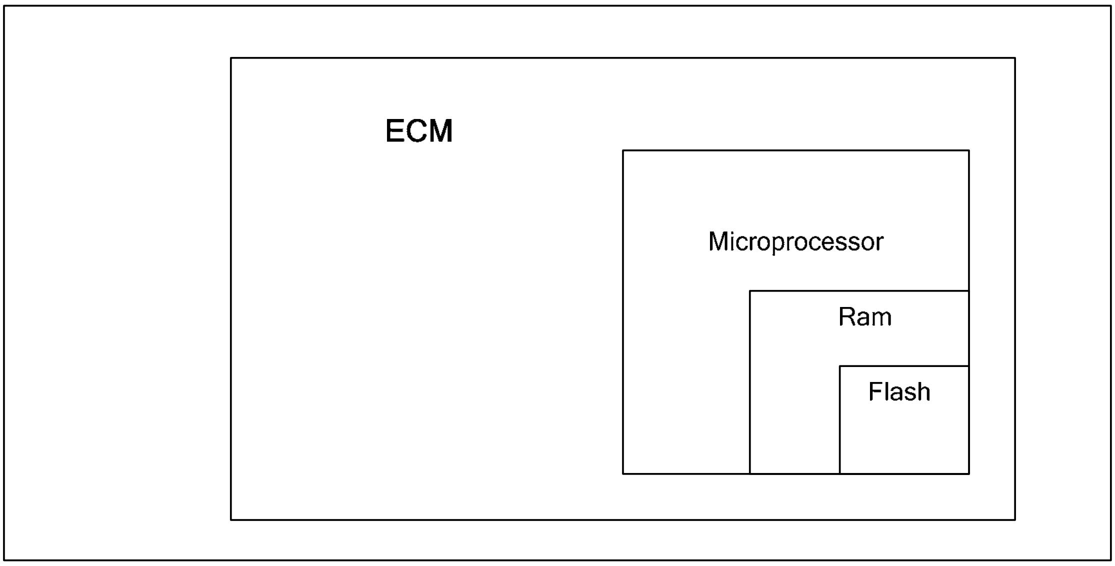
Circuit Description

The ECM has several internal checks that must be satisfied each time an instruction is executed. Several different things can happen within the microprocessor that will cause this fault. The ECM will attempt to reset itself in the event this fault is set. The MIL command is on and will remain on until the code is cleared using the DST. Power Derate level 2 will be enforced limiting maximum power.

DTC 601-Flash Checksum Invalid

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?		Go to Step (2)	Go to OBD System Check Section
2	• Key On, Engine Running • DST (Diagnostic Scan Tool) connected in System Data Mode • Clear system fault code Does DTC 601 reset with the engine idling?		Go to Step (3)	Intermittent problem Go to Intermittent section
3	• Check ECM power and ground circuits Did the power and ground circuits check OK?		Go to Step (4)	Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.
4	• Replace ECM Is the replacement complete?		Go to Step (5)	
5	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-601 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 604-RAM Failure



Conditions for Setting the DTC

- Engine Control Module
- Check Condition Key on
- Fault Condition Internal microprocessor error
- MIL On
- Adaptive Disabled for the remainder of the key-ON cycle
- Power Derate level 2

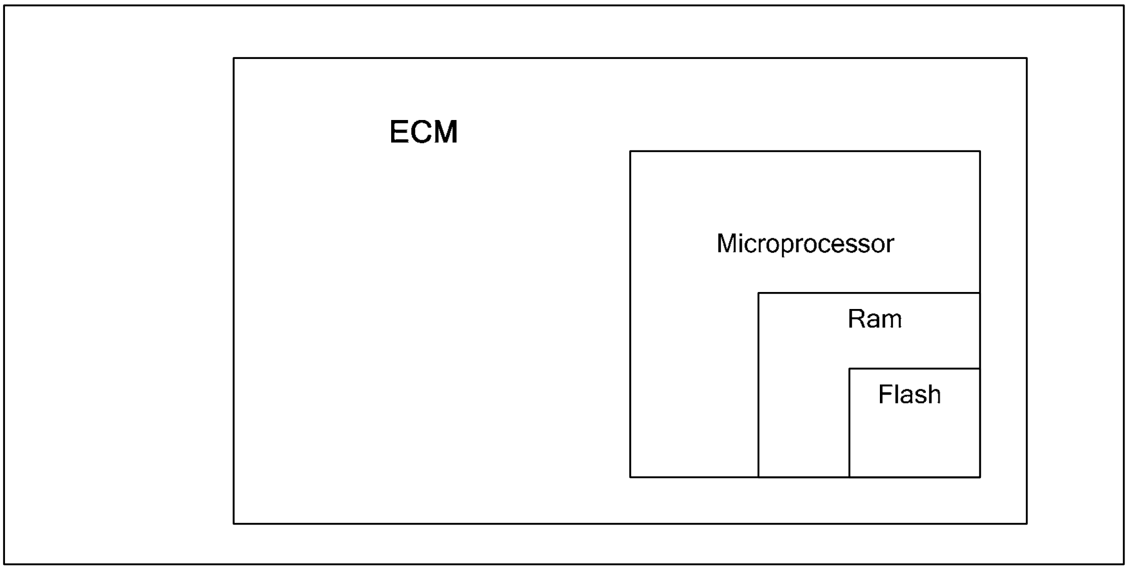
Circuit Description

The ECM has several internal checks that must be satisfied each time an instruction is executed. Several different things can happen within the microprocessor that will cause this fault. The ECM will attempt to reset itself in the event this fault is set. The MIL command is on and will remain on until the code is cleared using the DST. Power Derate level 2 will be enforced limiting maximum power output.

DTC 604-RAM Failure

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?		Go to Step (2)	Go to OBD System Check Section
2	• Key On, Engine Running • DST (Diagnostic Scan Tool) connected in System Data Mode • Clear system fault code Does DTC 604 reset with the engine idling?		Go to Step (3)	Intermittent problem Go to Intermittent section
3	• Check ECM power and ground circuits Did the power and ground circuits check OK?		Go to Step (4)	Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.
4	• Replace ECM Is the replacement complete?		Go to Step (5)	
5	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-604 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 606-COP Failure



Conditions for Setting the DTC

- Engine Control Module
- Check Condition Key on
- Fault Condition Internal microprocessor error
- MIL On
- Adaptive Disabled Power Derate level 2

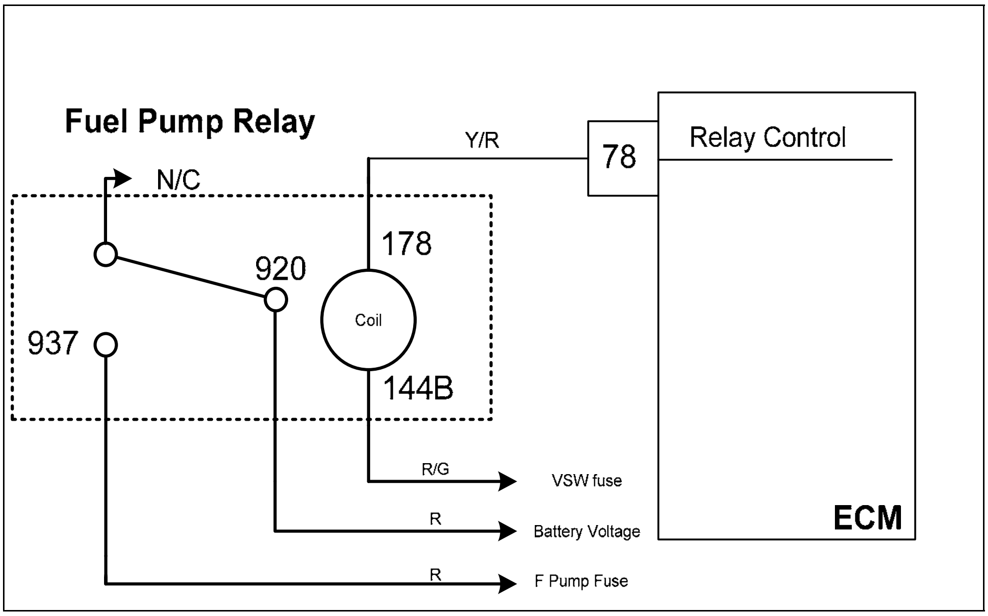
Circuit Description

The ECM has several internal checks that must be satisfied each time an instruction is executed. Several different things can happen within the microprocessor that will cause this fault. The ECM will attempt to reset itself in the event this fault is set. The MIL command is on and will remain on until the code is cleared using the DST. Power Derate level 2 will be enforced limiting maximum power output.

DTC 606-COP Failure

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?		Go to Step (2)	Go to OBD System Check Section
2	• Key On, Engine Running • DST (Diagnostic Scan Tool) connected in System Data Mode • Clear system fault code Does DTC 606 reset with the engine idling?		Go to Step (3)	Intermittent problem Go to Intermittent section
3	• Check ECM power and ground circuits Are the power and ground circuits OK?		Go to Step (4)	Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.
4	• Replace ECM Is the replacement complete?		Go to Step (5)	
5	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-606 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 627-Fuel Pump Relay Coil Open (Bi-Fuel/Gasoline Only)



Conditions for Setting the DTC

- Fuel pump relay check
- Check Condition-Key ON
- Fault Condition Relay coil open

Circuit Description

The fuel pump relay switches power out to the fuel pump for operation on gasoline fuel. This fault will set if the ECM detects an open circuit on the relay control output.

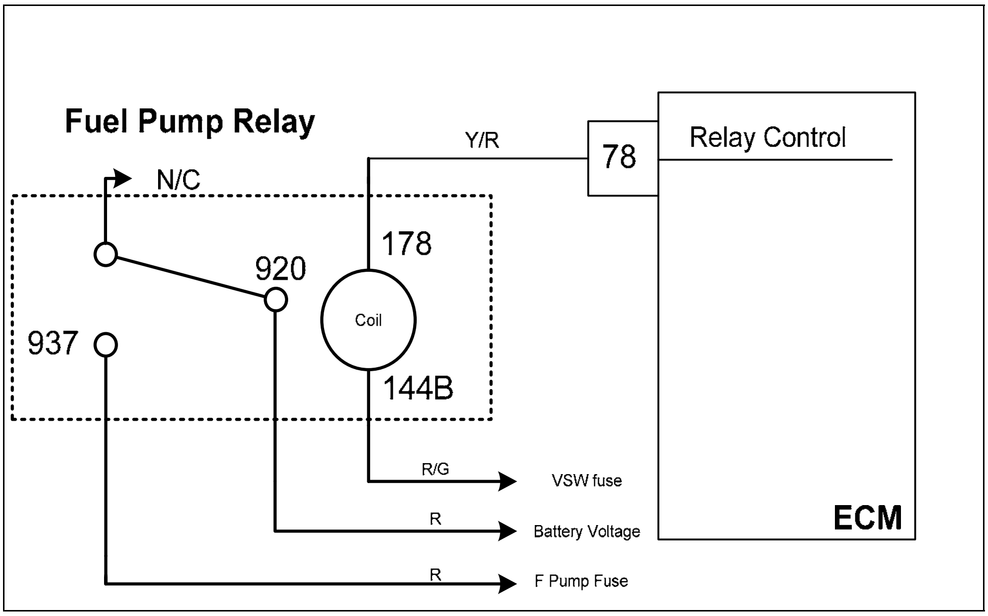
Diagnostic Aid
Relay coil resistance changes with temperature. The following diagnostic charts have steps to measure relay coil resistance values. When checking the resistance values be sure the relay is at a reasonable temperature, between +20 and +100 degrees F.

DTC 627-Fuel Pump Relay Coil Open (Bi-Fuel/Gasoline Only)

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?		Go to Step (2)	Go to OBD System Check Section
2	• DST connected and in the System Data Mode • Key OFF • Remove the fuel pump relay from the fuse block • Using a DVOM check the resistance of the relay coil between the relay terminals for circuits 144B and 178 Is the resistance value less than 100 ohms?		Go to Step (4)	Go to Step (3)
3	• Replace the relay Is the replacement complete?		Go to Step (9)	
4	• Check VSW fuse Is the fuse open?		Replace ECM fuse	Go to Step (5)
5	• Disconnect ECM connector CN1 • Using a DVOM check for continuity between ECM connector CN1 circuit 178 and fuel pump relay circuit 178 Do you have continuity?		Go to Step (6)	Repair the open circuit as required. See wiring harness repairs
6	• Remove ECM fuse • Using a DVOM check for continuity on circuit 144B between fuse block cavity for the fuel pump relay and the VSW fuse Do you have continuity?		Go to Step (7)	Repair the open circuit as required. See wiring harness repairs
7	• Check all system fuses. • Check all relay placement positions in fuse block. • Run complete pin to pin checks on chassis wiring to fuel system harness. • See complete fuel system schematic for further details Did you find the problem?		Go to Step (9)	Go to Step (8)

Step	Action	Value(s)	Yes	No
8	• Replace the ECM Is the replacement complete?		Go to Step (9)	–
9	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-627 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 628-Relay Control Ground Short (Bi-Fuel/Gasoline Only)



Conditions for Setting the DTC

- Fuel pump relay ground control
- Check Condition-Key ON
- Fault Condition Relay control shorted to ground

Circuit Description

The fuel pump relay switches power out to the fuel pump for operation on gasoline fuel. This fault will set if the ECM detects a short to ground on the relay control output.

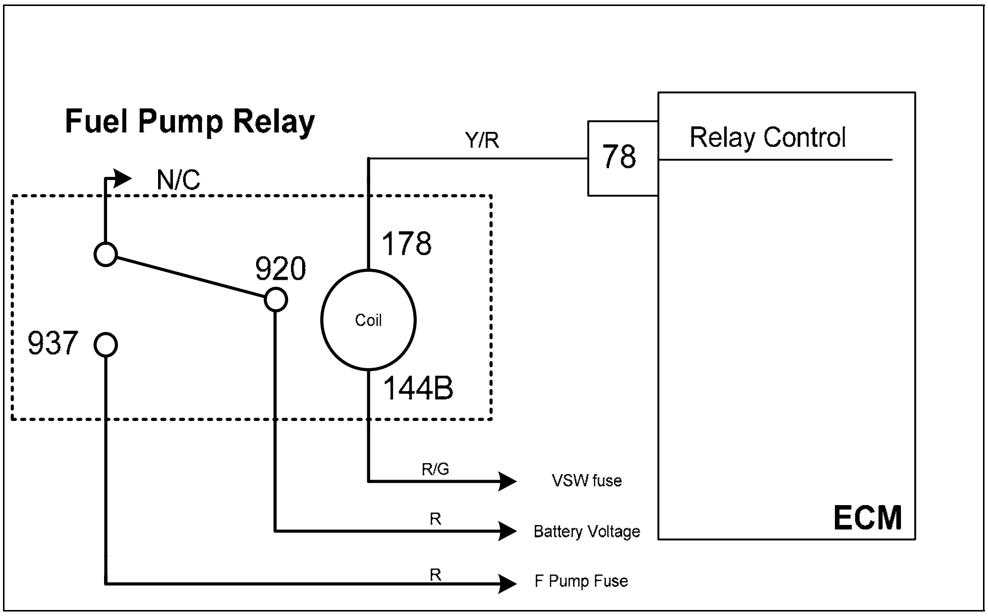
Diagnostic Aid

Relay coil resistance changes with temperature. The following diagnostic charts have steps to measure relay coil resistance values. When checking the resistance values be sure the relay is at a reasonable temperature, between +20 and +100 degrees F.

DTC 628-Relay Control Ground Short (Bi-Fuel/Gasoline Only)

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?		Go to Step (2)	Go to OBD System Check Section
2	• Key On, DST connected in the System Data Mode • Clear DTC 628 • Start the engine Does DTC 628 re-set?		Go to Step (3)	Intermittent problem Go to Intermittent section
3	• Disconnect ECM connector CN1 • Using a DVOM check the resistance value between ECM connector CN1 circuit 178 and engine ground Is the resistance less than 60 ohms?		Go to Step (4)	Go to Step (6)
4	• Remove the power relay from the fuse block • Using a DVOM check the resistance value again between ECM connector circuit 178 and engine ground Is the resistance less than 60 ohms?		Repair the shorted to ground relay control circuit as necessary. See wiring harness repairs	Go to Step (5)
5	• Replace the power relay Is the replacement complete?		Go to Step (7)	
6	• Replace ECM Is the replacement complete?		Go to Step (7)	
7	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-628 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 629-Relay Coil Short to Power (Bi-Fuel/Gasoline Only)



Conditions for Setting the DTC

- Fuel pump relay check
- Check Condition-Key ON
- Fault Condition Relay coil shorted to power

Circuit Description

The fuel pump relay switches power out to the fuel pump for operation on gasoline fuel. This fault will set if the ECM detects a short circuit to power on the relay control output.

Diagnostic Aid

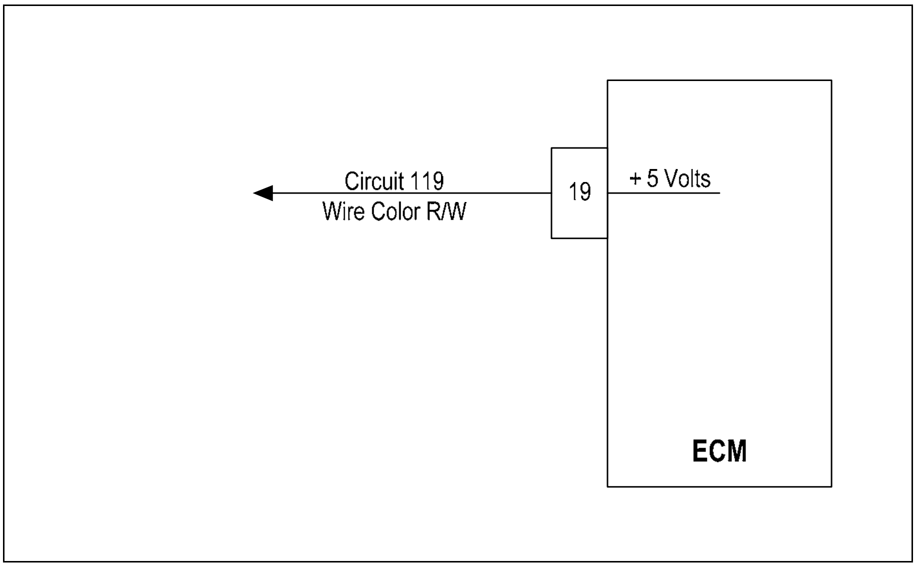
Relay coil resistance changes with temperature. The following diagnostic charts have steps to measure relay coil resistance values. When checking the resistance values be sure the relay is at a reasonable temperature, between +20 and +100 degrees F.

DTC 629-Relay Coil Short to Power (Bi-Fuel/Gasoline Only)

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?		Go to Step (2)	Go to OBD System Check Section
2	• DST connected and in the System Data Mode • Key OFF • Remove the power relay from the fuse block • Using a DVOM check the resistance of the relay coil between fuel pump relay terminals for circuits 178 and 144B Is the resistance value less than 60 ohms?		Go to Step (3)	Go to Step (4)
3	• Replace the power relay Is the replacement complete?		Go to Step (9)	
4	• Using a DVOM check for continuity between relay terminals for circuits 178 and 144B Do you have continuity between them?		Go to Step (3)	Go to Step (5)
5	• Key OFF • Disconnect ECM wire harness connector CN1 • Using a DVOM check for power between ECM connector circuit 178 and engine ground with the key ON Do you have power?	System battery voltage	Repair the short to power. See wiring harness repair.	Go to Step (6)
6	• Replace the power relay Is the replacement complete?		Go to Step (7)	
7	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-629 check for any stored codes. Does DTC 687 still re-set?		Go to Step (8)	Go to Step (9)

Step	Action	Value(s)	Yes	No
8	• Replace the ECM Is the replacement complete?		Go to Step (9)	–
9	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-629 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 642-External 5 Volt Reference Low



Conditions for Setting the DTC

- External 5 volt reference
- Check Condition-Engine cranking or running
- Fault Condition-5 volt reference voltage lower than 4.60 volts
- MIL-On during active fault
- Adaptive-Disabled during active fault

Circuit Description

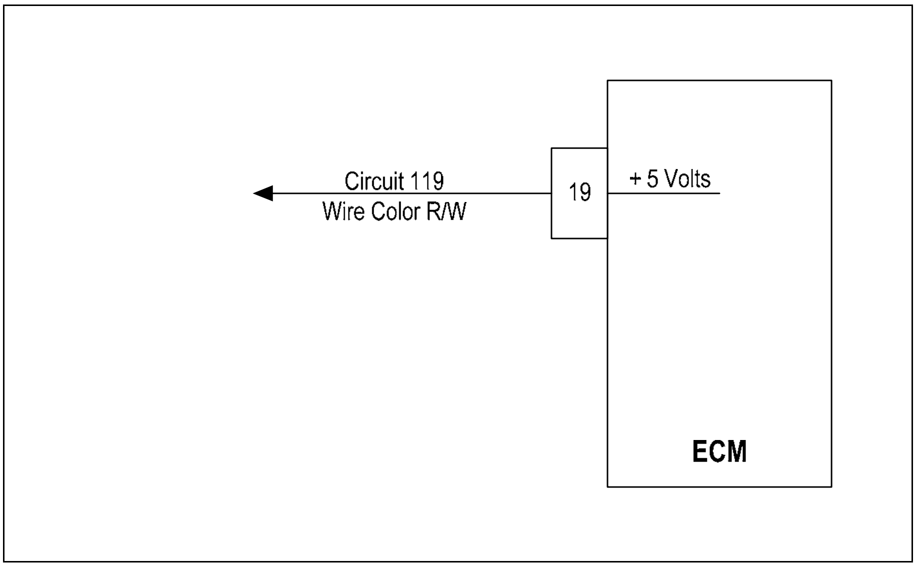
The external 5 volt supply powers many of the sensors and other components of the fuel system. The accuracy of the 5 volt supply is very important to the accuracy of the powered sensors and fuel control by the ECM. The ECM is able to determine if they are overloaded, shorted, or otherwise out of specification by monitoring the 5 volt supply. This fault will set if the 5 volt reference is below 4.60 volts. Adaptive Learn will be disabled during this fault.

DTC 642-External 5 Volt Reference Low

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?		Go to Step (2)	Go to OBD System Check Section
2	• Key ON, Engine Running • DST (Diagnostic Scan Tool) connected in System Fault Mode Does DST display DTC 642?		Go to Step (3)	Intermittent problem Go to Intermittent section
3	• Key OFF • Disconnect ECM connector CN1 • Using DVOM check for continuity between ECM 5 volt reference circuit 119 and engine ground Do you have continuity?		Go to Step (5)	Go to Step (4)
4	• Replace ECM Is the replacement complete?		Go to Step (7)	
5	• While monitoring DVOM for continuity between ECM 5 volt reference circuit 119 and engine ground • Disconnect each sensor (below) one at a time to find the shorted 5 volt reference. When continuity to ground is lost the last sensor disconnected is the area of suspicion. Inspect the 5 volt reference supply wire leads for shorts before replacing the sensor. • ECT • TMAP • Electronic Throttle • Gasoline Sensor • LPG temperature sensor • FPP • TPS 1 • TPS 2 • Crankshaft Sensor • Camshaft Sensor While disconnecting each sensor one at a time did you lose continuity?		Go to Step (6)	Repair shorted wire harness
6	• Replace the last disconnected sensor Is the replacement complete?		Go to Step (7)	

Step	Action	Value(s)	Yes	No
7	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-642 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 643-External 5 Volt Reference High



Conditions for Setting the DTC

- External 5 volt reference
- Check Condition-Engine cranking or running
- Fault Condition-5 volt reference higher than 5.40 volts
- MIL-On during active fault
- Adaptive-Disabled during active fault

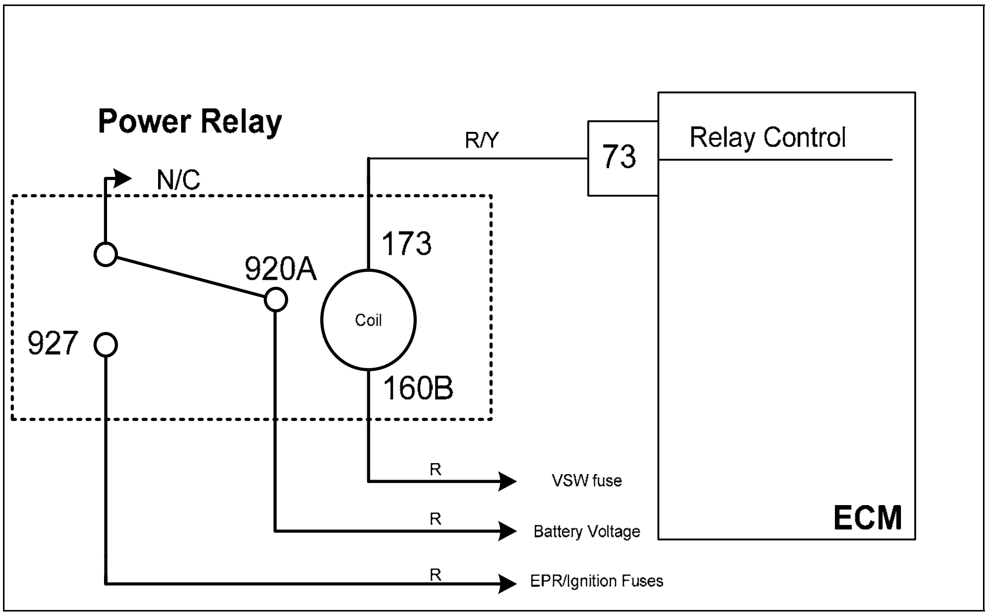
Circuit Description

The External 5 volt supply powers many of the sensors and other components in the fuel system. The accuracy of the 5 volt supply is very important to the accuracy of the powered sensors and fuel control by the ECM. The ECM is able to determine if they are overloaded, shorted, or otherwise out of specification by monitoring the 5volt supply. This fault will set if the 5 volt reference is greater than 5.40 volts anytime the engine is cranking or running. Adaptive Learn will be disabled during this fault

DTC 643-External 5 Volt Reference High

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?	-	Go to Step (2)	Go to OBD System Check Section
2	• Key ON, Engine running • DST (Diagnostic Scan Tool) connected in System Data Mode Does DST display DTC 643?		Go to Step (3)	Intermittent problem Go to Intermittent section
3	• Check all ECM ground connections • Refer to Engine electrical power and ground distribution. Are the ground connections OK?		Go to Step (4)	Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.
4	• Key OFF • Disconnect ECM connector CN1 • Key ON • Using DVOM check for Voltage between ECM connector CN1 circuit 119 and engine ground Do you have voltage?		Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to Step (5)
5	• Replace ECM Is the replacement complete?		Go to Step (6)	-
6	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-643 check for any stored codes. Does the vehicle engine normally with no stored codes?		System OK	Go to OBD System Check

DTC 685-Relay Coil Open



Conditions for Setting the DTC

- Power relay check
- Check Condition-Key ON
- Fault Condition Relay coil open

Circuit Description

The power relay switches power out to various sensors, actuators and solenoids in the fuel system. This fault will set if the ECM detects an open circuit on the relay control output.

Diagnostic Aid

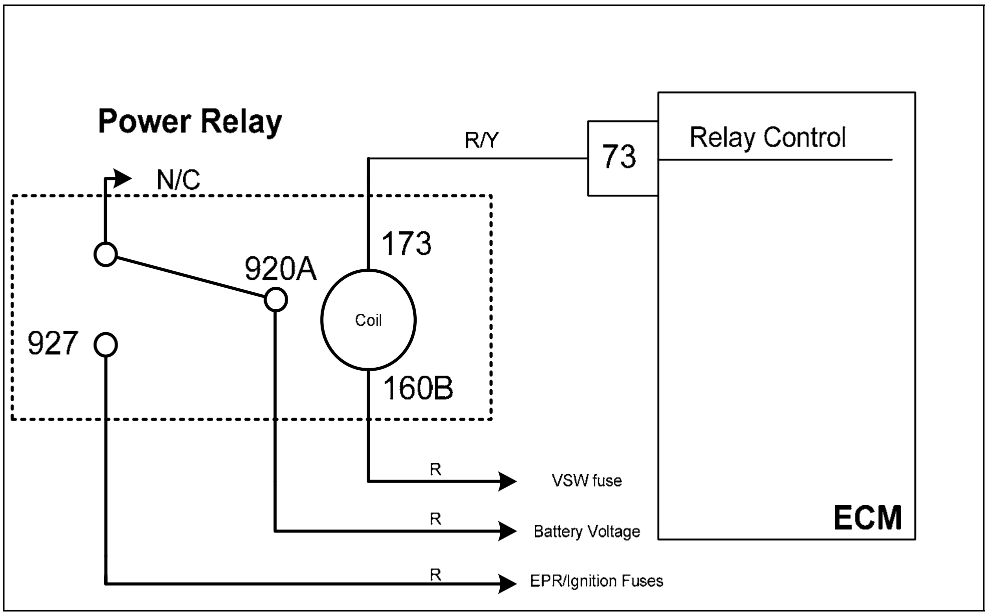
Relay coil resistance changes with temperature. The following diagnostic charts have steps to measure relay coil resistance values. When checking the resistance values be sure the relay is at a reasonable temperature, between +20 and +100 degrees F.

DTC 685-Relay Coil Open

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?		Go to Step (2)	Go to OBD System Check Section
2	• DST connected and in the system data mode • Key OFF • Remove the power relay from the fuse block • Using a DVOM check the resistance of the relay coil between the relay terminals for circuits 173 and 160B Is the resistance value less than 100 ohms?		Go to Step (4)	Go to Step (3)
3	• Replace the power relay Is the replacement complete?		Go to Step (9)	
4	• Check ECM fuse Is the fuse open?		Replace ECM fuse	Go to Step (5)
5	• Disconnect ECM connector CN1 • Using a DVOM check for continuity between ECM connector CN1 circuit 173 and power relay circuit 173 Do you have continuity?		Go to Step (6)	Repair the open circuit as required. See wiring harness repairs
6	• Remove ECM fuse • Using a DVOM check for continuity on circuit 160B between fuse block cavity for the power relay and the ECM fuse Do you have continuity?		Go to Step (7)	Repair the open circuit as required. See wiring harness repairs
7	• Check all system fuses. • Check all relay placement positions in fuse block. • Run complete pin to pin checks on chassis wiring to fuel system harness. • See complete fuel system schematic for further details Did you find the problem?		Go to Step (9)	Go to Step (8)

Step	Action	Value(s)	Yes	No
8	• Replace the ECM Is the replacement complete?		Go to Step (9)	–
9	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-685 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 686-Relay Control Ground Short



Conditions for Setting the DTC

- Power relay ground control
- Check Condition-Key ON
- Fault Condition Relay control shorted to ground

Circuit Description

The power relay switches power out to various sensors, actuators and solenoids in the fuel system. This fault will set if the ECM detects a short to ground on the relay control output.

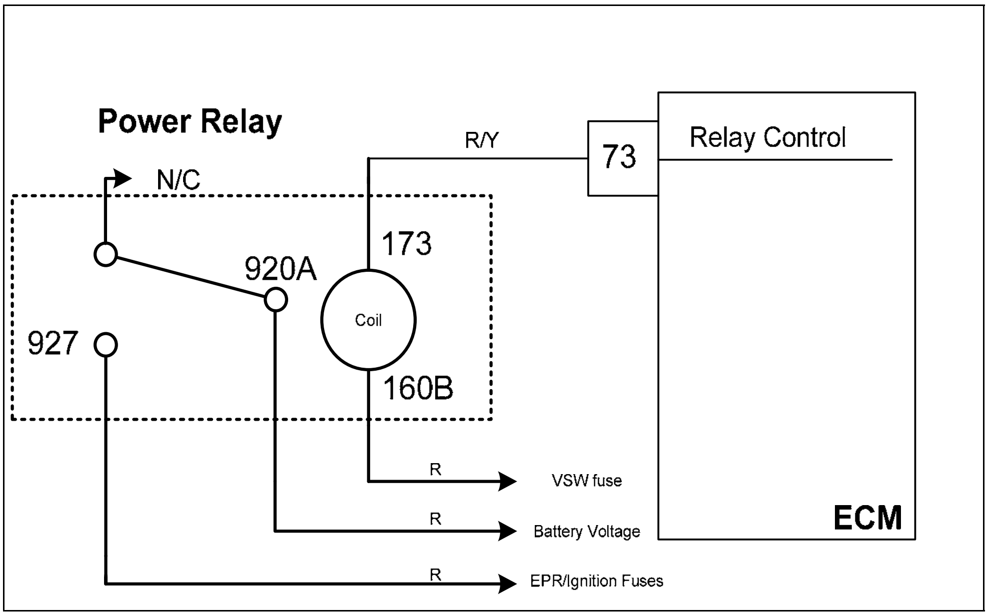
Diagnostic Aid

Relay coil resistance changes with temperature. The following diagnostic charts have steps to measure relay coil resistance values. When checking the resistance values be sure the relay is at a reasonable temperature, between +20 and +100 degrees F.

DTC 686-Relay Control Ground Short

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?		Go to Step (2)	Go to OBD System Check Section
2	• Key On, DST connected in the System Data Mode • Clear DTC 686 • Start the engine Does DTC 686 re-set?		Go to Step (3)	Intermittent problem Go to Intermittent section
3	• Disconnect ECM connector CN1 • Using a DVOM check the resistance value between ECM connector CN1 circuit 173 and engine ground Is the resistance less than 60 ohms?		Go to Step (4)	Go to Step (6)
4	• Remove the power relay from the fuse block • Using a DVOM check the resistance value again between ECM connector circuit 173 and engine ground Is the resistance less than 60 ohms?		Repair the shorted to ground relay control circuit as necessary. See wiring harness repairs	Go to Step (5)
5	• Replace the power relay Is the replacement complete?		Go to Step (7)	
6	• Replace ECM Is the replacement complete?		Go to Step (7)	
7	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-686 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 687-Relay Coil Short to Power



Conditions for Setting the DTC

- Power relay check
- Check Condition-Key ON
- Fault Condition Relay coil shorted to power

Circuit Description

The power relay switches power out to various sensors, actuators and solenoids in the fuel system. This fault will set if the ECM detects a short circuit to power on the relay control output.

Diagnostic Aid

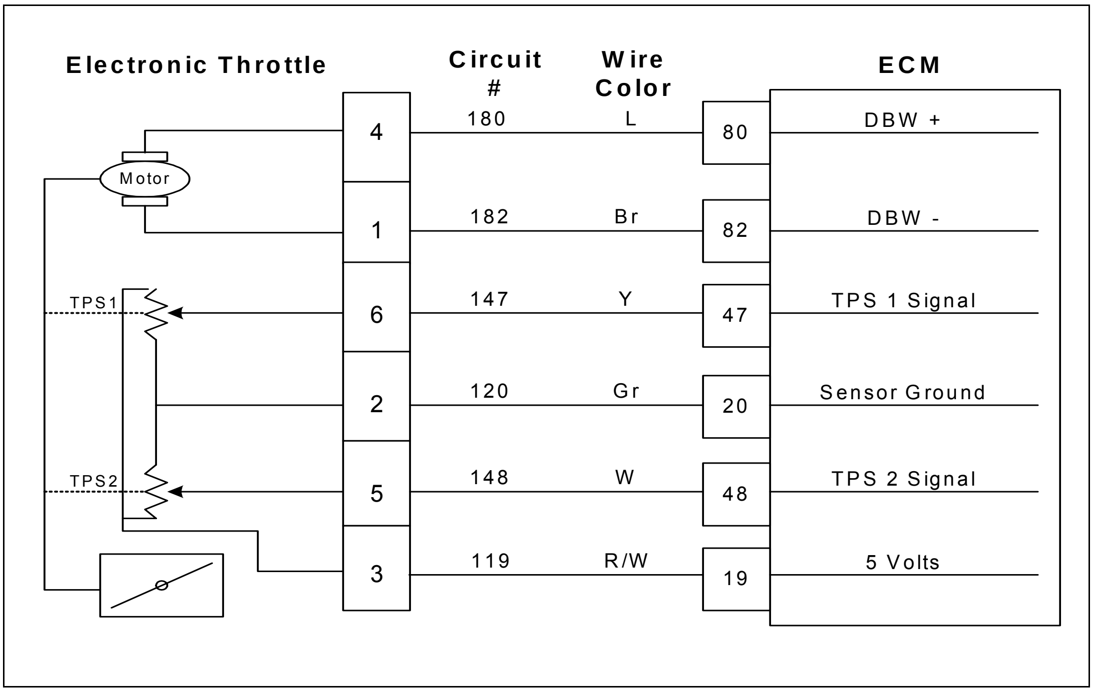
Relay coil resistance changes with temperature. The following diagnostic charts have steps to measure relay coil resistance values. When checking the resistance values be sure the relay is at a reasonable temperature, between +20 and +100 degrees F.

DTC 687-Relay Coil Short to Power

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?		Go to Step (2)	Go to OBD System Check Section
2	• DST connected and in the System Data Mode • Key OFF • Remove the power relay from the fuse block • Using a DVOM check the resistance of the relay coil between power relay terminals for circuits 173 and 160B Is the resistance value less than 60 ohms?		Go to Step (3)	Go to Step (4)
3	• Replace the power relay Is the replacement complete?		Go to Step (9)	
4	• Using a DVOM check for continuity between relay terminals for circuits 173 and 160B Do you have continuity between them?		Go to Step (3)	Go to Step (5)
5	• Key OFF • Disconnect ECM wire harness connector CN1 • Using a DVOM check for power between ECM connector circuit 173 and engine ground with the key ON Do you have power?	System battery voltage	Repair the short to power. See wiring harness repair.	Go to Step (6)
6	• Replace the power relay Is the replacement complete?		Go to Step (7)	
7	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-687 check for any stored codes. Does DTC 687 still re-set?		Go to Step (8)	Go to Step (9)

Step	Action	Value(s)	Yes	No
8	• Replace the ECM Is the replacement complete?		Go to Step (9)	–
9	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-687 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 1111-Fuel Rev Limit



Conditions for Setting the DTC

- Fuel Rev Limit
- Check Condition Engine Running
- Fault Condition Engine rpm greater than 4,000
- MIL On during active fault

Circuit Description

This fault will set anytime Engine rpm is greater than 4,000. When these conditions are met the ECM cuts off fueling to limit speed. This is to help prevent engine or equipment damage. The MIL will be on during this active fault.

Diagnostic Aid

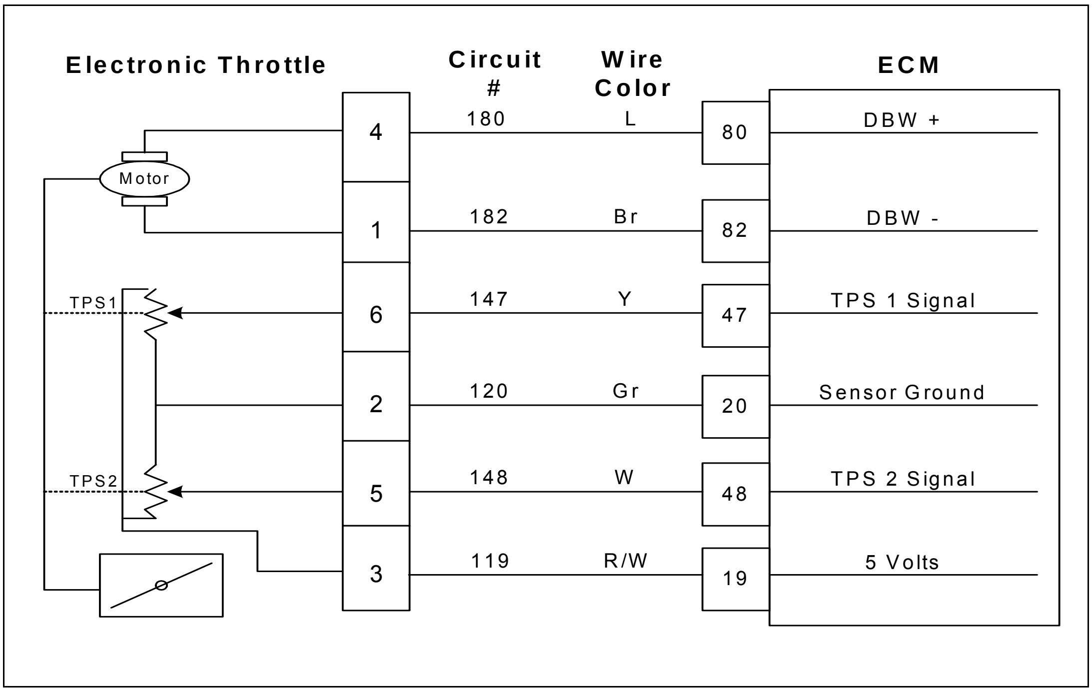
Always check for other stored DTC codes before using the following DTC chart for this code set. Repair any existing codes starting with the lowest numerical code first.

DTC 1111-Fuel Rev Limit

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?		Go to Step (2)	Go to OBD System Check Section
2	• Key ON, Engine OFF • DST in Active Fault Mode Are any other DTC codes present with DTC 1111?		Go to Step (3)	Go to Step (4)
3	• Diagnose and repair any other DTC codes before proceeding with this chart. Have any other DTC codes been diagnosed and repaired?		Go to Step (4)	
4	• Check the service part number on the ECM to ensure correct calibration is in use Is the service part number correct?		Go to Step (6)	Go to Step 5
5	• Replace ECM with the correct service part number Is the replacement complete?		Go to Step (9)	
6	• Check the mechanical operation of the throttle Is the mechanical operation of the throttle OK?		Go to Step (8)	Go to Step (7)
7	• Correct mechanical operation of the Throttle Body. Has the mechanical operation of the throttle been corrected?		Go to Step (9)	
8	• Check engine for large manifold vacuum leaks. Refer to Fuel Systems symptom diagnostics Did you find and correct the vacuum leak?		Go to Step (9)	Go to OBD System Check Section

Step	Action	Value(s)	Yes	No
9	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-1111 check for any stored codes Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 1112-Spark Rev Limit



Conditions for Setting the DTC

- Spark Rev Limit
- Check Condition Engine running
- Fault Condition Engine RPM greater than 4200
- MIL On during active fault
- Engine Shut Down

Circuit description

This fault will set anytime the engine RPM exceeds 3900. During this condition the ECM will shut off spark to the engine. This is to help prevent engine or equipment damage. The MIL command is ON during this active fault and the engine will shut down.

Diagnostic Aid

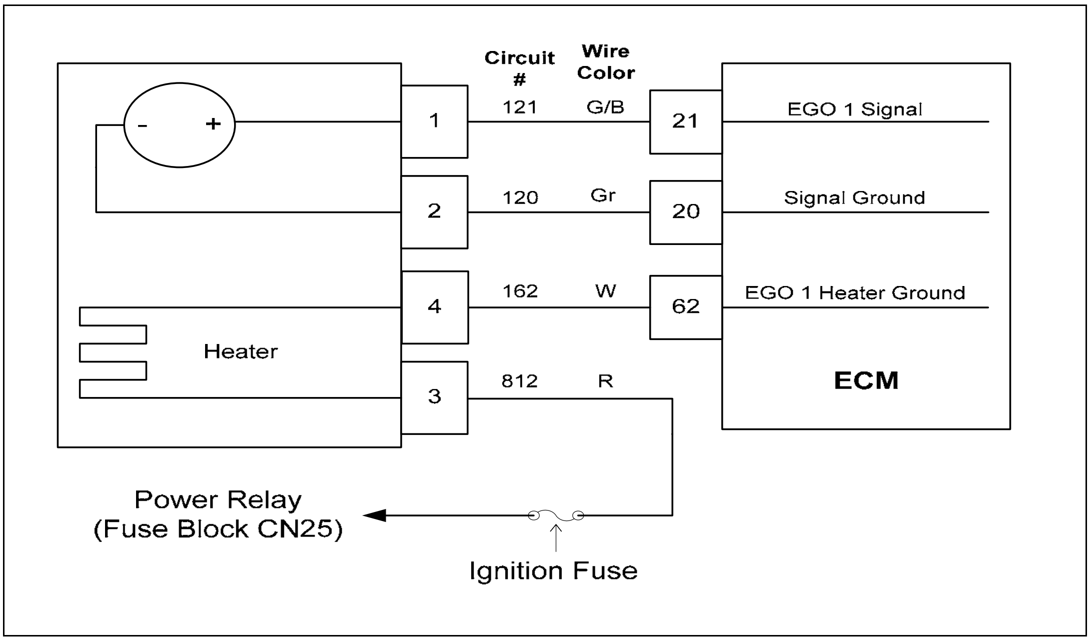
Always check for other stored DTC codes before using the following DTC chart for this code set. Repair any existing codes starting with the lowest numerical code first.

DTC 1112-Spark Rev Limit

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?	-	Go to Step (2)	Go to OBD System Check Section
2	• Key ON, Engine OFF • DST connected Are any other DTC codes present with DTC 1112?		Go to Step (3)	Go to Step (4)
3	• Diagnose any other DTC codes before proceeding with this chart. Have any other DTC codes been diagnosed and repaired?		Go to Step (4)	
4	• Check the service part number on the ECM to ensure correct calibration is in use Is the service part number Correct?		Go to Step (6)	Go to Step 5
5	• Replace ECM with correct service part Number Is the replacement complete?		Go to Step (9)	
6	• Check the mechanical operation of the throttle Is the mechanical operation of the throttle OK?		Go to Step (8)	Go to Step (7)
7	• Correct mechanical operation of the throttle. Refer to Engine & Component section Has the mechanical operation of the throttle been corrected?		Go to Step (9)	
8	• Check engine for large manifold vacuum leaks. Refer to Fuel Systems section Symptom Diagnostics Did you find and correct the vacuum leak?		Go to Step (9)	Go to OBD System Check Section

Step	Action	Value(s)	Yes	No
9	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-1112 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 1151-Closed Loop Multiplier High LPG



Conditions for Setting the DTC

- Heated Oxygen Sensor
- Check Condition-Engine running
- Fault Condition-Closed Loop multiplier out of range (greater than 35%)
- MIL-ON

Circuit description

The EGO sensor is used to determine if the fuel flow to the engine is correct by measuring the oxygen content in the exhaust gas. The ECM uses this information to correct the fuel flow with the Closed Loop multiplier and the adaptive multiplier. This fault sets if the Closed Loop multip-lier exceeds the limits of normal operation and cannot correctly modify the fuel flow within its limits.

Diagnostic Aid

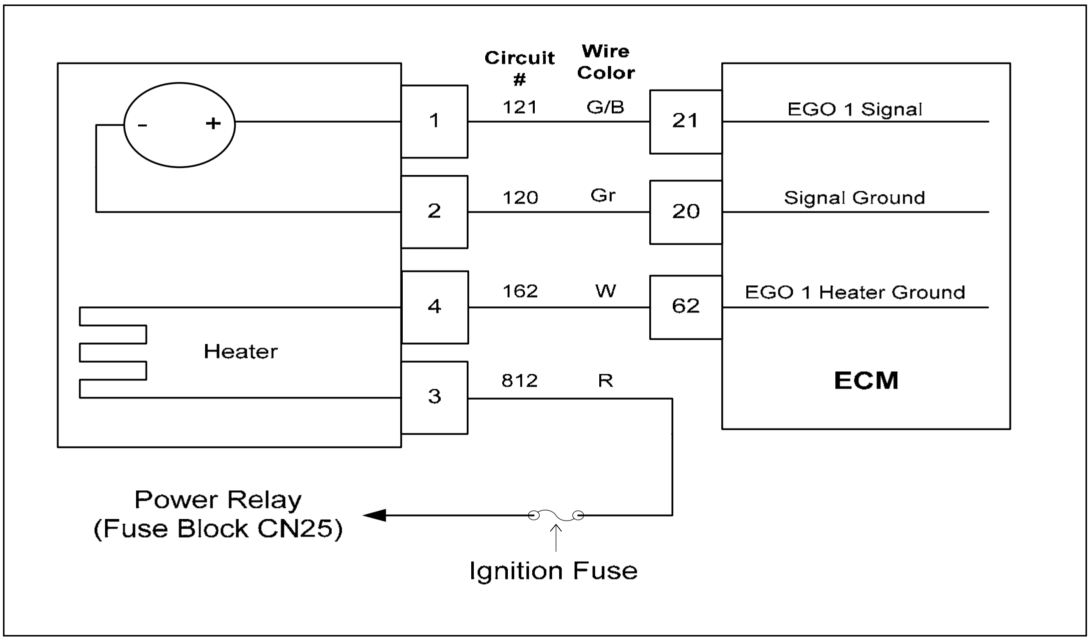
Oxygen Sensor Wire Heated Oxygen sensor wires may be mis-routed and contacting the ex-haust manifold.
Vacuum Leaks Large vacuum leaks and crankcase leaks can cause a lean exhaust condition at especially at light load.
Fuel Mixer System can be lean due to faulty EPR (Electronic Pressure Regulator) or faulty fuel mixer.
Fuel Pressure Low fuel pressure, faulty fuel regulator or contaminated fuel filter can cause fuel the system to run lean
Exhaust Leaks If there is an exhaust leak, outside air can be pulled into the exhaust and past the 02 sensor causing a false lean condition.
Fuel Quality Contaminated or spoiled fuel can cause the fuel system to be lean.
Ground Problem ECM grounds must be clean, tight and in the proper location.

DTC 1151-Closed Loop Multiplier High LPG

Step	Action	Value(s)	Yes	No
1	• Perform the On-Board (OBD) System Check? Are any other DTCs present?		Go to Step (3)	Go to Step (2)
2	Visually and physically check the following items: • The air intake duct for being collapsed or restricted • The air filter for being plugged • System power fuses are good and in the proper location • The EGO 1 sensor installed securely and the wire leads not contacting the exhaust manifold or ignition wires • ECM grounds must be clean and tight. Refer to Engine Electrical Power and Ground Distribution • Fuel System Diagnostics. Refer to Fuel System Diagnostics Was a repair made?		Go to Step (9)	Go to Step (4)
3	• Diagnose any other DTC codes before proceeding with this chart. Always repair existing codes starting with the lowest numerical code set first. Have any other DTC codes been detected, diagnosed and repaired?		Go to Step (9)	Go to Step (4)
4	• Disconnect EGO1 connector C005 • Using a DVOM check for voltage between EGO 1 connector pin B and engine ground • Key ON **(CHECK MUST BE MADE WITHIN 30 SECONDS OR BEFORE POWER RELAY SHUTS DOWN)** Do you have voltage?	System voltage	Go to Step (5)	Repair the open EGO power circuit as necessary. Refer to Wiring Repairs in Engine Electrical.
5	• Key OFF • Disconnect EGO 1 sensor wire harness connector CN11 • Disconnect ECM wire harness connector CN1 • Key ON • Using a high impedance DVOM check for continuity between EGO 1 connector signal circuit 121 and engine ground Do you have continuity?		Repair the shorted circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to Step (6)

Step	Action	Value(s)	Yes	No
6	• Using a high impedance DVOM check for continuity at the EGO 1 connector CN11 between signal circuit 121 and sensor ground circuit 120 Do you have continuity?		Repair the shorted circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to Step (7)
7	• Using a high impedance DVOM check for continuity on the EGO 1 heater circuit 162 between EGO 1 connector CN11 and ECM connector CN1 Do you have continuity?		Go to Step (8)	Repair the open EGO heater ground
8	• Replace EGO 1 sensor Is the replacement complete?		Go to Step (9)	-
9	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-1151 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 1152-Closed Loop Multiplier Low LPG



Conditions for Setting the DTC

- Heated Oxygen Sensor
- Functional Fault-Closed Loop multiplier out of range (at limit of-35%)
- MIL Disabled

Circuit Description

The EGO 1 sensor is used to determine if the fuel flow to the engine is correct by measuring the oxygen content in the exhaust gas. The ECM uses this information to correct the fuel flow with the Closed Loop multiplier and the adaptive multiplier. This fault sets if the Closed Loop multiplier exceeds the limits of normal operation. When the multiplier cannot correctly modify the fuel flow within its limits, it is limited at-35%.

Diagnostic Aid

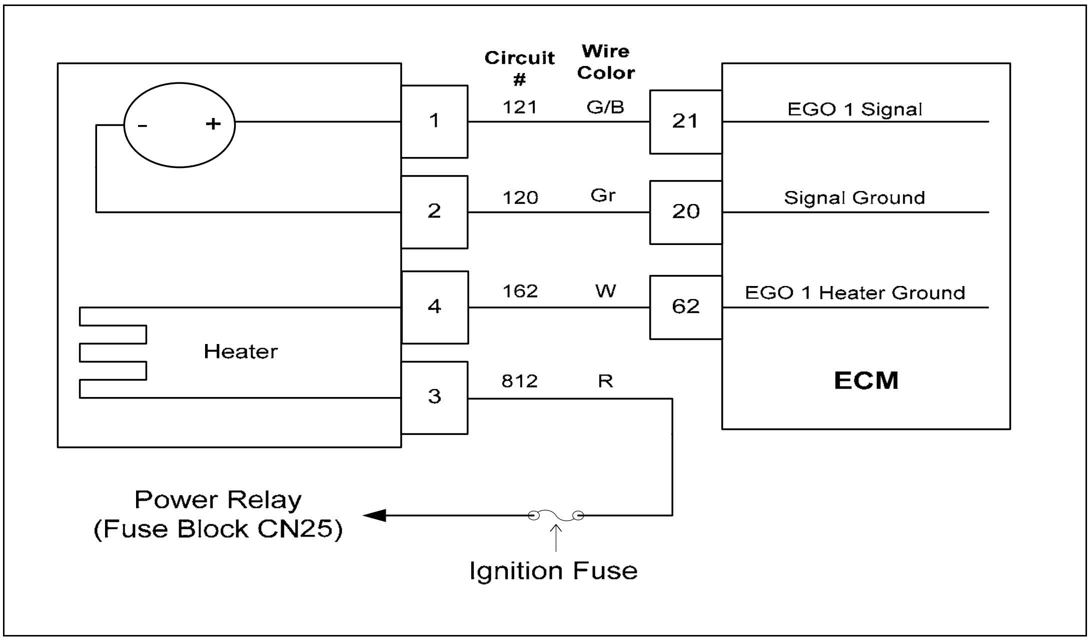
Fuel System High secondary fuel pressure will cause the system to run rich. A worn fuel mixer, faulty EPR (Electronic Pressure Regulator) may also cause the system to run rich.
Fuel Quality A drastic variation in fuel quality (very high butane content) may cause the fuel system to run rich. Be sure that the specified HD-5 or HD-10 motor fuel grade propane is used.
Air Filter A plugged, damaged or modified air filter may cause the system to run rich.

DTC 1152-Closed Loop Multiplier Low LPG

Step	Action	Value(s)	Yes	No
1	• Perform the On-Board (OBD) System Check? Are any other DTCs present?		Go to Step (3)	Go to Step (2)
2	Visually and physically check the following items: • The air intake duct for being collapsed or restricted • The air filter for being plugged • The EGO sensor installed securely and the wire leads not damaged contacting the secondary ignition wires • ECM grounds for being clean and tight. • Run the fuel system diagnostic checks Was a repair made?		Go to Step (6)	Go to Step (4)
3	• Diagnose any other DTC codes before proceeding with this chart. Have any other DTC codes been detected, diagnosed and repaired?		Go to Step (6)	Go to Step (4)
4	• Key OFF • Disconnect EGO sensor wire harness connector • Disconnect ECM wire harness connector • Key ON • Using a DVOM check for voltage between EGO 1 connector CN11 signal circuit 121 and engine ground Do you have voltage?		Repair the circuit short to voltage as necessary. Refer to wiring harness repair.	Go to Step (5)
5	• Replace EGO sensor Is the replacement complete?		Go to Step (6)	-

Step	Action	Value(s)	Yes	No
6	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-1152 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 1155-Closed Loop High (Bi-Fuel/Gasoline Only)



Conditions for Setting the DTC

- Heated Oxygen Sensor
- Check Condition-Engine Running
- Fault Condition-Closed Loop multiplier out of range greater than 35.0%
- MIL-On

Circuit Description

The EGO 1 sensor is used to determine if the fuel flow to the engine is correct by measuring the oxygen content in the exhaust gas. The ECM uses this information to correct the fuel flow with the Closed Loop multiplier and Adaptive multiplier. This fault will set if the adaptive multiplier exceeds the limits of normal operation. Always run fuel system diagnostic checks before using the following diagnostic chart.

Diagnostic Aid

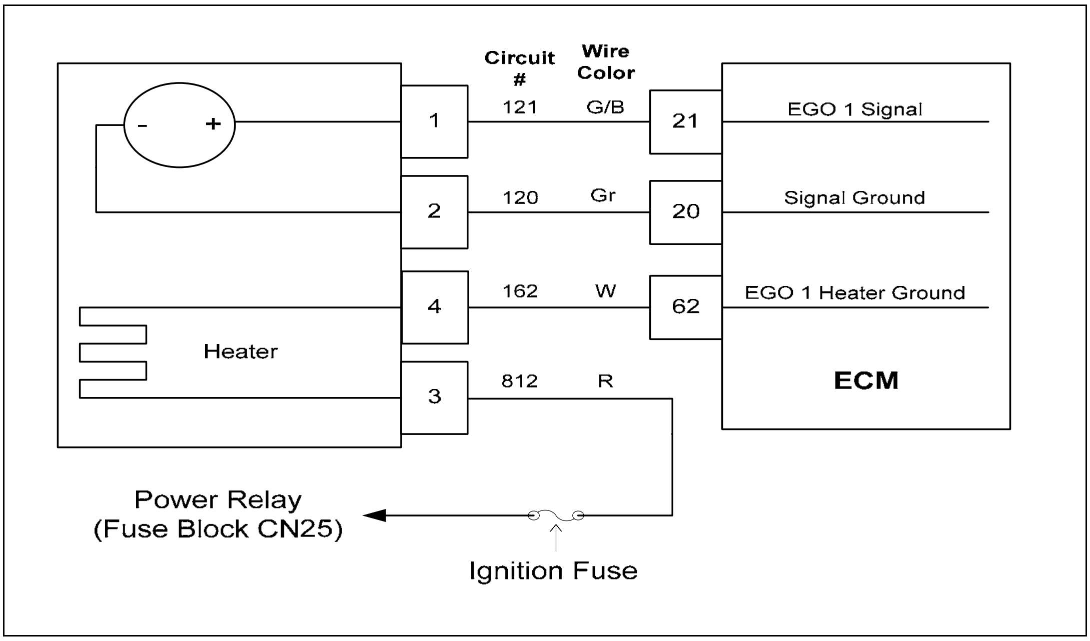
Oxygen Sensor Wire Heated Oxygen sensor wires may be mis-routed and contacting the exhaust manifold.
Vacuum Leaks Vacuum leaks and crankcase leaks can cause a lean condition at especially at light load.
Fuel Injectors The system may be lean due to contaminated or faulty fuel injectors
Fuel Pressure Low fuel pressure, faulty fuel regulator or contaminated fuel filter can cause fuel the system to run lean
Exhaust Leaks If there is an exhaust leak, outside air can be pulled into the exhaust and past the 02 sensor causing a false lean condition.
Fuel Quality Contaminated or spoiled fuel can cause the fuel system to be lean.
Ground Problem ECM grounds must be clean, tight and in the proper location.

DTC 1155-Closed Loop High (Bi-Fuel/Gasoline Only)

Step	Action	Value(s)	Yes	No
1	• Perform the On-Board (OBD) System Check Are any other DTCs present?		Go to Step (3)	Go to Step (2)
2	Visually and physically check the following items: • The air intake duct for being collapsed or restricted • The air filter for being plugged • System power fuses are good and in the proper location • The EGO 1 sensor installed securely and the wire leads not contacting the exhaust manifold or ignition wires • ECM grounds must be clean and tight. Refer to Engine Electrical Power and Ground Distribution • Fuel System Diagnostics. Refer to Fuel System Diagnostics Was a repair made?		Go to Step (9)	Go to Step (4)
3	• Diagnose any other DTC codes before proceeding with this chart. Always repair existing codes starting with the lowest numerical code set first. Have any other DTC codes been detected, diagnosed and repaired?		Go to Step (9)	Go to Step (4)
4	• Disconnect EGO1 connector CN11 • Using a DVOM check for voltage between EGO 1 connector CN11 circuit 812 and engine ground • Key ON (**CHECK MUST BE MADE WITHIN 30 SECONDS OR BEFORE POWER RELAY SHUTS DOWN)** Do you have voltage?	System voltage	Go to Step (5)	Repair the open EGO power circuit as necessary. Refer to Wiring Repairs in Engine Electrical.

Step	Action	Value(s)	Yes	No
5	• Key OFF • Disconnect EGO 1 sensor wire harness connector CN11 • Disconnect ECM wire harness connector CN1 • Key ON • Using a high impedance DVOM check for continuity between EGO 1 connector signal circuit 121 and engine ground Do you have continuity?		Repair the shorted circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to Step (6)
6	• Using a high impedance DVOM check for continuity on the EGO1 connector between the signal circuit 121 and ground circuit 120 Do you have continuity?		Repair the shorted circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to Step (7)
7	• Using a high impedance DVOM check for continuity between EGO 1 heater ground pin D and ECM pin 72 Do you have continuity?		Go to Step (8)	Repair the open EGO heater ground
8	• Replace EGO 1 sensor Is the replacement complete?		Go to Step (9)	
9	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-1155 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 1156-Closed Loop Low (Bi-Fuel/Gasoline Only)



Conditions for Setting the DTC

- Heated Oxygen Sensor
- Check Condition-Engine Running
- Fault Condition-Closed loop multiplier out of range greater than-35%
- MIL-On

Circuit Description

The EGO 1 sensor is used to determine if the fuel flow to the engine is correct by measuring the oxygen content in the exhaust gas. The ECM uses this information to correct the fuel flow with the Closed Loop multiplier and Adaptive multiplier. This fault will set if the adaptive multiplier exceeds the limits of normal operation. Always run the fuel system diagnostic checks before using the following diagnostic chart.

Diagnostic Aid

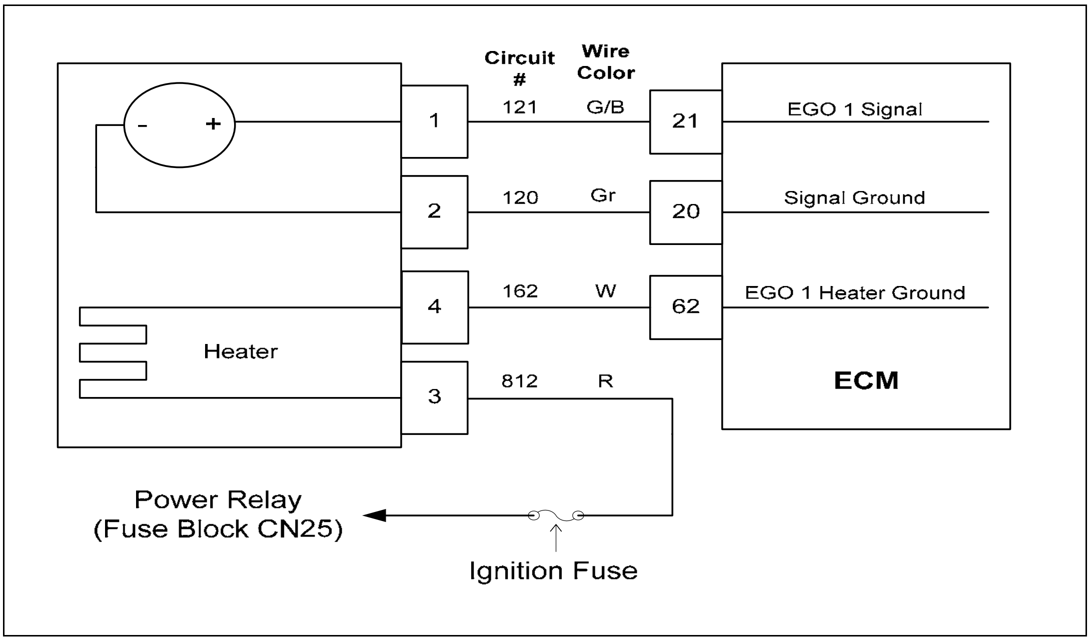
Fuel System The system will be rich if an injector fails to close properly. High fuel pressure due to a faulty fuel regulator or obstructed fuel return line will cause the system to run rich.
Ignition noise Open or poor ground circuit to or in the ignition system or ECM wiring may cause EMI (Electromagnetic interference). This noise could be interpreted by the ECM as ignition pulses or voltage across the oxygen sensor input causing the system to run rich.
MAP Sensor A higher manifold pressure than normal can cause the system to run rich. Temporarily disconnecting the MAP Sensor will allow the ECM to set a default value for MAP and is a good way to quickly eliminate this as a problem.
IAT Sensor Check for a shifted sensor that could cause the ECM to sense lower than actual temperature of incoming air. This can cause a rich exhaust condition.
ECT Sensor Check for a “skewed” sensor that could cause the ECM to sense engine temperature colder than it actually is. This can also cause a rich exhaust condition.

DTC 1156-Closed Loop Low (Bi-Fuel/Gasoline Only)

Step	Action	Value(s)	Yes	No
1	• Perform the On-Board (OBD) System Check? Are any other DTCs present?		Go to Step (3)	Go to Step (2)
2	Visually and physically check the following items: • The air intake duct collapsed or restricted • The air filter for being plugged • The EGO sensor installed securely and the wire leads not damaged or contacting the secondary ignition wires • ECM grounds for being clean and tight. • Run the fuel system diagnostic checks Was a repair made?		Go to Step (6)	Go to Step (4)
3	• Diagnose any other DTC codes before proceeding with this chart. Have any other DTC codes been detected, diagnosed and repaired?		Go to Step (6)	Go to Step (4)
4	• Key OFF • Disconnect EGO sensor wire harness connector CN11 • Disconnect ECM wire harness connector CN1 • Key ON • Using a DVOM check for voltage at the EGO connector C11 signal circuit 121 and engine ground Do you have voltage?		Repair the shorted circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to Step (5)
5	• Replace EGO sensor Is the replacement complete?		Go to Step (6)	-

Step	Action	Value(s)	Yes	No
6	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-1156 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 1161-Adaptive Learn High LPG



Conditions for Setting the DTC

- Heated Oxygen Sensor
- Check Condition-Engine Running
- Fault Condition-Adaptive multiplier out of range greater than 30%
- MIL-On

Circuit Description

The EGO 1 sensor is used to determine if the fuel flow to the engine is correct by measuring the oxygen content in the exhaust gas. The ECM uses this information to correct the fuel flow with the Closed Loop multiplier and Adaptive multiplier. This fault will set if the adaptive multiplier exceeds the limits of normal operation. Always run the fuel system diagnostic checks before using the following diagnostic chat.

Diagnostic Aid

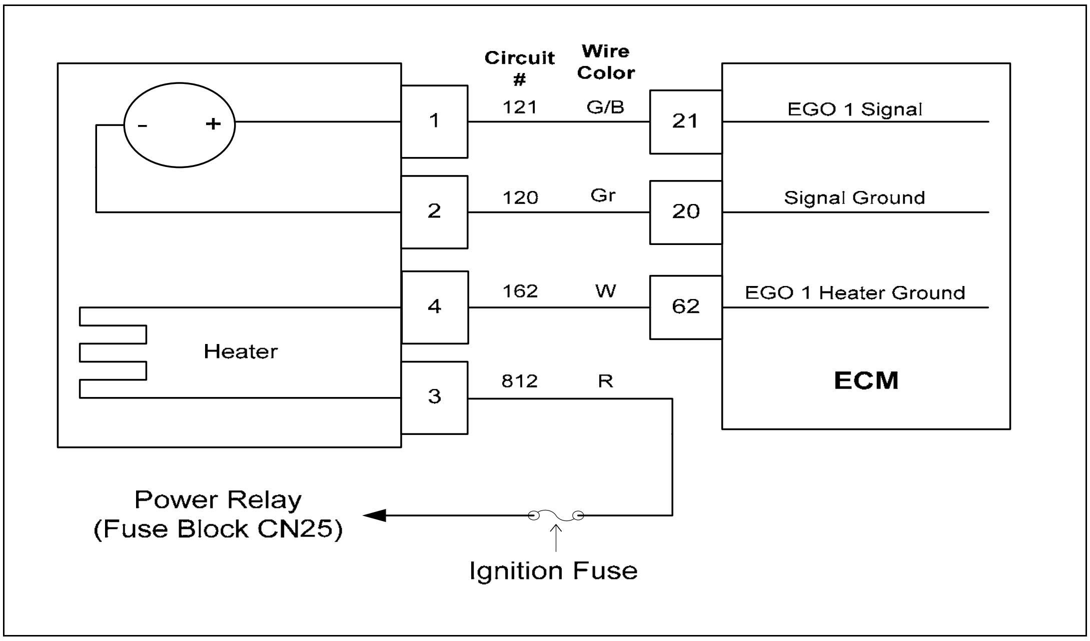
Oxygen Sensor Wire Heated Oxygen sensor wires may be mis-routed and contacting the exhaust manifold.
Vacuum Leaks Large vacuum leaks and crankcase leaks can cause a lean exhaust condition at especially at light load.
Fuel Mixer System can be lean due to faulty EPR (Electronic Pressure Regulator) or faulty fuel mixer.
Fuel Pressure Low fuel pressure, faulty fuel regulator or contaminated fuel filter can cause fuel the system to run lean
Exhaust Leaks If there is an exhaust leak, outside air can be pulled into the exhaust and past the 02 sensor causing a false lean condition.
Fuel Quality Contaminated or spoiled fuel can cause the fuel system to be lean.
Ground Problem ECM grounds must be clean, tight and in the proper location.

DTC 1161-Adaptive Learn High LPG

Step	Action	Value(s)	Yes	No
1	• Perform the On-Board (OBD) System Check? Are any other DTCs present?		Go to Step (3)	Go to Step (2)
2	Visually and physically check the following items: • The air intake duct for being collapsed or restricted • The air filter for being plugged • System power fuses are good and in the proper location • The EGO 1 sensor installed securely and the wire leads not contacting the exhaust manifold or ignition wires • ECM grounds must be clean and tight. Refer to Engine Electrical Power and Ground Distribution • Fuel System Diagnostics. Refer to Fuel System Diagnostics Was a repair made?		Go to Step (9)	Go to Step (4)
3	• Diagnose any other DTC codes before proceeding with this chart. Always repair existing codes starting with the lowest numerical code set first. Have any other DTC codes been detected, diagnosed and repaired?		Go to Step (9)	Go to Step (4)
4	• Disconnect EGO1 connector CN11 • Using a DVOM check for voltage between EGO 1 connector pin B and engine ground • Key ON **(CHECK MUST BE MADE WITHIN 30 SECONDS OR BEFORE POWER RELAY SHUTS DOWN)** Do you have voltage?	System voltage	Go to Step (5)	Repair the open EGO power circuit as necessary. Refer to Wiring Repairs in Engine Electrical.

Step	Action	Value(s)	Yes	No
5	• Key OFF • Disconnect EGO 1 sensor wire harness connector CN11 • Disconnect ECM wire harness connector CN1 • Key ON • Using a high impedance DVOM check for continuity between EGO 1 connector signal circuit 121 and engine ground Do you have continuity?		Repair the shorted circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to Step (6)
6	• Using a high impedance DVOM check for continuity on the EGO connector CN11 between signal circuit 121 and ground circuit 120 Do you have continuity?		Repair the shorted circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to Step (7)
7	• Using a high impedance DVOM check for continuity on the EGO 1 heater control circuit 162 between EGO 1 connector CN11 and ECM connector CN1 Do you have continuity?		Go to Step (8)	Repair the open EGO heater ground
8	• Replace EGO 1 sensor Is the replacement complete?		Go to Step (9)	-
9	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-1161 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 1162-Adaptive Learn Low LPG



Conditions for Setting the DTC

- Heated Oxygen Sensor
- Check Condition-Engine running
- Fault Condition-Adaptive multiplier out of range greater than-30%
- MIL-On

Circuit Description

The EGO1 sensor is used to determine if the fuel flow to the engine is correct by measuring the oxygen content in the exhaust gas. The ECM uses this information to correct the fuel flow with the Closed Loop multiplier and Adaptive multiplier. This fault will set if the adaptive multiplier exceeds the limits of normal operation. Always run the fuel system diagnostics before using the following diagnostic chart.

Diagnostic Aid

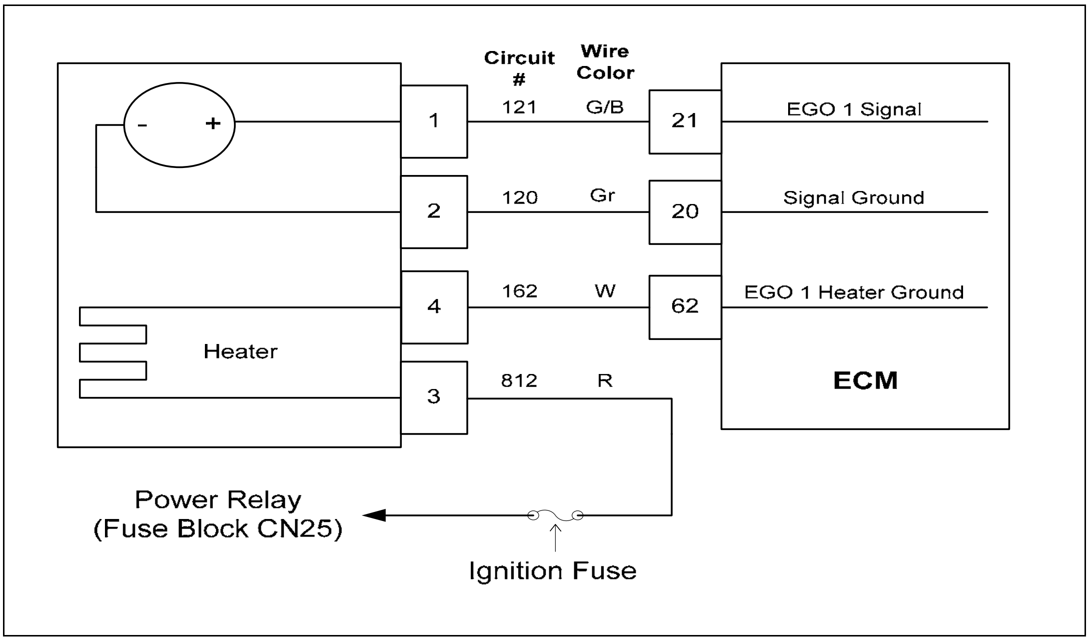
Fuel System High Secondary fuel pressure will cause the system to run rich. A worn fuel mixer, faulty EPR (Electronic Pressure Regulator) may also cause the system to run rich.
Fuel Quality A drastic variation in fuel quality (very high butane content) may cause the fuel system to run rich. Be sure that the specified HD-5 or HD-10 motor fuel grade propane is used.
Air Filter A plugged, damaged or modified air filter may cause the system to run rich.

DTC 1162-Adaptive Learn Low LPG

Step	Action	Value(s)	Yes	No
1	• Perform the On-Board (OBD) System Check? Are any other DTCs present?		Go to Step (3)	Go to Step (2)
2	Visually and physically check the following items: • The air intake duct for being collapsed or restricted • The air filter for being plugged • The EGO sensor is installed securely and the wire leads not damaged or contacting the secondary ignition wires • ECM grounds for being clean and tight. • Fuel system diagnostic checks Was a repair made?		Go to Step (6)	Go to Step (4)
3	• Diagnose any other DTC codes before proceeding with this chart. Have any other DTC codes been detected, diagnosed and repaired?		Go to Step (6)	Go to Step (4)
4	• Key OFF • Disconnect EGO sensor wire harness connector CN11 • Disconnect ECM wire harness connector CN1 • Key ON • Using a DVOM check for voltage at EGO 1 connector signal circuit 121 and engine ground Do you have voltage?		Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to Step (5)
5	• Replace EGO sensor Is the replacement complete?		Go to Step (6)	-

Step	Action	Value(s)	Yes	No
6	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-1162 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 1165-Catalyst Monitor Test



Conditions for Setting the DTC

- Heated Oxygen Sensor
- Check condition-Engine running
- Fault condition-Catalyst monitor test failed
- MIL-On during active fault
- Adaptive-Disabled during active fault
- Closed Loop-Disabled during active fault

Circuit Description

The catalyst monitor test is run under certain operating conditions to determine if the catalyst is functioning correctly. If the test is failed the fault will set letting the operator know the catalyst is not functioning as intended. Closed loop operation and adaptive learn capabilities are disabled upon activation of this fault.

DTC 1165-Catalyst Monitor Test

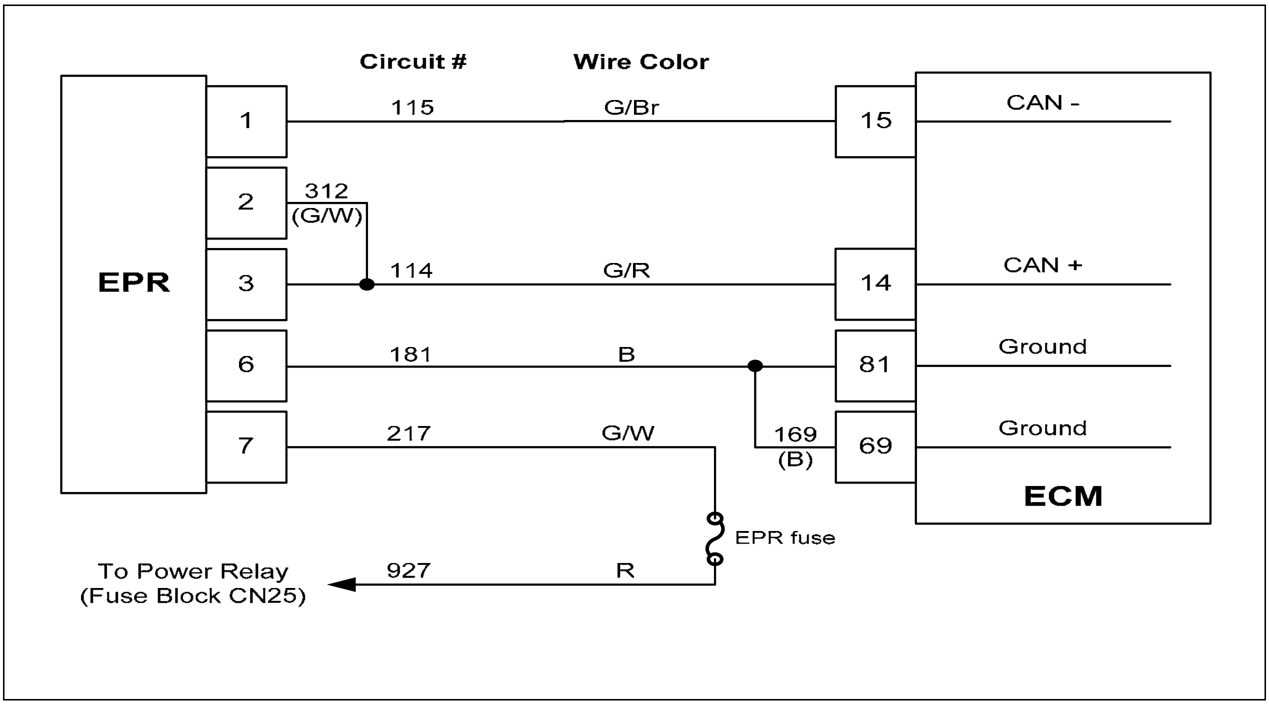
Diagnostic Aid

- Inspect the exhaust system for visual signs of damage, leaks, or modification and repair if necessary.

- Insure the pre catalyst and post catalyst oxygen sensors are mounted correctly and wiring is not damaged, melted, or corroded and repair if necessary.

- If none of the above problems are found replace the catalyst.

DTC 1171-EPR Pressure Higher Than Expected



Conditions for Setting the DTC

- EPR delivery pressure
- Check condition-Engine running or cranking
- MIL-On during active fault
- Fault condition-EPR actual pressure greater than 1.0 inches above commanded pressure
- Adaptive disabled

Circuit Description

The EPR (Electronic Pressure Regulator) unit measures and controls the amount of fuel that is able to pass to the fuel mixer. Pressure readings are sent over the CAN to the ECM and in re-turn the ECM sends back a control signal to the EPR to increase or decrease pressure for precise mixture control. This code will set in the event the actual pressure is 1.0 inches water pressure higher than the actual commanded pressure. Adaptive learn is disabled and the MIL command is ON during this fault.

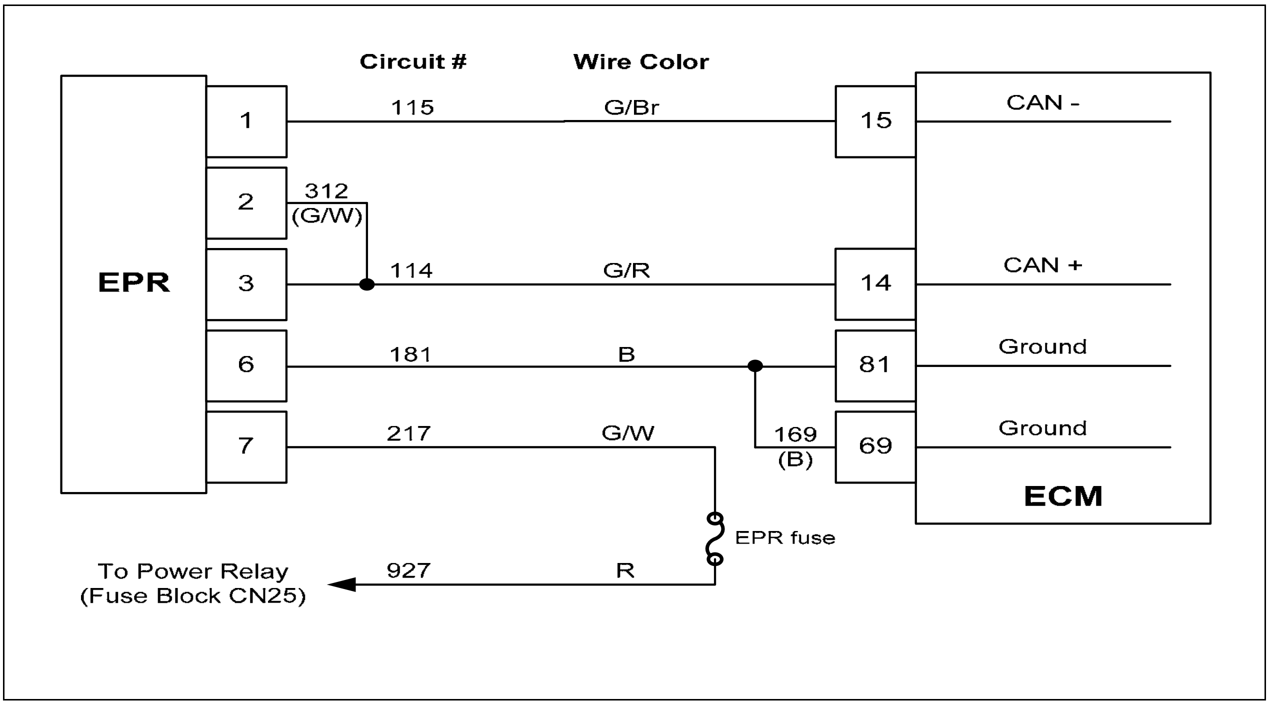
Diagnostic Aid

Always run the fuel system diagnostic pressure check before proceeding with the following di-agnostic chart. High secondary fuel pressure due to a worn or damaged primary or secondary seat may cause this fault to set

DTC 1171-EPR Pressure Higher Than Expected

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?		Go to Step (2)	Go to OBD System Check Section
2	Did you run the fuel pressure diagnostic test in the fuel system diagnostic section with no problems found?		Go to Step (4)	Go to Step (3)
3	• Run the EPR pressure test in the fuel system diagnostic section Did the EPR pass the fuel pressure test specifications?		Go to Step (4)	Follow the EPR service recommendations from the fuel pressure test chart.
4	• Inspect the EPR electrical connector pins C018 for damage, corrosion or contamination. Did you find a problem?		Repair the circuit as necessary. Refer to wire harness repair section.	Go to Step (5)
5	• Replace or repair the EPR Is the replacement complete?		Go to Step (6)	
6	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC1171 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 1172-EPR Pressure Lower Than Expected



Conditions for Setting the DTC

- EPR delivery pressure
- Check condition-Engine running or cranking
- MIL-On during active fault
- Fault condition-EPR actual pressure less than 1.0 inches below commanded pressure
- Adaptive disabled

Circuit Description

The EPR (Electronic Pressure Regulator) unit measures and controls the amount of fuel that is able to pass to the fuel mixer. Pressure readings are sent over the CAN to the ECM and in return the ECM sends back a control signal to the EPR to increase or decrease pressure for precise mixture control. This code will set in the event the actual pressure is 1.0 inches water pressure lower than the actual commanded pressure. Adaptive is disabled and the MIL command is ON during this fault.

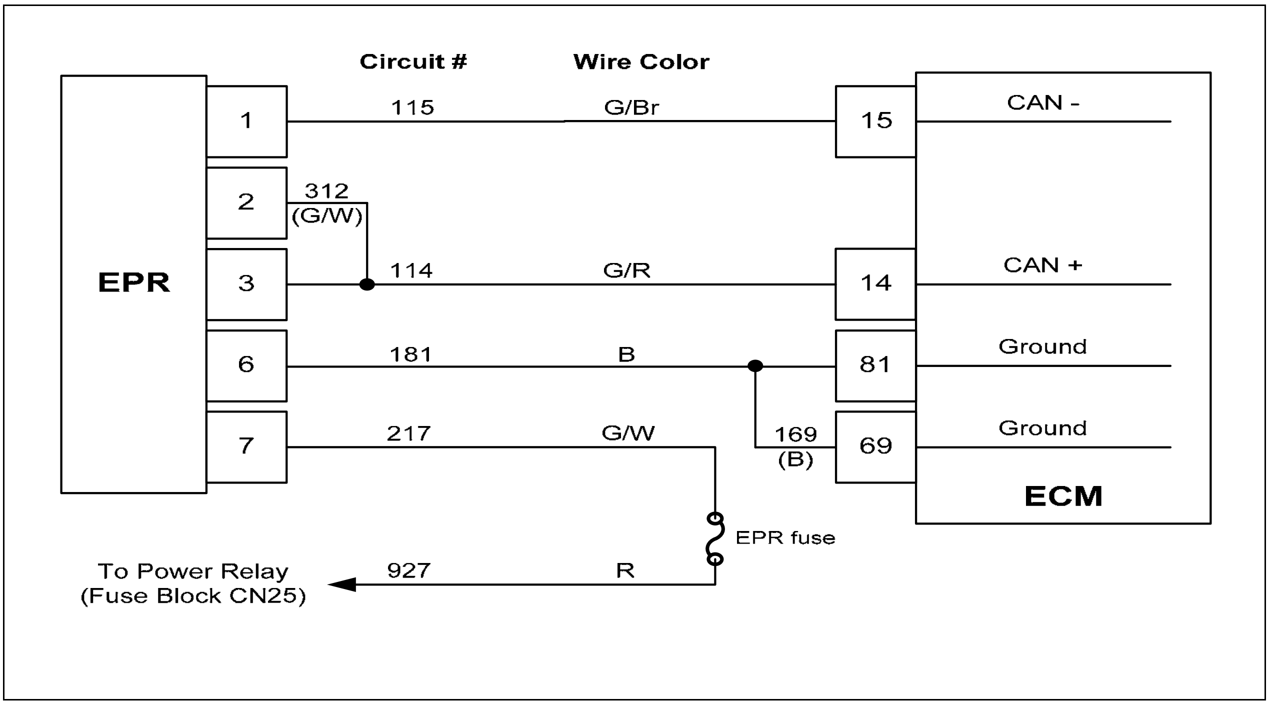
Diagnostic Aid

Always run the fuel system diagnostic pressure check before proceeding with the following diagnostic chart. Low secondary fuel pressure due to a fuel restriction or faulty regulator may cause this fault.

DTC 1172-EPR Pressure Lower Than Expected

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?		Go to Step (2)	Go to OBD System Check Section
2	Did you run the fuel pressure diagnostic test in the fuel system diagnostic section with no problems found?		Go to Step (4)	Go to Step 3
3	• Run the EPR pressure test in the fuel system diagnostic section Did the EPR pass the fuel pressure test specifications?		Go to Step (4)	Follow the EPR service recommendations from the fuel pressure test chart.
4	• Inspect the EPR electrical connector CN15 for damage, corrosion or contamination. Did you find a problem?		Repair the circuit as necessary. Refer to wire harness repair section.	Go to Step (5)
5	• Replace or repair the EPR Is the replacement complete?		Go to Step (6)	
6	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC1172 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC1173-EPR Communication Lost



Conditions for Setting the DTC

- EPR CAN communication
- Check condition-Engine running or cranking
- MIL-On during active fault
- Fault condition-No packets received within 500 ms
- Adaptive disabled

Circuit Description

The EPR (Electronic Pressure Regulator) unit measures and controls the amount of fuel that is able to pass to the fuel mixer. Pressure readings are sent over the CAN to the ECM and in return the ECM sends back a control signal to the EPR to increase or decrease pressure for precise mixture control. This code will set in the event communication with the ECM is lost. The MIL command is on.

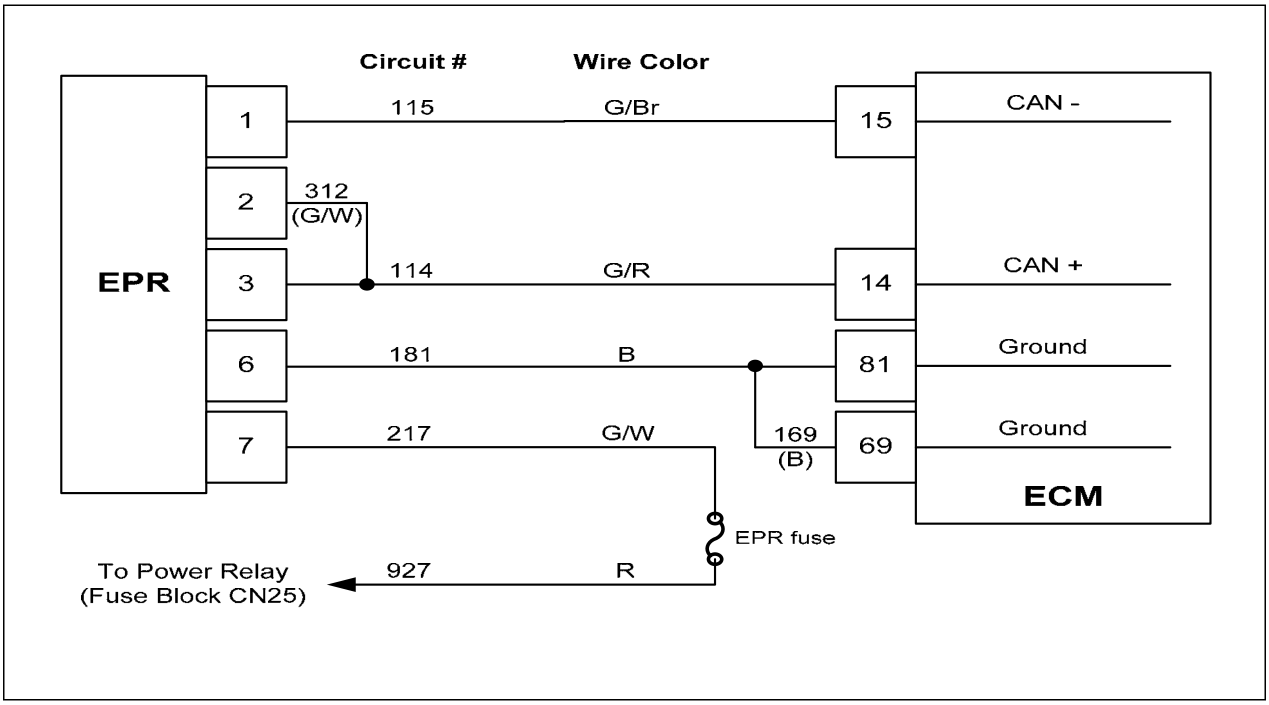
DTC 1173-EPR Communication Lost

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?	-	Go to Step (2)	Go to OBD System Check Section
2	• Key ON • DST (Diagnostic Scan Tool) connected in the system data mode • Clear DTC1173 • Key OFF • Key ON, and attempt to start the engine Does DTC1173 re-set?		Go to Step (3)	Intermittent problem. Go to Intermittent Problem section in the electrical section of this manual.
3	• Key OFF • Disconnect EPR electrical connector CN15 • Key ON • Using a DVOM check for system power between EPR connector circuit 217 and engine ground (Be sure to activate relay control ON using the DST function or check before ECM relay control times out) Do you have power?	System battery voltage	Go to Step (7)	Go to Step (4)
4	• Check the fuses Is the fuse open?		Go to Step (5)	Go to Step (6)
5	• Replace damaged fuse Is the replacement complete?		Go to Step (17)	–
6	• Using a DVOM check for system power at power relay terminal 3 (Be sure to activate relay control ON using the DST function or check before ECM relay control times out) Do you have power?	System battery voltage	Repair the open circuit between power relay pin 3 and EPR pin 7 Go to Step (17)	Repair the power relay circuit as required Go to Step (17)
7	• Using a DVOM check for continuity between EPR connector circuit 181 and engine ground Do you have continuity?		Go to Step (8)	Repair the open ground circuit as necessary. Refer to wiring repairs in engine electrical

Step	Action	Value(s)	Yes	No
8	• Key OFF • Disconnect the EPR connector CN15 • Disconnect the ECM connector CN1 • Using a DVOM check for continuity on the CAN-circuit 115 between EPR connector CN15 and ECM connector CN1 Do you have continuity?		Go to Step (9)	Repair the open circuit as necessary. Refer to wiring repairs in engine electrical
9	• Using a DVOM check for continuity on the CAN+ circuit 114 between EPR connector CN15 and ECM connector CN1 Do you have continuity?		Go to Step (10)	Repair the open circuit as necessary. Refer to wiring repairs in engine electrical
10	• Using a DVOM check for continuity between EPR CAN termination circuit 312 and circuit 114 on the EPR connector Do you have continuity?		Go to Step (11)	Repair the open circuit as necessary. Refer to wiring repairs in engine electrical
11	• Using a DVOM check for continuity on the EPR ground circuit 181 between EPR connector CN15 and ECM connector CN1 Do you have continuity?		Go to Step (12)	Repair the open circuit as necessary. Refer to wiring repairs in engine electrical
12	• Using a DVOM check for continuity on the EPR ground circuit between EPR connector circuit 181 and ECM circuit 169 Do you have continuity?		Go to Step (13)	Repair the open circuit as necessary. Refer to wiring repairs in engine electrical
13	• Disconnect DST from the DLC connector CN7 • Using a DVOM check for continuity between engine ground and EPR connector circuits 114 and 115 Do you have continuity?		Repair the shorted to ground CAN circuit as necessary. Refer to wiring repairs in engine electrical	Go to Step (14)
14	• Replace the EPR Is the replacement complete?		Go to Step (15)	

Step	Action	Value(s)	Yes	No
15	• Remove all test equipment and reconnect the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC1173 check for any stored codes. Does DTC1173 still re-set?		Go to Step (16)	System OK
16	• Replace the ECM Is the replacement complete?		Go to Step (17)	–
17	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC1173 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 1174-EPR Supply Voltage High



Conditions for Setting the DTC

- EPR supply voltage
- Check condition-Engine running or cranking
- MIL-On during active fault
- Fault condition-internal EPR supply voltage too high
- Adaptive disabled
- Closed loop disabled

Circuit Description

The EPR (Electronic Pressure Regulator) unit measures and controls the amount of fuel that is able to pass to the fuel mixer. Pressure readings are sent over the CAN to the ECM and in return the ECM sends back a control signal to the EPR to increase or decrease pressure for precise mixture control. This code will set if the EPR internal supply voltage is too high.

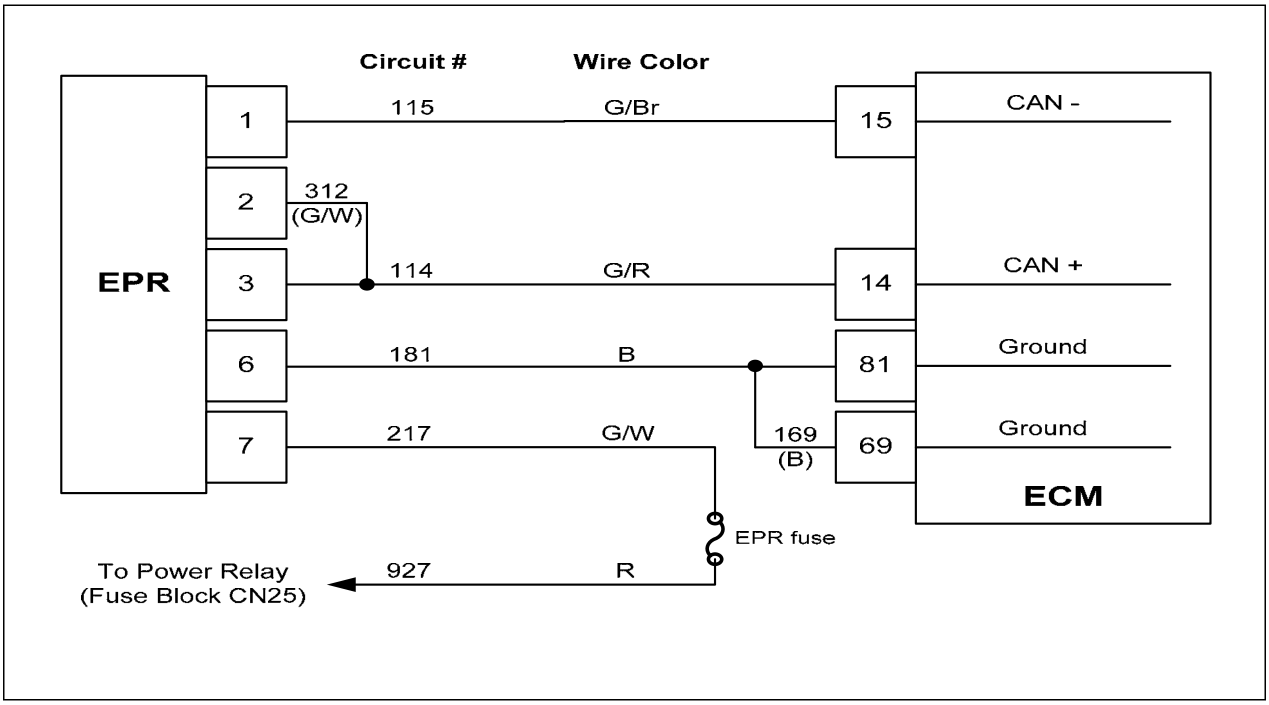
Diagnostic Aid

This DTC indicates abnormal EPR internal voltages that are not measurable externally. Check the system charging voltage to be sure this DTC and other over voltage DTC's are not present. Repair the charging system if it is found to be out of specification for high charge voltage. In the event of multiple code sets, always start the diagnostic repair with the lowest numerical value DTC first.

DTC 1174-EPR Voltage Supply High

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?		Go to Step (2)	Go to OBD System Check Section
2	• DST connected and in the System Data Mode • Engine running • Check the system battery voltage. Is the charging voltage within specifications?		Go to Step (3)	Repair the charging system
3	• Using a DVOM compare the system battery voltage to the DST display. Is the voltage reading within 1 volt between the two of them?	1 volt	Go to Step (4)	Go to Step (5)
4	• Replace the EPR Is the replacement complete?		Go to Step (6)	
5	• Replace the ECM Is the replacement complete?		Go to Step (6)	
6	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC1174 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 1175-EPR Supply Voltage Low



Conditions for Setting the DTC

- EPR supply voltage
- Check condition-Engine running or cranking
- MIL-On during active fault
- Fault condition-EPR internal supply voltage low
- Adaptive disabled

Circuit Description

The EPR (Electronic Pressure Regulator) unit measures and controls the amount of fuel that is able to pass to the fuel mixer. Pressure readings are sent over the CAN to the ECM and in return the ECM sends back a control signal to the EPR to increase or decrease pressure for precise mixture control. This code will set if the internal EPR supply voltage is low. Adaptive is disabled and the MIL command is ON.

Diagnostic Aid

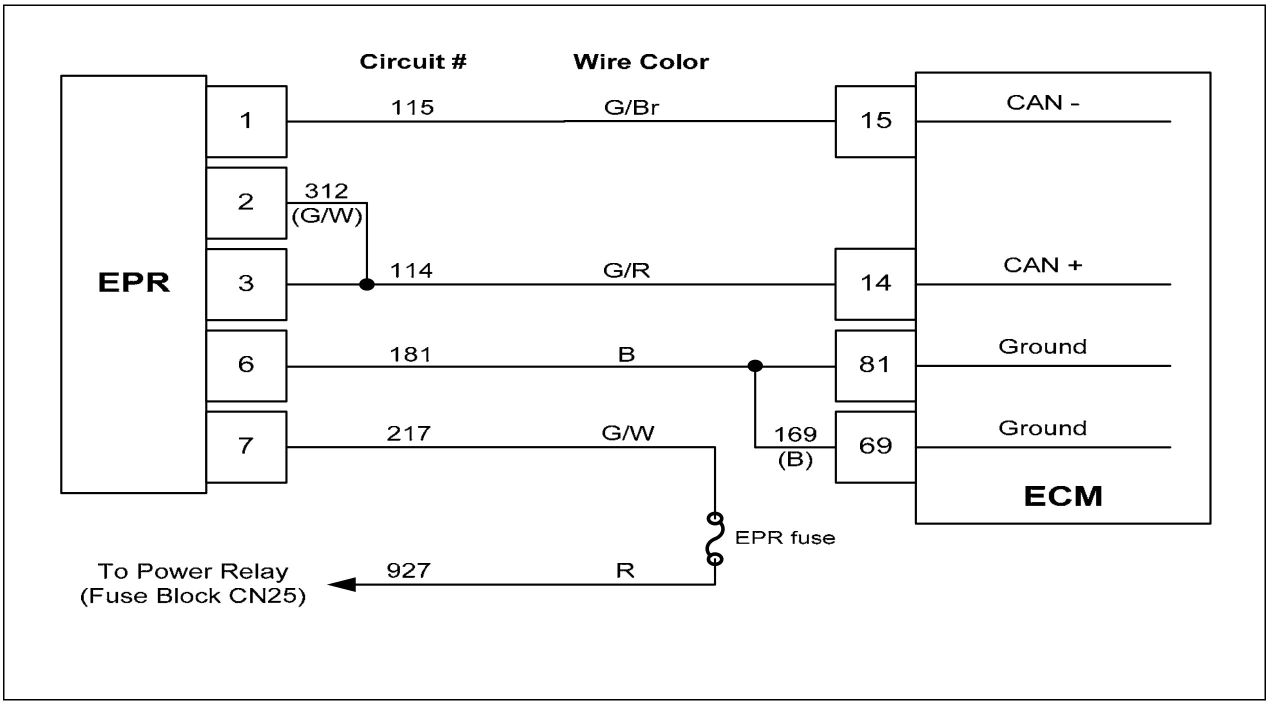
This DTC indicates abnormal EPR internal voltages that are not measurable externally. Check the system charging voltage to be sure this DTC and other low voltage DTC’s are not present. Repair the charging system if it is found to be out of specification for low charge voltage. In the event of multiple code sets, always start the diagnostic repair with the lowest numerical value DTC first.

DTC 1175-EPR Voltage Supply Low

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?	-	Go to Step (2)	Go to OBD System Check Section
2	• DST connected and in the system data mode • Engine running • Check the system battery voltage. Is the charging voltage within specifications?		Go to Step (3)	Repair the charging system
3	• Key OFF • Disconnect the EPR electrical connector CN15 • Using a DVOM check for power between the EPR connector circuit 217 and engine ground. • Key ON • Record the voltage reading. (Be sure to activate relay control ON using the DST function or check before ECM relay control times out) • Using a DVOM check the system battery power at the battery terminals and record the voltage reading. Are the recorded voltage readings within 1 volt of each other?		Go to Step (6)	Go to Step (4)
4	• Inspect the EPR connector and fuses for damage corrosion or contamination Did you find a problem?		Correct the problem as necessary. See wiring harness repair in the electrical section of this manual	Go to Step (5)
5	• Check the power relay circuit. Check the power relay connections for damage corrosion or contamination Did you find a problem?		Correct the problem as necessary. See wiring harness schematic in the electrical section of this manual	

Step	Action	Value(s)	Yes	No
6	• Key OFF • Disconnect the ECM connector CN1 • Using a DVOM check continuity between the EPR ground circuit 181 at EPR connector CN15 and ECM connector CN1 circuits 181 and 169 (Do not forget to subtract any resistance value that may be present in you test cables) Is the resistance reading less than 0.5 ohms?	Less than 0.5 Ohms	Go to Step (7)	Repair the poor EPR power ground circuit. See wiring harness repair in the electrical section of this manual
7	• Replace the EPR Is the replacement complete?		Go to Step (8)	
8	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC1175 check for any stored codes. Does DTC 1175 still re-set?		Go to Step (9)	System OK
9	• Replace the ECM Is the replacement complete?		Go to Step (10)	
10	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC1175 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 1176-EPR Internal Actuator Fault



Conditions for Setting the DTC

- EPR internal actuator test
- Check condition-Engine running or cranking
- MIL-On during active fault
- Fault condition-Failed actuator
- Adaptive disabled

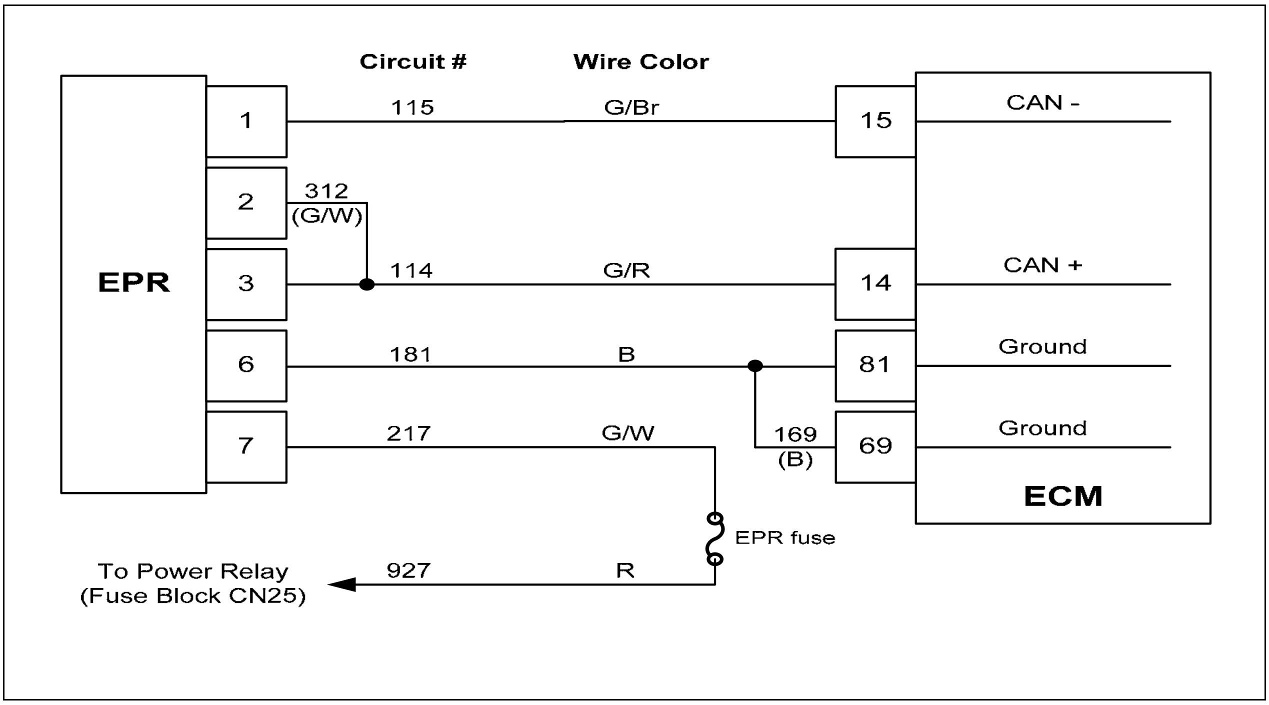
Circuit Description

The EPR (Electronic Pressure Regulator) unit measures and controls the amount of fuel that is able to pass to the fuel mixer. Pressure readings are sent over the CAN to the ECM and in return the ECM sends back a control signal to the EPR to increase or decrease pressure for precise mixture control. This code will set if the ECM detects an internal actuator fault with the EPR. In the event of multiple code sets, always start the diagnostic repair with the lowest numerical value DTC first. In most instances the EPR will need to be replaced in the event of this code set.

DTC 1176-EPR Internal Actuator Fault

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?	-	Go to Step (2)	Go to OBD System Check Section
2	• DST connected and in the system data mode • Check for any other current or active DTCs Does the DST show any other codes set?		Go to Step (3)	Go to Step (6)
3	• Repair any other DTC's set starting with the lowest DTC number first Have the other DTC's set been corrected?		Go to Step (4)	
4	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC1176 check for any stored codes. Does DTC 1176 still re-set?		Go to Step (5)	System OK
5	• Replace the EPR Is the replacement complete?		Go to Step (6)	
6	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC1176 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 1177-EPR internal Circuitry Fault



Conditions for Setting the DTC

- EPR internal circuitry test
- Check condition-Engine running or cranking
- MIL-On during active fault
- Fault condition-
- Adaptive disabled

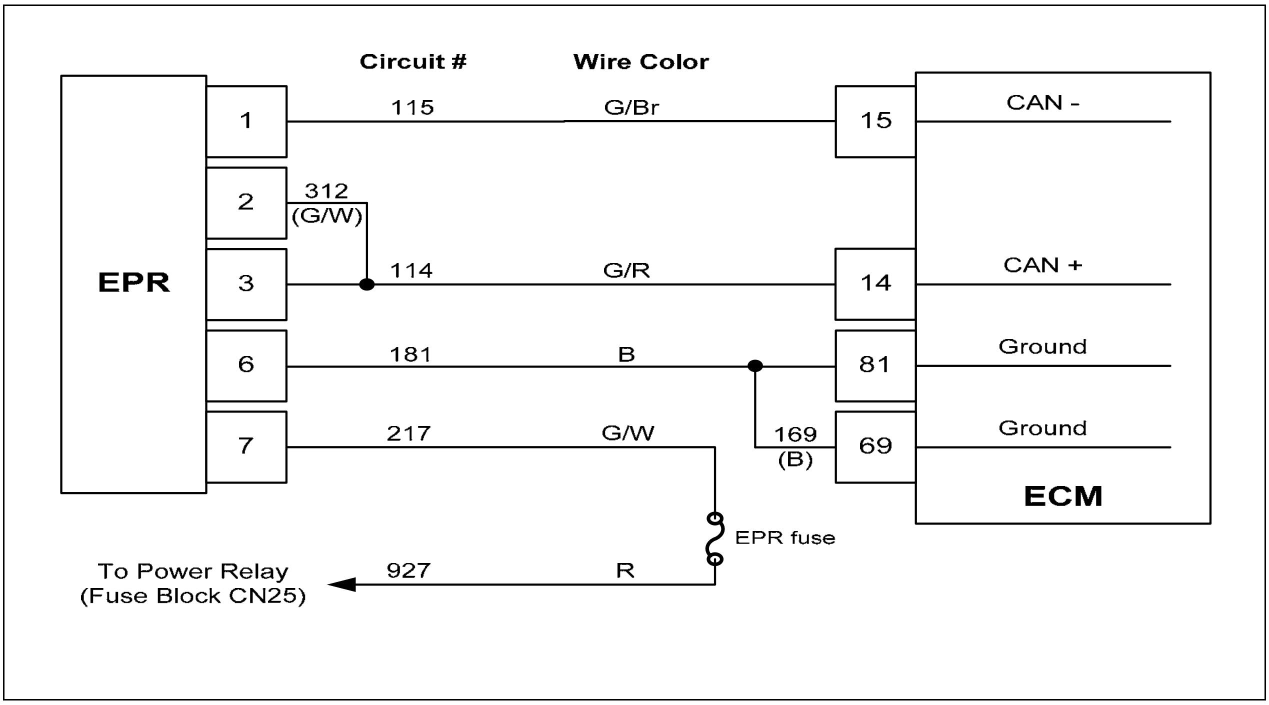
Circuit Description

The EPR (Electronic Pressure Regulator) unit measures and controls the amount of fuel that is able to pass to the fuel mixer. Pressure readings are sent over the CAN to the ECM and in return the ECM sends back a control signal to the EPR to increase or decrease pressure for precise mixture control. This code will set if the ECM detects an internal circuitry fault in the EPR. In the event of multiple code sets, always start the diagnostic repair with the lowest numerical value DTC first. In most instances the EPR will need to be replaced in the event of this code set.

DTC 1177-EPR Internal Circuitry Fault

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?		Go to Step (2)	Go to OBD System Check Section
2	• DST connected and in the system data mode • Check for any other current or active DTCs Does the DST show any other codes set?		Go to Step (3)	Go to Step (6)
3	• Repair any other DTC's set starting with the lowest DTC number first Have the other DTC's set been corrected?		Go to Step (4)	
4	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC1177 check for any stored codes. Does DTC 1177 still re-set?		Go to Step (5)	System OK
5	• Replace the EPR Is the replacement complete?		Go to Step (6)	
6	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC1177 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 1178-EPR Internal Communication Error



Conditions for Setting the DTC

- EPR internal communication test
- Check condition-Engine running or cranking
- MIL-On during active fault
- Fault condition-
- Adaptive disabled

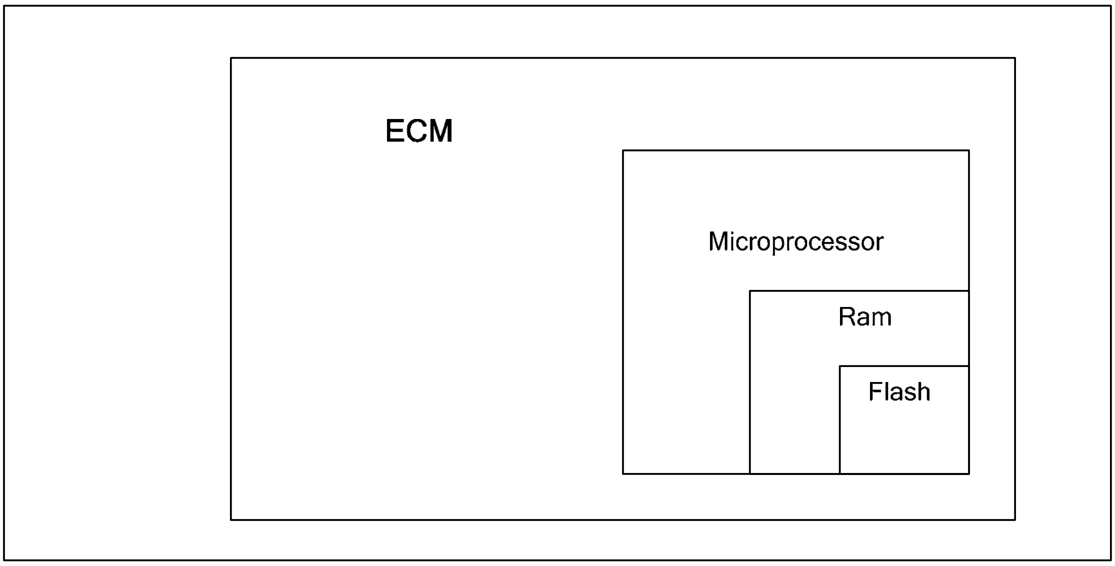
Circuit Description

The EPR (Electronic Pressure Regulator) unit measures and controls the amount of fuel that is able to pass to the fuel mixer. Pressure readings are sent over the CAN to the ECM and in return the ECM sends back a control signal to the EPR to increase or decrease pressure for precise mixture control. This code will set if the ECM detects an internal communication error in the EPR. In the event of multiple code sets, always start the diagnostic repair with the lowest numerical value DTC first. In most instances the EPR will need to be replaced in the event of this code set.

DTC 1178-EPR Internal Communication Error

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?	-	Go to Step (2)	Go to OBD System Check Section
2	• DST connected and in the system data mode • Check for any other current or active DTCs Does the DST show any other codes set?		Go to Step (3)	Go to Step (6)
3	• Repair any other DTC's set starting with the lowest DTC number first Have the other DTC's set been corrected?		Go to Step (4)	
4	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC1178 check for any stored codes. Does DTC 1178 still re-set?		Go to Step (5)	System OK
5	• Replace the EPR Is the replacement complete?		Go to Step (6)	
6	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC1178 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 1612-RTI 1 Loss



Conditions for Setting the DTC

- Engine Control Module
- Check Condition-Key on
- Fault Condition-Internal microprocessor error
- MIL-On
- Adaptive-Disabled for the remainder of the key-ON cycle
- Power Derate level 2

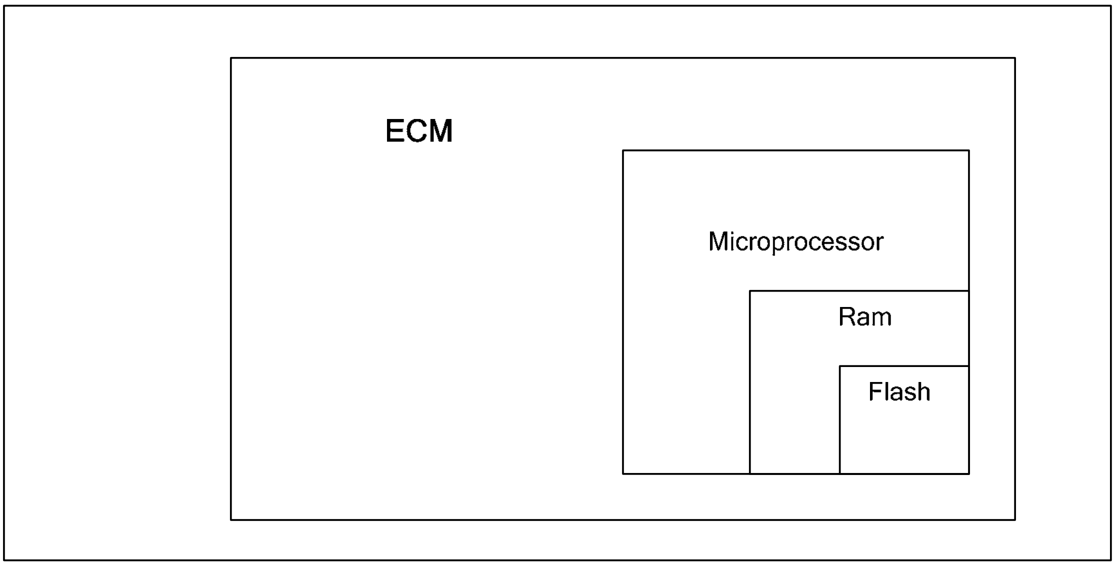
Circuit Description

The ECM has several internal checks that must be satisfied each time an instruction is executed. Several different things can happen within the microprocessor that will cause this fault. The ECM will attempt to reset itself in the event this fault is set. The MIL command is on and will remain on until the code is cleared using the DST. Power Derate level 2 will be enforced limiting maximum power.

DTC 1612-RT 1 Loss

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?		Go to Step (2)	Go to OBD System Check Section
2	• Key On, Engine Running • DST (Diagnostic Scan Tool) connected in System Data Mode • Clear system fault code Does DTC 1612 reset with the engine idling?		Go to Step (3)	Intermittent problem Go to Intermittent section
3	• Check ECM power and ground circuits Did the power and ground circuits check OK?		Go to Step (4)	Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.
4	• Replace ECM Is the replacement complete?		Go to Step (5)	
5	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-1612 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 1613-RTI 2 Loss



Conditions for Setting the DTC

- Engine Control Module
- Check Condition- Key on
- Fault Condition- Internal microprocessor error
- MIL- On
- Adaptive- Disabled for the remainder of the key-ON cycle
- Power Derate level 2

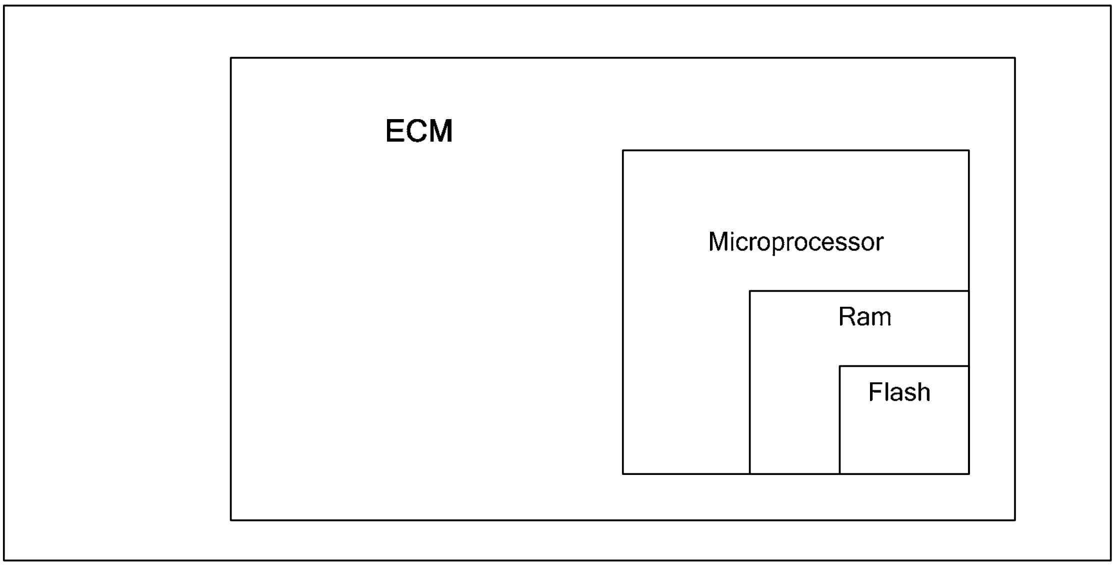
Circuit Description

The ECM has several internal checks that must be satisfied each time an instruction is executed. Several different things can happen within the microprocessor that will cause this fault. The ECM will attempt to reset itself in the event this fault is set. The MIL command is on and will remain on until the code is cleared using the DST. Power Derate level 2 will be enforced limiting maximum power.

DTC 1613-RTI 2 Loss

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?	-	Go to Step (2)	Go to OBD System Check Section
2	• Key On, Engine Running • DST (Diagnostic Scan Tool) connected in System Data Mode • Clear system fault code Does DTC 1613 reset with the engine idling?		Go to Step (3)	Intermittent problem Go to Intermittent section
3	• Check ECM power and ground circuits Did the power and ground circuits check OK?		Go to Step (4)	Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.
4	• Replace ECM Is the replacement complete?		Go to Step (5)	
5	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-1613 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 1614-RTI 3 Loss



Conditions for Setting the DTC

- Engine Control Module
- Check Condition-Key on
- Fault Condition-Internal microprocessor error
- MIL-On
- Adaptive-Disabled for the remainder of the key-ON cycle
- Power Derate level 2

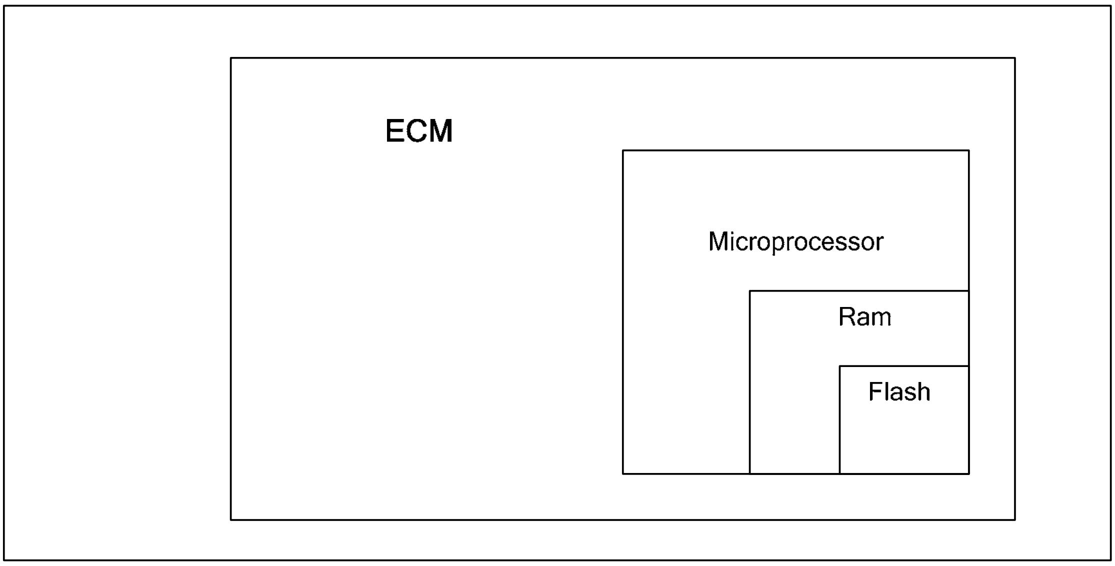
Circuit Description

The ECM has several internal checks that must be satisfied each time an instruction is executed. Several different things can happen within the microprocessor that will cause this fault. The ECM will attempt to reset itself in the event this fault is set. The MIL command is on and will remain on until the code is cleared using the DST. Power Derate level 2 will be enforced limiting maximum power.

DTC 1614-RTI 3 Loss

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?	-	Go to Step (2)	Go to OBD System Check Section
2	• Key On, Engine Running • DST (Diagnostic Scan Tool) connected in System Data Mode • Clear system fault code Does DTC 1614 reset with the engine idling?		Go to Step (3)	Intermittent problem Go to Intermittent section
3	• Check ECM power and ground circuits Did the power and ground circuits check OK?		Go to Step (4)	Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.
4	• Replace ECM Is the replacement complete?		Go to Step (5)	-
5	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-1614 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 1615-A/D Loss



Conditions for Setting the DTC

- Engine Control Module
- Check Condition-Key on
- Fault Condition-Internal microprocessor error
- MIL-On
- Adaptive-Disabled for the remainder of the key-ON cycle
- Power Derate level 2

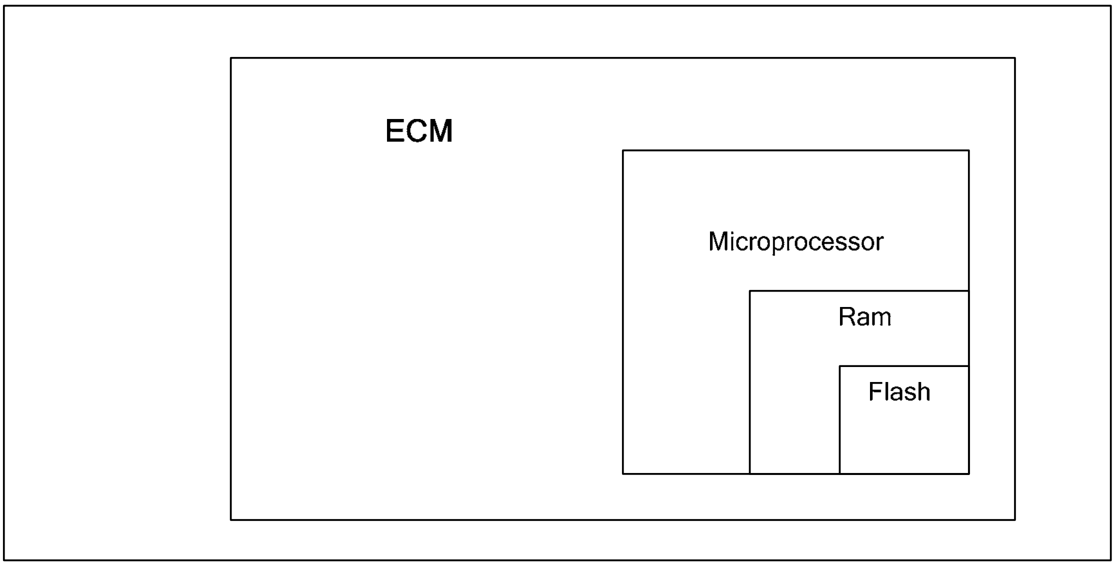
Circuit Description

The ECM has several internal checks that must be satisfied each time an instruction is executed. Several different things can happen within the microprocessor that will cause this fault. The ECM will attempt to reset itself in the event this fault is set. The MIL command is on and will remain on until the code is cleared using the DST. Power Derate level 2 will be enforced limiting maximum power.

DTC 1615-A/D Loss

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?	-	Go to Step (2)	Go to OBD System Check Section
2	• Key On, Engine Running • DST (Diagnostic Scan Tool) connected in System Data Mode • Clear system fault code Does DTC 1615 reset with the engine idling?		Go to Step (3)	Intermittent problem Go to Intermittent section
3	• Check ECM power and ground circuits Did the power and ground circuits check OK?		Go to Step (4)	Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.
4	• Replace ECM Is the replacement complete?		Go to Step (5)	-
5	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-1615 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 1616-Invalid Interrupt



Conditions for Setting the DTC

- Engine Control Module
- Check Condition-Key on
- Fault Condition-Internal microprocessor error
- MIL-On
- Adaptive-Disabled for the remainder of the key-ON cycle
- Power Derate level 2

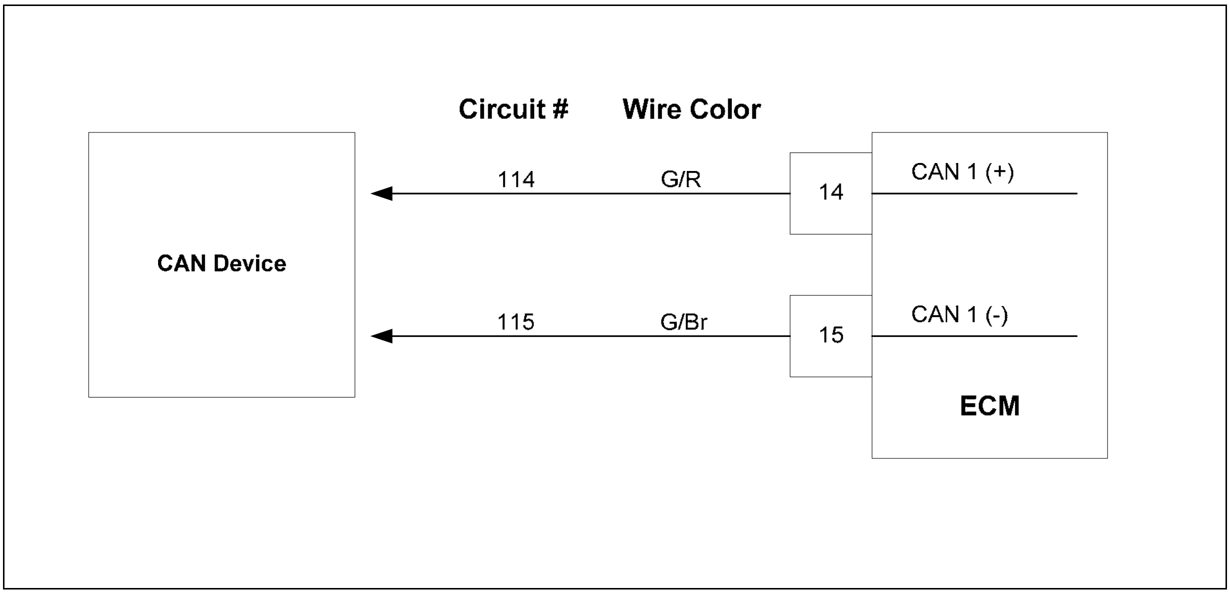
Circuit Description

The ECM has several internal checks that must be satisfied each time an instruction is executed. Several different things can happen within the microprocessor that will cause this fault. The ECM will attempt to reset itself in the event this fault is set. The MIL command is on and will remain on until the code is cleared using the DST. Power Derate level 2 will be enforced limiting maximum power.

DTC 1616-Invalid Interrupt

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?	-	Go to Step (2)	Go to OBD System Check Section
2	• Key On, Engine Running • DST (Diagnostic Scan Tool) connected in System Data Mode • Clear system fault code Does DTC 1616 reset with the engine idling?		Go to Step (3)	Intermittent problem Go to Intermittent section
3	• Check ECM power and ground circuits Did the power and ground circuits check OK?		Go to Step (4)	Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.
4	• Replace ECM Is the replacement complete?		Go to Step (5)	-
5	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-1616 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 1628-CAN Address Conflict



Conditions for Setting the DTC

- CAN Rx
- Check Condition-Engine running
- Fault Condition- 5 or more address conflict errors
- MIL-ON

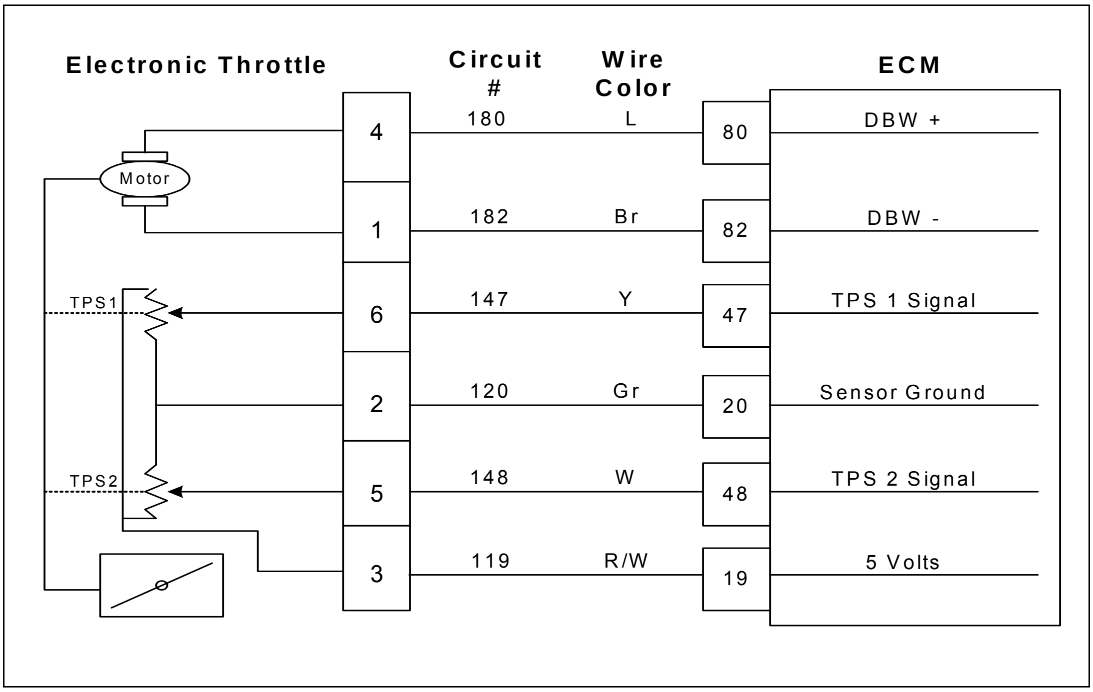
Circuit description

The CAN bus (controller area network) is used by the ECM to communicate with other digital devices used throughout the fuel system. Information is sent over the CAN bus in digital information "packets" that contain information for various control functions. Individual devices are assigned network addresses. This fault will set if the ECM detects an address conflict, such as two devices with the same address. This is usually not due to an infield failure and may be the results of "add on" CAN devices

DTC 1628-CAN Address Conflict

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?	-	Go to Step (2)	Go to OBD System Check Section
2	• Key On, Engine Running • DST (Diagnostic Scan Tool) connected in System Data Mode • Clear system fault code Does DTC1628 reset with the engine idling?		Go to Step (3)	Intermittent problem Go to Intermittent section
3	• Key OFF • Disconnect one CAN device • Clear DTC 1628 • Key ON (start engine if possible if not continue cranking for at least 3 seconds) • Wait 5 seconds Does DTC 1628 re-set		Repeat Step 3 until all CAN devices have been disconnected one at a time	Contact the CAN device manufacturer for additional CAN address information Go to Step (4)
4	Has the CAN device been replaced or address conflict resolved?		Go to Step (5)	
5	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-1628 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 2111-Unable To Reach Lower TPS



Conditions for Setting the DTC

- Throttle Position Sensor
- Check Condition-Cranking or Running
- Fault Condition-Actual throttle position is 20% greater than the throttle command
- MIL-On during active fault
- Engine shutdown

Circuit Description

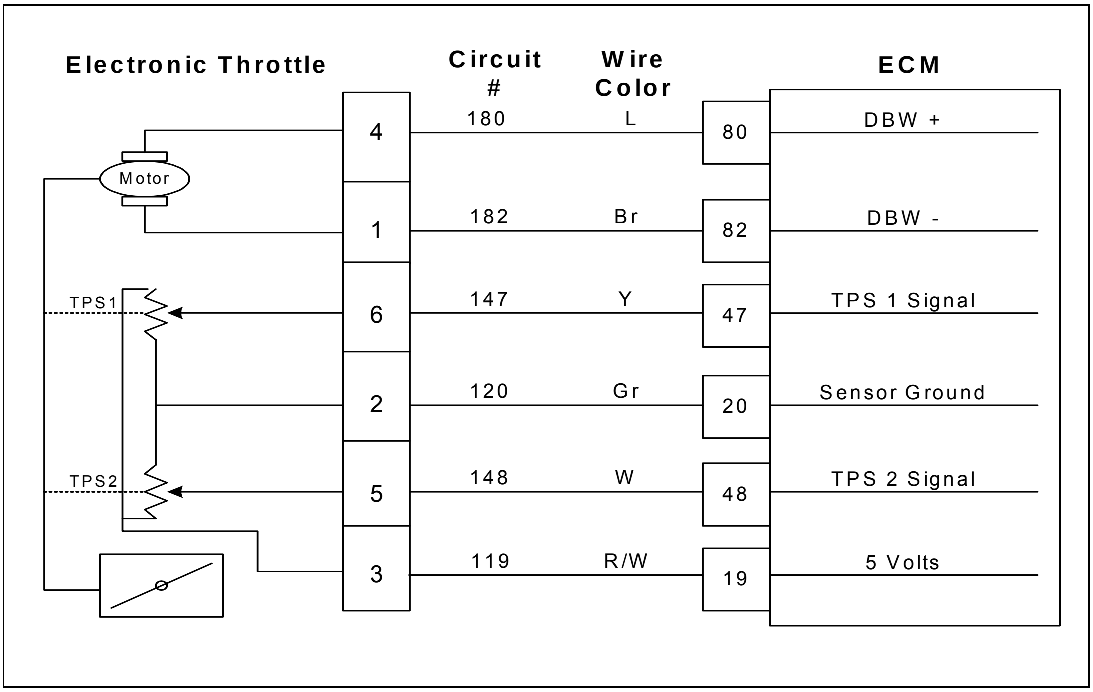
Dual throttle Position Sensors are used within the throttle that use variable resistors to determine signal voltage based on throttle plate position. TPS 1 will read low voltage when closed and TPS 2 will read high voltage when closed. The TPS 1 and TPS 2 percentages are calculated from these voltages. Although the voltages are different, the calculated values for the throttle position percentages should be very close to the same. The TPS values are used by the ECM to determine if the throttle is opening as commanded. This fault will set if the actual throttle position is 20% greater than the throttle command. During this active fault the MIL command is ON and the engine will shutdown.

DTC 2111-Unable To Reach Lower TPS

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?	-	Go to Step (2)	Go to OBD System Check Section
2	• Key ON, Engine OFF • DST (Diagnostic Scan Tool) connected in data stream mode • Depress Foot Pedal until the Throttle Command is between 63%-68% Is the TPS 1 voltage greater than 2.0 volts?		Go to Step (3)	Intermittent problem Go to Intermittent section
3	• Key OFF • Disconnect electronic throttle connector CN3 • Probe TPS 1 signal circuit 147 with a test light connected to battery voltage • Key ON Does DST display TPS 1 voltage less than 0.2 volts		Go to Step (6)	Go to Step (4)
4	• Key OFF • Disconnect ECM wire harness connector CN1 • Key ON • Using a DVOM check for voltage between throttle connector TPS 1 signal circuit 147 and engine ground Do you have voltage?		Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to Step (5)
5	• Replace ECM Is the replacement complete?		Go to Step (13)	
6	• Back probe sensor ground circuit 120 at ECM connector CN1 with a test light connected to battery voltage Does the test light come on?		Go to Step (9)	Go to Step (7)
7	• Key OFF • Disconnect ECM wire harness connector CN1 • Using a DVOM check for continuity between throttle connector signal ground circuit 120 and ECM connector signal ground circuit 120 Do you have continuity between them?		Go to Step (8)	Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.
8	• Replace ECM Is the replacement complete?		Go to Step (13)	

Step	Action	Value(s)	Yes	No
9	• Check throttle for foreign object in bore Did you find a foreign object in the bore?		Go to Step (10)	Go to Step (11)
10	• Remove foreign object Is the removal complete?		Go to Step (13)	-
11	• Inspect the throttle wire harness connector terminals for damage, corrosion or contamination Did you find the problem?		Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to Step (12)
12	• Replace throttle Is the replacement complete?		Go to Step (13)	-
13	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-2111 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 2112-Unable To Reach Higher TPS



Conditions for Setting the DTC

- Throttle Position Sensor
- Check Condition-Cranking or Running
- Fault Condition- Actual throttle position is 20% less than the throttle command
- MIL-On during active fault
- Engine shutdown

Circuit Description

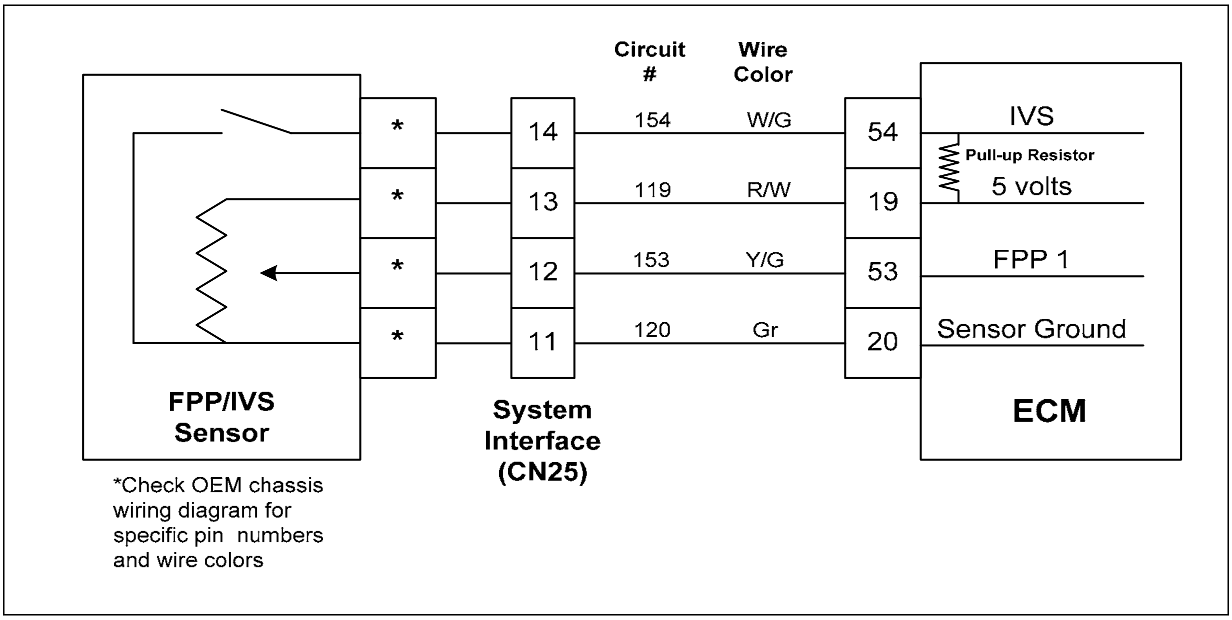
Dual throttle Position Sensors are used within the throttle that use variable resistors to determine signal voltage based on throttle plate position. TPS 1 will read low voltage when closed and TPS 2 will read high voltage when closed. The TPS 1 and TPS 2 percentages are calculated from these voltages. Although the voltages are different, the calculated values for the throttle position percentages should be very close to the same. The TPS values are used by the ECM to determine if the throttle is opening as commanded. This fault will set if the actual throttle position is 20% less than the throttle command. The MIL command is ON and the engine will shutdown.

DTC 2112-Unable To Reach Higher TPS

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?	-	Go to Step (2)	Go to OBD System Check Section
2	• Key ON, Engine OFF • DST (Diagnostic Scan Tool) connected in DBW data stream mode • Depress foot pedal until the throttle command is 63%-68% Is the TPS voltage less than 2.0 volts?		Go to Step (3)	Intermittent problem Go to Intermittent section
3	• Key OFF • Disconnect electronic throttle connector CN3 • Probe TPS 1 signal circuit 147 with test light connected to battery voltage • Key ON Is TPS voltage 4.0 volts or greater?		Go to Step (4)	Go to Step (8)
4	• Check throttle bore for foreign object Did you find a problem?		Go to Step (5)	Go to Step (6)
5	• Remove the foreign object Has the object been removed?		Go to Step (11)	
6	• Check the electronic throttle connector terminals for damage corrosion or contamination Did you find a problem?		Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to Step (7)
7	• Replace throttle Is the replacement complete?		Go to Step (11)	
8	• Key OFF • Disconnect ECM wire harness connector CN1 • Using a DVOM check for continuity on the TPS 1 signal circuit between throttle connector CN3 and ECM connector CN1 Do you have continuity between them?		Go to Step (9)	Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.

Step	Action	Value(s)	Yes	No
9	• Using a DVOM check for continuity between throttle connector TPS 1 signal circuit 147 and engine ground Do you have continuity between them?		Repair the shorted to ground circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to Step (10)
10	• Replace ECM Is the replacement complete?		Go to Step (11)	
11	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-2112 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 2115-FPP1 Higher Than IVS Limit



Conditions for Setting the DTC

- Foot Pedal Position
- Check Condition-Key On
- Fault Condition-FPP 1 sensor voltage greater than 1.0 volt and IVS at-idle
- MIL-On during active
- Power derate level 2

Circuit Description

The Foot Pedal Position sensor uses a variable resistor to determine signal voltage based on pedal position. This fault will set if the FPP 1 voltage is greater than 1.0 volt and the IVS indicates an at-idle condition. The two conditions conflict indicating a fault in the FPP or IVS circuits. The MIL command is ON and power derate 2 is in effect during this code set limiting full power output.

Diagnostic Aid

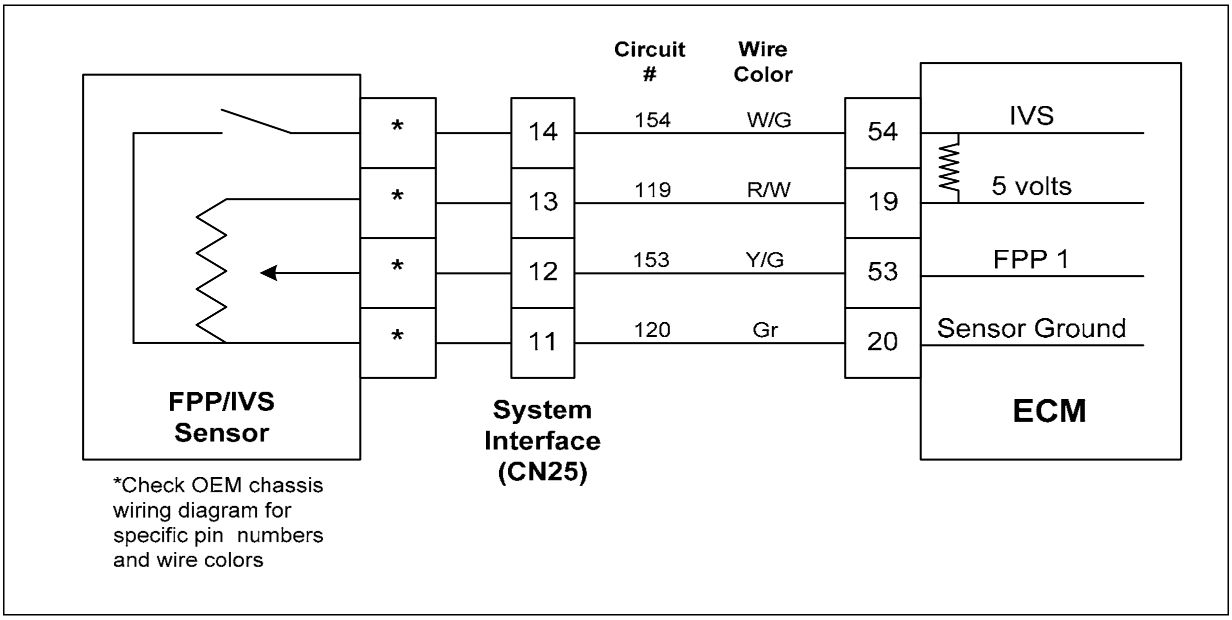
FPP sensors are OEM specific and vary in configuration. The exact wire color and pin numbers for the FPP connection must be verified in the OEM chassis wiring schematic. The FPP sensor used in this system provides an FPP signal and an IVS (Idle validation) sensor in one packaged assembly. FPP and IVS are not serviceable individually, and in the event of a failure the complete foot pedal sensor assembly must be replaced.

DTC 2115-FPP 1 Higher Than IVS Limit

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?	-	Go to Step (2)	Go to OBD System Check Section
2	• Key ON, Engine OFF • DST (Diagnostic Scan Tool) connected in System Data Mode Does the DST display FPP 1 voltage greater than 1.00 volts with the foot pedal in the idle position?	Greater than 1.00 volt	Go to Step (4)	Go to Step (3)
3	• Depress the foot pedal about half way Does IVS voltage drop below 1.0 volt with the foot pedal depressed?	Less than 1.00 volt	Go to Step (5)	Intermittent problem Go to Intermittent section
4	• Disconnect the System Interface connector CN21 • Check for continuity between circuits 153 and 119 at the system interface connector CN21 Do you have continuity?		Repair circuit as necessary. See wiring harness repair section.	Go to Step (6)
5	• Disconnect the System Interface connector CN21 • Check for continuity between circuits 154 and 119 at the system interface connector CN21 Do you have continuity?		Repair circuit as necessary. See wiring harness repair section.	Go to Step (6)
6	• Disconnect the ECM connector CN1 • Check for continuity on the sensor ground circuit 120 between the system interface connector CN21 and the ECM connector CN1 Do you have continuity on the circuit?		Go to Step (7)	Repair circuit as necessary. See wiring harness repair section.
7	• Inspect the FPP/IVS connector, the ECM connector CN1, and the system interface connector CN21 for damage, corrosion, or contamination. Any damage found?		Repair circuit as necessary. See wiring harness repair section.	Go to Step (8)
8	• Replace FPP/IVS sensor Is the replacement complete?		Go to Step (10)	-

Step	Action	Value(s)	Yes	No
9	• Replace ECM Is the replacement complete?		Go to Step (11)	-
10	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-2123 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to Step (9)
11	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-2123 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 2122-FPP 1 High Voltage



Conditions for Setting the DTC

- Foot Pedal Position
- Check Condition-Key On
- Fault Condition-FPP1 sensor voltage exceeds 4.00 volts
- MIL-On during active fault
- Low rev limit
- Force idle

Circuit Description

The Foot Pedal Position sensor uses a variable resistor to determine signal voltage based on pedal position. This fault will set if the FPP 1 voltage exceeds 4.00 volts at any operating condition while the key is on. If the voltage exceeds 4.00 volts the FPP is considered to be out of specification. The MIL command is ON. Forced idle and low rev limit will be in effect during this code set limiting full power output.

Diagnostic Aid

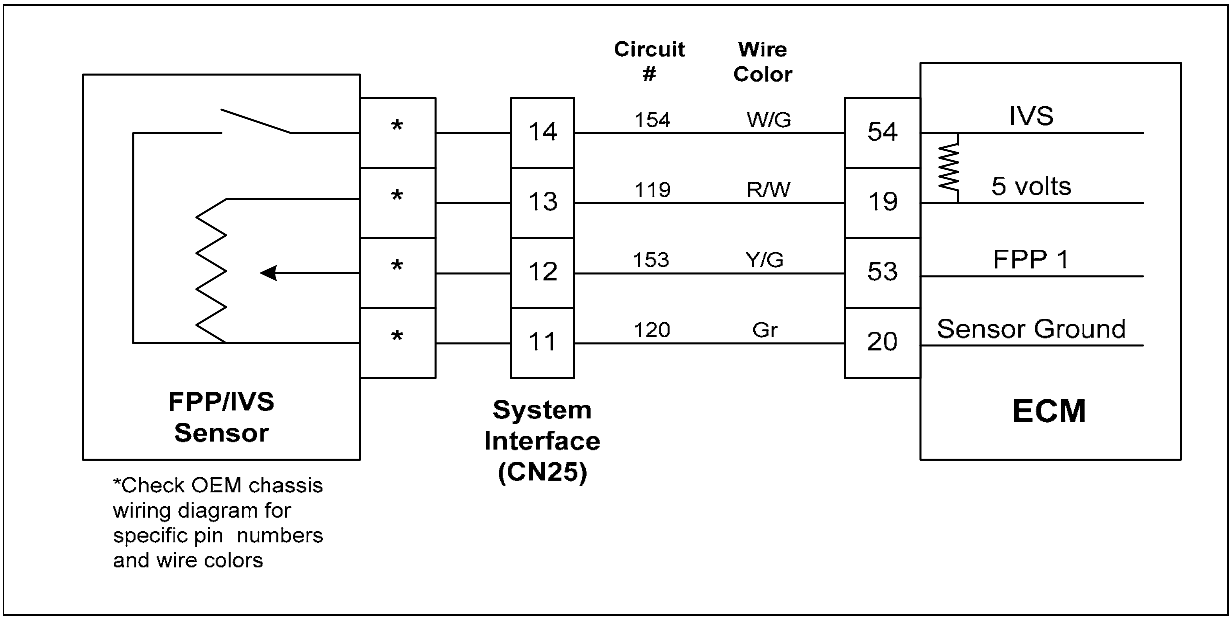
FPP sensors are OEM specific and vary in configuration. The exact wire color and pin numbers for the FPP connection must be verified in the OEM chassis wiring schematic. The FPP sensor used in this system provides an FPP signal and an IVS (Idle validation) sensor in one packaged assembly. FPP and IVS are not serviceable individually, and in the event of a failure the complete foot pedal sensor assembly must be replaced.

DTC 2122-FPP 1 Voltage High

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?	-	Go to Step (2)	Go to OBD System Check Section
2	• Key ON, Engine OFF • DST (Diagnostic Scan Tool) connected in System Data Mode Does the DST display FPP voltage of 4.00 volts or greater with the foot pedal in the idle position?	Greater than 4.00 volts	Go to Step (3)	Go to Step (3)
3	• Slowly increase FPP while observing FPP 1 voltage Does DST FPP voltage ever exceed 4.00 volts?		Go to Step (4)	Intermittent problem Go to Intermittent section
4	• Disconnect the FPP sensor connector Does the DST now show FPP 1 voltage below 0.200 volts?	0.200 volts or less	Go to Step (5)	Go to Step (6)
5	• Replace FPP sensor Is the replacement complete?		Go to Step (10)	-
6	• Key OFF • Disconnect ECM connector CN1 • Disconnect system interface connector CN21 • Using a DVOM check continuity between connector CN circuit 120 and ECM connector CN1 circuit 120 Do you have continuity?		Go to Step (7)	Repair the open ground circuit as required
7	• Key ON • Using a DVOM check for voltage between the System Interface connector CN21 circuit 153 and engine ground Do you have voltage?	No voltage	Repair the signal shorted to voltage circuit	Go to Step (8)
8	• Inspect ECM and FPP connectors for damage corrosion or contamination Did you find a problem?		Repair the circuit as required. See wire harness repair section	Go to Step (9)
9	• Replace ECM Is the replacement complete?		Go to Step (10)	-

Step	Action	Value(s)	Yes	No
10	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-2122 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 2123-FPP 1 Low Voltage



Conditions for Setting the DTC

- Foot Pedal Position
- Check Condition-Key On
- Fault Condition-FPP sensor voltage less than 0.300
- MIL-On during active
- Low rev limit
- Force idle

Circuit Description

The Foot Pedal Position sensor uses a variable resistor to determine signal voltage based on pedal position. This fault will set if the FPP 1 voltage is less than 0.300 volts at any operating condition while the key is on. If the voltage drops below 0.300 volts the FPP is considered to be out of specification. The MIL command is ON. Forced idle and low rev limit will be in effect during this code set limiting full power output.

Diagnostic Aid

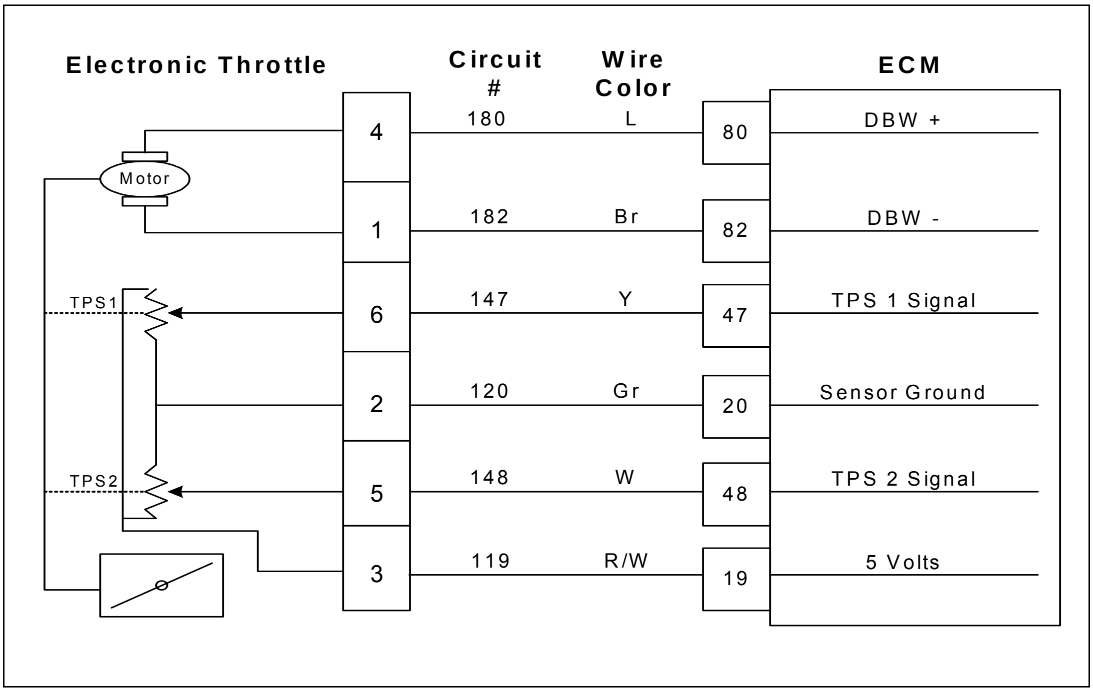
FPP sensors are OEM specific and vary in configuration. The exact wire color and pin numbers for the FPP connection must be verified in the OEM chassis wiring schematic. The FPP sensor used in this system provides an FPP signal and an IVS (Idle validation) sensor in one packaged assembly. FPP and IVS are not serviceable individually, and in the event of a failure the complete foot pedal sensor assembly must be replaced.

DTC 2123-FPP 1 Low Voltage

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?	-	Go to Step (2)	Go to OBD System Check Section
2	• Key ON, Engine OFF • DST (Diagnostic Scan Tool) connected in System Data Mode Does the DST display FPP 1 voltage of 0.300 volts or less with the foot pedal in the idle position?	0.300 volts or less	Go to Step (3)	Go to Step (3)
3	• Slowly increase FPP while observing the FPP 1 voltage Does the DST ever display FPP voltage below 0.300 volts?		Go to Step (4)	Intermittent problem Go to Intermittent section
4	• Disconnect the System Interface connector CN21 • Jump the FPP 1 circuit 153 and 5 volt reference circuit 119 Does the DST now show FPP 1 voltage above 0.300 volts?	Greater than 0.300 volts	Go to Step (5)	Go to Step (7)
5	• Inspect FPP 1 and CN21 connectors for damage corrosion or contamination Did you find a problem?		Repair the circuit as required. See wiring harness repair section	Go to Step (6)
6	• Replace FPP 1 sensor Is the replacement complete?		Go to Step (12)	-
7	• Key OFF • Disconnect ECM connector CN1 • Using a DVOM check for continuity on the 5 volt reference circuit 119 between system interface connector CN21 and ECM connector CN1 Do you have continuity?		Go to Step (8)	Repair the open circuit as required. See wiring harness repair section
8	• Using a DVOM check for continuity of the FPP1 circuit 153 between ECM connector CN1 and system interface connector CN21 Do you have continuity?		Go to Step (9)	Repair the open circuit as required. See wiring harness repair section

Step	Action	Value(s)	Yes	No
9	• Key ON • Using a DVOM check for continuity between ECM connector circuit153 and engine ground Do you have continuity?		Repair the signal shorted to ground circuit as required. See wiring harness repair section	Go to Step (10)
10	• Inspect system interface and ECM connectors for damage corrosion or contamination Did you find a problem?		Repair the circuit as required. See wiring harness repair section	Go to Step (11)
11	• Replace ECM Is the replacement complete?		Go to Step 12	-
12	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-2123 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 2135-TPS 1/2 Voltages Out Of Range



Conditions for Setting the DTC

- Throttle Position Sensor
- Check Condition-Cranking or Running
- Fault Condition- TPS 1 and TPS 2 signals simultaneously out of range
- MIL-On during active fault
- Engine shutdown

Circuit Description

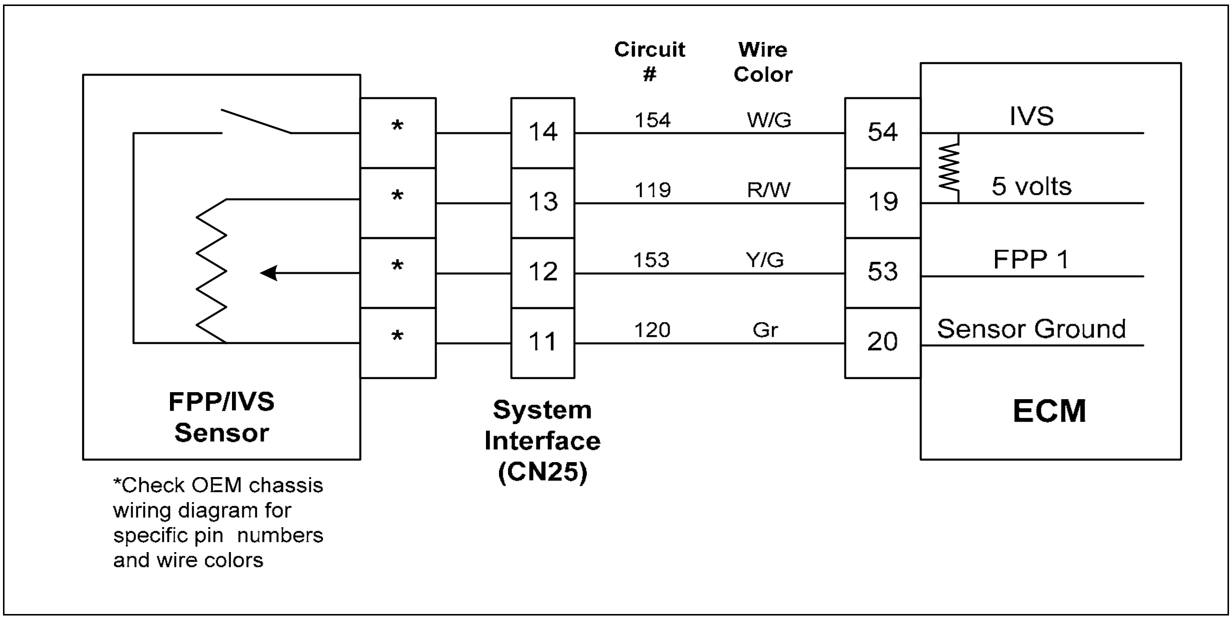
Dual throttle Position Sensors are used within the throttle that use variable resistors to determine signal voltage based on throttle plate position. TPS 1 will read low voltage when closed and TPS 2 will read high voltage when closed. The TPS 1 and TPS 2 percentages are calculated from these voltages. Although the voltages are different, the calculated values for the throttle position percentages should be very close to the same. The TPS values are used by the ECM to determine if the throttle is opening as commanded. This fault will set if the TPS 1 and TPS 2 signal voltages are simultaneously out of operational voltage ranges. The MIL command is ON and the engine will shutdown.

DTC 2135-TPS 1/2 Out Of Range

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?	-	Go to Step (2)	Go to OBD System Check Section
2	• Key ON, Engine OFF • DST (Diagnostic Scan Tool) connected in DBW (Drive By Wire) test mode • Depress foot pedal until the throttle command is 63%-68% Is the TPS voltage less than 2.0 volts?		Go to Step (3)	Intermittent problem Go to Intermittent section
3	• Key OFF • Disconnect electronic throttle connector CN3 • Key ON • Using a DVOM check the voltage between circuit 119 and engine ground Is the voltage greater than 4.5 volts?	Greater than 4.5 volts	Go to Step (4)	Repair circuit 119 as necessary. Refer to Wiring Repairs in Engine Electrical.
4	• Using a DVOM check the voltage between circuit 119 and circuit 120 at the throttle connector CN3 Is the voltage greater than 4.5 volts?	Greater than 4.5 volts	Go to Step (5)	Repair circuit 120 as necessary. Refer to Wiring Repairs in Engine Electrical.
5	• Disconnect ECM connector CN1 • Using a DVOM check continuity on circuit 147 between connector CN1 and CN3 Do you have continuity?		Go to Step (6)	Repair circuit 147 as necessary. Refer to Wiring Repairs in Engine Electrical.
6	• Using a DVOM check continuity on circuit 148 between connector CN1 and CN3 Do you have continuity?		Go to Step (7)	Repair circuit 148 as necessary. Refer to Wiring Repairs in Engine Electrical.

Step	Action	Value(s)	Yes	No
7	• Using a DVOM check continuity on circuit 120 between connector CN1 and CN3 Do you have continuity?		Go to Step (8)	Repair circuit 120 as necessary. Refer to Wiring Repairs in Engine Electrical.
8	• Replace throttle Is the replacement complete?		Go to Step (9)	
9	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-2112 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to Step (10)
10	• Replace ECM Is the replacement complete?		Go to Step (11)	
11	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-2112 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 2139-FPP 1 Lower Than IVS Limit



Conditions for Setting the DTC

- Foot Pedal Position
- Check Condition-Key On
- Fault Condition-FPP 1 voltage less than 0.850 volts and IVS off-idle
- MIL-On during active
- Power derate

Circuit Description

The Foot Pedal Position sensor uses a variable resistor to determine signal voltage based on pedal position. This fault will set if the FPP 1 voltage is less than 0.850 volts and the IVS indicates an off-idle state. The two conditions conflict indicating a fault in the FPP or IVS circuit. The MIL command is ON and power derate level two are in effect during this code set limiting full power output.

Diagnostic Aid

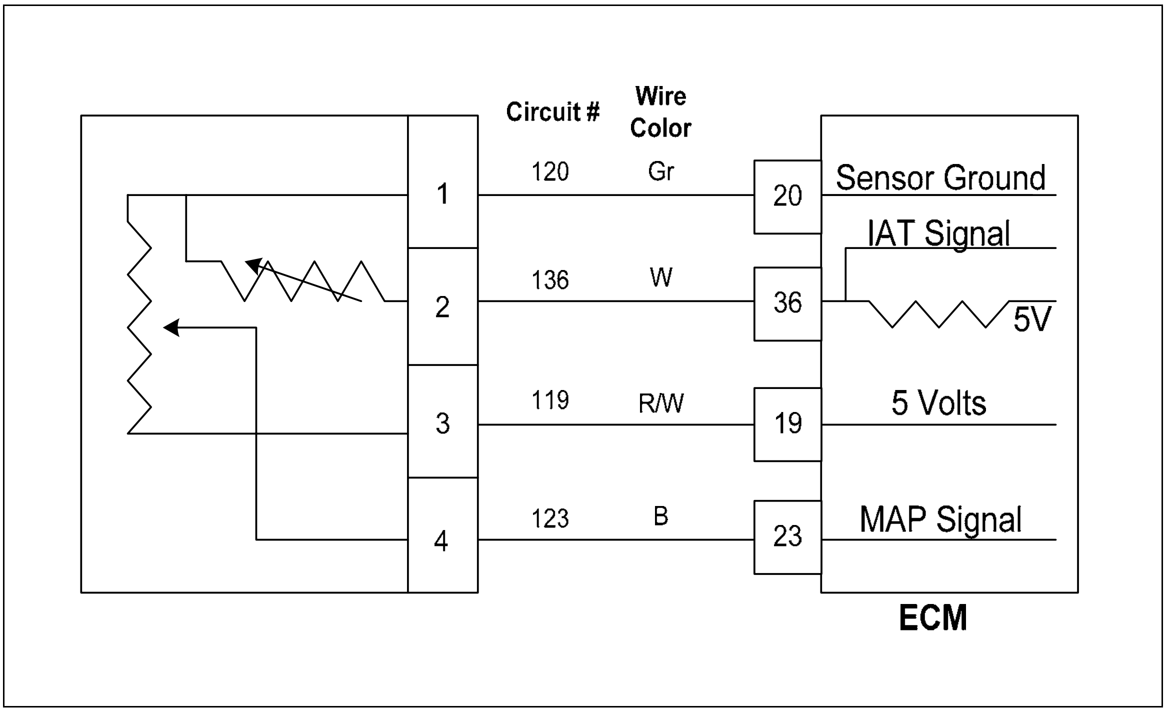
FPP sensors are OEM specific and vary in configuration. The exact wire color and pin numbers for the FPP connection must be verified in the OEM chassis wiring schematic. The FPP sensor used in this system provides an FPP signal and an IVS (Idle validation) sensor in one packaged assembly. FPP and IVS are not serviceable individually, and in the event of a failure the complete foot pedal sensor assembly must be replaced.

DTC 2139-FPP 1 Lower Than IVS Limit

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?	-	Go to Step (2)	Go to OBD System Check Section
2	• Key ON, Engine OFF • DST (Diagnostic Scan Tool) connected in System Data Mode Does the DST display IVS voltage less than 1.00 volts with the foot pedal in the idle position?	Greater than 1.00 volt	Go to Step (5)	Go to Step (3)
3	• Observe the FPP and IVS voltages • Stroke the pedal while observing the voltage readings Does FPP voltage drop below 0.85 volts at any time while the IVS reads less than 1.0 volt?	FPP less than 0.85 volts AND IVS less than 1.0 volt	Go to Step (4)	Intermittent problem Go to Intermittent section
4	• Disconnect the System Interface connector CN21 • Check for continuity between circuits 153 and 120 at the system interface connector CN21 Do you have continuity?		Repair circuit as necessary. See wiring harness repair section.	Go to Step (6)
5	• Disconnect the System Interface connector CN21 • Check for continuity between circuits 154 and 120 at the system interface connector CN21 Do you have continuity?		Repair circuit as necessary. See wiring harness repair section.	Go to Step (6)
6	• Disconnect the ECM connector CN1 • Check for continuity on the sensor ground circuit 120 between the system interface connector CN21 and the ECM connector CN1 Do you have continuity on the circuit?		Go to Step (7)	Repair circuit as necessary. See wiring harness repair section.
7	• Inspect the FPP/IVS connector, the ECM connector CN1, and the system interface connector CN21 for damage, corrosion, or contamination. Any damage found?		Repair circuit as necessary. See wiring harness repair section.	Go to Step (8)

Step	Action	Value(s)	Yes	No
8	• Replace FPP/IVS sensor Is the replacement complete?		Go to Step (10)	-
9	• Replace ECM Is the replacement complete?		Go to Step (11)	-
10	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-2123 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to Step (9)
11	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-2123 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 2229-BP High Pressure



Conditions for Setting the DTC

- Barometric Pressure
- Check Condition-Key On
- Fault Condition-BP greater than 16 psia
- MIL-On for active fault
- Adaptive-Disabled

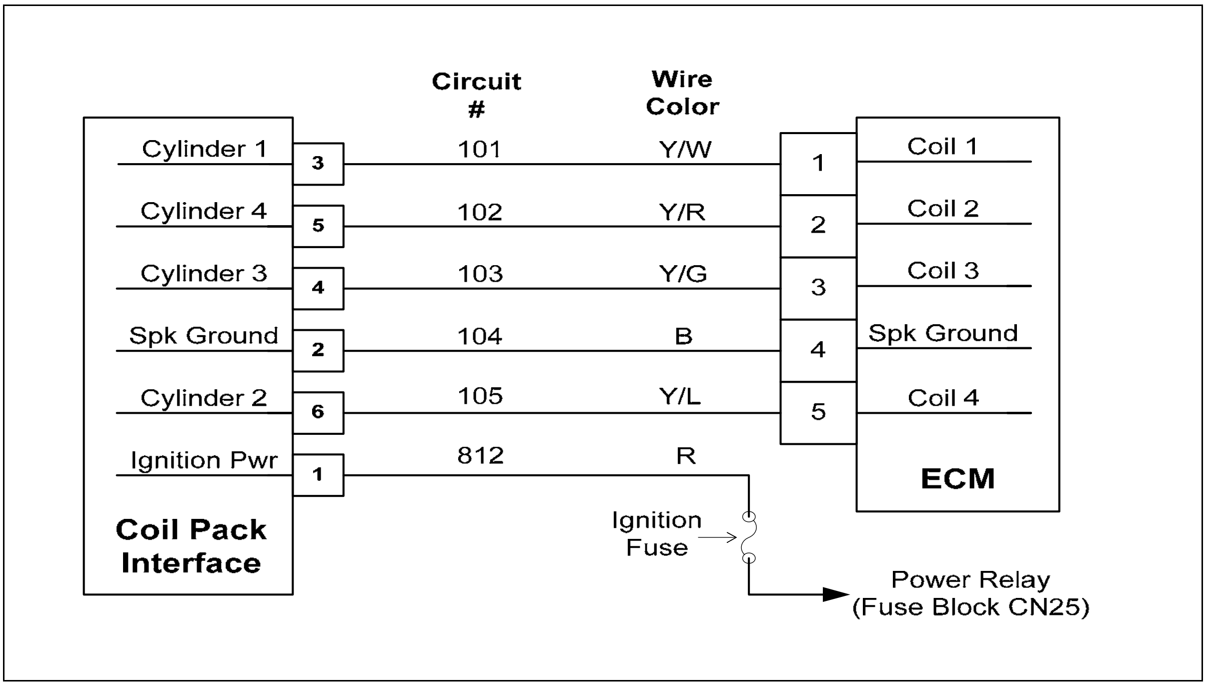
Circuit Description

The BP (Barometric Pressure) is estimated from the TMAP sensor. The barometric pressure value is used for fuel and airflow calculations. This fault sets in the event the BP value is out of the normal range.

DTC 2229-BP High Pressure

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?	-	Go to Step (2)	Go to OBD System Check Section
2	• Key On • DST (Diagnostic Scan Tool) connected in • System Data Mode Does DST display MAP pressure of 16 psia or greater?		Go to Step (3)	Intermittent problem Go to Intermittent section
3	Replace TMAP sensor. Is the repair complete?		Go to Step 4	-
4	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-2229 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 2300-Primary Loop Open/Low Side Short to Ground



Conditions for Setting the DTC

- Ignition Control Check
- Check condition-Engine running or cranking
- Fault condition-Adaptive dwell greater than 2.0ms or total dwell greater than 14.0ms
- MIL-On during active fault
- Adaptive-Disabled
- Closed Loop-Disabled

Circuit Description

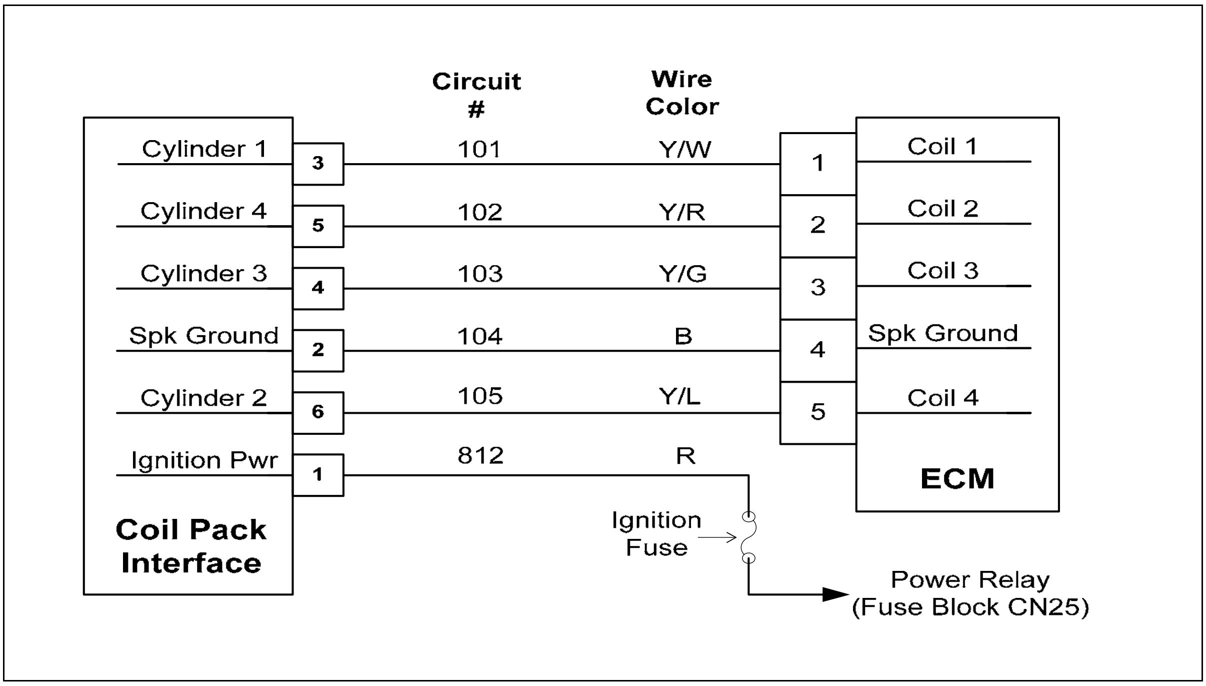
The ECM triggers ignition by providing ground to the ignition circuit 101. This code will set if the ECM low side driver circuit 101 is open or shorted to ground.

DTC 2300-Primary Loop Open/Low Side Short to Ground

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?		Go to Step (2)	Go to OBD System Check Section
2	• Key ON, Engine OFF • DST (Diagnostic Scan Tool) connected in System Data Mode • Clear DTC-2300 • Crank the engine Does DTC-2300 re-set?		Go to Step (3)	Intermittent problem. See Electrical Section Intermittent Electrical Diagnosis
3	• Remove and check the ignition fuse Is the fuse OK?		Go to Step (5)	Go to Step (4)
4	• Replace the ignition fuse Is the replacement complete?		Go to Step (12)	
5	• Key ON • Using a DVOM check for voltage at the ignition fuse terminal circuit 927 (**CHECK THIS BEFORE THE POWER RELAY CIRCUIT SHUTS DOWN**) Do you have voltage?		Go to Step (6)	Repair the open power circuit. See wiring harness repairs
6	• Key OFF • Disconnect the ignition module connector CN6 • Using a DVOM check for voltage between ignition module connector circuit 812 and engine ground Do you have voltage?		Go to Step (7)	Repair the open power circuit. See wiring harness repairs
7	• Disconnect ECM wire harness connector CN1 • Using a DVOM check for continuity on the coil control circuit 101 between ECM connector CN1 and engine ground Do you have continuity?		Repair the shorted to ground coil 1 circuit	Go To Step (8)
8	• Using a DVOM check for continuity on the coil control circuit 101 between ECM connector CN1 and ignition module connector CN6 Do you have continuity?		Go to Step (9)	Repair the open ignition module circuit. See wiring harness repairs.

Step	Action	Value(s)	Yes	No
9	• Replace the ignition module Is the replacement complete?		Go to Step (10)	
10	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-2300 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to Step (11)
11	• Replace the ECM Is the replacement complete?		Go to Step (12)	
12	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-2300 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD system check

DTC 2301-Primary Coil Shorted to Voltage



Conditions for Setting the DTC

- Ignition Control Check
- Check condition-Engine running or cranking
- Fault condition-Adaptive dwell less than-2.0ms or total dwell less than 4.0ms
- MIL-On during active fault
- Adaptive-Disabled
- Closed Loop-Disabled

Circuit Description

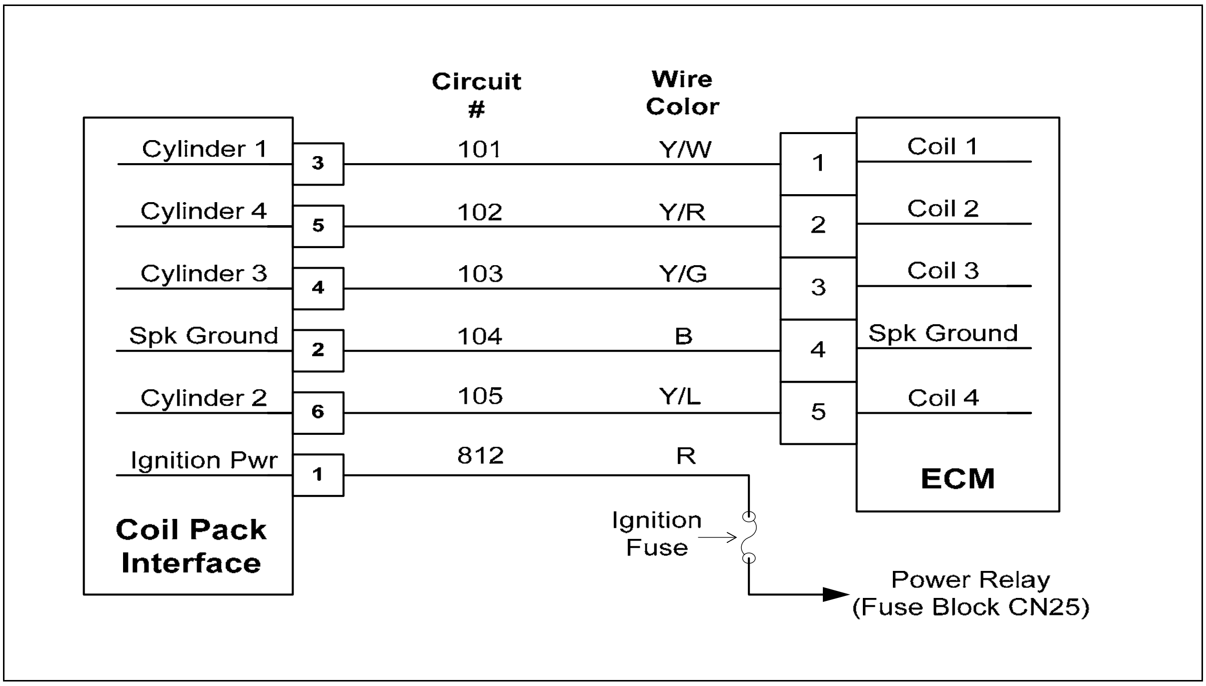
The ECM triggers the ignition coil 1 ignition by providing ground to the ignition connector circuit 101. This code will set if the ECM low side driver circuit 101 remains high or is shorted to voltage.

DTC 2301-Primary Coil Shorted to Voltage

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?		Go to Step (2)	Go to OBD System Check Section
2	• Key ON, Engine OFF • DST (Diagnostic Scan Tool) connected in System Data Mode • Clear DTC-2301 • Crank the engine Does DTC-2301 re-set?		Go to Step (3)	Intermittent problem. See Intermittent problems in the electrical section.
3	• Key OFF • Disconnect ECM connector CN1 • Disconnect ignition module connector CN6 • Using a DVOM check for voltage between ignition module connector CN6 circuit 101 and engine ground Do you have voltage?		Repair the shorted to voltage coil 1 circuit	Go to Step (4)
4	• Replace the ignition module Is the replacement complete?		Go to Step (6)	

Step	Action	Value(s)	Yes	No
5	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-2301 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to Step (6)
6	• Replace the ECM Is the replacement complete?		Go to Step (7)	
7	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-2301 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD system check

DTC 2303-Primary Loop Open/Low Side Short to Ground



Conditions for Setting the DTC

- Ignition Control Check
- Check condition-Engine running or cranking
- Fault condition-Adaptive dwell greater than 2.0ms or total dwell greater than 14.0ms
- MIL-On during active fault
- Adaptive-Disabled
- Closed Loop-Disabled

Circuit Description

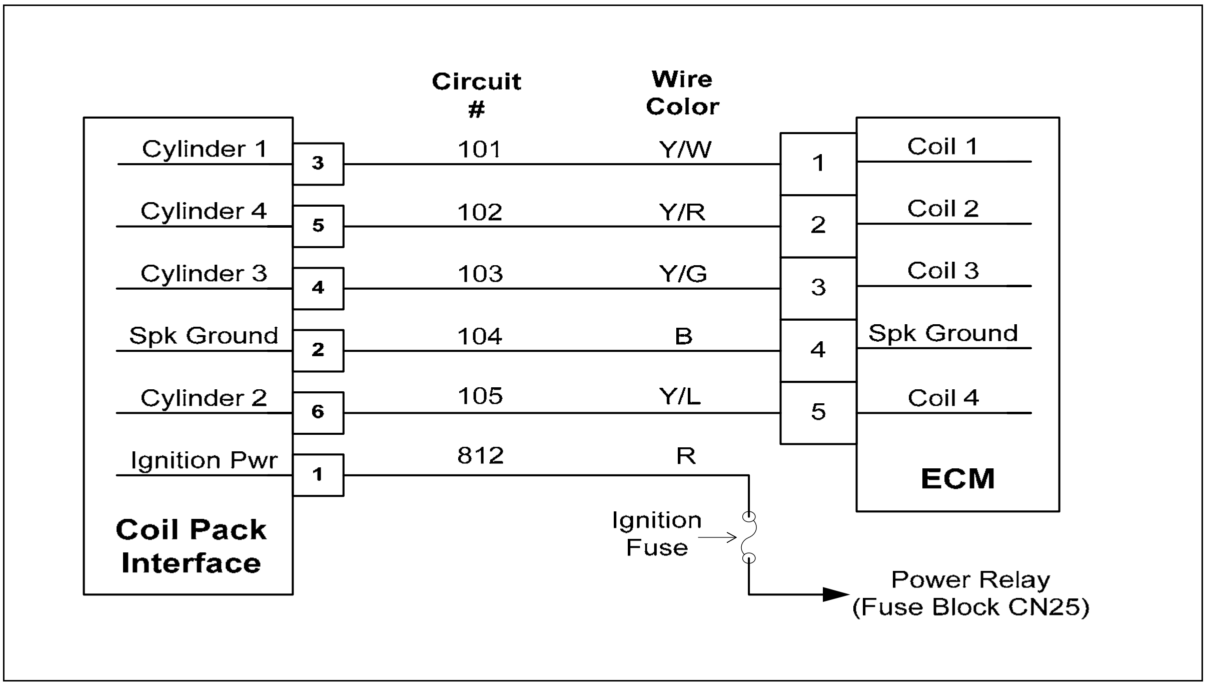
The ECM triggers ignition by providing ground to the ignition circuit 102. This code will set if the ECM low side driver circuit 102 is open or shorted to ground.

DTC 2303-Primary Loop Open/Low Side Short to Ground

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?		Go to Step (2)	Go to OBD System Check Section
2	• Key ON, Engine OFF • DST (Diagnostic Scan Tool) connected in System Data Mode • Clear DTC-2303 • Crank the engine Does DTC-2303 re-set?		Go to Step (3)	Intermittent problem. See Electrical Section Intermittent Electrical Diagnosis
3	• Remove and check the ignition fuse Is the fuse OK?		Go to Step (5)	Go to Step (4)
4	• Replace the ignition fuse Is the replacement complete?		Go to Step (12)	
5	• Key ON • Using a DVOM check for voltage at the ignition fuse terminal circuit 927 **(CHECK THIS BEFORE THE POWER RELAY CIRCUIT SHUTS DOWN)** Do you have voltage?		Go to Step (6)	Repair the open power circuit. See wiring harness repairs
6	• Key OFF • Disconnect the ignition module connector CN6 • Using a DVOM check for voltage between ignition module connector circuit 812 and engine ground Do you have voltage?		Go to Step (7)	Repair the open power circuit. See wiring harness repairs
7	• Disconnect ECM wire harness connector CN1 • Using a DVOM check for continuity on the coil control circuit 102 between ECM connector CN1 and engine ground Do you have continuity?		Repair the shorted to ground coil 1 circuit	Go To Step (8)
8	• Using a DVOM check for continuity on the coil control circuit 102 between ECM connector CN1 and ignition module connector CN6 Do you have continuity?		Go to Step (9)	Repair the open ignition module circuit . See wiring harness repairs.
9	• Replace the ignition module Is the replacement complete?		Go to Step (10)	

Step	Action	Value(s)	Yes	No
10	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-2303 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to Step (11)
11	• Replace the ECM Is the replacement complete?		Go to Step (12)	
12	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-2303 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD system check

DTC 2304-Primary Coil Shorted to Voltage



Conditions for Setting the DTC

- Ignition Control Check
- Check condition-Engine running or cranking
- Fault condition-Adaptive dwell less than-2.0ms or total dwell less than 4.0ms
- MIL-On during active fault
- Adaptive-Disabled
- Closed Loop-Disabled

Circuit Description

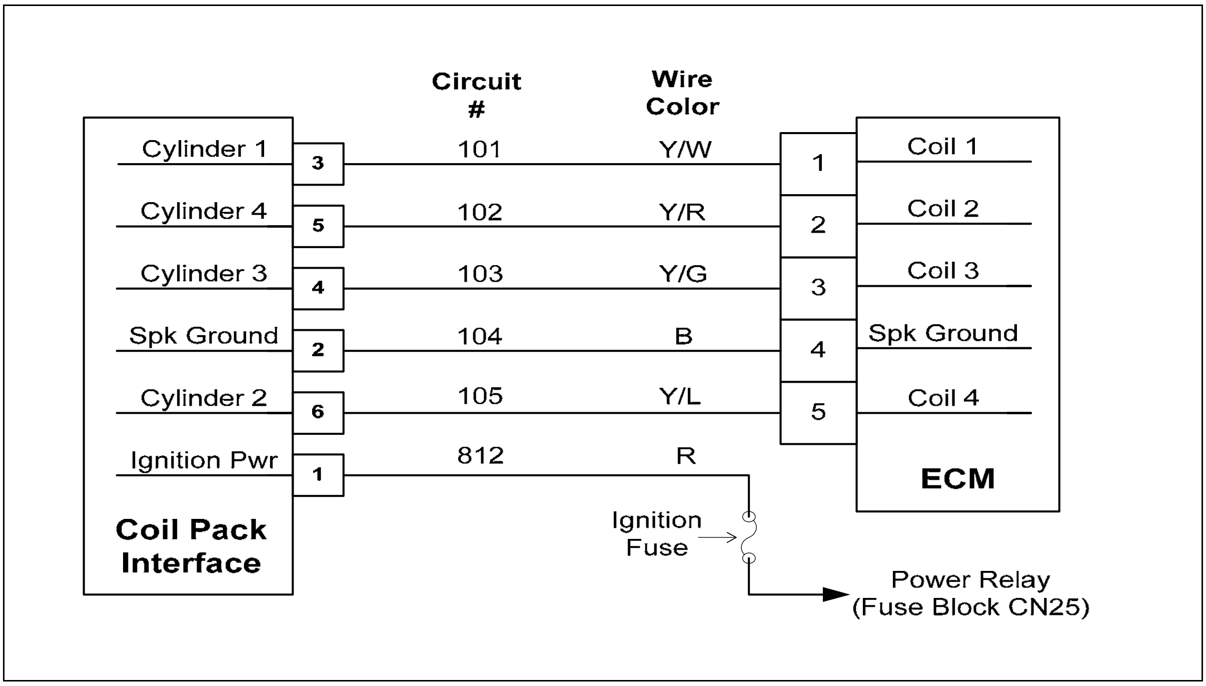
The ECM triggers the ignition coil 2 ignition by providing ground to the ignition connector circuit 102. This code will set if the ECM low side driver circuit 102 remains high or is shorted to voltage.

DTC 2304-Primary Coil Shorted to Voltage

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?		Go to Step (2)	Go to OBD System Check Section
2	• Key ON, Engine OFF • DST (Diagnostic Scan Tool) connected in System Data Mode • Clear DTC-2304 • Crank the engine Does DTC-2304 re-set?		Go to Step (3)	Intermittent problem. See Intermittent problems in the electrical section.
3	• Key OFF • Disconnect ECM connector CN1 • Disconnect ignition module connector CN6 • Using a DVOM check for voltage between ignition module connector CN6 circuit 102 and engine ground Do you have voltage?		Repair the shorted to voltage coil 1 circuit	Go to Step (4)
4	• Replace the ignition module Is the replacement complete?		Go to Step (6)	

Step	Action	Value(s)	Yes	No
5	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-2304 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to Step (6)
6	• Replace the ECM Is the replacement complete?		Go to Step (7)	
7	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-2304 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD system check

DTC 2306-Primary Loop Open/Low Side Short to Ground



Conditions for Setting the DTC

- Ignition Control Check
- Check condition-Engine running or cranking
- Fault condition-Adaptive dwell greater than 2.0ms or total dwell greater than 14.0ms
- MIL-On during active fault
- Adaptive-Disabled
- Closed Loop-Disabled

Circuit Description

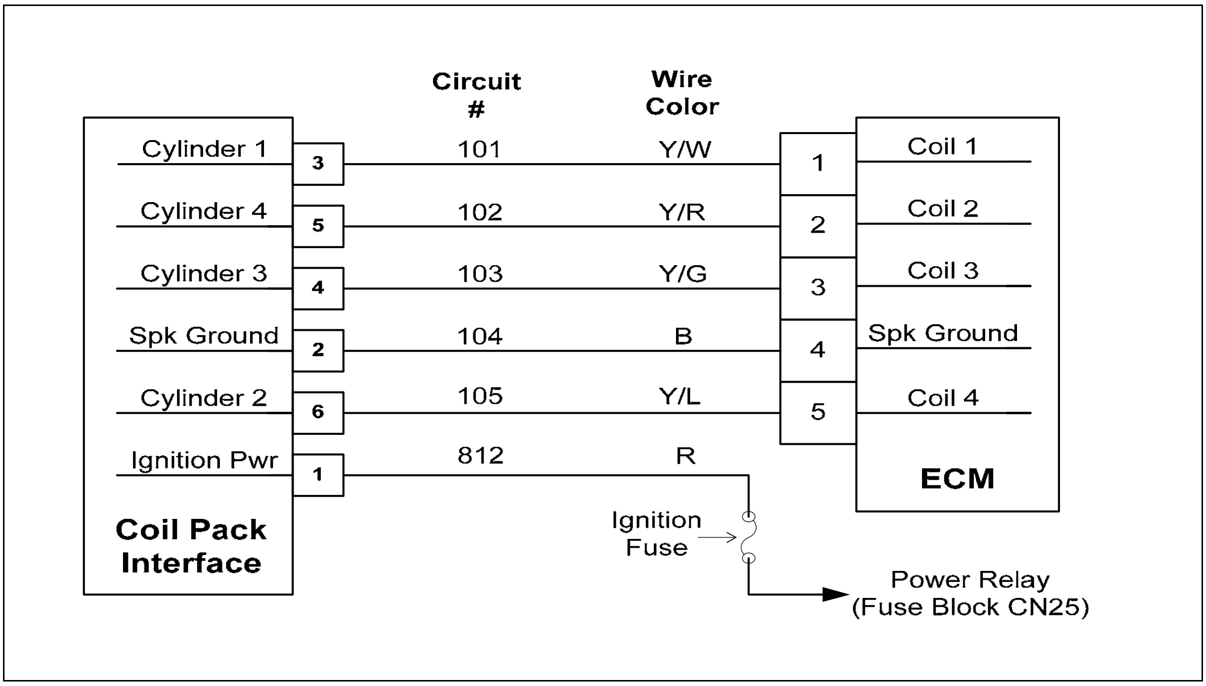
The ECM triggers ignition by providing ground to the ignition circuit 103. This code will set if the ECM low side driver circuit 103 is open or shorted to ground.

DTC 2306-Primary Loop Open/Low Side Short to Ground

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?		Go to Step (2)	Go to OBD System Check Section
2	• Key ON, Engine OFF • DST (Diagnostic Scan Tool) connected in System Data Mode • Clear DTC-2306 • Crank the engine Does DTC-2306 re-set?		Go to Step (3)	Intermittent problem. See Electrical Section Intermittent Electrical Diagnosis
3	• Remove and check the ignition fuse Is the fuse OK?		Go to Step (5)	Go to Step (4)
4	• Replace the ignition fuse Is the replacement complete?		Go to Step (12)	
5	• Key ON • Using a DVOM check for voltage at the ignition fuse terminal circuit 927 (**CHECK THIS BEFORE THE POWER RELAY CIRCUIT SHUTS DOWN**) Do you have voltage?		Go to Step (6)	Repair the open power circuit. See wiring harness repairs
6	• Key OFF • Disconnect the ignition module connector CN6 • Using a DVOM check for voltage between ignition module connector circuit 812 and engine ground Do you have voltage?		Go to Step (7)	Repair the open power circuit. See wiring harness repairs
7	• Disconnect ECM wire harness connector CN1 • Using a DVOM check for continuity on the coil control circuit 103 between ECM connector CN1 and engine ground Do you have continuity?		Repair the shorted to ground coil 1 circuit	Go To Step (8)
8	• Using a DVOM check for continuity on the coil control circuit 103 between ECM connector CN1 and ignition module connector CN6 Do you have continuity?		Go to Step (9)	Repair the open ignition module circuit. See wiring harness repairs.

Step	Action	Value(s)	Yes	No
9	• Replace the ignition module Is the replacement complete?		Go to Step (10)	
10	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-2306 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to Step (11)
11	• Replace the ECM Is the replacement complete?		Go to Step (12)	
12	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-2306 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD system check

DTC 2307-Primary Coil Shorted to Voltage



Conditions for Setting the DTC

- Ignition Control Check
- Check condition-Engine running or cranking
- Fault condition-Adaptive dwell less than-2.0ms or total dwell less than 4.0ms
- MIL-On during active fault
- Adaptive-Disabled
- Closed Loop-Disabled

Circuit Description

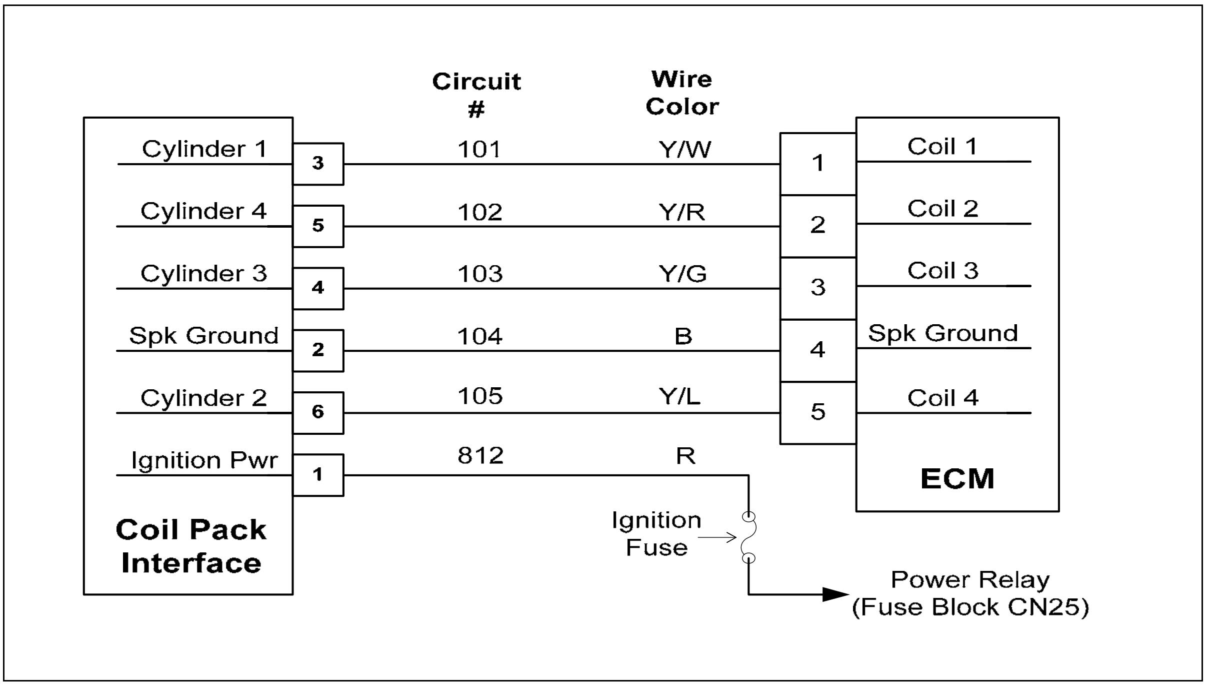
The ECM triggers the ignition coil 1 ignition by providing ground to the ignition connector circuit 103. This code will set if the ECM low side driver circuit 103 remains high or is shorted to voltage.

DTC 2307-Primay Coil Shorted to Voltage

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?		Go to Step (2)	Go to OBD System Check Section
2	• Key ON, Engine OFF • DST (Diagnostic Scan Tool) connected in System Data Mode • Clear DTC-2307 • Crank the engine Does DTC-2307 re-set?		Go to Step (3)	Intermittent problem. See Intermittent problems in the electrical section.
3	• Key OFF • Disconnect ECM connector CN1 • Disconnect ignition module connector CN6 • Using a DVOM check for voltage between ignition module connector CN6 circuit 103 and engine ground Do you have voltage?		Repair the shorted to voltage coil 1 circuit	Go to Step (4)
4	• Replace the ignition module Is the replacement complete?		Go to Step (6)	

Step	Action	Value(s)	Yes	No
5	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-2307 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to Step (6)
6	• Replace the ECM Is the replacement complete?		Go to Step (7)	
7	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-2307 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD system check

DTC 2309-Primary Loop Open/Low Side Short to Ground



Conditions for Setting the DTC

- Ignition Control Check
- Check condition-Engine running or cranking
- Fault condition-Adaptive dwell greater than 2.0ms or total dwell greater than 14.0ms
- MIL-On during active fault
- Adaptive-Disabled
- Closed Loop-Disabled

Circuit Description

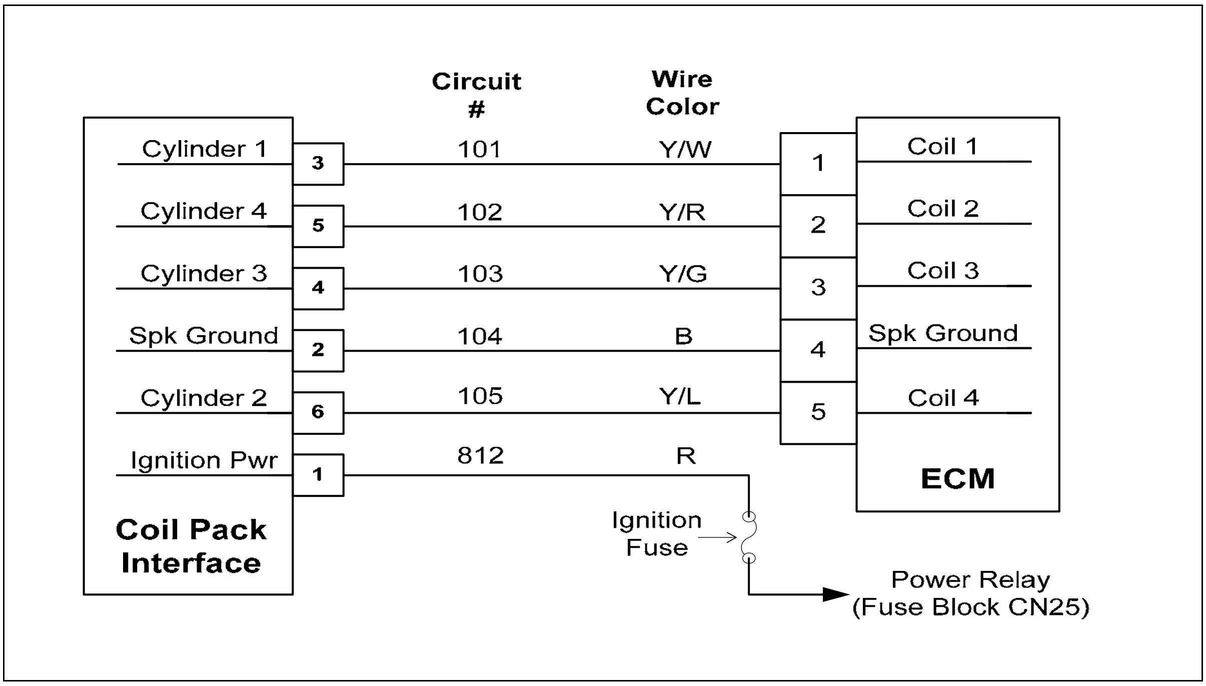
The ECM triggers ignition by providing ground to the ignition circuit 104. This code will set if the ECM low side driver circuit 104 is open or shorted to ground.

DTC 2309-Primary Loop Open/Low Side Short to Ground

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?		Go to Step (2)	Go to OBD System Check Section
2	• Key ON, Engine OFF • DST (Diagnostic Scan Tool) connected in System Data Mode • Clear DTC-2309 • Crank the engine Does DTC-2309 re-set?		Go to Step (3)	Intermittent problem. See Electrical Section Intermittent Electrical Diagnosis
3	• Remove and check the ignition fuse Is the fuse OK?		Go to Step (5)	Go to Step (4)
4	• Replace the ignition fuse Is the replacement complete?		Go to Step (12)	
5	• Key ON • Using a DVOM check for voltage at the ignition fuse terminal circuit 927 (**CHECK THIS BEFORE THE POWER RELAY CIRCUIT SHUTS DOWN**) Do you have voltage?		Go to Step (6)	Repair the open power circuit. See wiring harness repairs
6	• Key OFF • Disconnect the ignition module connector CN6 • Using a DVOM check for voltage between ignition module connector circuit 812 and engine ground Do you have voltage?		Go to Step (7)	Repair the open power circuit. See wiring harness repairs
7	• Disconnect ECM wire harness connector CN1 • Using a DVOM check for continuity on the coil control circuit 104 between ECM connector CN1 and engine ground Do you have continuity?		Repair the shorted to ground coil 1 circuit	Go To Step (8)
8	• Using a DVOM check for continuity on the coil control circuit 104 between ECM connector CN1 and ignition module connector CN6 Do you have continuity?		Go to Step (9)	Repair the open ignition module circuit. See wiring harness repairs.

Step	Action	Value(s)	Yes	No
9	• Replace the ignition module Is the replacement complete?		Go to Step (10)	
10	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-2309 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to Step (11)
11	• Replace the ECM Is the replacement complete?		Go to Step (12)	
12	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-2309 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD system check

DTC 2310-Primary Coil Shorted to Voltage



Conditions for Setting the DTC

- Ignition Control Check
- Check condition-Engine running or cranking
- Fault condition-Adaptive dwell less than-2.0ms or total dwell less than 4.0ms
- MIL-On during active fault
- Adaptive-Disabled
- Closed Loop-Disabled

Circuit Description

The ECM triggers the ignition coil 1 ignition by providing ground to the ignition connector circuit 104. This code will set if the ECM low side driver circuit 104 remains high or is shorted to voltage.

DTC 2310-Primary Coil Shorted to Voltage

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?		Go to Step (2)	Go to OBD System Check Section
2	• Key ON, Engine OFF • DST (Diagnostic Scan Tool) connected in System Data Mode • Clear DTC-2310 • Crank the engine Does DTC-2310 re-set?		Go to Step (3)	Intermittent problem. See Intermittent problems in the electrical section.
3	• Key OFF • Disconnect ECM connector CN1 • Disconnect ignition module connector CN6 • Using a DVOM check for voltage between ignition module connector CN6 circuit 104 and engine ground Do you have voltage?		Repair the shorted to voltage coil 1 circuit	Go to Step (4)
4	• Replace the ignition module Is the replacement complete?		Go to Step (6)	

Step	Action	Value(s)	Yes	No
5	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-2310 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to Step (6)
6	• Replace the ECM Is the replacement complete?		Go to Step (7)	
7	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-2310 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD system check

Servicing the Fuel System

PROTECTION OF ELECTRICAL COMPONENTS

CAUTION

To prevent permanent damage to the ECM and/or other electrical components, following the steps listed below

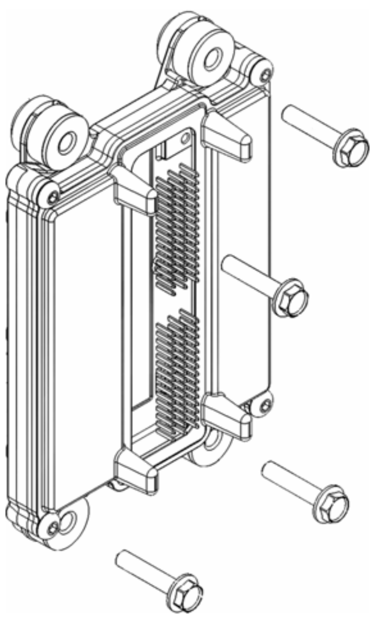
1. ALWAYS turn ignition to OFF prior to removing the harness and/or the negative or positive battery cable.
2. ALWAYS disconnect the negative and positive battery cable (Remove the negative cable first) when welding on a vehicle.
3. NEVER use a charger or voltage supply in excess of 16 volts.

I. ENGINE CONTROL MODULE

This procedure relates to removal and installation of the ECM--see Diagnostic Scan Tool for accessing ECM software.

REMOVAL PROCEDURE

1. Disconnect Negative battery cable.
2. Push connector lock back to unlock connector, unplug the Wire Harness from ECM and remove.
3. Remove four bolts mounting the controller to the mounting bracket.



ECM and its Four Mounting Bolts

INSTALLATION PROCEDURE

IMPORTANT
The ECM is calibrated for each engine. Verify you have the correct controller by noting the P/N on the ECM label. The calibration number can also be found by connecting the DST and finding the calibration number on the Gauge Page.

1. Mount controller into mounting bracket with four screws. **Torque to 7.5 Nm (5.5 ft. lbs.)**
2. Plug connector into controller.
3. Push lock into place.
4. Reconnect the negative battery cable.
5. Install Diagnostic Service Tool.
6. Start the vehicle and let run until it reaches normal operating temperature.
7. If a DTC code is found, refer to the Electrical Section for further diagnosis.

II. ENGINE WIRE HARNESS REPLACEMENT

1. Disconnect negative battery cable.
2. Lay out the new wire harness, noting the location, type of connectors, and identifying markings. Take special note of identical or similar connectors (such as the coils or HEGO Sensors) to avoid crossing connections during installation. Note the routing of the existing wire harness in and around the engine and the vehicle. Refer to the Electrical Schematic.

CAUTION

Ensure that all connections are made to the correct locations on the engine and its components. Crossing connections may cause poor engine performance, a MIL warning and/or permanent damage to the ECM.

3. Remove all wire harness connectors on the vehicle.
4. Remove all clips and brackets holding the wire harness and remove harness from vehicle.
5. Lay the new wire harness over the engine and route each end to its connection. Verify that all connectors match prior to installation.
6. Connect all connectors and ring terminals.
7. Install all clips and brackets to hold down the harness.
8. Reconnect negative battery cable.

9. Start the vehicle and let run until it reaches normal operating temperature.
10. If a DTC code is found, refer to the Electrical Section for further diagnosis.

III. LPG FUEL SYSTEM PRESSURE RELIEF

CAUTION

The LPG fuel system operates at pressure up to 21.5 bar (312 psi). To minimize personal injury, relieve the LPG fuel system pressure before servicing the LPG fuel system components.

1. Close the valve on the LPG tank.
2. Start and run the vehicle until the engine stalls running out of fuel.
3. Turn the ignition switch to OFF.

WARNING

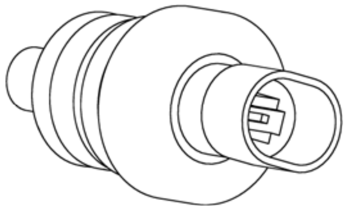
Residual vapor pressure will be present in the fuel system. Ensure the work area is well ventilated before disconnecting any fuel line.

CAUTION

Never use an open flame of any type to check for LPG leaks.

IMPORTANT
Always inspect the LPG fuel system for leaks after performing service. Check for leaks at the fittings of the serviced or replaced component. Use a commercially available liquid leak detector or an electronic leak detector. When using both methods, use the electronic leak detector first to avoid contamination by the liquid leak detector

IV. FUEL TEMPERATURE (FT) SENSOR REPLACEMENT (LPG ONLY)



Fuel Temperature Sensor

1. Relieve the LPG fuel system pressure. Refer to *III. LPG Fuel System Pressure Relief on page 459).*
2. Disconnect the negative battery cable.
3. Locate the Fuel Temperature Sensor on the EPR port.
4. Remove retaining clip holding the Fuel Temp Sensor and remove the Sensor from the EPR port.
5. Remove electrical connector.
6. Inspect the EPR for debris or “heavy ends” and remove with a Safety Solvent if necessary.

WARNING

Only use a Safety Solvent to clean any part of the fuel system. Harsh cleaners such as carb or brake cleaners may damage gaskets, O-rings, seals and other non-metallic components in the fuel system.

INSTALLATION

1. Lubricate O-rings on the sensor with petroleum jelly or Vaseline.

WARNING

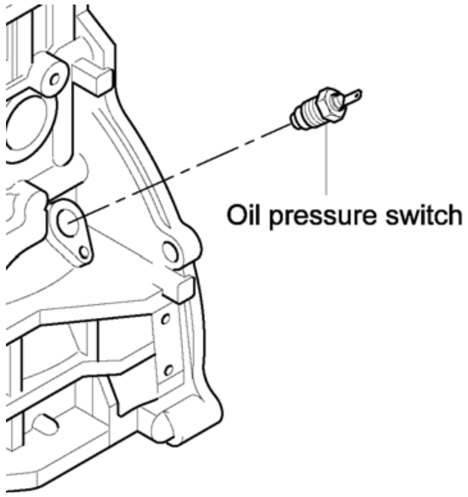
Contamination of the HEGO sensor can result from the use of an inappropriate RTV sealer or silicone spray products. Do not use silicone sprays or hoses which are assembled using silicone lubricants. Always use “oxygen sensor safe” RTV sealant for repair procedures. Silicon contamination will cause a high but false HEGO signal voltage (rich exhaust indication). The ECM will then reduce the amount of fuel delivery to the engine, causing a severe driveability problem. If silicone contamination is suspected, remove and visually inspect the sensor element. If contaminated, the portion of the sensor exposed to the exhaust stream will have a white powdery coating. Always be sure to eliminate the cause of contamination before replacing the sensor.

2. Install the sensor into the EPR port. Lock in place with retaining clip.
3. Reconnect electrical connector.
4. Reconnect the negative battery cable.
5. Using the DST, clear DTC information from the ECM.
6. Turn the ignition OFF and wait 30 seconds.
7. Start the vehicle and let run until it reaches normal operating temperature.
8. If a DTC code is found, refer to the Electrical Section for further diagnosis.

V. OIL PRESSURE SWITCH

REMOVAL PROCEDURE

1. Disconnect the negative battery cable.
2. Locate the Oil Pressure Switch on the side of the engine.



Location of the Oil Pressure Switch

3. Remove electrical connection from Oil Pressure Switch.
4. Unscrew and remove.

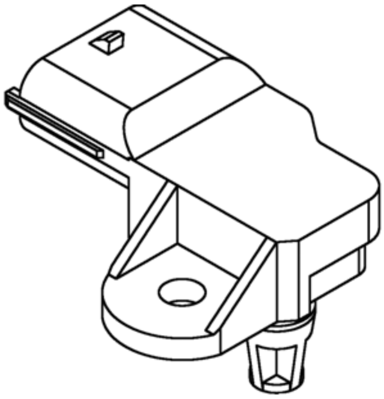
INSTALLATION PROCEDURE

1. Apply Loctite 567 (or equivalent high-temp thread locker/sealer) to the threads on the Oil Pressure Switch.
2. Install Oil Pressure Sender. **Torque to 9.4-10.8 ft.lbs (12.7-14.7 Nm)**
3. Plug in electrical connector.
4. Reconnect negative battery cable.
5. Start the vehicle and check for leaks. Let run until it reaches normal operating temperature
6. If a DTC code is found, refer to the Electrical Section for further diagnosis.

VI. TEMPERATURE MANIFOLD ABSOLUTE PRESSURE SENSOR (TMAP)

REMOVAL PROCEDURE

1. Disconnect the negative battery cable.
2. Locate the TMAP Sensor on the intake manifold.
3. Remove the retaining screw.
4. Remove TMAP Sensor by pulling straight up with a slight rocking motion.



TMAP Sensor

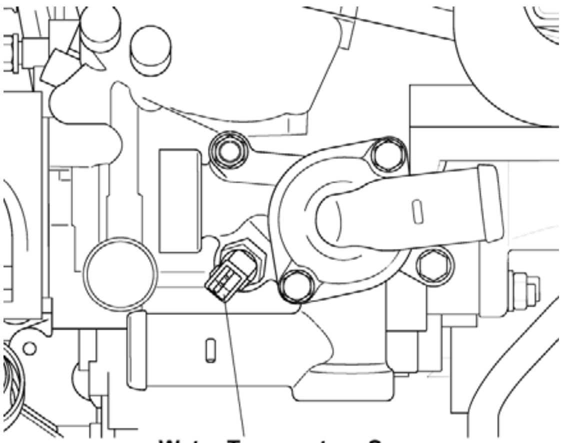
INSTALLATION PROCEDURE

1. Install the TMAP and **torque the retaining screw to 19 in.lbs. (2.1 Nm).**
2. Reconnect the negative battery cable.
3. Start the vehicle and let run until it reaches normal operating temperature.
4. If a DTC code is found, refer to the Electrical Section for further diagnosis.

VII. ENGINE COOLANT TEMPERATURE SENSOR (ECT)

REMOVAL PROCEDURE

1. Disconnect the negative battery cable.
2. Locate the Engine Coolant Temperature Sensor on the back of the engine (opposite end of the fan).



Location of the Water Temperature Sensor

3. Remove electrical connector.
4. Drain the cooling system.
5. Remove the sensor.

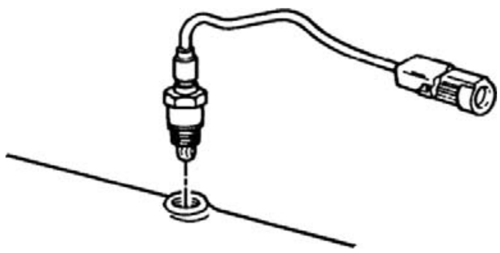
INSTALLATION PROCEDURE

1. Apply a minimal amount of Loctite 962T or equivalent sealer to threads on the Engine Coolant Temperature Sensor. Remove any excess sealer on the sensor threads.
2. Install Engine Coolant Temperature Sensor. **Torque to 10.8-14.5 ft.lbs. (14.7-19.6 Nm).**
3. Refill the cooling system.
4. Reconnect electrical connector.
5. Reconnect the negative battery cable.
6. Start the vehicle and let run until it reaches normal operating temperature.
7. If a DTC code is found, refer to the Electrical Section for further diagnosis.

VIII. HEATED EXHAUST GAS OXYGEN SENSOR (HEGO)

REPLACEMENT

1. Disconnect Negative battery cable.
2. Locate the affected Oxygen Sensor on the three way catalytic converter/muffler assembly. There are two sensors: one between the engine and catalytic brick (upstream) and one between the catalytic brick and tail pipe (downstream).
3. Disconnect the Oxygen sensor electrical connector.



HEGO and Connector

4. Using an Oxygen Sensor socket, remove the Oxygen Sensor.

INSTALLATION PROCEDURE

IMPORTANT
Before install the Oxygen sensor lubricate threads with anti-seize compound P/N 5613695 or equivalent. Avoid contaminating sensor tip with compound.

1. Install Oxygen Sensor. **Torque to 36.2-43.4 ft. lbs. (49.0-58.8 Nm)**
2. Reconnect electrical connector to the Oxygen Sensor.
3. Reconnect the negative battery cable.
4. Start the vehicle and let run until it reaches normal operating temperature.
5. If a DTC code is found, refer to the Electrical Section for further diagnosis.

IX. MIXER/ADAPTER/THROTTLE BODY & RELATED SEALS

REMOVAL PROCEDURE

1. Disconnect the negative battery cable.
2. Relieve the LPG fuel system pressure. Refer to *III. LPG Fuel System Pressure Relief.*
3. Remove the air intake duct.
4. Remove the retaining pin holding the fuel hose fitting and remove fuel hose.

WARNING

Residual vapor pressure will be present in the fuel system. Ensure the work area is well ventilated before disconnecting any fuel line.

5. Remove the two hoses on the side of the Mixer.
6. Remove electrical connector on Throttle Body
7. Remove the four screws under the Mixer that secure the Mixer, Adapter and Throttle Body.
8. Remove the Mixer and Adapter.
9. Remove Throttle Body.

INSTALLATION PROCEDURE

1. Lightly lubricate new O-rings with Vaseline or petroleum jelly prior to installation.

WARNING

Contamination of the HEGO sensor can result from the use of an inappropriate RTV sealer or silicone spray products. Do not use silicone sprays or hoses which are assembled using silicone lubricants. Always use "oxygen sensor safe" RTV sealant for repair procedures. Silicon contamination will cause a high but false HEGO signal voltage (rich exhaust indication). The ECM will then reduce the amount of fuel delivery to the engine, causing a severe driveability problem. If silicone contamination is suspected, remove and visually inspect the sensor element. If contaminated, the portion of the sensor exposed to the exhaust stream will have a white powdery coating. Always be sure to eliminate the cause of contamination before replacing the sensor.

2. Place new O-rings on top of the Throttle Body.
3. Place Gasket and Throttle Body on intake adapter.
4. Place Adapter and Mixer on top of Throttle Body and align screw holes. Secure with the four retaining screws and **Torque to 80 in.lb. (9 Nm).**
5. Install the fuel hose fitting into the Mixer and hold with the retaining pin.
6. Install the air intake duct.
7. Install the two hoses to the 90° fittings on Mixer.
8. Reconnect the negative battery cable.
9. Open LPG tank valve.
10. Turn ignition to ON for approximately 30 seconds, then OFF.
11. Leak check the LPG fuel system at each serviced fitting.
12. Start the vehicle and leak check the LPG fuel system at each serviced fitting.
13. Test drive vehicle to ensure it operates correctly at all throttle ranges. If a DTC code is found, refer to the Electrical Section for further diagnosis.

X. CRANKCASE VENTILATION SYSTEM INSPECTION/DIAGNOSIS

RESULTS OF INCORRECT OPERATION

A plugged positive crankcase ventilation (PCV) orifice or hose may cause the following conditions:

- Rough or unstable idle
- Stalling or low idle speed
- Oil leaks
- Oil in the air cleaner

- Sludge in the engine

A leaking PCV orifice or hose may cause the following problems:

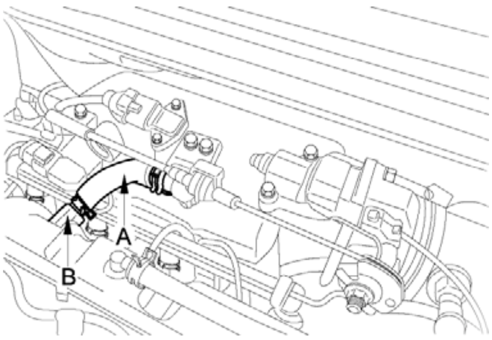
- Rough Idle
- Stalling
- High idle speed

FUNCTIONAL CHECK

Any blow-by in excess of the system capacity, from a badly worn engine, sustained heavy load, etc., is exhausted into the air cleaner and is drawn back into the engine.

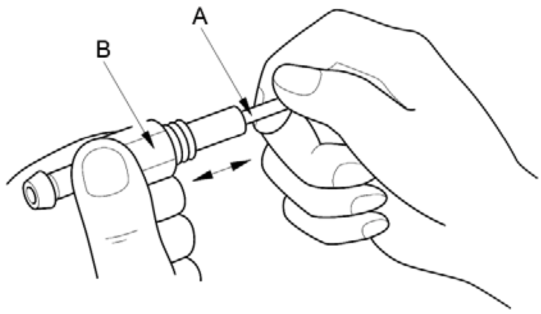
Proper operation of the crankcase ventilation system depends on a sealed engine. If irregular oil flow or dilution is noted and the crankcase ventilation system is functioning properly, check the engine for another possible cause. Correct any of these problems first.

If an engine is idling rough, inspect for a clogged PCV orifice, a dirty vent filter, air cleaner element, or plugged hose. Replace any faulty items found. Use the following procedure:



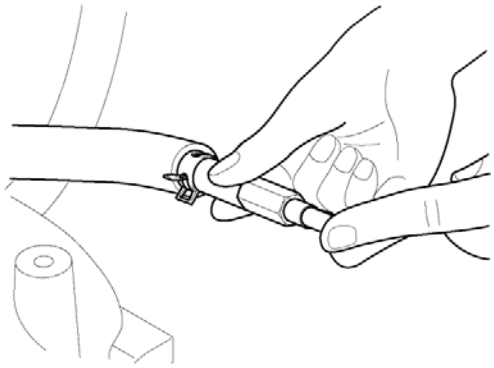
The PCV is Located Between Two Hoses, as Shown Above.

1. Locate the PCV connected to hoses as shown above.
2. Remove the PCV.
3. Insert a thin rod into the PCV against the plunger and gently push.



Testing the PCV Action

4. If the plunger moves irregularly or fails to move, the PCV is clogged and should be cleaned or replaced.
5. Connect the PCV to the vacuum hose, leaving the opposite end open.
6. Start engine.



Testing the PCV for Vacuum

7. Place your finger over the end of the hose in order to check for vacuum. If there is no vacuum at the hose end, inspect for plugged hoses and/or clogged or damaged manifold vacuum port.
8. Turn the engine OFF.
9. Inspect the PCV orifice in the valve cover for debris or blockage. Clean with carburetor cleaner as necessary.
10. Reconnect hose to PCV.
11. Start the vehicle and let run until it reaches normal operating temperature.
12. If a DTC code is found, refer to the Electrical Section for further diagnosis.

XI. MIXER/ADAPTER/THROTTLE BODY & RELATED SEALS

REMOVAL PROCEDURE

1. Disconnect the negative battery cable.

2. Relieve the LPG fuel system pressure. Refer to *III. LPG Fuel System Pressure Relief.*
3. Remove the air intake duct.
4. Remove the retaining pin holding the fuel hose fitting and remove fuel hose.
5. Remove two hoses attached to the sides of the Mixer.
6. Remove the electrical connector to the Throttle Body.
7. Remove four screws on Mixer that secure the Mixer, Adapter and Throttle Body to the Intake Manifold
8. Lift up Mixer and Adapter, noting the placement of the O-rings on the neck or inlet of the Throttle Body. Three O-rings are used: two are quad seals with an "X" cross section and one has a round cross section.
9. Remove gasket between Throttle Body and Intake Manifold.
10. Remove O-rings from the Throttle Body neck.

INSTALLATION PROCEDURE

1. Lightly lubricate new O-rings with Vaseline or petroleum jelly prior to installation.

WARNING

Contamination of the HEGO sensor can result from the use of an inappropriate RTV sealer or silicone spray products. Do not use silicone sprays or hoses which are assembled using silicone lubricants. Always use "oxygen sensor safe" RTV sealant for repair procedures. Silicon contamination will cause a high but false HEGO signal voltage (rich exhaust indication). The ECM will then reduce the amount of fuel delivery to the engine, causing a severe driveability problem. If silicone contamination is suspected, remove and visually inspect the sensor element. If contaminated, the portion of the sensor exposed to the exhaust stream will have a white powdery coating. Always be sure to eliminate the cause of contamination before replacing the sensor.

2. Place the quad seals and third O-ring on the neck of the Throttle Body, maintaining the same order as before.

IMPORTANT
Verify that the quad seals rest flat against the neck of the Throttle Body with no twists.

3. Carefully place the Adapter on top of the Throttle Body, ensuring the seals properly seat and are not twisted or pushed down.
4. Place Mixer on top of the Adapter.
5. Place gasket on top of Intake Manifold.
6. Align the holes of the Mixer, Adapter, Throttle Body, Gasket and Intake Manifold and secure with four screws. **Torque to 106 in. lbs. (12 Nm).**
7. Attach the two hoses to Mixer.
8. Attach the air intake duct from the Mixer.
9. Reconnect negative battery cable.
10. Open LPG tank valve.
11. Start the vehicle and let run until it reaches normal operating temperature.
12. If a DTC code is found, refer to the Electrical Section for further diagnosis.

XII. FUEL VAPOR HOSE--(EPR) TO FUEL MIXER REMOVAL PROCEDURE

1. Disconnect negative battery cable.
2. Remove retaining clip from EPR end of hose and remove hose from EPR port with Port Fitting.
3. Remove retaining clip from Mixer end of hose and remove hose from Mixer with Port Fitting.
4. Remove Port Fittings from both ends of the hose.

IMPORTANT
Hoses are designed for specific applications, DO NOT use hose material or length other than specified by the OEM.

INSTALLATION PROCEDURE

1. Lightly lubricate Port Fitting O-rings with Vaseline or petroleum jelly prior to installation.
2. Insert Port Fittings into each end of the hose and secure with hose clamps.

WARNING

Contamination of the HEGO sensor can result from the use of an inappropriate RTV sealer or silicone spray products. Do not use silicone sprays or hoses which are assembled using silicone lubricants. Always use "oxygen sensor safe" RTV sealant for repair procedures. Silicon contamination will cause a high but false HEGO signal voltage (rich exhaust indication). The ECM will then reduce the amount of fuel delivery to the engine, causing a severe driveability problem. If silicone contamination is suspected, remove and visually inspect the sensor element. If contaminated, the portion of the sensor exposed to the exhaust stream will have a white powdery coating. Always be sure to eliminate the cause of contamination before replacing the sensor.

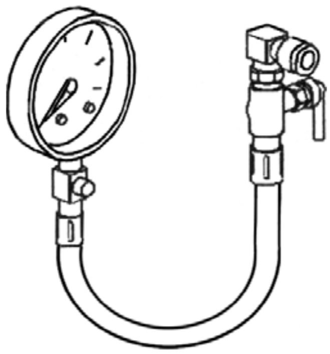
3. Reinstall Port Fittings on both ends of the hose and secure with retaining pins. Make sure hose is correctly positioned and not twisted or kinked.
4. Reconnect negative battery cable.
5. Open valve on the LPG tank.
6. Turn Key to the ON position for several seconds, then turn back to OFF. Using a liquid or electronic leak detection tool, inspect the EPR, fuel hoses and all serviced fittings for leaks.
7. Start the vehicle and check for leaks. Let run until it reaches normal operating temperature.
8. If a DTC code is found, refer to the Electrical Section for further diagnosis.

XIII. LPG FUEL SYSTEM PRESSURE CHECK

1. Turn ignition to OFF.
2. Disconnect negative battery cable.
3. Remove plug on EPR listed as "PRIMARY PRESSURE TEST."
4. Install Pressure Gauge.
5. Reconnect negative battery cable.
6. Start engine and note value on gauge.
7. Turn engine OFF.
8. Relieve the LPG fuel system pressure. Refer to *III. LPG Fuel System Pressure Relief.*
9. Disconnect negative battery cable.
10. Remove Gauge.
11. Replace Plug.
12. Reconnect negative battery cable.
13. Turn ignition to ON for approximately 30 seconds, then OFF.
14. Check for leaks.

XIV. GASOLINE FUEL PRESSURE CHECK

ITK-3 or ITK-4 test kit gauge or J 34730-1A fuel pressure gauge or equivalent.



Fuel Pressure Gauge

1. Turn ignition to OFF.
2. Disconnect the negative battery cable.
3. Refer to the *Fuel Injection Pressure Tester Owner's Manual* supplied in the IMPCO Test Kit for instructions on relieving gasoline fuel pressure for fuel systems without a Schrader valve or test port.

WARNING

Systems without test ports require that fuel lines be removed or disconnected. Be aware that these lines may be UNDER PRESSURE and when remove could cause fuel to spray and/or leakage onto hot engine parts.

CAUTION

Remove the fuel tank cap and relieve the fuel system pressure before servicing the fuel system to reduce the risk of personal injury. After you relieve the fuel system pressure, a small amount of fuel may still be released when servicing the fuel lines, the fuel injection pump, or the connections. Always cover the fuel system components with a shop towel before disconnecting to absorb any fuel that may leak out. Dispose of towel in an approved container when the procedure is completed. Follow any additional user recommendations in the manufacturer instructions for the fuel pressure gauge in use.

CAUTION

Do not drain fuel into an open container. Never store the fuel in an open container due to the possibility of a fire and/or explosion.

4. Clean any spillage of gas with a shop towel and dispose of properly.
5. Reconnect negative battery cable.
6. Turn ON the ignition with the engine OFF for 2 seconds. Inspect for leaks. Turn ON ignition for 10 seconds and inspect for leaks.
7. Start and run fuel pressure test.

XV. LPG FUEL CONTROL SYSTEM CHECK

1. The fuel system can be thoroughly diagnosed by use of the DST tool. See section *DIAGNOSTIC SCAN TOOL*.

XVI. LPG FUEL SYSTEM LEAK TEST

1. Use a commercially available liquid leak detector or an electronic leak detector and follow the manufacturer's instructions.

IMPORTANT
When using both methods, use the electronic leak detector first to avoid contamination by the liquid leak detector

XVII. ELECTRONIC PRESSURE REGULATOR (EPR)

REMOVAL PROCEDURE

1. Disconnect the negative battery cable.
2. Relieve the LPG fuel system pressure. Refer to *III. LPG Fuel System Pressure Relief.*
3. Disconnect the LPG fuel inlet line from the Shut-Off Valve fitting.
4. Disconnect the EPR electrical connector.
5. Disconnect the Shut-Off Valve electrical connector.
6. Clamp both coolant lines near the EPR fittings.
7. Remove the retaining pins from the water inlet and outlet fittings, fuel hose and Temperature Sensor.
8. Remove coolant inlet and outlet Port Fittings and fuel hose.
9. Remove the three nuts securing the Vibration mounts to the EPR/ECM mounting bracket.
10. Remove Shutoff valve and fitting and Temperature Sensor.
11. Remove the three vibration mounts from the EPR.

INSTALLATION PROCEDURE

1. Apply Loctite 567 (or equivalent high-temp thread locker/sealer) to the threads of the Shut-Off valve 90° fitting. Install the Shut-Off valve fitting to the EPR and turn until finger tight plus 1 to 2 turns, ensuring the Shut-Off Valve is in the correct clock position.

CAUTION

Do not use Teflon tape on any fuel fitting. Use a liquid pipe thread sealant when installing threaded fittings.

2. Connect the EPR electrical connector.
3. Install the fuel inlet line. **Torque to 20 ft. lbs. (27 Nm)**.
4. Connect the Shut-Off Valve electrical connector.
5. Lubricate the O-rings on each of the port fittings and Temperature Sensor with petroleum jelly or Vaseline.

WARNING

Contamination of the HEGO sensor can result from the use of an inappropriate RTV sealer or silicone spray products. Do not use silicone sprays or hoses which are assembled using silicone lubricants. Always use “oxygen sensor safe” RTV sealant for repair procedures. Silicon contamination will cause a high but false HEGO signal voltage (rich exhaust indication). The ECM will then reduce the amount of fuel delivery to the engine, causing a severe driveability problem. If silicone contamination is suspected, remove and visually inspect the sensor element. If contaminated, the portion of the sensor exposed to the exhaust stream will have a white powdery coating. Always be sure to eliminate the cause of contamination before replacing the sensor.

6. Install the inlet and outlet water fittings, Fuel Hose and Temperature Sensor. Secure with retaining pins.
7. Remove clamps from coolant hoses.
8. Inspect coolant level and add coolant as necessary.
9. Reconnect the negative battery cable.
10. Open LPG tank valve.
11. Turn ignition ON for approximately 30 seconds, then OFF.
12. Leak check the LPG fuel system at each serviced fitting.
13. Start the vehicle and let run until it reaches normal operating temperature. Leak check the LPG fuel system at each serviced fitting.
14. If a DTC code is found, refer to the Electrical Section for further diagnosis.
15. Test drive vehicle to ensure correct operation.

XVIII. ELECTRONIC PRESSURE REGULATOR (EPR)

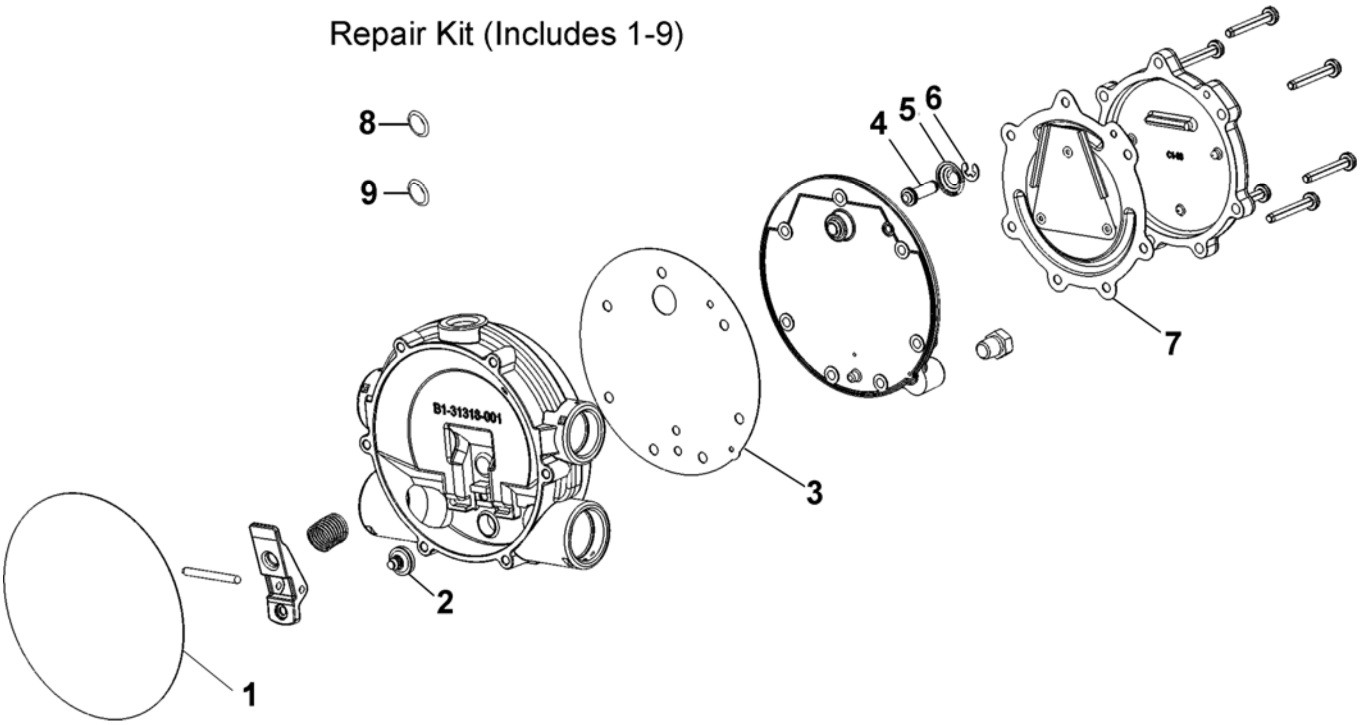
A Repair Kit is available to service and replace the following components in the Spectrum III Electronic Pressure Regulator (EPR):

1. Seal, Clamp Plate
2. Seat, Secondary
3. Gasket, Body Secondary
4. Pin, Primary
5. Spring, Primary
6. Clip, Primary
7. Diaphragm, Primary
8. O-ring
9. O-ring

NOTE
The Repair Kit consists of nine parts which are not available separately. These are the only serviceable components of the EPR. Any attempt to service other components may damage or cause the EPR to malfunction, and void warranty coverage.

WARNING

The Repair Kit consists of the only serviceable components for the Spectrum III EPR. Do not use any other components or regulator repair kits to service the Spectrum III EPR. The Kit is specifically designed for the Spectrum III EPR and is not compatible with other regulators.



Expanded View of the EPR Regulator and the Repair Kit Components.

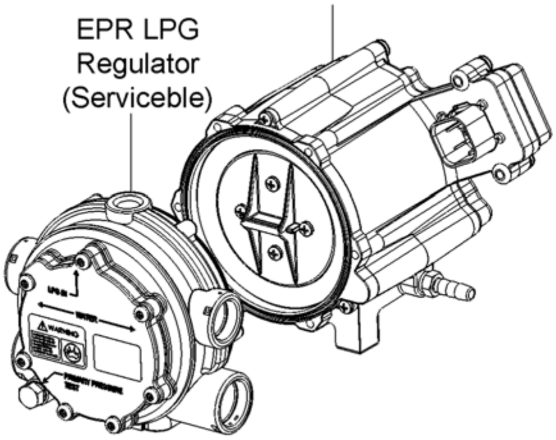
REPAIR INSTRUCTIONS

DISASSEMBLY OF EPR

1. Disconnect negative battery cable.
2. Relieve the LPG fuel system pressure. Refer to *III.LPG Fuel System Pressure Relief.*
3. Disconnect electrical connector from EPR.
4. Remove three nuts securing EPR to Mounting Bracket.
5. Inspect the outside of the EPR assembly for cracks, signs of leakage, corrosion, electrolysis, damage, stripped threads, etc. If damage is found, the EPR assembly is not repairable and must be replaced.
6. Remove the six screws that connect the Regulator to the Actuator.

NOTE
Be sure to identify the type of screw and its location during each stage of disassembly to ensure proper placement during reassembly.

7. Gently pull the Regulator away from the Actuator. If necessary, tap around the edge of the face plate with the handle of a plastic screwdriver to break the regulator free. Note that the lever from the primary valve slides into a slot of the secondary diaphragm, requiring the Regulator to be moved sideways to free the tab from the diaphragm. Remove and discard Clamp Plate Seal.



The two major components of the EPR Assembly: Regulator and the Actuator.

WARNING

Care must be used when removing regulator from the actuator to prevent damage to the lever and diaphragm. Neither part is serviceable and if damaged, the entire EPR assembly must be replaced.

8. Place Regulator face down and remove the retaining screw holding the secondary lever.
9. Remove secondary lever, fulcrum pin and spring.
10. Inspect lever and fulcrum pin for excessive wear. If the pin diameter is reduced at any point or if the holes in the lever are irregular (oblong), the EPR assembly is not repairable and must be replaced.
11. Turn the Regulator over and remove the seven screws from the face of the Regulator. Remove cover.
12. Remove the primary diaphragm.
13. Remove the body cover plate and C-clip from the primary valve pin.
14. Turn the plate over and remove pin and spring. Discard pin and keep the spring.
15. Remove the secondary body gasket.
16. Inspect the Regulator body and cover plates for debris, deposits or “heavy ends” and remove using a Safety Solvent as necessary. Ensure all mating surfaces are clean.

Optional:
If leaks are detected or if the replacement of the O-rings on the Coolant Hose(s), Fuel Temperature Sensor or the Fuel Vapor Hose is deemed necessary, the follow the additional steps. Otherwise, continue to Reassembly.

17. Release coolant pressure.
18. Clamp off the two radiator hoses near the point where they connect to the EPR.
19. Remove Coolant Hoses, Fuel Temperature Sensor and Fuel Vapor Hose by first removing Retaining Clips, then pulling each out of the EPR ports.
20. Remove O-rings from the Temperature Sensor, both Coolant Hose fittings, and the Fuel Vapor Hose. Clean Temperature Sensor EPR ports and hose fittings as necessary using a Safety Solvent.

WARNING

Use only Safety Solvents for the cleaning of the regulator and its components. Solvents such as carburetor or brake cleaners may damage gaskets, seals, O-rings, diaphragms or other non-metal components.

REASSEMBLY OF EPR

1. Inspect all parts to ensure the Repair Kit is complete and all components are free of deterioration, cracks, tears, etc.
2. Place the new primary valve pin into the cover plate orifice.
3. Holding the valve pin in place, turn the body cover plate over. Place the valve pin spring

over the valve pin and install C-clip or retaining clip.

4. Place a new secondary body gasket ensuring the small hole in the gasket is aligned with the small hole in the body cover. Place body cover and gasket on the front of Regulator body, ensuring the holes in the gasket are aligned with all screw holes.
5. Set new primary diaphragm the face of the body cover using the screw hole for proper alignment.
6. Place the Regular face over the diaphragm and hand thread all seven screws through the face plate and body cover into the Regulator body. **Torque the screws to 4.5 Nm (40 in. lbs.)** in a criss-cross pattern.
7. Using side-cutters, cut off the nose of the soft secondary seat and remove from secondary lever.
8. Push the nose or button of the new secondary seat through the hole of the secondary lever.
9. Set the secondary spring on its seat on the back of the Regulator body, then position the secondary lever and fulcrum pin assembly on top of the secondary spring. Push down, compressing the spring until the fulcrum pin can be slid into place.
10. Insert screw to hold lever and **torque to 4.5 Nm (40 in. lbs.)**.
11. Verify the secondary lever height by placing a straight edge over the mating surface (rim) of the Regular body. The distance between the rim of the Regulator (as determined by a straight edge) and lever should be 1/32" (.794mm). If the measurement does not meet this specification, the EPR cannot be repaired and must be replaced.
12. Place the EPR Actuator facing upward and place the new clamp plate seal into the open end of the Actuator.
13. Place the Regulator above the Actuator, noting the position of the lever tab and slot on the secondary diaphragm. Carefully slide the lever tab into the slot of the secondary diaphragm and align the Regulator to the Actuator. Place the Regulator on top the Actuator, aligning the screw holes.
14. Insert the six screws through the Actuator holes and into the Regulator. Finger tighten as many screws as possible.
15. Holding the Regulator to the Actuator, turn the assembly over so that it is resting on its face. **Torque screws to 40 in. lbs. (4.5 Nm)**.

Optional:
If hoses and O-rings were removed during the Removal Procedure, then follow the additional steps 17-20; otherwise, continue to Step 21.

16. Lubricate new O-rings using petroleum jelly or Vaseline. Mount new O-rings on the Temperature Sensor and hose fittings.

⚠ WARNING

Contamination of the HEGO sensor can result from the use of an inappropriate RTV sealer or silicone spray products. Do not use silicone sprays or hoses which are assembled using silicone lubricants. Always use "oxygen sensor safe" RTV sealant for repair procedures. Silicon contamination will cause a high but false HEGO signal voltage (rich exhaust indication). The ECM will then reduce the amount of fuel delivery to the engine, causing a severe driveability problem. If silicone contamination is suspected, remove and visually inspect the sensor element. If contaminated, the portion of the sensor exposed to the exhaust stream will have a white powdery coating. Always be sure to eliminate the cause of contamination before replacing the sensor.

17. Mount EPR assembly in vehicle and reconnect electrical connector to EPR.
18. Insert Temperature Sensor and hose fittings into EPR and lock each into place using original retaining clips.
19. Remove clamps on coolant hoses. Check coolant fluid level.
20. Clean Shut-Off Valve fitting, apply LPG compatible pipe thread sealer and install into EPR assembly.

⚠ WARNING

Do not use Teflon tape to seal any LPG fittings.

21. Reconnect negative battery cable.
22. Open valve on the LPG tank.

23. Turn Key to the ON position for several seconds, then turn back to OFF. Using a liquid or electronic leak detection tool, inspect the EPR, fuel hoses and all serviced fittings for leaks.
24. Start the vehicle and let run until it reaches normal operating temperature.
25. If a DTC code is found, refer to the Electrical Section for further diagnosis.

XIX. EPR COOLANT HOSE REPLACEMENT

REMOVAL PROCEDURE

1. Drain coolant.
2. Remove Retaining Pins securing Coolant Hose Port Fittings and remove, still attached to the Coolant Hose.
3. Remove the Coolant Hoses from opposite ends, by removing hose clamp.

> **CAUTION**
>
> **The coolant may be hot. Use caution when removing hose(s) to prevent contact.**

INSTALLATION PROCEDURE

IMPORTANT
Coolant hoses are specifically designed for their application. DO NOT use hose material or length other than the OEM specified parts. DO NOT mix the inlet or outlet hoses when reinstalling

1. Lightly lubricate Port Fitting O-rings with Vaseline or petroleum jelly prior to installation.
2. Insert Port Fittings into each end of the hose and secure with hose clamps.
3. Insert Coolant Hose Port Fittings into the EPR and secure with Retaining Pins.
4. Install hose on both ends and secure with hose clamps. Make sure the hoses are in the proper position and are not twisted or kinked.
5. Refill with coolant.
6. Start engine and run until operation temperature is reached.
7. Let engine cool and check coolant level.

XX. SHUT-OFF VALVE REPLACEMENT

REMOVAL PROCEDURE

1. Disconnect the negative battery cable.
2. Relieve the LPG fuel system pressure. Refer to *III. LPG Fuel System Pressure Relief.*

> **CAUTION**
>
> **The LPG fuel system operates at pressure up to 21.5 bar (312 psi). To minimize personal injury, relieve the LPG fuel system pressure before servicing the LPG fuel system components.**

3. Disconnect Shut-Off Valve electrical connector and remove connector from bracket.
4. Disconnect the LPG fuel inlet line from the Shut-Off Valve fitting.
5. Remove Shut-Off Valve and fitting as an assembly.
6. Remove brass fitting from the Shut-Off Valve.

INSTALLATION PROCEDURE

1. Add pipe thread sealer to male threads on the Shut-Off Valve and brass fitting.
2. Connect brass fitting to Shut-Off Valve.
3. Connect elbow, Shut-Off Valve and fitting assembly to the EPR.
4. Connect electrical connector to the Shut-Off Valve.
5. Connect the LPG fuel inlet line from the Shut-Off Valve fitting.
6. Reconnect negative battery cable.
7. Open LPG tank valve.
8. Turn Key to the ON position for several seconds, then turn back to OFF. Using a liquid or electronic leak detection tool, inspect the EPR, fuel hoses and all serviced fittings for leaks.
9. Start engine and check for leaks.

XXI. EPR/ECM MOUNTING BRACKET

REMOVAL PROCEDURE

1. Disconnect the negative battery cable.
2. Relieve the LPG fuel system pressure. Refer to *III. LPG Fuel System Pressure Relief.*
3. Remove ECM (Refer to *I. Engine Control*

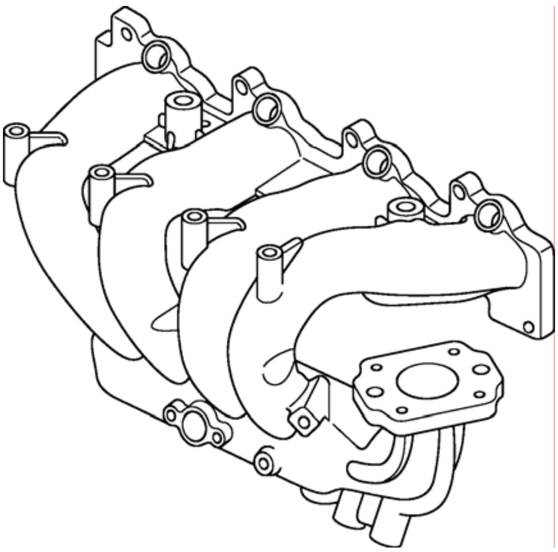
Module).
4. Remove EPR (Refer to *XVIII Electronic Pressure Regulator*).
5. Remove four screws securing the EPR/ECM bracket to the Intake Manifold.

INSTALLATION PROCEDURE

1. Place EPR/ECM Mounting Bracket on adapter. Secure with four screws. **Torque to 12 Nm (106 in. lbs.)**.
2. Mount EPR (Refer to *XVIII. Electronic Pressure Regulator*).
3. Mount ECM (Refer to *I. Engine Control Module).*
4. Reconnect negative battery cable.
5. Open valve on the LPG tank.
6. Start the vehicle and let run until it reaches normal operating temperature.
7. If a DTC code is found, refer to the Electrical Section for further diagnosis.

XXII. INTAKE MANIFOLD

REMOVAL PROCEDURE



Intake Manifold

1. Remove ECM (Refer to *I. Engine Control Module).*
2. Remove EPR (Refer to *XVIII. Electronic Pressure Regulator).*
3. Remove Mixer, Adapter and Throttle Body Assembly (Refer to *XI. Mixer/Adapter/ Throttle Body & Related Seals*)
4. Remove ECM/Mixer Bracket (Refer to *XXII. EPR/ECM Mounting Bracket*).
5. Remove the TMAP (Refer to *VI. Temperature Manifold Absolute Pressure Sensor*).
6. Remove Coolant Hose support brackets.
7. Remove two bolts securing the Manifold to the bracket.
8. Remove eight bolts securing the Manifold to the side of the engine and remove.
9. Remove Gasket.

INSTALLATION PROCEDURE

1. Place bolt through Intake Manifold and Gasket and mount on engine. **Torque bolts to 11.6-16.6 ft.lbs. (15.7-22.6Nm).**
2. Install two bolts at bottom of the manifold, securing the manifold to the bracket**. Torque bolts to 11.6-16.6 ft.lbs. (15.7-22.6Nm).**
3. Install TMAP (Refer to *VI. Temperature Manifold Absolute Pressure Sensor*).
4. Install ECM/Mixer Bracket (Refer to *XXII. EPR/ECM Mounting Bracket.*)
5. Install Mixer, Adapter and Throttle Body assembly (Refer to *IX. Mixer/Adapter/Throttle Body & Related Seals*).
6. Install ECM.
7. Start the vehicle and let run until it reaches normal operating temperature.
8. If a DTC code is found, refer to the Electrical Section for further diagnosis.

XXIII. EXHAUST MANIFOLD

REMOVAL PROCEDURE

1. Remove three bolts securing exhaust manifold cover.
2. Remove HEGO 1 (refer to *VIII. Heated Exhaust Gas Oxygen Sensor*).
3. Remove two screws securing the exhaust pipe to the exhaust manifold.
4. Remove eight screws securing the exhaust manifold to the engine block and remove the manifold.

INSTALLATION PROCEDURE

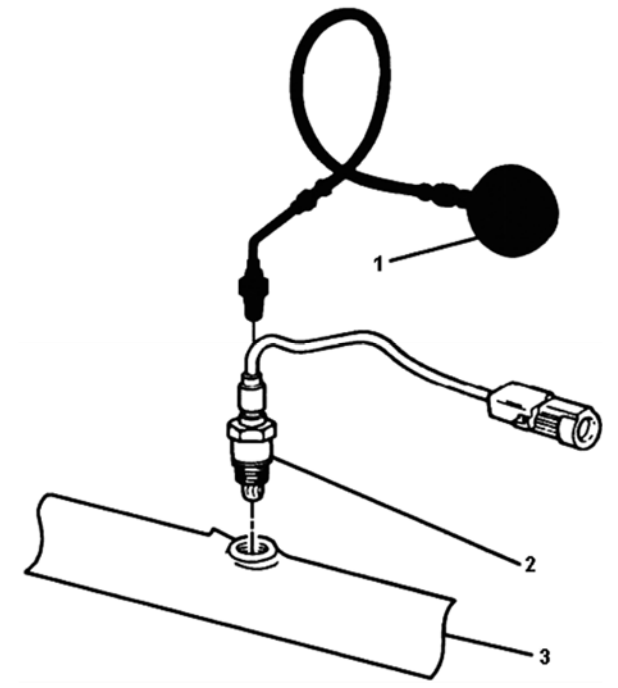
1. Place exhaust manifold against engine block. Align holes and thread eight screws into the block. **Torque to 31.1-39.8ft.lbs. (42.2Nm-53.9).**

2. Install the exhaust manifold cover with three screws. **Torque to 10.8-14.5ft.lbs. (14.7-19.6Nm).**

XXIV. RESTRICTED EXHAUST SYSTEM DIAGNOSIS

PROCEDURE:

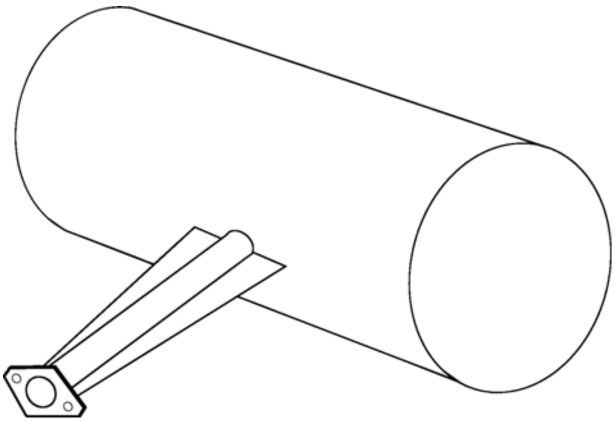
1. Carefully remove the HEGO 2(Refer to *VIII. Heated Exhaust Gas Oxygen Sensor*).
2. Install Exhaust Back Pressure Test Gauge (J35314-A) in place of the HEGO 2.
3. With the engine idling at normal operating temperature, observe the exhaust system back pressure reading on the gauge. Reading should not exceed 8.6 kPa (1.25 psi).
4. Increase engine speed to 2000 RPM and observe gauge. Reading should not exceed 20.7 kPa (3 psi).
5. If the back pressure at either speed exceeds specification, a restricted exhaust system is indicated.
6. Inspect the entire exhaust system for a collapsed pipe, heat distress or possible internal catalytic converter failure.
7. If there are no obvious reasons for the excessive back pressure, the catalytic converter is likely damaged and should be replaced.
8. Check for MIL and clear using the DST.



1. Back Pressure Gauge
2. Heated Exhaust Gas Oxygen Sensor (HEGO 1—Sensor between the engine and Catalytic Converter).
3. Exhaust Pipe/Muffler

Exhaust Back Pressure Test

XXV. CATALYTIC CONVERTER



Catalytic Muffler

REMOVAL PROCEDURE

1. Remove the Catalytic Converter using the OEM end product processes

INSTALLATION PROCEDURE

IMPORTANT
The Catalytic converter is specifically designed to meet the emission control of the certified engine. Use only the OEM specified part. Install the Catalytic Converter using the OEM end product processes.

1. Start engine
2. Check for any DTC codes and clear
3. Verify engine is in closed loop and no MIL lights are present.

XXVI. VACUUM LINE

REMOVAL PROCEDURE

1. Disconnect the negative battery cable.
2. Remove the Vacuum Line from each fitting.
3. Start engine and check for leaks.

INSTALLATION PROCEDURE

IMPORTANT
DO NOT use a hose other than the OEM specified part.

1. Reinstall the Fuel Vapor Hose to each fitting
2. Reconnect negative battery cable.
3. Start engine and check for leaks.

Definitions

Air Valve Vacuum (AVV): The vacuum signal taken from below the air valve assembly and above the throttle butterfly valve.

ADP: Adaptive Digital Processor.

Air/Fuel Ratio: The amount or balance of air and fuel in the air fuel mixture that enters the engine.

Analog Voltmeter: A meter that uses a mechanical needle to point to a value on a scale of numbers. It is usually of the low impedance type and used to measure voltage and resistance.

Aromatics: Pertaining to or containing the six-carbon ring characteristic of the benzene series. Found in many petroleum distillates.

Backfire: Combustion of the air/fuel mixture in the intake or exhaust manifolds. A backfire can occur if the intake or exhaust valves are open when there is a mis-timed ignition spark.

Benzene: An aromatic (C_6H_6). Often blended with gasoline to improve anti-knock value. Benzene is toxic and suspected of causing cancer.

Bi-Fueled: A vehicle equipped to run on two fuels.

Blow-By: Gases formed by the combustion of fuel and air, which ordinarily should exert pressure only against the piston crown and first compression ring. When rings do not seal, these gases escape or "blow by" the side of the piston into the crankcase.

BTU: British Thermal Unit. A measurement of the amount of heat required to raise the temperature of 1lb. of water 1 degree F.

Butane: An odorless, colorless gas, C_4H_{10} found in natural gas and petroleum. One of the five LP gases.

CAFE: Corporate Average Fuel Economy.

CARB: California Air Resources Board.

Carbon Monoxide (CO): A chemical compound of a highly toxic gas that is both odorless and colorless.

Carburetor: An apparatus for supplying an internal-combustion engine a mixture of vaporized fuel and air.

Cathode Ray Tube: A vacuum tube in which cathode rays usually in the form of a slender beam are projected on a fluorescent screen and produce a luminous spot.

Circuit: A path of conductors through which electricity flows.

Closed Loop Operation: Applies to systems utilizing an oxygen sensor. In this mode of operation, the system uses oxygen sensor information to determine air/fuel ratio. Adjustments are made accordingly and checked by comparing the new oxygen sensor to previous signals. No stored information is used.

CNG: Compressed Natural Gas.

CKP: Crankshaft Position Sensor

CMP: Camshaft Position Sensor

Conductor: A material, normally metallic, that permits easy passage of electricity.

Contaminants: Impurities or foreign material present in fuel.

Control Module: One of several informal names for a solid state microcomputer which monitors engine conditions and controls certain engine functions; i.e. air/fuel ratio, injection and ignition time, etc. The formal name and the one used throughout this manual is ECM, or Engine Control Module.

Converter: A LPG fuel system component containing varying stages of fuel pressure regulation combined with a vaporizer.

Cryogen: A refrigerant used to obtain very low temperatures.

Current: The volume or flow of electrons through a conductor. Measured in amperes or amps.

DBW: Drive By Wire

Dedicated Fuel System: A motor fuel system designed to operate on only one fuel type.

Diaphragm: A thin, flexible membrane that separates two chambers. When the pressure in one chamber is lower than in the other chamber, the diaphragm will move toward the side with the low pressure.

Diaphragm Port: The external port located at the fuel inlet assembly and connected to the vacuum chamber above the air valve diaphragm.

DLC: Data Link Connector.

DTC: Diagnostic Trouble Code

DST: Diagnostic Scan Tool.

DVOM: Digital Volt/ohm Meter**.** A meter that uses a numerical display in place of a gauge and is usually of the high impedance type.

ECT: Engine Coolant Temperature.

ECM: Electronic Control Module

ECOM: A DLC cable supporting CAN and serial communication with a Spectrum II or III ECM.

EFI: Electronic Fuel Injection. A fuel injection system, which uses a microcomputer (ECM) to determine and control the amount of fuel, required by, and injected into, a particular engine.

EGO: Exhaust Gas Oxygen, used to describe a sensor. Also known as "HEGO" (Heat Exhaust Gas Oxygen) sensor, "O_2" or "Oxygen sensor.

EGR: Exhaust Gas Recirculation.

EPA: Environmental Protection Agency: A regulating agency of the Federal government which, among other duties, establishes and enforces automotive emissions standards.

Ethanol: Grain alcohol (C_2H_5OH), generally produced by fermenting starch or sugar.

Evaporative Emissions Controls: An automotive emission control system designed to reduce hydrocarbon emissions by trapping evaporated fuel vapors from the fuel system.

Excess Flow Valve: A check valve that is caused to close by the fuel when the flow exceeds a predetermined rate.

FTV: Fuel Trim Valve.

FFV: Flexible Fuel Vehicle.

Firing Line: The portion of an oscilloscope pattern that represents the total amount of voltage being expended through the secondary circuit.

FMVSS: Federal Motor Vehicle Safety Standards.

FPP: Foot Pedal Position Sensor

Fuel Injector: a spring loaded, electromagnetic valve which delivers fuel into the intake manifold, in response to an electrical input from the control module.

Fuel Lock: A solenoid-controlled valve located in the fuel line to stop the flow when the engine stops or the ignition switch is off.

Gasohol: 10 percent ethanol, 90 percent gasoline. Often referred to as E-10.

Gasoline: A motor vehicle fuel that is a complex blend of hydrocarbons and additives. Typical octane level is 89.

GCP: Spectrum III (90-pin) ECM.

Greenhouse Effect: A scientific theory suggesting that carbon dioxide from the burning of fossil fuels is causing the atmosphere to trap heat and cause global warming.

HC: Hydrocarbon. An organic chemical compound.

HD 10: A fuel of not less than 80% liquid volume propane and not more than 10% liquid volume propylene.

HD 5: A fuel of not less than 90% liquid volume propane and not more than 5% liquid volume propylene.

HDV: Heavy Duty Vehicle.

Heavy Ends: A term used to describe the buildup of wax-like impurities that fall out of LPG when vaporized.

HEGO: Heated Exhaust Gas Oxygen, used to describe a sensor. Also known as “EGO” (Exhaust Gas Oxygen sensor), “O_2” or “Oxygen sensor.

Hg: Chemical symbol for the element mercury. Used in reference to a measure of vacuum (inches of Hg).

Histogram: The graphical version of a table which shows what proportion of values fall into specific categories over a specific period of time.

Hydrocarbon: A chemical compound made up of hydrogen and carbon (HC). Gasoline and almost all other fuels are hydrocarbons.

Hydrostatic Relief Valve: A pressure relief device installed in the liquid LPG hose on a LPG fuel system.

IAT: Intake Air Temperature

Ideal Mixture: The air/fuel ratio at which the best compromise of engine performance to exhaust emissions is obtained. Typically 14.7:1.

Ignition Reserve: The difference between available voltage and the required voltage.

ILEV: Inherently Low Emission Vehicle.

IMPCO: Imperial Machine Products Company.

IMPCO Technologies, Inc. A manufacturer of both LPG and Gasoline fuel systems.

Impedance: A form of opposition of AC electrical current flow (resistance) measured in ohms.

Insulation: A nonconductive material used to cover wires in electrical circuits to prevent the leakage of electricity and to protect the wire from corrosion.

Intercept: An electrical term for a type of splice where the original circuit is interrupted and redirected through another circuit.

ITK: IMPCO Test Kit

Knock: Sound produced when an engine’s air/fuel mixture is ignited by something other than the spark plug, such as a hot spot in the combustion chamber. Also caused by a fuel with an octane rating that is too low and/or incorrect ignition timing. Also called detonation or ping.

Lambda Sensor: A feedback device, usually located in the exhaust manifold, which detects the amount of oxygen present in exhaust gases in relation to the surrounding atmosphere. (See HEGO).

LDV: Light Duty Vehicle.

Lean Mixture: An air to fuel ratio above the stoichiometric ratio; too much air.

LEV: Low Emission Vehicle.

Limp-in or Limp Home: A mode where the ECM or a component has failed, but the vehicle remains operational although the engine may operate minimally. This term may also describe the drivability characteristics of a failed computer system.

Liquid Petroleum Gas (LPG): A fuel commonly known as propane consisting mostly of propane (C_3H_8), derived from the liquid components of natural gas stripped out before the gas enters the pipeline, and the lightest hydrocarbons produced during petroleum refining. Octane level of LPG is 107.

LPG: Liquified Petroleum Gas.

M85: A blend of gasoline and methanol consisting of 85% methanol and 15% gasoline.

MSV: (Abbreviated MSV). Refers to the manually operated valve on the LPG tank.

Measurements of Pressure: 1 PSI=2.06" Hg (mercury) = 27.72" H_2O (water column). At sea level atmospheric pressure is 29.92" Hg.

Methanol: Known as wood alcohol (CH_3OH), a light, volatile, flammable alcohol commonly made from natural gas.

MIL: Malfunction Indicator Lamp.

Misfire: Failure of the air/fuel mixture to ignite during the power stroke.

Mixer: Fuel introduction device that does not include a throttle plate.

MFI: Multiport Fuel Injection. A fuel injection system that uses one injector per cylinder mounted on the engine to spray fuel near the intake valve area of combustion chamber.

MSV: Manual Shut-Off Valve. Refers to the manually operated valve on the LPG tank.

MTBE: Methyl Tertiary Butyl Ether. Oxygenate add to gasoline to reduce harmful emissions and to improve the octane rating.

Multi-fuel System: A motor fuel system designed to operate on two different fuels, such as LPG and gasoline.

Natural Gas: A gas formed naturally from buried organic material, composed of a mixture of hydrocarbons, with methane (CH_4) being the dominant component.

NGV: Natural Gas Vehicle.

NOX: See Oxides of Nitrogen.

OBD: On Board Diagnostic

Octane Rating: The measurement of the antiknock value of a motor fuel.

OEM: Original Equipment Manufacturer, the vehicle manufacturer.

Open-Loop: An operational mode during which control module memory information is used to determine air/fuel ratio, injection timing, etc., as opposed to actual oxygen sensor input.

Orifice: A port or passage with a calibrated opening designed to control or limit the amount of flow through it.

Oscilloscope: An instrument that converts voltage and frequency readings into traces on a cathode ray tube (also see Cathode Ray Tube).

Oxides of Nitrogen: Chemical compounds of nitrogen bonded to various amounts of oxygen (NOX). A chief smog forming-agent.

Oxygen Sensor: An automotive fuel system that produces a signal in accordance with the oxygen content of the exhaust gas. (See Lambda Sensor).

Oxygenate: Oxygenates (such as MTBE, ethanol and methanol) added to gasoline to increase the oxygen content and therefore reduce exhaust emissions.

Ozone: A radical oxygen module (O_3) that is found in the upper atmosphere and filters out ultraviolet radiation from the sun. Ground level ozone is formed by NOX, during the formation of photochemical smog.

Particulates: Microscopic pieces of solid or liquid substances such as lead and carbon that are discharged into the atmosphere by internal combustion engines.

Positive Crankcase Ventilation (PCV): An automotive emission control system designed to reduce hydrocarbon emissions by routing crankcase fumes into the intake manifold rather than to the atmosphere.

Power Derate: A mode of reduced engine power output for the purposes of protecting engine components during a failure or malfunction.

Pressure Differential: The differential between atmospheric pressure and intake manifold (referred to as vacuum) pressure.

Pressure Regulator: A device to control the pressure of fuel delivered to the fuel injector(s).

Primary Circuit: The low-voltage or input side of the ignition coil.

Propane: An odorless and colorless gas, C_3H_8, found in natural gas and petroleum.

Psia: pounds per square inch absolute

PTV: Pressure Trim Valve

Reactivity: Refers to the tendency of an HC in the presence of NOX and sunlight to cause a smog-forming reaction. The lighter the HC, the lower reactivity tends to be.

Regulator: An assembly used to reduce and control the pressure of a liquid or vapor.

Resistance: The opposition to the flow of current in an electrical circuit. Measured in ohms.

Rest Pressure: Fuel pressure maintained within the system after engine shutdown.

Rich Mixture: An air to fuel ratio below the stoichiometric ratio; too much fuel.

SAE: Society of Automotive Engineers.

Secondary Circuit: The high-voltage output side of the ignition coil.

SEFI or SFI: Sequential Electronic Fuel Injection or Sequential Fuel Injection.

Sensors: Devices that provide the control module with engine information as needed to properly control engine function.

Spark Line: The portion of an oscilloscope pattern that represents the time during which the air/fuel mixture is being burned in the combustion chamber.

Splice: An electrical term for the joining of two or more conductors at a single point.

Stoichiometric Ratio: An ideal fuel/air ratio for combustion in which all of the fuel and most of the oxygen will be burned.

Sulfur Oxides: Chemical compounds where sulfur is bonded to oxygen produced by the combustion of gasoline or any other fuel that contains sulfur. As sulfur oxides combine with water in the atmosphere to form sulfuric acid.

System Pressure: The fuel pressure maintained in the system during normal engine operation.

Tap: An electrical term for a type of splice where the original circuit is not interrupted.

TBI: Throttle Body Injection. Any of several injection systems that have the fuel injector(s) mounted in a centrally located throttle body.

Throttle Body: Controls engine RPM by adjusting the engine manifold vacuum to the mixer. Consists of a housing shaft, throttle liner and butterfly valve.

TLEV: Transitional Low Emission Vehicle.

TMAP: Combined Air Inlet and Manifold Pressure Sensor.

Toluene: A liquid aromatic hydrocarbon C_7H_8.

TPS: Throttle Position Sensor.

TSB: Technical Service Bulletin.

ULEV: Ultra Low Emission Vehicle.

USB: Universal Serial Bus. A plug or interface supplied on most personal computers.

Vaporization: A process in which liquid changes states into gas.

Venturi Air Valve Vacuum (VAVV): An amplified air valve vacuum signal coming from the venturi area of the mixer, directly exposed to airflow before the addition of vaporized LPG.

Volt/ohmmeter (VOM): A combination meter used to measure voltage and resistance in an electrical circuit. Available in both analog and digital types. May also referred to as AVOM and DVOM.

Voltage: The electrical pressure that causes current to flow in a circuit. Measured in volts.

Voltage Drop: A lowering of the voltage in a circuit when resistance or electrical load is added.

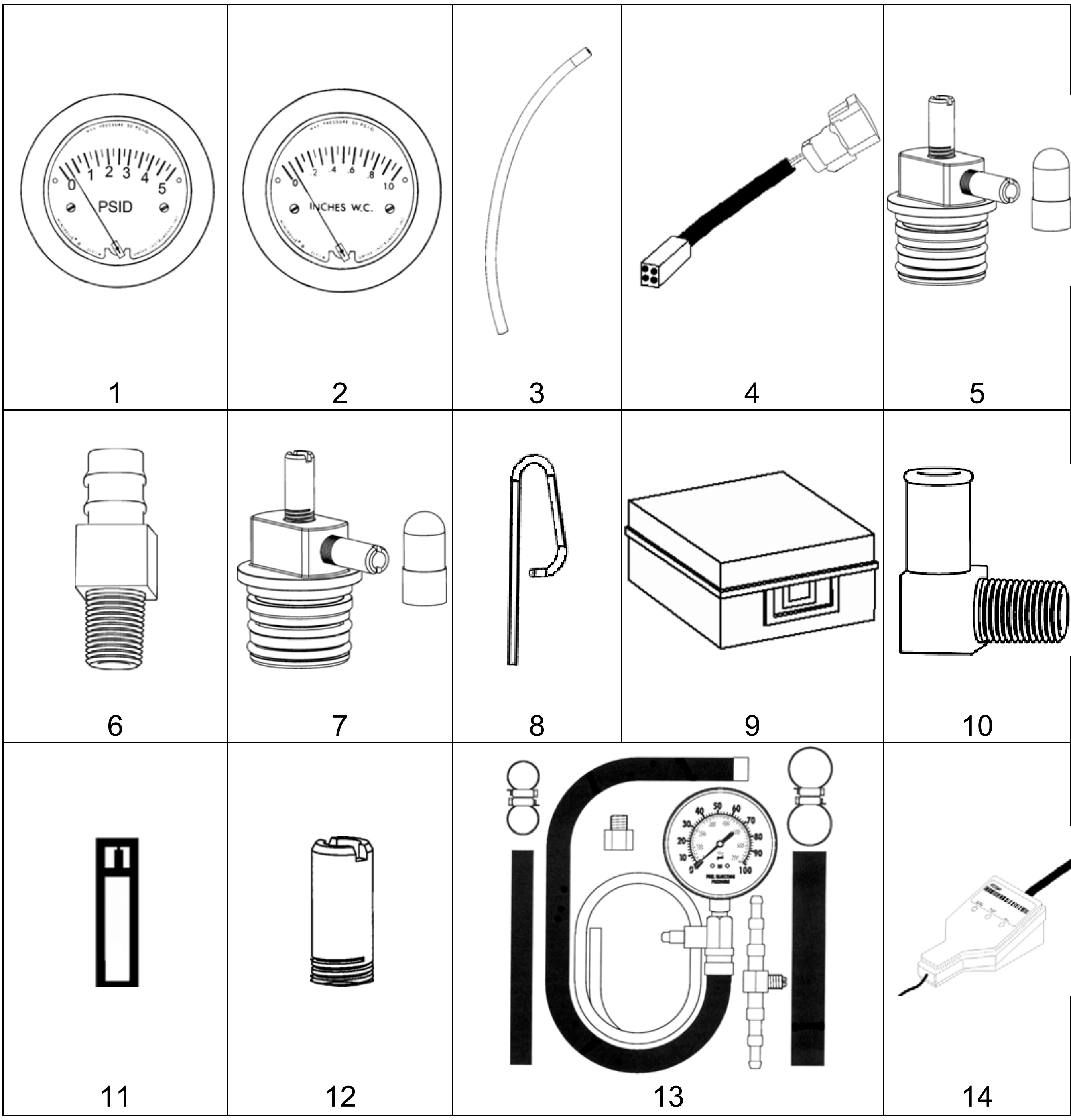
Voltmeter: A meter that uses a needle to point to a value on a scale of numbers usually of the low impedance type; used to measure voltage and resistance.

VSS: Vehicle Speed Sensor.

Xylene: $C_6H_4\ (CH_3)_2$. Any of three toxic, flammable, and oily isomeric aromatic hydrocarbons that are dimethyl homologues of benzene and usually obtained from petroleum or natural gas distillates.

ZEV: Zero Emission Vehicle.

TOOL KIT & ACCESSORIES



TOOL KIT, IMPCO P/N ITK-4

Item #	Description	Qty. Used	IMPCO Part Number
1	Test Kit Gauge 0-5 PSI (2-5205)	1	TG-005
2	Test Kit-Gage 0-10" WC (2-5010)	1	TG-010
3	Hose, 3/16" Id Vacuum, Bulk	1.5’	H1-11
4	Harness, Adapter Gen 2 DLC to Gen 1 DLC	1	E1557400
5	Fitting Assembly, Test Cap (System II LPR Secondary Pressure Test Adapter)	1	AF4-31105
6	Fitting, 1/8 NPT 3/16Hs Nip Brass	2	F4-4
7	Assembly, Fitting Test Cap 3/4	1	AF4-50254-002
8	Pin, Retainer	10	P1-30559
9	Case, Metal, 14.25 x 9 x 4.25	1	C9-50724-001
10	Fitting, 1/8 NPT 1/4Hs El Nylon	2	F4-8
11	Tool, 20IPR Torx-Plus Bit	1	T7-50172
12	Fitting, ¼ UNF, ¼ HS Vac Nip	1	F4-2
13	Gauge, Test Gasoline Fuel System	1	TG-31119-001
14	ASM, CAN Dongle (ECOM Cable)	1	E2046002

Appendix

Altitude vs. Barometric Pressure

Altitude Measured In Feet (ft)	Kilopascals (kPa)	Pounds Per Square Inch (PSIA)
14,000	56-64	8.1-9.2
13,000	58-66	8.4-9.6
12,000	61-69	8.8-10.0
11,000	64-72	9.3-10.4
10,000	66-74	9.6-10.7
9,000	69-77	10.0-11.2
8,000	71-79	10.3-11.4
7,000	74-82	10.7-11.9
6,000	77-85	11.2-12.3
5,000	80-88	11.6-12.8
4,000	83-91	12.0-13.2
3,000	87-95	12.6-13.8
2,000	90-98	13.0-14.2
1,000	94-102	13.6-14.8
0	96-104	13.9-15.0
-1,000	101-105	14.6-15.2

Ignition System Specifications

Firing Order	1-3-4-2
Spark Plug Type	Hyundai 27410-23400
	NGK PFRN6N
	Champion RC8PYPB
Spark Plug Gap	.028-.031 in (0.7-0.8mm)