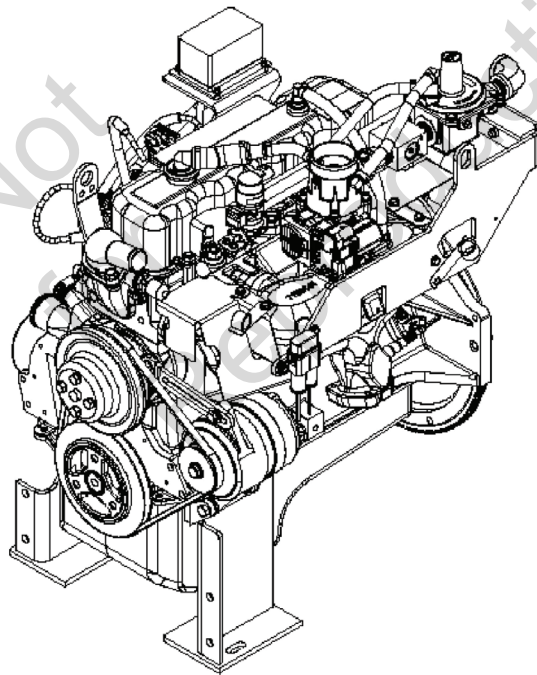




3.0 L Impco Engine Service and Repair Manual for Fuel System



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Save These Instructions

Important Safety Instructions

SAVE THESE INSTRUCTIONS - This manual contains important instructions that should be followed during the service and repair of the engine.

Safety Symbols and Meanings



Explosion



Fire



Electrical Shock



Toxic Fumes



Rotating Parts



Hot Surface



Auto Start



Explosive Pressure



Chemical Burn



Rotating Belt/Pulley



Rotating Fan Blade



Exploding Battery



Lift Hazard



Read Manual

▲ The safety alert symbol indicates a potential personal injury hazard. A signal word (DANGER, WARNING, or CAUTION) is used with the alert symbol to designate a degree or level of hazard seriousness. A safety symbol may be used to represent the type of hazard. The signal word NOTICE is used to address practices not related to personal injury.

▲ **DANGER** indicates a hazard which, if not avoided, *will* result in death or serious injury.

▲ **WARNING** indicates a hazard which, if not avoided, *could* result in death or serious injury.

▲ **CAUTION** indicates a hazard which, if not avoided, *could* result in minor or moderate injury.

NOTICE addresses practices not related to personal injury.

The manufacturer cannot possibly anticipate every possible circumstance that might involve a hazard. The warnings in this manual, and the tags and decals affixed to the unit are, therefore, not all-inclusive. If you use a procedure, work method or operating technique that the manufacturer does not specifically recommend, you must satisfy yourself that it is safe for you and others. You must also make sure that the procedure, work method or operating technique that you choose does not render the generator system unsafe.

▲ **WARNING** Running engine gives off carbon monoxide, an odorless, colorless, poison gas.



Breathing carbon monoxide could result in death, serious injury, headache, fatigue, dizziness, vomiting, confusion, seizures, nausea or fainting.

- Operate this product **ONLY** outdoors in an area that will not accumulate deadly exhaust gas.
- Keep exhaust gas away from any windows, doors, ventilation intakes, soffit vents, crawl spaces, open garage doors or other openings that can allow exhaust gas to enter inside or be drawn into a potentially occupied building or structure.
- Carbon monoxide detector(s) **MUST** be installed and maintained indoors according to the manufacturer's instructions/recommendations. Smoke alarms cannot detect carbon monoxide gas.

▲ **WARNING** The engine exhaust from this product contains chemicals known to the State of California to cause cancer, birth defects, or other reproductive harm.

▲ **WARNING** Certain components in this product and related accessories contain chemicals known to the State of California to cause cancer, birth defects, or other reproductive harm. Wash hands after handling.

▲ **WARNING** Battery posts, terminals, and related accessories contain lead and lead compounds - chemicals known to the State of California to cause cancer and reproductive harm. Wash hands after handling.

⚠ WARNING Generator produces hazardous voltage.



Failure to properly ground generator could result in electrocution.

Failure to isolate generator from power utility could result in death or serious injury to electric utility workers due to backfeed of electrical energy.

- When using generator for backup power, notify utility company.
- DO NOT touch bare wires or bare receptacles.
- DO NOT use generator with electrical cords which are worn, frayed, bare or otherwise damaged.
- DO NOT handle generator or electrical cords while standing in water, while barefoot, or while hands or feet are wet.
- If you must work around a unit while it is operating, stand on an insulated dry surface to reduce the risk of a shock hazard.
- DO NOT allow unqualified persons or children to operate or service generator.
- In case of an accident caused by electrical shock, immediately shut down the source of electrical power and contact the local authorities. **Avoid direct contact with the victim.**
- Despite the safe design of the residential generator, operating this equipment imprudently, neglecting its maintenance or being careless could cause possible injury or death.
- Remain alert at all times while working on this equipment. Never work on the equipment when you are physically or mentally fatigued.
- Before performing any maintenance on the generator, disconnect the battery cable indicated by a **NEGATIVE, NEG** or (-) first. When finished, reconnect that cable last.
- After your system is installed, the generator may crank and start without warning any time there is a power failure. To prevent possible injury, always set the generator's system switch to **OFF**, remove the service disconnect from the disconnect box AND remove the 15 Amp fuse BEFORE working on the equipment.

⚠ WARNING Propane and Natural Gas are extremely flammable and explosive, which could cause burns, fire or explosion resulting in death, serious injury and/or property damage.



- Install the fuel supply system according to NFPA 37 and other applicable fuel-gas codes.
- Before placing the generator into service, the fuel system lines must be properly purged and leak tested.
- After the generator is installed, you should inspect the fuel system periodically.
- NO leakage is permitted.
- DO NOT operate engine if smell of fuel is present or other explosive conditions exist.
- DO NOT smoke around the generator. Wipe up any oil spills immediately. Ensure that no combustible materials are left in the generator compartment. Keep the area near the generator clean and free of debris.

⚠ WARNING Exhaust heat/gases could ignite combustibles or structures resulting in death, serious injury and/or property damage. Contact with muffler area could cause burns resulting in serious injury.



- DO NOT touch hot parts and AVOID hot exhaust gases.
- Allow equipment to cool before touching.
- DO NOT install the generator closer than 5 feet (1.5m) from any combustibles or structures with combustible walls having a fire resistance rating of less than 1 hour.
- Keep at least minimum distances shown in *General Location Guidelines* to insure for proper generator cooling and maintenance clearances.
- It is a violation of California Public Resource Code, Section 4442, to use or operate the engine on any forest-covered, brush-covered, or grass-covered land unless the exhaust system is equipped with a spark arrester, as defined in Section 4442, maintained in effective working order. Other states or federal jurisdictions may have similar laws. Contact the original equipment manufacturer, retailer, or dealer to obtain a spark arrester designed for the exhaust system installed on this engine.
- Replacement parts must be the same and installed in the same position as the original parts.

▲ WARNING Storage batteries give off explosive hydrogen gas during recharging. Slightest spark will ignite hydrogen and cause explosion, resulting in death, serious injury and/or property damage.



Battery electrolyte fluid contains acid and is extremely caustic.

Contact with battery contents could cause severe chemical burns.

A battery presents a risk of electrical shock and high short circuit current.

- DO NOT dispose of battery in a fire. Recycle battery.
- DO NOT allow any open flame, spark, heat, or lit cigarette during and for several minutes after charging a battery.
- DO NOT open or mutilate the battery.
- Wear protective goggles, rubber apron, rubber boots and rubber gloves.
- Remove watches, rings, or other metal objects.
- Use tools having insulated handles.

▲ WARNING Hazardous Voltage - Contact with power lines could cause electric shock or burns, resulting in death or serious injury. Lifting Hazard / Heavy Object - Could result in serious injury.



- If lifting or hoisting equipment is used, DO NOT contact any power lines.
- DO NOT lift or move generator without assistance.
- Use lifting pipes as described in *Lifting the Generator*.
- DO NOT lift unit by roof as damage to generator will occur.

▲ WARNING Moving parts could crush and cut. Starter and other rotating parts could entangle hands, hair, clothing, or accessories resulting in serious injury.



- NEVER operate generator without protective housings, covers, or guards in place.
- DO NOT wear loose clothing, jewelry or anything that could be caught in the starter or other rotating parts.
- Tie up long hair and remove jewelry.
- Before servicing, remove 15 Amp fuse from control panel and disconnect **Negative (NEG or -)** battery cable.

▲ WARNING Hot pressurized coolant could cause serious injury and/or property damage.



- DO NOT open radiator cap when hot.
- Before servicing, allow coolant to cool.

▲ CAUTION Installing the 15A fuse could cause the engine to start at any time without warning resulting in minor or moderate injury.



- Observe that the 15 Amp fuse has been removed from the control panel for shipping.
- DO NOT install this fuse until all plumbing and wiring has been completed and inspected.

This service manual has been developed to provide the service technician with the basic understanding of the IMPCO certified fuel and emission systems for the 3.0L GM engine.

The IMPCO GM 3.0L Engine is an inline four cylinder water cooled design that has been specifically configured to run in stationary power generating applications and fueled by either Natural Gas or propane vapor. This engine package will provide up to 25kW of standby electrical power when using Natural Gas and up to 30kW when using propane. The engine and fuel system components support UL 2200 applications.

The IMPCO GM 3.0L stationary engine features a low pressure single point fuel delivery system along with the Delphi MEF15 engine control unit which has been programmed and calibrated by IMPCO. By continually monitoring various engine sensors and exhaust gas composition, the air/fuel ratio is constantly modified to maintain the desired power and emission performance using fuel types encountered in North America.

The engine speed is monitored and processed by the ECU 60 times per engine revolution to ensure that the electronic throttle is able to control the engine speed within ISO 8582 G3 operating limits.

How To Identify the Model Year

The emission label on the engine will identify the specific model year.

Engine Maintenance

Fuel Recommendations

The IMPCO GM 3.0L Stationary Power Generating engine is shipped from the factory calibrated for NG operation. To convert the engine from NG to LP vapor operation, follow these steps:

1. Set generator circuit breaker to **OFF**.
2. Set control panel system switch to **OFF**.
3. Remove 15 Amp fuse from system control panel.
4. Locate the fuel selector switch. Using a 6mm Allen wrench, turn the selector switch to either LP or NG.
5. Reinstall 15 Amp fuse in system control panel.
6. Set exercise timer.

Fuel Pressure

The fuel system relies on fuel pressure to the engine systems low pressure regulator to deliver advertised power levels. Be sure the gas supply pressure is maintained to the fuel systems low pressure shutoff valve(s) as shown:

- Both LP vapor and natural gas fuel supply pressure at the generator's fuel inlet port should be between 7 to 11 inches (18 to 28 cm) of water (in. W.C.) at full load with all gas appliances turned on and operating. *Maximum pressure with engine OFF at No Load is 13.85 psi.*
- LPG engines and fuel systems 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.

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

Fuel Consumption

Estimated fuel supply requirements at half and full load for natural gas and LP vapor fuels are shown here.

	Natural Gas		LP Vapor	
	1/2 Load	Full Load	1/2 Load	Full Load
27kW	203 C	345 C	131 C	222 C
	203,000 B	345,000 B	328,000 B	555,000 B

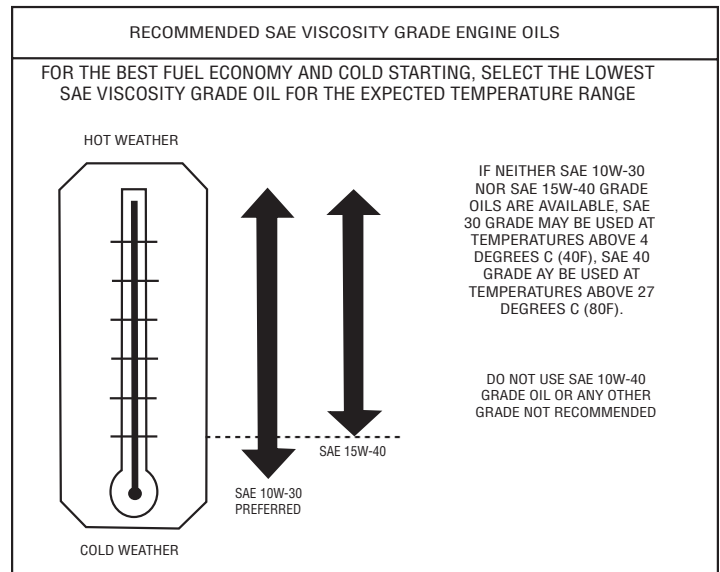
C = Cubic feet per hour
B = BTU's per hour

Power Loss

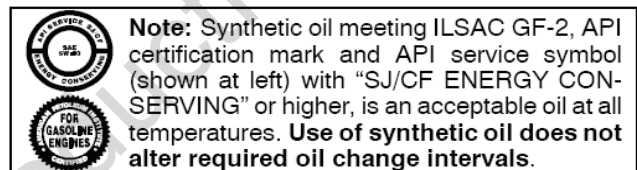
Air density is less at high altitudes, resulting in less available engine power. Specifically, engine power will decrease 3.5% for each 1,000 feet (300 m) above sea level and 1% for each 10° F (5.6°C) above 77°F (25°C). Generators located in these conditions must have their transfer switch programmed appropriately for this power decrease.

Oil Recommendations

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



The oil must meet GM specification 9986231. Motor oils meeting this spec receive the API (American Petroleum Institute) starburst symbol:



ILSAC GF-4 oils are highly recommended. Oils meeting the SL-4 spec are improved over the previous generation GF-3 oils in many ways

- Reduced Phosphorous levels (20%) for reduced catalyst poisoning
- Improved oxidation resistance (4X oxidation inhibitor treat level = 100% improvement)
- Improved hi temp deposit control (1.5X detergents = 25% improvement)

It is noted that the GF-4 oils are also “backward compatible” and are equal or better than previous grades of oil in all aspects.

OEM’s may opt for higher viscosity oils based on their application experience however GF-4 oils may not be available in these viscosity ranges. In this case it is recommended the OEM utilize high quality oil (API rating SM).

NOTICE Do not to operate engine with an oil level below the normal operating range. Severe engine damage could occur.

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.

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Maintenance Chart

This maintenance schedule represents the manufacturer's recommended maintenance intervals to maintain proper engine/equipment function.

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

Maintenance	Interval Hours									
	Prior to each use	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 oil filter	Every 100 hours or Annually									
Check fuel system for leaks	Before and after any service or maintenance activity									
Inspect accessory drive belts		X		X		X		X		X
Inspect electrical system wiring				X				X		
Inspect all vacuum lines and fitting				X				X		
Engine Coolant Section										
Clean debris from radiator core	Every 100 hours or 60 days of operation									
Change coolant - Ethylene Glycol 50-50 mixture w/ distilled water		X		X		X		X		X
Inspect coolant hoses		X				X				X
Replace coolant hoses and accessory drive belt	Every 2,000 Hours or two years, whichever occurs first									
Engine Ignition System										
Inspect battery case for leaks/damage		X		X		X		X		X
Inspect battery cables		X		X		X		X		X
Inspect all electrical connector retainer locks		X		X		X		X		X
Replace spark plugs			X			X			X	
Inspect crank sensor timing wheel	Every 100 hours or annually									
Replace distributor cap and rotor				X				X		
Clean secondary ignition coil tower		X		X		X		X		X
Check spark plug wires				X						
Replace spark plug wires								X		
Fuel System Maintenance										
Inspect air cleaner	Every 200 hours (or every 100 hours in severe environments) and Annually									
Check fuel shut-off valve function				X				X		
Replace inline LPG filter		X		X		X		X		X
Check LPG shut-off solenoid valve function				X				X		
Check air induction system				X				X		
Check intake manifold					X					X
Engine Exhaust System										
Inspect exhaust manifold and piping				X				X		
Check oxygen sensor connector				X				X		

Checking Engine Oil Level

NOTICE: It is important to be careful when checking engine oil level. Oil must be maintained between the “ADD” 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 “ADD” and “FULL” marks.
5. If the oil level is below the “ADD” mark, reinstall the dipstick and proceed to step 7.
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 (Figure 1). Reinstall the oil filler cap to the valve rocker arm cover and wipe any excess oil clean.

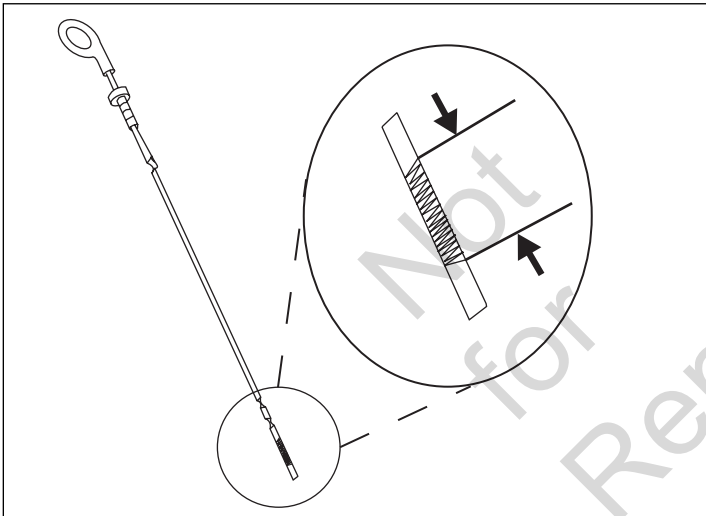


Figure 1

Changing Engine Oil



KEEP OUT OF REACH OF CHILDREN. DON'T POLLUTE. CONSERVE RESOURCES. RETURN USED OIL TO COLLECTION CENTERS.

Change oil while the engine is still warm from running. When changing the oil, always change the oil filter.

1. Place oil drain hose (A, Figure 2) into an approved container.
2. Open valve (B) located at bottom of oil pan.

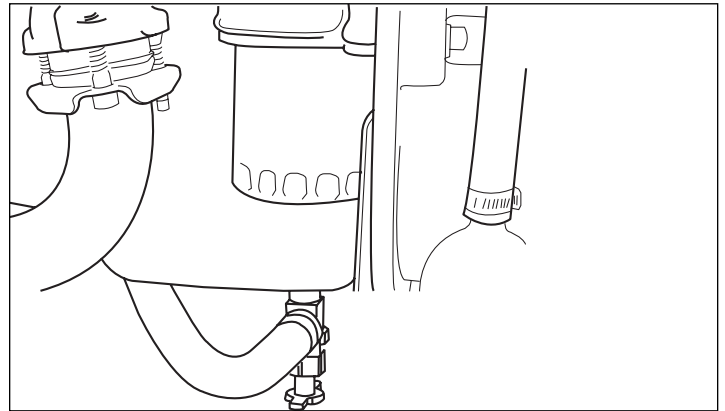


Figure 2

3. When oil has drained, close valve.
4. 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 Oil Filter

1. Remove drain plug and allow the oil to drain.
2. Remove and discard oil filter and its sealing ring.
3. 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. Hand tighten 1/2 turn after gasket contacts the mounting surface.
4. 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 reinstall plug into the pan.

Engine Air Cleaner

Once each year service the air cleaner, as follows. If operating in a dusty environment, service more often.

1. Set control board system switch to **OFF**.
2. Remove 15 Amp fuse from control panel.
3. Remove filter cartridge. Remove the service cover by disengaging three clips and detaching cover, starting with the bottom two clips and the top clip last. Gently move the end of the filter back and forth, then rotate while pulling straight out.
4. Clean outlet tube and check Vacuator™ valve - Use a clean cloth to wipe the filter sealing surface and the outlet tube surfaces. Make sure that all contaminant is removed before the new filter is inserted. Be careful to not damage the sealing area on the tube.

Visually check and physically squeeze Vacuator valve attached to service cover to make sure it is flexible and not inverted, damaged or plugged.



5. Clean filter - Use a soft bristle brush to loosen dirt and a vacuum cleaner to remove dirt and debris. Low pressure air (not to exceed 25 psi) may also be used to blow away dirt. Replace filter cartridge if any holes are detected in filter media.
6. Install clean filter properly - Insert the filter carefully. Seat the filter by hand, making certain it is completely into the air cleaner housing before securing the cover in place. To complete a tight seal, apply pressure by hand at the outer rim of the filter, not the flexible center. (Avoid pushing on the center of the urethane end cap.) No cover pressure is required to hold the seal.

NEVER use the service cover to push the filter into place! Using the cover to push the filter in could cause damage to the housing, cover, or fasteners and will void the warranty. If the service cover hits the filter before it is fully in place, remove the cover and push the filter (by hand) further into the air cleaner and try again. The cover should go on with no extra force.

7. Reinstall service cover - Once the filter is in place, reinstall the service cover, positioning the cover with the arrow and the word TOP to the top. Fasten the top clip first, the bottom two clips last. Make sure that all mounting bands, clamps, bolts, and connections in the entire air cleaner system are tight and verify absence of holes in piping - repair if needed.

Generator Electrical System Maintenance

The generator'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 located in the Maintenance section of this manual.

When inspecting the electrical system, check the following:

- Check positive (+) and negative (-) battery cables for corrosion, rubbing, chafing, burning, and ensure tight connections at both ends.
- Check battery for cracks or damage to the case. Replace as necessary.
- Inspect engine wire harness for rubbing, chafing, pinching, burning, and cracks or breaks in the wiring.
- Verify that the engine harness connectors are correctly locked in.
- Inspect ignition coil wire for hardening, cracking, chafing, burning, separation, and split boot covers.
- Inspect spark plug wires for hardening, cracking, chafing, 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.

Engine Coolant System

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



WARNING Hot pressurized coolant could cause serious injury and/or property damage.

- DO NOT open radiator cap when hot.
- Before servicing, allow coolant to cool.

NOTICE: Alcohol or methanol based anti-freeze or plain water are not recommended for use in the cooling system at any time.

The cooling system must be maintained according to the recommended maintenance schedule and inspection should 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.
- Inspect the radiator cap to ensure proper sealing.

Coolant

With the engine cold, check the coolant level in the coolant recovery bottle (see *Controls*). Specifications for the coolant system can be found in the *Maintenance* chart of this manual.

Engine V-Belts

The engine installed in this equipment uses drive belt(s) that drive the water pump and alternator. The drive belt(s) are an integral part of the cooling and charging system and should be inspected according to the maintenance schedule. 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.

Fuel System Inspection and Maintenance

Natural Gas/Propane Fuel System

The fuel system installed on this industrial engine has been designed to various standards to ensure performance and reliability. To ensure compliance to these standards, follow the recommended maintenance schedule contained in this section.

Pressure Regulator Maintenance and Inspection

NOTICE: The pressure regulator components have been specifically designed and calibrated to meet the fuel system requirements of the engine.

If the regulator 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 to ensure the regulator is securely mounted and the mounting bolts are tight.
- Check the regulator for external damage.

Venturi/Throttle Control Device Maintenance and Inspection

NOTICE: The venturi and throttle body components have been specifically designed and calibrated to meet the fuel system requirements of the engine.

When inspecting the venturi and throttle body, check for the following items:

NOTICE: A dirty air cleaner may significantly alter the venturi performance.

- Leaks at all fittings.
- Ensure the venturi and throttle body are securely mounted.
- Inspect air cleaner element according to the recommended maintenance schedule found in this section.
- Inspect air inlet hose connection and clamp. Inspect hose for cracking, splitting, or chaffing. Replace if any of these conditions exist.
- Check fuel lines for cracking, splitting, or chaffing. Replace if any of these conditions exist.
- Check for leaks at the throttle body and intake manifold.

Exhaust System Maintenance and Inspection

When inspecting the exhaust system, check the following:

- Inspect exhaust manifold at the cylinder head for leaks and that all retaining bolts and shields (if used) are in place.
- Inspect manifold to exhaust pipe fasteners to ensure they are tight and that there are not exhaust leaks. Repair as necessary.
- Inspect the oxygen sensor electrical connector to ensure connector is seated and locked, check wires to ensure there is no cracking, splitting, chaffing, or burning. Replace or replace if necessary.
- Inspect exhaust pipe connection for leaks. Repair if necessary.

Engine Exterior

Periodically inspect the engine exterior for contamination and potential damage from dirt, leaves, rodents, spider webs, insects, etc. and remove.

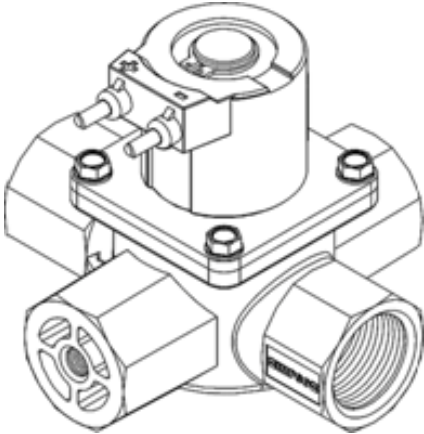
Not
for
Reproduction

Natural Gas/Propane Fuel System

Fuel System Components

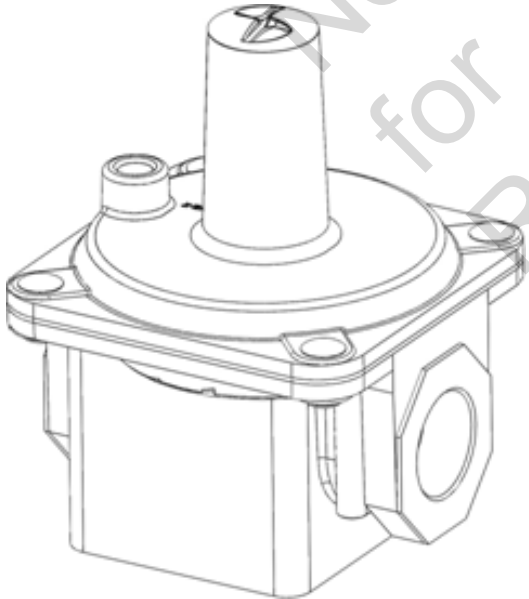
Fuel Shut-off Valve

Two low pressure shutoff valves are used, each with an integrated assembly consisting of a 12 volt solenoid and a normally closed valve. When energized, the solenoid opens the valve and allows the gas fuel to flow through the valve. The valve opens during cranking and engine run cycles. Voltage to the shutoff valves is controlled by the engine control module (ECM).



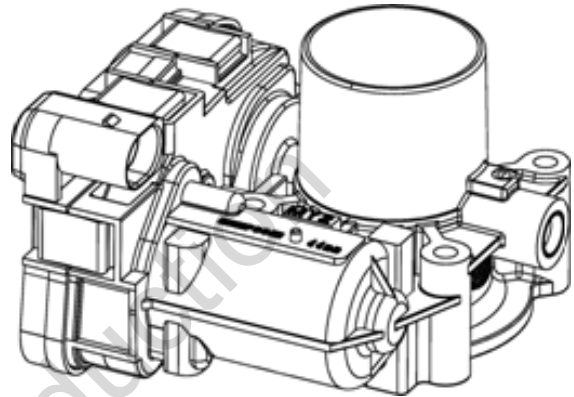
Fuel Pressure Regulator

The fuel pressure regulator regulates pressure of fuel vapor to the venturi.



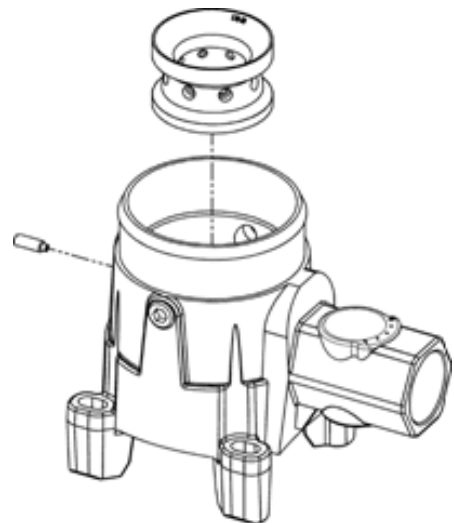
Throttle Body

Engine speed control is maintained by the ECM. Defaults programmed into the ECM software and throttle position sensors allow the ECM to maintain safe operating control over the engine while maintaining speed and load control. In a drive by wire application, the electronic throttle control device or throttle body assembly is mounted to the engine. The electronic throttle control device utilizes an electric motor connected to the throttle blade. 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 supply to the engine. The electronic throttle control device incorporates an internal Throttle Position Sensor (TPS) which provides 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.



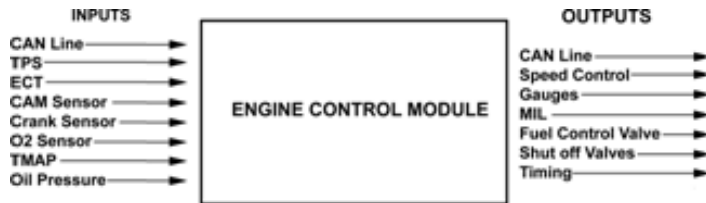
Venturi

The venturi rests on top of the throttle body and mixes the air and fuel. Air passing through the throat of the venturi creates a low pressure (vacuum), drawing fuel through holes in the venturi and into the throat of the venturi adapter. The amount of fuel delivered to the venturi is monitored by the ECM and can be modified by signals to the fuel control valve. A power valve is used to adjust high speed mixture and is preset and not adjustable in the field.



Engine Control Module

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



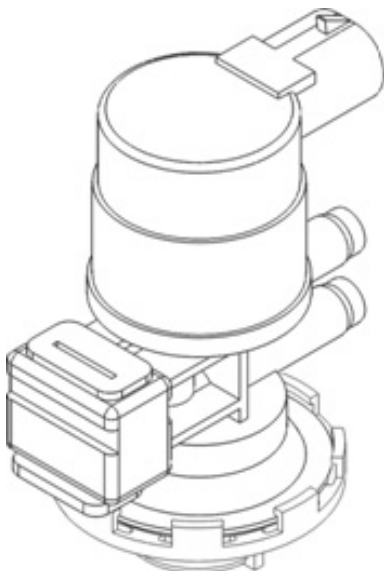
Engine Control Module (ECM) Inputs & Out-puts

A 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 ECM. The ECM then signals the fuel control valve to modify the vacuum signal to the regulator, changing the amount of fuel delivered to the venturi.

The controller also performs diagnostic functions on the fuel system and notifies the operator of engine malfunctions by illuminating a Malfunction Indicator Light (MIL). Malfunctions in the system are identified by one or more Diagnostic Trouble Code (DTC) number(s) and stored in its memory. A technician can then utilize a computerized diagnostic scan tool to retrieve the stored diagnostic code and use the diagnostic charts in this manual to determine the cause of the malfunction.

Fuel Control Valve

The Fuel Control Valve is an ECM controlled vacuum switch that meters manifold vacuum delivered to the atmospheric pressure reference of the regulator. Based on the fuel requirements of the engine, the ECM signals the valve to open or close, altering the fuel pressure delivered from the regulator to the venturi.



Heated Exhaust Gas Oxygen Sensor

The Heated Exhaust Gas Oxygen (HEGO) Sensor is mounted in the exhaust system and is used to measure the amount of oxygen present in the exhaust stream to determine whether the fuel air ratio is too rich or too 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.

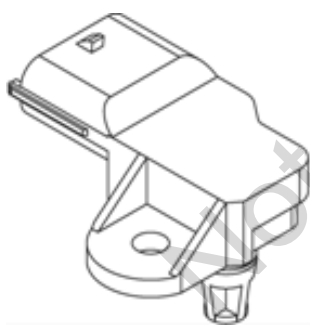


NOTICE: Contamination of the HEGO sensor can result from the use of an inappropriate RTV sealer or silicone spray products. Do not use silicone sprays or hoses which are assembled using silicone lubricants. Always use "oxygen sensor safe" RTV sealant for repair procedures. Silicon contamination will 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 performance 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.

TMAP Sensor

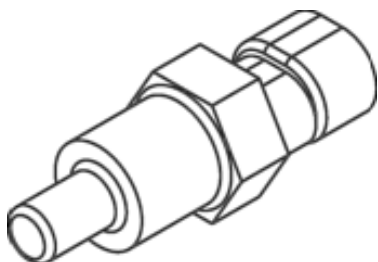
The air temperature/manifold absolute pressure or TMAP sensor is a combination of two sensors:

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 manifold air temperature (MAT 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.



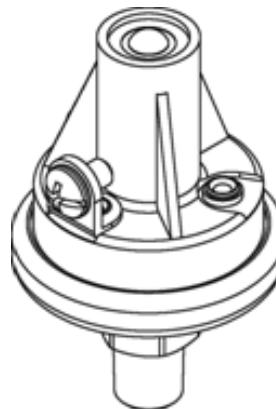
Coolant Temperature Sensor

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 resistance 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.



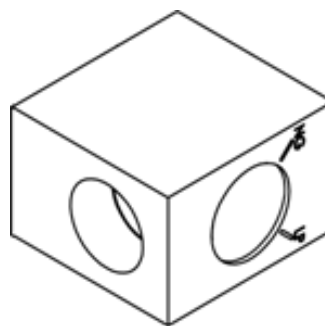
Oil Pressure Sender

The engine oil pressure sender is designed to ensure adequate lubrication throughout the engine. It provides a pressure value and is monitored by the ECM. If the pressure drops, a MIL will occur.



Fuel Selector Switch

A fuel selector switch is necessary to properly adjust the vapor fuel flow and compensate for the differences between Natural Gas and LPG vapor. It has two settings: NG for Natural Gas and LP for LPG. The switch is calibrated at the factory for NG operation. Using a 6mm Allen wrench, turn the selector switch to either LP or NG.



DIAGNOSTIC SCAN TOOL (DST)

The Spectrum IV DST is the next generation all CAN (Controller Area Network) enabled diagnostic tool (Part Number 19616) is available from your Briggs and Stratton source of supply. The tool kit includes the Can Bus wire harness adapter and the CAN USB dongle. It is designed to be compatible for all 2010 Spectrum fuel systems that use both the MEFI (industrial) and S3000 (mobile) ECM applications.

Always check first to be sure the ECM has been programmed with the latest calibration before attempting any diagnostic or service repair procedure. The files and password are available on *The Power Portal*.

The functions are listed below:

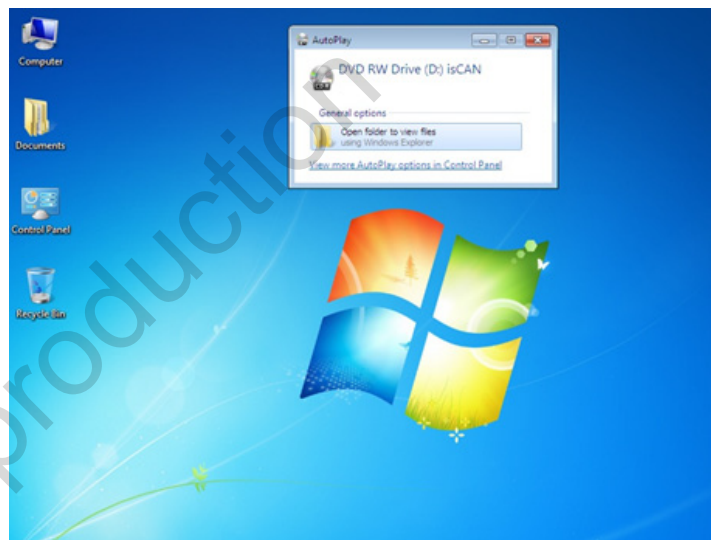
- Updating the ECM calibration using the .s37 calibration file.
- Provide graphical display interface for engine and sensors parameters
- Display DTC (Diagnostic Trouble Codes)
- Provide data stream information from engine sensors and actuators
- Plot data.
- Record Data

Ifak Driver and Utility Installation:

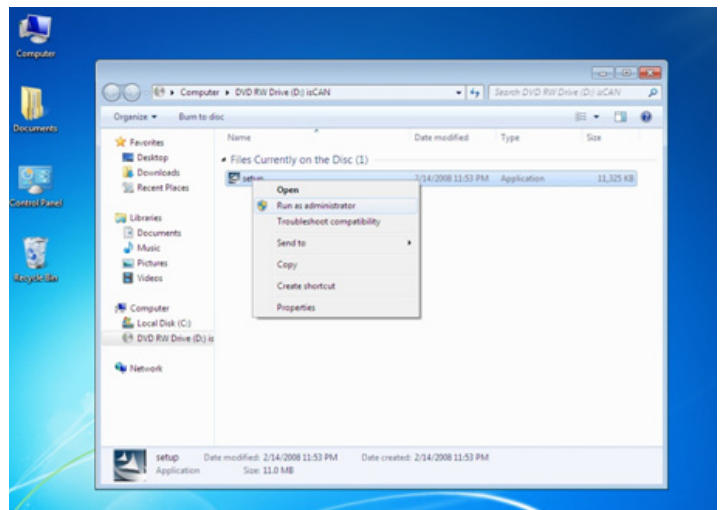
NOTICE: Close any open applications prior to installing the DST.

Examples and snapshots used in this manual are based off of the initial DST tool release as of August, 2010 using the Windows 7 operating system. This tool is used for multiple fuel systems and is frequently updated. Snapshot illustrations may vary depending on the installed operating system and changes included in any updated DST display Interface. This software has the ability to automatically detect functions that may or may not be used in any one particular fuel system. In this instance unused or irrelevant values and graphic displays will be shaded in gray on the DST display screens. Terms, names and descriptions of systems and other servicing procedures may be updated periodically with new DST installation software.

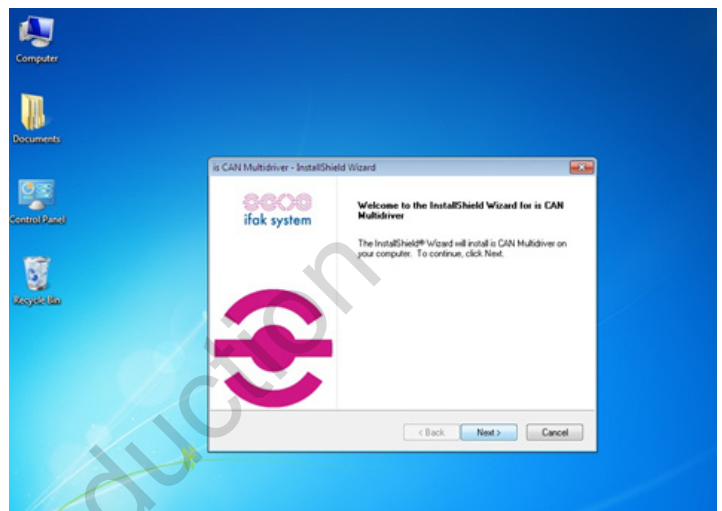
1. Insert the Ifak CD included with your USB to CAN adapter and open the file folder.



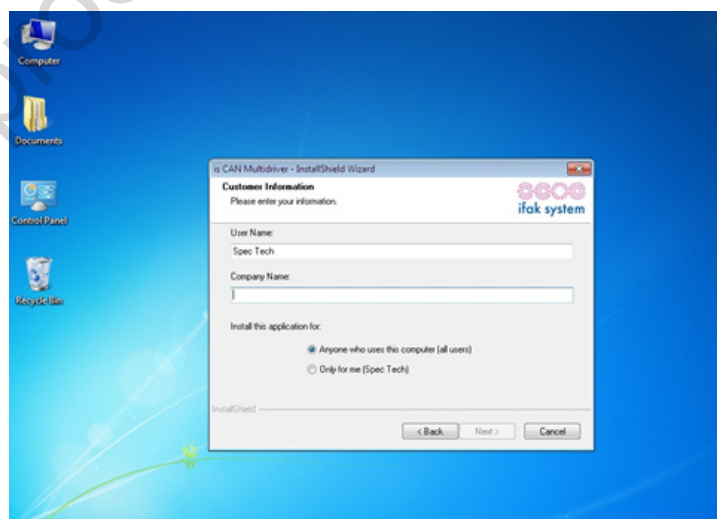
2. For users with restricted rights using Windows 7 or Windows Vista, select **RUN** as administrator. For all others, select the **SETUP** file. You may receive a Windows message asking you to confirm the installation request by an unknown publisher. You must select **YES** to continue the installation.



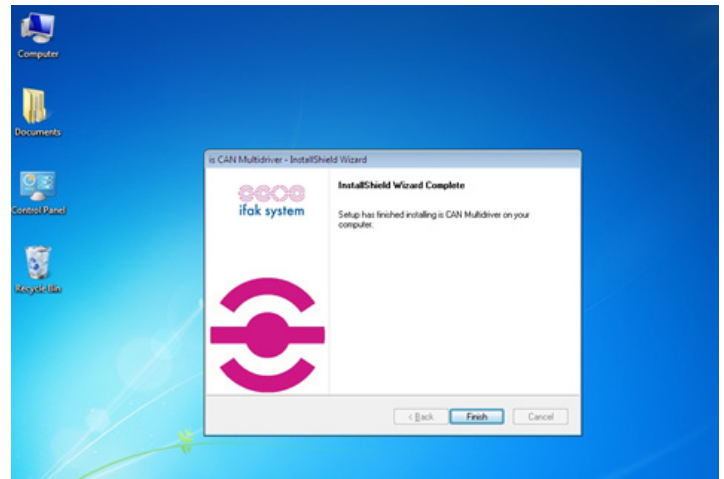
3. Select the **NEXT** box to continue with the installation.



4. Enter your company name or organization and click the **NEXT** box. Follow the next steps using the recommended defaults.



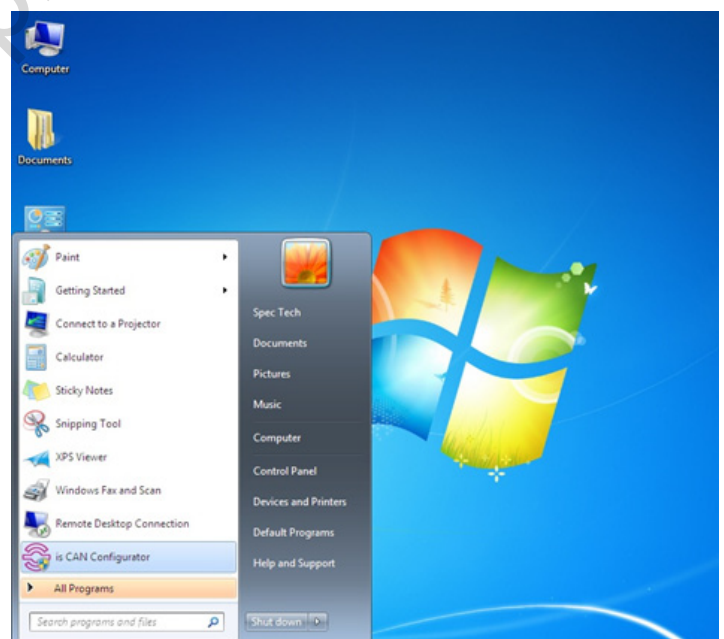
5. Click the **FINISH** box to complete the installation. It is now recommended that you reboot your computer.



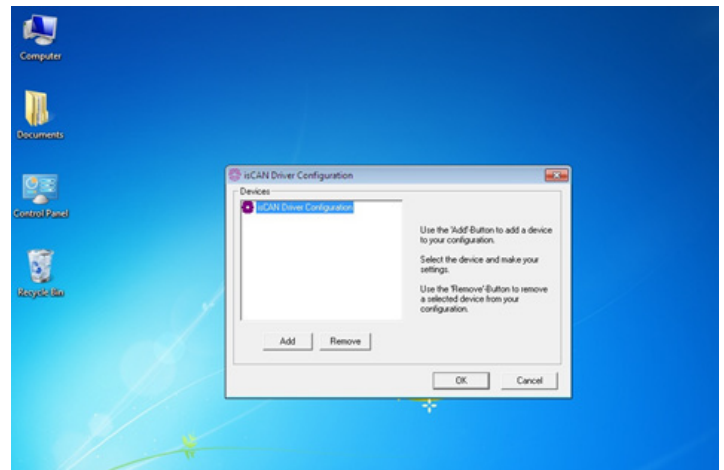
6. Connect the Ifak adapter to an available USB port. You may see a message confirming you wish to make changes to the computer from an unknown publisher. If so, you must select the **YES** box to continue the installation. Windows will now install the Ifak driver to your computer. You should see a message confirming the driver was successfully installed as shown above.



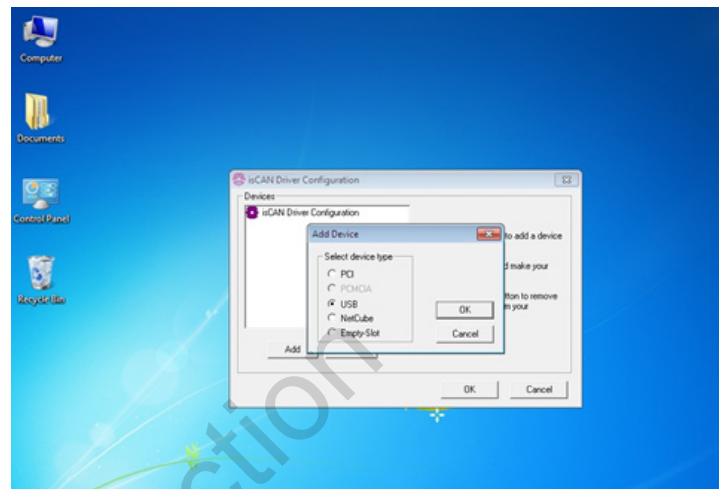
7. Open the **START** menu. You should see the is CAN Configuration utility confirming the utility installation. Select the **CAN CONFIGURATOR**.



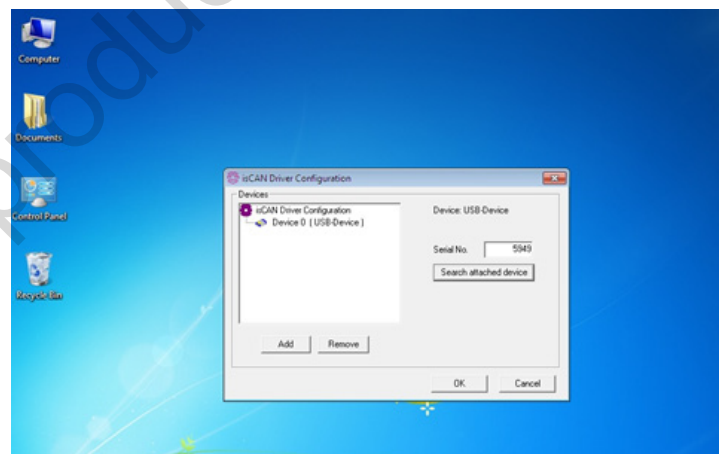
8. Click the **ADD** box.



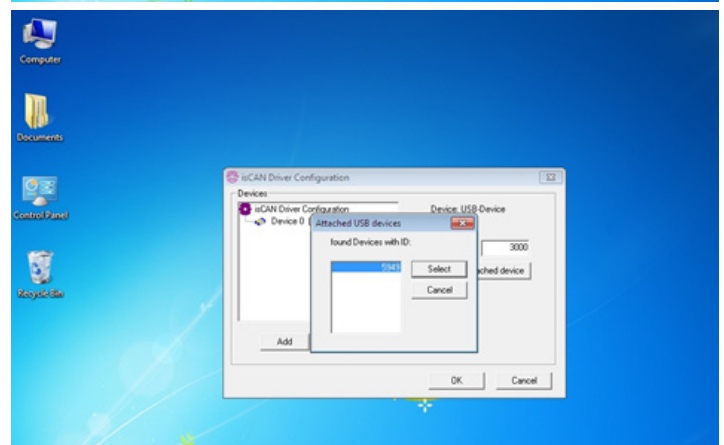
9. Select the **USB BUTTON**, then click the **OK** box.



10. Click on the **SEARCH ATTACHED DEVICE BOX**.



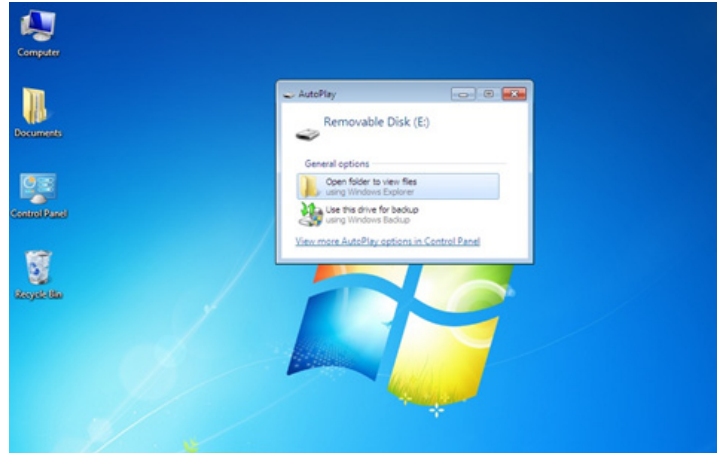
11. When the Ifak device serial number is shown, click the **SELECT** box, then click the **OK** box. The Ifak driver and utility installation is now complete. If you had problems during this installation please see the additional information and test instructions for your Ifak adapter included with your service test kit.



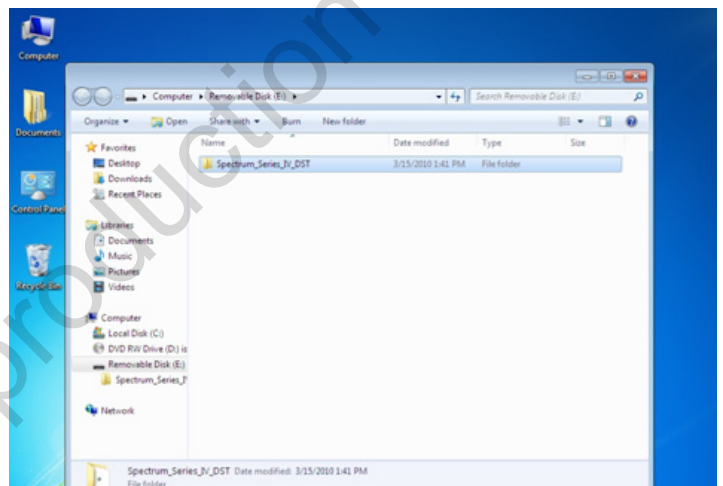
Spectrum Series IV DST Software Installation:

The DST Software installation files are available on *The Power Portal*. Always check first to be sure the ECM has been programmed with the latest calibration before attempting any diagnostic or service repair procedure. Calibration files are supplied in the .s37 file format.

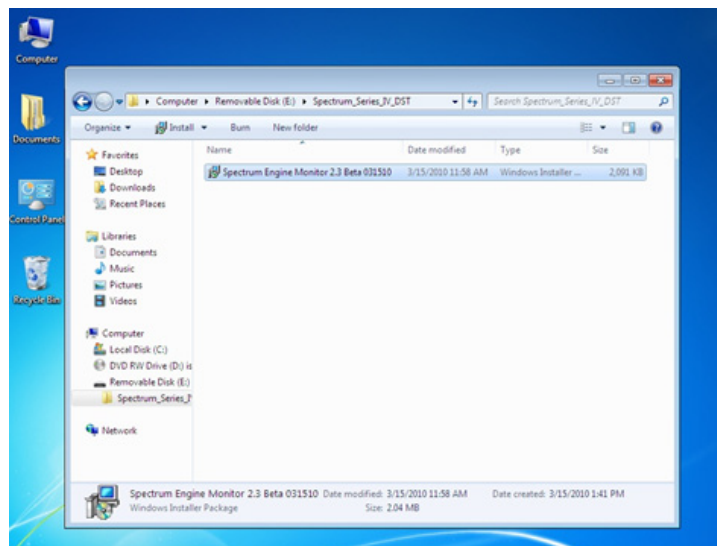
1. Insert the CD, USB flash drive, other storage media or find the location where the DST software has been saved on your computer.



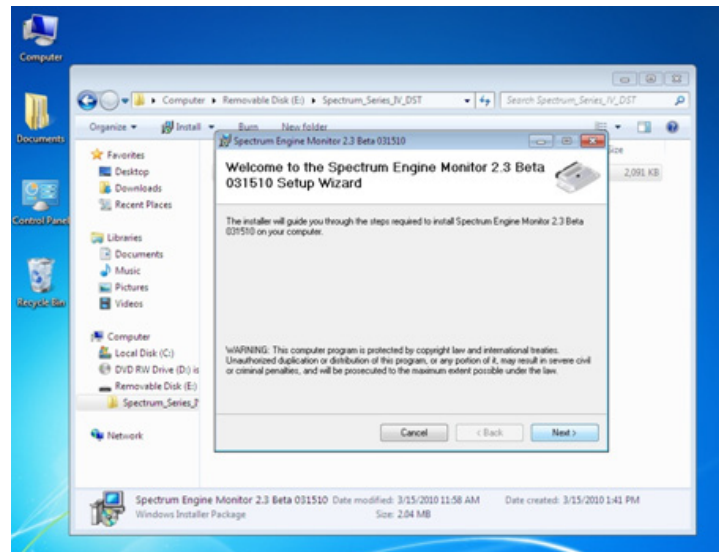
2. Open the **Spectrum_Series_IV_DST** file folder.



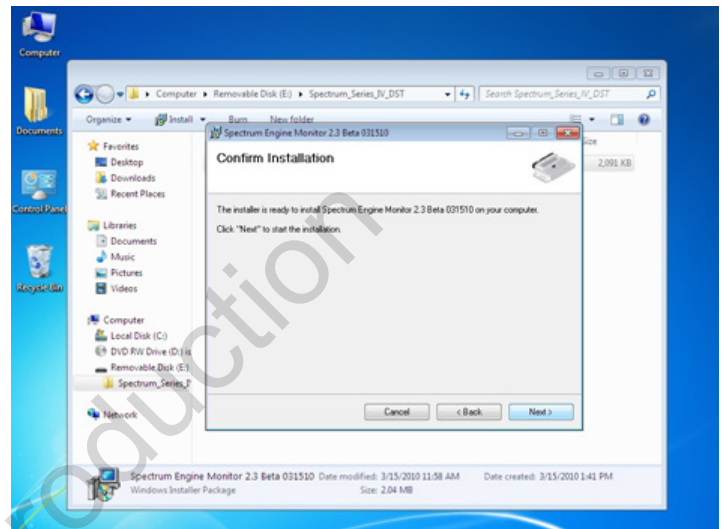
3. For users with restricted rights using Windows 7 or Windows Vista, it may be necessary to select the **RUN AS ADMINISTRATOR** box similar to the Ifak USB driver installation. For all others, click the **Spectrum Engine Monitor.msi** file. You may receive a Windows message asking you to confirm the installation request by an unknown publisher. If so, you must select the **YES** box to continue the installation.



4. Click the **NEXT** box.



5. Follow the on screen prompts that will guide you through the installation.

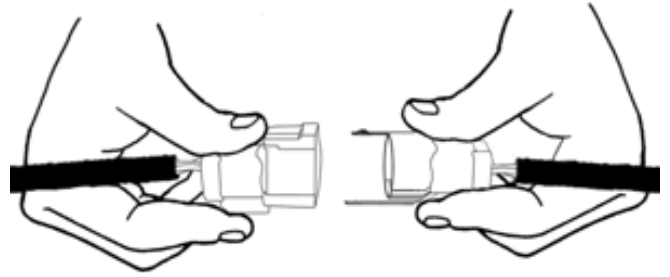


6. The *Spectrum 4* logo shortcut is placed on the desktop confirming the installation is complete. It is now recommended that you reboot your computer.



Connecting the DST:

1. Connect the Diagnostic Link Connector or DLC (orange cable) to the Ifak adapter's DB-9 pin connector. Connect the other end of the DLC connector to the engine harness (3 pin connector).



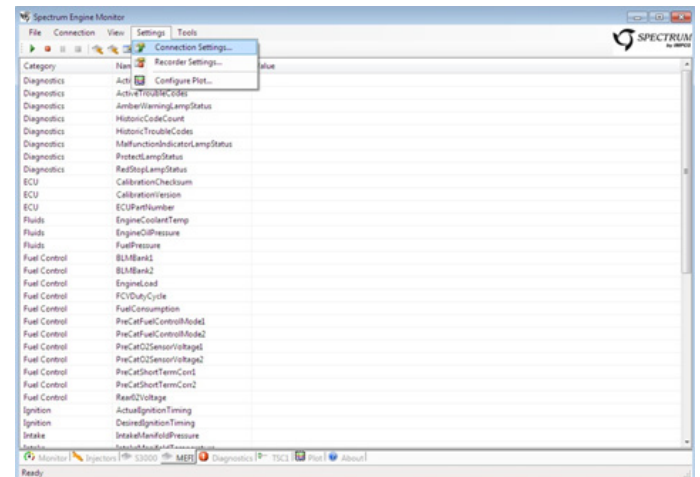
2. Click on the **Spectrum 4** shortcut to open the DST software program. Turn the engine ignition power **ON**.



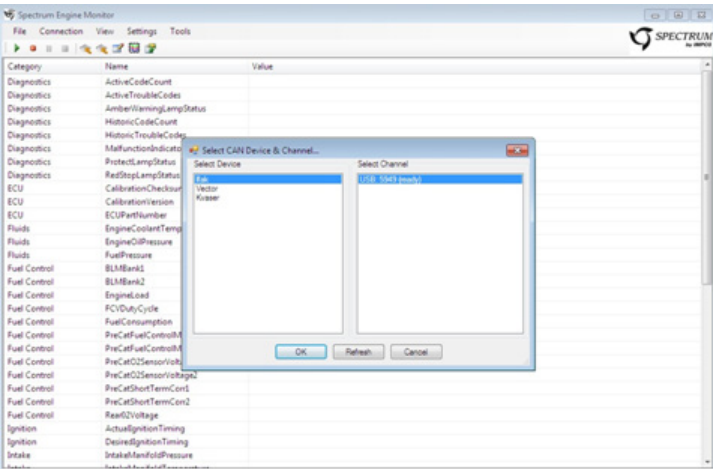
3. Click on the **MEFI TAB** at the lower left of the Spectrum Engine Monitor page.



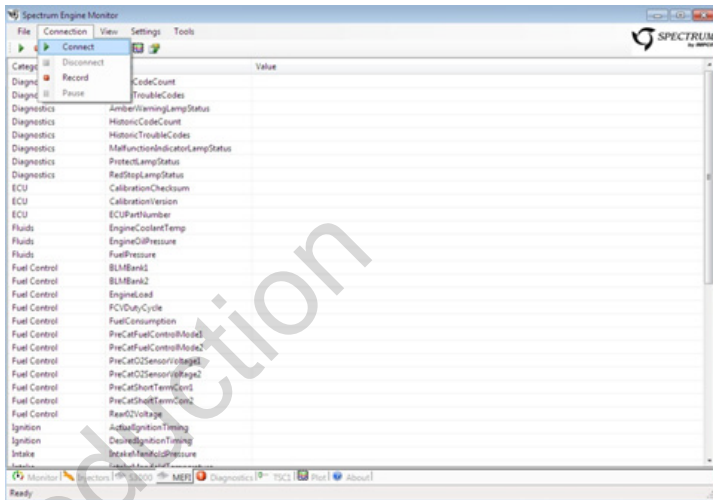
4. On the MEFI data stream page, pull down the Settings menu and click on **CONNECTION SETTINGS**.



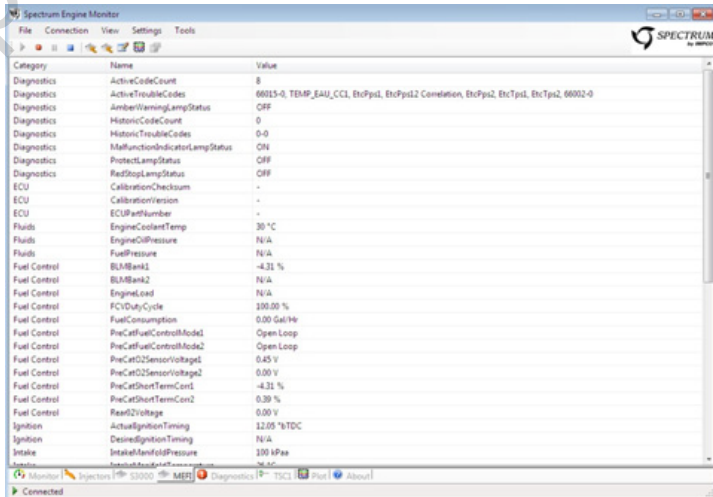
- The Select CAN Device & Channel dialog box will appear. Select the **IFAK DEVICE**, and then click the **OK** box.



- Under the Connection drop down menu, select **CONNECT**.



- When connected, the live data stream appears in the Value column.

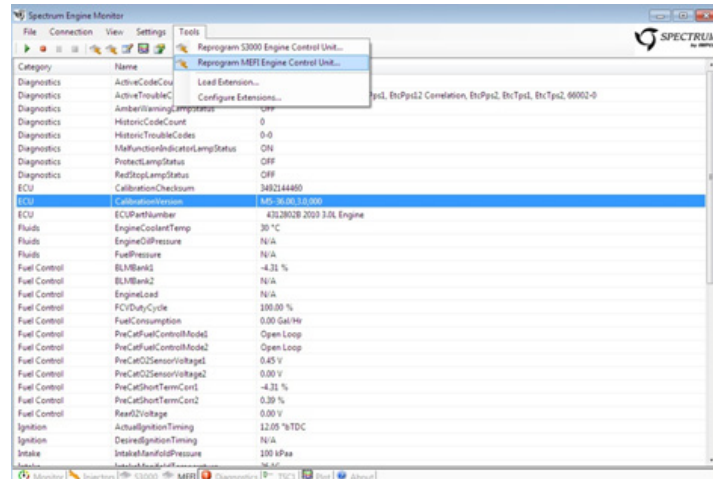


Updating the ECM Calibration

In-field updates (or reflashing) are possible with the MEFI ECM using the DST. Always check first to be sure the ECM has been programmed with the latest calibration before attempting any diagnostic or service repair procedure. Calibration files are supplied in the .s37 file format. These files will be supplied to you on *The Power Portal* along with a password unique to that particular s.37 file. You will need the password to complete the reprogramming procedure. Before reprogramming the ECM, shut down any other programs running on your PC including wireless and e-mail programs. The PC must be dedicated to the reprogramming process at this time. Be sure your PC battery is adequately charged. **Failure to follow these instructions may render the ECM not usable in the field.**

NOTICE Any interruption during the reprogramming process may render the ECM unusable in the field.

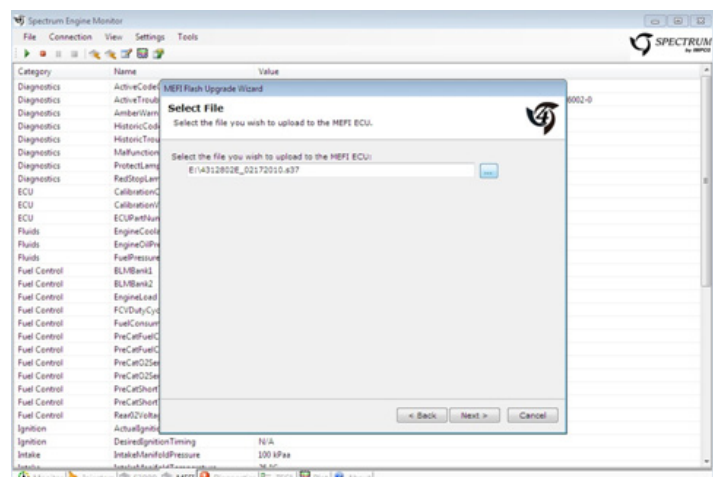
1. Under the Tools drop down menu, select **REPROGRAM MEFI ENGINE CONTROL UNIT**. Turn ignition power ON.



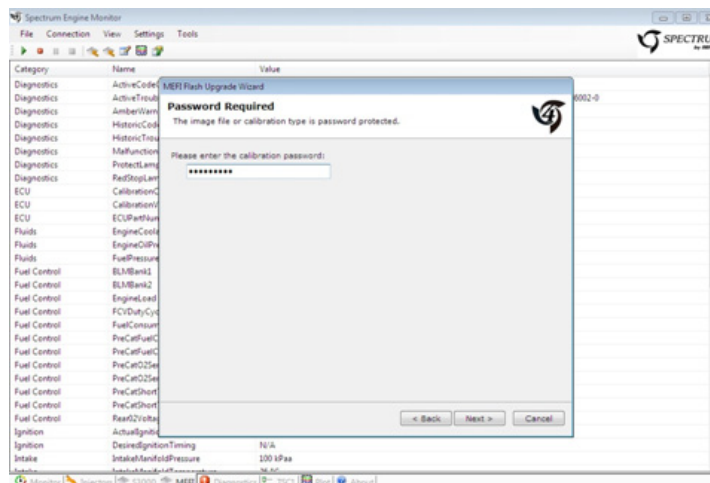
2. The MEFI Flash Upgrade Wizard dialog box will appear. Select the **NEXT** box.



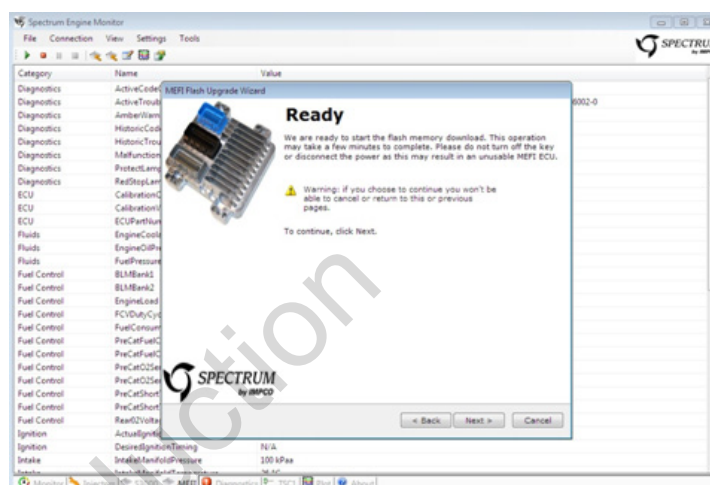
3. Use the Browse box to navigate to the location of the .s37 calibration file.



4. Enter the password that was supplied with the .s37 calibration file.

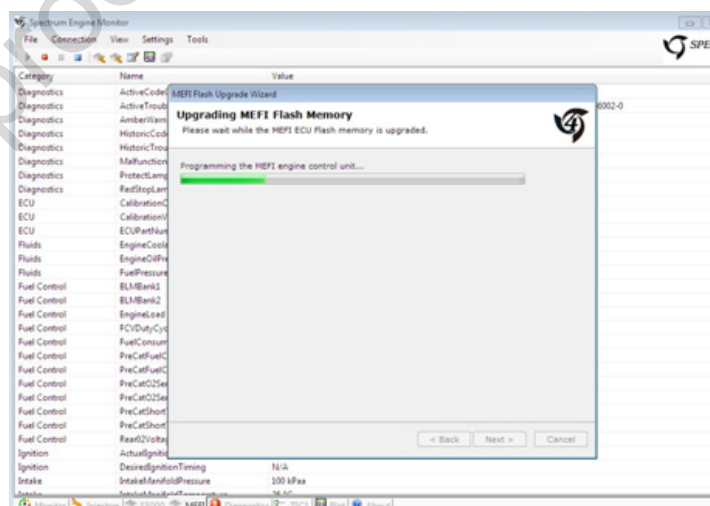


5. Select the **NEXT** box.

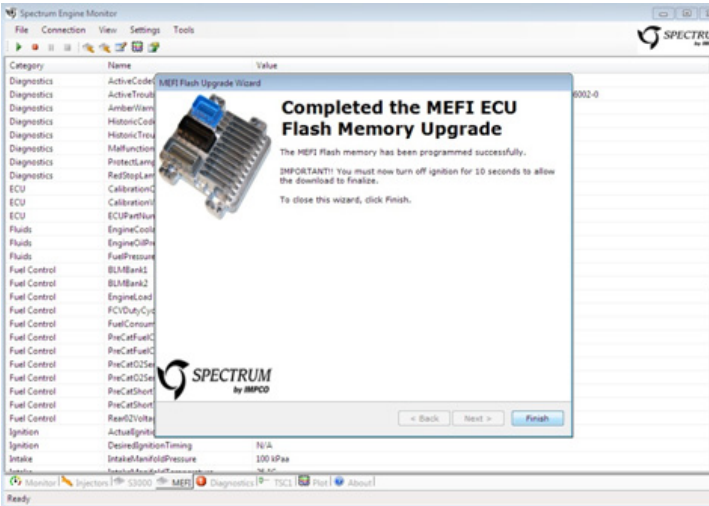


6. The progress bar shows the status updating. Please wait until you receive a message confirming the update is complete.

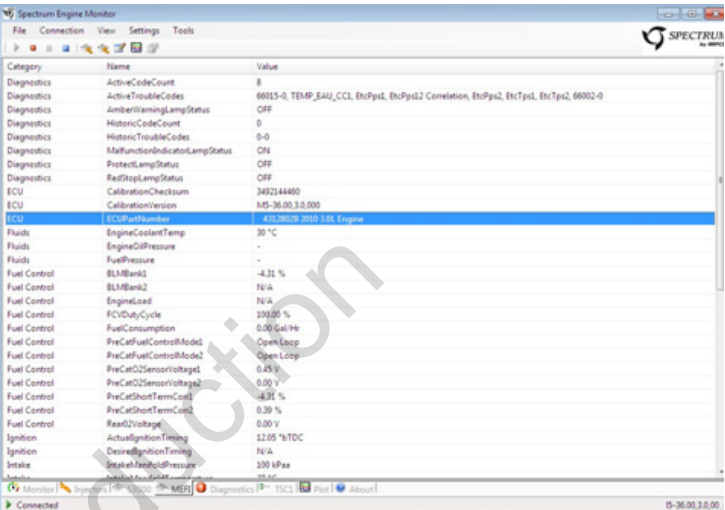
NOTICE Any interruption during the reprogramming process may render the ECM unusable in the field.



7. Turn the ignition power OFF. Wait 10 seconds and select **FINISH**.

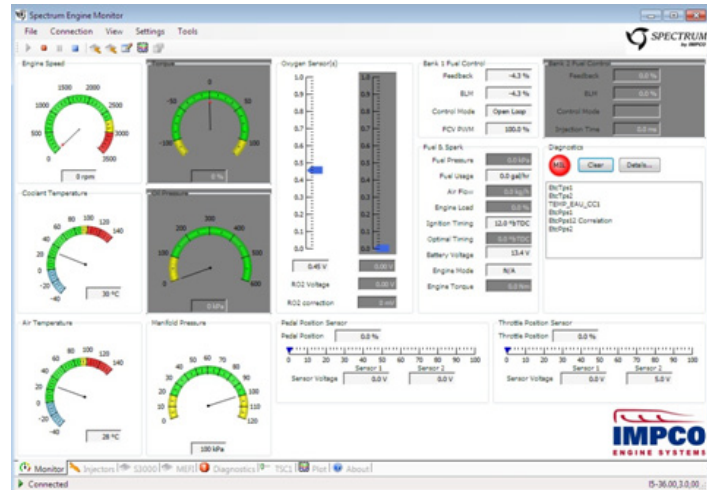


8. Turn the ignition **ON**. Verify the calibration updated with the new .s37 file number in the ECU Part Number data stream shown above. The reprogramming process is now complete.



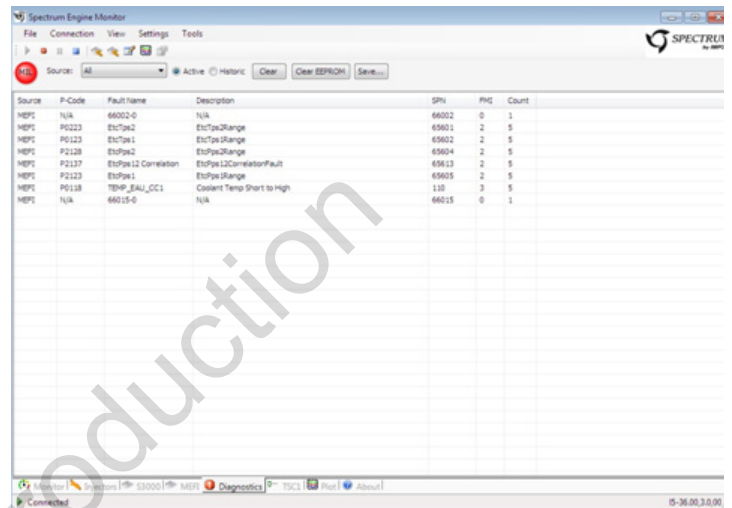
Graphic Display Interface

Shown as the monitor page in the DST, the page shown at the right is the default entry page that opens with the DST program. It provides a graphical interface for important engine parameters. Graphics shown in gray are not available for the specific application the DST may be connected to as shown above. This function is controlled by the ECM calibration file and cannot be changed by the service technician.



Display DTC (Diagnostic Trouble Codes)

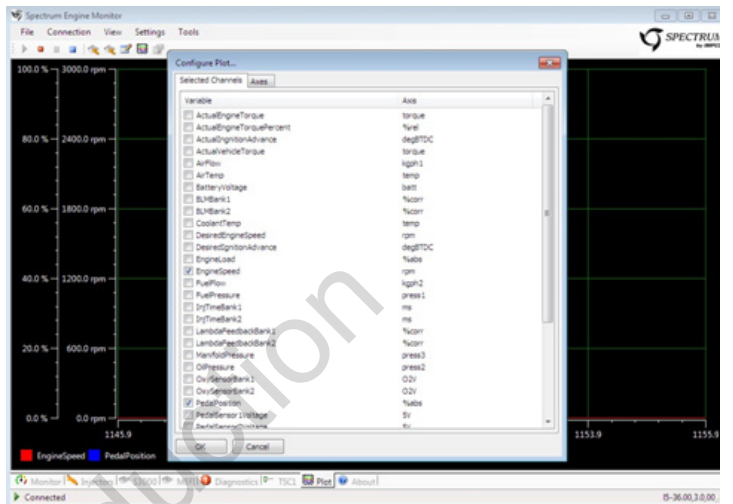
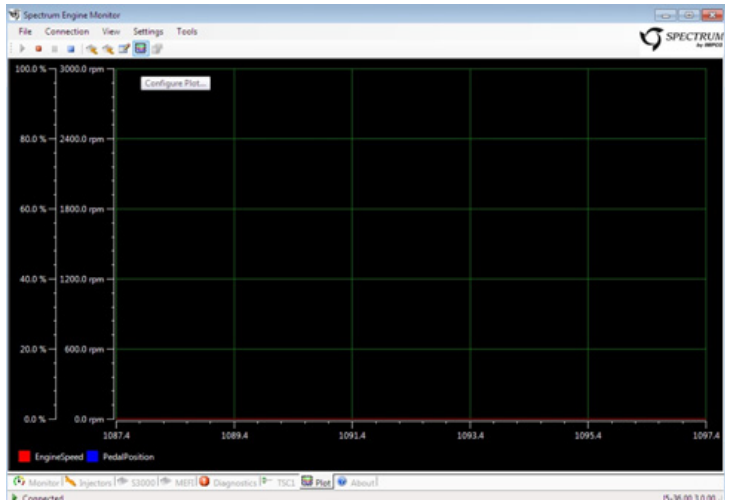
DTC codes can be read by clicking on the Diagnostics tab at the bottom of the monitor page. The source of the DTC stream can be set manually for the MEFI ECM or the S3000 ECM, or left in the default All position for auto detection of the DTC codes from either MEFI or the S3000 ECM. Codes that can be viewed are set in two categories, active and historic. Active codes are codes that are set and the fault that is causing the code to set is constant. Historic codes are codes that have set in the past, but the fault that caused them has been corrected such as with an intermittent problem. This function is selectable by choosing the Active or Historic. Codes can be cleared by clicking the Clear box. The DTC set code list may also be saved by clicking the Save box shown above. The file will be saved in a convenient HTML file compatible with Windows Internet Explorer and will provide a browse function to save the file to a location of choice for the service technician.



Plot Data:

Data stream information may also be selected for a trace plot. This page is available by clicking the Plot tab.

The custom parameters of the plot can be selected by clicking on the plot icon just below the Settings menu item. To save the custom settings select **OK**.



Diagnosing Intermittent Problems

Intermittent fuel system problems can prove to be the most challenging to diagnose. It is important, when diagnosing intermittent problems, to operate the engine system while monitoring with the DST and pressure gauge set. 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 engine is operating at full load, not at low or no load because the leaning effect does not occur until full load. Electrical problems should be treated in a similar same way. One excellent tool for finding intermittent electrical problems is the DST plot function. Set up the plot for the sensor 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 may 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. The connectors are splash proof but if high pressure water or steam is sprayed directly at the connector moisture can become trapped behind the connector seal and cause serious system problems, many of them showing up as intermittents. 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 low voltage connectors and terminals. When running electrical diagnostics avoid back probing the wire connectors as this may damage the wire seal.

NOTICE: When running the continuity checks, use a wire probe to only touch the wire terminal. Forcing the electrical probe into the terminal may cause the terminal to spread leading to permanent damage.

More Intermittent diagnostic information can be found on the Fuel Symptom Diagnostics, Intermittent Diagnostic Charts.

Fuel System Checks

This system has OBD (Onboard Diagnostics) for many sensors, relays and monitors, but not all malfunctions have a DTC code available to alert the service technician to a problem. A good example of this would be the engine ignition system. If a spark plug, cap, rotor or wire fails a DTC code may not be set. The DST provides advanced diagnostic capabilities, but some items are still left to the basics of general engine mechanics. Following the recommended maintenance schedule is the best way to prevent this type of problem for which a DTC code does not exist. Many times the basics are overlooked and can be attributed to improper maintenance. Some general rules to follow are:

- Check to be sure the ECM is programmed with the latest calibration file.
- Check general engine tune up items such as spark plugs, distributor cap and rotor, spark plug wires, air, and fuel filters if equipped with such.
- Check that the charging system is working correctly.
- Check block heaters, battery heaters, battery terminals and fuel supply systems for proper operation.

Fuel Symptom Diagnosis

Fuel Pressure

The fuel system relies on fuel pressure to the engine systems low pressure regulator to deliver advertised power levels. Be sure the gas supply pressure is maintained to the fuel systems low pressure shutoff valve(s) as shown:

- Both LP vapor and natural gas fuel supply pressure at the generator's fuel inlet port should be between 7 to 11 inches (18 to 28 cm) of water (in. W.C.) at full load with all gas appliances turned on and operating. *Maximum pressure with engine OFF at No Load is 13.85 psi.*
- LPG engines and fuel systems 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.

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

Maximum Fuel System Regulator Outlet Pressure

This system uses on a near zero fuel pressure regulator to supply fuel to the intake venturi and throttle assembly.

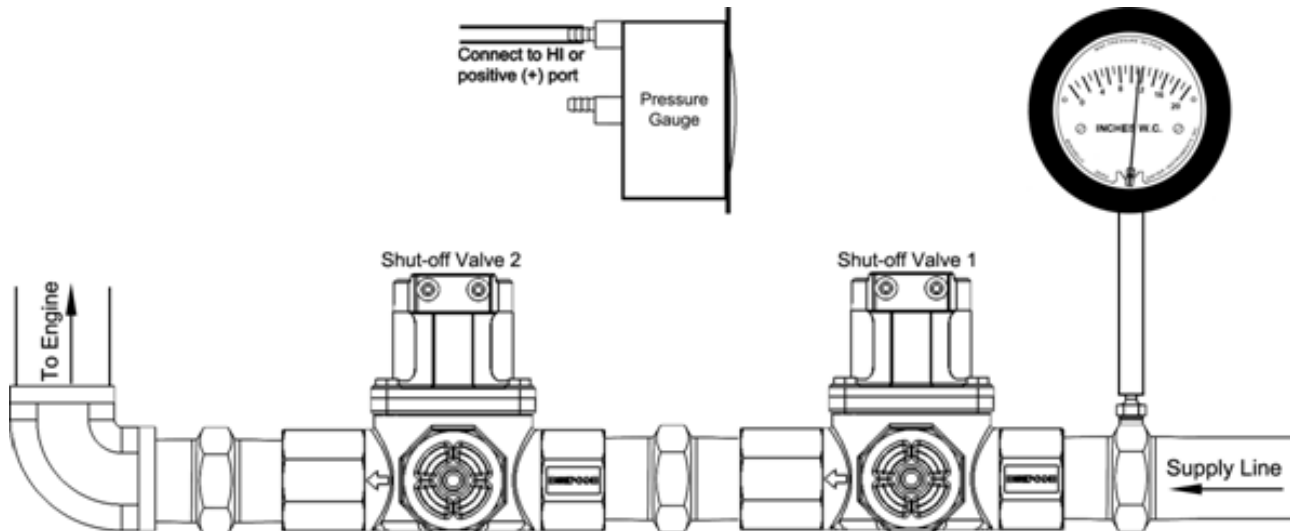
Pressure readings taken from the regulator outlet port with the engine running should show negative pressure. (Slightly positive pressures may only be observed during the engine cranking cycle to assist in cold engine starts.)

Once the engine warms and goes into closed loop fuel control the negative pressure should typically swing between -2.0" W.C. to -6.0" W.C.

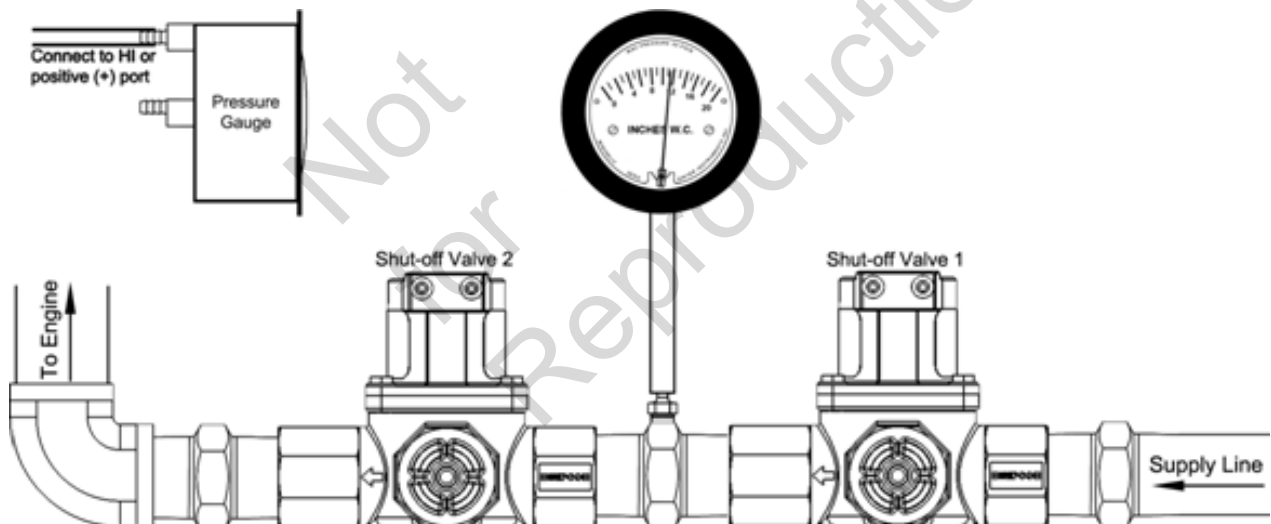
- Any negative pressure over -8.0 inches water indicates inadequate fuel supply to the venturi causing a lean condition.
- A lean condition may cause low power output, increased engine temperature, hard starting, and induction backfire.
- This could be the fault of the fuel system low pressure regulator, but is most likely due to inadequate supply pressure to the fuel system low pressure regulator.
- Inversely, a constant positive pressure would create a rich condition causing excessive fuel consumption, low power output, increased exhaust temperatures, hard starting and exhaust system backfire.

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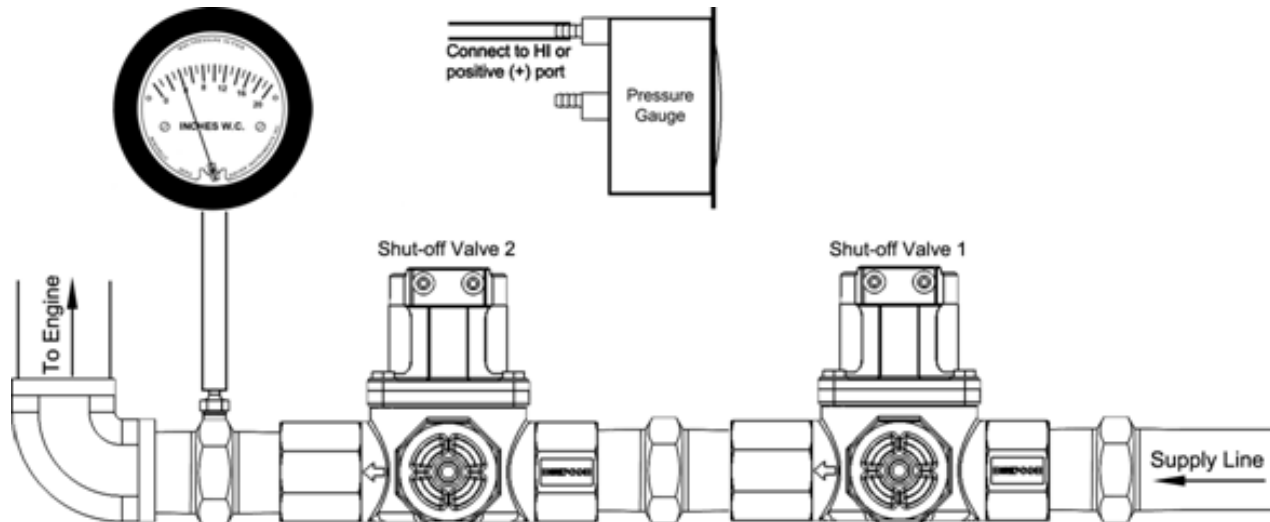
The following diagrams show how to correctly install the fuel pressure gauges to determine if such a problem may exist.



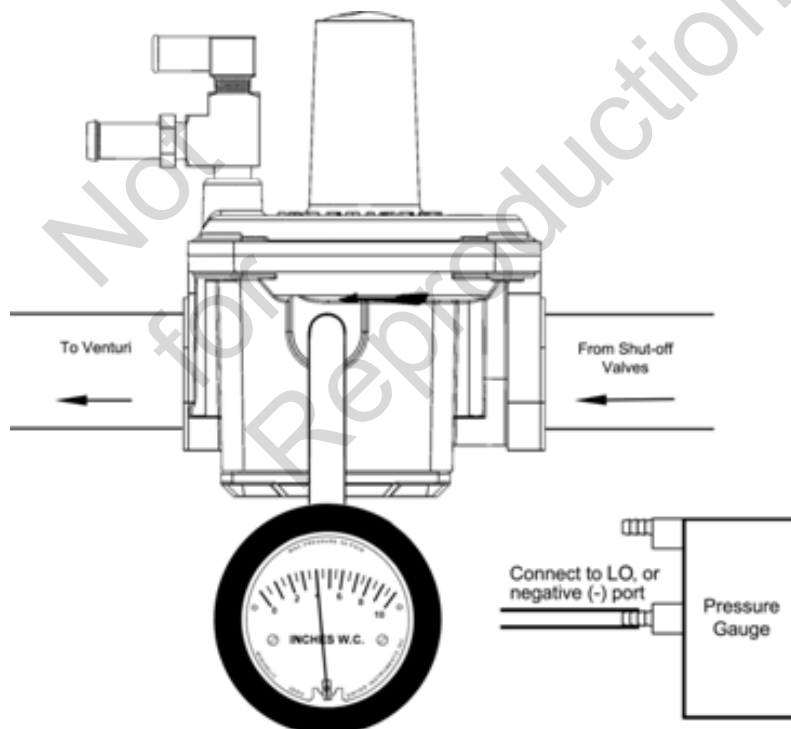
The above illustration shows the 0-20 in. (0.0 - 50 cm) W.C. gauge installed to measure the supply line fuel pressure



The above illustration shows the 0-20 in. (0.0 - 50 cm) W.C. gauge installed to measure fuel pressure after the solenoid shut-off valve number 1.



The above illustration shows the 0-20 in. (0.0- 50 cm) W.C. gauge installed to measure fuel pressure after the solenoid shut-off valve number 2.



The above illustration shows the 0-10 in. (0.0 - 25 cm) W.C. gauge installed to measure the pressure at the regulator outlet.

Fuel System Diagnostic Chart

Use this chart if you were referred to the Fuel System Diagnostics from the DTC section, or have a problem with a running engine. For no start issues use the *Symptom Diagnostic Charts* shown in the manual.

STEP	ACTION	YES	NO
1	- Turn the manual shutoff valve on the gas supply line OFF. - Install the 0 - 20 in. (0.0 - 20.0 cm) (water column gauge to the fuel pressure test port at the number one fuel solenoid inlet as shown in the <i>Fuel System Diagnostic</i> section of this manual. <i>Is the pressure gauge installed properly?</i>	Go to Step (2)	Refer to the pressure gauge illustrated diagram in the <i>Fuel System Diagnostic</i> section of this manual.
2	Install the 0 - 10 in. (0.0 - 10.0 cm) water column gauge at the fuel system low pressure regulator outlet test port as shown in the <i>Fuel System Diagnostic</i> section of this manual. <i>Is the pressure gauge installed properly?</i>	Go to Step (3)	Refer to the pressure gauge illustrated diagram in the <i>Fuel System Diagnostic</i> section of this manual.
3	- Slowly turn the manual shutoff valve ON - Check the gauge hose and adapter fittings for any gas leakage <i>Are the fittings and hoses secure and tight with no gas leakage?</i>	Go to Step (4)	Correct the leakage problem before proceeding with this diagnostic chart.
4	Observe the 0 - 20 in. (0.0 - 50 cm) water column gauge installed at the fuel shut off solenoid inlet test port. <i>Is the pressure between +6.0 - +13.85 inches (15.0 - 35 cm) water column pressure?</i>	Go to Step (5)	Correct the improper gas supply pressure. Notify the gas utility company or authorized contactor for assistance
5	- Start the engine - Run the engine to full operating temperature. If you were directed to this chart from the DTC section run the engine at the same load point where the DTC code was set, if known. Otherwise run the engine to full load. - Observe the 0 - 10 in. (0.0 - 25 cm) water column gauge. <i>Does the gauge show a pressure reading between 0 and -8.0 in. (0.0 - 20 cm) water column pressure?</i>	Go to Step (6)	Go to Step (8)
6	Observe the 0 - 20 in. (0.0 - 50 cm) water column gauge <i>Does the gauge show a pressure between +6.0 to +13.85 inches (15.0 - 35 cm) water column pressure?</i>	Go to Step (7)	Correct the improper gas supply pressure. Notify the gas utility company or authorized contactor for assistance.
7	Observe the 0 - 10 in. (0.0 - 25 cm) water column gauge <i>Does the gauge reading swing between 0 and -8.0 inches (0.0 - 20 cm) water column pressure?</i>	Fuel System OK	Go to OBD System Check

STEP	ACTION	YES	NO
8	- Turn the manual shutoff valve on the gas supply line OFF - Remove the 0 to 20 in. (0.0 - 50 cm) water column gauge from the number one fuel shutoff solenoid inlet pressure test port. - Reinstall the test port plug using the recommended Loctite® thread sealant #567 <i>Is the test port plug securely installed the pipe thread sealant?</i>	Go to Step (9)	
9	- Install the 0 to 20 in. (0.0 - 50 cm) water column gauge to the fuel pressure test port between the number one fuel solenoid outlet and the number two fuel lock solenoid inlet as shown in the <i>Fuel System Diagnostic</i> section of this manual. - Slowly turn the manual shutoff valve ON - Check the gauge hose and adapter fittings for any gas leakage, including the previously reinstalled test port <i>Are the fittings and hoses secure and tight with no gas leakage?</i>	Go to Step (10)	
10	- Start the engine. If you were directed to this chart from the DTC section, run the engine at the same load point where the DTC code was set, if known, otherwise run the engine to full load. - Observe the 0 to 20 in. (0.0 - 50 cm) water column gauge. <i>Does the gauge show a pressure between +6.0 to +13.85 inches (15.0 - 35 cm) water column pressure?</i>	Go to Step (12)	Go to Step (11)
11	- Turn the manual shutoff valve on the gas supply line OFF. - Replace the number one fuel lock solenoid <i>Is the replacement complete?</i>	Go to Step (5)	
12	- Turn the manual shutoff valve on the gas supply line OFF - Remove the 0 to 20 in. (0.0 - 50 cm) water column gauge between the number one and number two fuel shutoff solenoids. - Reinstall the test port plug using the recommended Loctite® thread sealant #567 <i>Is the test port plug securely installed the pipe thread sealant?</i>	Go to Step (13)	
13	- Install the 0 to 20 in. (0.0 - 5.0 cm) water column gauge to the fuel pressure test port at the outlet of the number two fuel lock solenoid as shown in the <i>Fuel System Diagnostic</i> section of this manual. - Slowly turn the manual shutoff valve ON - Check the gauge hose and adapter fittings for any gas leakage, including the previously reinstalled test port <i>Are the fittings and hoses secure and tight with no gas leakage?</i>	Go to Step (14)	
14	- Start the engine. If you were directed to this chart from the DTC section run the engine at the same load point where the DTC code was set, if known. Otherwise run the engine to full load. - Observe the 0 to 20" water column gauge <i>Does the gauge show a pressure between +6.0 to +13.85 inches (15.0 - 35 cm) water column?</i>	Go to Step (16)	Go to Step (15)
15	- Turn the manual shutoff valve on the gas supply line OFF. - Replace the number two fuel lock solenoid <i>Is the replacement complete?</i>	Go to Step (5)	
16	Replace the fuel system low pressure regulator. <i>Is the replacement complete?</i>	Go to Step (5)	

Fuel Symptom Diagnostics

CHECKS	ACTION
Before Using This Section	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.
Fuel System Check	1. Verify the customer complaint. 2. Locate the correct symptom table. 3. Check the items indicated under that symptom. 4. Operate the engine under the conditions the symptom occurs. Verify HEGO switching between lean and rich (cycling of voltage). IMPORTANT! Normal HEGO switching indicates the 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.
Visual and Physical Checks	• 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 and leakage around the regulator, venturi and throttle body. Check the ignition wires for the following conditions: • Cracking • Hardening • Proper routing • Carbon tracking Check the wiring for the following items: • Proper connections • Pinches • Cuts.

NOTICE: 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.

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 table if a fault is an intermittent, the use of the DTC tables with this condition 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 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 <i>Wiring Schematics</i>. - 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, operate the engine with the DST connected. When the problem occurs, an abnormal voltage or scan reading indicates a problem circuit.
Intermittent MIL Illumination	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.
Loss of DTC Memory	To check for the loss of the DTC Memory: - Disconnect the TMAP sensor. - Run engine under no load until the MIL illuminates. - 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.

NO START

CHECKS	ACTION
DEFINITION: The engine cranks OK but does not start.	
ECM Checks	Use the DST to : • Check for proper communication with both the ECM • Check all system fuses engine fuse holder. Refer to <i>Engine Controls Schematics</i>. • Check battery power, ignition power and ground circuits to the ECM.
Sensor Checks	• Check the TMAP sensor. • Check the cam/crank sensors for output (rpm). This can be verified by an RPM signal on the DST.
Fuel System Checks	Important: A closed gas supply valve will create a no-start condition. • Verify proper operation of the shut-off solenoid valves. • Check for air intake system leakage around the regulator, venturi and throttle body. • Check the fuel system pressures. • Refer to the <i>Fuel System Diagnosis</i>.
Ignition System Checks	Note: Natural Gas and Propane require 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. Check the spark plugs for the following conditions: • Wet plugs (Oil Fouling) • Cracks • Wear • Improper gap • Burned electrodes • Heavy deposits • Check for bare or shorted ignition wires. • Check for loose ignition coil connections at the coil
Engine Mechanical Checks	Check for the following: • Manifold vacuum leaks • Venturi vacuum leaks • Engine 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.

HARD START

CHECKS	ACTION
DEFINITION: The engine cranks OK, but does not start for a long time. The engine does eventually run, or may start but immediately stalls.	
Sensor Checks	- 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/crank sensors. - Check the electronic throttle connections.
Fuel System Checks	Important: A partially closed fuel supply valve will create an extended crank OR no start condition. Check venturi assembly for proper installation and leakage. - Verify proper operation of the shutoff solenoid valves. - Verify proper operation of the system low pressure regulator. - Check for air intake system leakage between the venturi, throttle body and air filter assembly. Check the fuel system pressures. Refer to the <i>Fuel System Diagnosis</i>.
Ignition System Checks	Note: Natural Gas and Propane require higher secondary ignition system voltages for the equivalent gasoline operating conditions. - Check for the proper ignition voltage output with J 26792 tool 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 (oil fouling) - Cracks - Wear - Burned electrodes - Heavy deposits - Check for bare or shorted ignition wires - Check for moisture in the distributor cap - Check for loose ignition coil connections Important: - If the engine starts but then immediately stalls, check the cam/crank sensor. - Check for improper gap, debris or faulty connections.
Engine Mechanical Checks	Check for the following: - Engine vacuum leaks - Manifold vacuum leaks - Venturi 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

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 low speed, or hard acceleration for the fuel starvation that can cause the engine to cut-out.	
Ignition System Checks	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. 5. Remove the spark plugs and check for the following conditions: • Insulation cracks • Wear • Improper gap • Burned electrodes • Heavy deposits 6. Inspect the secondary ignition for the following: • Ignition wires for arcing and proper routing • Cross-firing • Ignition coils for cracks or carbon tracking
Engine Mechanical Checks	Perform a cylinder compression check and 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
Fuel System Checks	Check the fuel system: • Plugged fuel filter (if equipped). • Low fuel pressure, etc. Refer to <i>Fuel System Diagnosis</i>. • Check the condition of the wiring to the shutoff valves.
Additional Check	Check for Electromagnetic Interference (EMI), which may cause a misfire condition. Using the DST, monitor the engine rpm and note sudden increases in rpm 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 engine has a momentary lack of response when accelerating the engine. The condition can occur at any engine speed. The condition may cause the engine to stall if it's severe enough.	
Fuel System Checks	• Check the fuel pressure. Refer to <i>Fuel System Diagnosis</i> • 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 shutoff electrical connections • Check the regulator, venturi and throttle body for proper installation and leakage
Ignition System Checks	Note: Natural Gas and Propane require 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 for faulty spark plug wires • Check for oil fouled spark plugs
Additional Check	• Check for manifold vacuum or air induction system leaks • Check the alternator output voltage

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BACKFIRE

CHECKS	ACTIONS
DEFINITION: The fuel ignites in the intake manifold, or in the exhaust system, making a loud popping noise.	
Ignition System Checks	Note: Natural Gas and Propane require higher secondary ignition system voltages for the equivalent gasoline operating conditions. • Check for the proper ignition coil output voltage using the spark tester J 26792 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 ignition coil • Check for deteriorated spark plug wire insulation Remove the plugs and inspect them for the following conditions: • Wet plugs (oil fouling) • Cracks • Wear • Improper gap • Burned electrodes • Heavy deposits
Engine Mechanical Check	Check the engine for the following • Improper valve timing • Engine compression • Manifold vacuum leaks • Intake manifold gaskets • Sticking or leaking valves • Exhaust system leakage
Fuel System Checks	Perform a fuel system diagnosis. Refer to <i>Fuel System Diagnosis</i> .

LACK OF POWER / SLUGGISHNESS / SPONGINESS

CHECKS	ACTIONS
DEFINITION: The engine delivers less than expected power. There is little or no increase in speed when throttling the engine.	
Preliminary Checks	- Refer to the fuel system OBD System Check. - Compare the customer's engine with a similar unit to verify customer has an actual problem. Do not compare the power output of the engine operating on Natural Gas and Propane to one operating on gasoline as the fuels do have different performance characteristics. - Remove the air filter and check for dirt or restriction.
Fuel System Checks	- Check for contaminated fuel, or improper fuel pressure. Refer to <i>Fuel System Diagnosis</i>. - Check for the proper ignition output voltage with the spark tester J 26792 or the equivalent. - Check the regulator, venturi and throttle body for proper installation and leakage. Check all air inlet ducts for condition and proper installation. - Check for fuel leaks in supply lines - Verify that the manual shutoff valve on the supply line is open
Sensor Checks	Check the Heated Exhaust Gas Oxygen Sensor (HEGO) for contamination and performance. Check for proper operation of the TMAP sensor.
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
Engine Mechanical Check	Check the engine for the following: - Engine compression - Valve timing - Improper or worn camshaft - Refer to <i>Engine Mechanical in the Service Manual</i>
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	ACTIONS
DEFINITION: Fuel economy, as measured by refueling records, is noticeably lower than expected. Also, the economy is noticeably lower than it was on this engine 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
Fuel System Checks	• Check the regulator fuel pressure. Refer to <i>Fuel System Diagnosis</i> • 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 (oil fouling) • 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.

ROUGH, UNSTABLE, or INCORRECT ENGINE SPEED / ENGINE STALLING

CHECKS	ACTONS
DEFINITION: The engine runs unevenly at under no load. If severe enough, the engine may shake. The engine speed may vary in rpm. Either condition may be severe enough to stall the engine.	
Sensor Checks	• Check the Heated Exhaust Gas Oxygen Sensor (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 performance 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. • Run the engine at the speed of the complaint. • Monitoring the oxygen sensor will help identify the problem. • Verify proper operation of the regulator. • Perform a cylinder compression test. Refer to <i>Engine Mechanical in the Service Manual</i>. • Check the regulator fuel pressure. Refer to the <i>Fuel System Diagnosis</i>. • Check the regulator, venturi and throttle body for proper installation and leakage.
Ignition System Checks	Check for the proper ignition output voltage using the spark tester J 26792 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 (oil fouling) • 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 poor engine performance. • 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 engine performance.
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	ACTIONS
DEFINITION: The engine has a power variation under a steady throttle. The engine feels as if it speeds up and slows down with no change to the throttle.	
Sensor Checks	Check the Heated Exhaust Gas Oxygen Sensor (HEGO) performance
Fuel System Checks	• Check for rich or lean symptom that causes the condition • Run the engine at the speed of the complaint. Monitoring the oxygen sensor will help identify the problem • Check the fuel pressure while the condition exists. Refer to <i>Fuel System Diagnosis</i> • Verify proper fuel control shutoff valve operation • Verify that the manual shutoff valve on the gas supply line is fully open
Ignition System Checks	• Check for the proper ignition output voltage using the spark tester J 26792 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 (oil fouling) • 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 alternator output voltage • Check the vacuum hoses for kinks or leaks

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 engine speed
- Stalling
- Oil leaks
- Oil in the air cleaner
- Sludge in the engine

A leaking PCV orifice or hose may cause the following problems:

- Rough or unstable engine speed.
- Stalling

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.

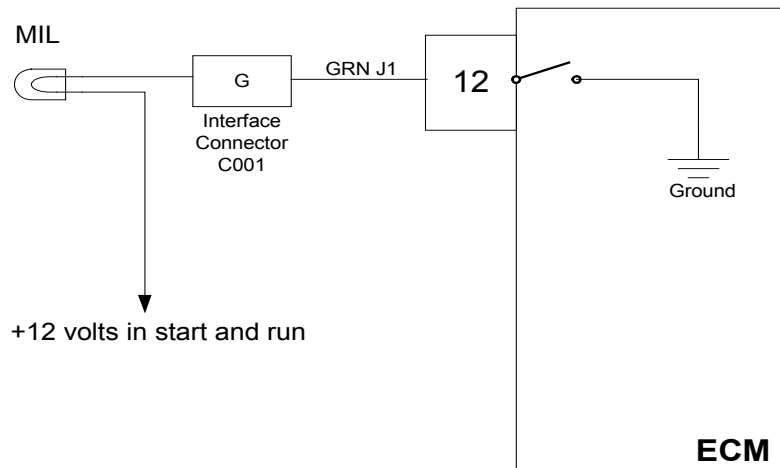
Proper operation of the crankcase ventilation system depends on a sealed engine. If irregular oil flow or dilution is noted and the crankcase ventilation system is functioning properly, check the engine for another possible cause. Correct any of these problems first.

If an engine is running 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:

- Remove the PCV hose (positive side) from the rocker arm cover.
- Operate the engine at no load.
- Place your thumb over the end of the hose in order to check for vacuum. If there is no vacuum at the hose end, inspect for the following items:
- Plugged hoses
- The manifold vacuum port
- Turn the engine OFF.
- Inspect the PCV orifice in the valve cover for debris or blockage.

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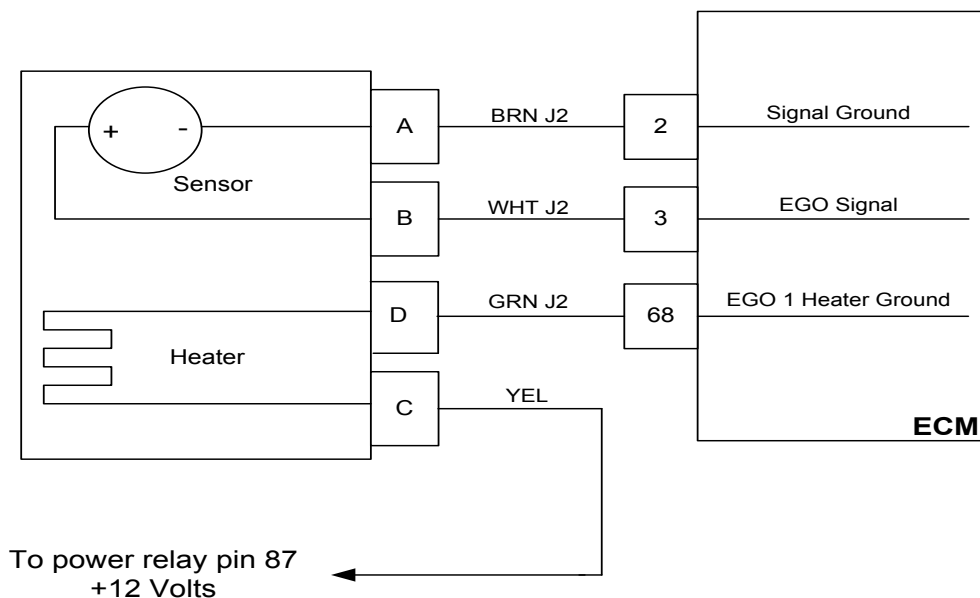
DIAGNOSTIC TROUBLE CODES



Circuit Description

The engine is equipped with on-board diagnostics (OBD) that monitor the operation of emission related components. If an emission related problem has been detected, the system control panel display will alternate between run hours and ENG- in three second intervals while the generator is running. If ENG- displays while the generator is running, a diagnostic trouble code may be set or a problem may exist in the system which has caused the engine emissions to go outside the standards certified by the Environmental Protection Agency.

DTC P0031 Oxygen Sensor Heater Short Low/Open



Conditions for Setting the DTC

- Heated Oxygen Sensor
- Check Condition Ignition ON
- Fault Condition - Less than 30mv
- MIL ON

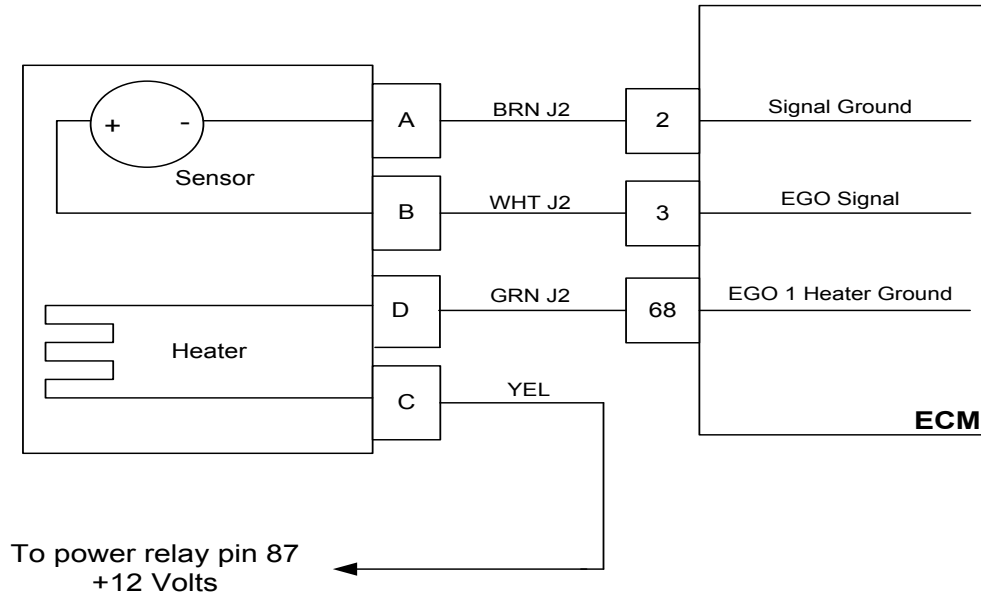
Circuit Description

The EGO sensor (Exhaust Gas Oxygen) sensor is used to determine if the fuel flow to the engine is correct by measuring the oxygen content in the exhaust gas. The EGO sensor uses an internal heating element to keep the sensor active. This fault will set if the ECM detects a short low or open in the HEGO heater element or control circuit.

DTC P0031 Oxygen Sensor Heater Short Low/Open

STEP	ACTION	YES	NO
1	<i>Did you perform the On-Board (OBD) System Check?</i>	Go to Step (2)	Go to OBD System Check Section
2	- Ignition OFF - Disconnect HEGO connector C014 - Ignition ON - Using a DVOM check for voltage between EGO connector pins C and D <i>Does the DVOM show voltage?</i>	Go to Step (8)	Go To Step (3)
3	- Ignition ON - Using a DVOM check for voltage between HEGO connector pin C and engine ground <i>Do you have voltage?</i>	Repair open HEGO heater supply circuit from power relay. See wire harness repair.	Go to Step (4)
4	- Using a DVOM check for voltage between HEGO connector pin D and battery positive - Ignition ON <i>Do you have voltage?</i>	Repair open HEGO ground circuit. See wire harness repair.	Go to Step (5)
5	- Ignition OFF - Disconnect ECM connector C0J2 - Using a DVOM check for continuity between ECM connector pin 68 and HEGO connector pin D <i>Does the DVOM show continuity?</i>	Go to Step (6)	Repair the open HEGO heater ground. See wire harness repair.
6	- Ignition ON - Using a DVOM check for voltage between HEGO connector pin D and battery positive <i>Does the DVOM show voltage?</i>	Repair the HEGO heater ground shorted to voltage. See wire harness Repair.	Go to Step (7)
7	Replace ECM <i>Is the replacement complete?</i>	Go to Step (10)	
8	Using a DVOM measure the resistance of the HEGO heater (sensor side) between pins C and D (the two white wires) <i>Does the DVOM show a resistance value greater than 25 Ohms?</i>	Go to Step (9)	Go to Step (5)
9	Replace the HEGO sensor <i>Is the replacement complete?</i>	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 run to full operating temperature - Observe the MIL - Observe engine performance - After operating the engine within the test parameters of DTC P0031 check for any stored codes <i>Does the engine operate normally with no stored codes?</i>	System OK	Go to OBD System Check

DTC P0032 Oxygen Sensor Heater Short High



Conditions for Setting the DTC

- Heated Oxygen Sensor
- Check Condition Ignition ON
- Fault Condition - Greater than 14.30 Volts
- MIL-ON

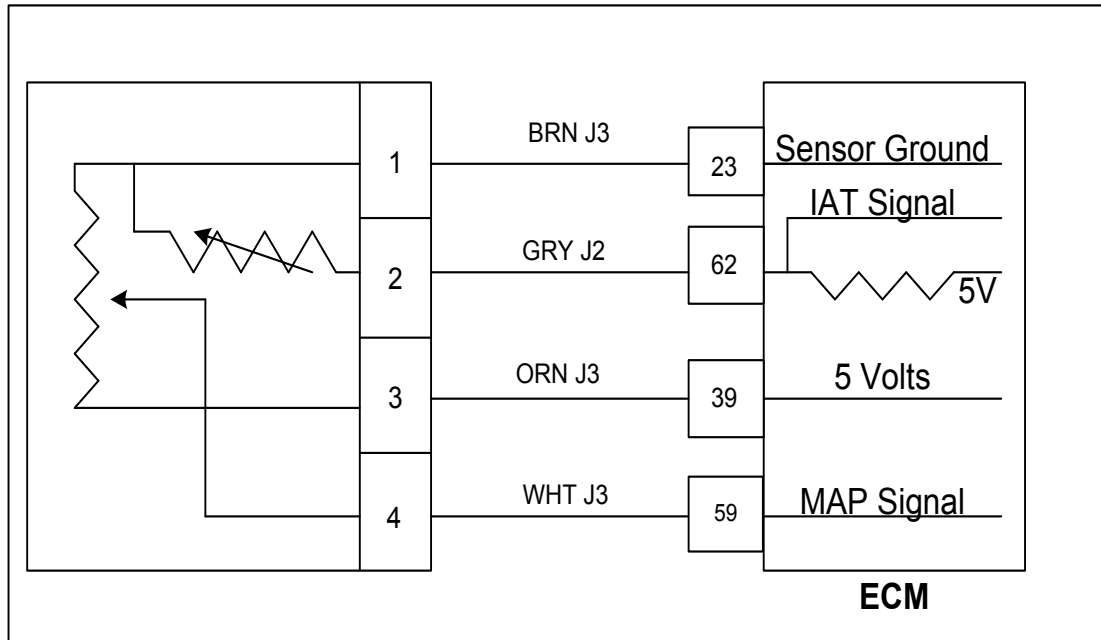
Circuit Description

The EGO sensor (Exhaust Gas Oxygen) sensor is used to determine if the fuel flow to the engine is correct by measuring the oxygen content in the exhaust gas. The EGO sensor uses an internal heating element to keep the sensor active. This fault will set if the ECM detects a short high in the HEGO heater element or control circuit.

DTC P0032 Oxygen Sensor Heater Short High

STEP	ACTION	YES	NO
1	<i>Did you perform the On-Board (OBD) System Check?</i>	Go to Step (2)	Go to OBD System Check Section
2	- Ignition OFF - Disconnect HEGO connector C014 - Ignition ON - Using a DVOM check for voltage between EGO connector pins C and D <i>Does the DVOM show voltage?</i>	Go to Step (8)	Go To Step (3)
3	- Ignition ON - Using a DVOM check for voltage between HEGO connector pin C and engine ground <i>Do you have voltage?</i>	Repair open HEGO heater supply circuit from power relay. See wire harness repair.	Go to Step (4)
4	- Using a DVOM check for voltage between HEGO connector pin D and battery positive - Ignition ON <i>Do you have voltage?</i>	Repair open HEGO ground circuit. See wire harness repair.	Go to Step (5)
5	- Ignition OFF - Disconnect ECM connector C0J2 - Using a DVOM check for continuity between ECM connector pin 68 and HEGO connector pin D <i>Does the DVOM show continuity?</i>	Go to Step (6)	Repair the open HEGO heater ground. See wire harness repair.
6	- Ignition ON - Using a DVOM check for voltage between HEGO connector pin D and battery positive <i>Does the DVOM show voltage?</i>	Repair the HEGO heater ground shorted to voltage. See wire harness Repair.	Go to Step (7)
7	Replace ECM <i>Is the replacement complete?</i>	Go to Step (10)	
8	Using a DVOM measure the resistance of the HEGO heater (sensor side) between pins C and D (the two white wires). <i>Does the DVOM show a resistance value of less than 5 Ohms?</i>	Go to Step (9)	Go to Step (5)
9	Replace the HEGO sensor <i>Is the replacement complete?</i>	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 run to full operating temperature - Observe the MIL - Observe engine performance - After operating the engine within the test parameters of DTC P0032 check for any stored codes <i>Does the engine operate normally with no stored codes?</i>	System OK	Go to OBD System Check

DTC P0107-TMAP Low Voltage



Conditions for Setting the DTC

- MAP Sensor
- Check Condition - Engine cranking or running
- Fault Condition - MAP less than 0.25 volts
- MIL-ON

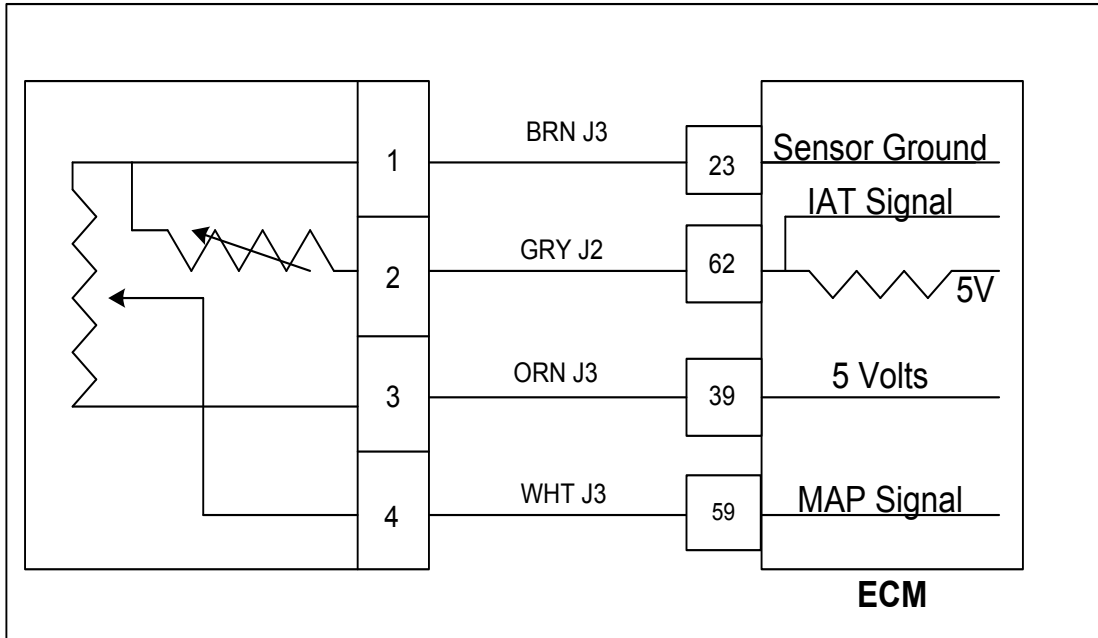
Circuit Description

The MAP (Manifold Absolute Pressure) sensor is a pressure transducer connected to the intake manifold. It is used to measure the manifold pressure. This system incorporates a TMAP (Temperature Manifold Absolute Pressure) sensor that also measures temperature in the intake manifold prior to induction. This diagnostic indicates a possible problem in the MAP portion of the sensor. The pressure and temperature readings are used in conjunction with other inputs to estimate the airflow requirement of the engine. This fault will set if the MAP voltage is greater than 4.84 volts

DTC P0107-TMAP Low Voltage

STEP	ACTION	YES	NO
1	<i>Did you perform the On-Board (OBD) System Check?</i>	Go to Step (2)	Go to OBD System Check Section
2	- Ignition ON, Engine OFF - DST (Diagnostic Scan Tool) connected in the data stream mode. - Clear DTC P0107 - Ignition OFF - Ignition ON <i>Does DTC P0107 reset?</i>	Go to Step (3)	Intermittent problem. Go to Intermittent section
3	- Ignition OFF - Disconnect ECM connector C0J3 - Disconnect the TMAP sensor connector C020 - Using a DVOM check for continuity between ECM connector pin 23 and TMAP connector pin 1 <i>Does the DVOM show continuity?</i>	Go to Step (4)	Repair the open sensor ground circuit as necessary. Refer to Wiring Repairs.
4	Using a DVOM check for continuity between ECM pin 39 and TMAP connector pin 3 <i>Does the DVOM show continuity?</i>	Go to Step (5)	Repair the open circuit as necessary. Refer to Wiring Repairs.
5	Using a DVOM check for continuity between ECM pin 59 and TMAP connector pin 4 <i>Does the DVOM show continuity?</i>	Go to Step (6)	Repair the open 5 volt circuit as necessary. Refer to Wiring Repairs
6	Using a DVOM check for continuity between TMAP connector pin 4 and engine ground <i>Does the DVOM show continuity?</i>	Repair the shorted signal circuit as necessary. Refer to Wiring Repairs	Go to Step (7)
7	Using a DVOM check for continuity between TMAP connector pin 3 and engine ground <i>Does the DVOM show continuity?</i>	Repair the shorted 5 volt signal circuit shorted to ground as necessary. Refer to Wiring Repairs.	Go to Step (8)
8	Replace the TMAP sensor <i>Is the replacement complete?</i>	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 run to full operating temperature - Observe the MIL - Observe engine performance <i>Does the engine operate normally with no stored codes?</i>	System OK	Go to Step (10)
10	Replace the ECM <i>Is the replacement complete?</i>	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 Ignition to full operating temperature - Observe the MIL - Observe engine performance <i>Does the engine operate normally with no stored codes?</i>	System OK	Go to OBD System Check

DTC P0108-MAP Sensor High



Conditions for Setting the DTC

- MAP Sensor
- Check Condition - Ignition ON
- Fault Condition - MAP sensor voltage exceeds 4.84 volts
- MIL - ON during active fault

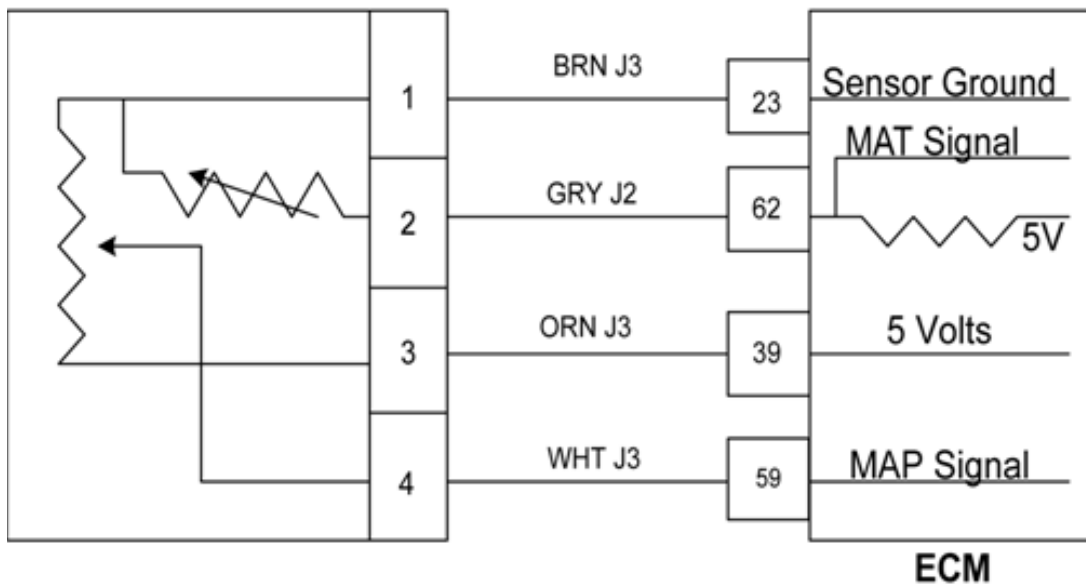
Circuit Description

The MAP (Manifold Absolute Pressure) sensor is a pressure transducer connected to the intake manifold. It is used to measure the manifold pressure. This system incorporates a TMAP (Temperature Manifold Absolute Pressure) sensor that also measures temperature in the intake manifold prior to induction. This diagnostic indicates a possible problem in the MAP portion of the sensor. The pressure and temperature readings are used in conjunction with other inputs to estimate the airflow requirement of the engine. This fault will set if the MAP voltage is greater than 4.84 volts.

DTC P0108-MAP Sensor High

STEP	ACTION	YES	NO
1	<i>Did you perform the On-Board (OBD) System Check?</i>	Go to Step (2)	Go to OBD System Check Section
2	- Ignition ON, Engine OFF - DST (Diagnostic Scan Tool) connected in the data stream mode - Clear DTC P0108 - Ignition OFF - Ignition ON <i>Does DTC P0108 reset?</i>	Go to Step (3)	Intermittent problem. Go to Intermittent section
3	- Ignition OFF - Disconnect ECM connector C0J3 - Disconnect TMAP connector C020 - Using a DVOM check for continuity between TMAP connector pin1 and ECM connector pin 23 <i>Do you have continuity between them?</i>	Go to Step (4)	Repair the open ground circuit as necessary. Refer to Wiring Repairs in Engine Electrical
4	Using a DVOM check for continuity between TMAP connector pins 3 and 4 <i>Do you have continuity between them?</i>	Repair the shorted signal to 5 volt circuit as necessary. Refer to Wiring Repairs in Engine Electrical	Go to Step (5)
5	Using a DVOM check for continuity between TMAP connector pin 4 and battery positive <i>Do you have continuity between them?</i>	Repair the shorted signal to battery voltage circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to Step (6)
6	Inspect the throttle connector terminals for damage, corrosion or contamination <i>Did you find a problem?</i>	Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to Step (7)
7	Replace the TMAP sensor <i>Is the replacement complete?</i>	Go to Step (9)	
8	Replace the ECM <i>Is the replacement complete?</i>	Go to Step (10)	
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 run to full operating temperature - Observe the MIL - Observe engine performance <i>Does the engine operate normally with no stored codes?</i>	System OK	Go to Step (8)
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 run to full operating temperature - Observe the MIL - Observe engine performance <i>Does the engine operate normally with no stored codes?</i>	System OK	Go to OBD System Check

DTC P0112 MAT Sensor Low



Conditions for Setting the DTC

- Manifold Air Temperature
- Check Condition - Ignition ON
- Fault Condition - MAT Sensor Voltage less than 100mv
- MIL - ON during active fault

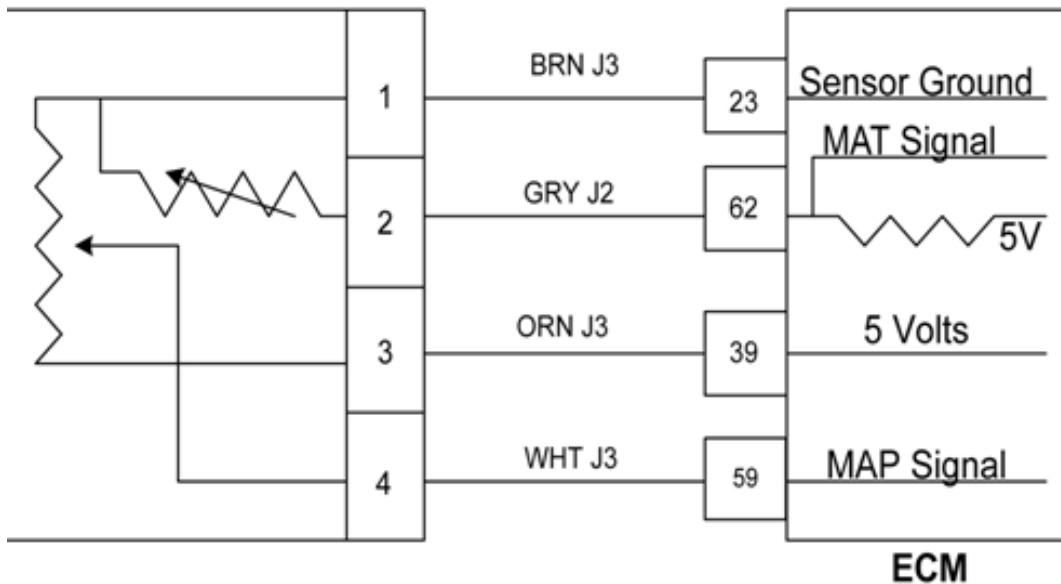
Circuit Description

The MAT (Manifold Air Temperature) sensor is located in the intake air stream of the engine. A temperature sensitive resistor is used in the MAT to monitor the intake air temperature. The MAT value along with other sensors is used by the ECM to calculate the engines airflow requirement. This fault will set if the MAT signal voltage is less than 100mv.

DTC P0112 MAT Sensor Low

STEP	ACTION	YES	NO
1	<i>Did you perform the On-Board (OBD) System Check?</i>	Go to Step (2)	Go to OBD System Check Section
2	- Ignition ON - DST (Diagnostic Scan Tool) connected In System Data Mode <i>Does DST display MAT temperature locked at 104°F (40°C)?</i>	Go to Step (3)	Intermittent problem. Go to Intermittent section
3	- Ignition OFF - Disconnect the TMAP sensor connector C020 and jump pins 1 and 2 together - Ignition ON <i>Does the DST display MAT temperature greater than 266 °F (130°C)?</i>	Go to Step (5)	Go to Step (4)
4	- Disconnect ECM connector C0J2 - Using a DVOM check for continuity between TMAP sensor connector pin 1 and ECM connector pin 23 <i>Does the DVOM show continuity?</i>	Go to Step (6)	Repair the open ground circuit as necessary. Refer to Wire Harness Repair section.
5	Replace the TMAP sensor. <i>Is the replacement complete?</i>	Go to Step (10)	
6	Using a DVOM check for continuity between TMAP connector pin 2 and ECM pin 62. <i>Does the DVOM show continuity?</i>	Go to Step (7)	Repair the open signal circuit as necessary. Refer to Wire Harness Repair Section
7	Using a DVOM check for continuity between TMAP connector pin 2 and engine ground <i>Does the DVOM show continuity?</i>	Repair the shorted signal to ground circuit as necessary. Refer to Wire Harness Repair Section.	Go to Step (8)
8	Inspect TMAP connector pins 1 and 2, and ECM pins 23 and 62 for damage corrosion or contamination. <i>Did you find a problem?</i>	Repair the damaged electrical connector. Refer to Wire Harness Repair Section	Go to Step (9)
9	Replace the ECM <i>Is the replacement complete?</i>	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 engine to full operating temperature - Observe the MIL - Observe engine performance - After operating the engine within the test parameters of DTC P0112 check for any stored codes <i>Does the engine operate normally with no stored codes?</i>	System OK	Go to OBD System Check

DTC P0113 MAT Sensor High



Conditions for Setting the DTC

- Intake Air Temperature
- Check Condition-Ignition ON
- Fault Condition-MAT Sensor Voltage greater than 4.70 volts
- MIL-On during active fault

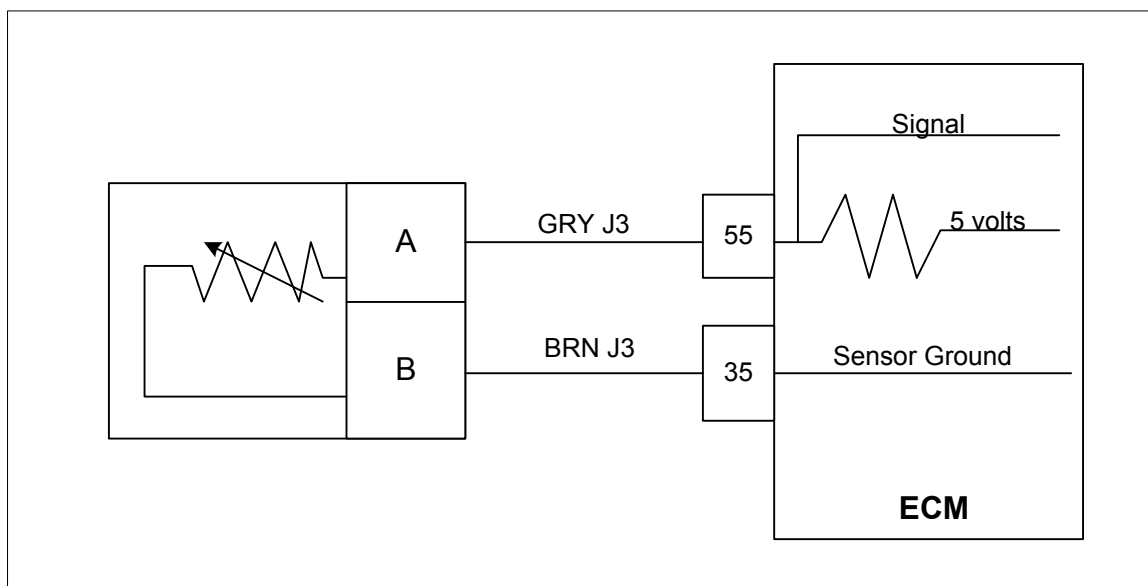
Circuit Description

The MAT (Manifold Air Temperature) sensor is located in the intake air stream of the engine. A temperature sensitive resistor is used in the MAT to monitor the intake air temperature. The MAT value along with other sensors is used by the ECM to calculate the engines airflow requirement. This fault will set if the MAT signal voltage is greater than 4.70 volts.

DTC P0113 MAT Sensor High

STEP	ACTION	YES	NO
1	<i>Did you perform the On-Board (OBD) System Check?</i>	Go to Step (2)	Go to OBD System Check Section
2	- Ignition ON - DST (Diagnostic Scan Tool) connected in System Data Mode <i>Does DST display MAT?</i>	Go to Step (3)	Intermittent problem. Go to Intermittent section
3	- Ignition OFF - Disconnect the TMAP sensor connector C020 and jump pins 1 and 2 together - Ignition ON <i>Does the DST display MAT temperature greater than 130°C?</i>	Go to Step (5)	Go to Step (4)
4	- Disconnect ECM connector C0J2 - Using a DVOM check for continuity between TMAP sensor connector pin 1 and ECM connector pin 23 <i>Does the DVOM show continuity?</i>	Go to Step (6)	Repair the open ground circuit as necessary. Refer to Wire Harness Repair section.
5	Replace the TMAP sensor. <i>Is the replacement complete?</i>	Go to Step (10)	
6	Using a DVOM check for continuity between TMAP connector pin 2 and ECM pin 62. <i>Does the DVOM show continuity?</i>	Go to Step (7)	Repair the open signal circuit as necessary. Refer to Wire Harness Repair Section
7	- Ignition ON - Using a DVOM check for voltage between TMAP connector pin 2 and engine ground <i>Does the DVOM show voltage?</i>	Repair the shorted to voltage signal circuit as necessary. Refer to Wire Harness Repair Section.	Go to Step (8)
8	Inspect TMAP connector pins 1 and 2, and ECM pins 23 and 62 for damage corrosion or contamination. <i>Did you find a problem?</i>	Repair the damaged electrical connector. Refer to Wire Harness Repair Section	Go to Step (9)
9	Replace the ECM <i>Is the replacement complete?</i>	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 engine to full operating temperature - Observe the MIL - Observe engine performance - After operating the engine within the test parameters of DTC P0113 check for any stored codes <i>Does the engine operate normally with no stored codes?</i>	System OK	Go to OBD System Check

DTC P0117-ECT Low Voltage



Conditions for Setting the DTC

- Engine Coolant Temperature
- Check Condition - Ignition ON
- Fault Condition - ECT sensor voltage less than 0.36 volts
- MIL - On during active fault

Use the temperature vs. Ohms chart at right to determine the sensor accuracy. Resistance readings should be $\pm 5\%$.

Temp (deg F)	Ohms
242.4	101
231.9	121
211.6	175
201.4	209
181.9	302
163.1	434
144.9	625
127.4	901
102.4	1,556
78.9	2,689
49.9	5,576
23.5	11,562
-5.7	28,770
-21.2	49,715
-30.8	71,589
-40.0	99,301

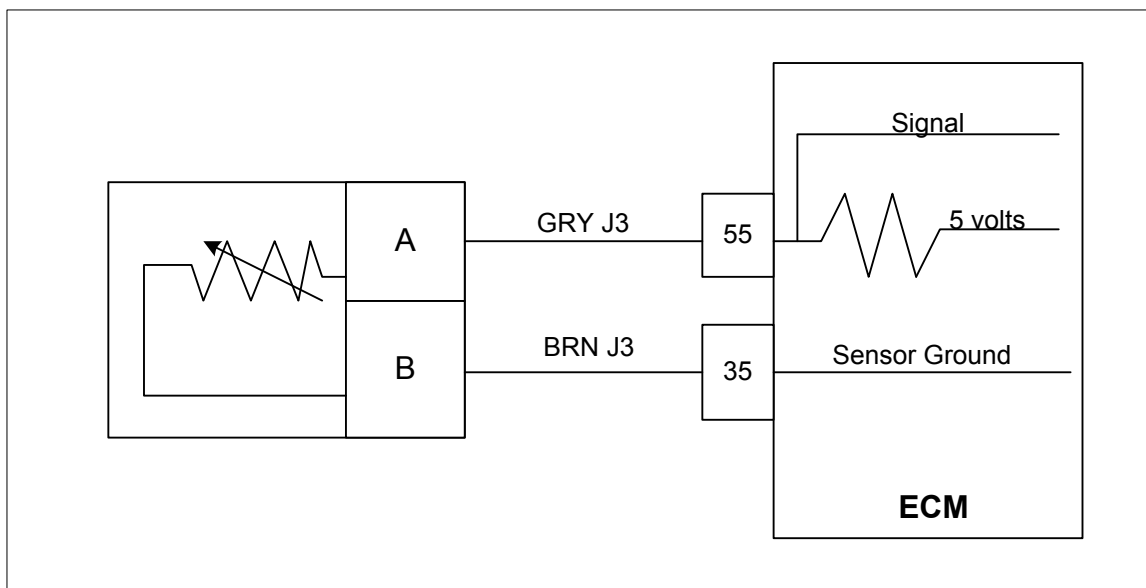
Circuit Description

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 .36 volts anytime the engine is running. The ECM will use a default value for the ECT sensor in the event of this fault.

DTC P0117-ECT Low Voltage

STEP	ACTION	YES	NO
1	<i>Did you perform the On-Board (OBD) System Check?</i>	Go to Step (2)	Go to OBD System Check Section
2	- Ignition ON - DST (Diagnostic Scan Tool) connected in System Data Mode <i>Does DST display ECT (Engine Coolant Temperature) fixed at 30°C?</i>	Go to Step (4)	Go to Step (3)
3	- Disconnect the ECT sensor connector C019 and jump terminals A and B together - Ignition ON <i>Does the DST display ECT temperature fixed at 30°C?</i>	Go to Step (4)	Go to Step (6)
4	- Ignition OFF - Disconnect ECT sensor connector - Using a DVOM check the resistance between the two terminals of the ECT sensor and compare the resistance reading to the chart <i>Does the resistance value agree with the chart?</i>	Go to Step (6)	Go to Step (5)
5	Replace ECT sensor <i>Is the replacement complete?</i>	Go to Step (10)	
6	- Ignition OFF - Disconnect ECM connector J3 - Using a DVOM check for continuity between ECT connector pin B and ECM connector pin 35 <i>Does the DVOM show continuity?</i>	Go to Step (7)	Repair the open sensor ground circuit. See Wire Harness repair Section
7	Using a DVOM check for continuity between ECT connector pin A and ECM connector pin 55. <i>Does the DVOM show continuity?</i>	Go to Step (8)	Repair the open sensor signal circuit. See Wire Harness repair Section.
8	Using a DVOM check for continuity between ECT connector pin A and engine ground. <i>Does the DVOM show continuity?</i>	Repair the sensor signal short to ground. See Wire Harness Repair Section	Go to Step (9)
9	Replace the ECM <i>Is the replacement complete?</i>	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 Genset to full operating temperature - Observe the MIL - Observe engine performance - After operating the engine within the test parameters of DTC P0117 check for any stored codes <i>Does the engine operate normally with no stored codes?</i>	System OK	Go to OBD System Check

DTC P0118 ECT Voltage High



Conditions for Setting the DTC

- Engine Coolant Temperature
- Check Condition - Ignition ON
- Fault Condition - ECT sensor voltage exceeds 4.70 volts
- MIL - ON during active fault

Use the temperature vs. Ohms chart (at right) to determine the sensor accuracy. Resistance readings should be $\pm 5\%$.

Temp (deg F)	Ohms
242.4	101
231.9	121
211.6	175
201.4	209
181.9	302
163.1	434
144.9	625
127.4	901
102.4	1,556
78.9	2,689
49.9	5,576
23.5	11,562
-5.7	28,770
-21.2	49,715
-30.8	71,589
-40.0	99,301

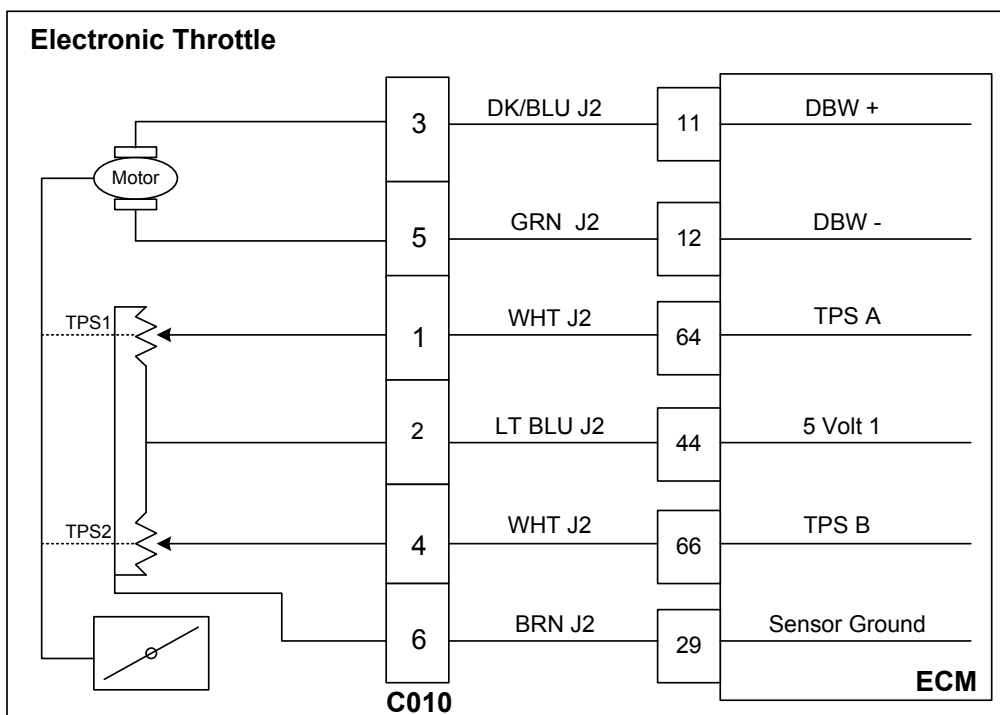
Circuit Description

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 4.70 volts anytime the engine is running. The ECM will use a default value for the ECT sensor in the event of this fault.

DTC P0118 ECT Voltage High

STEP	ACTION	YES	NO
1	<i>Did you perform the On-Board (OBD) System Check?</i>	Go to Step (2)	Go to OBD System Check Section
2	- Ignition ON - DST (Diagnostic Scan Tool) connected in System Data Mode <i>Does DST display ECT (Engine Coolant Temperature) fixed at 86°F (30°C)?</i>	Go to Step (4)	Go to Step (3)
3	- Disconnect the ECT sensor connector C019 and Jump terminals A and B together - Ignition ON <i>Does the DST display ECT temperature fixed at 86°F (30°C)?</i>	Go to Step (4)	Go to Step (6)
4	- Ignition OFF - Disconnect ECT sensor connector - Using a DVOM check the resistance between the two terminals of the ECT sensor and compare the resistance reading to the chart <i>Does the resistance value agree with the chart?</i>	Go to Step (6)	Go to Step (5)
5	Replace ECT sensor <i>Is the replacement complete?</i>	Go to Step (10)	
6	- Ignition OFF - Disconnect ECM connector J3 - Using a DVOM check for continuity between ECT connector pin B and ECM connector pin 35 <i>Does the DVOM show continuity?</i>	Go to Step (7)	Repair the open sensor ground circuit. See Wire Harness repair Section
7	Using a DVOM check for continuity between ECT connector pin A and ECM connector pin 55. <i>Does the DVOM show continuity?</i>	Go to Step (8)	Repair the open sensor signal circuit. See Wire Harness repair Section.
8	Using a DVOM check for continuity between ECT connector pin A and engine ground. <i>Does the DVOM show continuity?</i>	Repair the sensor signal short to ground. See Wire Harness Repair Section.	Go to Step (9)
9	Replace the ECM <i>Is the replacement complete?</i>	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 engine to full operating temperature - Observe the MIL - Observe engine performance. - After operating the engine within the test parameters of DTC P0118 check for any stored codes <i>Does the engine operate normally with no stored codes?</i>	System OK	Go to OBD System Check

DTC P0122 ETC TPS 1 Range



Conditions for Setting the DTC

- Electronic Throttle Control
- Check Condition - Ignition ON
- Fault Condition - TPS 1 voltage below 0.25 TPS 2 voltage greater than 4.95
- MIL - ON during active fault

Circuit Description

Dual throttle position sensors (TPS) are used with the electronic throttle control (ETC) to determine throttle plate position. The TPS values are used by the ECM to determine if the throttle is opening and closing as commanded. The ECM runs several checks at ignition on to validate the working condition of the ETC. This fault will set if the ECM detects a problem with the TPS sensor range.

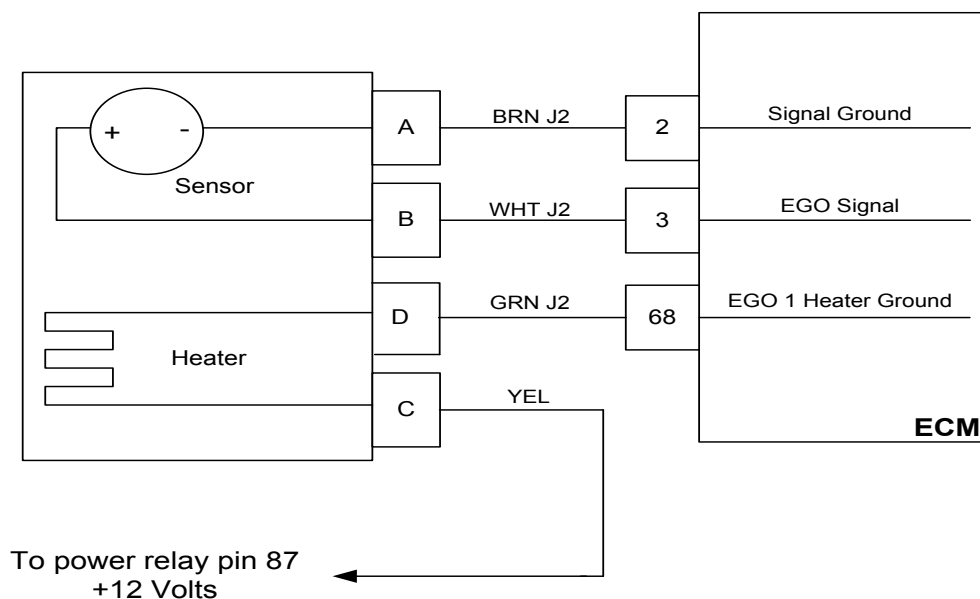
DTC P0122 ETC TPS 1 Range

STEP	ACTION	YES	NO
1	<i>Did you perform the On-Board (OBD) System Check?</i>	Go to Step (2)	Go to OBD System Check Section
2	- Ignition ON - DST (Diagnostic Scan Tool) connected in data stream mode. - Clear DTC P0122 - Start the engine <i>Does DTC P0122 reset?</i>	Go to Step (3)	Intermittent problem. Go to Intermittent section
3	- Ignition OFF - Disconnect electronic throttle connector C010 - Disconnect ECM wire harness connector C0J2 - Inspect the electronic throttle connector and ECM wire harness connector for damage corrosion or contamination <i>Did you find a problem?</i>	Correct the problem as required. See wire harness repair	Go to Step (4)
4	- Ignition OFF - Disconnect electronic throttle connector C010 - Disconnect ECM wire harness connector C0J2 - Using a DVOM check for continuity between electronic throttle connector pin 6 and ECM connector pin 29 <i>Does the DVOM show continuity?</i>	Go to Step (5)	Repair the open ground circuit as necessary. Refer to Wiring Repairs.
5	Using a DVOM check for continuity between electronic throttle connector pin 4 and ECM connector pin 66 <i>Does the DVOM show continuity?</i>	Go to Step (6)	Repair the open circuit as necessary. Refer to Wiring Repairs.
6	Using a DVOM check for continuity between electronic throttle connector pin 4 and engine ground <i>Does the DVOM show continuity?</i>	Repair the shorted to ground TPS circuit as necessary. Refer to Wiring Repairs.	Go to Step (7)
7	Using a DVOM check for continuity between electronic throttle connector pin 2 and ECM connector pin 44 <i>Does the DVOM show continuity?</i>	Go to Step (8)	Repair the open 5 volt circuit as necessary. Refer to Wiring Repairs
8	Using a DVOM check for continuity between electronic throttle connector pin 2 and engine ground <i>Does the DVOM show continuity?</i>	Repair the shorted 5 volt circuit to ground as necessary. Refer to Wiring Repairs.	Go to Step (9)
9	Using a DVOM check for continuity between electronic throttle connector pin 1 and ECM connector pin 64 <i>Does the DVOM show continuity?</i>	Go to Step (10)	Repair the open TPS circuit as necessary. Refer to Wiring Repairs.
10	Using a DVOM check for continuity between electronic throttle connector pin 1 and engine ground <i>Does the DVOM show continuity?</i>	Repair the shorted TPS circuit to ground as necessary. Refer to Wiring Repairs	Go to Step (11)
11	Using a DVOM check for continuity between electronic throttle connector pin 5 and ECM connector pin 12 <i>Does the DVOM show continuity?</i>	Go to Step (12)	Repair the open DBW circuit as necessary. Refer to Wiring Repairs.
12	Using a DVOM check for continuity between electronic throttle connector pin 3 and ECM connector pin 11 <i>Does the DVOM show continuity?</i>	Go to Step (13)	Repair the open DBW circuit as necessary. Refer to Wiring Repairs

STEP	ACTION	YES	NO
13	Using a DVOM check for continuity between electronic throttle connector pin 3 and engine ground <i>Does the DVOM show continuity?</i>	Repair the shorted DBW circuit to ground as necessary. Refer to Wiring Repairs.	Go to Step (14)
14	- Ignition ON - Using a DVOM check for voltage between electronic throttle connector pin 1 and engine ground <i>Does the DVOM show voltage?</i>	Repair the TPS signal shorted to voltage as necessary. Refer to Wiring Repairs.	Go to Step (15)
15	Replace throttle Is the replacement complete?	Go to Step (16)	
16	- 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 run to full operating temperature - Observe the MIL - Observe engine performance - After operating the engine within the test parameters of DTC P0122 check for any stored codes <i>Does the engine operate normally with no stored codes?</i>	System OK	Go to Step (17)
17	Replace the ECM 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 run to full operating temperature - Observe the MIL - Observe engine performance - After operating the engine within the test parameters of DTC P0122 check for any stored codes <i>Does the engine operate normally with no stored codes?</i>	System OK	Go to OBD System Check

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DTC P0130 Oxygen Sensor Voltage Open



Conditions for Setting the DTC

- Heated Oxygen Sensor
- Check condition - Engine running
- Fault condition - EGO sensor signal open. ECT above 50°C with minimum engine run time of 60 seconds.
- MIL - ON during active fault

Circuit Description

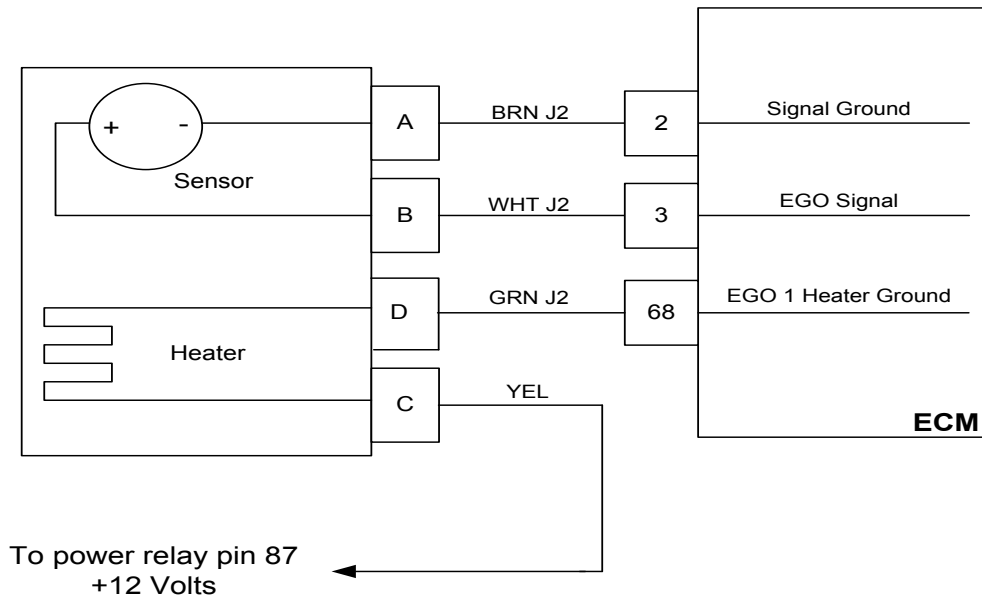
The EGO sensor (Exhaust Gas Oxygen) sensor is used to determine if the fuel flow to the engine is correct by measuring the oxygen content in the exhaust gas. This fault will set if the EGO signal circuit is open or unresponsive.

NOTE: EGO voltage fixed between .35 and .450 volts is a good indication that the signal circuit is open.

DTC P0130 Oxygen Sensor Voltage Open

STEP	ACTION	YES	NO
1	<i>Did you perform the On-Board (OBD) System Check?</i>	Go to Step (2)	Go to OBD System Check Section
2	- Ignition ON, Engine Running - DST (Diagnostic Scan Tool) connected in System Data Mode - Run engine to full operating temperature and then run under no load for a minimum of 2 minutes <i>Does DST display HEGO voltage fixed between .3 and .5 volts after at least 60 seconds run time?</i>	Go to Step (3)	Intermittent problem. See Electrical Section Intermittent Electrical Di-agnosis
3	- Ignition OFF - Disconnect EGO 1 connector C014 - Ignition ON <i>Does the DST now show EGO voltage at .45 volts?</i>	Go to Step (4)	Go To Step (4)
4	Jump HEGO connector pins A and B <i>Does the DST now show HEGO voltage at less than .1 volts ?</i>	Go to Step (5)	Go to Step (6)
5	Replace the oxygen sensor <i>Is the replacement complete?</i>	Go to Step (8)	
6	- Ignition OFF - Disconnect ECM connector C0J2 - Using a DVOM check for continuity between HEGO connector pin B and ECM connector pin 3. <i>Does the DVOM show continuity?</i>	Go to Step (5)	Repair the open HEGO signal circuit. See wire harness repair.
7	Using a DVOM Check for continuity between HEGO pin B and engine ground. <i>Does the DVOM show continuity?</i>	Repair the shorted to ground HEGO signal circuit. See wire harness repair	
8	Replace ECM <i>Is the replacement complete?</i>	Go to Step (8)	
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 run to full operating temperature - Observe the MIL - Observe engine performance - After operating the engine within the test parameters of DTC P0130 check for any stored codes <i>Does the engine operate normally with no stored codes?</i>	System OK	Go to OBD System Check

DTC P0131 Oxygen Sensor Voltage Low



Conditions for Setting the DTC

- Heated Oxygen Sensor
- Check condition - Engine running
- Fault condition - EGO less than 200mv with ECT greater than 122° F (50°C.)
- MIL - ON

Circuit Description

The EGO sensor (Exhaust Gas Oxygen) sensor is used to determine if the fuel flow to the engine is correct by measuring the oxygen content in the exhaust gas. This fault will set if the EGO voltage is persistently below 200mv during closed loop operation.

DTC P0131 Oxygen Sensor Voltage Low

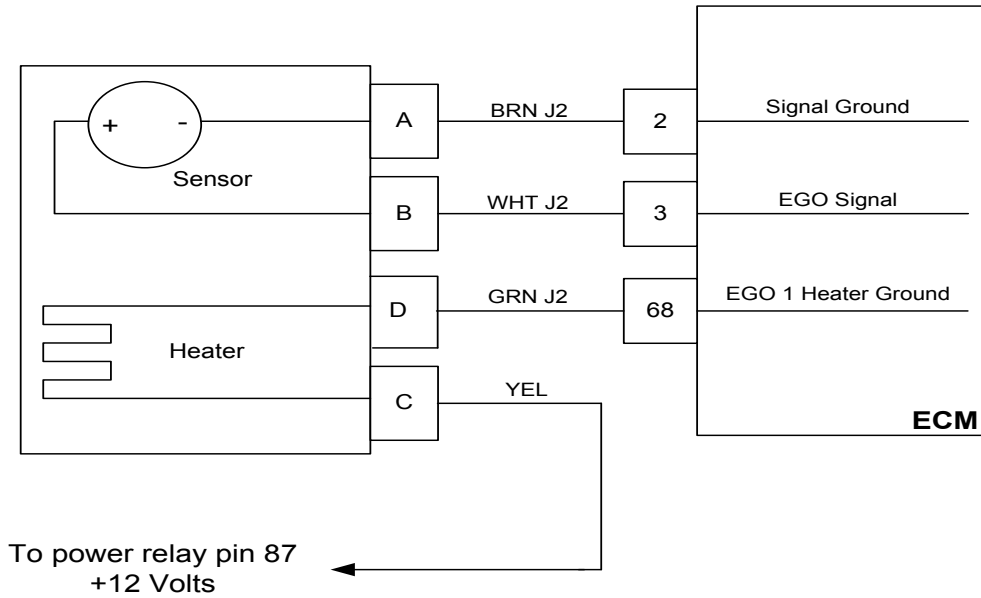
STEP	ACTION	YES	NO
1	Perform the On-Board (OBD) System Check? <i>Are any other DTCs present?</i>	Go to Step (3)	Go to Step (2)
2	Visually and physically check the following items: - Power Relay Fuse - The HEGO sensor installed securely and the wire leads not damaged or contacting the exhaust manifold - ECM grounds for being clean and tight Run the fuel system diagnostic checks <i>Was a repair made?</i>	Go to Step (6)	Go to Step (4)
3	Diagnose any other DTC codes before proceeding with this chart. <i>Have any other DTC codes been detected, diagnosed and repaired?</i>	Go to Step (13)	Go to Step (2)
4	- Ignition ON - Disconnect HEGO sensor wire harness connector C014. - Using a DVOM check for voltage between HEGO connector pins C and D. <i>Do you have voltage?</i>	Go to Step (7)	Go to Step (5)
5	Using a DVOM check for voltage between HEGO connector pin C and engine ground. <i>Does the DVOM show voltage?</i>	Repair the open HEGO heater ground circuit as necessary. Refer to wiring harness repair.	Go to Step (6)
6	Using a DVOM check for voltage between HEGO connector pin D and battery positive. <i>Does the DVOM show voltage?</i>	Repair the open HEGO heater power supply circuit as necessary. Refer to wiring harness repair	Go to Step (7)
7	- Ignition OFF - Disconnect ECM connector C0J2 - Using a DVOM check for continuity between ECM pin 2 and HEGO connector pin A. <i>Does the DVOM show continuity?</i>	Go to Step (8)	Repair the open sensor ground circuit as necessary. Refer to wiring harness repair.
8	Using a DVOM check for continuity between ECM pin 3 and HEGO connector pin B. <i>Does the DVOM show continuity?</i>	Go to Step (9)	Repair the open sensor signal circuit as necessary. Refer to wiring harness repair.
9	Using a DVOM check for continuity between ECM pin 68 and HEGO connector pin D. <i>Does the DVOM show continuity?</i>	Go to Step (10)	Repair the open HEGO heater ground circuit as necessary. Refer to wiring harness repair

10	Using a DVOM check for continuity between HEGO connector pin B and engine ground <i>Does the DVOM show continuity?</i>	Repair the signal shorted to ground circuit. Refer to wiring harness repair.	Go to Step (11)
11	Inspect ECM pins 2,3,68 and HEGO pins A, B, C, and D for damage, corrosion or contamination. <i>Did you find a problem?</i>	Repair the connector as necessary. Refer to wiring harness repair	Go to Step (12)
12	Replace the HEGO sensor <i>Is the replacement complete?</i>	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 run to full operating temperature - Observe the MIL - Observe engine performance - After operating the engine within the test parameters of DTC P0131 check for any stored codes <i>Does the engine operate normally with no stored codes?</i>	System OK	Go to Step (14)
14	Replace the ECM <i>Is the replacement complete?</i>	Go to Step (13)	

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DTC P0132 Oxygen Sensor Voltage High



Conditions for Setting the DTC

- EGO
- Check condition - Engine running.
- Fault condition - EGO voltage greater than 960mv for 5 seconds or longer with ECT greater than 122°F (50°C), with system ignition voltage above 10 volts.
- MIL - ON during active fault

Circuit Description

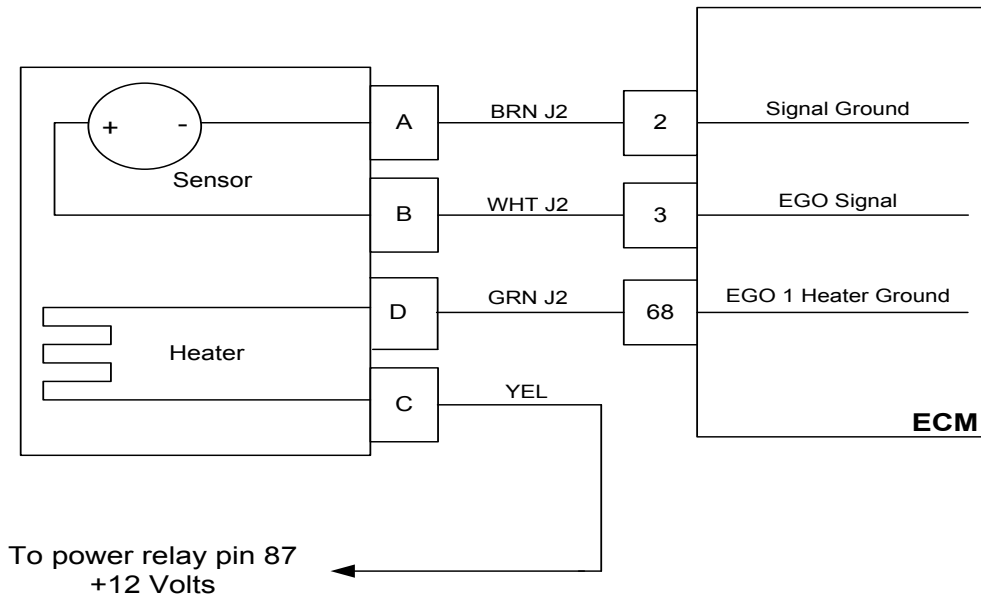
The EGO sensor is used to determine if the fuel flow to the engine is correct by measuring the oxygen content in the exhaust gas. The ECM uses this information to correct the fuel flow with the block learn memory. This fault detects an EGO sensor signal shorted high or excessively rich biased fuel metering.

Always run the fuel system diagnostic checks before proceeding with this diagnostic chart.

DTC P0132 Oxygen Sensor Voltage High

STEP	ACTION	YES	NO
1	Perform the On-Board (OBD) System Check. <i>Are any other DTCs present?</i>	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 HEGO 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 <i>Was a repair made?</i>	Go to Step (6)	Go to Step (4)
3	Diagnose any other DTC codes before proceeding with this chart. <i>Have any other DTC codes been detected, diagnosed and repaired?</i>	Go to Step (6)	Go to Step (4)
4	- Ignition OFF - Disconnect HEGO sensor wire harness connector C014 - Disconnect ECM wire harness connector C0J2 - Ignition ON - Using a DVOM check for voltage at the HEGO connector C014 signal pin B and engine ground <i>Do you have voltage above .5 volts?</i>	Repair the circuit short to voltage as necessary. Refer to wiring harness repair	Go to Step (5)
5	Replace HEGO sensor <i>Is the replacement complete?</i>	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 engine to full operating temperature - Observe the MIL - Observe engine performance - After operating the engine within the test parameters of DTC P0132 check for any stored codes <i>Does the engine operate normally with no stored codes?</i>	System OK	Go to OBD System Check

DTC P0133 Oxygen Sensor Response Slow



Conditions for Setting the DTC

- EGO (Exhaust Gas Oxygen Sensor)
- Check condition - Engine running.
- Fault condition - EGO Average lean to rich time 70ms.
- Average rich to lean time 80ms. ECT greater than 122°F (50°C) with MAP greater than 30 kPa but less than 80 kPa. RPM greater than 700 but less than 3000 with minimum engine run time of 60 seconds.
- MIL - ON during active fault

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 BLM (block learn memory). This fault detects a degraded sensor by monitoring the average response time of rich to lean and lean to rich switching points.

Always run the fuel system diagnostic checks before proceeding with this diagnostic chart.

DTC P0133 Oxygen Sensor Response Slow

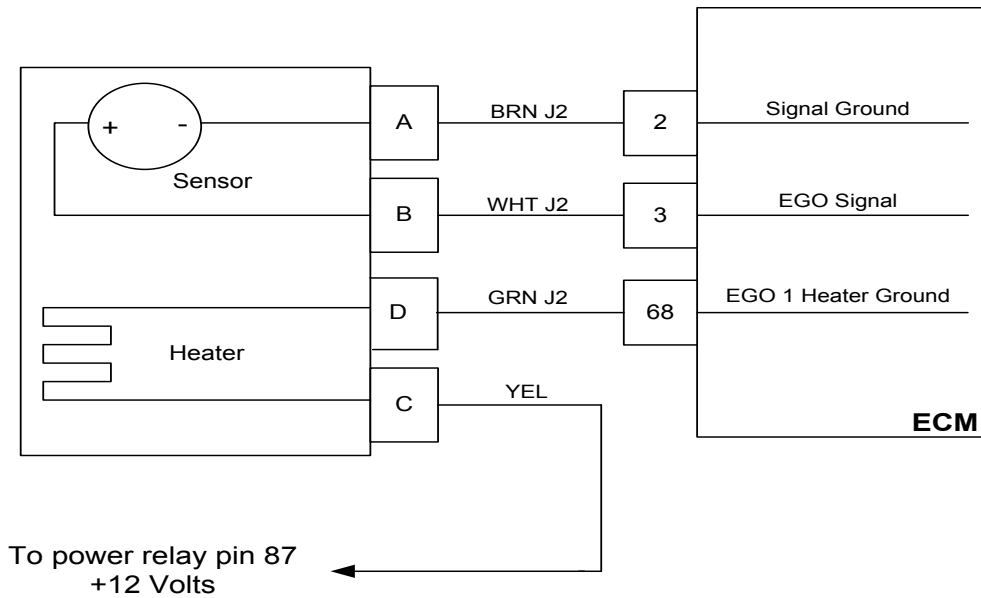
STEP	ACTION	YES	NO
1	Perform the On-Board (OBD) System Check? <i>Are any other DTCs present?</i>	Go to Step (3)	Go to Step (2)
2	Visually and physically check the following items: • Check for vacuum leaks at the venturi adapter • That the HEGO sensor is installed securely and the wire leads are not damaged or contacting the exhaust manifold or secondary spark plug wires • ECM grounds for being clean and tight • Run the fuel system diagnostic checks <i>Was a repair made?</i>	Go to Step (6)	Go to Step (4)
3	Diagnose any other DTC codes before proceeding with this chart. <i>Have any other DTC codes been detected, diagnosed and repaired?</i>	Go to Step (13)	Go to Step (2)
4	• Ignition ON • Disconnect HEGO sensor wire harness connector C014. • Using a DVOM check for voltage between HEGO connector pins C and D. <i>Do you have voltage?</i>	Go to Step (7)	Go to Step (5)
5	Using a DVOM check for voltage between HEGO connector pin C and engine ground. <i>Does the DVOM show voltage?</i>	Repair the open HEGO heater ground circuit as necessary. Refer to wiring harness repair.	Go to Step (6)
6	Using a DVOM check for voltage between HEGO connector pin D and battery positive. <i>Does the DVOM show voltage?</i>	Repair the open HEGO heater power supply circuit as necessary. Refer to wiring harness repair	Go to Step (7)
7	• Ignition OFF • Disconnect ECM connector C0J2 • Using a DVOM check for continuity between ECM pin 2 and HEGO connector pin A. <i>Does the DVOM show continuity?</i>	Go to Step (8)	Repair the open sensor ground circuit as necessary. Refer to wiring harness repair.
8	Using a DVOM check for continuity between ECM pin 3 and HEGO connector pin B. <i>Does the DVOM show continuity?</i>	Go to Step (9)	Repair the open sensor signal circuit as necessary. Refer to wiring harness repair
9	Using a DVOM check for continuity between ECM pin 68 and HEGO connector pin D. <i>Does the DVOM show continuity?</i>	Go to Step (10)	Repair the open HEGO heater ground circuit as necessary. Refer to wiring harness repair
10	Using a DVOM check for continuity between HEGO connector pin B and engine ground <i>Does the DVOM show continuity?</i>	Repair the signal shorted to ground circuit. Refer to wiring harness repair.	Go to Step (11)
11	Inspect ECM pins 2,3,68 and HEGO pins A,B,C, and D for damage, corrosion or contamination. <i>Did you find a problem?</i>	Repair the connector as necessary. Refer to wiring harness repair	Go to Step (12)

STEP	ACTION	YES	NO
12	Replace the HEGO sensor <i>Is the replacement complete?</i>	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 run to full operating temperature - Observe the MIL - Observe engine performance - After operating the engine within the test parameters of DTC P0133 check for any stored codes <i>Does the engine operate normally with no stored codes?</i>	System OK	Go to Step (14)
14	Replace the ECM <i>Is the replacement complete?</i>	Go to Step (13)	

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DTC P0134 Oxygen Sensor Insufficient Switching



Conditions for Setting the DTC

- EGO (Exhaust Gas Oxygen) Sensor.
- Check condition - Engine running
- Fault condition - EGO sensor less than 4 cross counts (rich lean transitions) within 30 seconds.
- Engine running for 60 seconds.
- ECT greater than 122° F (50°C) MAP greater than 30 kPa but less than 80 kPa. RPM greater than 700 but less than 3000.
- 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 adaptive block learn. This fault will set if the EGO sensor switching is slow indicating a possible problem with the sensor.

Always run the fuel system diagnostic checks before performing this diagnostic. Never use silicone sprays, lubricants or sealants that are not labeled "oxygen sensor safe." Air leaks at the venturi adapter may also cause the sensor to switch slow.

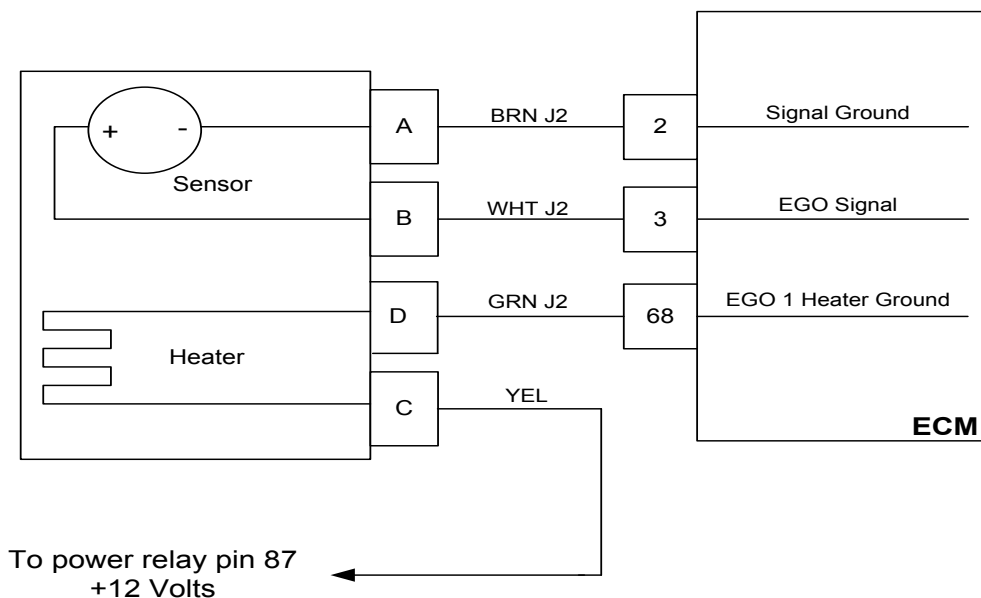
DTC P0134 Oxygen Sensor Insufficient Switching

STEP	ACTION	YES	NO
1	Perform the On-Board (OBD) System Check? <i>Are any other DTCs present?</i>	Go to Step (3)	Go to Step (2)
2	Visually and physically check the following items: • Check for vacuum leaks at the venturi adapter • That the HEGO sensor is installed securely and the wire leads are not damaged or contacting the exhaust manifold or secondary spark plug wires • ECM grounds for being clean and tight • Run the fuel system diagnostic checks <i>Was a repair made?</i>	Go to Step (6)	Go to Step (4)
3	Diagnose any other DTC codes before proceeding with this chart. <i>Have any other DTC codes been detected, diagnosed and repaired?</i>	Go to Step (13)	Go to Step (2)
4	• Ignition ON • Disconnect HEGO sensor wire harness connector C014. • Using a DVOM check for voltage between HEGO connector pins C and D. <i>Do you have voltage?</i>	Go to Step (7)	Go to Step (5)
5	Using a DVOM check for voltage between HEGO connector pin C and engine ground. <i>Does the DVOM show voltage?</i>	Repair the open HEGO heater ground circuit as necessary. Refer to wiring harness repair.	Go to Step (6)
6	Using a DVOM check for voltage between HEGO connector pin D and battery positive. <i>Does the DVOM show voltage?</i>	Repair the open HEGO heater power supply circuit as necessary. Refer to wiring harness repair	Go to Step (7)
7	• Ignition OFF • Disconnect ECM connector C0J2 • Using a DVOM check for continuity between ECM pin 2 and HEGO connector pin A. <i>Does the DVOM show continuity?</i>	Go to Step (8)	Repair the open sensor ground circuit as necessary. Refer to wiring harness repair.
8	Using a DVOM check for continuity between ECM pin 3 and HEGO connector pin B. <i>Does the DVOM show continuity?</i>	Go to Step (9)	Repair the open sensor signal circuit as necessary. Refer to wiring harness repair.
9	Using a DVOM check for continuity between ECM pin 68 and HEGO connector pin D. <i>Does the DVOM show continuity?</i>	Go to Step (10)	Repair the open HEGO heater ground circuit as necessary. Refer to wiring harness repair

10	Using a DVOM check for continuity between HEGO connector pin B and engine ground <i>Does the DVOM show continuity?</i>	Repair the signal shorted to ground circuit. Refer to wiring harness repair.	Go to Step (11)
11	Inspect ECM pins 2,3,68 and HEGO pins A, B, C, and D for damage, corrosion or contamination. <i>Did you find a problem?</i>	Repair the connector as necessary. Refer to wiring harness repair	Go to Step (12)
12	Replace the HEGO sensor <i>Is the replacement complete?</i>	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 run to full operating temperature - Observe the MIL - Observe engine performance - After operating the engine within the test parameters of DTC P0134 check for any stored codes <i>Does the engine operate normally with no stored codes?</i>	System OK	Go to Step (14)
14	Replace the ECM <i>Is the replacement complete?</i>	Go to Step (13)	

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DTC P0135 Oxygen Sensor Heater Duty Cycle High



Conditions for Setting the DTC

- Heated Oxygen Sensor
- Check Condition - Ignition ON
- Fault Condition - HEGO duty cycle greater than 89.5% for more than 120 seconds
- MIL - ON

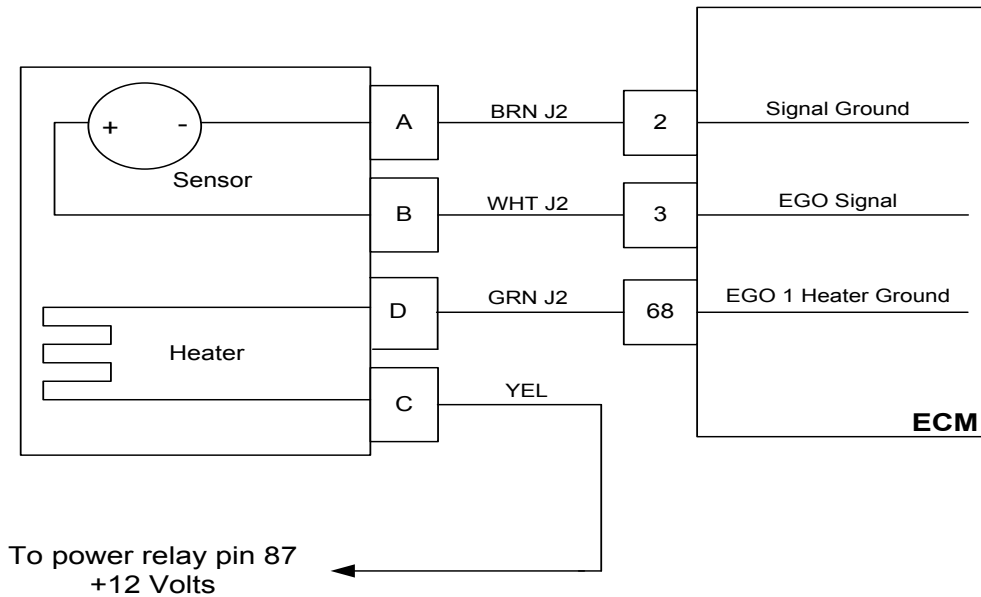
Circuit Description

The EGO sensor (Exhaust Gas Oxygen) sensor is used to determine if the fuel flow to the engine is correct by measuring the oxygen content in the exhaust gas. The EGO sensor uses an internal heating element to keep the sensor active. This fault will set if the ECM detects a problem with the HEGO heater feedback control circuit.

DTC P0135 Oxygen Sensor Heater Duty Cycle High

STEP	ACTION	YES	NO
1	Perform the On-Board (OBD) System Check? <i>Are any other DTCs present?</i>	Go to Step (3)	Go to Step (2)
2	Visually and physically check the following items: That the HEGO sensor electrical connector C014 is not damaged, corroded or contaminated, and is connected properly and securely <i>Was a repair made?</i>	Go to Step (9)	Go to Step (3)
3	Diagnose any other DTC codes before proceeding with this chart. Always repair existing codes starting with the lowest numerical code set first <i>Have any other DTC codes been detected, diagnosed and repaired?</i>	Go to Step (9)	Go to Step (4)
4	- Ignition OFF - Disconnect HEGO connector C014 - Using a DVOM measure the resistance of the HEGO heater (sensor side) between pins C and D (the two white wires) <i>Does the DVOM show a resistance value between 5 and 20 Ohms?</i>	Go to Step (6)	Go to Step (5)
5	Replace EGO 1 sensor <i>Is the replacement complete?</i>	Go to Step (9)	
6	- Disconnect ECM connector C0J2 - Using a high impedance DVOM check for continuity between HEGO connector pin D and ECM pin 68 <i>Does the DVOM show continuity?</i>	Go to Step (7)	Repair the open HEGO heater ground circuit. See wire harness repair.
7	Using a high impedance DVOM check for continuity between HEGO connector pin C and power relay terminal 87 <i>Do you have continuity?</i>	Go to Step (8)	Repair the open HEGO heater power supply circuit. See wire harness repair.
8	Replace the ECM <i>Is the replacement complete?</i>	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 run to full operating temperature - Observe the MIL - Observe engine performance - After operating the engine within the test parameters of DTC-1161 check for any stored codes <i>Does the engine operate normally with no stored codes?</i>	System OK	Go to OBD System Check

DTC P0171 Fuel Trim High



Conditions for Setting the DTC

- Heated Oxygen Sensor
- Check Condition - Engine Running
- Fault Condition - BLM greater than 25%
- MIL - ON

Circuit Description

The EGO (Exhaust Gas Oxygen) 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 BLM (Block Learn Memory). This fault will set if the BLM exceeds 25% fuel correction.

Always run the fuel system diagnostic checks before using the following this diagnostic chart.

EGO Sensor Wires — EGO sensor wires may be misrouted and contacting the exhaust manifold.

Vacuum Leaks — Vacuum leaks, plugged feedback jet and crankcase leaks can cause a lean exhaust condition especially at light load.

Fuel Mixer — The system can be lean due to faulty fuel mixer or venturi adapter seal.

Fuel Pressure — Low regulator inlet/outlet fuel pressure or a faulty fuel pressure regulator 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 EGO 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.

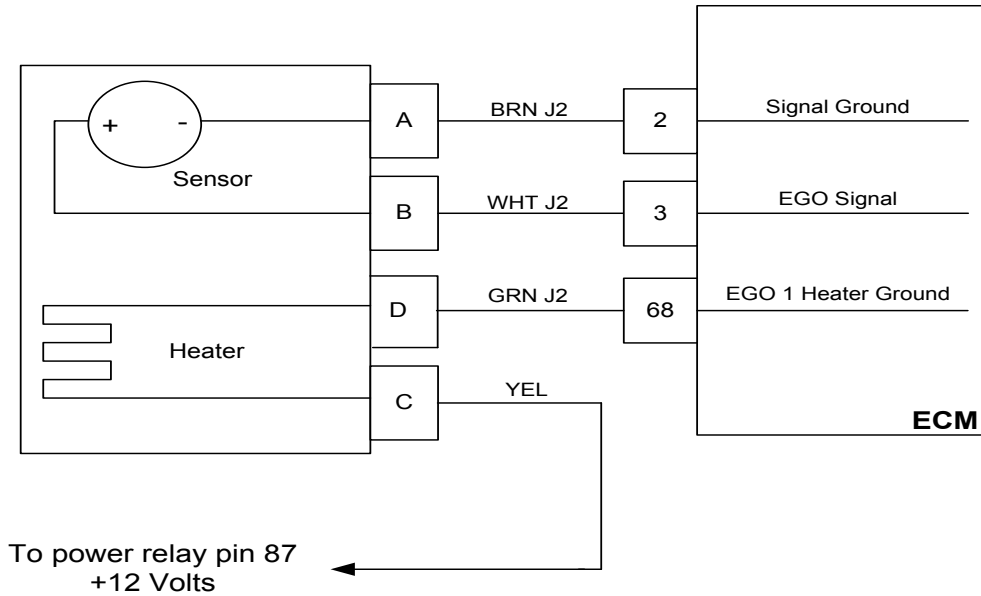
DTC P0171 Fuel Trim High

STEP	ACTION	YES	NO
1	Perform the On-Board (OBD) System Check? <i>Are any other DTCs present?</i>	Go to Step (3)	Go to Step (2)
2	- Visually and physically check the following items: - Power Relay Fuse - The HEGO sensor installed securely and the wire leads not damaged or contacting the exhaust manifold - ECM grounds for being clean and tight - Run the fuel system diagnostic checks <i>Was a repair made?</i>	Go to Step (6)	Go to Step (4)
3	Diagnose any other DTC codes before proceeding with this chart. <i>Have any other DTC codes been detected, diagnosed and repaired?</i>	Go to Step (13)	Go to Step (2)
4	- Ignition ON - Disconnect HEGO sensor wire harness connector C014 - Using a DVOM check for voltage between HEGO connector pins C and D <i>Do you have voltage?</i>	Go to Step (7)	Go to Step (5)
5	Using a DVOM check for voltage between HEGO connector pin C and engine ground <i>Does the DVOM show voltage?</i>	Repair the open HEGO heater ground circuit as necessary. Refer to wiring harness repair.	Go to Step (6)
6	Using a DVOM check for voltage between HEGO connector pin D and battery positive <i>Does the DVOM show voltage?</i>	Repair the open HEGO heater power supply circuit as necessary. Refer to wiring harness repair	Go to Step (7)
7	- Ignition OFF - Disconnect ECM connector C0J2 - Using a DVOM check for continuity between ECM pin 2 and HEGO connector pin A <i>Does the DVOM show continuity?</i>	Go to Step (8)	Repair the open sensor ground circuit as necessary. Refer to wiring harness repair.
8	Using a DVOM check for continuity between ECM pin 3 and HEGO connector pin B <i>Does the DVOM show continuity?</i>	Go to Step (9)	Repair the open sensor signal circuit as necessary. Refer to wiring harness repair.

9	Using a DVOM check for continuity between ECM pin 68 and HEGO connector pin D <i>Does the DVOM show continuity?</i>	Go to Step (10)	Repair the open HEGO heater ground circuit as necessary. Refer to wiring harness repair
10	Using a DVOM check for continuity between HEGO connector pin B and engine ground <i>Does the DVOM show continuity?</i>	Repair the signal shorted to ground circuit. Refer to wiring harness repair.	Go to Step (11)
11	Inspect ECM pins 2,3,68 and HEGO pins A, B, C, D for damage, corrosion or contamination <i>Did you find a problem?</i>	Repair the connector as necessary. Refer to wiring harness repair	Go to Step (12)
12	Replace the HEGO sensor <i>Is the replacement complete?</i>	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 run to full operating temperature - Observe the MIL - Observe engine performance - After operating the engine within the test parameters of DTC P0171 check for any stored codes <i>Does the engine operate normally with no stored codes?</i>	System OK	Go to Step (14)
14	Replace the ECM <i>Is the replacement complete?</i>	Go to Step (13)	

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DTC P0172 Fuel Trim Low



Conditions for Setting the DTC

- Heated Oxygen Sensor
- Check Condition-Engine running
- Fault Condition-BLM (Block Learn Memory) Greater than -25%
- MIL-On

Circuit Description

The EGO (Exhaust Gas Oxygen) 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 BLM (Block Learn Memory). This fault will set if the BLM exceeds -25% fuel corrections.

Fuel System — High secondary fuel pressure will cause the system to run rich. A faulty fuel venturi or pressure regulator may also cause the system to run rich.

FCV — A faulty fuel control valve can cause the system to run rich.

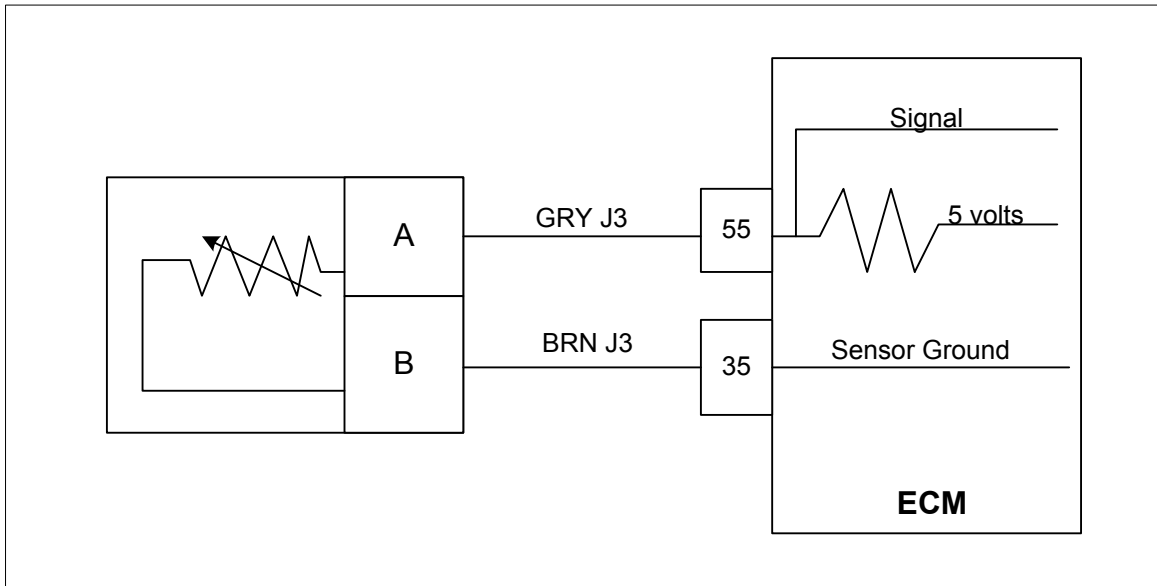
Fuel Quality — A drastic variation in fuel quality (very high butane content) may cause the fuel system to run rich.

Air Filter — A plugged, damaged or modified air filter may cause the system to run rich.

DTC P0172 Fuel Trim Low

STEP	ACTION	YES	NO
1	Perform the On-Board (OBD) System Check? <i>Are any other DTCs present?</i>	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 HEGO 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 <i>Was a repair made?</i>	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	• Ignition OFF • Disconnect EGO sensor wire harness connector C014 • Disconnect ECM wire harness connector C0J2 • Ignition ON • Using a DVOM check for voltage at the HEGO connector pin B and engine ground <i>Do you have voltage?</i>	Repair the circuit short to voltage as necessary. Refer to wiring harness repair.	Go to Step (5)
5	Replace EGO sensor <i>Is the replacement complete?</i>	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 engine to full operating temperature • Observe the MIL • Observe engine performance • After operating the engine within the test parameters of DTC P0172 check for any stored codes <i>Does the engine operate normally with no stored codes?</i>	System OK	Go to OBD System Check

DTC P0217-Coolant Temp High Warning



Conditions for Setting the DTC

- Cylinder head temperature
- Check Condition - Engine running
- Fault Condition - ECT greater than 1.10 volts 219°F (104°C.)
- MIL - ON during active fault

Use the temperature vs. Ohms chart at right to determine the sensor accuracy. Resistance readings should be $\pm 5\%$.

Temp (°F)	Ohms
242.4	101
231.9	121
211.6	175
201.4	209
181.9	302
163.1	434
144.9	625
127.4	901
102.4	1,556
78.9	2,689
49.9	5,576
23.5	11,562
-5.7	28,770
-21.2	49,715
-30.8	71,589
-40.0	99,301

Circuit Description

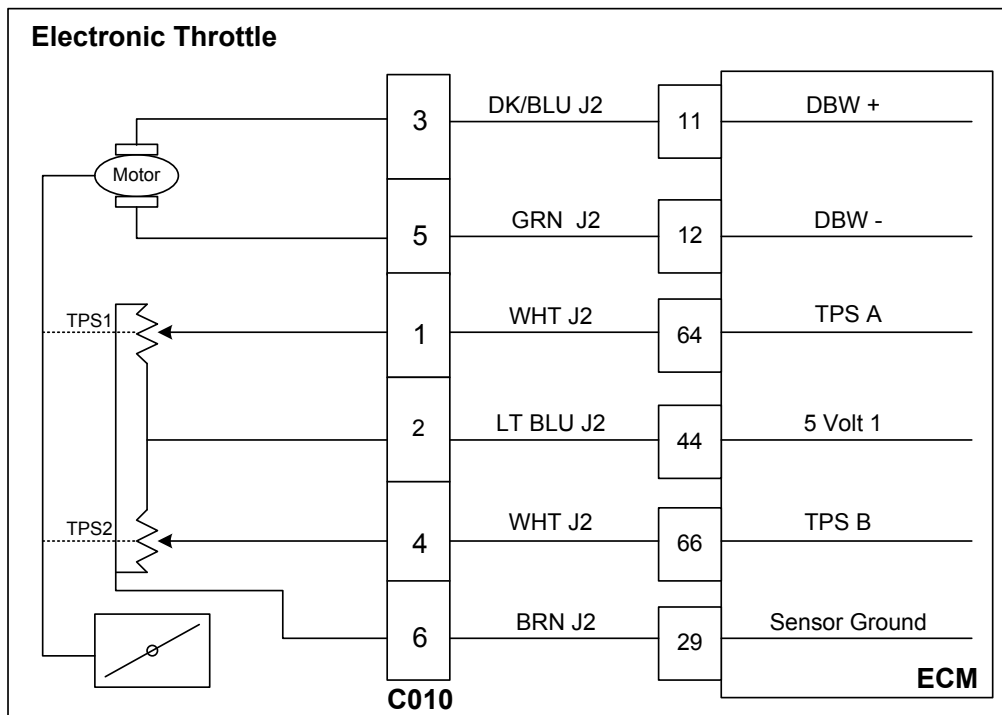
The ECT (Engine Coolant Temperature) sensor is a temperature sensitive resistor located at the cylinder head or near the thermostat housing. It is used for the engine airflow calculation, ignition timing and other temperature dependant functions. This fault will set if the engine temperature exceeds 219°F (104°C.)

DTC P0217-Coolant Temp High Warning

STEP	ACTION	YES	NO
1	Did you perform the On-Board (OBD) System Check?	Go to Step (2)	Go to OBD System Check Section
2	- Ignition ON - DST (Diagnostic Scan Tool) connected in System Data Mode - Clear DTC P0217 - Run the engine to full operating temperature, and then load the engine to at least 50% load. <i>Does the DST display ECT temperature of 219°F (104°C) or greater with the engine running at 50% load ?</i>	Go to Step (3)	Intermittent problem. Go to Intermittent section
3	Verify with a temperature gauge that the engine coolant is 219°F (104°C) or greater <i>Does the temperature gauge indicate 219°F (104°C) or greater ?</i>	Repair the Cooling system	Go to Step (4)
4	Verify ECT circuit function. Follow the DTC chart procedure for DTC P0117 ECT/CHT Low Voltage		

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DTC P0222 ETC TPS 2 Range



Conditions for Setting the DTC

- Electronic Throttle Control
- Check Condition - Ignition ON
- Fault Condition - TPS 2 voltage below .25 TPS 2 voltage greater than 4.95
- MIL - ON during active fault

Circuit Description

Dual throttle position sensors (TPS) are used with the electronic throttle control (ETC) to determine throttle plate position. The TPS values are used by the ECM to determine if the throttle is opening and closing as commanded. The ECM runs several checks at ignition on to validate the working condition of the ETC. This fault will set if the ECM detects a problem with the TPS sensor range.

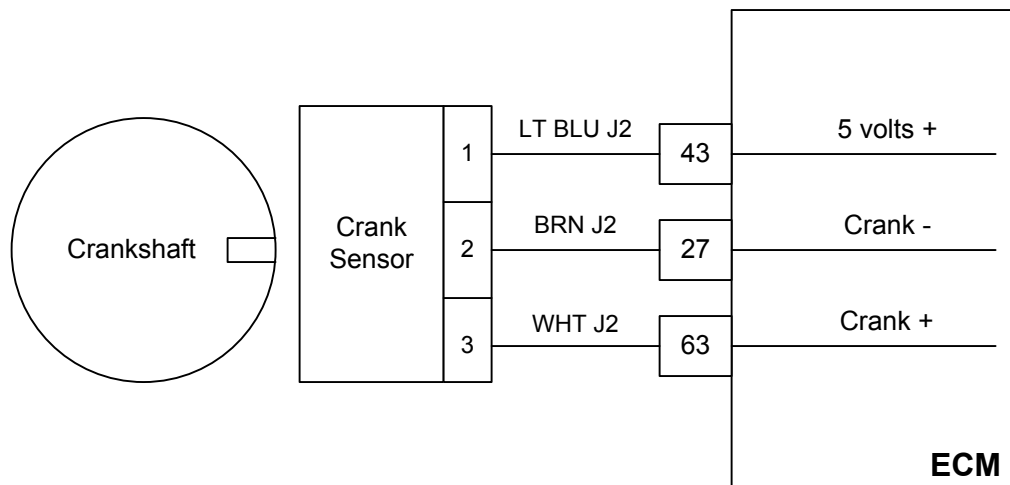
DTC P0222 ETC TPS 2 Range

STEP	ACTION	YES	NO
1	<i>Did you perform the On-Board (OBD) System Check?</i>	Go to Step (2)	Go to OBD System Check Section
2	- Ignition ON - DST (Diagnostic Scan Tool) connected in data stream mode. - Clear DTC P0222 - Start the engine <i>Does DTC P0222 reset?</i>	Go to Step (3)	Intermittent problem. Go to Intermittent section
3	- Ignition OFF - Disconnect electronic throttle connector C010 - Disconnect ECM wire harness connector C0J2 - Inspect the electronic throttle connector and ECM wire harness connector for damage corrosion or contamination <i>Did you find a problem?</i>	Correct the problem as required. See wire harness repair.	Go to Step (4)
4	- Ignition OFF - Disconnect electronic throttle connector C010 - Disconnect ECM wire harness connector C0J2 Using a DVOM check for continuity between electronic throttle connector pin 6 and ECM connector pin 29 <i>Does the DVOM show continuity?</i>	Go to Step (5)	Repair the open ground circuit as necessary. Refer to Wiring Repairs.
5	Using a DVOM check for continuity between electronic throttle connector pin 4 and ECM connector pin 66. <i>Does the DVOM show continuity?</i>	Go to Step (6)	Repair the open circuit as necessary. Refer to Wiring Repairs.
6	Using a DVOM check for continuity between electronic throttle connector pin 4 and engine ground <i>Does the DVOM show continuity?</i>	Repair the shorted to ground TPS circuit as necessary. Refer to Wiring Repairs.	Go to Step (7)
7	Using a DVOM check for continuity between electronic throttle connector pin 2 and ECM connector pin 44 <i>Does the DVOM show continuity?</i>	Go to Step (8)	Repair the open 5 volt circuit as necessary. Refer to Wiring Repairs.
8	Using a DVOM check for continuity between electronic throttle connector pin 2 and engine ground <i>Does the DVOM show continuity?</i>	Repair the shorted 5 volt circuit to ground as necessary. Refer to Wiring Repairs.	Go to Step (9)
9	Using a DVOM check for continuity between electronic throttle connector pin 1 and ECM connector pin 64 <i>Does the DVOM show continuity?</i>	Go to Step (10)	Repair the open TPS circuit as necessary. Refer to Wiring Repairs.

10	Using a DVOM check for continuity between electronic throttle connector pin 1 and engine ground <i>Does the DVOM show continuity?</i>	Repair the shorted TPS circuit to ground as necessary. Refer to Wiring Repairs	Go to Step (11)
11	Using a DVOM check for continuity between electronic throttle connector pin 5 and ECM connector pin 12 <i>Does the DVOM show continuity?</i>	Go to Step (12)	Repair the open DBW circuit as necessary. Refer to Wiring Repairs
12	Using a DVOM check for continuity between electronic throttle connector pin 3 and ECM connector pin 11 <i>Does the DVOM show continuity?</i>	Go to Step (13)	Repair the open DBW circuit as necessary. Refer to Wiring Repairs.
13	Using a DVOM check for continuity between electronic throttle connector pin 3 and engine ground <i>Does the DVOM show continuity?</i>	Repair the shorted DBW circuit to ground as necessary. Refer to Wiring Repairs	Go to Step (14)
14	- Ignition ON - Using a DVOM check for voltage between electronic throttle connector pin 1 and engine ground <i>Does the DVOM show voltage?</i>	Repair the TPS signal shorted to voltage as necessary. Refer to Wiring Repairs.	Go to Step (15)
15	Replace throttle <i>Is the replacement complete?</i>	Go to Step (16)	
16	- 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 run to full operating temperature - Observe the MIL - Observe engine performance - After operating the engine within the test parameters of DTC P0222 check for any stored codes <i>Does the engine operate normally with no stored codes?</i>	System OK	Go to Step (17)
17	Replace the ECM <i>Is the replacement complete?</i>	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 run to full operating temperature - Observe the MIL - Observe engine performance - After operating the engine within the test parameters of DTC P0222 check for any stored codes <i>Does the engine operate normally with no stored codes?</i>	System OK	Go to OBD System Check

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DTC P0337 Crank Sync Fault



Conditions for setting the DTC

- CKP (Crankshaft Position Sensor)
- Check Condition - Engine Cranking or Running
- Fault Condition - Crank Sync Loss for more than 25 ms
- MIL - ON during active fault

Circuit Description

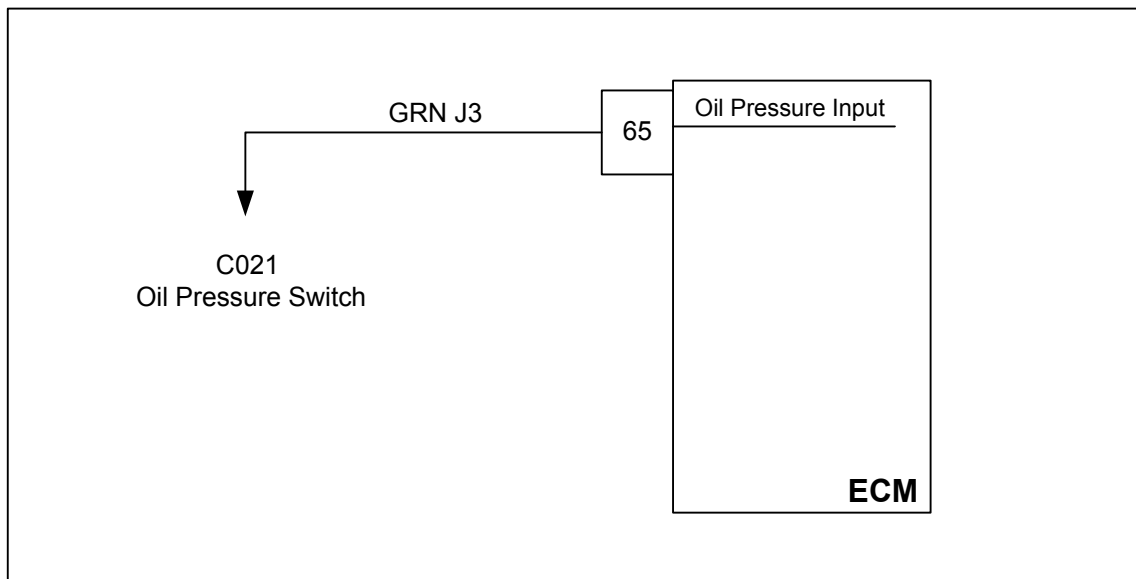
The CKP is a 5 volt powered sensor that picks up signals from the crankshaft. A pulse wheel located on the crankshaft is used with the CKP sensor to measure engine rpm and its signal is used to synchronize the ignition and fuel system. This fault will set if no signal is present for 25 ms or longer.

Poor engine grounds, open spark plug wires faulty cap and rotor are known causes of EMI that may set this code. If this code is set with DTC P0642 run the diagnostic chart for this code first as a failure of the 5 volt circuit may cause this code to set.

DTC P0337 Crank Sync Fault

STEP	ACTION	YES	NO
1	<i>Did you perform the On-Board (OBD) System Check?</i>	Go to Step (2)	Go to OBD System Check Section
2	Check that the system power and ground terminals C002, C003,C0012 and C016 are clean and tight <i>Are the power ground terminals clean and tight?</i>	Go to Step (3)	Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical
3	- Ignition OFF - Disconnect ECM connector C0J2 - Disconnect CKP (Crankshaft Position Sensor) connector C013 - Using a DVOM check for continuity between CKP connector pin 1 and ECM pin 43 <i>Does the DVOM show continuity?</i>	Go to Step (4)	Repair the open circuit as necessary. Refer to Wiring harness Repair.
4	Using a DVOM check for continuity between CKP connector pin 2 and ECM pin 27 <i>Does the DVOM show continuity?</i>	Go to Step (5)	Repair the open circuit as necessary. Refer to Wiring harness Repair.
5	Using a DVOM check for continuity between CKP connector pin 3 and ECM pin 63 <i>Does the DVOM show continuity?</i>	Go to Step (6)	Repair the open circuit as necessary. Refer to Wiring harness Repair
6	Using a DVOM check for continuity between CKP connector pins 2 and 3 <i>Does the DVOM show continuity?</i>	Repair the shorted circuit as necessary. Refer to Wiring harness Repair	Go to Step (7)
7	Using a DVOM check for continuity between CKP connector pin 2 and engine ground <i>Does the DVOM show continuity?</i>	Repair the shorted to ground circuit as necessary. Refer to Wiring harness Repair	Go to Step (8)
8	Using a DVOM check for continuity between CKP connector pin 3 and engine ground <i>Does the DVOM show continuity?</i>	Repair the shorted to ground circuit as necessary. Refer to Wiring harness Repair	Go to Step (9)
9	Replace CKP sensor <i>Is the replacement complete?</i>	Go to Step (11)	
10	Replace ECM <i>Is the replacement complete?</i>	Go to Step (12)	
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 run to full operating temperature - Observe the MIL - Observe engine performance - After operating the engine within the test parameters of DTC P0337 check for any stored codes <i>Does the engine operate normally with no stored codes?</i>	System OK	Go to Step (10)
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 run to full operating temperature - Observe the MIL - Observe engine performance - After operating the engine within the test parameters of DTC P0337 check for any stored codes <i>Does the engine operate normally with no stored codes?</i>	System OK	Go to OBD System Check

DTC 524-Oil Pressure Low Warning



Conditions for Setting the DTC

- Engine Low Oil Pressure Signal
- Check Condition - Engine running for greater than 10 seconds with engine speed greater than 500 rpm.
- Fault Condition - No oil pressure signal for more than 5 seconds

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. This fault will set if the oil pressure switch remains closed with the engine running. The switch is set to open above 6 PSI.

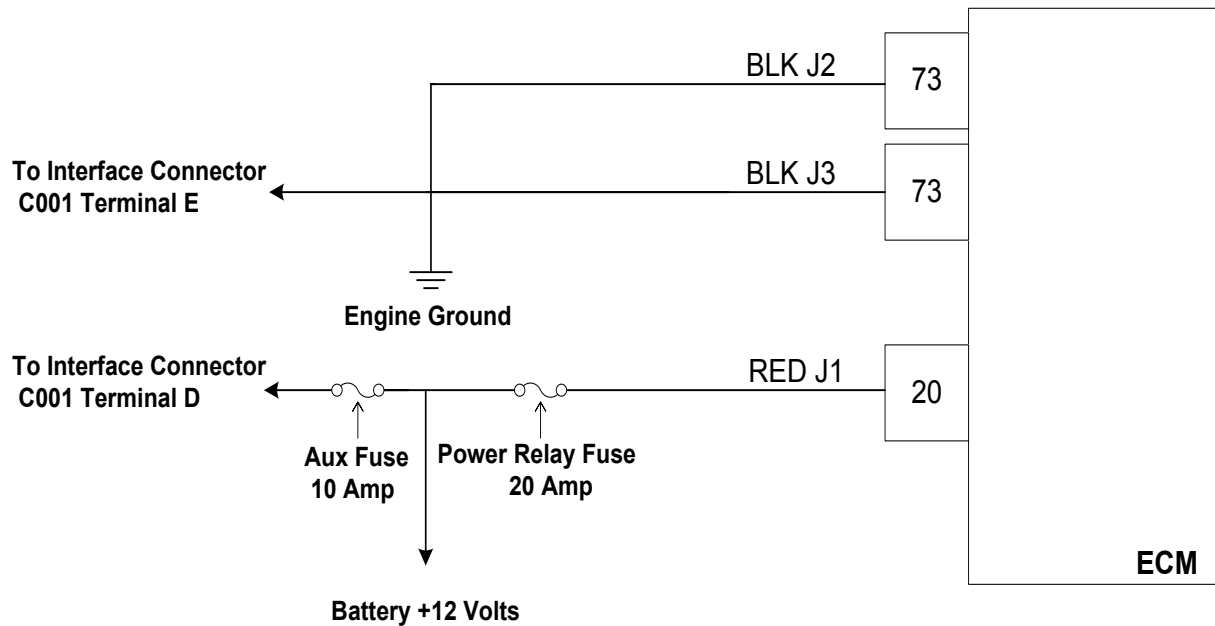
Circuit Description

Never assume the fault is due to an electrical malfunction. Low oil pressure can damage the engine. Verify oil pressure before proceeding with this diagnostic.

DTC 524-Oil Pressure Low Warning

STEP	ACTION	YES	NO
1	<i>Did you perform the On-Board (OBD) System Check?</i>	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 with this chart. Oil pressure must remain above 6 psi. <i>Does the engine have oil pressure above 6 psi?</i>	Go to Step (3)	Repair faulty Oiling System
3	- Ignition ON, Engine Running DST connected in stem Data Mode - Clear DTC 524 - Warm the engine by idling until the ECT temperature is above 160°F (71°C.) and has been running for at least one minute - Increase engine speed above 500 RPM <i>Does DTC 524 reset?</i>	Go to Step (4)	Intermittent problem. Go to Intermittent section
4	- Clear DTC P0524 - Key OFF - Disconnect oil pressure switch connector C021 and isolate the connector from engine ground - Start and run the engine <i>Does DTC P0524 reset?</i>	Go to Step (6)	Go to Step (5)
5	Replace oil pressure switch <i>Is the replacement complete?</i>	Go to Step (9)	
6	- Ignition OFF - Disconnect ECM harness connector C0J3 - Using a DVOM check for continuity between the oil pressure switch connector pin and engine ground <i>Does the DVOM show continuity?</i>	Repair the shorted to ground oil pressure circuit as necessary. Refer to Wiring Repairs	Go to Step (7)
7	Inspect ECM connector pin 65 for damage corrosion or contamination <i>Did you find a problem?</i>	Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical	Go to Step (8)
8	Replace ECM <i>Is the replacement complete?</i>	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 run to full operating temperature - Observe the MIL - Observe engine performance - After operating the engine within the test parameters of DTC-P0524 check for any stored codes <i>Does the engine operate normally with no stored codes?</i>	System OK	Go to OBD System Check

DTC P0562 System Voltage Low Warning



Conditions for Setting the DTC

- System Voltage
- Check Condition - Ignition ON
- Fault Condition-System - voltage less than 10 volts
- MIL - ON

Circuit Description

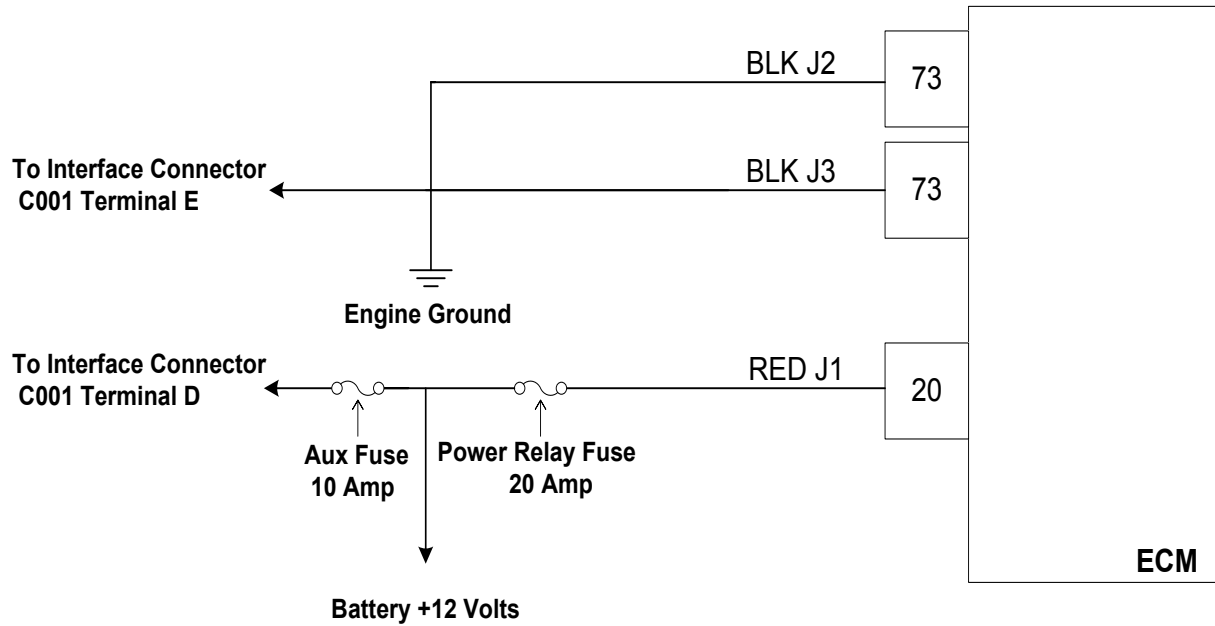
The battery voltage powers the ECM and must be measured to correctly operate drivers, trim valves and ignition coils. This fault will set if the ECM detects a system supply voltage less than 10 volts.

Check battery condition and cables, charging system and starter condition before proceeding with this diagnostic chart.

DTC P0562 System Voltage Low Warning

STEP	ACTION	YES	NO
1	<i>Did you perform the On-Board (OBD) System Check?</i>	Go to Step (2)	Go to OBD System Check Section
2	- Ignition On, Engine Running - DST (Diagnostic Scan Tool) connected in System Data Mode - Run engine greater than 1500 rpm. <i>Does DST display system voltage greater than 16 volts?</i>	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 1500 rpm <i>Is it greater than 16 volts?</i>	Go to Step (4)	
4	Repair the charging system <i>Has the charging system been repaired?</i>	Go to Step (6)	
5	Replace ECM <i>Is the replacement complete?</i>	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 run to full operating temperature - Observe the MIL - Observe engine performance - After operating the engine within the test parameters of DTC P0562 check for any stored codes <i>Does the engine operate normally with no stored codes?</i>	System OK	Go to OBD System Check

DTC P0563 System Voltage High Warning



Conditions for Setting the DTC

- System Voltage to ECM
- Check Condition - Ignition ON
- Fault Condition-System - battery voltage at ECM greater than 16 volts
- MIL - ON for active fault

Circuit Description

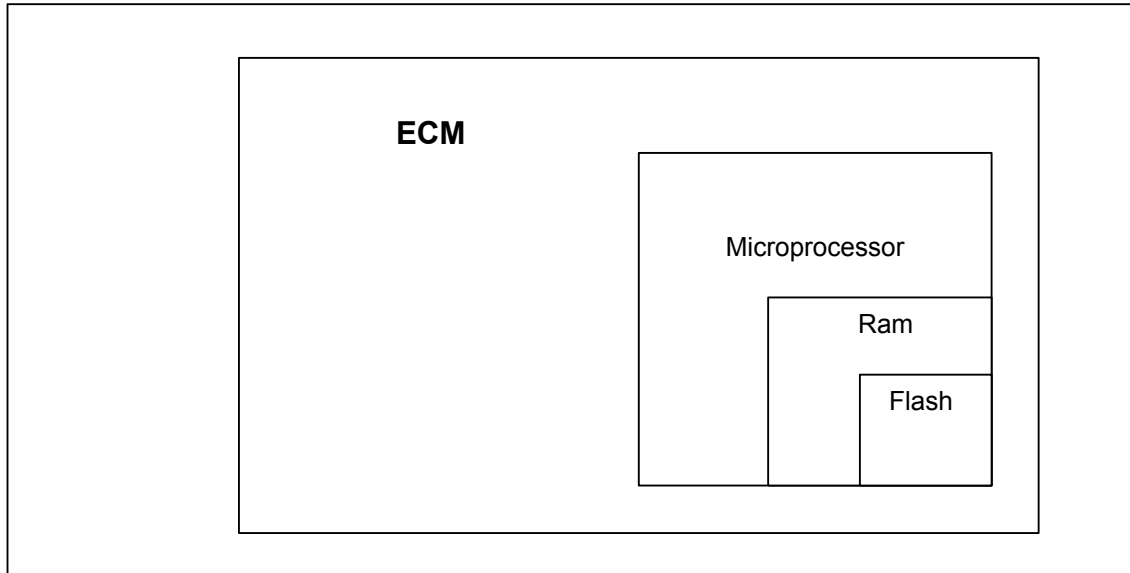
The battery voltage powers the ECM and must be measured to correctly operate drivers, trim valves and ignition coils. This fault will set if the ECM detects a supply voltage greater than 16 volts.

NOTICE: Avoid the use of “boost start” battery chargers. Check the condition of the charging system before proceeding with this diagnostic.

DTC P0563 System Voltage High Warning

STEP	ACTION	YES	NO
1	<i>Did you perform the On-Board (OBD) System Check?</i>	Go to Step (2)	Go to OBD System Check Section
2	- Ignition ON, Engine Running - DST (Diagnostic Scan Tool) connected in System Data Mode - Start and run the engine. <i>Does DST display system voltage greater than 16 volts?</i>	Go To Step (3)	Intermittent problem. Go to Engine Electrical Intermittent section
3	Check voltage at the battery terminals with DVOM with the engine running. <i>Does the DVOM show voltage greater than 16 volts?</i>	Go to Step (4)	Go to Step (5)
4	Repair the charging system <i>Has the charging system been repaired?</i>	Go to Step (6)	
5	Replace ECM <i>Is the replacement complete?</i>	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 to full operating temperature - Observe the MIL - Observe engine performance - After operating the engine within the test parameters of DTC P0563 check for any stored codes <i>Does the engine operate normally with no stored codes?</i>	System OK	Go to OBD System Check

DTC P0601 Cal Memory Failure



Conditions for Setting the DTC

- Engine Control Module
- Check Condition - Ignition ON
- Fault Condition - Internal microprocessor error
- MIL - ON

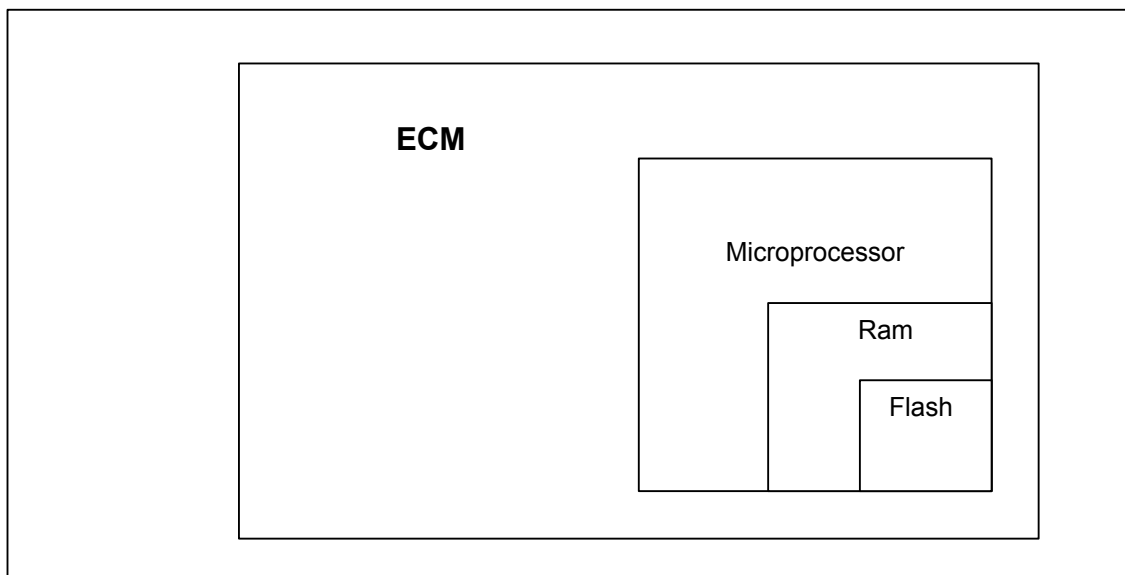
Circuit Description

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. This diagnostic applies to internal microprocessor integrity conditions within the engine control module (ECM). This diagnostic also addresses if the ECM is not programmed or the program checksum does not match or has become corrupted. Always verify that the ECM was flashed with the proper calibration files before using the following diagnostic chat.

DTC P0601 Cal Memory Failure

STEP	ACTION	YES	NO
1	<i>Did you perform the On-Board (OBD) System Check?</i>	Go to Step (2)	Go to OBD System Check Section
2	- Ignition ON - DST (Diagnostic Scan Tool) connected in System Data Mode - Clear system fault code - Ignition OFF - Ignition ON <i>Does DTC P0601 reset with the Ignition ON?</i>	Go to Step (3)	Intermittent problem. Go to Intermittent section
3	Check ECM power and ground connections at C001 pins E and F, C002, C012 and C016 <i>Did the power and ground circuits check OK?</i>	Go to Step (4)	Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical
4	- Reflash the ECM with the correct calibration file - Repeat all in step (2) <i>Does DTC P0601 still set?</i>	Go to Step (5)	Go to Step (6)
5	Replace ECM <i>Is the replacement complete?</i>	Go to Step (5)	
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 run to full operating temperature - Observe the MIL - Observe engine performance - After operating the engine within the test parameters of DTC P0601 check for any stored codes <i>Does the engine operate normally with no stored codes?</i>	System OK	Go to OBD System Check

DTC P0606 MHC Failure



Conditions for Setting the DTC

- Engine Control Module
- Check Condition - Key ON
- Fault Condition - Malfunction in control module
- MIL- ON

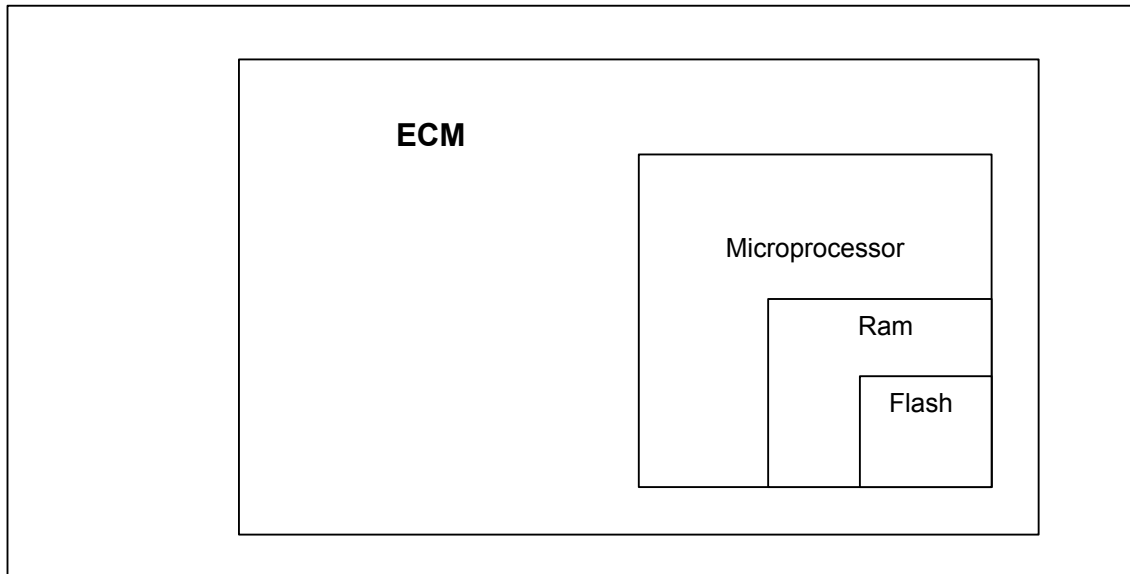
Circuit Description

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. This diagnostic applies to internal microprocessor integrity conditions within the engine control module (ECM). This diagnostic also addresses if the ECM is not programmed or the program checksum does not match or has become corrupted. Always verify that the ECM was flashed with the proper calibration files before using the following diagnostic chat.

DTC P0606 MHC Failure

STEP	ACTION	YES	NO
1	<i>Did you perform the On-Board (OBD) System Check?</i>	Go to Step (2)	Go to OBD System Check Section
2	- Ignition On - DST (Diagnostic Scan Tool) connected in System Data Mode - Clear system fault code - Ignition OFF - Ignition ON <i>Does DTC P0606 reset with the Ignition ON?</i>	Go to Step (3)	Intermittent problem. Go to Intermittent section
3	Check ECM power and ground connections at C001 pins E and F, C002, C012 and C016 <i>Did the power and ground circuits check OK?</i>	Go to Step (4)	Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.
4	- Reflash the ECM with the correct calibration file - Repeat all in step (2). <i>Does DTC P0606 still set?</i>	Go to Step (5)	Go to Step (6)
5	Replace ECM <i>Is the replacement complete?</i>	Go to Step (5)	
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 run to full operating temperature - Observe the MIL - Observe engine performance - After operating the engine within the test parameters of DTC P0606 check for any stored codes <i>Does the engine operate normally with no stored codes?</i>	System OK	Go to OBD System Check

DTC P06B8 NV RAM Failure



Conditions for Setting the DTC

- Engine Control Module
- Check Condition - Ignition ON
- Fault Condition - NV (non volatile) RAM Checksum does not match
- MIL- ON

Circuit Description

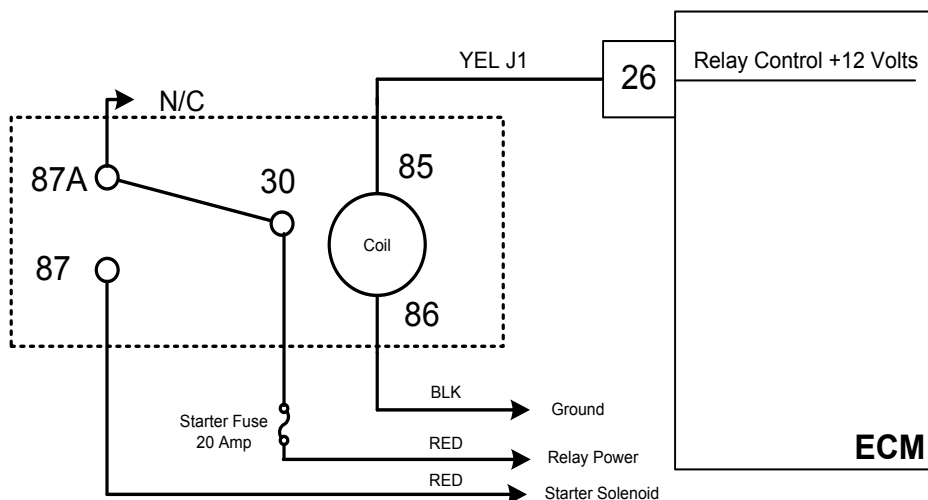
The ECM has several internal checks that must be satisfied each time an instruction is executed. Several different things can happen within the microprocessor that will cause this fault. This diagnostic applies to internal microprocessor integrity conditions within the engine control module (ECM). This diagnostic also addresses if the ECM is not programmed or the program check/sum does not match or has become corrupted. Always verify that the ECM was flashed with the proper calibration files before using the following diagnostic chat.

DTC P06B8 NV RAM Failure

STEP	ACTION	YES	NO
1	<i>Did you perform the On-Board (OBD) System Check?</i>	Go to Step (2)	Go to OBD System Check Section
2	- Ignition ON - DST (Diagnostic Scan Tool) connected in System Data Mode - Clear system fault code - Ignition OFF - Ignition ON <i>Does DTC P06B8 reset with the Key ON?</i>	Go to Step (3)	Intermittent problem. Go to Intermittent section
3	Check the system power and ground connections at C001 pins E and F, C002, C012 and C016 <i>Did the power and ground circuits check OK?</i>	Go to Step (4)	Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical
4	- Reflash the ECM with the correct calibration file - Repeat all in step (2) <i>Does DTC P06B8 still set?</i>	Go to Step (5)	Go to Step (6)
5	Replace ECM <i>Is the replacement complete?</i>	Go to Step (5)	
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 engine to full operating temperature - Observe the MIL - Observe engine performance - After operating the engine within the test parameters of DTC P06B8 check for any stored codes <i>Does the engine operate normally with no stored codes?</i>	System OK	Go to OBD System Check

DTC P0616 Starter Relay HS Driver Short Low

Starter Relay



Conditions for Setting the DTC

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

Circuit Description

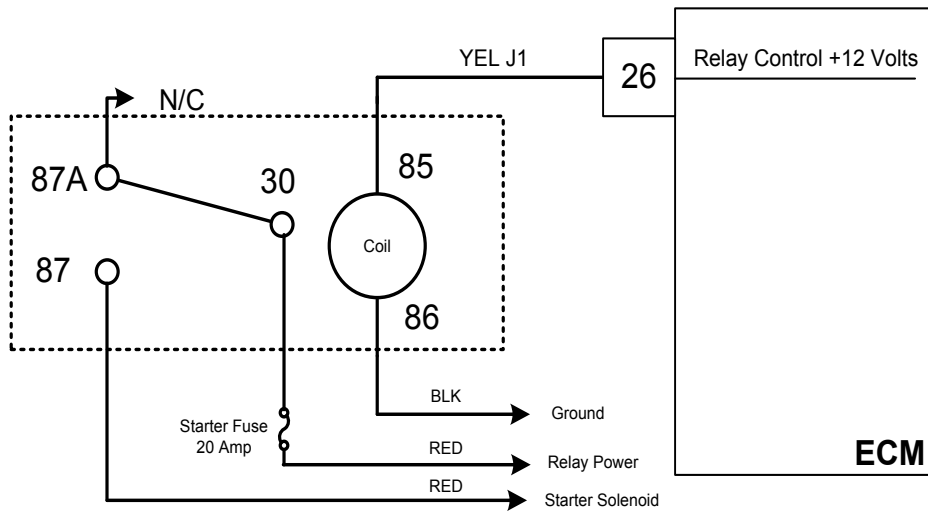
The power relay switches power out to various sensors, actuators and solenoids in the fuel system. This fault will set if the ECM detects a short circuit to power on the relay control output.

DTC P0616 Starter Relay HS Driver Short Low

STEP	ACTION	YES	NO
1	<i>Did you perform the On-Board (OBD) System Check?</i>	Go to Step (2)	Go to OBD System Check Section
2	- Key On, DST connected in the System Data mode - Clear DTC 616 - Start the engine <i>Does DTC 616 reset?</i>	Go to Step (3)	Intermittent problem. Go to Intermittent section
3	- Disconnect ECM connector C001 - Using a DVOM check the resistance value between ECM pin 26 and engine ground <i>Is the resistance less than 60 ohms?</i>	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 pin 26 and engine ground <i>Is the resistance less than 60 ohms?</i>	Repair the shorted to ground relay control circuit as necessary. See wiring harness repairs	Go to step (5)
5	Replace the power relay <i>Is the replacement complete?</i>	Go to step (7)	
6	Replace ECM <i>Is the replacement complete?</i>	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 run to full operating temperature - Observe the MIL - Observe engine performance - After operating the engine within the test parameters of DTC-616 check for any stored codes <i>Does the engine operate normally with no stored codes?</i>	System OK	Go to OBD System Check

DTC P0617 Starter Relay HS Driver Short High/Open

Starter Relay



Conditions for Setting the DTC

- Power relay check
- Check Condition - Ignition ON
- Fault Condition - Relay control circuit at zero volts

Circuit Description

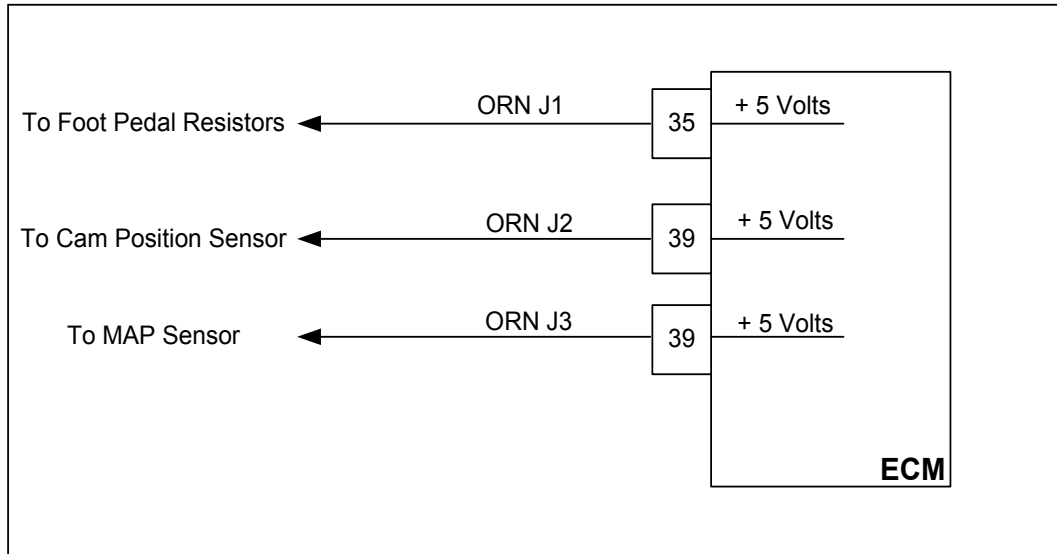
The power relay switches power out to various sensors, actuators and solenoids in the fuel system. This fault will set if the ECM detects a short circuit to power or open circuit on the relay control output.

NOTICE: 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°F (-7° and 38°C.)

DTC P0617 Starter Relay HS Driver Short High/Open

STEP	ACTION	YES	NO
1	<i>Did you perform the On-Board (OBD) System Check?</i>	Go to Step (2)	Go to OBD System Check Section
2	- DST connected and in the system data mode - Ignition OFF - Remove the power relay from the fuse block - Using a DVOM check the resistance of the relay coil between terminals 85 and 86 <i>Is the resistance value greater than 125 ohms?</i>	Go to Step (3)	Go to Step (4)
3	Replace the power relay <i>Is the replacement complete?</i>	Go to Step (11)	
4	- Disconnect ECM connector C0J1 - Using a DVOM check for continuity between ECM pin 26 and terminal 85 for the power relay at the fuse box <i>Does the DVOM show continuity?</i>	Go to Step (5)	Repair the open power relay control circuit as required. See wiring harness repairs
5	Using a DVOM check for continuity between engine ground and terminal 86 for the power relay at the fuse box <i>Does the DVOM show continuity?</i>	Go to Step (6)	Repair the open power relay control circuit as required. See wiring harness repairs
6	- Ignition ON - Using a DVOM check for voltage between engine ground and terminal 86 for the power relay at the fuse box <i>Does the DVOM show voltage?</i>	Repair the shorted to power relay control circuit as required. See wiring harness repairs	Go to Step (7)
7	Using a DVOM check for voltage between engine ground and terminal 85 for the power relay at the fuse box <i>Does the DVOM show voltage?</i>	Repair the shorted to power relay control circuit as required. See wiring harness repairs	Go to Step (8)
8	Replace the power relay <i>Is the replacement complete?</i>	Go to Step (10)	
9	Replace the ECM <i>Is the replacement complete?</i>	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 run to full operating temperature - Observe the MIL - Observe engine performance - After operating the engine within the test parameters of DTC P0617 check for any stored codes <i>Does the engine operate normally with no stored codes?</i>	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 run to full operating temperature - Observe the MIL - Observe engine performance - After operating the engine within the test parameters of DTC P0617 check for any stored codes <i>Does the engine operate normally with no stored codes?</i>	System OK	Go to OBD System Check

DTC P0642 5 Volt Buff A 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 4.43 volts
- MIL - ON

Circuit Description

The 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 these powered sensors used 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 A is below 4.43 volts.

DTC P0642 5 Volt Buff A Reference Low

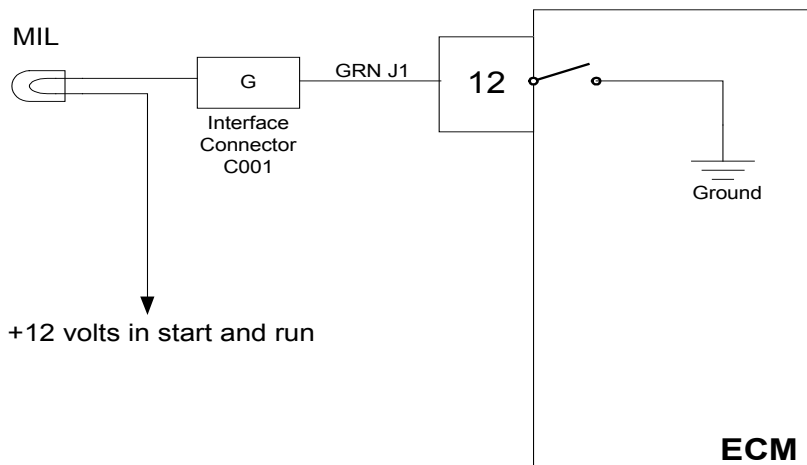
STEP	ACTION	YES	NO
1	<i>Did you perform the On-Board (OBD) System Check?</i>	Go to Step (2)	Go to OBD System Check Section
2	- Engine Running - DST (Diagnostic Scan Tool) connected in System Fault Mode <i>Does DST display DTC P0642?</i>	Go to Step (3)	Intermittent problem. Go to Intermittent section
3	- Ignition OFF - Disconnect ECM connector C0J1 - Using DVOM check for continuity between ECM pin 35 and ECM pin 37engine ground <i>Does the DVOM show a resistance value of 4.1K Ohms $\pm$10%</i>	Go to Step (4)	Repair the open 5 volt circuit. Refer to wire harness repair section
4	Using a DVOM check between ECM pin 35 and engine ground <i>Does the DVOM show continuity?</i>	Repair the shorted 5 volt circuit. Refer to wire harness repair section	Go to Step (5)
5	- Disconnect the ECM connector C0J2 - Disconnect the cam sensor connector C015 - Using a DVOM check for continuity between ECM pin 39 and cam sensor pin C <i>Does the DVOM show continuity?</i>	Go to Step (6)	Repair the open 5 volt circuit. Refer to wire harness repair section
6	Using a DVOM check between ECM pin 35 and engine ground <i>Does the DVOM show continuity?</i>	Repair the shorted 5 volt circuit. Refer to wire harness repair section	Go to Step (7)
7	- Disconnect the ECM connector C0J3 - Disconnect the TMAP sensor connector C020 - Using a DVOM check for continuity between ECM connector pin 39 and TMAP connector pin 3 <i>Does the DVOM show continuity?</i>	Go to Step (8)	Repair the open 5 volt circuit. Refer to wire harness repair section
8	Using a DVOM check between ECM pin 35 and engine ground <i>Does the DVOM show continuity?</i>	Repair the shorted 5 volt circuit. Refer to wire harness repair section	Go to Step (9)
9	- While monitoring DVOM for continuity between ECM 5 volt reference and engine ground - Disconnect each sensor (below) one at a time to find the shorted 5 volt reference. When continuity to engine 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. - TMAP - Camshaft Sensor <i>While disconnecting each sensor one at a time did you lose continuity?</i>	Go to Step (10)	Repair or replace shorted wire harness or foot pedal resistor block
10	Replace the last disconnected sensor <i>Is the replacement complete?</i>	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 run to full operating temperature - Observe the MIL - Observe engine performance - After operating the engine within the test parameters of DTC P0642 check for any stored codes <i>Does the engine operate normally with no stored codes?</i>	System OK	Go to Step (12)
12	Replace the ECM <i>Is the replacement complete?</i>	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 run to full operating temperature - Observe the MIL - Observe engine performance - After operating the engine within the test parameters of DTC P0642 check for any stored codes <i>Does the engine operate normally with no stored codes?</i>	System OK	Go to OBD System check

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DTC P0650 MIL Driver Shorted Low/Open



Conditions for setting the DTC

- MIL check
- Check Condition - Ignition ON
- Fault Condition - ECM MIL circuit shorted low or open
- MIL Command - ON

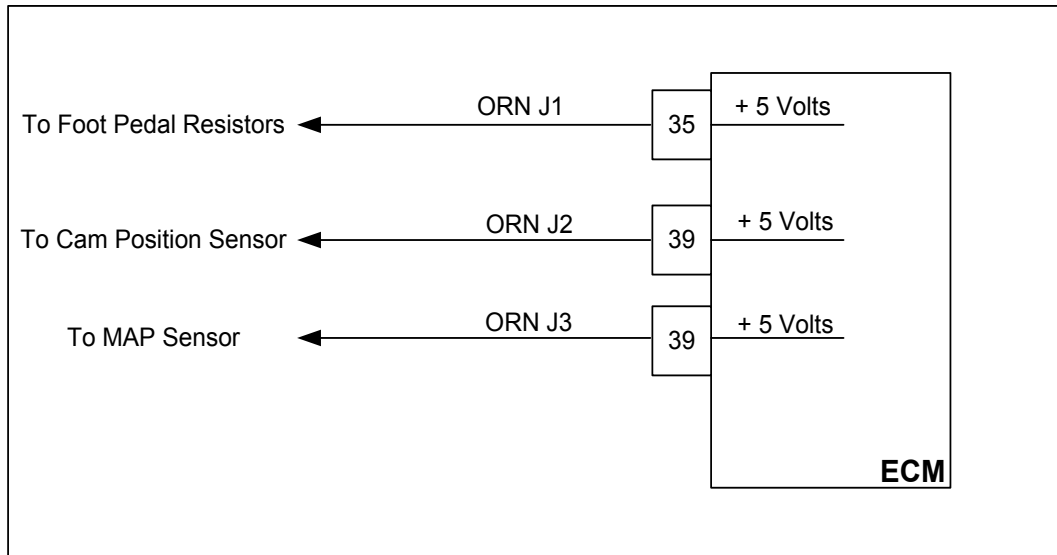
Circuit Description

The electrical schematic above shows the MIL power source supplied to the lamp. The ECM completes the circuit to ground to turn the MIL ON. This fault will set if the ECM MIL control circuit is open or shorted low.

DTC P0650 MIL Driver Shorted Low/Open

STEP	ACTION	YES	NO
1	<i>Did you perform the On-Board (OBD) System Check?</i>	Go to Step (2)	Go to OBD System Check Section
2	- Ignition ON, Engine Running - DST (Diagnostic Scan Tool) connected In System Data Mode - Clear system fault code - Ignition OFF - Ignition ON <i>Does DTC P0650 reset?</i>	Go to Step (3)	Intermittent problem. Go to Intermittent section
3	- Remove the MIL bulb - Inspect the MIL bulb socket - Using a DVOM check for continuity through the bulb <i>Do you have continuity?</i>	Go to Step (5)	Go to Step (4)
4	Replace the open MIL bulb or faulty socket <i>Is the replacement complete?</i>	Go to Step (8)	
5	- Ignition OFF - Reinstall the bulb or driver device - Disconnect the interface connector C001 - Using a DVOM check for continuity between Genset interface connector pin G and battery positive <i>Do you have continuity?</i>	Go to Step (6)	Repair the open circuit as required. See wire harness repair
6	- Disconnect ECM wire harness connector C0J1 - Using a DVOM check for continuity between ECM harness connector pin 12 and Genset interface connector pin G <i>Do you have continuity?</i>	Go to Step (7)	Repair the open circuit as required. See wire harness repair
7	Inspect ECM wire harness connector pin 12 and Genset interface connector pin G for damage, corrosion or contamination <i>Did you find a problem?</i>	Correct the problem as required. See wiring harness repair	Go to Step (8)
8	Replace The ECM <i>Is the replacement complete?</i>	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 run to full operating temperature - Observe the MIL - Observe engine performance. - After operating the engine within the test parameters of DTC P0650 check for any stored codes <i>Does the MIL operate normally with no stored codes?</i>	System OK	Go to OBD System check

DTC P0652 5 Volt Buff B 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 4.43 volts
- MIL - ON during active fault

Circuit Description

The 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 these powered sensors used 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 B is below 4.43 volts.

DTC P0652 5 Volt Buff B Reference Low

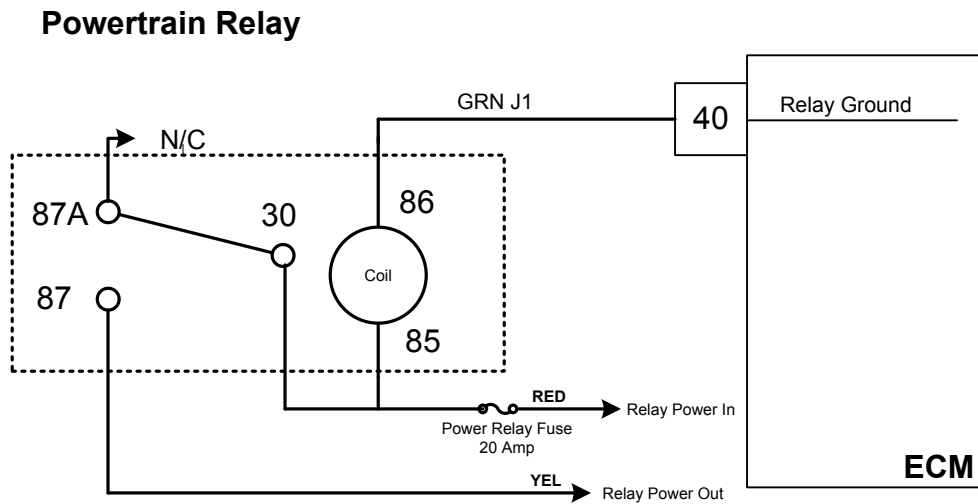
STEP	ACTION	YES	NO
1	<i>Did you perform the On-Board (OBD) System Check?</i>	Go to Step (2)	Go to OBD System Check Section
2	- Engine Running - DST (Diagnostic Scan Tool) connected in System Fault Mode <i>Does DST display DTC P0652?</i>	Go to Step (3)	Intermittent problem. Go to Intermittent section
3	- Ignition OFF - Disconnect ECM connector C0J1 - Using DVOM check for continuity between ECM pin 33 and ECM pin 36 engine ground <i>Does the DVOM show a resistance value of 4.1K Ohms $\pm$10%</i>	Go to Step (4)	Repair the open 5 volt circuit. Refer to wire harness repair section
4	Using a DVOM check between ECM pin 33 and engine ground <i>Does the DVOM show continuity?</i>	Repair the shorted 5 volt circuit. Refer to wire harness repair section	Go to Step (5)
5	- Disconnect the ECM connector C0J2 - Disconnect the crank sensor connector C013 - Using a DVOM check for continuity between ECM pin 43 and crank sensor pin 1 <i>Does the DVOM show continuity?</i>	Go to Step (6)	Repair the open 5 volt circuit. Refer to wire harness repair section
6	Using a DVOM check between ECM pin 43 and engine ground. <i>Does the DVOM show continuity?</i>	Repair the shorted 5 volt circuit. Refer to wire harness repair section	Go to Step (7)
7	- Disconnect the throttle connector C010 - Using a DVOM check for continuity between ECM connector pin 44 and throttle connector pin 2 <i>Does the DVOM show continuity?</i>	Go to Step (8)	Repair the open 5 volt circuit. Refer to wire harness repair section
8	Using a DVOM check between ECM pin 44 and engine ground <i>Does the DVOM show continuity?</i>	Repair the shorted 5 volt circuit. Refer to wire harness repair section	Go to Step (9)
9	- While monitoring DVOM for continuity between ECM 5 volt reference and engine ground - Disconnect each sensor (below) one at a time to find the shorted 5 volt reference. When continuity to engine 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. - Throttle connector - Crankshaft Sensor <i>While disconnecting each sensor one at a time did you lose continuity?</i>	Go to Step (10)	Repair or re-place shorted wire harness or foot pedal resistor block
10	Replace the last disconnected sensor <i>Is the replacement complete?</i>	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 run to full operating temperature - Observe the MIL - Observe engine performance - After operating the engine within the test parameters of DTC P0652 check for any stored codes <i>Does the engine operate normally with no stored codes?</i>	System OK	Go to Step (12)
12	Replace the ECM 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 run to full operating temperature - Observe the MIL - Observe engine performance - After operating the engine within the test parameters of DTC P0652 check for any stored codes <i>Does the engine operate normally with no stored codes?</i>	System OK	Go to OBD System check

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DTC P0685 Powertrain Relay Contact Low



Conditions for Setting the DTC

- Power relay check
- Check Condition - Ignition ON
- Fault Condition - Relay contact voltage 3.0 volts lower than ignition voltage.

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 relay contact voltage 3.0 volts lower than ignition voltage.

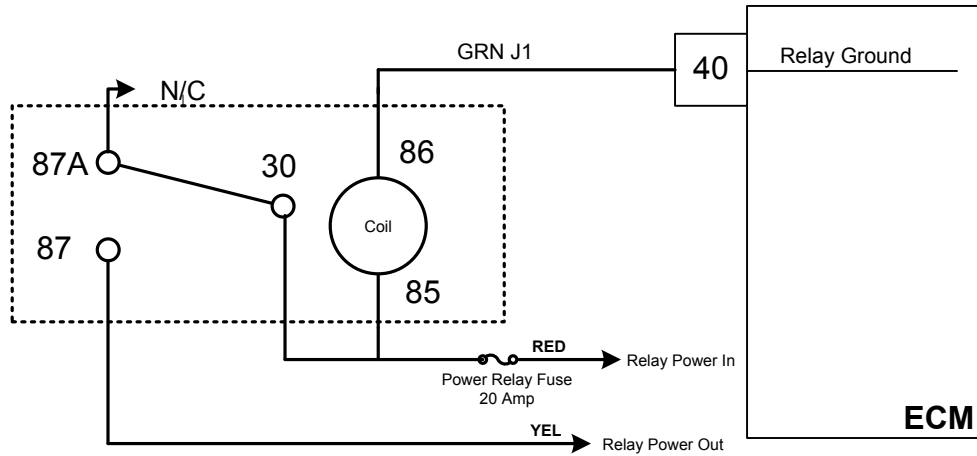
NOTICE: Check battery and starter condition before proceeding with the diagnostic.

DTC P0685 Powertrain Relay Contact Low

STEP	ACTION	YES	NO
1	<i>Did you perform the On-Board (OBD) System Check?</i>	Go to Step (2)	Go to OBD System Check Section
2	- Check the system power and ground connections at C002, C012, and C016 for damage corrosion or contamination - Check the power and ground connections at the GIC (Get Set Interface Connector) pins A, D and E for damage, corrosion or contamination - Check the system power fuse contacts at the VSW fuse, power relay fuse and AUX fuse for damage, corrosion or contamination <i>Did you find a problem and make a repair?</i>	Go to Step (6)	Go to Step (3)
3	- Ignition OFF - Remove power relay from the fuse box - Remove power relay fuse (20 Amp) - Remove the ECM connector C0J1 - Using a DVOM check for continuity between ECM pin 20 and power relay fuse contact (relay side) <i>Does the DVOM show continuity with less than 1.0 Ohm?</i>	Go to Step (4)	Repair the open power relay circuit. See wire harness repair.
4	- Disconnect ignition coil connector C005 - Using a DVOM check for continuity at the fuse box between the power relay terminal 87 and ignition coil pin A. <i>Does the DVOM show continuity with less than 1.0 Ohm?</i>	Go to Step (5)	Repair the open power relay circuit. See wire harness repair.
5	Replace the Power Relay <i>Is the replacement complete?</i>	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 run to full operating temperature - Observe the MIL - Observe engine performance - After operating the engine within the test parameters of DTC P0685 check for any stored codes <i>Does the engine operate normally with no stored codes?</i>	System OK	Go to OBD System Check

DTC P0686 Powertrain Relay Driver Short Low/Open

Powertrain Relay



Conditions for Setting the DTC

- Power relay check
- Check Condition - Ignition ON
- Fault Condition - Power relay control circuit at zero volts.

Circuit Description

The ECM provides ground to energize the power relay coil. This fault will set if the relay control circuit (ground side) detects zero voltage indicating a short to ground or open relay coil control circuit.

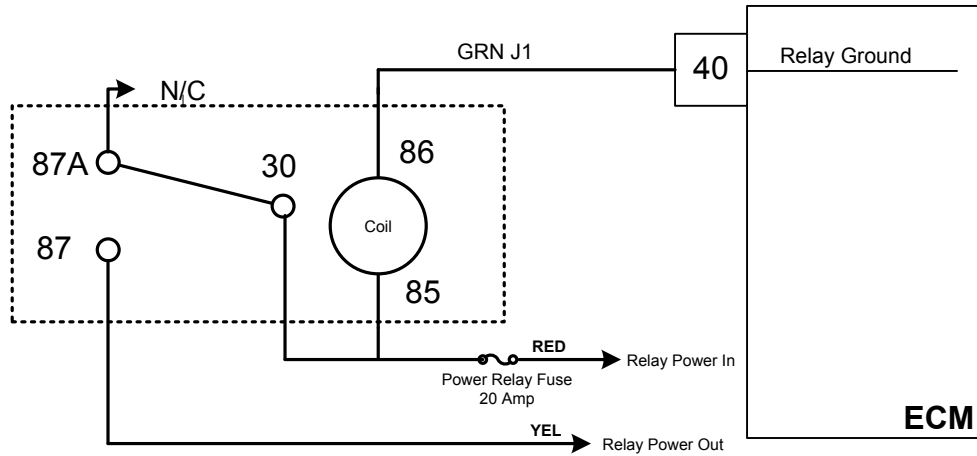
Relay coil resistance changes with temperature. The following diagnostic charts have steps to measure relay coil resistance values. When checking the resistance values is sure the relay is at a reasonable temperature, between +20 and +100°F (-7° and 37°C.)

DTC P0686 Powertrain Relay Driver Short Low/Open

STEP	ACTION	YES	NO
1	<i>Did you perform the On-Board (OBD) System Check?</i>	Go to Step (2)	Go to OBD System Check Section
2	- DST connected and in the system data mode - Ignition OFF - Remove the power relay from the fuse block - Using a DVOM check the resistance of the relay coil between terminals 85 and 86 <i>Is the resistance value greater than 125 ohms?</i>	Go to Step (3)	Go to Step (4)
3	Replace the power relay <i>Is the replacement complete?</i>	Go to Step (10)	
4	Check the Power Relay (20 AMP) fuse <i>Is the fuse open?</i>	Replace fuse F2	Go to Step (5)
5	- Disconnect ECM connector C0J1 - Remove Power Relay from fuse box - Using a DVOM check for continuity between ECM pin 40 and fuse box terminal for relay pin 86 <i>Do you have continuity?</i>	Go to Step (6)	Repair the open Power Relay Control circuit as required. See wiring harness repairs
6	Using a DVOM check for continuity between ECM pin 40 and engine ground <i>Do you have continuity?</i>	Repair the shorted to ground Power Relay Control circuit as required. See wiring harness repairs	Go to Step (7)
7	Replace the power relay <i>Is the replacement complete?</i>	Go to Step (9)	
8	Replace the ECM <i>Is the replacement complete?</i>	Go to Step (10)	
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 run to full operating temperature - Observe the MIL - Observe engine performance - After operating the engine within the test parameters of DTC P0686 check for any stored codes <i>Does the engine operate normally with no stored codes?</i>	System OK	Go to Step (8)
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 run to full operating temperature - Observe the MIL - Observe engine performance - After operating the engine within the test parameters of DTC P0686 check for any stored codes <i>Does the engine operate normally with no stored codes?</i>	System OK	Go to OBD System Check

DTC P0687 Powertrain Relay Driver Short High

Powertrain Relay



Conditions for Setting the DTC

- Power relay control circuit check
- Check Condition - Ignition ON
- Fault Condition - Power relay driver circuit greater than 12.0 volts

Circuit Description

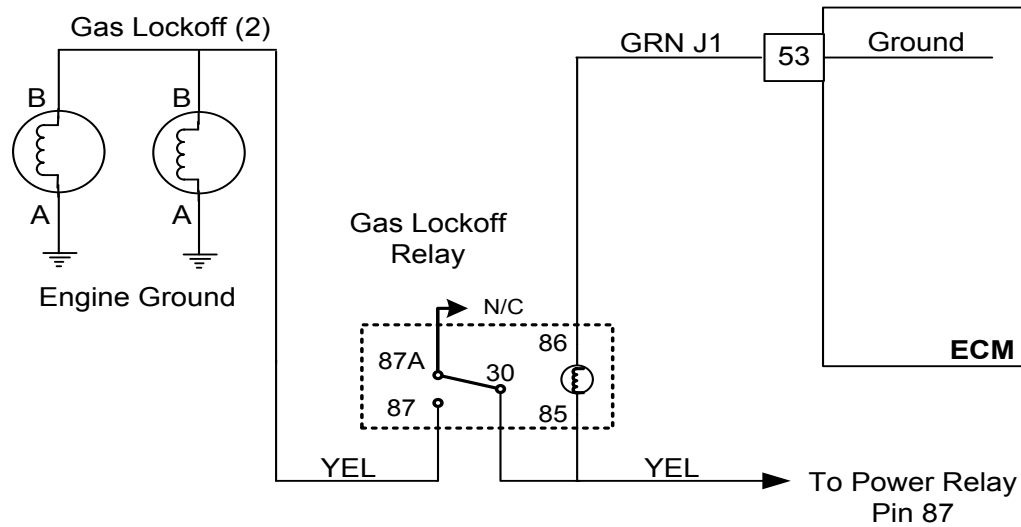
The ECM provides ground to energize the power relay coil. This fault will set if the relay control circuit (ground side) detects voltage above 12 volts indicating a short to voltage or shorted relay coil.

Relay coil resistance changes with temperature. The following diagnostic charts have steps to measure relay coil resistance values. When checking the resistance values is sure the relay is at a reasonable temperature, between +20 and +100°F (-7° and 37°C.)

DTC P0687 Powertrain Relay Driver Short High

STEP	ACTION	YES	NO
1	<i>Did you perform the On-Board (OBD) System Check?</i>	Go to Step (2)	Go to OBD System Check Section
2	- DST connected and in the system data mode - Ignition OFF - Remove the power relay from the fuse block - Using a DVOM check the resistance of the relay coil between terminals 85 and 86 <i>Is the resistance value less than 100 ohms?</i>	Go to Step (3)	Go to Step (4)
3	Replace the power relay <i>Is the replacement complete?</i>	Go to Step (8)	
4	- Disconnect ECM connector C0J1 - Ignition ON - Using a DVOM check for voltage between ECM pin 71 and engine ground. <i>Does the DVOM show voltage?</i>	Repair the shorted to voltage power relay control circuit as required. See wiring harness repairs	Go to Step (5)
5	Replace the power relay <i>Is the replacement complete?</i>	Go to Step (7)	
6	Replace the ECM <i>Is the replacement complete?</i>	Go to step (8)	
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 run to full operating temperature - Observe the MIL - Observe engine performance - After operating the engine within the test parameters of DTC P0687 check for any stored codes <i>Does the engine operate normally with no stored codes?</i>	System OK	Go to step (6)
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 run to full operating temperature - Observe the MIL - Observe engine performance - After operating the engine within the test parameters of DTC P0687 check for any stored codes <i>Does the engine operate normally with no stored codes?</i>	System OK	Go to OBD System Check

P1180 Gas Lock Off Relay Short Low/Open



Conditions for Setting the DTC

- Gas Lock Off Solenoid Relay
- Check Condition - Ignition ON
- Fault Condition - Gas solenoid relay control circuit at zero volts

Circuit Description

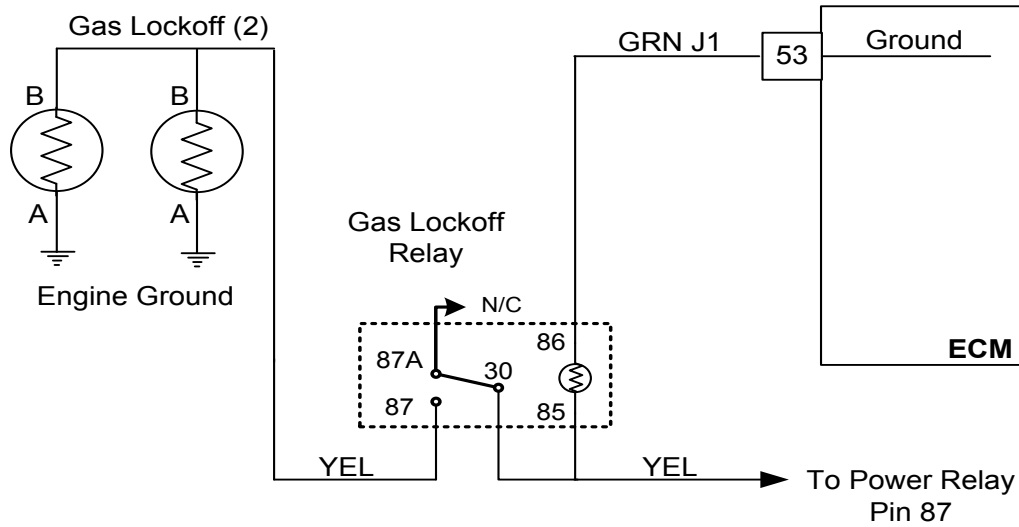
The gas lock-off solenoid is an electrically operated fuel shutoff shut off safety device. The solenoid is normally closed and opens to allow the flow of natural gas or propane vapor when the solenoid is energized. The gas lock-off solenoid is controlled by the gas lock off relay. This code will set if the voltage on the gas solenoid relay control circuit is at zero volts indicating an open relay coil or relay control circuit.

Gas solenoid relay coil resistance changes with temperature. The following diagnostic charts have steps to measure relay coil resistance values. When checking the resistance values is sure the relay is at a reasonable temperature, between +20 and +100°F (-7° and 37°C.)

P1180 Gas Lock Off Relay Short Low/Open

STEP	ACTION	YES	NO
1	Did you perform the On-Board (OBD) System Check?	Go to Step (2)	
2	- Ignition OFF - Remove the gas lock off relay from the fuse box - Using a DVOM check the resistance between pin 85 and 86 of the relay <i>Does the DVOM show a resistance value greater than 115 Ohms?</i>	Go to Step (3)	Go to Step (4)
3	Replace the Gas Lock Off Relay <i>Is the replacement complete?</i>	Go to Step (7)	
4	- Ignition OFF - Disconnect the ECM wire harness connector C0J1 - Ignition ON - Using a DVOM check for continuity between ECM pin 53 and fuse box pin for relay terminal 86 <i>Does the DVOM show continuity?</i>	Repair the relay control circuit shorted to voltage. See wire harness repair.	Go to Step (6)
5	Inspect the ECM wire harness and connector for damage corrosion or contamination <i>Did you find a problem?</i>	Correct the problem as required. See wire harness repair.	Go to Step (6)
6	Replace the ECM <i>Is the replacement complete?</i>	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 run to full operating temperature - Observe the MIL - Observe engine performance - After operating the engine within the test parameters of DTC P1180 check for any stored codes <i>Does the engine operate normally with no stored codes?</i>	System OK	Go to OBD System Check

P1181 Gas Lock Off Relay Short High



Conditions for Setting the DTC

- Gas Lock Off Relay Control
- Check Condition - Ignition ON
- Fault Condition - Gas lock-off relay control circuit equal to or higher than system voltage

Circuit Description

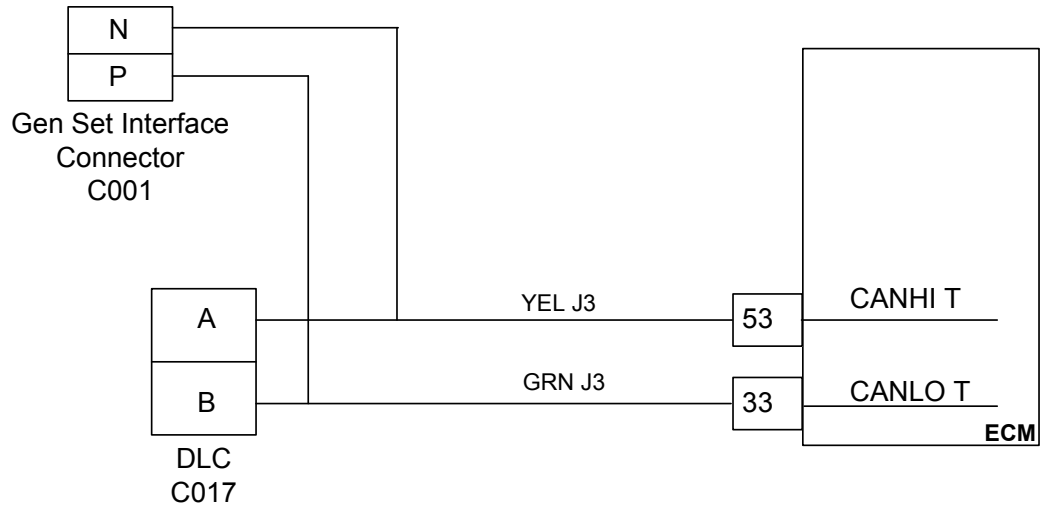
The gas lock-off solenoid is an electrically operated fuel shutoff shut off safety device. The solenoid is normally closed and opens to allow the flow of natural gas or propane vapor when the solenoid is energized. The gas lock-off solenoid is controlled by the gas lock-off relay. This code will set if the voltage on the gas solenoid relay control circuit is equal to or greater than system voltage indicating a shorted gas solenoid relay coil or shorted to voltage control circuit.

Gas solenoid relay coil resistance changes with temperature. The following diagnostic charts have steps to measure relay coil resistance values. When checking the resistance values is sure the relay is at a reasonable temperature, between +20 and +100°F (-7° and 37°C.)

P1181 Gas Lock Off Relay Short High

STEP	ACTION	YES	NO
1	Did you perform the On-Board (OBD) System Check?	Go to Step (2)	
2	- Ignition OFF - Remove the gas lock off relay from the fuse box - Using a DVOM check the resistance between pin 85 and 86 of the relay <i>Does the DVOM show a resistance value greater than 115 Ohms?</i>	Go to Step (3)	Go to Step (4)
3	Replace the Gas Lock Off Relay <i>Is the replacement complete?</i>	Go to Step (7)	
4	- Ignition OFF - Disconnect the ECM wire harness connector C0J1 - Ignition ON - Using a DVOM check for continuity between ECM pin 53 and fuse box pin for relay terminal 86 <i>Does the DVOM show continuity?</i>	Repair the relay control circuit shorted to voltage. See wire harness repair.	Go to Step (6)
5	Inspect the ECM wire harness and connector for damage corrosion or contamination <i>Did you find a problem?</i>	Correct the problem as required. See wire harness repair.	Go to Step (6)
6	Replace the ECM <i>Is the replacement complete?</i>	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 run to full operating temperature - Observe the MIL - Observe engine performance - After operating the engine within the test parameters of DTC P1180 check for any stored codes <i>Does the engine operate normally with no stored codes?</i>	System OK	Go to OBD System Check

DTC P1627 CAN Bus Hardware Fault



Conditions for Setting the DTC

- CAN Rx
- Check Condition - Engine running
- Fault Condition - CAN error packets lost, not received or corrupt
- MIL - ON

Circuit description

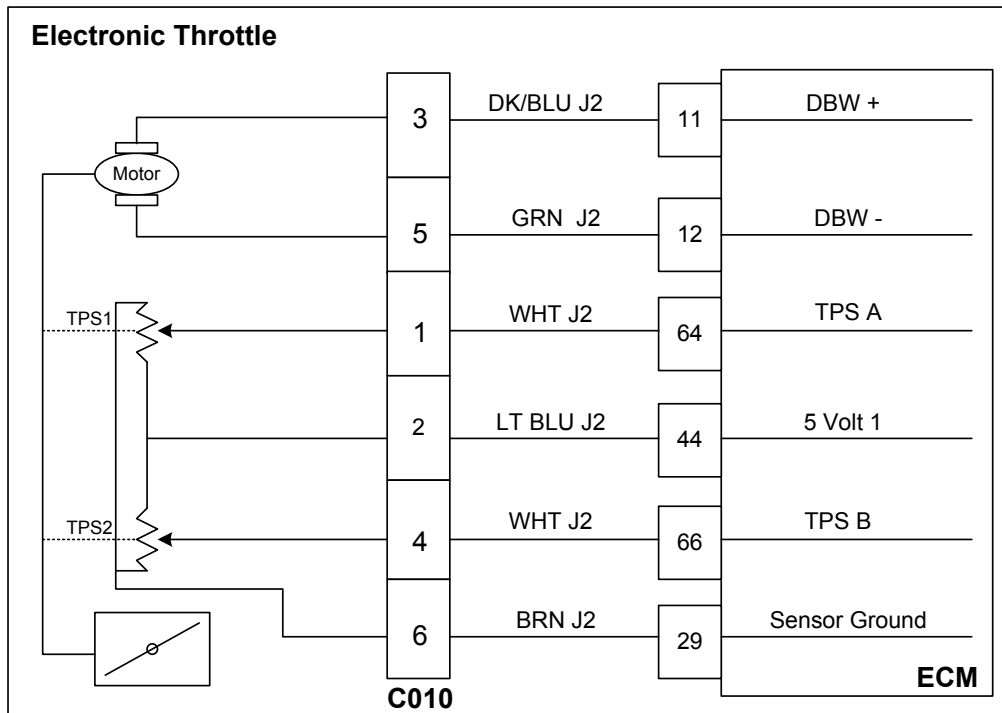
The CAN bus (controller area network) is used by the ECM to communicate with other digital devices used throughout the fuel system. Information is sent over the CAN bus in digital information “packets” that contain information for various control functions. This fault will set if the ECM detects continuous CAN communications hardware errors or CAN policy violations.

Always run the gen set control panel diagnostics before proceeding with this chart. Disconnect individual CAN devices that may have been installed on the CAN line to see if the problem is resolved before proceeding with this chart.

DTC P1627 CAN Bus Hardware Fault

STEP	ACTION	YES	NO
1	<i>Did you perform the On-Board (OBD) System Check?</i>	Go to Step (2)	Go to OBD System Check Section
2	- Ignition ON, Engine Running - DST (Diagnostic Scan Tool) connected in System Data Mode - Clear system fault code <i>Does DTC1627 reset with the engine running?</i>	Go to Step (3)	Intermittent problem. Go to Intermittent section
3	- Check that the ECM power connection C002 is clean and tight - Check that the ECM ground connections C012 and C016 are clean and tight <i>Are the power and ground circuits OK?</i>	Go to Step (4)	Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.
4	- Ignition OFF - Disconnect ECM harness connector C0J3 - Disconnect Genset Interface Connector (GIC) - Using a DVOM check for continuity between ECM connector pin 53 and GIC connector pin P <i>Do you have continuity?</i>	Go to Step (5)	Repair the open circuit as necessary. Refer to Wiring Repairs in Engine Electrical.
5	Using a DVOM check for continuity between ECM connector pin 33 and GIC connector pin N <i>Do you have continuity?</i>	Repair the open circuit as necessary. Refer to Wiring Repairs in Engine Electrical	Go to Step (6)
6	Using a DVOM check for continuity to engine ground between ECM pins 53 and 33 <i>Does the DVOM show a resistance value of less than 40 ohms?</i>	Repair the shorted circuit as necessary. Refer to Wiring Repairs in Engine Electrical	Go to Step (7)
7	Using a DVOM check for continuity to engine ground on ECM pins 33 and 53. <i>Do have continuity them?</i>	Repair the shorted to ground circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to Step (8)
8	Using a DVOM check for continuity to battery positive on ECM pins 33 and 53. <i>Do have continuity them?</i>	Repair the shorted to voltage circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to Step (9)
9	Replace the ECM. <i>Is the replacement complete?</i>	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 run to full operating temperature - Observe the MIL - Observe engine performance - After operating the engine within the test parameters of DTC P1627 and check for any stored codes <i>Does the engine operate normally with no stored codes?</i>	System OK	Go to OBD System Check

DTC P2111 ETC Return Fault



Conditions for Setting the DTC

- Electronic Throttle Control
- Check Condition - Ignition ON
- Fault Condition - Throttle return spring test
- MIL - On during active fault

Circuit Description

Dual throttle position sensors (TPS) are used with the electronic throttle control (ETC) to determine throttle plate position. The TPS values are used by the ECM to determine if the throttle is opening and closing as commanded. The ECM runs several checks at ignition on to validate the working condition of the ETC. This fault will set if the ECM detects a problem with the ETC internal return spring.

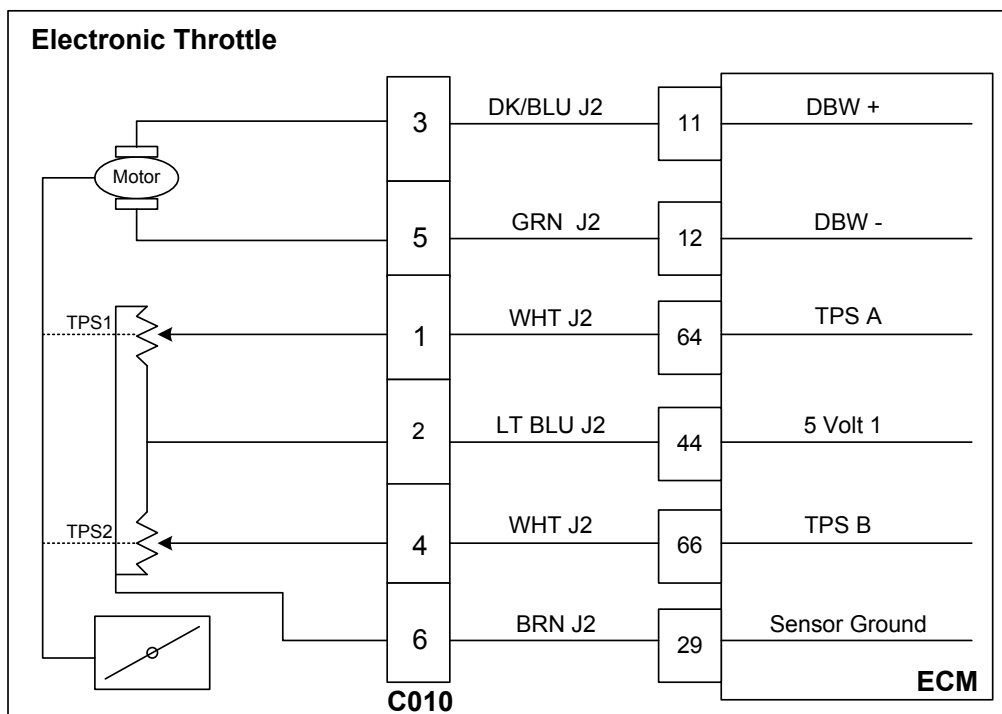
DTC P2111 ETC Return Fault

STEP	ACTION	YES	NO
1	<i>Did you perform the On-Board (OBD) System Check?</i>	Go to Step (2)	Go to OBD System Check Section
2	- Ignition ON - DST (Diagnostic Scan Tool) connected in data stream mode - Clear DTC P2111 - Ignition OFF - Ignition ON <i>Does DTC P2111 reset?</i>	Go to Step (3)	Intermittent problem. Go to Intermittent section
3	Check the electronic throttle for a foreign object in the throttle bore or damaged throttle bore or fly assembly. <i>Did you find damage or a foreign object in the bore?</i>	Remove the foreign object or replace the throttle if damage is found. Go to Step (17)	Go to Step (4)
4	- Ignition OFF - Disconnect electronic throttle connector C010 - Disconnect ECM wire harness connector C0J2 - Using a DVOM check for continuity between electronic throttle connector pin 6 and ECM connector pin 29 <i>Does the DVOM show continuity?</i>	Go to Step (5)	Repair the open ground circuit as necessary. Refer to Wiring Repairs.
5	Using a DVOM check for continuity between electronic throttle connector pin 4 and ECM connector pin 66 <i>Does the DVOM show continuity?</i>	Go to Step (6)	Repair the open circuit as necessary. Refer to Wiring Repairs.
6	Using a DVOM check for continuity between electronic throttle connector pin 4 and engine ground <i>Does the DVOM show continuity?</i>	Repair the shorted to ground TPS circuit as necessary. Refer to Wiring Repairs.	Go to Step (7)
7	Using a DVOM check for continuity between electronic throttle connector pin 2 and ECM connector pin 44 <i>Does the DVOM show continuity?</i>	Go to Step (8)	Repair the open 5 volt circuit as necessary. Refer to Wiring Repairs.
8	Using a DVOM check for continuity between electronic throttle connector pin 2 and engine ground <i>Does the DVOM show continuity?</i>	Repair the shorted 5 volt circuit to ground as necessary. Refer to Wiring Repairs.	Go to Step (9)
9	Using a DVOM check for continuity between electronic throttle connector pin 1 and ECM connector pin 64 <i>Does the DVOM show continuity?</i>	Go to Step (10)	Repair the open TPS circuit as necessary. Refer to Wiring Repairs.
10	Using a DVOM check for continuity between electronic throttle connector pin 1 and engine ground <i>Does the DVOM show continuity?</i>	Repair the shorted TPS circuit to ground as necessary. Refer to Wiring Repairs	Go to Step (11)
11	Using a DVOM check for continuity between electronic throttle connector pin 5 and ECM connector pin 12 <i>Does the DVOM show continuity?</i>	Go to Step (12)	Repair the open DBW circuit as necessary. Refer to Wiring Repairs
12	Using a DVOM check for continuity between electronic throttle connector pin 3 and ECM connector pin 11 <i>Does the DVOM show continuity?</i>	Go to Step (13)	Repair the open DBW circuit as necessary. Refer to Wiring Repairs.

13	Using a DVOM check for continuity between electronic throttle connector pin 3 and engine ground. <i>Does the DVOM show continuity?</i>	Repair the shorted DBW circuit to ground as necessary. Refer to Wiring Repairs.	Go to Step (14)
14	Replace throttle <i>Is the replacement complete?</i>	Go to Step (15)	
15	- 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 run to full operating temperature - Observe the MIL - Observe engine performance - After operating the engine within the test parameters of DTC P2111 check for any stored codes <i>Does the engine operate normally with no stored codes?</i>	System OK	Go to Step (16)
16	Replace the ECM <i>Is the replacement complete?</i>	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 run to full operating temperature - Observe the MIL - Observe engine performance - After operating the engine within the test parameters of DTC P2111 check for any stored codes <i>Does the engine operate normally with no stored codes?</i>	System OK	Go to OBD System Check

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DTC 2119 ETC Actuation Fault



Conditions for Setting the DTC

- Throttle Position Sensor
- Check Condition - Ignition ON
- Fault Condition - Actual and desired throttle position greater than 10%
- Battery voltage greater than 9 volts
- MIL - ON during active fault

Circuit Description

Dual throttle position sensors (TPS) are used with the electronic throttle control (ETC) to determine throttle plate position. The TPS values are used by the ECM to determine if the throttle is opening and closing as commanded. This fault will set if the ECM detects a problem with the ETC TPS, malfunctioning throttle control motor or sticking throttle valve assembly.

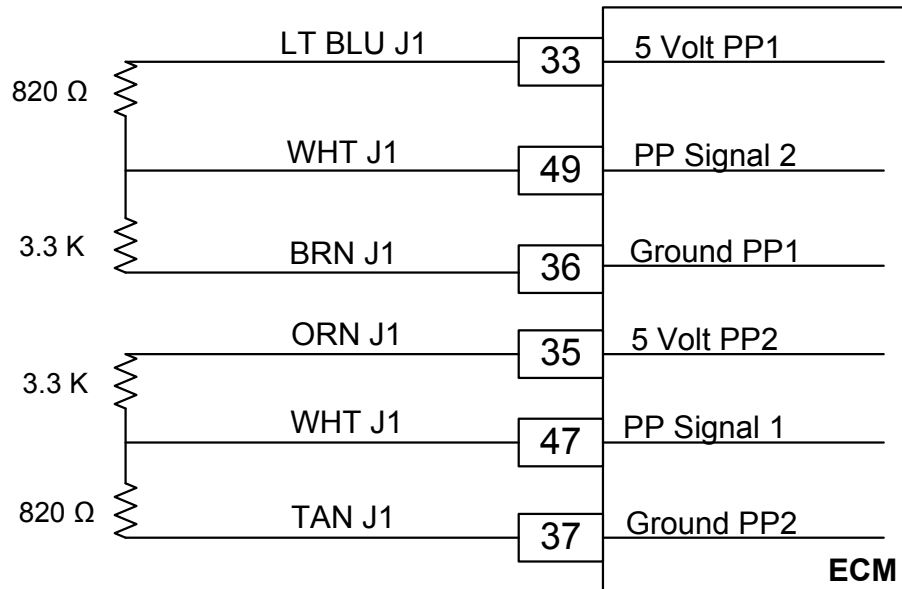
DTC 2119 ETC Actuation Fault

STEP	ACTION	YES	NO
1	<i>Did you perform the On-Board (OBD) System Check?</i>	Go to Step (2)	Go to OBD System Check Section
2	- Ignition ON - DST (Diagnostic Scan Tool) connected in data stream mode. - Clear DTC P2119 - Ignition OFF - Ignition ON <i>Does DTC P2119 reset?</i>	Go to Step (3)	Intermittent problem. Go to Intermittent section
3	Check the electronic throttle for a foreign object in the throttle bore or damaged throttle bore or fly assembly. <i>Did you find damage or a foreign object in the bore?</i>	Remove the foreign object or replace the throttle if damage is found. Go to Step (17)	Go to Step (4)
4	- Ignition OFF - Disconnect electronic throttle connector C010 - Disconnect ECM wire harness connector C0J2 - Using a DVOM check for continuity between electronic throttle connector pin 6 and ECM connector pin 29 <i>Does the DVOM show continuity?</i>	Go to Step (5)	Repair the open ground circuit as necessary. Refer to Wiring Repairs.
5	Using a DVOM check for continuity between electronic throttle connector pin 4 and ECM connector pin 66 <i>Does the DVOM show continuity?</i>	Go to Step (6)	Repair the open circuit as necessary. Refer to Wiring Repairs.
6	Using a DVOM check for continuity between electronic throttle connector pin 4 and engine ground <i>Does the DVOM show continuity?</i>	Repair the shorted to ground TPS circuit as necessary. Refer to Wiring Repairs.	Go to Step (7)
7	Using a DVOM check for continuity between electronic throttle connector pin 2 and ECM connector pin 44 <i>Does the DVOM show continuity?</i>	Go to Step (8)	Repair the open 5 volt circuit as necessary. Refer to Wiring Repairs.
8	Using a DVOM check for continuity between electronic throttle connector pin 2 and engine ground <i>Does the DVOM show continuity?</i>	Repair the shorted 5 volt circuit to ground as necessary. Refer to Wiring Repairs.	Go to Step (9)
9	Using a DVOM check for continuity between electronic throttle connector pin 1 and ECM connector pin 64 <i>Does the DVOM show continuity?</i>	Go to Step (10)	Repair the open TPS circuit as necessary. Refer to Wiring Repairs.
10	Using a DVOM check for continuity between electronic throttle connector pin 1 and engine ground <i>Does the DVOM show continuity?</i>	Repair the shorted TPS circuit to ground as necessary. Refer to Wiring Repairs	Go to Step (11)
11	Using a DVOM check for continuity between electronic throttle connector pin 5 and ECM connector pin 12 <i>Does the DVOM show continuity?</i>	Go to Step (12)	Repair the open DBW circuit as necessary. Refer to Wiring Repairs
12	Using a DVOM check for continuity between electronic throttle connector pin 3 and ECM connector pin 11 <i>Does the DVOM show continuity?</i>	Go to Step (13)	Repair the open DBW circuit as necessary. Refer to Wiring Repairs.

13	Using a DVOM check for continuity between electronic throttle connector pin 3 and engine ground. <i>Does the DVOM show continuity?</i>	Repair the shorted DBW circuit to ground as necessary. Refer to Wiring Repairs.	Go to Step (14)
14	Replace throttle <i>Is the replacement complete?</i>	Go to Step (15)	
15	- 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 run to full operating temperature - Observe the MIL - Observe engine performance - After operating the engine within the test parameters of DTC P2111 check for any stored codes <i>Does the engine operate normally with no stored codes?</i>	System OK	Go to Step (16)
16	Replace the ECM <i>Is the replacement complete?</i>	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 run to full operating temperature - Observe the MIL - Observe engine performance - After operating the engine within the test parameters of DTC P2119 check for any stored codes <i>Does the engine operate normally with no stored codes?</i>	System OK	Go to OBD System Check

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DTC P2121 ETC PPS1 AD Conversion



Conditions for Setting the DTC

- PPS Test
- Check Condition- Ignition ON
- Fault Condition- PPS 1 not responding to intrusive ECM test
- MIL-On

Circuit Description

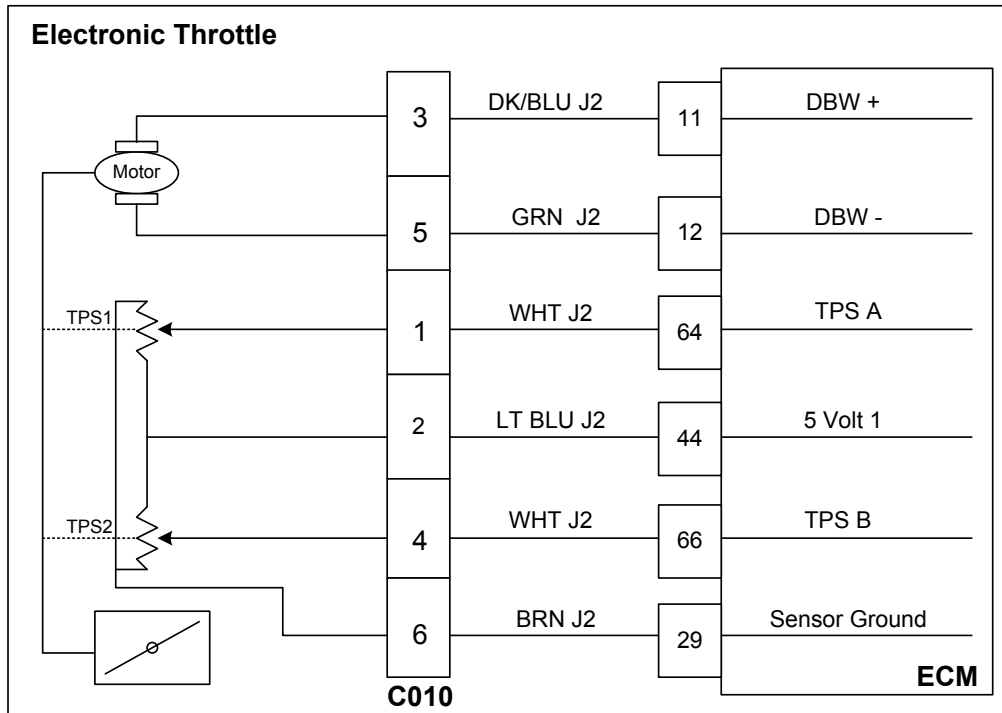
Dual PPS (Pedal Position Sensor) are normally used by the ECM to command the ETC (Electronic Throttle Control). For generator applications the PPS is replaced by a bank of fixed resistors to provide a constant engine speed. This fault will set if the ECM detects a problem with the PPS or fixed resistor bank located in the engine wiring harness.

Be sure the ECM is programmed with the latest calibration before using this diagnostic chart.

DTC P2121 ETC PPS1 AD Conversion

STEP	ACTION	YES	NO
1	<i>Did you perform the On-Board (OBD) System Check?</i>	Go to Step (2)	Go to OBD System Check Section
2	- Ignition ON - DST (Diagnostic Scan Tool) connected in data stream mode - Clear DTC P2111 - Ignition OFF - Start the engine <i>Does DTC P2111 reset?</i>	Go to Step (3)	Intermittent problem. Go to Intermittent section
3	- Disconnect the ECM connector J01 - Using a DVOM check the resistance value between ECM pins 33 and 49 <i>Does the DVOM show a resistance value of 820 Ohms $\pm$ 20%?</i>	Go to Step (4)	Repair or replace the faulty resistor bank. See wiring harness repair.
4	Using a DVOM check the resistance value between ECM pins 36 and 49 <i>Does the DVOM show a resistance value of 3.3k Ohms $\pm$ 20%?</i>	Go to Step (5)	Repair or replace the faulty resistor bank. See wiring harness repair.
5	Using a DVOM check the resistance value between ECM pins 35 and 47 <i>Does the DVOM show a resistance value of 3.3k Ohms $\pm$ 20%?</i>	Go to Step (6)	Repair or replace the faulty resistor bank. See wiring harness repair.
6	Using a DVOM check the resistance value between ECM pins 37 and 47 <i>Does the DVOM show a resistance value of 820 Ohms $\pm$ 20%?</i>	Go to Step (7)	Repair or replace the faulty resistor bank. See wiring harness repair.
7	Using a DVOM check the resistance value between ECM pin 49 and engine ground <i>Does the DVOM show a resistance value greater than 3.6k Ohms.</i>	Go to Step (8)	Repair or replace the shorted to ground resistor bank. See wiring harness repair.
8	Using a DVOM check the resistance value between ECM pin 47 and engine ground <i>Does the DVOM show a resistance value greater than 3.6k Ohms</i>	Go to Step (9)	Repair or replace the shorted to ground resistor bank. See wiring harness repair.
9	Check that the latest calibration been flashed to the ECM <i>Is the latest calibration in use?</i>	Go to Step (10)	Re-flash the ECM
10	Replace the ECM <i>Is the replacement complete?</i>	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 run to full operating temperature - Observe the MIL - Observe engine performance - After operating the engine within the test parameters of DTC P2111 check for any stored codes <i>Does the engine operate normally with no stored codes?</i>	System OK	Go to OBD System Check

DTC P2135 ETC TPS 1 and TPS 2 Range



Conditions for Setting the DTC

- Electronic Throttle Control
- Check Condition - Ignition ON
- Fault Condition - TPS 1 and 2 calculated values exceed 10%
- MIL - ON during active fault

Circuit Description

Dual throttle position sensors (TPS) are used with the electronic throttle control (ETC) to determine throttle plate position. Although the actual voltage values between them are inverse, the calculated position values should remain very close. The TPS values are used by the ECM to determine if the throttle is opening and closing as commanded. This fault will set if the ECM detects more than a 10% difference in calculated values between TPS 1 and TPS 2.

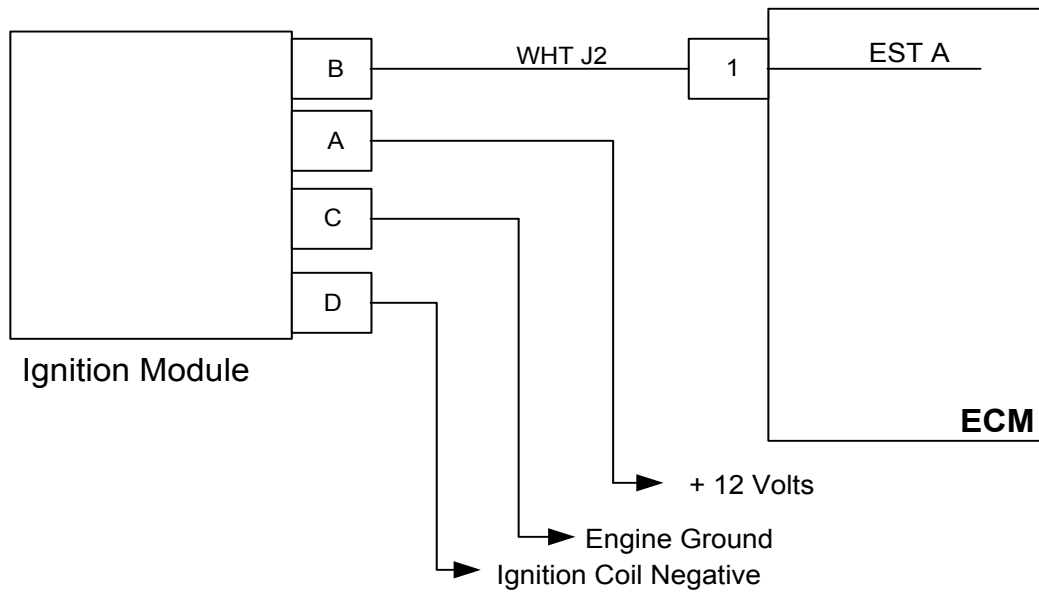
DTC P2135 ETC TPS 1 and TPS 2 Range

STEP	ACTION	YES	NO
1	<i>Did you perform the On-Board (OBD) System Check?</i>	Go to Step (2)	Go to OBD System Check Section
2	- Ignition ON - DST (Diagnostic Scan Tool) connected in data stream mode. - Clear DTC P2135 - Start the engine <i>Does DTC P2135 re-set?</i>	Go to Step (3)	Intermittent problem. Go to Intermittent section
3	- Ignition OFF - Disconnect electronic throttle connector C010 - Disconnect ECM wire harness connector C0J2 - Inspect the electronic throttle connector and ECM wire harness connector for damage corrosion or contamination <i>Did you find a problem?</i>	Correct the problem as required. See wire harness repair.	Go to Step (4)
4	- Ignition OFF - Disconnect electronic throttle connector C010 - Disconnect ECM wire harness connector C0J2 - Using a DVOM check for continuity between electronic throttle connector pin 6 and ECM connector pin 29 <i>Does the DVOM show continuity?</i>	Go to Step (5)	Repair the open ground circuit as necessary. Refer to Wiring Repairs
5	Using a DVOM check for continuity between electronic throttle connector pin 4 and ECM connector pin 66 <i>Does the DVOM show continuity?</i>	Go to Step (6)	Repair the open circuit as necessary. Refer to Wiring Repairs
6	Using a DVOM check for continuity between electronic throttle connector pin 4 and engine ground <i>Does the DVOM show continuity?</i>	Repair the shorted to ground TPS circuit as necessary. Refer to Wiring Repairs	Go to Step (7)
7	Using a DVOM check for continuity between electronic throttle connector pin 2 and ECM connector pin 44 <i>Does the DVOM show continuity?</i>	Go to Step (8)	Repair the open 5 volt circuit as necessary. Refer to Wiring Repairs
8	Using a DVOM check for continuity between electronic throttle connector pin 2 and engine ground <i>Does the DVOM show continuity?</i>	Repair the shorted 5 volt circuit to ground as necessary. Refer to Wiring Repairs.	Go to Step (9)
9	Using a DVOM check for continuity between electronic throttle connector pin 1 and ECM connector pin 64 <i>Does the DVOM show continuity?</i>	Go to Step (10)	Repair the open TPS circuit as necessary. Refer to Wiring Repairs.
10	Using a DVOM check for continuity between electronic throttle connector pin 1 and engine ground <i>Does the DVOM show continuity?</i>	Repair the shorted TPS circuit to ground as necessary. Refer to Wiring Repairs	Go to Step (11)
11	Using a DVOM check for continuity between electronic throttle connector pin 5 and ECM connector pin 12 <i>Does the DVOM show continuity?</i>	Go to Step (12)	Repair the open DBW circuit as necessary. Refer to Wiring Repairs.

12	Using a DVOM check for continuity between electronic throttle connector pin 3 and ECM connector pin 11 <i>Does the DVOM show continuity?</i>	Go to Step (13)	Repair the open DBW circuit as necessary. Refer to Wiring Repairs
13	Using a DVOM check for continuity between electronic throttle connector pin 3 and engine ground <i>Does the DVOM show continuity?</i>	Repair the shorted DBW circuit to ground as necessary. Refer to Wiring Repairs.	Go to Step (14)
14	- Ignition ON - Using a DVOM check for voltage between electronic throttle connector pin 1 and engine ground <i>Does the DVOM show voltage?</i>	Repair the TPS signal shorted to voltage as necessary. Refer to Wiring Repairs.	Go to Step (15)
15	Replace throttle <i>Is the replacement complete?</i>	Go to Step (16)	
16	- 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 run to full operating temperature - Observe the MIL - Observe engine performance - After operating the engine within the test parameters of DTC P2135 check for any stored codes <i>Does the engine operate normally with no stored codes?</i>	System OK	Go to Step (17)
17	Replace the ECM <i>Is the replacement complete?</i>	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 run to full operating temperature - Observe the MIL - Observe engine performance - After operating the engine within the test parameters of DTC P2135 check for any stored codes <i>Does the engine operate normally with no stored codes?</i>	System OK	Go to OBD System Check

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DTC P2300 EST Short Low



Conditions for Setting the DTC

- Check condition - Engine running or cranking
- Fault condition - 100 ms for 720 degrees engine rotation
- MIL - ON during active fault

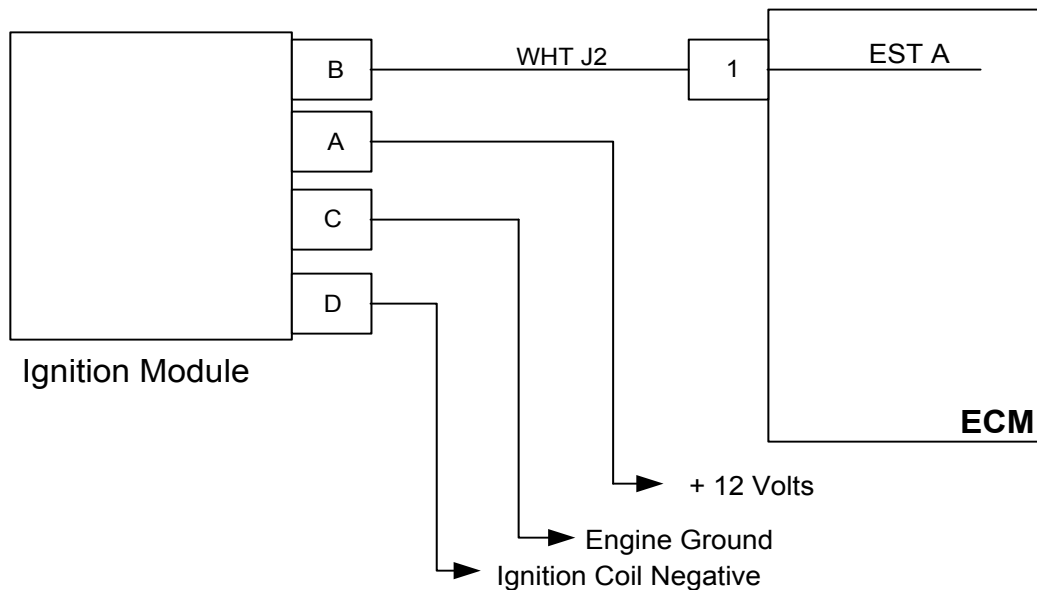
Circuit Description

The ECM triggers the ignition module by providing a signal to the EST A pin 1. The ignition module then completes the ignition coil primary circuit ground from pin D to power the ignition coil. This code will set if the ECM detects the EST circuit to be shorted low.

DTC P2300 EST Short Low

STEP	ACTION	YES	NO
1	<i>Did you perform the On-Board (OBD) System Check?</i>	Go to Step (2)	Go to OBD System Check Section
2	- Ignition ON, Engine OFF - DST (Diagnostic Scan Tool) connected in System Data Mode - Clear DTC P2300 - Crank the engine <i>Does DTC P2300 re-set?</i>	Go to Step (3)	Intermittent problem. See Electrical Section Intermittent Electrical Diagnosis
3	- Ignition OFF - Disconnect the ignition module connector C004 - Disconnect the ECM connector C0J2 - Using a DVOM check for continuity between ECM connector pin 1 and engine ground <i>Does the DVOM show continuity?</i>	Repair the shorted to ground EST control circuit	Go to Step (4)
4	Replace the Ignition module <i>Is the replacement complete?</i>	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 - Start the engine and run to full operating temperature - Observe the MIL - Observe engine performance - After operating the engine within the test parameters of DTC P2300 check for any stored codes <i>Does the engine operate normally with no stored codes?</i>	System OK	Go to Step (6)
6	Replace the ECM <i>Is the replacement complete?</i>	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 run to full operating temperature - Observe the MIL - Observe engine performance - After operating the engine within the test parameters of DTC P2300 check for any stored codes <i>Does the engine operate normally with no stored codes?</i>	System OK	Go to OBD system check

DTC P2301 EST Short High or Open



Conditions for Setting the DTC

- Check condition - Engine running or cranking
- Fault condition - 100 ms for 720 degrees engine rotation
- MIL - ON during active fault

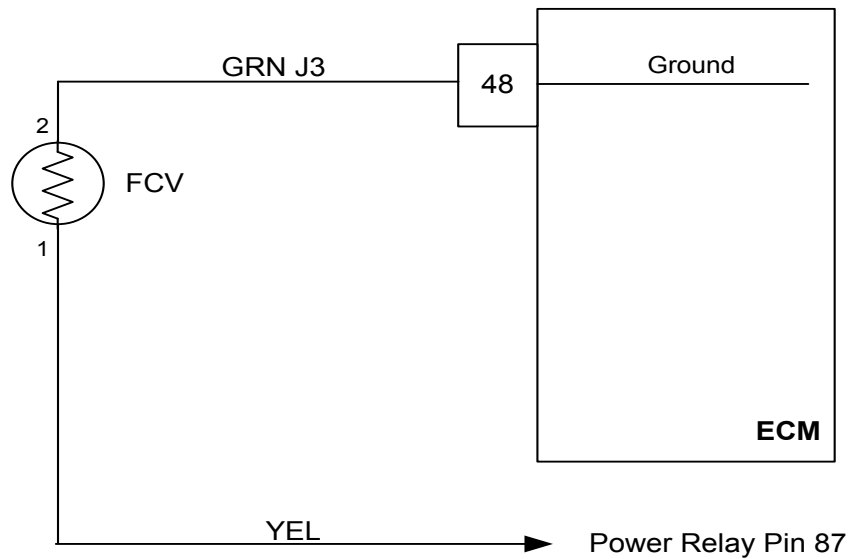
Circuit Description

The ECM triggers the ignition module by providing a signal to the EST A pin 1. The ignition module then completes the ignition coil primary circuit ground from pin D to power the ignition coil. This code will set if the ECM detects the EST circuit to be shorted to voltage or open.

DTC P2301 EST Short High or Open

STEP	ACTION	YES	NO
1	<i>Did you perform the On-Board (OBD) System Check?</i>	Go to Step (2)	Go to OBD System Check Section
2	- Ignition ON, Engine OFF - DST (Diagnostic Scan Tool) connected in System Data Mode - Clear DTC P2301 - Crank the engine <i>Does DTC P2301 re-set?</i>	Go to Step (3)	Intermittent problem. See Electrical Section Intermittent Electrical Diagnosis
3	- Ignition OFF - Disconnect the ignition module connector C004 - Disconnect the ECM connector C0J2 - Using a DVOM check for continuity between ECM connector pin 1 and ignition module connector pin B. <i>Does the DVOM show continuity?</i>	Repair the open EST control circuit	Go to Step (4)
4	- Ignition ON - Using a DVOM - Check for voltage between ECM pin 1 and engine ground <i>Does the DVOM show voltage?</i>	Repair the shorted to voltage EST control circuit. See wire harness repair.	Go to Step (5)
5	Replace the Ignition module <i>Is the replacement complete?</i>	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 - Start the engine and run to full operating temperature - Observe the MIL - Observe engine performance - After operating the engine within the test parameters of DTC P2300 check for any stored codes <i>Does the engine operate normally with no stored codes?</i>	System OK	Go to Step (7)
7	Replace the ECM <i>Is the replacement complete?</i>	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 run to full operating temperature - Observe the MIL - Observe engine performance - After operating the engine within the test parameters of DTC P2301 check for any stored codes <i>Does the engine operate normally with no stored codes?</i>	System OK	Go to OBD system check

P2633 Fuel Control Valve Short Low/Open



Conditions for Setting the DTC

- FCV
- Check Condition - Ignition ON
- Fault Condition - FCV control circuit zero volts

Circuit Description

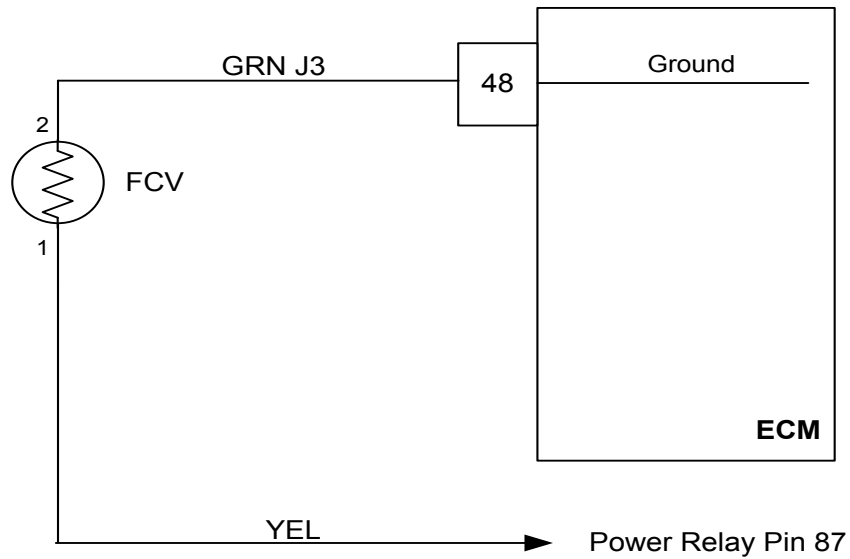
The FCV (Fuel Control Valve) is used to control the fuel regulator pressure output. The ECM cycles the FCV to provide the rich lean transitions required for low exhaust emissions and peak engine performance. This code will set if the voltage on the FCV control circuit is at zero volts indicating a short to ground or open FCV.

FCV coil resistance changes with temperature. The following diagnostic charts have steps to measure relay coil resistance values. When checking the resistance values is sure the relay is at a reasonable temperature, between +20 and +100°F (-7° and 37°C.)

P2633 Fuel Control Valve Short Low/Open

STEP	ACTION	YES	NO
1	<i>Did you perform the On-Board (OBD) System Check?</i>	Go to Step (2)	Go to OBD system Check Section
2	Check the Power Relay fuse and fuse contacts <i>Are the Power Relay Fuse and contacts OK?</i>	Go to Step (3)	Replace the fuse as required.
3	- Ignition OFF - Disconnect the FCV (Fuel Control Valve) connector C018 - Using a DVOM check the resistance between the two pins of the FCV solenoid <i>Does the DVOM show a resistance value greater than 42 Ohms?</i>	Go to Step (4)	Go to Step (5)
4	Replace the FCV <i>Is the replacement complete?</i>	Go to Step (9)	
5	- Ignition OFF - Disconnect the ECM wire harness connector C0J3 - Ignition ON - Using a DVOM check continuity between ECM pin 48 and FCV connector pin 2 <i>Does the DVOM show continuity?</i>	Go to Step (6)	Repair the open FCV control circuit as required. See wire harness repair.
6	- Remove the power relay from the fuse box - Using a DVOM check for continuity between FCV connector pin 1 and the fuse box terminal for the 87 pin for the power relay. <i>Does the DVOM show continuity?</i>	Go to Step (7)	Repair the open FCV control circuit as required. See wire harness repair
7	Using a DVOM check for continuity between FCV connector pin 2 and engine ground <i>Does the DVOM show continuity?</i>	Repair the shorted to ground FCV control circuit as required. See wire harness repair	Go to Step (8)
8	Inspect the ECM wire harness and connector and FCV connector for damage corrosion or contamination <i>Did you find a problem?</i>	Correct the problem as required. See wire harness repair	Go to Step (9)
9	Replace the ECM <i>Is the replacement complete?</i>	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 run to full operating temperature - Observe the MIL - Observe engine performance - After operating the engine within the test parameters of DTC P2633 check for any stored codes <i>Does the engine operate normally with no stored codes?</i>	System OK	Go to OBD System Check

P2634 Fuel Control Valve Short High



Conditions for Setting the DTC

- FCV
- Check Condition - Ignition ON
- Fault Condition - FCV control circuit equal to or higher than system voltage

Circuit Description

The FCV (Fuel Control Valve) is used to control the fuel regulator pressure output. The ECM cycles the FCV to provide the rich lean transitions required for low exhaust emissions and peak engine performance. This code will set if the voltage on the FCV control circuit is equal to or greater than system voltage indicating a shorted FCV valve coil or shorted to voltage control circuit.

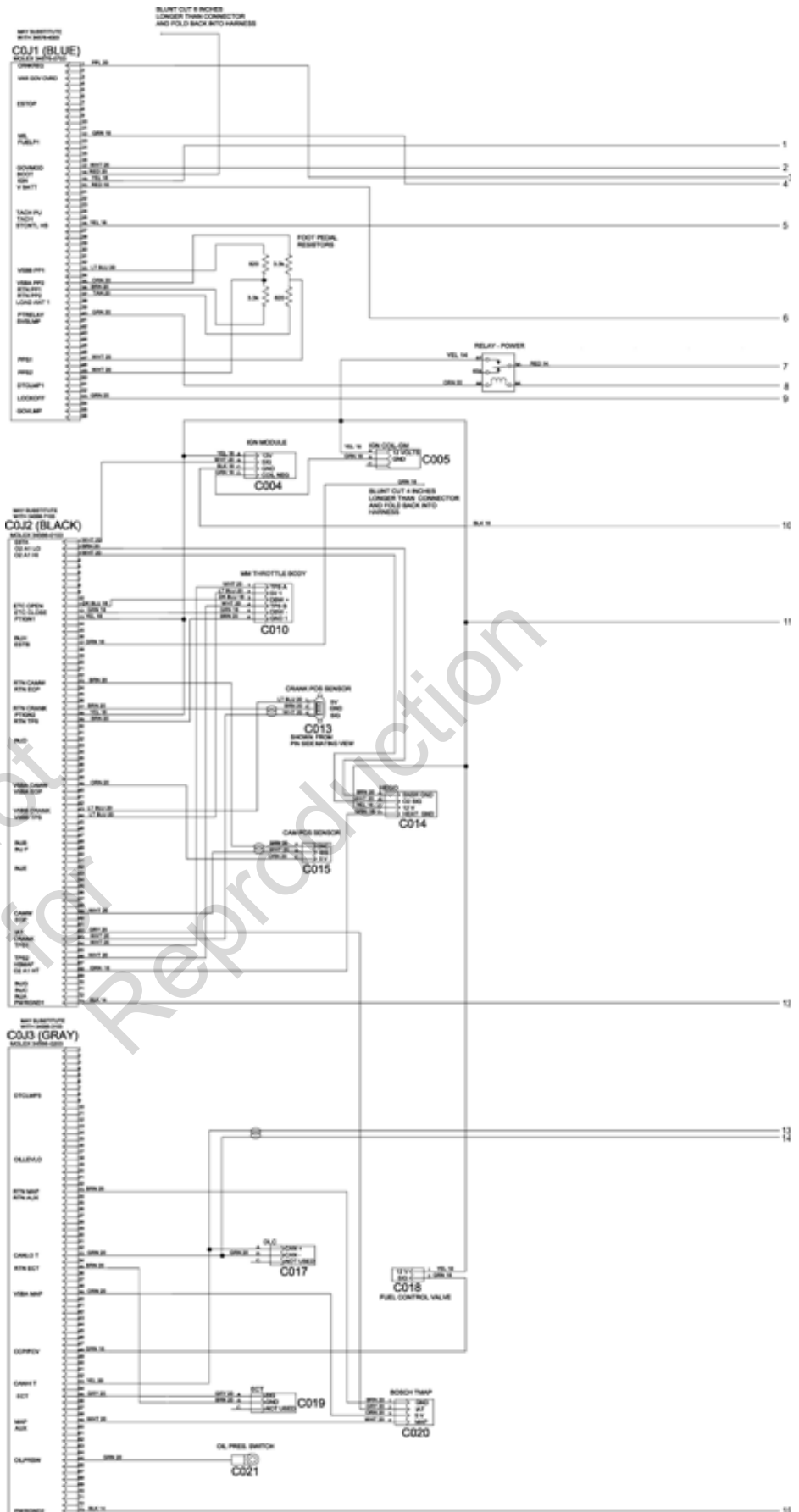
FCV coil resistance changes with temperature. The following diagnostic charts have steps to measure relay coil resistance values. When checking the resistance values is sure the relay is at a reasonable temperature, between +20 and +100°F (-7° and 37°C.)

P2634 Fuel Control Valve Short High

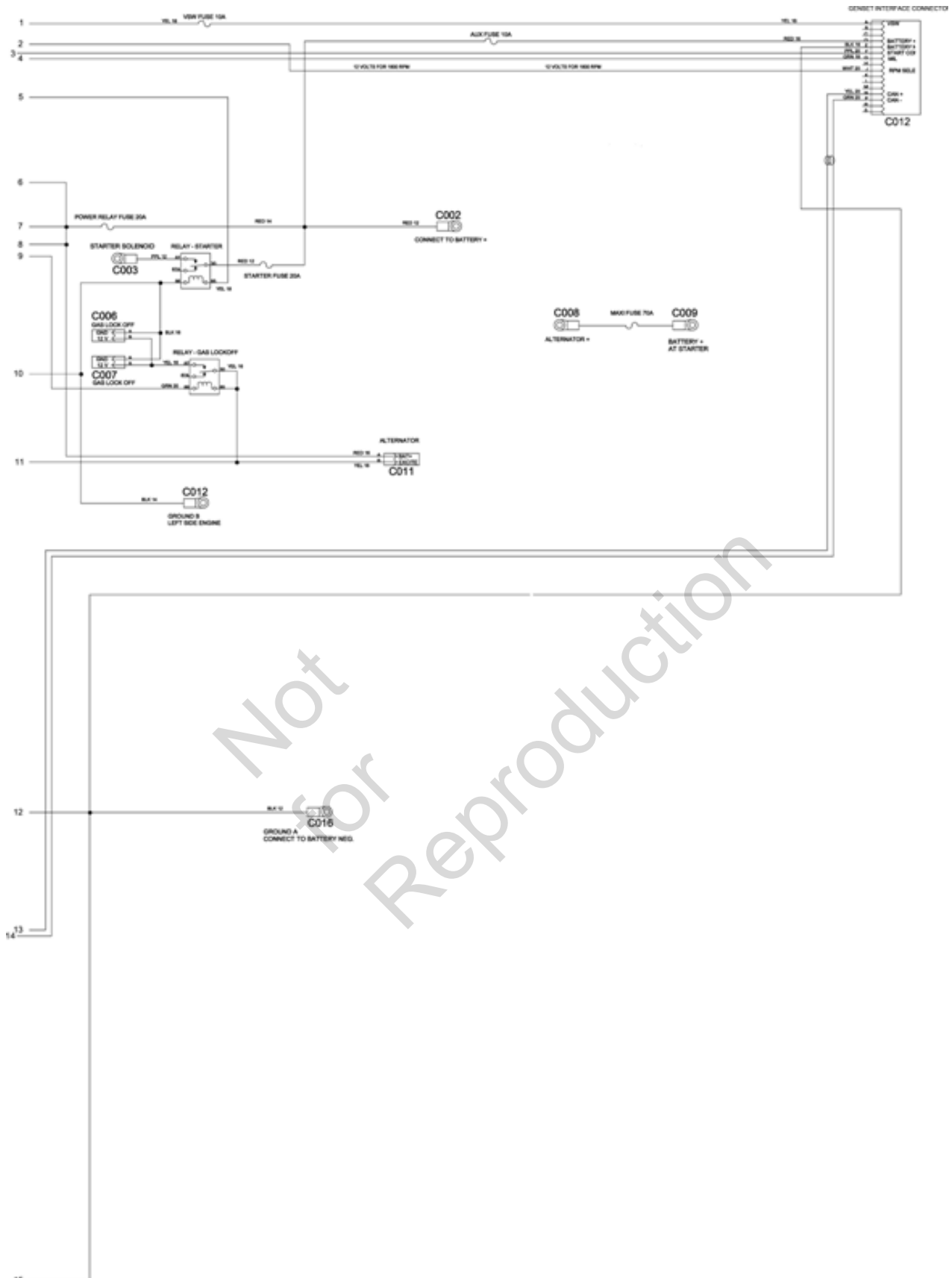
STEP	ACTION	YES	NO
1	<i>Did you perform the On-Board (OBD) System Check?</i>	Go to Step (2)	
2	- Ignition OFF - Disconnect the FCV (Fuel Control Valve) connector C018 - Using a DVOM check the resistance between the two pins of the FCV solenoid <i>Does the DVOM show a resistance value of less than 32 Ohms?</i>	Go to Step (3)	Go to Step (4)
3	Replace the FCV Is the replacement complete?	Go to Step (7)	
4	- Ignition OFF - Disconnect the ECM wire harness connector C0J3 - Ignition ON - Using a DVOM check for voltage between ECM pin 48 and engine ground <i>Does the DVOM show full system battery voltage?</i>	Repair the FCV control circuit shorted to voltage. See wire harness repair.	Go to Step (6)
5	Inspect the ECM wire harness and connector for damage corrosion or contamination <i>Did you find a problem?</i>	Correct the problem as required. See wire harness repair.	Go to Step (7)
6	Replace the ECM <i>Is the replacement complete?</i>	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 run to full operating temperature - Observe the MIL - Observe engine performance - After operating the engine within the test parameters of DTC P2634 check for any stored codes <i>Does the engine operate normally with no stored codes?</i>	System OK	Go to OBD System Check

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3.0L Stationary Power Generation Engine Wire Harness Schematic



3.0L Stationary Power Generation Engine Wire Harness Schematic



Servicing the Fuel System

ENGINE CONTROL MODULE (ECM)

This procedure relates to removal and installation of the ECM. See *Diagnostic Scan Tool* for accessing ECM software or reflash instructions.

REMOVAL PROCEDURE

1. Disconnect Negative (-) battery cable.
2. Unlock the connectors, unplug the wire harness from the ECM (Figure 3) and remove.
3. Remove four bolts, washers and spacers mounting the ECM to the bracket.

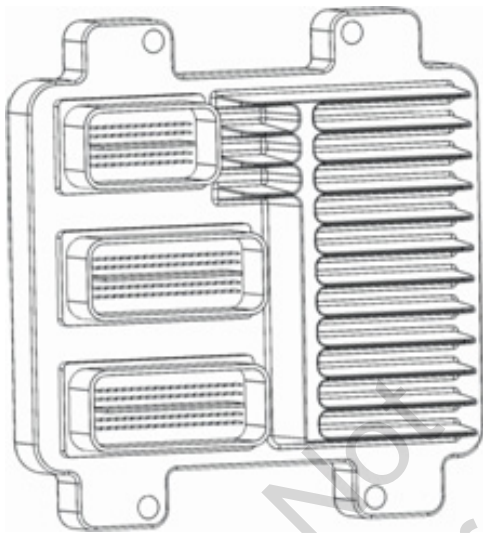


Figure 3

ECM BRACKET

REMOVAL PROCEDURE

1. Remove ECM.
2. Remove ignition coil.
3. Remove bolt securing ECM bracket to the engine and remove the bracket (A, Figure 4).

INSTALLATION PROCEDURE

1. Place the ECM bracket on the studs.
2. Secure the bracket with bolt, lock washer and washer and torque to 7-9 ft.lbs. (9.5-12.2 Nm).
3. Install the ignition coil.
4. Install the ECM.

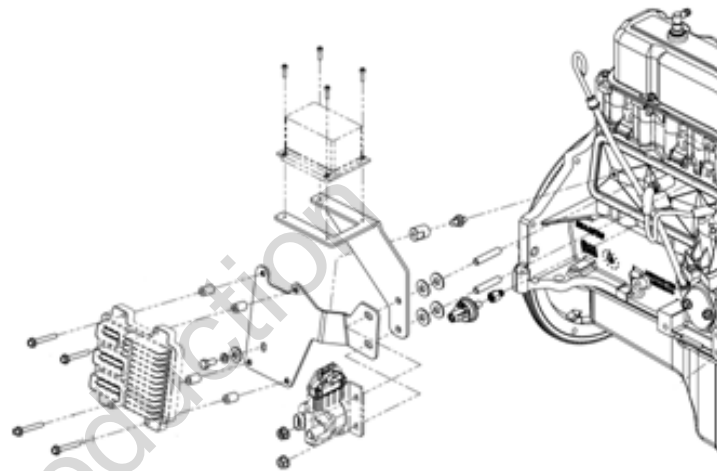


Figure 4

INSTALLATION PROCEDURE

NOTICE: The calibration number may be found by connecting the DST and finding the calibration number.

1. Mount ECM on bracket with four screws, washers and spacers. Torque to 7-9 ft.lbs. (9.5-12.2 Nm).
2. Plug connectors into the ECM and push locks into place.
3. Reconnect the negative (-) battery cable.
4. Install the Diagnostic Service Tool (DST).
5. Start engine and let run until it reaches normal operating temperature.
6. Check for any DTC codes and clear.
7. Verify engine is in closed loop and no MIL light is present.
8. If a DTC code is found, refer to the *Electrical Section* for further diagnosis

IGNITION COIL/MODULE

REMOVAL PROCEDURE

1. Disconnect negative (-) battery cable.
2. Remove all electrical connections to the ignition coil/module assembly (Figure 5).
3. Remove two nuts securing the ignition coil/module assembly to the studs on the side of the engine.
4. Remove ignition coil from studs.

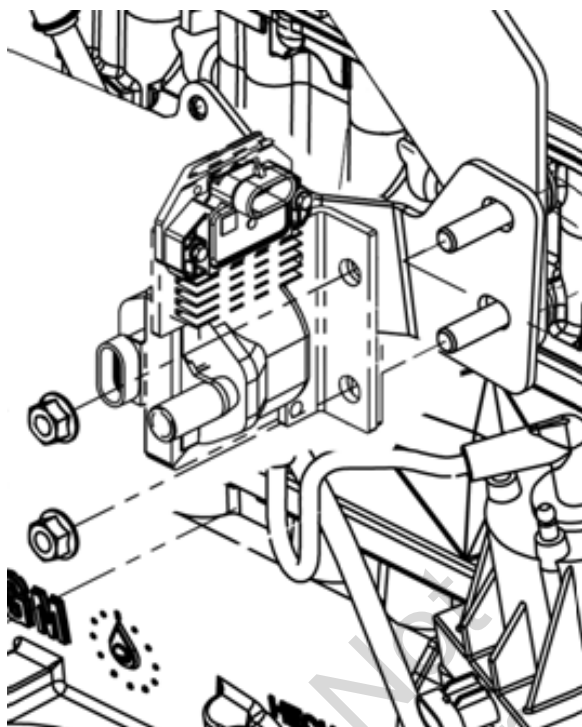


Figure 5

INSTALLATION

1. Place ignition coil/module on studs.
2. Thread nuts on studs and torque to 27.3-33.2 ft.lbs. (37-45Nm).
3. Connect electrical connectors to the ignition coil/module assembly.
4. Reattach negative (-) battery cable.
5. Start the engine and check for proper operation in all throttle ranges. If a DTC code is found, refer to the *Electrical Section* for further diagnosis.

FUSE BOX BRACKET

REMOVAL PROCEDURE

1. Disconnect negative (-) battery cable.
2. Remove four screws securing the fuse box to the bracket and remove the fuse box.
3. Remove ignition coil, ECM and ECM bracket.
4. Remove bracket from studs.

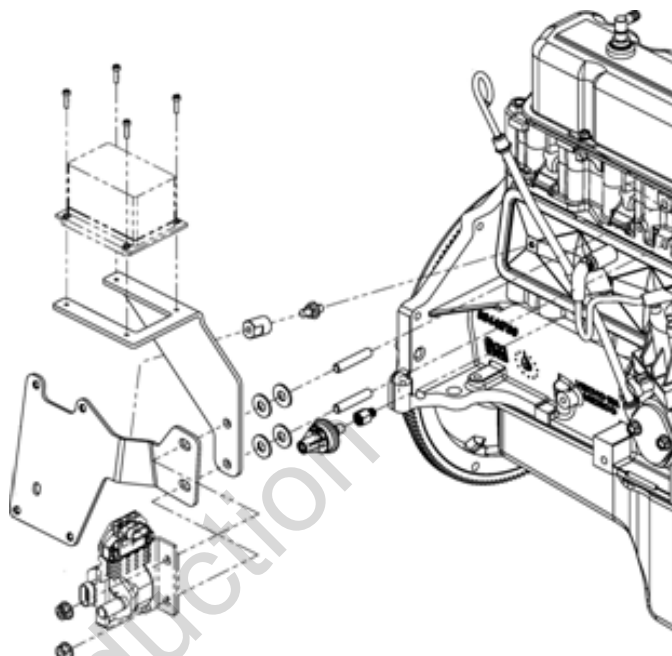


Figure 6

INSTALLATION PROCEDURE

1. Place the fuse box bracket, ECM bracket and ignition coil on studs.
2. Thread nuts on studs and torque to 27.3-33.2 ft.lbs. (37-45Nm).
3. Place fuse box on top of bracket and thread screws with washers into the bracket. Torque to 2-3 ft.lbs (2.7-4.0Nm).
4. Connect electrical connectors to the ignition coil.
5. Reattach negative (-) battery cable.
6. Start engine.
7. If a DTC code is found, refer to the *Electrical Section* for further diagnosis.

ENGINE WIRE HARNESS REPLACEMENT

REPLACEMENT PROCEDURE

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 to avoid crossing connections during installation. Note the routing of the existing wire harness in and around the engine and the engine. Refer to the *Electrical Schematic*.

NOTICE 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 engine.
4. Remove all clips and brackets holding the wire harness and remove harness from engine.
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 engine.
10. If a DTC code is found, refer to the *Electrical Section* for further diagnosis

OIL PRESSURE SENDER

The Oil Pressure Sender, shown installed on the side of the engine below the ECM and above the starter.

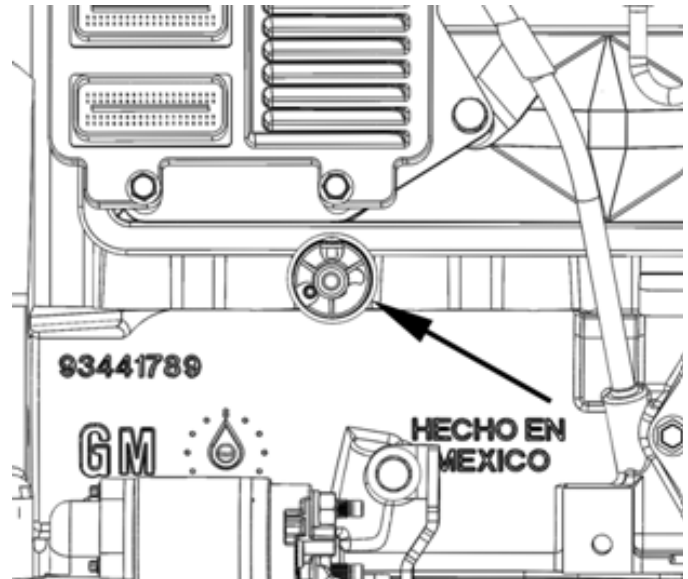


Figure 7

REMOVAL PROCEDURE

1. Disconnect the negative (-) battery cable.
2. Locate the oil pressure sender on the side of the engine.
3. Remove electrical connection from oil pressure sender.
4. Using a wrench, hold the brass adapter (to prevent from turning) and turn the switch counterclockwise and remove. Do not remove the brass adapter from the engine block (unless it is to be replaced).

INSTALLATION PROCEDURE

1. Apply Loctite® 567 (or equivalent high-temp thread locker/sealer) to the threads on the oil pressure sender. If the brass adapter was removed or is to be added to a new sender, add thread locker/sealer and thread on to the engine block. Torque to 2-3 turns past tight.
2. Install oil pressure sender. Torque to 2-3 turns past tight, ensuring the electric connector (screw) is accessible.
3. Attach electrical connector.
4. Reconnect negative battery cable.
5. Start the engine and let run until it reaches normal operating temperature. Check for oil leaks around sensor. If leaks are found, repair as necessary.
6. If a DTC code is found, refer to the *Electrical Section* for further diagnosis.

TEMPERATURE MANIFOLD PRESSURE SENSOR (TMAP)

ENGINE COOLANT TEMPERATURE SENSOR (ECT)

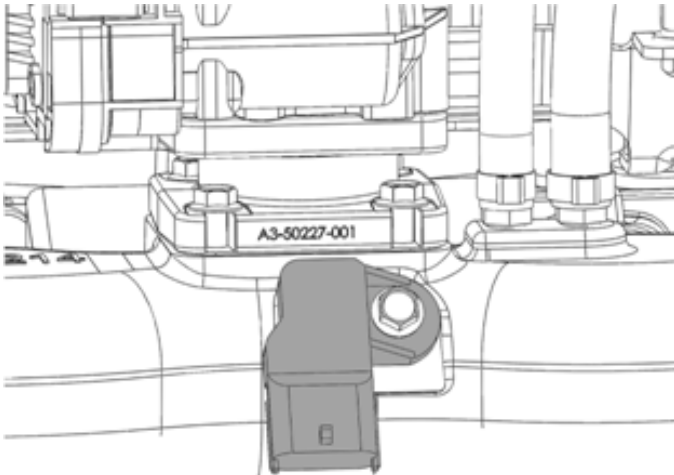


Figure 8

REMOVAL PROCEDURE

1. Disconnect the negative (-) battery cable.
2. Locate the TMAP Sensor on the intake manifold plenum.
3. Disconnect electrical connector.
4. Remove the retaining screw.
5. Remove TMAP sensor by pulling straight up with a slight rocking motion.

INSTALLATION PROCEDURE

Lightly apply petroleum jelly to the O-ring on the TMAP.

1. Install the TMAP and secure with retaining screw. Torque to 7-9 ft.lbs. (9.5-12.2 Nm).
2. Reconnect electrical connector.
3. Reconnect the negative battery cable.
4. Start engine and run until it reaches normal operating temperature.
5. Check for MIL illumination. If a DTC code is found, refer to the *Electrical Section* for further diagnosis.

NOTICE 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 performance 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

The ECT is mounted to the lower thermostat housing located on the front of the engine.

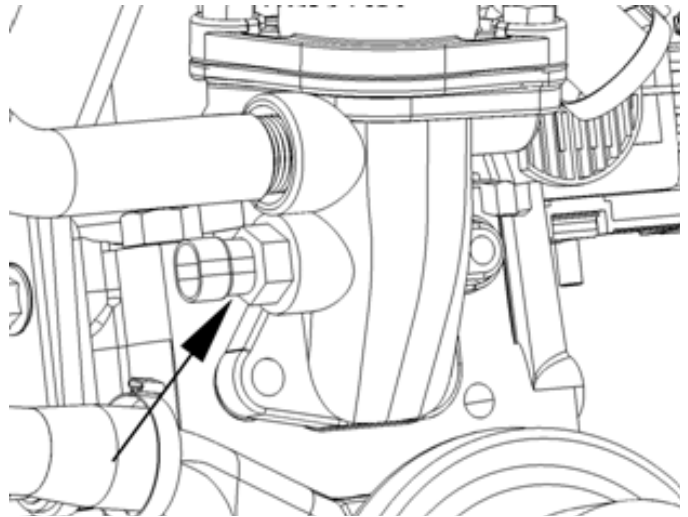


Figure 9

⚠ WARNING Hot pressurized coolant could cause serious injury and/or property damage.



- DO NOT open radiator cap when hot.
- Before servicing, allow coolant to cool.

REMOVAL PROCEDURE

1. Disconnect the negative (-) battery cable.
2. Drain the coolant.
3. Locate the ECT on the side of the engine.
4. Remove electrical connector from the ECT.
5. Unscrew the sensor from the engine

INSTALLATION PROCEDURE

1. Apply a light coat of Loctite® 567 or equivalent pipe thread sealant on the threads of the ECT.
2. Install the ECT into the engine and torque until tight.
3. Connect the ECT electrical connector.
4. Refill the cooling system.
5. Reconnect the negative (-) battery cable.
6. Start the engine and let run until it reaches normal operating temperature. Check for leaks. If leaks are found, repair as necessary.
7. If a DTC code is found, refer to the *Electrical Section* for further diagnosis.
8. Allow the engine to cool, check coolant level and add coolant if necessary.

HEATED EXHAUST GAS OXYGEN SENSOR (HEGO)

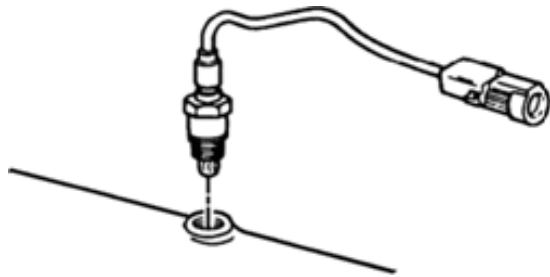


Figure 10

REMOVAL PROCEDURE

1. Disconnect negative (-) battery cable.
2. Locate the oxygen sensor.
3. Disconnect the oxygen sensor electrical connector.
4. Using an oxygen sensor socket, remove the oxygen sensor.

INSTALLATION PROCEDURE

NOTICE 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 performance 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

NOTICE: Before installing the oxygen sensor lubricate threads with anti-seize compound GM P/N 5613695 or equivalent. Avoid contaminating sensor tip with compound.

1. Install oxygen sensor. Torque to 30 ft. lbs. (41 Nm).
2. Reconnect electrical connector to the oxygen sensor.
3. Reconnect the negative (-) battery cable.
4. Start the engine and let run until it reaches normal operating temperature and is in closed loop.
5. If a DTC code is found, refer to the *Electrical Section* for further diagnosis.

DISTRIBUTOR

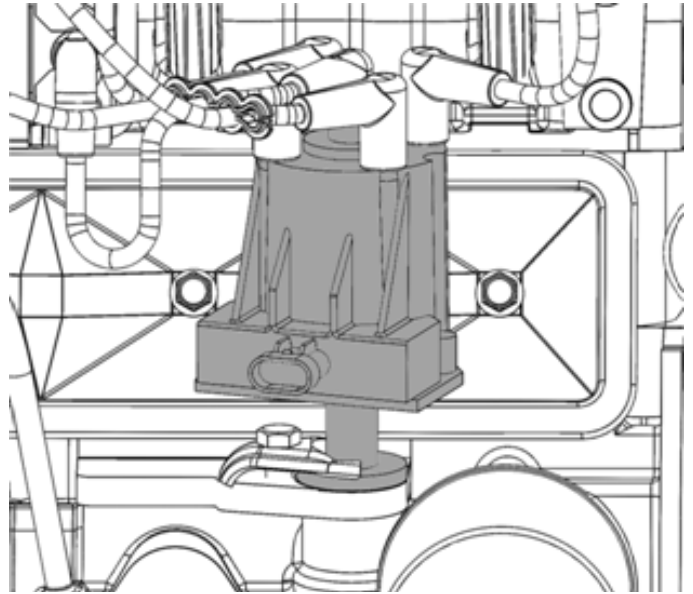


Figure 11

REMOVAL PROCEDURE

1. Disconnect negative (-) battery cable.
2. Mark each spark plug wire with its corresponding cylinder or position on the distributor cap.
3. Remove spark plug wires from the distributor cap by pulling and twisting each spark plug wire boot ½ turn.
4. Remove ignition coil wire.
5. Remove the electrical connector from the base of the distributor.
6. Remove the two Screws that hold the Distributor Cap to the housing and remove Cap.
7. Using a grease pencil or similar marking tool, mark the location of the rotor on the distributor housing and engine.
8. Remove the distributor hold down bolt.

NOTICE: Do not engage the starter, or change the positions of the cam or crankshaft, timing gears or any other internal engine components while the distributor is removed. Any change in the position of these components will alter the timing.

INSTALLATION PROCEDURE

1. Align the rotor with the mark made on the distributor housing (the location of the rotor when it was removed) and place into the engine ensuring the rotor, distributor housing and the mark on the engine are all in alignment when the distributor is fully seat-ed.
2. Install the distributor mounting clam bolt and tighten to 18 ft. lbs (25 Nm). Verify that the rotor and distributor housing remain in line with the mark.
3. Install distributor cap.

NOTICE: Do not reuse old distributor cap screws. Use new screws only.

4. Connect the electrical connection to the base of the distributor.
5. Connect spark plug wires to the distributor cap, ensuring the wires are connected to the correct cylinder. Note that the firing order is 1-3-4-2.
6. Connect ignition coil wire to distributor cap.
7. Reconnect negative (-) battery cable.
8. Start engine. Run engine through all throttle ranges and under load to ensure normal operation.
9. Using the DST, clear DTC information from the ECM.
10. If a DTC code is found, refer to the *Electrical Section* for further diagnosis.

ALTERNATOR

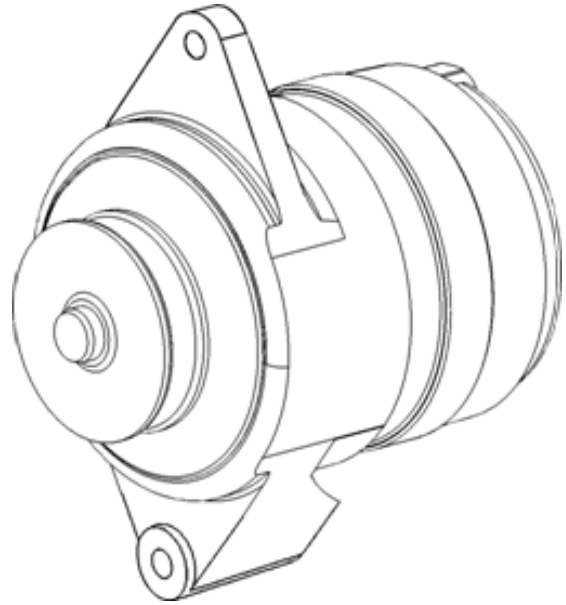


Figure 12

REMOVAL PROCEDURE

1. Disconnect the negative (-) battery cable.
2. Remove the electrical connectors from the alternator.
3. Remove nut on the lower bolt.
4. Remove the bolt securing the alternator to the bracket.
5. Remove the V-belt.
6. Slide the lower bolt out and remove alternator. Note that a washer, located between the bracket and alternator mounting flange, may fall out.

INSTALLATION PROCEDURE

1. Insert bolt through the first hole (the one closest to the front of the engine), then place a washer on the bolt just behind the first hole. Put alternator in place and slide in lower bolt, through the flange on the alternator and second hole.
2. Add the spacer, washer, lockwasher and nut to the lower bolt. Finger tighten nut.
3. Place V-belt on pulleys.
4. While applying outward pressure to the alternator to tighten the V-belt, insert and tighten the screw to secure the alternator to the bracket and tighten. Check for play in V-belt. If too loose, loosen bolt and retighten. If tension on V-belt is correct, torque the top bolt to 12.5 ft.lbs (17 Nm).
5. Torque the nut on the lower bolt to 33.2 ft.lbs (45 Nm) and ensure the alternator is securely mounted with no play.
6. Connect electrical connections to the alternator. Tighten the output terminal nut and torque to 7-9 ft.lbs. (9.5-12.2 Nm).
7. Reconnect the negative (-) battery cable.
8. Start engine and check for MIL. If a DTC code is found, refer to the *Electrical Section* for further diagnosis.

STARTER

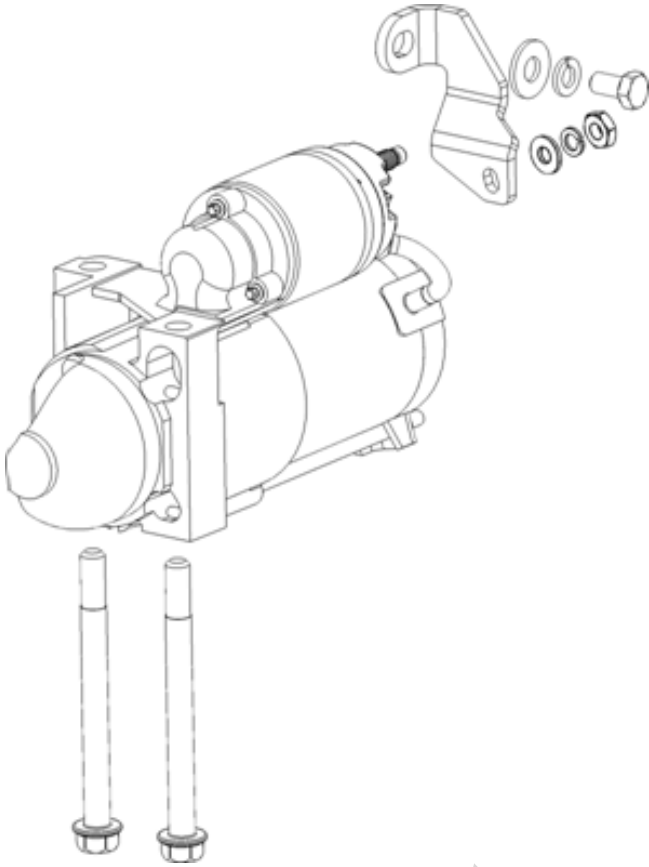


Figure 13

REMOVAL PROCEDURE

1. Disconnect the negative (-) battery cable.
2. Remove the two electrical connections (battery and start switch) connection from the starter solenoid on top of the starter. Do not remove the cable between the solenoid and starter.
3. Remove the bolt securing the starter bracket to the side of the engine.
4. Remove the two bolts securing the starter and remove starter.

INSTALLATION PROCEDURE

1. Place starter in position, making sure the starter teeth are properly meshed with the flywheel.
2. Insert the two bolts under the starter and hand tighten.
3. Insert the bolt securing the starter bracket to the side of the engine and torque to 22.1 ft.lbs. (30Nm).
4. Torque the two long starter bolts to 25.8-33.2 ft.lb (35-45Nm).
5. Connect the positive battery terminal wire and nut to the solenoid stud and torque to 5.9-8.1 ft.lbs (8-11Nm).
6. Connect the starter solenoid wire and nut to the smaller stud on the solenoid and torque to 14.1-26.6 in.lbs. (1.6-3Nm).
7. Connect negative (-) battery cable.
8. Start engine to ensure proper operation of the starter.

CAMSHAFT POSITION SENSOR

REMOVAL PROCEDURE

1. Disconnect negative (-) battery cable.
2. Label spark plug wires with matching distributor cap number and remove by pulling and twisting each spark plug wire boot ½ turn.
3. Remove ignition coil wire.
4. Remove the electrical connector from the base of the distributor.
5. Remove the two screws that hold the distributor cap to the housing and remove cap.
6. Remove the rotor screws.
7. Turn the engine crankshaft to align the square slot in the reluctor wheel with the cam Sensor.
8. Remove the two screws securing the CMP Sensor
9. Remove the camshaft sensor from the distributor.

INSTALLATION PROCEDURE

NOTICE: Do not reuse the old distributor cap, rotor or cam sensor screws.

1. Mount camshaft sensor on distributor and secure with new screws. Torque to 19 in.lbs. (2.2 Nm)
2. Install the rotor on the reluctor wheel and secure with new rotor screws. Torque to 18 in.lbs. (2.0 Nm).
3. Install new rotor cap and secure with new screws. Torque to 21 in.lbs. (2.4 Nm)
4. Connect the sensor harness connector.
5. Connect spark plug wires to the distributor cap, ensuring the wires are connected to the correct cylinder. Note that the firing order is 1-3-4-2.
6. Start engine. If a DTC code is found, refer to the *Electrical Section* for further diagnosis.

CRANKSHAFT POSITION SENSOR

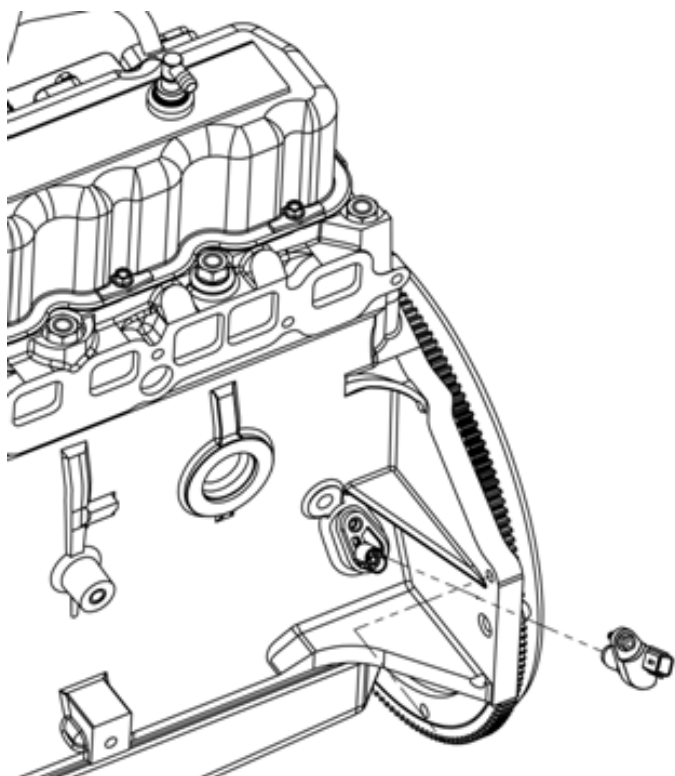


Figure 14

REMOVAL PROCEDURE

1. Disconnect negative (-) battery cable.
2. Remove electrical connector from crank sensor.
3. Remove bolt securing the crank sensor and remove from the side of the engine.

INSTALLATION PROCEDURE

1. Place the crank sensor into the hole in the side of the engine and secure with bolt. Torque to 7-9 ft.lbs. (9.5-12.2 Nm).
2. Attach electrical connector.
3. Attach negative battery cable.
4. Start engine. If a DTC code is found, refer to the *Electrical Section* for further diagnosis.

CRANKSHAFT SENSOR RELUCTOR RING

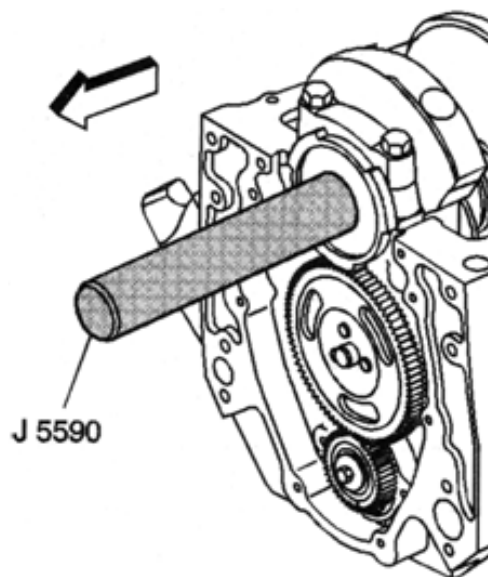


Figure 15

REMOVAL PROCEDURE

1. Remove front engine cover assembly.
2. Slide the CKP sensor reluctor ring off the crankshaft.

NOTICE: The CKP sensor reluctor ring is dish shaped. Note its orientation prior to removal to ensure proper installation.

INSTALLATION PROCEDURE

1. Align the keyway on the CKP sensor reluctor ring and crankshaft and install the CKP sensor reluctor ring.
2. Use tool J 5590 to push the CKP sensor reluctor ring until it is firmly seated against the crankshaft sprocket.
3. Install the front engine cover assembly.

VENTURI & ADAPTER

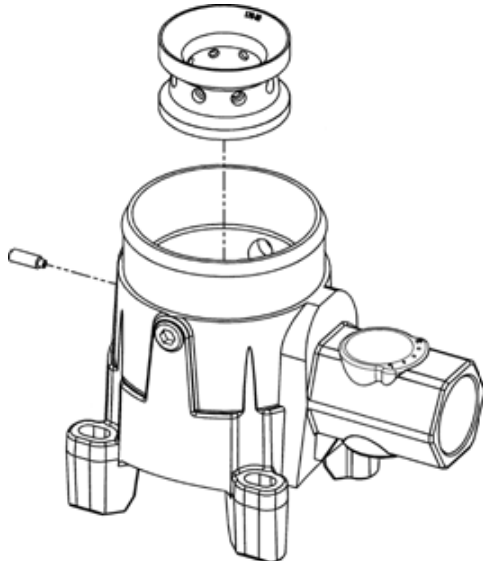


Figure 16

REMOVAL PROCEDURE

1. Remove the air intake assembly connected to the venturi adapter.
2. Using a 2mm hex tool, loosen the set screw securing the venturi.
3. Gently pull the venturi from the adapter and remove.

NOTICE The venturi is a precision component and damage to it or the adapter may affect the performance of the fuel system. Do not use sharp tools to remove or insert the venturi as they may scratch or cause damage. When placing the venturi in the adapter, ensure it is placed straight into the adapter and bottomed out against the seat inside the adapter.

INSTALLATION PROCEDURE

1. Clean the venturi and venturi adapter to remove any dirt or debris that may enter the throttle Body.
2. Place the venturi in the venturi adapter, ensuring the engraved part number and word "TOP" are visible, and it is properly seated on the bottom of the adapter.

NOTE: There is no clock position for the venturi. As long as it is properly seated, it can be rotated to any position.

3. Lightly add Loctite® 242 to the threads on the set screw and thread into the venturi adapter. Torque to 7-13 in.lbs. (0.8-1.5 Nm).
4. Reattach the air intake assembly to the venturi adapter.
5. Start the engine and let run until it reaches normal operating temperature.
6. If a DTC code is found, refer to the *Electrical Section* for further diagnosis.

VENTURI ADAPTER/THROTTLE BODY

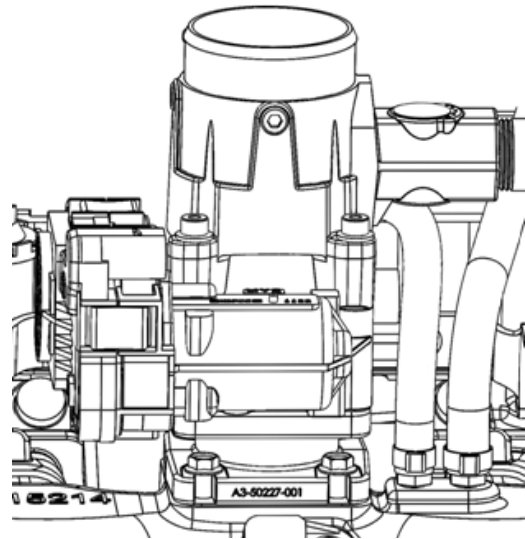


Figure 17

REMOVAL PROCEDURE

1. Turn the manual shut-off valve to OFF and relieve the fuel system pressure.
2. Disconnect the negative (-) battery cable.
3. Remove the air intake from the venturi adapter.
4. Remove the electrical connector from the throttle body.
5. Remove the hoses connected to the adapter fittings.
6. Remove hoses connected to the regulator.
7. Remove the screw at the bottom of the clamp and open the clamp to release the pipe.
8. Disconnect fuel supply hose.
9. Remove four screws that secure the venturi, throttle body and the adapter to the intake manifold.
10. Remove the venturi adapter and throttle body assembly (complete with the fuel pipe and regulator still attached).
11. If the venturi adapter, throttle body or the seal are to be replaced, separate the two.

NOTE: Unless the adapter, throttle body or the seal between the two require replacement, keep the venturi adapter and throttle body together as an assembly to maintain the seal between the throttle body and venturi adapter.

NOTICE: Place tape, a clean cloth or some other covering over the intake manifold to prevent debris from entering the engine and causing permanent engine damage.

12. Remove the pipe from the venturi adapter and place the regulator assembly aside.
13. If venturi adapter is to be replaced, remove the venturi and the fittings.

INSTALLATION PROCEDURE

1. Inspect venturi adapter gasket. Replace if necessary.
2. Clean components of any loose debris. Ensure that all mating surfaces are smooth, clean and free of any old gaskets.
3. Insert venturi if removed. If the venturi adapter was replaced, ensure the plug, elbows and set screw are installed. Apply a light coat of Loctite® 567 or equivalent pipe thread sealant on the threads of the plug and nylon elbows and insert into the adapter. Torque until tight. Continue turning the nylon elbow until it is in the correct clock position.

NOTICE Do not use Teflon tape to seal any fuel fittings. Fragments of the tape may enter into the fuel system, causing damage or malfunction of critical fuel system components.

4. Place Loctite® 567 or equivalent pipe thread sealant on the threads of the pipe (on the regulator assembly) and thread the adapter on to the pipe until tight, then continue turning until both the adapter and the regulator match the same clock position.
5. If the venturi adapter and throttle Body were separated, verify the throttle body seal is not crushed, cracked or otherwise damaged. If so, replace.
6. Place on top of throttle body, throttle body gasket and throttle body adapter, then insert four hex screws and finger tighten.
7. Ensure the fuel pipe is properly cradled in the regulator support clamp and finger tighten the screw on the regulator support clamp.
8. Torque the four hex screws securing the throttle body/venturi adapter assembly to 7-9 ft.lbs. (9.5-12.2 Nm).
9. Torque the screw of the regulator support clamp to tight.
10. Connect fuel hose and secure with clamp.
11. Connect the two vacuum hoses to the regulator and secure with clamps.
12. Connect the electrical connector to the throttle body.
13. Attach the air intake to the venturi adapter.
14. Inspect all mating surfaces ensuring that all components and gaskets are properly seated and no air leaks may exist.
15. Reconnect negative (-) battery cable.
16. Start engine and verify correct operation in all throttle ranges.
17. Using the DST, clear DTC information from the ECM.
18. Turn the ignition OFF and wait 30 seconds.
19. Start the engine and let run until it reaches normal operating temperature. If a DTC code is found, refer to the *Electrical Section* for further diagnosis.

THROTTLE BODY ADAPTER AND/OR GASKET

The throttle body adapter, shown mounted to the intake manifold with the throttle body and gasket removed.

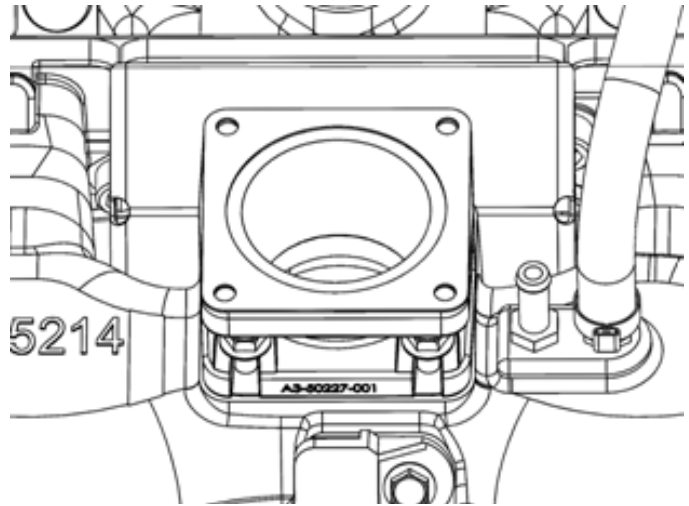


Figure 18

REMOVAL PROCEDURE

1. Disconnect the negative (-) battery cable. remove venturi adapter/throttle body assembly.
2. Remove throttle body/throttle body adapter seal.
3. Remove four screws securing the throttle body adapter to the intake manifold and remove adapter and gasket.

NOTICE: Place tape, a clean cloth or some other covering over the intake manifold to prevent debris from entering the engine and causing permanent engine damage.

INSTALLATION PROCEDURE

1. Place gasket on top of intake manifold.
2. Insert four screws on the intake manifold and torque to 7-9 ft.lbs. (9.5-12.2 Nm).
3. Replace throttle body and adapter.
4. Inspect all mating surfaces ensuring that all components and gaskets are properly seated and no air leaks may exist.
5. Reconnect the negative (-) battery cable.
6. Start engine and verify correct operation in all throttle ranges.
7. Using the DST, clear DTC information from the ECM.
8. Turn the ignition OFF and wait 30 seconds.
9. Start the engine and let run until it reaches normal operating temperature. If a DTC code is found, refer to the *Electrical Section* for further diagnosis

SHUT-OFF VALVES

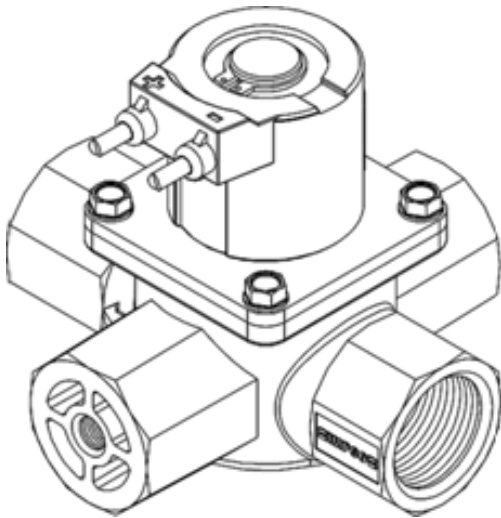


Figure 19

REMOVAL PROCEDURE

1. Relieve the fuel system pressure.
2. Disconnect the negative (-) battery cable.
3. Disconnect shut-off valve electrical connectors.
4. Disconnect fuel inlet line.
5. Remove shut-off valve, 90° elbow and fuel line fitting as an assembly by unscrewing the elbow at the threaded port located at the top of the regulator.
6. Remove 90° elbow and fuel line fitting from the shut-off valve.

INSTALLATION PROCEDURE

1. Add Loctite® 567 or equivalent thread sealer to all male pipe threads, including the elbow, hose adapter, fuel inlet fittings, etc.

NOTICE Do not use Teflon tape to seal any fuel fittings. Fragments of the tape may enter into the fuel system, causing damage or malfunction of critical fuel system components.

2. Connect elbow and other fittings, making sure that the elbow has the correct orientation to the shut-off valve.
3. Connect elbow, shut-off valves and fuel pipes together. Torque until tight, then continue until each component is aligned to its proper clock position.
4. Make electrical connections to the shut-off valves.
5. Connect the fuel inlet line to the shut-off valve fitting.
6. Reconnect negative (-) battery cable.
7. Slowly turn the manual shut-off valve ON. Check for leaks using a soapy solution or an electronic leak detector. If leaks are detected, make repairs.

8. Start engine and check for leaks using a soapy solution or an electronic leak detector. If leaks are detected, make repairs.
9. If a DTC code is found, refer to the *Electrical Section* for further diagnosis

TEST PROCEDURE

1. Close the fuel source valve.
2. Start and run the engine until the engine stalls from lack of fuel.
3. Turn the ignition switch to OFF.
4. Remove the plug from the pipe nipple after the second shut-off valve.

▲ WARNING Propane and Natural Gas are extremely flammable and explosive, which could cause burns, fire or explosion resulting in death, serious injury and/or property damage.

- DO NOT operate engine if smell of fuel is present or other explosive conditions exist.
- DO NOT smoke around the generator. Wipe up any oil spills immediately. Ensure that no combustible materials are left in the generator compartment. Keep the area near the generator clean and free of debris.

5. Connect test port fitting to the plug opening, then connect a hose and gauge to the fitting.
6. Slowly turn the manual shutoff valve ON.
7. Start engine and note pressure reading on gauge. If the fuel pressure noted was close to zero and/or the engine fails to start, check electrical connection on both shut-off valves.
8. Turn engine and ignition switch to OFF.
9. Close the fuel source valve.
10. Start and run the engine until the engine stalls from lack of fuel.
11. Remove the test port fitting, Hose and gauge. Apply Loctite 567® or equivalent thread sealer to male threads on the plug and replace.

NOTICE Do not use Teflon tape to seal any fuel fittings. Fragments of the tape may enter into the fuel system, causing damage or malfunction of critical fuel system components.

12. Slowly turn the manual shutoff valve ON.
13. Start engine and check for leaks using a soapy solution or an electronic leak detector. If leaks are detected, make repairs.
14. If a DTC code is found, refer to the *Electrical Section* for further diagnosis

FUEL SUPPLY PRESSURE TEST

1. Turn the manual supply valve to OFF and relieve the system fuel pressure.
2. Remove the plug on the test port fitting between the manual supply valve and the first shut-off valve.

▲ WARNING Propane and Natural Gas are extremely flammable and explosive, which could cause burns, fire or explosion resulting in death, serious injury and/or property damage.

- DO NOT operate engine if smell of fuel is present or other explosive conditions exist.
- DO NOT smoke around the generator. Wipe up any oil spills immediately. Ensure that no combustible materials are left in the generator compartment. Keep the area near the generator clean and free of debris.

3. Install the test port fitting into the supply line and torque until tight.
4. Attach the hose to the test port fitting and the 0-20 in. (0.0 - 50 cm) W.C. gauge. Note that the test port fitting, hose and gauge are included with test kit, ITK-1-IND.
5. Slowly turn the manual shutoff valve ON and note the pressure on the gauge. The pressure should not exceed 13.85 in. (35 cm) W.C.

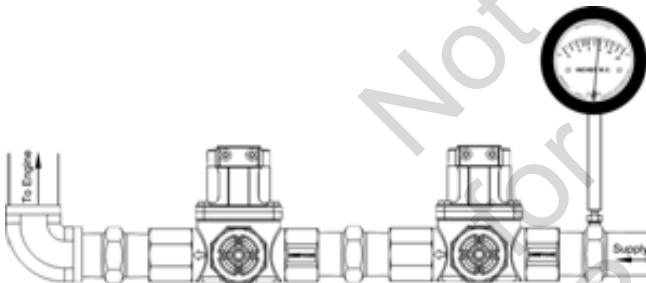


Figure 20

6. Turn the manual supply valve to OFF.
7. Remove the gauge, hose and test port fitting.
8. Apply Loctite® 567 to the test port plug and insert into the test port. Torque until tight.

LOW PRESSURE REGULATOR

NOTICE: The low pressure regulator features tamper resistant caps and fasteners and cannot be serviced, rebuilt or adjusted.

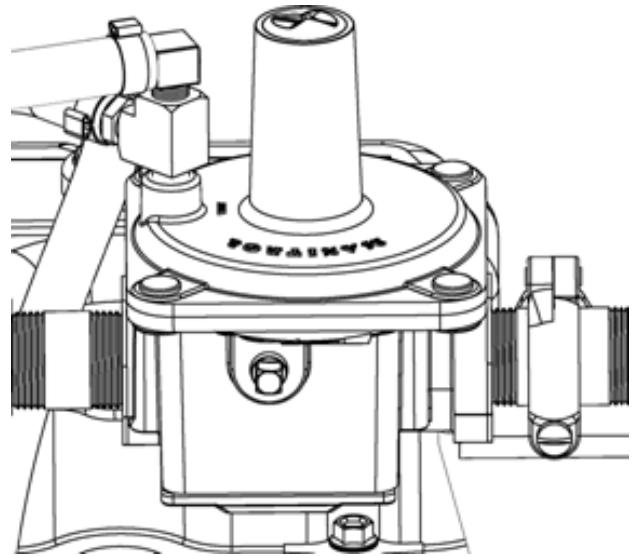


Figure 21

REMOVAL PROCEDURE

1. Turn off fuel source and relieve the fuel system pressure.
2. Disconnect negative (-) battery cable.
3. Disconnect hoses attached to the brass T on the regulator.
4. Remove the fuel hose clamp and hose from the elbow nearest the regulator.
5. Remove clamp supporting the pipe that leads to the regulator.
6. Remove the venturi adapter, fuel pipes (including the fuel selector switch) and regulator together as an assembly.

Note: Be sure to spin the regulator on the pipe and avoid placing any side pressure on the regulator that may damage the venturi adapter or one of its seals.

7. Remove the fuel pipes attached to the regulator.
8. Remove the 90° nylon elbow, the brass hose barb and the brass T-fitting on top of the regulator.

INSTALLATION PROCEDURE

1. Place Loctite® 567 or equivalent thread sealer on all male threads of the fuel pipes.

NOTICE Do not use Teflon tape to seal any fuel fittings. Fragments of the tape may enter into the fuel system, causing damage or malfunction of critical fuel system components.

2. Assemble the fuel pipes and elbow in the regulator and torque until tight.

NOTE: The longer pipe is attached to the inlet side of the regulator and the shorter one to the outlet side.

3. Insert the fuel pipe end of the regulator and fuel pipe assembly into the venturi adaptor and torque until tight, then continue to turn so the regulator and venturi adapter are in the same clock position.

Note: Be sure to spin the regulator on the pipe and avoid placing any side pressure that may damage the venturi adapter or one of its seals.

4. Attach the elbow and fuel hose barb to the fuel pipe.
5. Place the assembly on top the throttle body.
6. Secure fuel pipe to bracket. Torque screws to 30-36 ft.lbs. (41-49 Nm).
7. Place the elbow on the fuel pipe and turn until tight, then continue to turn until it is positioned in line with the fuel hose.
8. Place Loctite® 567 or equivalent thread sealer on threads of the hose barb. Insert into elbow and torque to tight.
9. Place Loctite® 567 or equivalent thread sealer on the threads of the brass T and insert into the top of the regulator. Torque until tight, then continue turning until the T is pointed towards the engine.
10. Place Loctite® 567 or equivalent thread sealer on the threads of the vacuum hose barb adapter. Insert into the brass T and torque until tight.
11. Place Loctite 567® or equivalent thread sealer on the male threads of the nylon elbow, then insert into brass T. Torque until tight, then continue to turn until it points to the fuel control valve.
12. Place Loctite 567® or equivalent thread sealer on the male threads of the nylon elbow, then insert into brass T. Torque until tight.
13. Reconnect vacuum hoses to the barb fittings. The fittings may require some minor turning to meet the direction of the hoses.
14. Reconnect negative (-) battery cable.
15. Slowly turn the manual shut-off valve ON.
16. Start engine and check for leaks using a soapy solution or an electronic leak detector. If leaks are detected make repairs. Verify correct operation in all throttle ranges.
17. If a DTC code is found, refer to the *Electrical Section* for further diagnosis.

REGULATOR TEST PORT/OUTLET FUEL PRESSURE

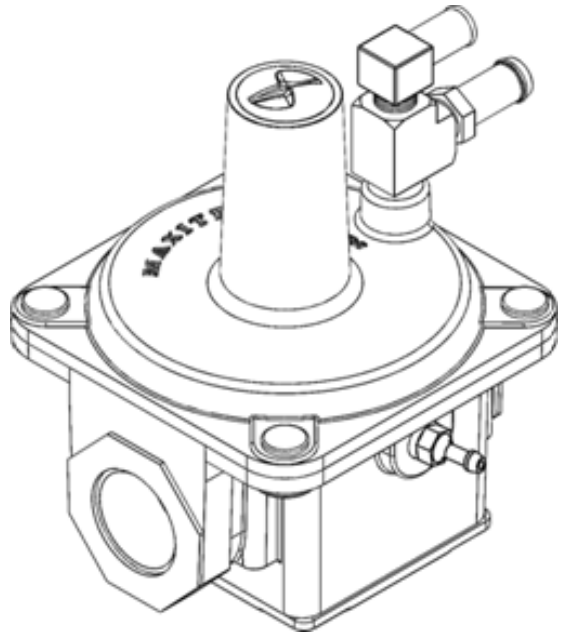


Figure 22

REMOVAL PROCEDURE

1. Turn the manual shut-off valve to OFF and relieve the fuel system pressure.
2. Disconnect the negative (-) battery cable.
3. Remove one of the two test port plugs (one is on each side of the pressure regulator).
4. Insert the test port fitting (included in the test kit ITK-1-IND) and connect the hose to the test port and 0-10 in. (0.0 - 25 cm) W.C. gauge.
5. Reconnect the negative (-) battery cable.
6. Slowly turn the manual shutoff valve ON.
7. Start the engine and note the fuel pressure.
8. Turn the manual shut-off valve OFF and relieve the fuel system pressure.
9. Remove gauge, hose and test port fitting
10. Apply Loctite® 567 or equivalent thread sealer to male threads on the plug and replace. Torque to tight.
11. Slowly turn the manual shutoff valve ON
12. Start engine and check for leaks using a soapy solution or an electronic leak detector. If leaks are detected make repairs. Verify correct operation in all throttle ranges.
13. If a DTC code is found, refer to the *Electrical Section* for further diagnosis.

FUEL CONTROL VALVE

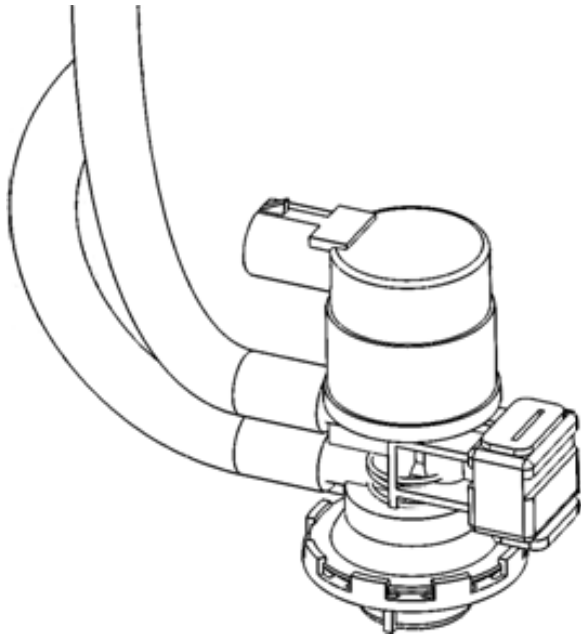


Figure 23

REMOVAL PROCEDURE

1. Disconnect the negative (-) battery cable.
2. Disconnect electrical connector
3. Disconnect vacuum hoses
4. While rocking the control valve back and forth, gently pull the valve up and remove from the bracket.

INSTALLATION PROCEDURE

1. Press the fuel control valve on the mounting bracket.
2. Connect two vacuum hoses.

NOTE: The lower hose is attached to the intake manifold and the upper hose is attached to the regulator.

3. Attach electrical connector.
4. Connect the negative (-) battery cable.
5. Start engine and check for leaks using a soapy solution or an electronic leak detector. If leaks are detected make repairs. Verify correct operation in all throttle ranges.
6. If a DTC code is found, refer to the *Electrical Section* for further diagnosis.

FUEL CONTROL VALVE BRACKET

REMOVAL PROCEDURE

1. Remove screws securing the bracket and remove bracket.

INSTALLATION PROCEDURE

1. Place bracket on top of the main bracket, align in position and secure with two screws. Torque to 4-6 ft.lbs. (5.4-8.1Nm).

FUEL SYSTEM PRESSURE RELIEF

1. Turn the manual shut-off valve to OFF.
2. Start and run the engine until the engine stalls from lack of fuel.
3. Turn the engine and Ignition switch to OFF.
4. Disconnect the negative (-) battery cable.



WARNING Propane and Natural Gas are extremely flammable and explosive, which could cause burns, fire or explosion resulting in death, serious injury and/or property damage.

- Install the fuel supply system according to NFPA 37 and other applicable fuel-gas codes.
- Before placing the generator into service, the fuel system lines must be properly purged and leak tested.
- After the generator is installed, you should inspect the fuel system periodically.
- NO leakage is permitted.
- DO NOT operate engine if smell of fuel is present or other explosive conditions exist.
- DO NOT smoke around the generator. Wipe up any oil spills immediately. Ensure that no combustible materials are left in the generator compartment. Keep the area near the generator clean and free of debris.

FUEL SYSTEM LEAK TEST

1. Use a commercially available liquid leak detector or an electronic leak detector and follow the manufacturer's instructions.

NOTICE: When using both methods, use the electronic leak detector first to avoid contamination by the liquid leak detector.

2. If leaks are detected, make repairs

FUEL CONTROL SYSTEM CHECK

1. The fuel system can be thoroughly diagnosed by use of the DST tool. See section *DIAGNOSTIC SCAN TOOL*.

CRANKCASE VENTILATION SYSTEM INSPECTION/DIAGNOSIS

The PCV, shown mounted on top of the valve cover.

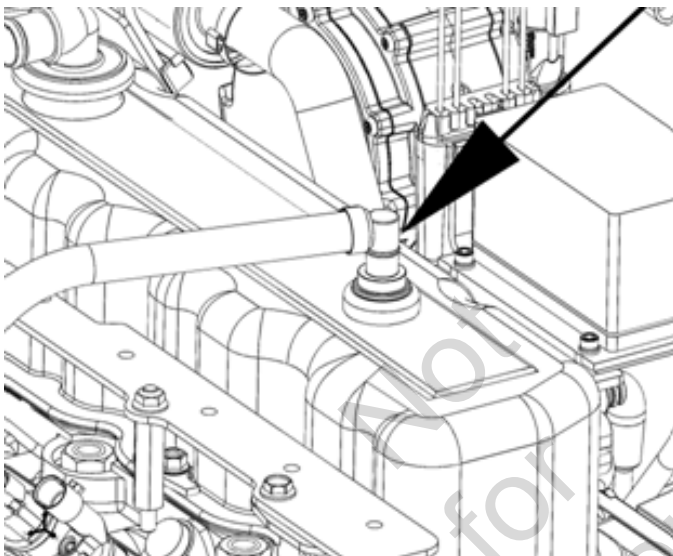


Figure 24

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:

1. Remove the PCV hose from the rocker arm or valve cover.
2. Operate the engine under no load.
3. Place your thumb 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.
4. Turn the engine OFF.
5. Inspect the PCV orifice in the valve cover for debris or blockage. Clean with carburetor cleaner as necessary.

FUNCTIONAL CHECK

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:

1. Remove the PCV hose from the rocker arm cover.
2. Operate the engine under no load.
3. Place your thumb 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.
4. Turn the engine OFF.
5. Inspect the PCV orifice in the valve cover for debris or blockage. Clean with carburetor cleaner as necessary.

FUEL SELECTOR SWITCH

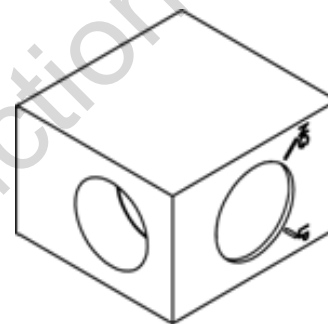


Figure 25

NOTE: The fuel selector switch is factory set for NG operation. Using a 6mm Allen wrench, turn the selector switch to either LP or NG.

REMOVAL PROCEDURE

1. Remove the low pressure regulator assembly, including the pipes and fuel selector switch.
2. Remove the pipes on both sides of the fuel selector switch.

INSTALLATION PROCEDURE

1. Verify that the fuel selector switch is set for the correct fuel and install the expansion plug.
2. Apply Loctite® 567 to the male threads of the fuel pipes.
3. Thread the pipes into each side of the fuel selector switch and torque until tight.
4. Reinstall the low pressure regulator assembly.

COOLANT HOSE

REMOVAL PROCEDURE

⚠ WARNING Hot pressurized coolant could cause serious injury and/or property damage.



- DO NOT open radiator cap when hot.
- Before servicing, allow coolant to cool.

1. Drain coolant.
2. Remove hose clamps from both ends and remove.

INSTALLATION PROCEDURE

NOTICE: Coolant hoses are specifically designed for a specific application. DO NOT use hose material or length other than the OEM specified parts. DO NOT mix the inlet or outlet ends of the hose when reinstalling.

1. Slide clamps over each end of the hose.
2. Place hose over each barb, ensuring the hose is relaxed and not twisted or kinked.
3. Slide hose clamp to a position approximately 1/4" from the end of the hose and tighten.
4. Refill with coolant.
5. Start engine and let run until it reaches operating temperature.
6. Check for leaks. If leaks are detected, make repairs.
7. Stop engine and allow to cool. Check coolant level and add coolant as necessary.

THERMOSTAT & HOUSING

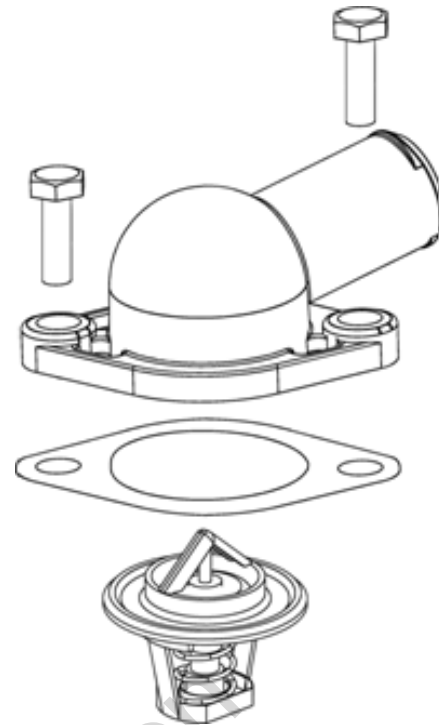


Figure 26

REMOVAL PROCEDURE

1. Drain coolant.

⚠ WARNING Hot pressurized coolant could cause serious injury and/or property damage.



- DO NOT open radiator cap when hot.
- Before servicing, allow coolant to cool.

2. Remove radiator hose from thermostat housing.
3. Remove two bolts securing the thermostat housing and remove housing, gasket and thermostat.

INSTALLATION PROCEDURE

1. Clean gasket mounting surfaces and place the thermostat in place and a new gasket on top.
2. Place the thermostat housing on top the gasket, align the housing and gasket to the holes and insert bolts. Torque the bolts to 21 ft.lbs (28Nm).
3. Attach radiator hose to thermostat housing and secure with clamp.
4. Refill coolant.
5. Start engine and inspect for coolant leaks. Repair if necessary.
6. Allow engine to cool and add coolant if necessary.

FUEL VAPOR HOSE

REMOVAL PROCEDURE

1. Relieve the fuel system pressure.
2. Disconnect negative (-) battery cable.
3. Remove hose clamps.
4. Remove hose from barbs at both ends.



▲ WARNING Propane and Natural Gas are extremely flammable and explosive, which could cause burns, fire or explosion resulting in death, serious injury and/or property damage.

- Install the fuel supply system according to NFPA 37 and other applicable fuel-gas codes.
- Before placing the generator into service, the fuel system lines must be properly purged and leak tested.
- After the generator is installed, you should inspect the fuel system periodically.
- NO leakage is permitted.
- DO NOT operate engine if smell of fuel is present or other explosive conditions exist.
- DO NOT smoke around the generator. Wipe up any oil spills immediately. Ensure that no combustible materials are left in the generator compartment. Keep the area near the generator clean and free of debris.

NOTICE: Hoses are designed for specific applications. DO NOT use Hose material or length other than specified by the OEM. DO NOT mix the inlet or outlet ends of the hose when reinstalling.

INSTALLATION PROCEDURE

1. Slide hose clamps over each end and towards the middle of the fuel hose.
2. Place fuel hose over each barb, ensuring the hose is relaxed and not twisted or kinked.
3. Slide each hose clamp to a position approximately 1/4" from the end of the hose and tighten.

NOTICE 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 performance 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

4. Slowly turn the manual shutoff valve ON.
5. Start engine and check for leaks using a soapy solution or an electronic leak detector. If leaks are detected, make repairs.
6. If a DTC code is found, refer to the *Electrical Section* for further diagnosis.

VACUUM HOSE

REMOVAL PROCEDURE

1. Remove the vacuum line from each fitting.

OETIKER CLAMPS



Figure 27

NOTICE: Oetiker clamps can be used only once. Once removed, they can no longer be reused and should be discarded.

REMOVAL PROCEDURE

1. Place the pincer jaws or diagonal wire cutters across the ear and cut through it.
2. Remove clamp and discard.

INSTALLATION PROCEDURE

Two Oetiker pliers exist: one standard and one for use when space is restricted:

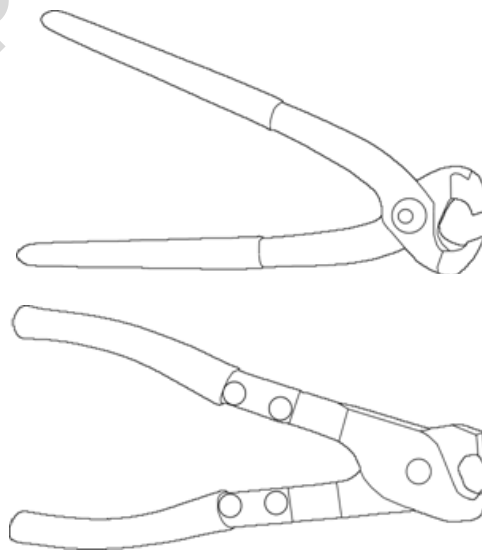


Figure 28

Only use recommended tools to close Oetiker clamp ears. The ears of the clamp should be closed with a uniform force, sufficient to pinch the two sides of the ear together while applying enough compression on the hose to keep it snug on the barb without crushing. The deformation of the clamp ear provides the means to inspect the clamp.

Using the correct tool, crimp the ear so that the clamp is fully closed. Verify the clamp and the hose are both tight and secure on the barb.

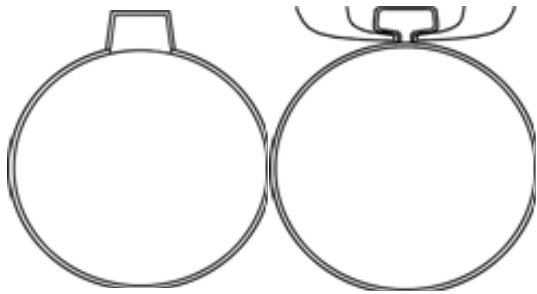


Figure 29

The Oetiker clamp on the left is shown end view as new and uncompressed and the one on the right is shown compressed using the Oetiker pliers.

1. Always inspect the hose connections for leaks after servicing any hoses. Run engine until normal operating temperature is reached and check for leaks using 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.

MAIN BRACKET ASSEMBLY

REMOVAL PROCEDURE

1. Remove fuel control valve and bracket.
2. Remove the nut securing the bracket to the stud located towards the front of the engine.
3. Remove the two bolts and nuts on the upper support bracket near the back of the engine.
4. Remove the nut securing the upper support bracket near the rear of the engine and the Nut on the heat shield. Remove heat shield.
5. Remove two screws securing the main supporting bracket and remove bracket.

INSTALLATION PROCEDURE

1. Mount the upper support bracket and heat shield on stud and secure with nut and torque to 30.4-36.1 ft.lbs. (41-49Nm).
2. Thread in stud near front of engine and torque to 27.3-33.2 ft.lbs. (37-45Nm).
3. Replace the fuel control valve and bracket.

INTAKE & EXHAUST MANIFOLDS AND/OR GASKET

⚠ WARNING Exhaust heat/gases could ignite combustibles or structures resulting in death, serious injury and/or property damage. Contact with muffler area could cause burns resulting in serious injury.

- DO NOT touch hot parts and AVOID hot exhaust gases.
- Allow equipment to cool before touching.
- Replacement parts must be the same and installed in the same position as the original parts.

REMOVAL PROCEDURE

1. Remove vacuum hoses from the top of the intake manifold.
2. Remove four screws securing the throttle body adapter to the intake manifold.
3. Remove two screws securing maxifuse and maxifuse mount and remove.
4. Remove nuts and screws securing heat shields to the manifolds.
5. Remove TMAP from intake manifold.
6. Remove HEGO.
7. Remove the exhaust pipe connection with the exhaust manifold.
8. Remove remaining four screws that secure the manifolds.
9. Remove intake and exhaust manifolds.
10. Remove gasket.

INSTALLATION PROCEDURE

Clean the manifolds and inspect for the following:

1. Damage to the gasket sealing surfaces.
2. Cracks or damage.
3. Damage to threaded bolt holes.
4. Place gasket on the engine.
5. Place the exhaust manifold over the studs.
6. Apply anti-seize compound to the studs and four screws that secure the Intake and exhaust manifolds.
7. Place the intake manifold against block and secure with four bolts. Torque to 30-36 ft.lbs. (41-49 Nm).
8. Starting with the large center one shield, install nuts and screws securing heat shields to the manifolds, including the Maxifuse and its mounting bracket. Torque Screws to 7-9 ft.lbs. (9.5-12.2 Nm) and Nuts to 30-36 ft.lbs. (41-49 Nm).
9. Connect exhaust manifold to exhaust pipe.
10. Install HEGO.
11. Install TMAP sensor on the intake manifold.

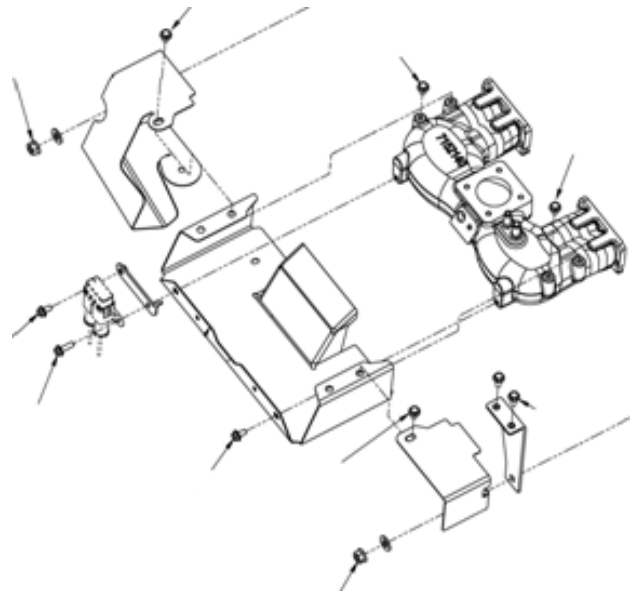


Figure 30

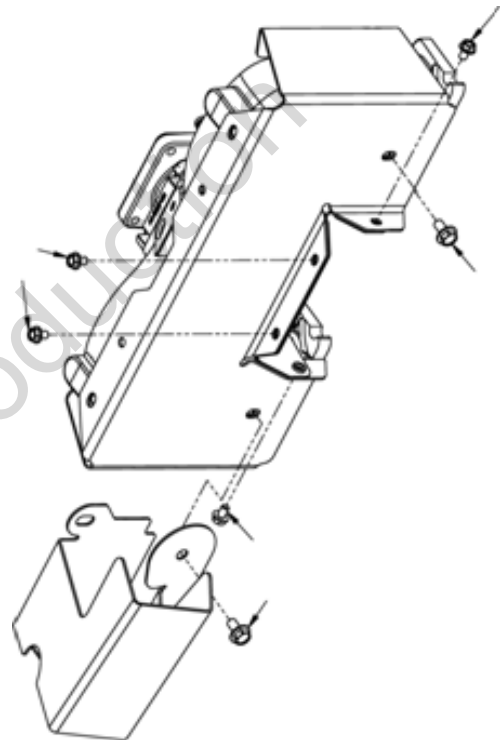


Figure 31

1. Secure throttle body adapter to the intake manifold with four screws.
2. Install vacuum lines to the barbs on the intake manifold and secure with new clamps.
3. Start engine and check for leaks around the intake manifold, thermostat housing, oil sensor and all other serviced fittings and components. If leaks are found, repair as necessary.
4. Check for MIL. If a DTC code is found, refer to the *Electrical Section* for further diagnosis

RESTRICTED EXHAUST SYSTEM DIAGNOSIS

TEST PROCEDURE

1. Carefully remove the HEGO.
2. Install exhaust back pressure test gauge (J35314-A) in place of the HEGO.
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 2,000 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 or heat distress.
7. Connect DST and look for closed loop operation as shown by switching of the HEGO.
8. If a DTC code is found, refer to the electrical section for further diagnosis.

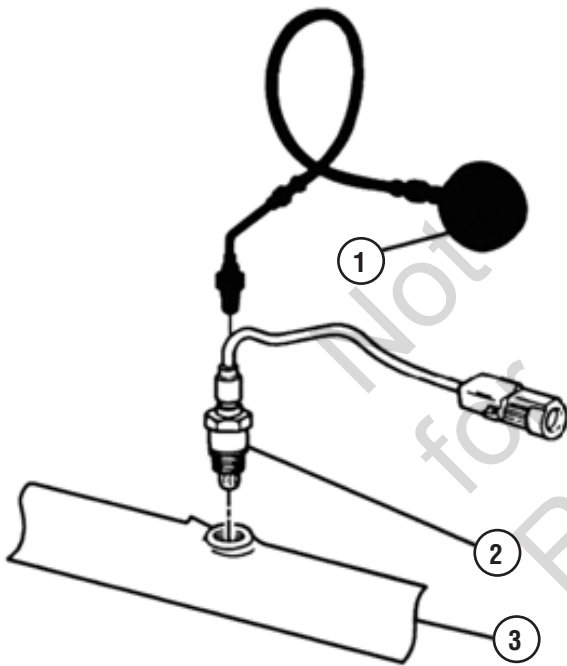


Figure 32

1. Back Pressure Gauge
 2. Heated Exhaust Gas Oxygen Sensor
 3. Exhaust Pipe/Muffler
9. Reinstall the vacuum hose to each fitting and secure with clamp, if used originally.
 10. Start engine and check for leaks using a soapy solution or an electronic leak detector. If leaks are detected make repairs.

Oil Drain Valve Removal

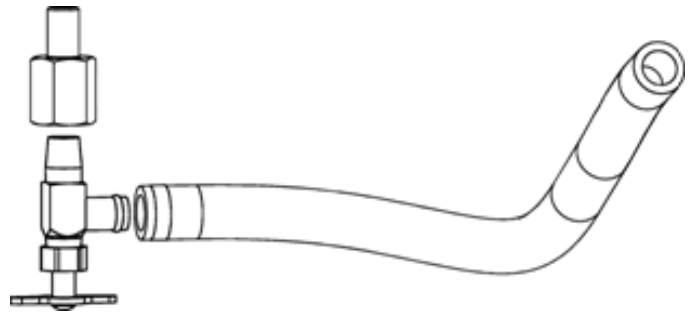


Figure 33

REMOVAL PROCEDURE

1. Drain Oil. Refer to changing the oil in the general information section.
2. Remove hose clamp and hose from drain valve.
3. Remove drain valve and adapter together by turning the adapter counterclockwise.
4. Remove valve from adapter.
5. Catch any oil dripping from the oil pan and any other oil spilled and dispose of oil in a safe and responsible manner.

INSTALLATION PROCEDURE

1. Apply Loctite® 567 to the male threads of the valve and adapter.
2. Thread valve into adapter and torque until tight.
3. Thread valve and adapter assembly into the oil pan and torque until tight. Continue turning the valve until it reaches the correct clock position.
4. Place clamp over the oil hose and secure approximately 1/4" from the end of the hose.
5. Refill oil.
6. Start engine and run until it reaches normal operating temperature. Check for leaks. If leaks are found, make repairs.
7. If a DTC code is found, refer to the *Electrical Section* for further diagnosis.

3.0L ENGINE SPECIFICATIONS

Fluid Capacities and Types		
Oil	10W-30	4.0 quart (3.8L) without filter 4.3 quart (4.1L) with filter
Coolant	Ethylene Glycol - 50-50 mixture with distilled water	1.8 Gallon (6.8L)(Engine Capacity Only)

Engine Mechanical Specifications	
Engine	3.0L, 4-cycle, Inline 4
Displacement	3.0 L (181 cu.in.)
Bore / Stroke	101.6 mm x 91.4 mm (4.0 in. x 3.6 in.)
Compression Ratio	10.5:1
Piston Speed	329 m / minute (1080 ft. / minute)
Governor Type	Electronic
Frequency Regulation	No-Load to Full-Load Isochronous
	Steady State $\pm 0.5\%$
Alternator Air Gap	
Armature Air Gap	
Crankshaft End Play	
Spark Plug Gap	
Valve Clearance - Intake	
Valve Clearance - Exhaust	

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FASTENER TORQUE SPECIFICATIONS

APPLICATION	Torque (lb-in / lb-ft)	Torque (Nm)
Camshaft Retainer Bolts	80 lb-in	9 Nm
Coolant Inlet Housing Bolt	25-30 lb-ft	34-40 Nm
Coolant Temperature Sensor	15 lb-ft	20 Nm
Coolant Thermostat Housing Bolts	18-23 lb-ft	24-31 Nm
Connecting Rod Cap Nuts	45 lb-ft	61 Nm
Crankshaft Main Bearing Cap Bolts	65 lb-ft	88 Nm
Crankshaft Position Sensor Retaining Bolt	88 lb-in	10 Nm
Crankshaft Rear Oil Seal Retainer Nuts	135 lb-in	15 Nm
Cylinder Head Bolts	96 lb-ft	130 Nm
Distributor Hold Down Bolt	20 lb-ft	27 Nm
Flywheel Bolts	65 lb-ft	88 Nm
Front Cover Bolts	27-35 lb-in	3-4 Nm
Fuel Rail to Fuel Rail Bracket Bolts	106 lb-in	12 Nm
Ignition Coil Bracket Attaching Bolts	18 lb-ft	25 Nm
Ignition Coil Module to Bracket Bolts	18 lb-in	2 Nm
Intake to Exhaust Manifold Attaching Nuts and Bolt	20-25 lb-ft	27-34 Nm
Intake/Exhaust Manifold to Head (center)	20-25 lb-ft	27-34 Nm
Intake/Exhaust Manifold to Head (outer)	15-20 lb-ft	20-27 Nm
Lift Bracket Bolts	40 lb-ft	54 Nm
Oil Level Bracket Nut	80 lb-in	9 Nm
Oil Pan Nuts (rear)	165 lb-in	19 Nm
Oil Pan Bolts (to crankcase)	80 lb-in	9 Nm
Oil Pan Bolts (to front cover)	45 lb-in	5 Nm
Oil Pan Studs to Oil Seal Retainer or Crankcase	15 lb-in	2 Nm
Oil Pump Cover	72 lb-in	8 Nm
Oil Pump to Block	120 lb-in	14 Nm
Oil Pump Pickup	60 lb-in	7 Nm
Pushrod Cover Bolts	40 lb-in	5 Nm
Rocker Arm Cover Bolts	40 lb-in	5 Nm
Spark Plugs	22 lb-ft	30 Nm
Water Pump Bolts	15 lb-ft	20 Nm

ENGINE SPECIFICATIONS

Lubrication System		
Oil Pump Type	Gear Driven	
Cylinder Block		
Bore Diameter	101.5873-101.6635 mm	3.9995-4.0025 in
Bore Out-of-Round Production	0.0254 mm (Maximum)	0.001 in (Maximum)
Bore Out-of-Round Service Limit	0.0508 mm (Maximum)	0.002 in (Maximum)
Bore Taper Thrust Side Production	0.0127 mm (Maximum)	0.0005 in (Maximum)
Bore Taper Thrust Side Service Limit	0.0254 mm (Maximum)	0.001 in (Maximum)
Bore Taper Relief Side Production	0.0127 mm (Maximum)	0.0005 in (Maximum)
Bore Taper Relief Side Service Limit	0.0254 mm (Maximum)	0.001 in (Maximum)
Runout - Rear Face of Block to Crankshaft Center Line	0.05 mm (Maximum)	0.002 in (Maximum)
Piston		
Piston-To-Bore Clearance Production	0.0635-0.0889 mm	0.0025-0.0035 in
Piston Rings		
Piston Compression Ring Groove Clearance Production Top	0.03048-0.07366 mm	0.0012-0.0029 in
Piston Compression Ring Groove Clearance Production 2nd	0.03048-0.07366 mm	0.0012-0.0029 in
Piston Compression Ring Groove Clearance Service Limit	0.09906 mm (Maximum)	0.0039 in (Maximum)
Piston Compression Ring Gap Top Production *	0.254-0.508 mm	0.01-0.02 in
Piston Compression Ring Gap 2nd Production *	0.4318-0.635 mm	0.017-0.025 in
Piston Compression Ring Gap Top Service Limit *	0.88 mm (Maximum)	0.035 In (Maximum)
Piston Compression Ring Gap 2nd Service Limit *	0.88 mm (Maximum)	0.035 in (Maximum)
Piston Oil Ring Groove Clearance Production	0.0254-0.1524 mm	0.001-0.006 in
Piston Oil Ring Groove Clearance Service Limit	0.1778 mm (Maximum)	0.007 in (Maximum)
Piston Oil Ring Gap Production *	0.25-0.76 mm	0.01-0.03 in
Piston Oil Ring Gap Service Limit *	1.016 mm (Maximum)	0.04 in (Maximum)
Piston Pin		
Diameter	23.545-23.548 mm	0.9270-0.927 in
Clearance in Piston Production	0.00762-0.01651 mm	0.0003-0.00065 in
Clearance in Piston Service Limit	0.0254 mm (Maximum)	0.001 in (Maximum)
Fit in Connecting Rod	0.02032-0.050292 mm (Interference)	0.0008-0.00198 in (Interference)
Crankshaft		
Crankshaft Journal Diameter (All)	58.3666-58.4047 mm	2.2979-2.2994 in
Crankshaft Journal Taper Production	0.005 mm (Maximum)	0.0002 in (Maximum)
Crankshaft Journal Taper Service Limit	0.0254 mm (Maximum)	0.001 in (Maximum)
Crankshaft Journal Out-of-Round Production	0.005 mm (Maximum)	0.0002 in (Maximum)
Crankshaft Journal Out-of-Round Service Limit	0.0254 mm (Maximum)	0.001 in (Maximum)
Crankshaft Bearing Clearance Production #1 - #4	0.0254-0.06096 mm	0.001-0.0024 in
Crankshaft Bearing Clearance Production #5	0.0406-0.0889 mm	0.0016-0.0035 in
Crankshaft Bearing Clearance Service Limit #1 - #4	0.0254-0.0635 mm	0.001-0.0025 in
Crankshaft Bearing Clearance Service Limit #5	0.0381-0.0889 mm	0.0015-0.0035 in
Crankshaft End Play	0.05-0.1524 mm	0.002-0.006 in
Crankshaft Sprocket Runout	0.07 mm (Maximum)	0.003 in (Maximum)

ENGINE SPECIFICATIONS

Connecting Rod		
Connecting Rod Journal Diameter	53.2892-53.3273 mm	2.0980-2.0995 in
Connecting Rod Journal Taper Production	0.00762 mm (Maximum)	0.0003 in (Maximum)
Connecting Rod Journal Taper Service Limit	0.0254 mm (Maximum)	0.001 in (Maximum)
Connecting Rod Journal Out-of-Round Production	0.005 mm (Maximum)	0.0002 in (Maximum)
Connecting Rod Journal Out-of-Round Service Limit	0.0254 mm (Maximum)	0.001 in (Maximum)
Rod Bearing Clearance Production	0.04318-0.06858 mm	0.0017-0.0027 in
Rod Bearing Clearance Service Limit	0.0762 mm (Maximum)	0.003 in (Maximum)
Rod Side Clearance	0.1524-0.4318 mm	0.006-0.017 in
Camshaft		
Journal Diameter	47.440-47.490 mm	1.8677-1.8697 in
End Play	0.0762-0.2032 mm	0.003-0.008 in
Camshaft Sprocket Runout	0.1 mm (Maximum)	0.004 in (Maximum)
Timing Sprocket Teeth Backlash	0.10-0.15 mm	0.004-0.006 in
Lobe Lift Intake	6.4247 mm	0.25294
Lobe Lift Exhaust	6.4247 mm	0.25294
Lobe Lift Service Limit	±0.0254 mm	±0.001 in
Valve System		
Valve Lifter	Hydraulic	
Valve Rocker Arm Ratio	1.75:1	
Valve Lash	Half to One Turn Down From Zero Lash	
Face Angle	45 Degrees	
Seat Angle	46 Degrees	
Seat Runout	0.05 mm (Maximum)	0.002 in (Maximum)
Seat Width Intake	1.27-1.778 mm	0.050-0.070 in
Seat Width Exhaust	1.524-2.032 mm	0.060-0.080 in
Stem Clearance Intake Production	0.0254-0.06858 mm	0.001-0.0027 in
Stem Clearance Exhaust Production	0.01778-0.06858 mm	0.0007-0.0027 in
Stem Clearance Intake Service Limit	0.09398 mm (Maximum)	0.0037 in (Maximum)
Stem Clearance Exhaust Service Limit	0.1193 mm (Maximum)	0.0047 in (Maximum)
Valve Spring Free Length	52.324 mm	2.06 in
Valve Spring Pressure Closed	444-490 N at 40.89 mm	100-110 lb at 1.61 in
Valve Spring Pressure Open	925-987 N at 30.99 mm	208-222 lb at 1.22 in
Valve Spring Installed Height Intake	41.91 mm	1.65 in
Valve Spring Installed Height Exhaust	41.91 mm	1.65 in
Valve Lift Intake	11.25 mm	0.443 in
Valve Lift Exhaust	11.25 mm	0.443 in
Cylinder Head Warpage		
Cylinder Head Deck (measured within a 152.4 mm (6.0 in) area)	0.0762 mm	0.003 in
Cylinder Head Deck (measuring the overall length of the cylinder head)	0.1778 mm	0.007 in

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