Service

Engine Fuel System
and Diagnostic Troubleshooting Codes

Models:

KG6208 Naturally Aspirated
KG6208T, KG10V08T Turbocharged
Propane, Liquefied Petroleum Gas (LPG)
Natural Gas (NG) Fueled

KOHLER®

TP-7097 11/20b

⚠ **WARNING:** This product can expose you to chemicals, including carbon monoxide and benzene, which are known to the State of California to cause cancer and birth defects or other reproductive harm. For more information go to www.P65warnings.ca.gov

Product Identification Information

Product identification numbers determine service parts. Record the product identification numbers in the spaces below immediately after unpacking the products so that the numbers are readily available for future reference.

Engine Identification

Record the product identification information from the engine nameplate.

Model Designation: _____

Serial Number: _____

Purchase Date

Upon purchase of your Kohler equipment, record the purchase date for reference when communicating with your authorized Kohler distributor/dealer.

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Read and follow all safety precautions and instructions. SAVE THESE INSTRUCTIONS.

⚠ DANGER

DANGER indicates a hazardous situation which, if not avoided, will result in death or serious injury.

⚠ WARNING

WARNING indicates a hazardous situation which, if not avoided, could result in death or serious injury.

⚠ CAUTION

CAUTION indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

NOTICE

NOTICE is used to address practices not related to physical injury.

Note:

A Note is used to inform you of important installation, operation, or maintenance information.

Accidental Starting

⚠ WARNING	**Accidental starting.** **Can cause severe injury or death.** Disconnect the battery cables before working on the engine. Remove the negative (–) lead first when disconnecting the battery. Reconnect the negative (–) lead last when reconnecting the battery.
	

Disabling the engine. Accidental starting can cause severe injury or death. Before working on the engine or connected equipment, disable the engine as follows: 1) Disconnect the ignition coil. 2) Remove the battery cables, negative (–) lead first. Reconnect the negative (–) lead last when reconnecting the battery. Follow these precautions to prevent the accidental starting of the engine.

Battery

WARNING	**Sulfuric acid in batteries.** **Can cause severe injury or death.** Wear protective goggles and clothing. Battery acid may cause blindness and burn skin.
	

Battery electrolyte is a diluted sulfuric acid. Battery acid can cause severe injury or death. Battery acid can cause blindness and burn skin. Always wear splashproof safety goggles, rubber gloves, and boots when servicing the battery. Do not open a sealed battery or mutilate the battery case. If battery acid splashes in the eyes or on the skin, immediately flush the affected area for 15 minutes with large quantities of clean water. Seek immediate medical aid in the case of eye contact. Never add acid to a battery after placing the battery in service, as this may result in hazardous spattering of battery acid.

Battery acid cleanup. Battery acid can cause severe injury or death. Battery acid is electrically conductive and corrosive. Add 500 g (1 lb.) of bicarbonate of soda (baking soda) to a container with 4 L (1 gal.) of water and mix the neutralizing solution. Pour the neutralizing solution on the spilled battery acid and continue to add the neutralizing solution to the spilled battery acid until all evidence of a chemical reaction (foaming) has ceased. Flush the resulting liquid with water and dry the area.

Battery gases. Explosion can cause severe injury or death. Battery gases can cause an explosion. Do not smoke or permit flames or sparks to occur near a battery at any time, particularly when it is charging. Do not dispose of a battery in a fire. To prevent burns and sparks that could cause an explosion, avoid touching the battery terminals with tools or other metal objects. Remove all jewelry before servicing the equipment. Discharge static electricity from your body before touching batteries by first touching a grounded metal surface away from the battery. To avoid sparks, do not disturb the battery charger connections while the battery is charging. Always turn the battery charger off before disconnecting the battery connections. Ventilate the compartments containing batteries to prevent accumulation of explosive gases.

Battery short circuits. Explosion can cause severe injury or death. Short circuits can cause bodily injury and/or equipment damage. Disconnect the battery before maintenance. Remove all jewelry before servicing the equipment. Use tools with insulated handles. Remove the negative (–) lead first when disconnecting the battery. Reconnect the negative (–) lead last when reconnecting the battery. Never connect the negative (–) battery cable to the positive (+) connection terminal of the starter solenoid. Do not test the battery condition by shorting the terminals together.

Engine Backfire/Flash Fire

WARNING	
	**Risk of fire.** **Can cause severe injury or death.** Do not smoke or permit flames or sparks near fuels or the fuel system.

Servicing the fuel system. A flash fire can cause severe injury or death. Do not smoke or permit flames or sparks near the fuel mixer, fuel line, fuel filter, or other potential sources of fuel vapors. When removing the fuel line or fuel system be aware that liquid propane can cause frostbite on contact.

Servicing the air cleaner. A sudden backfire can cause severe injury or death. Do not operate the engine with the air cleaner/silencer removed.

Combustible materials. A fire can cause severe injury or death. Engine fuels and fuel vapors are flammable and explosive. Handle these materials carefully to minimize the risk of fire or explosion. Equip the compartment or nearby area with a fully charged fire extinguisher. Select a fire extinguisher rated ABC or BC for electrical fires or as recommended by the local fire code or an authorized agency. Train all personnel on fire extinguisher operation and fire prevention procedures.

Troubleshooting and/or repairing the sensors or the ECM. A backfire due to an open fuel shut-off valve can cause severe injury or death. If power is supplied to the shut-off valve during ECM or sensor troubleshooting, fuel may enter the air intake manifold or the air cleaner and cause a backfire. Make sure that the fuel supply is turned OFF and that the fuel supply valves are DISCONNECTED from the power source BEFORE turning the ECM power on.

Engine Fluids and Chemical Products

WARNING	
	**Handling caustic engine fluids and chemical products.** **Can cause severe chemical burns, nausea, fainting, or death.** Most chemicals such as used engine oil, antifreeze/coolant, rustproofing agent, inhibiting oil, degreasing agent, spray paint, and adhesives are hazardous to health. Read and follow the user information found on the packaging. Avoid inhalation and skin contact. Use only in well-ventilated areas and use a protective mask when spraying. Store engine fluids and chemical products in a locked cabinet. Contact your local recycling center for disposal information and locations.

Fire-damaged or burned O-rings may cause the formation of hydrofluoric acid. Contact with hydrofluoric acid may cause severe skin irritation and chemical burns. O-rings and other fluoroelastomer seals exposed to fire or temperatures above 316°C (600°F) (i.e., during welding) may decompose forming hydrofluoric acid. Avoid inhalation or skin contact. Do not incinerate O-rings. Dispose of O-ring waste material in a responsible manner.

Used engine oil. Contact with used engine oil may cause severe skin irritation. Repeated and prolonged skin exposure may have other health risks. Used engine oil is a suspected carcinogen. Avoid contact with skin. Thoroughly wash your hands and nails with soap and water shortly after handling used engine oil. Wash or dispose of clothing or rags containing used engine oil. Dispose of used engine oil in a responsible manner. Contact your local recycling center for disposal information and locations.

Exhaust System

WARNING	
	**Carbon monoxide.** **Can cause severe nausea, fainting, or death.** The exhaust system must be leakproof and routinely inspected.

Carbon monoxide symptoms. Carbon monoxide can cause severe nausea, fainting, or death. Carbon monoxide is a poisonous gas present in exhaust gases. Carbon monoxide is an odorless, colorless, tasteless, nonirritating gas that can cause death if inhaled for even a short time. Carbon monoxide poisoning symptoms include but are not limited to the following:

- Light-headedness, dizziness
- Physical fatigue, weakness in joints and muscles
- Sleepiness, mental fatigue, inability to concentrate or speak clearly, blurred vision
- Stomachache, vomiting, nausea

If experiencing any of these symptoms and carbon monoxide poisoning is possible, seek fresh air immediately and remain active. Do not sit, lie down, or fall asleep. Alert others to the possibility of carbon monoxide poisoning. Seek medical attention if the condition of affected persons does not improve within minutes of breathing fresh air.

WARNING	
	**Carbon monoxide.** **Can cause severe nausea, fainting, or death.** Avoid inhaling exhaust fumes.

Engine Operation. Carbon monoxide can cause severe nausea, fainting, or death. Engine exhaust gases contain poisonous carbon monoxide. Carbon monoxide is an odorless, colorless, tasteless, nonirritating gas that can cause death if inhaled for even a short time. Avoid breathing exhaust fumes when working on or near the engine. Never operate the engine inside a building. Never operate the engine where exhaust gas could seep inside or be drawn into a potentially occupied building through windows, air intake vents, or other openings.

Fuel System

WARNING	
	**Explosive fuel vapors.** **Can cause severe injury or death.** Use extreme care when handling, storing, and using fuels.

The fuel system. Explosive fuel vapors can cause severe injury or death. Vaporized fuels are highly explosive. Use extreme care when handling and storing fuels. Store fuels in a well-ventilated area away from spark-producing equipment and out of the reach of children. Never add fuel to the tank while the engine is running because spilled fuel may ignite on contact with hot parts or from sparks. Do not smoke or permit flames or sparks to occur near sources of spilled fuel or fuel vapors. Keep the fuel lines and connections tight and in good condition. Do not replace flexible fuel lines with rigid lines. Use flexible sections to avoid fuel line breakage caused by vibration. Do not operate the engine in the presence of fuel leaks, fuel accumulation, or sparks. Repair fuel systems before resuming engine operation.

Explosive fuel vapors can cause severe injury or death. Take additional precautions when using the following fuels:

Propane (LPG)—Adequate ventilation is mandatory. Because propane is heavier than air, install propane gas detectors low in a room. Inspect the detectors per the manufacturer's instructions.

Natural Gas—Adequate ventilation is mandatory. Because natural gas rises, install natural gas detectors high in a room. Inspect the detectors per the manufacturer's instructions.

WARNING	
	**Explosive fuel vapors.** **Can cause fires and severe burns.** If a gaseous odor is detected, ventilate the area and contact an authorized service technician.

Gas fuel leaks. Explosive fuel vapors can cause severe injury or death. Fuel leakage can cause an explosion. Check the LPG vapor or natural gas fuel system for leakage by using a soap and water solution with the fuel system test pressurized to 6–8 ounces per square inch (10–14 inches water column). Do not use a soap solution containing either ammonia or chlorine because both prevent bubble formation. A successful test depends on the ability of the solution to bubble.

Hazardous Noise

CAUTION	
	**Hazardous noise.** **Can cause hearing loss.** Never operate the engine without a muffler or with a faulty exhaust system.

Hazardous Voltage/Moving Parts

CAUTION 	**Hazardous voltage.** **Electrical shock can cause injury.** Do not touch wires while the engine is running. Stop the engine and disconnect the battery leads, negative (-) lead first, before servicing the engine.

WARNING 	**Spring-loaded parts.** **Can cause severe personal injury or property damage.** Wear protective goggles when servicing spring-loaded parts. Hold parts securely during disassembly.

WARNING 	**Airborne particles.** **Can cause severe injury or blindness.** Wear protective goggles and clothing when using power tools, hand tools, or compressed air.

CAUTION 	**Damaged harmonic balancer, crankshaft, or flywheel.** **Can cause personal injury.** Broken fragments from the harmonic balancer, crankshaft, and flywheel can be thrown from the engine. Do not use a hammer to install or remove. Inspect these parts for damage and replace if needed.

WARNING 	**Pinch and entanglement hazards.** **Can cause severe injury and possible death.** Never check drive belt tension while the engine is running.

WARNING 	**Moving parts.** **Can cause severe injury or death.** Operate the engine only when all guards and electrical enclosures are in place. Stay away from moving parts while the engine is in operation.

Servicing the engine when it is operating. Exposed moving parts can cause severe injury or death. Keep hands, feet, hair, clothing, and test leads away from the belts and pulleys when the engine is running. Replace guards, screens, and covers before operating the engine.

Heavy Equipment

WARNING	
	**Unbalanced weight.** **Improper lifting can cause severe injury or death and equipment damage.** Use adequate lifting capacity. Always maintain a safe distance from the equipment being lifted. Never stand under the equipment.

Hot Parts

WARNING	
	**Hot engine and exhaust system.** **Can cause severe injury or death.** Do not work on the engine until it cools.

Servicing the exhaust system. Hot parts can cause severe injury or death. Do not touch hot engine parts. The engine and exhaust system components become extremely hot during operation.

Hot engine components. Can cause severe injury or death. Never operate the engine with heat shields or guards removed.

WARNING	
	**Hot coolant and steam.** **Can cause severe injury or death.** Before removing the pressure cap, stop the engine and allow it to cool. Then loosen the pressure cap to relieve pressure.

This manual applies to the KG6208 (naturally aspirated), the KG6208T (turbocharged) 6.2 L engines, the KG10V08T (turbocharged) 10.3 L engines and provides an understanding of the fuel system and sensors for troubleshooting and diagnostic purposes. Use the following troubleshooting steps to resolve diagnostic problems

1. Use the connection kit to connect to the electronic control module (ECM) and to read any logged Diagnostic Troubleshooting Codes (DTC).

   Note:
   Refer to the diagnostic tool service bulletin, SB-750, for connection details and kit numbers.

2. Refer to the “Fuel System Overview” to learn more about the theory of operation, location, and how the components work.
3. Refer to the section on “Diagnostic Troubleshooting Codes” in this manual to look up the cause and recommended troubleshooting steps.
4. Use the Table of Contents to find related content for a specific DTC.
5. Follow the DTC troubleshooting tree to resolve the issue.
6. If the troubleshooting steps require a component to be replaced, refer to the engine service manual for instructions.

Information in this publication represents data available at the time of print. Kohler Co. reserves the right to change this publication and the products represented without notice and without any obligation or liability whatsoever.

Read this manual and carefully follow all procedures and safety precautions to ensure proper equipment operation and to avoid bodily injury. Read and follow the Safety Precautions and Instructions section at the beginning of this manual. Keep this manual with the equipment for future reference.

Unless otherwise specified, all units of measurement are metric, followed by the Imperial (U.S.) equivalent.

Related Literature

The following chart identifies related literature available for the KG6208 and KG10V08T engines. Only trained and qualified personnel should install or service this engine.

Literature Type	Part Number
Engine Operation Manual 6.2 L	TP-7095
Engine Operation Manual 10.3 L	TP-7172
Engine Service Manual 6.2 L	TP-7096
Engine Service Manual 10.3 L	TP-7176
Engine Parts Catalog 6.2 L	TP-7098
Engine Parts Catalog 10.3 L	TP-7177
Engine Display Interface Software (EDIS) Manual 6.2 L, 10.3 L	TP-7124
Diagnostic Tool Service Bulletin 6.2 L, 10.3 L	SB-750

Service Assistance

For professional advice and conscientious service, please contact your nearest Kohler distributor or dealer.

- Visit the Kohler Co. website at KOHLERPower.com.
- Look at the labels and decals on your Kohler product or review the appropriate literature or documents included with the product.
- Call toll free in the US and Canada 1-800-544-2444.
- Outside the US and Canada, call the nearest regional office.

Headquarters Europe, Middle East, Africa (EMEA)

Kohler EMEA Headquarters
Netherlands B.V.
Kristallaan 1
4761 ZC Zevenbergen
The Netherlands
Phone: (31) 168 331630
Fax: (31) 168 331631

Asia Pacific

Kohler Asia Pacific Headquarters
Singapore, Republic of Singapore
Phone: (65) 6264-6422
Fax: (65) 6264-6455

China

North China Regional Office, Beijing
Phone: (86) 10 6518 7950
(86) 10 6518 7951
(86) 10 6518 7952
Fax: (86) 10 6518 7955

East China Regional Office, Shanghai
Phone: (86) 21 6288 0500
Fax: (86) 21 6288 0550

India, Bangladesh, Sri Lanka

India Regional Office
Bangalore, India
Phone: (91) 80 3366208
(91) 80 3366231
Fax: (91) 80 3315972

Japan, Korea

North Asia Regional Office
Tokyo, Japan
Phone: (813) 3440-4515
Fax: (813) 3440-2727

1.1 Introduction

Naturally Aspirated Engine

The KG6208 shown in Figure 1 is a four-stroke internal combustion engine certified to operate on Natural Gas (NG) or Liquefied Petroleum Gas (LPG) vapor. The engine design is optimized for use on generator sets and the system configuration is factory preset for NG and can be reset for LPG applications.

At startup, the engine ECM operates in an open-loop fuel state, which means fuel delivery is based on a fuel calibration program internal to the ECM. The ECM sends signals to the direct-acting electronic pressure regulator (DEPR) to achieve optimum air-fuel ratio.

After the oxygen sensor heats up and the engine coolant temperature reaches a predetermined level, the ECM calibration program transitions to a closed-loop mode.

- The air/fuel delivery is based on the oxygen sensor input and TMAP sensor data. The engine ECM uses this data to regulate the direct-acting electronic pressure regulator (DEPR), which controls the fuel pressure, and the throttle body, which controls the amount of fuel entering the engine.
- The crankshaft position sensor and camshaft position sensor send engine timing data to the ECM. The ECM uses this data to control the ignition signal sent to the ignition coil and distributor.

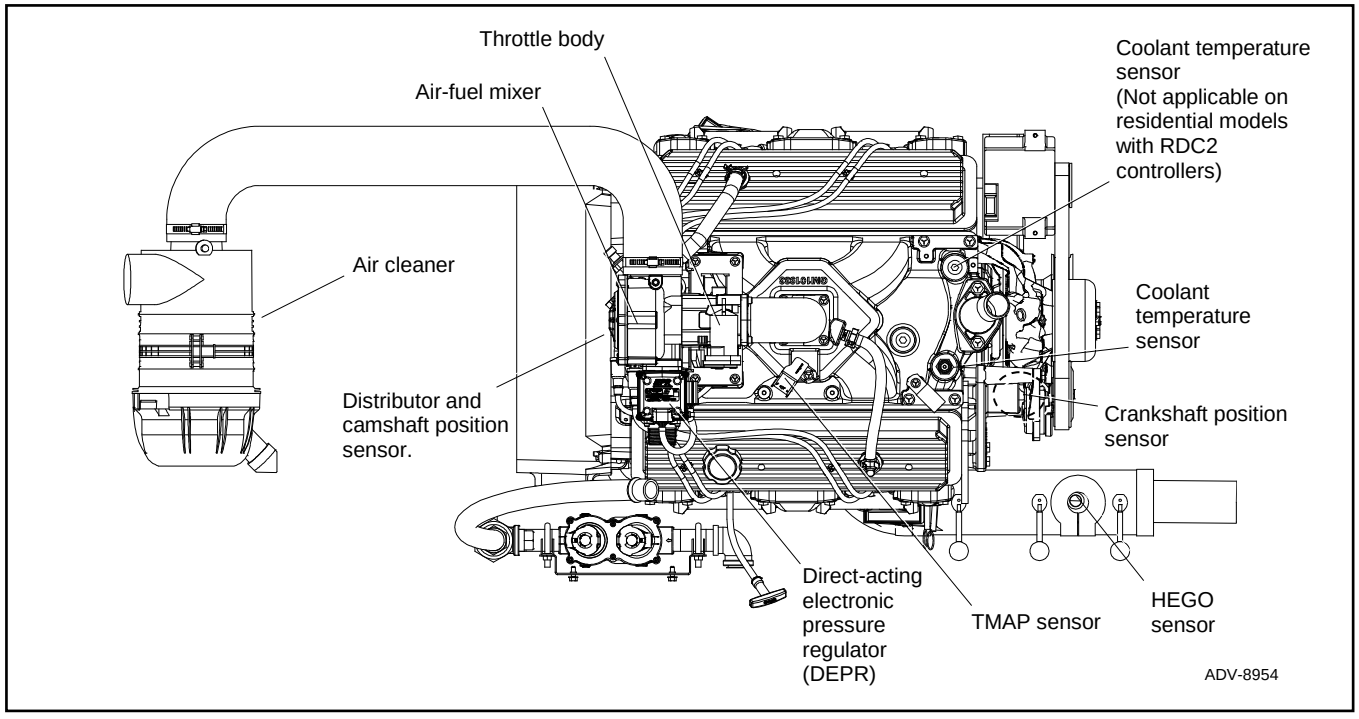


Figure 1 Fuel System Overview, KG6208 6.2 L Naturally Aspirated Engine (60RCLA Shown)

Turbo-Charged Engine

The KG6208T and KG10V08T engines shown in Figure 2, Figure 3 and Figure 4 is a turbocharged, four-stroke, internal combustion engine certified to operate on Natural Gas (NG) or Liquefied Petroleum Gas (LPG) vapor. The engine design is optimized for use on generator sets and the system configuration is factory preset for NG and can be reset for LPG applications. The KG6208T turbocharged engine is available in either a standard duty (KG6208TSD) or heavy duty (KG6208THD) version.

Note:
Turbocharged engine models (KG6208TSD, KG6208THD and KG10V08T) do not have a distributor or a camshaft position sensor. The heavy duty engines (KG6208THD and KG10V08T) have an oil separator, knock sensor and a boost control solenoid.

At startup, the engine ECM operates in an open-loop fuel state, which means fuel delivery is based on a fuel calibration program internal to the ECM. The ECM sends signals to the direct-acting electronic pressure regulator (DEPR) to achieve optimum air-fuel ratio.

After the oxygen sensor heats up and the engine coolant temperature reaches a predetermined level, the ECM calibration program transitions to a closed-loop mode.

- The air/fuel delivery is based on the oxygen sensor input, throttle inlet pressure (TIP) sensor, and air temperature/manifold absolute pressure (TMAP) sensor data. The engine ECM uses this data to regulate the direct-acting electronic pressure regulator (DEPR), which controls the fuel pressure, and the throttle body, which controls the amount of air/fuel mixture entering the engine.

  Note:
  The TIP sensor monitors absolute pressure upstream of the throttle body and the TMAP sensor monitors intake manifold absolute pressure downstream of the throttle body.

- The crankshaft position sensor sends engine timing data to the ECM. The ECM uses this timing data to control the ignition signal sent to the ignition coil pack. The ignition coils then provide voltage to the spark plugs through high tension leads. The ECM also uses a knock sensor, located on the engine block, to monitor ignition detonation and improve ignition timing.

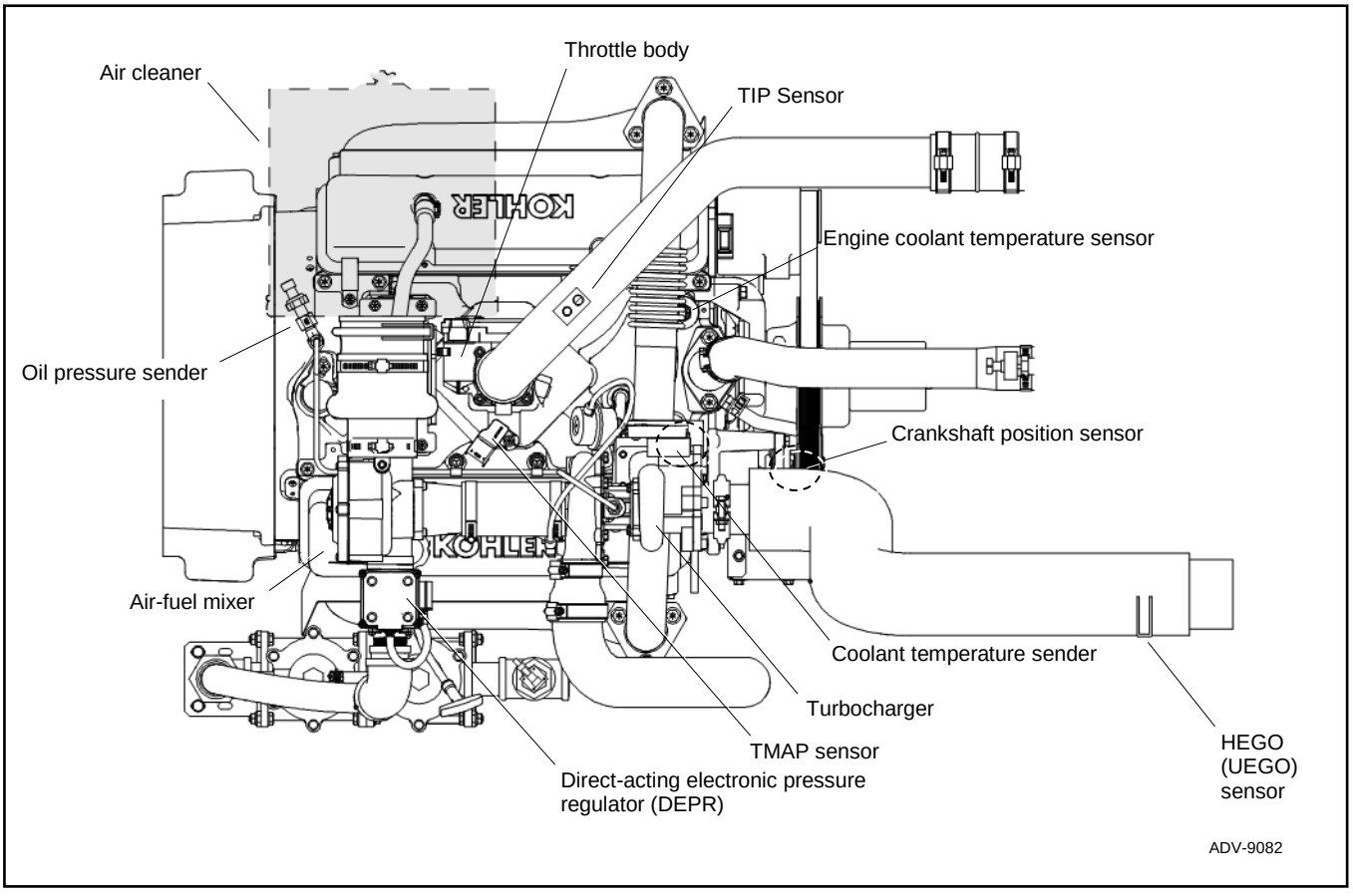


Figure 2 Fuel System Overview, KG6208TSD, 6.2 L Standard Duty Turbocharged Engine (KG80 Shown)

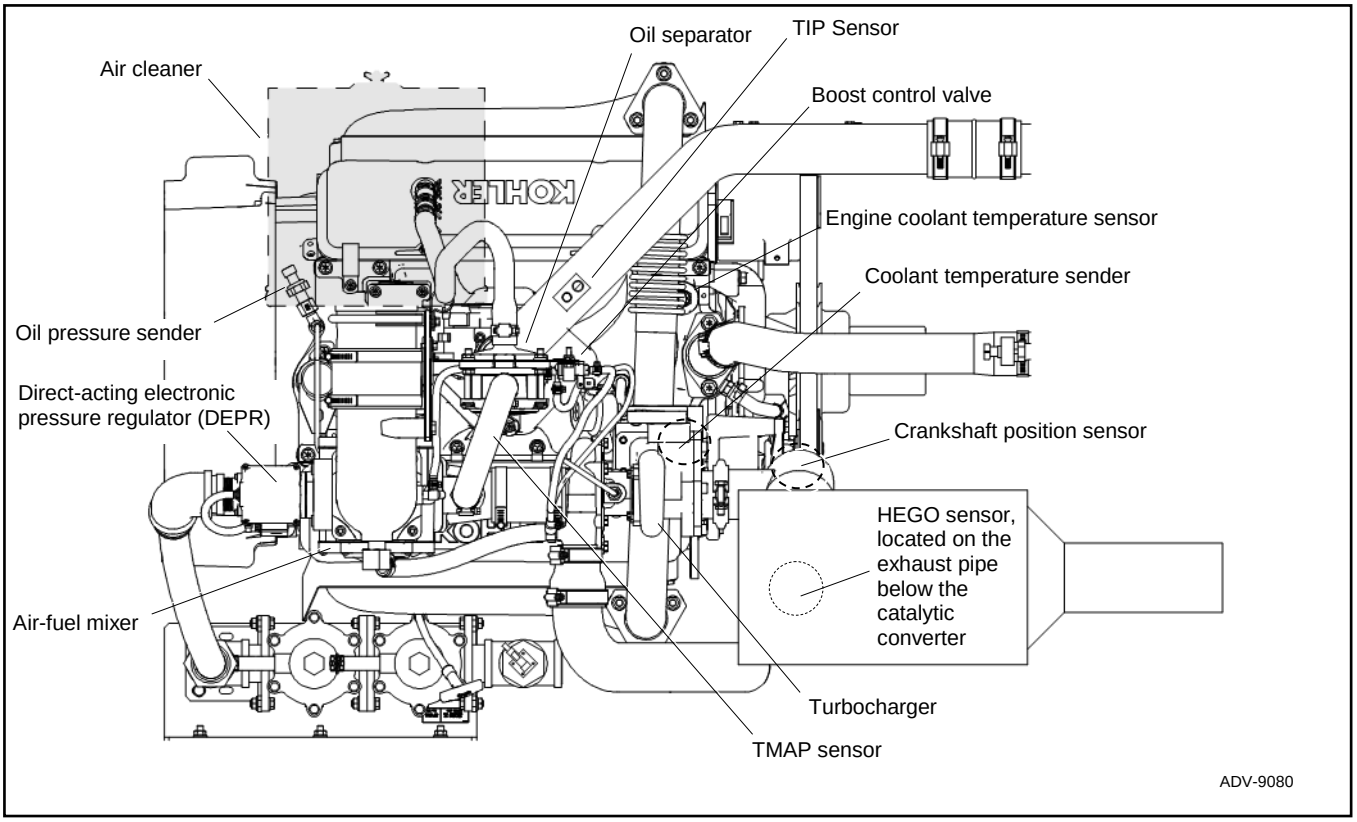


Figure 3 Fuel System Overview, KG6208THD, 6.2 L Heavy Duty Turbocharged Engine (KG100 Shown)

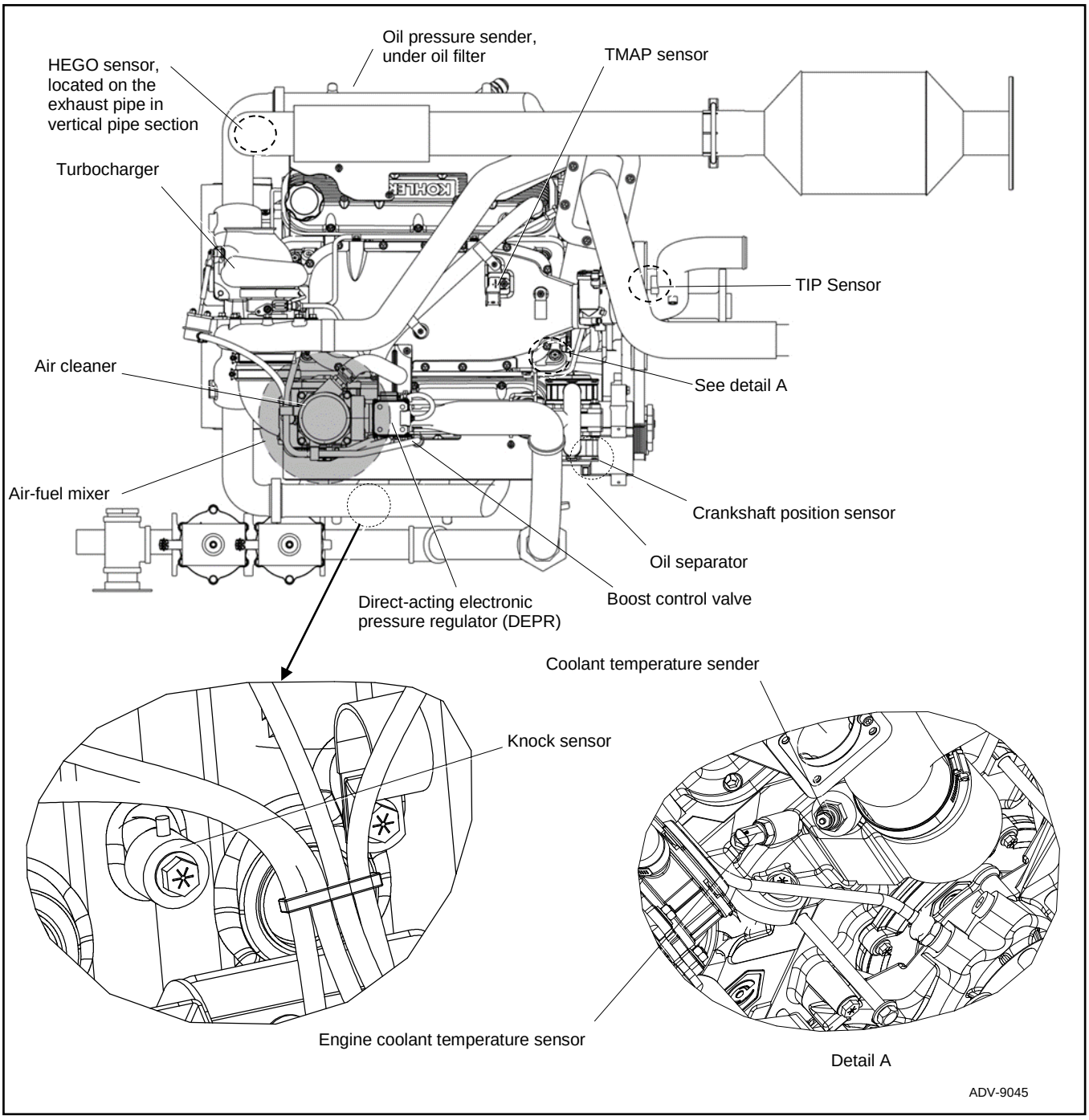


Figure 4 Fuel System Overview, KG10V08T-6CGS and KG10V08T-6DGS, 10.3 L Turbocharged Engine

1.2 Air Fuel Mixer

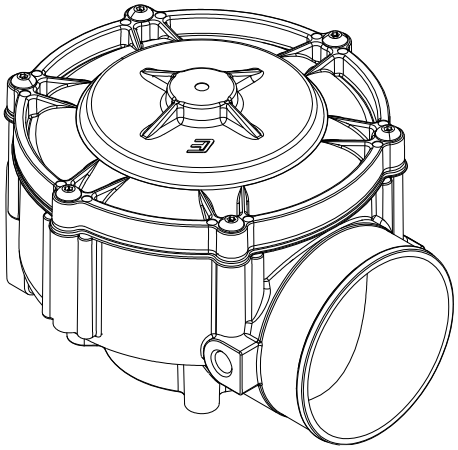


Figure 5 Air-Fuel Mixer

The air-fuel mixer shown in Figure 5 is an air-fuel metering device and is completely self-contained. The mixer is an air valve design, utilizing a relatively constant pressure drop to draw fuel into the mixer from cranking to full load. The mixer is mounted in the air stream ahead of the throttle control device.

When the engine begins to crank it draws in air with the air valve covering the inlet, and negative pressure begins to build. This negative pressure signal is communicated to the top of the air valve chamber through vacuum ports in the air valve assembly.

The mixer is equipped with a low speed mixture adjustment which is retained in a tamper proof housing. The mixer has been preset at the factory and should not be adjusted.

Important: The air-fuel mixer has been calibrated for the engine's emissions requirements and should never be disassembled or rebuilt. If the air-fuel mixer is not functioning correctly, order a replacement part. See the engine parts catalog.

1.3 Wastegate Control Solenoid (KG6208THD and KG10V08T, Turbocharged Engines Only)

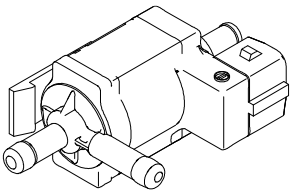


Figure 6 Wastegate Control Solenoid (KG6208THD, Heavy-Duty Turbocharged Engines Only)

The wastegate control solenoid is an ECM controlled valve which reduces and regulates wastegate actuator pressure. The wastegate control solenoid allows boost pressure to match the operating condition.

1.4 Charge Air Cooler (KG6208TSD, KG6208THD, and KG10V08T-6DGS,Turbocharged Engines Only)

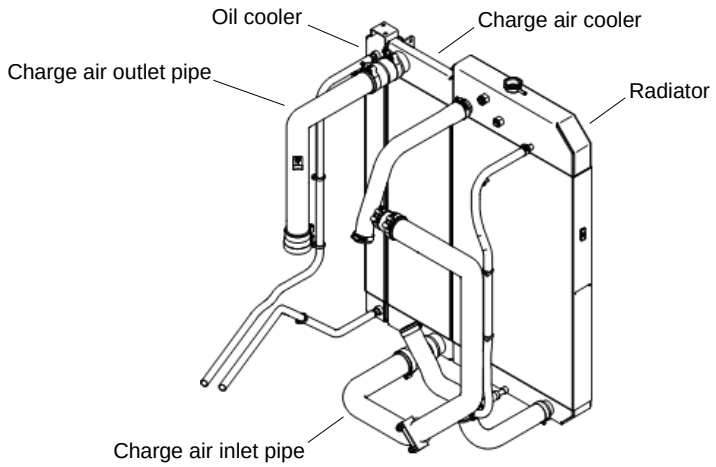


Figure 7 Charge Air Cooler (KG6208TSD and KG6208THD Shown)

The KG6208TSD (standard-duty), KG6208THD (heavy-duty) and KG10V08T-6DGS engines are equipped with a charge air cooler located next to the radiator. The charge air cooler cools the compressed air-fuel mixture before it enters the intake manifold. The cooler intake manifold charge helps maintain emissions at the high power level of the turbocharged engine.

Note:
The KG10V08T-6CGS engine does not have a charge air cooler.

1.5 Coolant Temperature Sensor

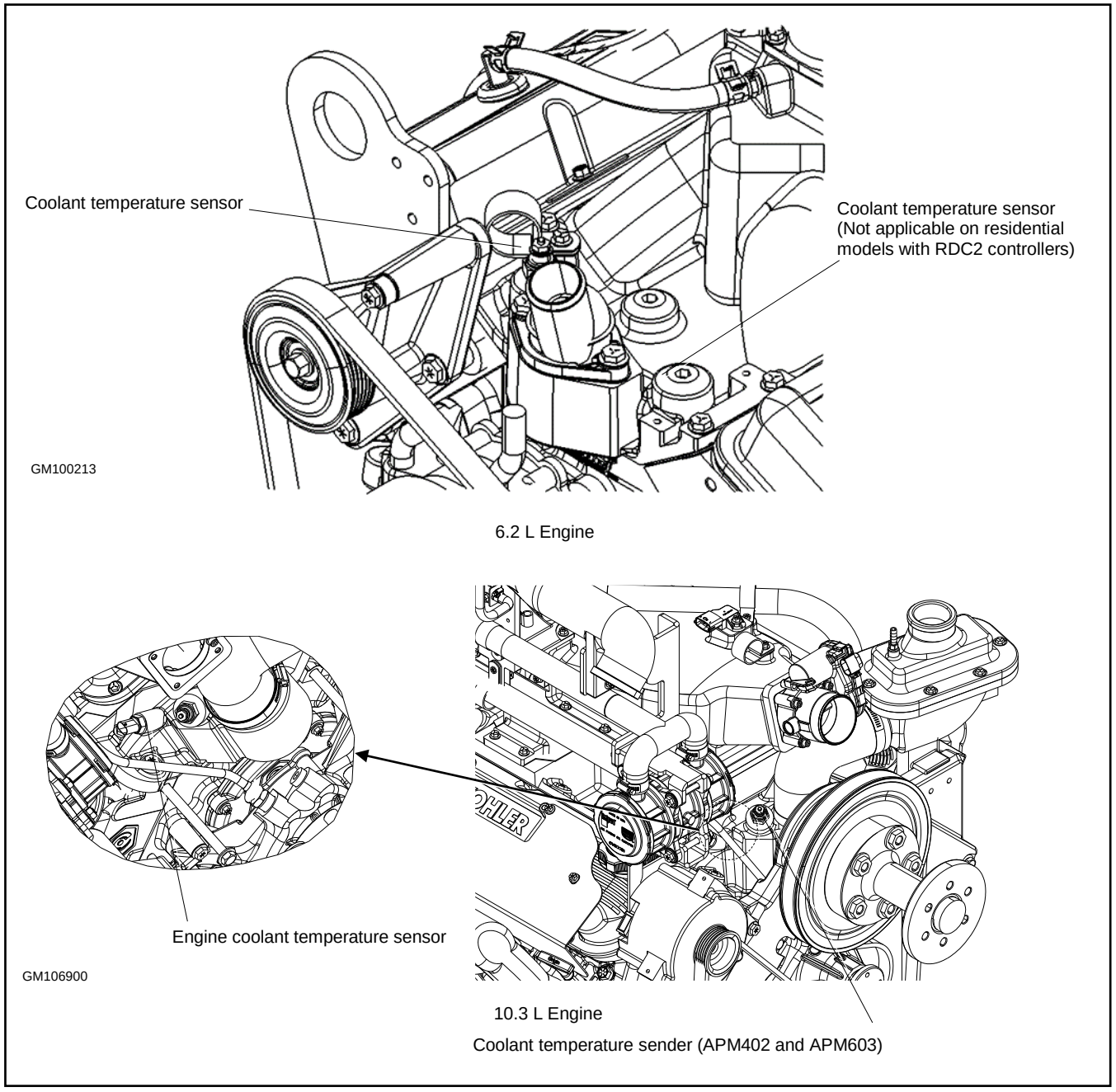


Figure 8 Coolant Temperature Sensor

The coolant temperature (CT) sensor shown in Figure 8 is a temperature sensitive variable resistance thermistor located in the engine coolant passage. The ECM monitors the change in resistance to calculate engine coolant temperature to enable temperature dependent features such as overheat protection.

Note:
On units with an APM402 or Decision-Maker® 3000 controller, the generator set controller also monitors the coolant temperature through a second coolant temperature sensor. See Figure 8.

1.6 Crankshaft Position (CKP) Sensor

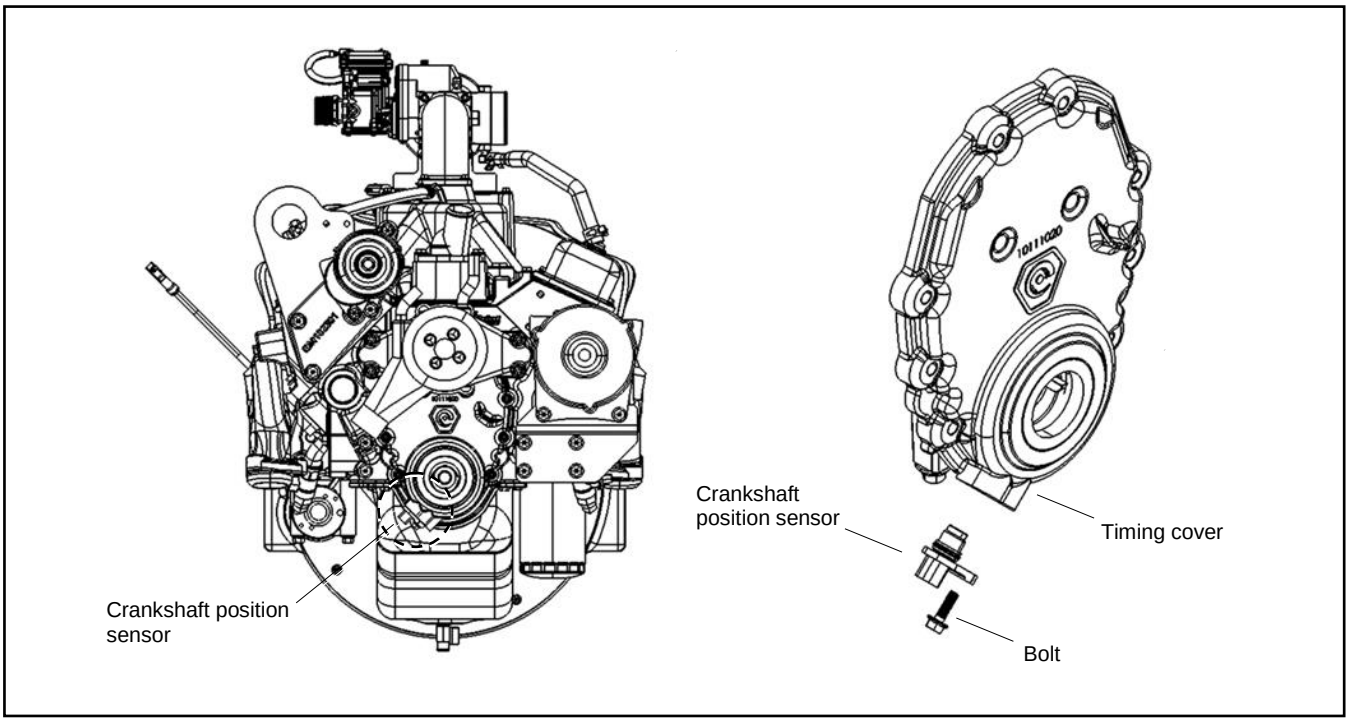


Figure 9 Crankshaft Position Sensor (KG6208 Shown)

The crankshaft position sensor (CKP), located on the bottom of the timing cover, measures the rotary speed and crankshaft turning angle. The ECM ensures the ignition timing for each cylinder depending on the turning signal. The sensor consists of a permanent magnet and coil. When the crankshaft is turning, the gear ring (reluctor wheel) passes the sensor at different speeds and causes a change of magnet resistance at the sensor to produce a changeable signal. See Figure 9.

As the engine starts to crank, the crank position sensor (CKP) sends a small AC signal to the ECM. The ECM uses this signal for speed sensing and engine timing. With this CKP signal now active, the ECM will send a signal to the electronic throttle control (ETC) opening the throttle for fuel flow and initiate the firing of the electronic ignition.

The ECM uses the signal from the crankshaft position sensor to determine where each piston is in relation to its combustion cycle and to activate the ignition.

1.7 Direct Acting Electronic Pressure Regulator

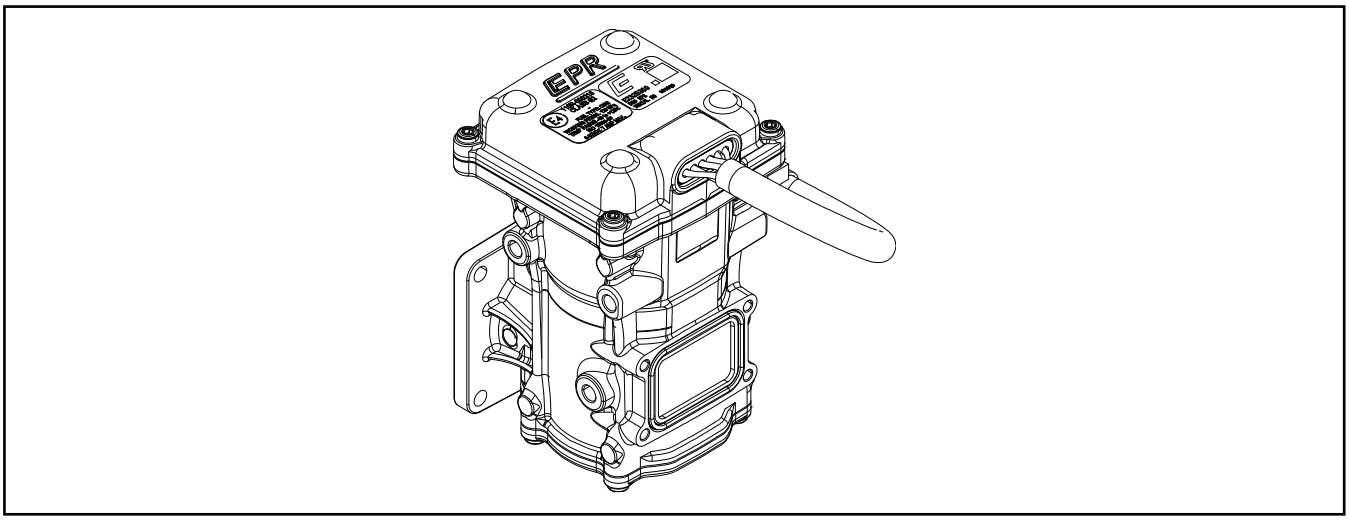


Figure 10 Fuel Pressure Regulator

The direct acting electronic pressure regulator (DEPR), shown in Figure 10, controls the gaseous fuel pressure and fuel delivery. The DEPR receives fuel pressure commands from the ECM and modulates fuel pressure to the air-fuel mixer. The DEPR allows for fast and accurate gaseous fuel control to provide a combustible mixture to the engine.

1.8 Electronic Control Module

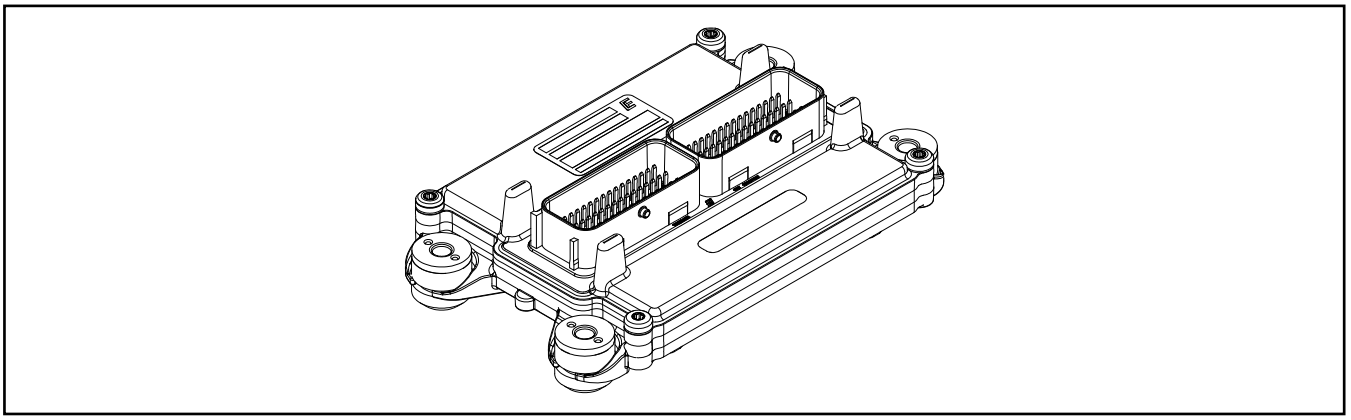


Figure 11 Electronic Control Module

To obtain maximum and accurate control of the air fuel ratio, the engine is equipped with an onboard computer or Electronic Control Module (ECM). See Figure 11. The ECM receives input data from sensors mounted to the engine and fuel system and then outputs various signals to control engine operation.

The ECM adjusts the engine speed, ignition timing, and fuel supply in response to changes in the applied load, surrounding air temperature, operating temperature of the engine, and amount of oxygen present in the exhaust.

1.9 Heated Exhaust Gas Oxygen (HEGO) Sensor

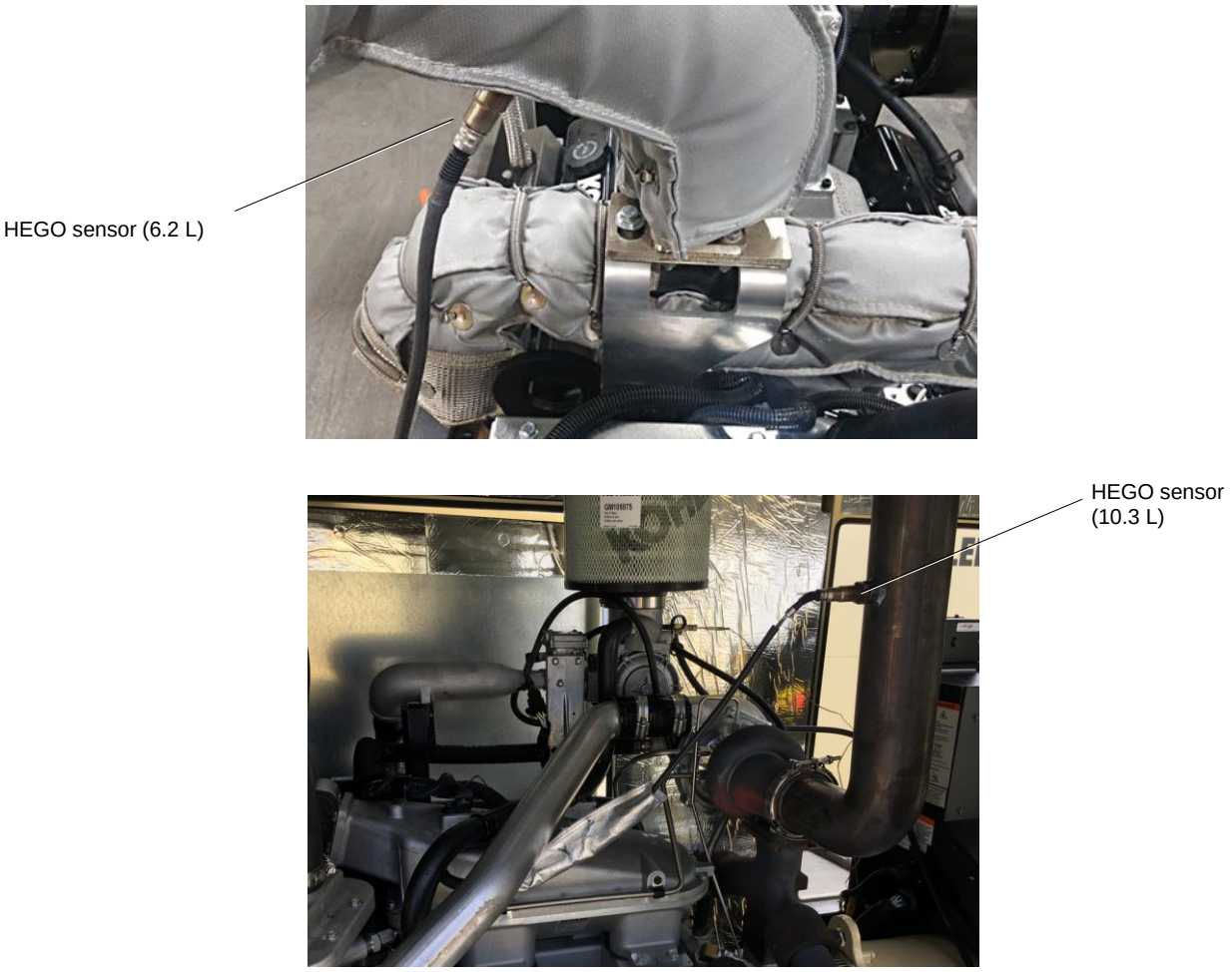


Figure 12 HEGO Sensor

The heated exhaust gas oxygen (HEGO) sensor, shown in Figure 12, mounts to the exhaust system and is composed of a sensor and an internal heating element.

During operation, heat from the exhaust increases the temperature of the heating element and activates the sensor. Once activated, the sensor measures the oxygen content in the exhaust gas and sends a signal to the ECM.

The ECM uses this signal to adjust the fuel flow to the engine and to prevent the fuel flow from becoming too rich or too lean. If the sensor signal indicates that the fuel is too rich or too lean for an extended period of time, the ECM will log a diagnostic code.

Important:
Silicone sprays or inappropriate RTV (room temperature vulcanization) sealers can contaminate the HEGO sensor. Contaminated HEGO sensors can produce false or high readings resulting in poor fuel mixtures and severe performance problems. Always verify that the sealer is safe to use with the HEGO sensor before applying the sealer.

1.10 Ignition System

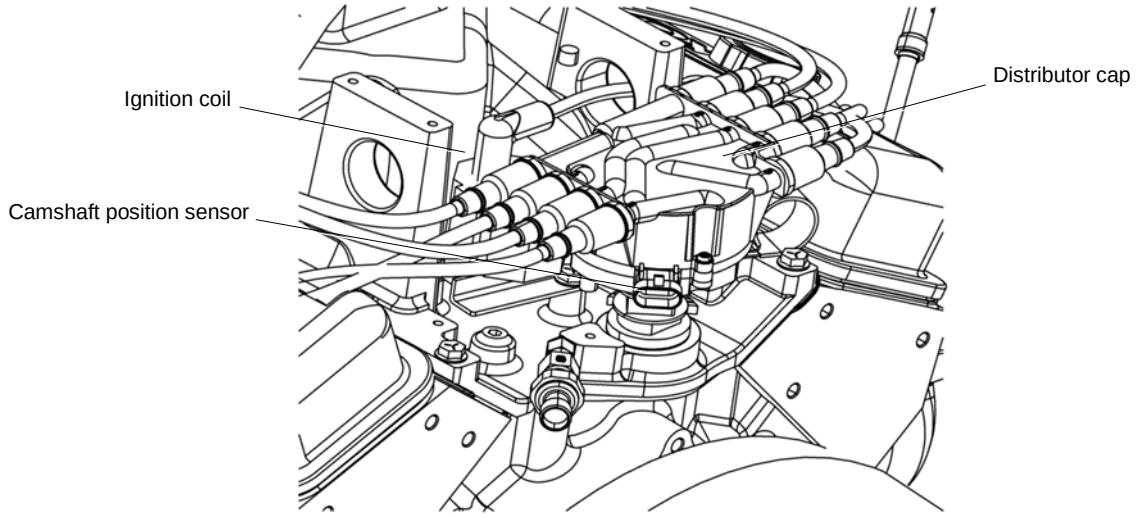


Figure 13 Ignition System, Distributor (KG6208, Naturally Aspirated Engine Only)

The ignition system for the KG6208, naturally aspirated engine, consists of the ignition coil, distributor, and spark plugs. The ECM receives signals from the crankshaft position sensor and camshaft position sensor to control ignition timing. The ECM then sends a signal to the ignition coil, which in turn supplies voltage to the distributor. As the rotor in the distributor spins, voltage is supplied to the spark plugs and ignition is supplied to the cylinders.

Note:
Turbocharged engine models, KG6208T and KG10V08T, use ignition coil packs and do not have a distributor or camshaft position sensor.

Ignition System (KG6208TSD, KG6208THD, KG10V08T-6CGS and KG10V08T-6DGS, Turbocharged Engines Only)

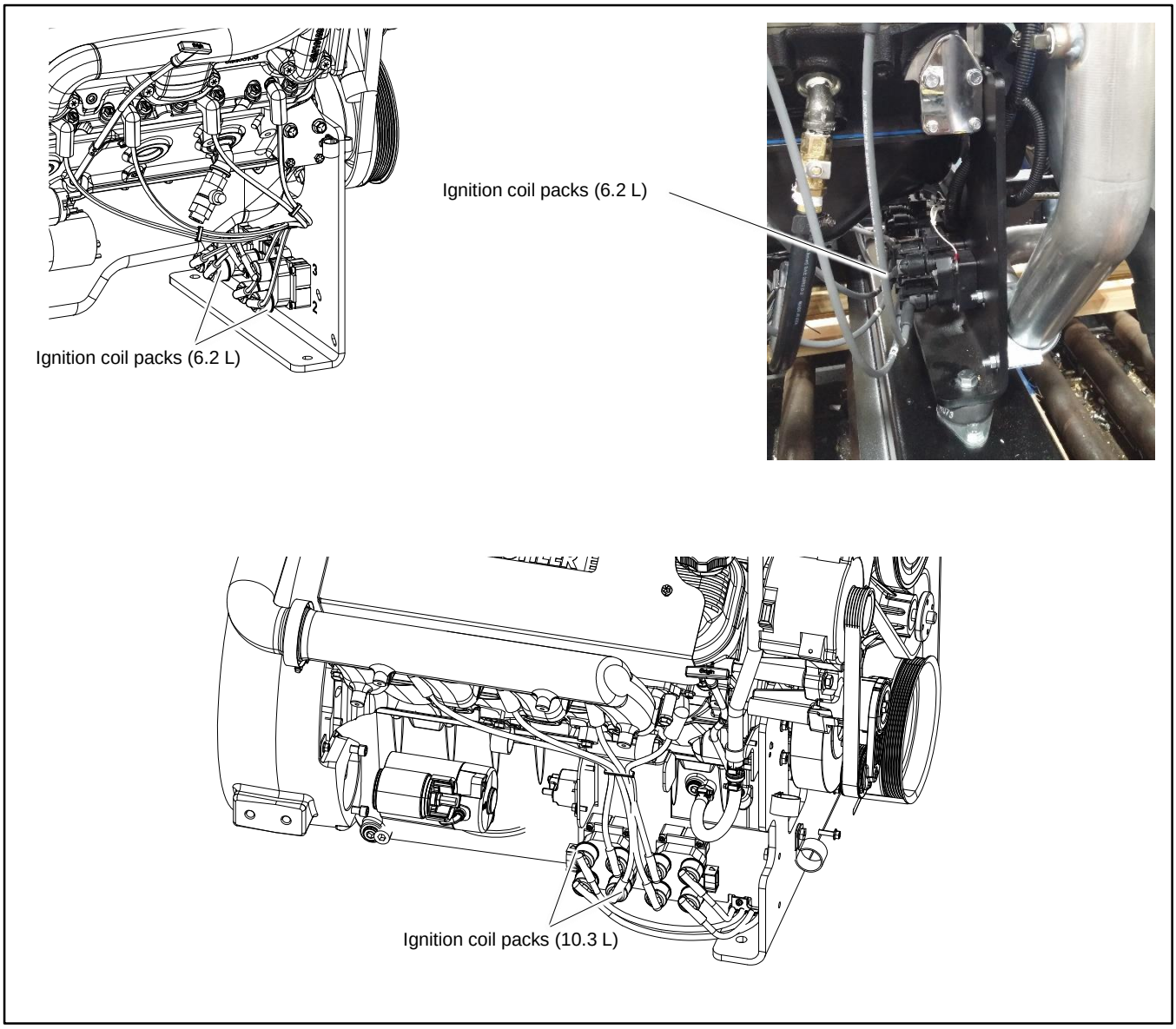


Figure 14 Ignition System, Ignition Coil

The ignition system for the KG6208TSD (standard-duty), KG6208THD (heavy-duty), KG10V08T-6CGS, and KG10V08T-6DGS turbocharged engines consists of two ignition coil packs, spark plug wires, and spark plugs. The ignition coil pack controls the spark timing for the engine.

This ignition system is a wasted-spark system. In a wasted spark system, spark is provided to two cylinders simultaneously. One spark plug fires during the compression stroke of a cylinder and creates combustion; while the other spark plug fires during the exhaust stroke and is wasted.

After receiving the crank signal, the ECM sends the ignition control packs a triggering signal that controls the timing of the ignition spark. The ignition coils then provide voltage to the spark plugs through high tension leads.

Note:
Turbocharged engine models do not have a distributor or a camshaft position sensor.

1.11 Oil Pressure Sender

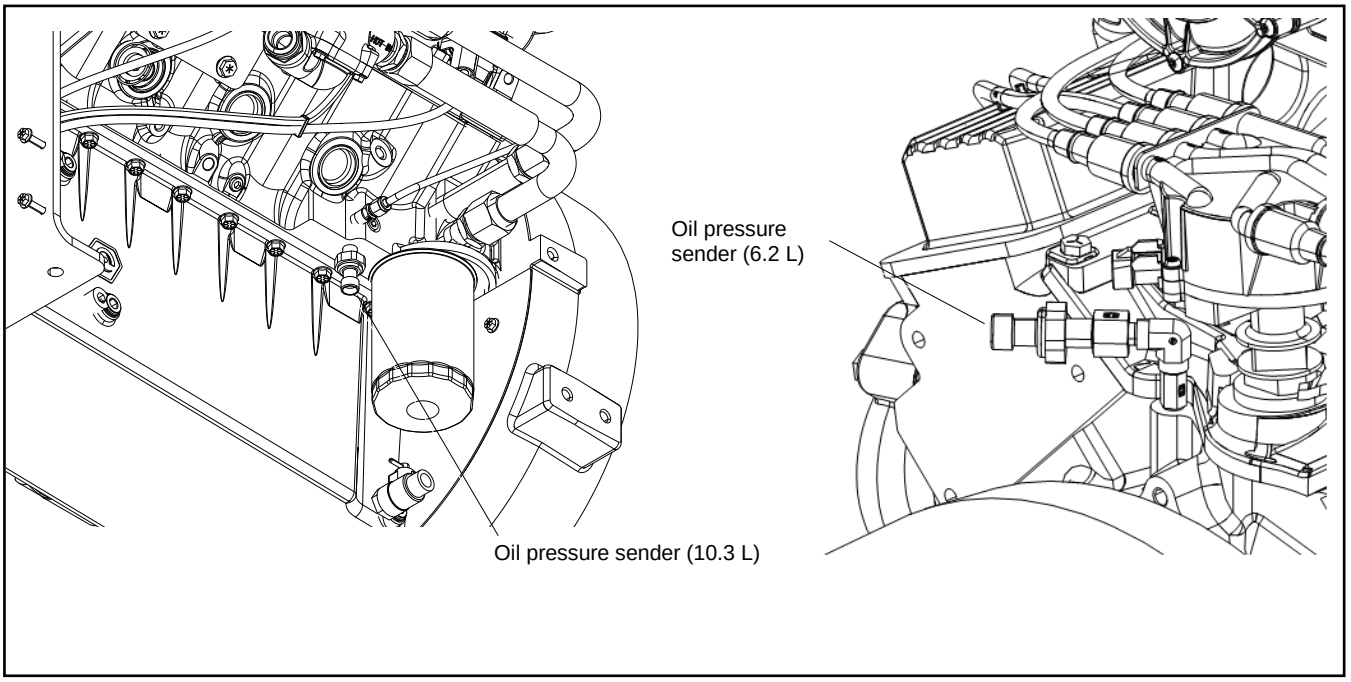


Figure 15 Oil Pressure Sender

The oil pressure sender is used to communicate a low oil pressure condition to the ECM. See Figure 15. Engine damage can occur if the engine is operated with low oil pressure.

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, the ECM issues a diagnostic troubleshooting code (DTC).

1.12 Oil Separator (KG6208THD and KG10V08T, Turbocharged Engines Only)

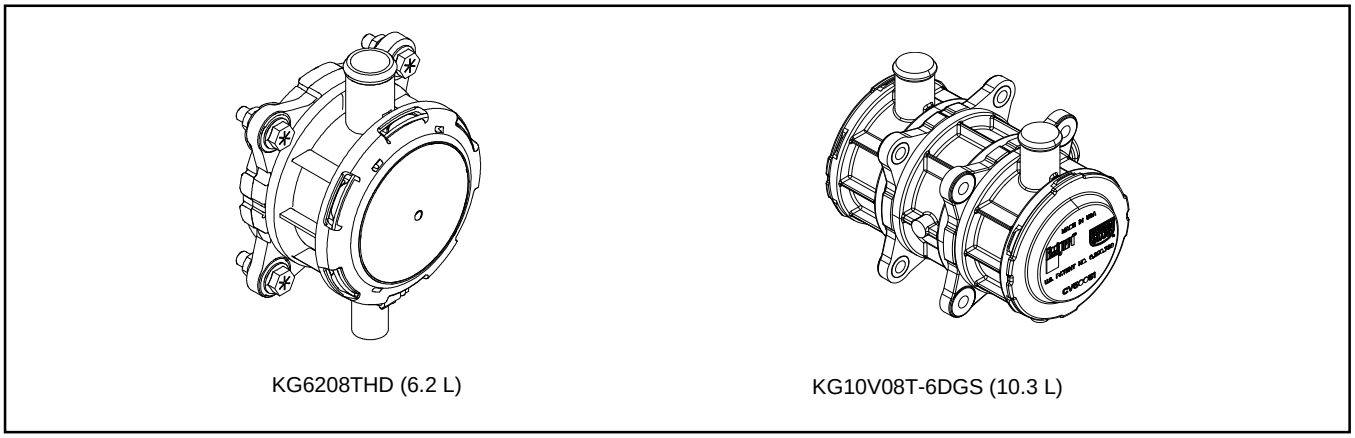


Figure 16 Oil Separator (KG6208THD, and KG10V08T-6DGS, Heavy-Duty Turbocharged Engines Only)

The oil separator is part of the closed crankcase ventilation system. Blow-by gas in the crankcase is circulated through the oil separator. Oil is separated and drained into the engine block and the cleaned blow-by gas is circulated back into the air intake.

1.13 Throttle Body

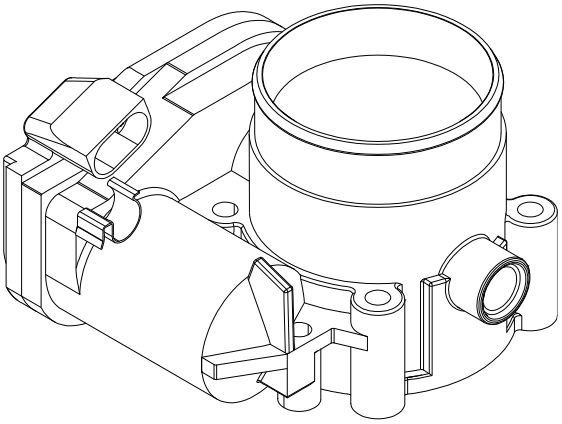


Figure 17 Throttle Body

The throttle body, shown in Figure 17, controls the amount of fuel and air that enters the engine and is composed of a throttle blade, electric throttle motor, and a throttle position (TP) sensor.

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.

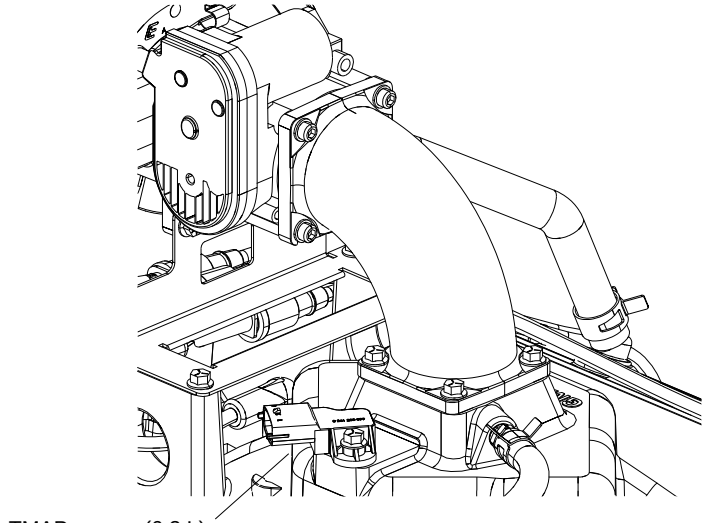
The throttle body utilizes an electric motor connected to the throttle blade. The ECM sends an electrical signal to the throttle body to increase or decrease the angle of the throttle blade thus increasing or decreasing the fuel supply to the engine.

The throttle body incorporates an internal Throttle Position (TP) sensor which provides output signals to the ECM as to the location of the throttle shaft and blade. The TP sensor information is used by the ECM to correct for speed and load control.

1.14 Throttle Inlet Pressure (TIP) Sensor (KG6208T and KG10V08T, Turbocharged Engines Only)

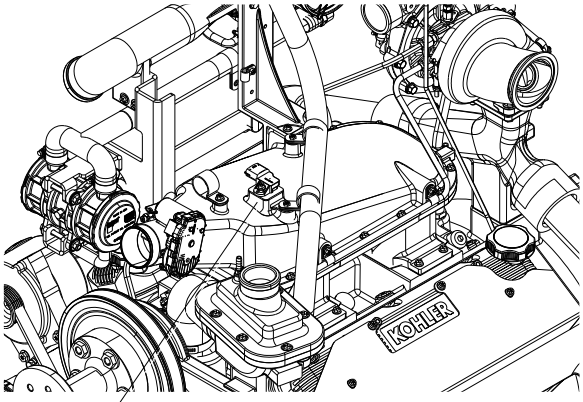
On turbocharged engines, KG6208TSD (standard-duty), KG6208THD (heavy-duty) and KG10V08T, the Throttle Inlet Pressure (TIP) sensor monitors the absolute pressure in the air induction system up-stream of the throttle. Data returned by the TIP sensor prompts the ECM to adjust the air-fuel mixture as needed.

1.15 TMAP Sensor



TMAP sensor (6.2 L)

GM100213



TMAP sensor (10.3 L)

GM106900

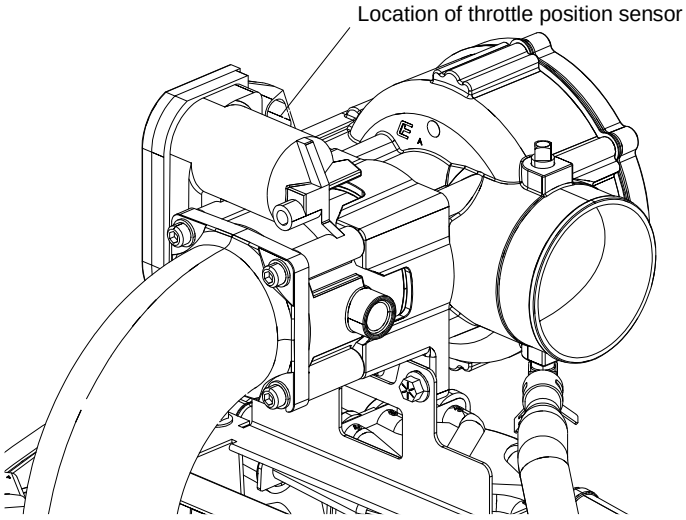
Figure 18 TMAP Sensor

The TMAP sensor, shown in Figure 18, is a combination of two sensors: the manifold absolute pressure (MAP) sensor and the manifold air temperature (MAT) or intake air temperature (IAT) sensor. The MAP Sensor measures the intake manifold pressure and the MAT or IAT sensor measures the air temperature in the intake manifold. The ECM uses the pressure and temperature readings in conjunction with other inputs to estimate the airflow requirement of the engine.

The MAT sensor uses a variable resistance thermistor to measure the air temperature and then sends a voltage signal to the ECM. The ECM interprets the signal voltage to indicate the temperature. If a cold start is indicated, the ECM enriches the fuel mixture.

The MAP (Manifold Absolute Pressure) sensor portion of the TMAP sensor is a pressure transducer connected to the intake manifold. The MAP Sensor uses a variable resistor to measure the absolute pressure in the intake manifold. The ECM uses the signal from the MAP sensor to determine the engine load and then adjusts the fuel mixture to improve performance and emissions.

1.16 Throttle Position (TP) Sensor



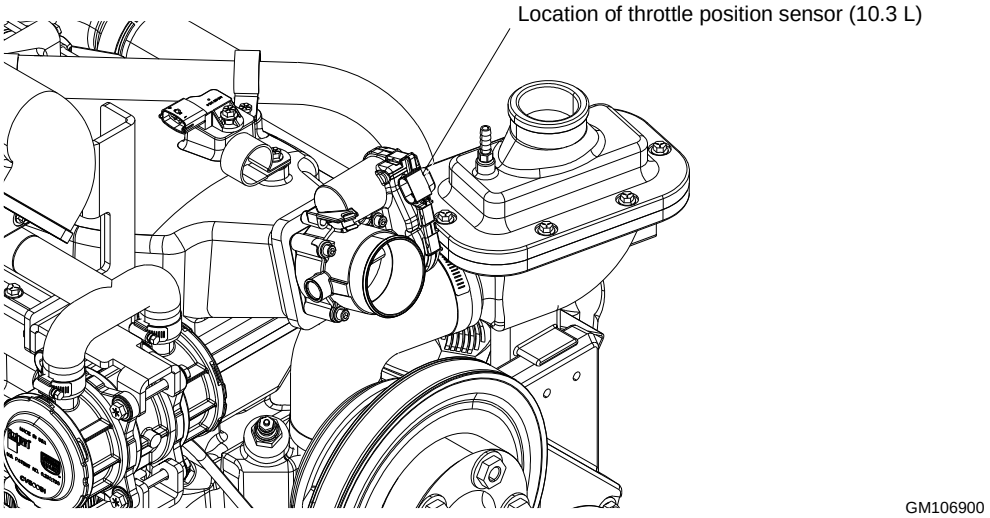


Figure 19 Throttle Position Sensor

The throttle position (TP) sensor, shown in Figure 19, is part of the throttle body and is composed of three components: an electronic throttle control (ETC), throttle position sensor 1 (TP1), and throttle position sensor 2 (TP2). TP1 and TP2 determine the throttle blade position and send signals to ECM. The ECM receives information from TP1 and TP2 and sends a signal to the ETC to open or close the throttle blade. The ETC controls an electric motor that opens and closes the throttle blade.

1.17 Turbocharger (KG6208T and KG10V08T, Turbocharged Engines Only)

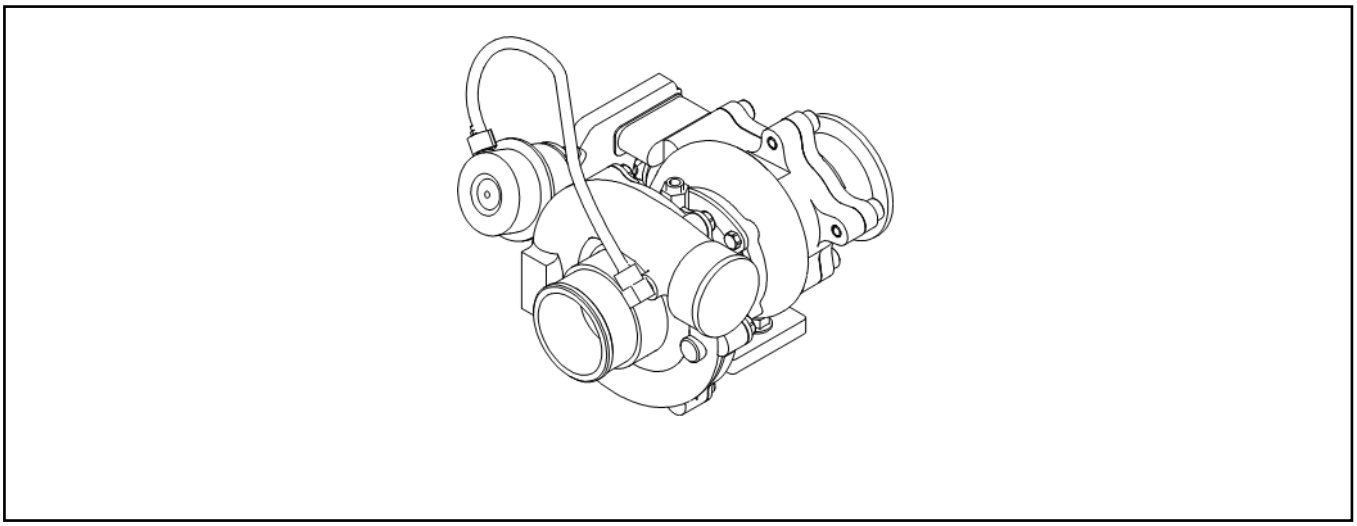


Figure 20 Turbocharger (KG6208T, Turbocharged Engines Only)

The KG6208TSD (standard-duty), KG6208THD (heavy-duty), KG10V08T-6CGS, and KG10V08T-6DGS turbocharged engines are equipped with a turbocharger. The turbocharger utilizes exhaust gas flowing through the turbine to spin a compressor. The turbocharger compressor increases boost pressure and density of the air/fuel mixture entering the intake manifold resulting in higher power output compared to the naturally aspirated engine. A wastegate on the turbocharger bypasses exhaust gas around the turbine when the boost pressure reaches a maximum limit.

1.18 Turbocharger Oil Lines (KG6208T and KG10V08T, Turbocharged Engines Only)

On the KG6208TSD (standard-duty), KG6208THD (heavy-duty), KG10V08T-6CGS, and KG10V08T-6DGS turbocharged engines, turbocharger bearings require oil for lubrication and cooling. Oil is fed to the turbocharger bearings from the oil supply line on the top side of the bearing housing and returned to the oil sump through a line connecting the bottom side of the bearings to the sump.

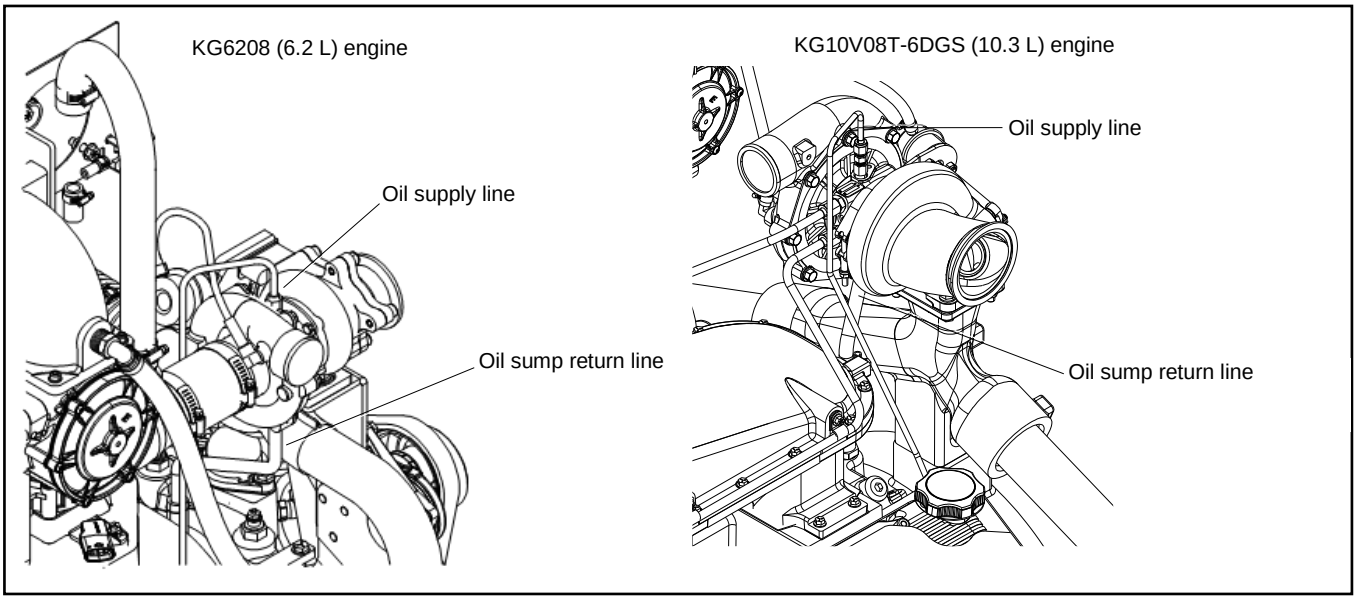


Figure 21 Turbocharger Oil Lines (KG6208TSD, KG6208THD, KG10V08T-6CGS, and KG10V08T-6DGS , Turbocharged Engines Only)

The engine control module for spark-ignited engine applications incorporates a set of diagnostic tests that perform specific functions to aid in verifying proper engine control. This section describes the tests supported, test states, and operating criteria for each test.

Diagnostic tests are software selectable through the diagnostic scan tool software using the ECIPP protocol or can be initiated via CAN using CCP.

2.1 Spark Advance Test

The Spark Advance Test commands a calibrated base spark advance if engine speed and manifold pressure are below a calibrated limit. If engine is operated above the calibrated operating limit, base spark advance as set in the normal calibration will be used until the engine set point falls below the calibrated limit. This test may be initiated by selecting “Enabled” in the software or through use of a switched hardware input. The test reverts to normal operation when “Normal” state is selected or when ignition voltage is cycled from high to low.

Important:
When using the spark advance test, command an ignition timing value between 10 and 30 degrees before top dead center (BTDC).

States

1. Disabled: State of normal operation
2. Active: Sets spark timing to a calibrated default spark advance

Monitored Status

1. Test not started
2. Test is running
3. Test finished
4. Cannot start test

3.1 Safety Precautions

WARNING	
	**Accidental starting.** **Can cause severe injury or death.** Disconnect the battery cables before working on the engine. Remove the negative (–) lead first when disconnecting the battery. Reconnect the negative (–) lead last when reconnecting the battery.

Disabling the engine. Accidental starting can cause severe injury or death. Before working on the engine or connected equipment, disable the engine as follows: 1) Disconnect the ignition coil. 2) Remove the battery cables, negative (–) lead first. Reconnect the negative (–) lead last when reconnecting the battery. Follow these precautions to prevent the accidental starting of the engine.

WARNING	
	**Carbon monoxide.** **Can cause severe nausea, fainting, or death.** Avoid inhaling exhaust fumes.

Engine Operation. Carbon monoxide can cause severe nausea, fainting, or death. Engine exhaust gases contain poisonous carbon monoxide. Carbon monoxide is an odorless, colorless, tasteless, nonirritating gas that can cause death if inhaled for even a short time. Avoid breathing exhaust fumes when working on or near the engine. Never operate the engine inside a building. Never operate the engine where exhaust gas could seep inside or be drawn into a potentially occupied building through windows, air intake vents, or other openings.

WARNING	
	**Risk of fire.** **Can cause severe injury or death.** Do not smoke or permit flames or sparks near fuels or the fuel system.

WARNING	
	**Pinch and entanglement hazards.** **Can cause severe injury and possible death.** Never check drive belt tension while the engine is running.

CAUTION	
	**Hazardous voltage.** **Electrical shock can cause injury.** Do not touch wires while the engine is running. Stop the engine and disconnect the battery leads, negative (-) lead first, before servicing the engine.

WARNING	
	**Moving parts.** **Can cause severe injury or death.** Operate the engine only when all guards and electrical enclosures are in place. Stay away from moving parts while the engine is in operation.

Servicing the engine when it is operating. Exposed moving parts can cause severe injury or death. Keep hands, feet, hair, clothing, and test leads away from the belts and pulleys when the engine is running. Replace guards, screens, and covers before operating the engine.

WARNING	
	**Hot engine and exhaust system.** **Can cause severe injury or death.** Do not work on the engine until it cools.

Hot engine components. Can cause severe injury or death. Never operate the engine with heat shields or guards removed.

WARNING	
	**Hot coolant and steam.** **Can cause severe injury or death.** Before removing the pressure cap, stop the engine and allow it to cool. Then loosen the pressure cap to relieve pressure.

WARNING	
	**Explosive fuel vapors.** **Can cause fires and severe burns.** If a gaseous odor is detected, ventilate the area and contact an authorized service technician.

The fuel system. Explosive fuel vapors can cause severe injury or death. Vaporized fuels are highly explosive. Use extreme care when handling and storing fuels. Store fuels in a well-ventilated area away from spark-producing equipment and out of the reach of children. Never add fuel to the tank while the engine is running because spilled fuel may ignite on contact with hot parts or from sparks. Do not smoke or permit flames or sparks to occur near sources of spilled fuel or fuel vapors. Keep the fuel lines and connections tight and in good condition. Do not replace flexible fuel lines with rigid lines. Use flexible sections to avoid fuel line breakage caused by vibration. Do not operate the engine in the presence of fuel leaks, fuel accumulation, or sparks. Repair fuel systems before resuming engine operation.

WARNING	
	**Handling caustic engine fluids and chemical products.** **Can cause severe chemical burns, nausea, fainting, or death.** Most chemicals such as used engine oil, antifreeze/coolant, rustproofing agent, inhibiting oil, degreasing agent, spray paint, and adhesives are hazardous to health. Read and follow the user information found on the packaging. Avoid inhalation and skin contact. Use only in well-ventilated areas and use a protective mask when spraying. Store engine fluids and chemical products in a locked cabinet. Contact your local recycling center for disposal information and locations.

Fire-damaged or burned O-rings may cause the formation of hydrofluoric acid. Contact with hydrofluoric acid may cause severe skin irritation and chemical burns. O-rings and other fluoroelastomer seals exposed to fire or temperatures above 316°C (600°F) (i.e., during welding) may decompose forming hydrofluoric acid. Avoid inhalation or skin contact. Do not incinerate O-rings. Dispose of O-ring waste material in a responsible manner.

⚠ WARNING	**Spring-loaded parts.** **Can cause severe personal injury or property damage.** Wear protective goggles when servicing spring-loaded parts. Hold parts securely during disassembly.
	

⚠ WARNING	**Explosive fuel vapors.** **Can cause severe injury or death.** Use extreme care when handling, storing, and using fuels.
	

Gas fuel leaks. Explosive fuel vapors can cause severe injury or death. Fuel leakage can cause an explosion. Check the LPG vapor or natural gas fuel system for leakage by using a soap and water solution with the fuel system test pressurized to 6–8 ounces per square inch (10–14 inches water column). Do not use a soap solution containing either ammonia or chlorine because both prevent bubble formation. A successful test depends on the ability of the solution to bubble.

Used engine oil. Contact with used engine oil may cause severe skin irritation. Repeated and prolonged skin exposure may have other health risks. Used engine oil is a suspected carcinogen. Avoid contact with skin. Thoroughly wash your hands and nails with soap and water shortly after handling used engine oil. Wash or dispose of clothing or rags containing used engine oil. Dispose of used engine oil in a responsible manner. Contact your local recycling center for disposal information and locations.

⚠ CAUTION	**Damaged harmonic balancer, crankshaft, or flywheel.** **Can cause personal injury.** Broken fragments from the harmonic balancer, crankshaft, and flywheel can be thrown from the engine. Do not use a hammer to install or remove. Inspect these parts for damage and replace if needed.
	

3.2 Powering the ECM On and Off

Many of the troubleshooting steps require the use of a digital Volt-Ohm meter (DVOM) when checking for voltage and resistance and may also require the ECM to be either powered or turned off. The following instructions explain how to turn the ECM power on and off with either SiteTech™ software or the Kohler® RDC2 generator set controller.

Note:
For instructions on powering the ECM with the APM402 or Decision-Maker® 3000, refer to the controller operation manual.

Note:
For the APM603 controller, the operator can also power the ECU ON and OFF through the controller menus. The operator password is required. Refer to the controller operation manual for details.

To turn the ECM power ON and OFF using Kohler® SiteTech™ software:

1. Use SiteTech™ to connect to the equipment controller.
2. Locate ***ECM Power*** under the Genset System Configuration group.
3. Change the setting to ***ON*** to power the ECM***.***
4. Change the setting to ***OFF*** to turn off the ECM power.

To turn the ECM power ON and OFF using the RDC2 controller:

1. From the main menu, scroll down (press the Down arrow) to ***Overview*** and press the Selection button. See Figure 22.
2. In the Overview menu, scroll down to ***SW Version***. Press and hold the Selection button until the display shows ***ECM powered*** to power the ECM.
3. Press the Stop button to turn off the ECM power.

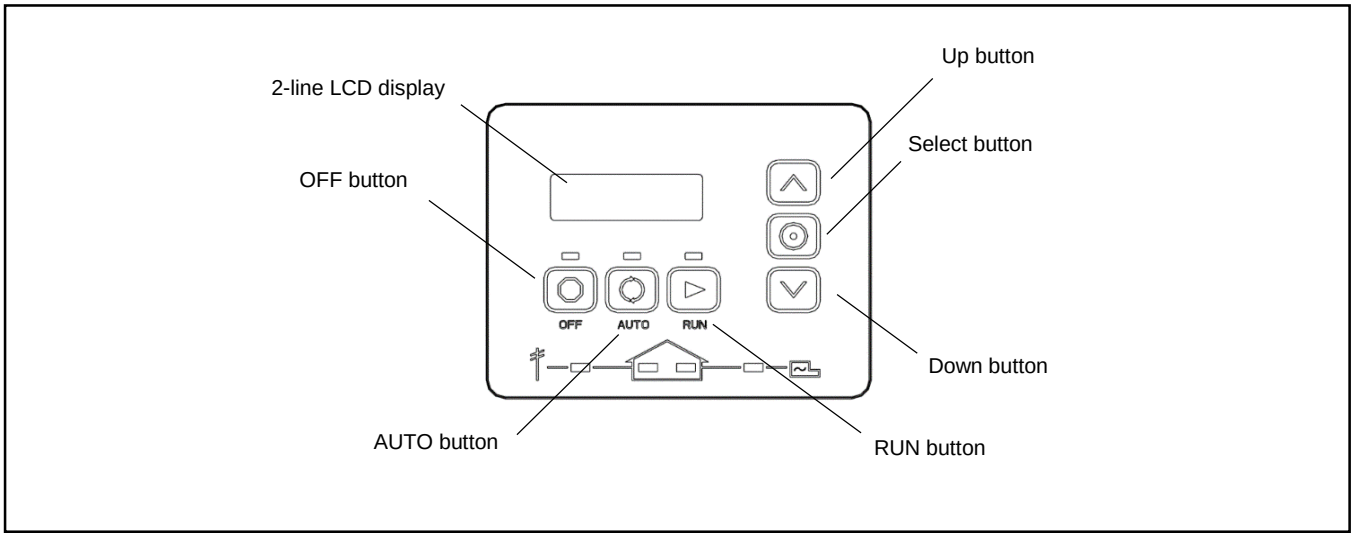


Figure 22 RDC2 Controller Interface

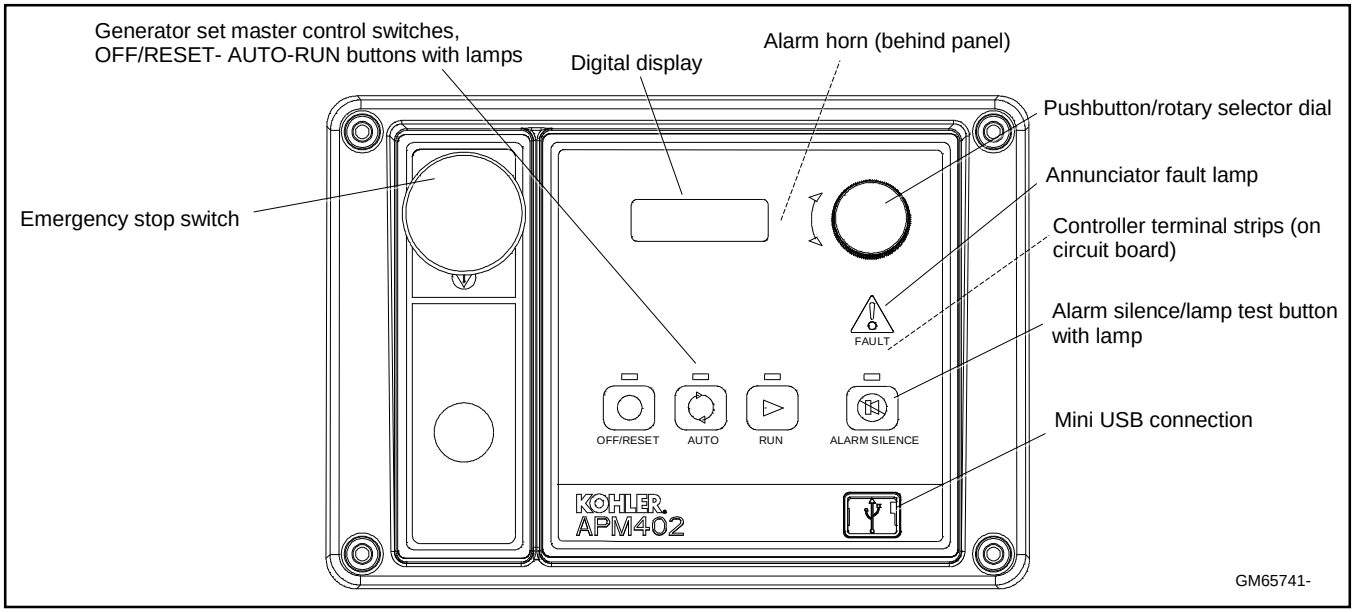


Figure 23 APM402 Controller Interface

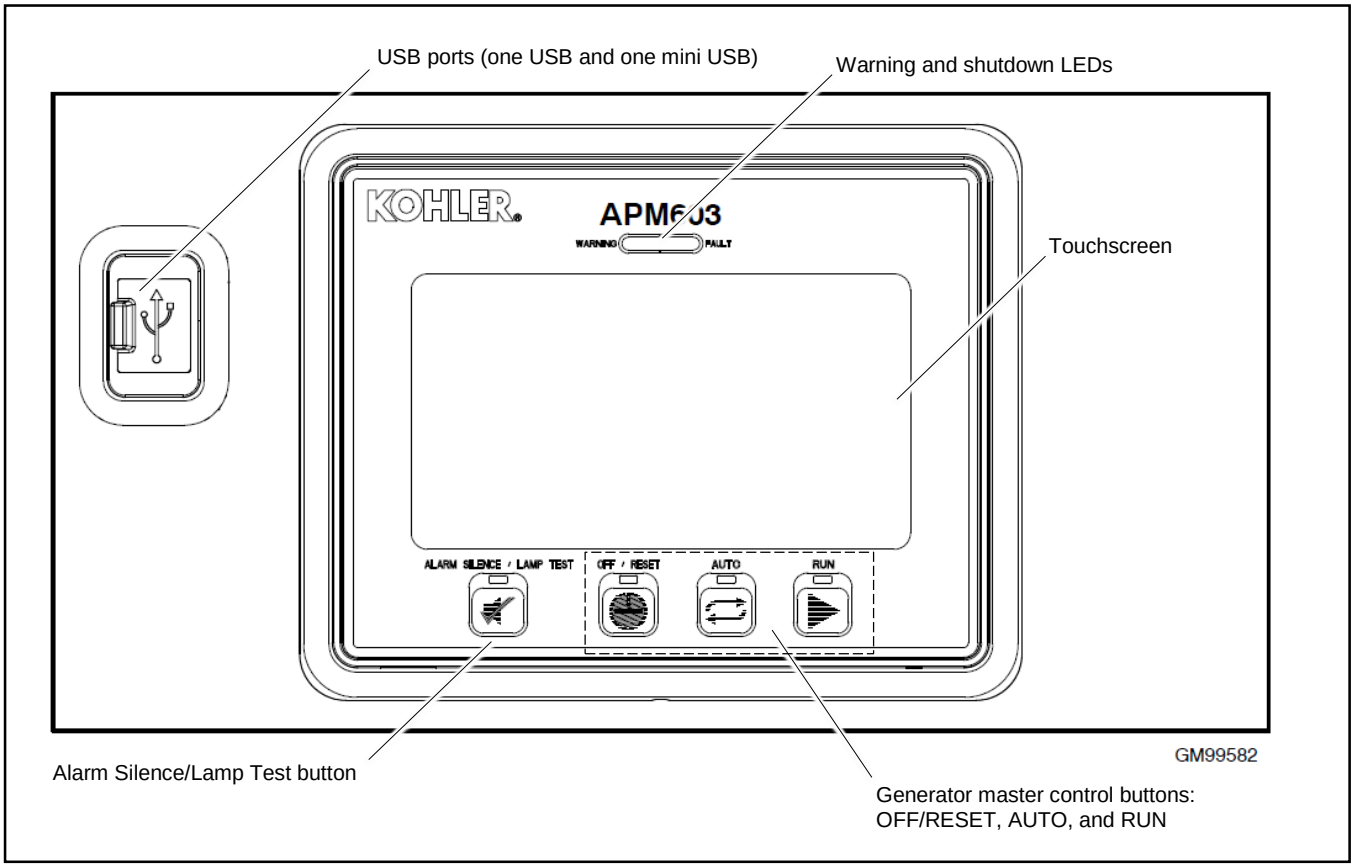


Figure 24 APM603 Controller Interface

3.3 DTC to SPN/FMI Cross Reference

The following chart cross-references SPN/FMI codes with DTC codes. When obtaining the SPN/FMI codes with a J1939-based diagnostic scan tool or multi-function display unit, use this chart to find the corresponding DTCs discussed in this manual.

Flash Code	Fault Description	SPN	FMI
6	Lockoff open / ground short	632	4
7	Lockoff short to power	632	3
11	Intake cam / distributor position	520800	7
16	Never crank synced at start	636	8
31	EGOH1 open / ground short	3222	4
32	EGOH1 short to power	3222	3
51	EGOH2 open / ground short	3232	4
52	EGOH2 short to power	3232	3
107	MAP low voltage	106	4
108	MAP high pressure	106	16
112	IAT low voltage	105	4
113	IAT high voltage	105	3
116	ECT higher than expected 1	110	15
117	ECT / CHT low voltage	110	4
118	ECT / CHT high voltage	110	3
121	TPS1 lower than TPS2	51	1
122	TPS1 low voltage	51	4
123	TPS1 high voltage	51	3
127	IAT higher than expected 2	105	0
128	Failed to reach operating temperature	110	17
129	BP low pressure	108	1
134	EGO open / lazy pre-cat 1	3217	5
140	EGO open / lazy post-cat 1	3256	5
154	EGO open / lazy pre-cat 2/post-cat 1	3227	5
160	EGO open / lazy post-cat 2	3266	5
187	FT gaseous fuel low	3468	4
187	FT gaseous fuel extremely low	3468	1
188	FT gaseous fuel high	3468	3
217	ECT higher than expected 2	110	0
219	Max govern speed override	515	15
221	TPS1 higher than TPS2	51	0
222	TPS2 low voltage	3673	4
223	TPS2 high voltage	3673	3
234	Control overboost (only with turbo models)	102	0
236	TIP/TOP active (only with turbo models)	102	2
237	TIP/TOP low voltage (only with turbo models)	102	4
238	TIP/TOP high voltage (only with turbo models)	102	3
299	Control underboost (only with turbo models)	102	1
336	Crank sync noise	636	2
337	Crank loss	636	4
341	Cam sync noise	723	2
342	Cam loss	723	4
350	External Spark Module Failure	1268	31
351	External Spark Module Coil Failure (Cylinder 1)	1268	31
352	External Spark Module Coil Failure (Cylinder 2)	1269	31
353	External Spark Module Coil Failure (Cylinder 3)	1270	31
354	External Spark Module Coil Failure (Cylinder 4)	1271	31
355	External Spark Module Coil Failure (Cylinder 5)	1272	31
356	External Spark Module Coil Failure (Cylinder 6)	1273	31
357	External Spark Module Coil Failure (Cylinder 7)	1274	31
358	External Spark Module Coil Failure (Cylinder 8)	1275	31
359	Fuel run-out longer than expected	632	31

Flash Code	Fault Description	SPN	FMI
520	Oil pressure low stage 1 (sender)	100	18
521	Oil pressure high (sender)	100	0
522	Oil pressure sender low voltage	100	4
523	Oil pressure sender high voltage	100	3
524	Oil pressure low stage 2 (sender)	100	1
562	Voltage low	168	17
563	Voltage high	168	15
601	Flash checksum invalid	628	13
604	RAM failure	630	12
606	COP failure	629	31
615	Start relay coil open	1321	5
616	Start relay control ground short	1321	4
617	Start relay coil short to power	1321	3
642	5VE1 low voltage	1079	4
643	5VE1 high voltage	1079	3
650	MIL open	1213	5
652	5VE2 low voltage	1080	4
653	5VE2 high voltage	1080	3
685	Relay coil open	1485	5
686	Relay control ground short	1485	4
687	Relay coil short to power	1485	3
698	5VE3 low voltage	3511	4
699	5VE3 high voltage	3511	3
1068	MAP higher than expected	3563	15
1087	Secondary fuel pressure low	94	1
1088	Secondary fuel pressure high	94	0
1111	Fuel rev limit	515	16
1112	Spark rev limit	515	0
1113	RPM higher than expected	515	31
1114	Unable to achieve low target speed	515	15
1131	WGP high voltage	1192	3
1132	WGP low voltage	1192	4
1151	CL high LPG	4236	0
1152	CL low LPG	4236	1
1153	CL high NG	4236	0
1154	CL low NG	4236	1
1161	AL high LPG	4237	0
1162	AL low LPG	4237	1
1163	AL high NG	4237	0
1164	AL low NG	4237	1
1165	LPG cat monitor	3050	11
1166	NG cat monitor	3050	11
1171	EPR / CFV regulation pressure higher than expected	520260	0
1172	EPR / CFV regulation pressure lower than expected	520260	1
1173	EPR / CFV comm lost	520260	31
1174	EPR / CFV voltage supply high	520260	3
1175	EPR / CFV voltage supply low	520260	4
1176	EPR / CFV internal actuator fault detection	520260	12
1177	EPR / CFV internal circuitry fault detection	520260	12
1178	EPR / CFV internal comm fault detection	520260	12
1182	Fuel impurity level high	520401	0
1183	EPR autozero / lockoff failed	520803	31
1311	Misfire detected (Cylinder 1)	1323	11
1312	Misfire detected (Cylinder 2)	1324	11
1313	Misfire detected (Cylinder 3)	1325	11
1314	Misfire detected (Cylinder 4)	1326	11

Flash Code	Fault Description	SPN	FMI
1315	Misfire detected (Cylinder 5)	1327	11
1316	Misfire detected (Cylinder 6)	1328	11
1317	Misfire detected (Cylinder 7)	1329	11
1318	Misfire detected (Cylinder 8)	1330	11
1325	Knock retard at limit	731	15
1351	Spark Plug or Coil Failure (Cylinder 1)	1268	11
1352	Spark Plug or Coil Failure (Cylinder 2)	1269	11
1353	Spark Plug or Coil Failure (Cylinder 3)	1270	11
1354	Spark Plug or Coil Failure (Cylinder 4)	1271	11
1355	Spark Plug or Coil Failure (Cylinder 5)	1272	11
1356	Spark Plug or Coil Failure (Cylinder 6)	1273	11
1357	Spark Plug or Coil Failure (Cylinder 7)	1274	11
1358	Spark Plug or Coil Failure (Cylinder 8)	1275	11
1425	AUX Temperature 3 high	703	0
1425	AUX Temperature 3 low	703	1
1426	ERWT2 higher than expected level 1	1386	15
1426	AUX Temperature delta T 1 high	1385	0
1426	AUX Temperature delta T 1 low	1385	1
1427	ERWT1 higher than expected level 2	1385	0
1427	AUX Temperature 1 low	1385	1
1428	ERWT2 higher than expected level 2	1386	0
1428	AUX Temperature 1 high	1385	0
1435	AUX Temperature 4 high	704	0
1435	AUX Temperature 4 low	704	1
1436	AUX Temperature delta T 2 high	1386	0
1436	AUX Temperature delta T 2 low	1386	1
1437	AUX Temperature 2 low	1386	1
1438	AUX Temperature 2 high	1386	0
1470	AUX Pressure 3 high	703	0
1470	AUX Pressure 3 low	703	1
1470	AUX Pressure 4 high	704	0
1470	AUX Pressure 4 low	704	1
1471	AUX Pressure delta P 1 high	1387	0
1471	AUX Pressure delta P 1 low	1387	1
1471	AUX Pressure delta P 2 high	1388	0
1471	AUX Pressure delta P 2 low	1388	1
1472	AUX Pressure 1 low	1387	1
1472	AUX Pressure 2 low	1388	1
1473	AUX Pressure 1 high	1387	0
1473	AUX Pressure 2 high	1388	0
1511	AUX analog PU1 high	701	3
1512	AUX analog PU1 low	701	4
1513	AUX analog PU2 high	702	3
1514	AUX analog PU2 low	702	4
1515	AUX analog PD1 high	710	3
1516	AUX analog PD1 low	710	4
1517	AUX analog PU3 high	703	3
1518	AUX analog PU3 low	703	4
1521	CHT higher than expected 1	110	16
1522	CHT higher than expected 2	110	0
1541	AUX analog PUD1 high	704	3
1542	AUX analog PUD1 low	704	4
1543	AUX analog PUD2 high	705	3
1544	AUX analog PUD2 low	705	4
1545	AUX analog PUD3 high	706	3
1546	AUX analog PUD3 low	706	4

Flash Code	Fault Description	SPN	FMI
1547	AUX analog PUD4 high	713	3
1548	AUX analog PUD4 low	713	4
1551	AUX DIG1 high	707	3
1552	AUX DIG1 low	707	4
1553	AUX DIG2 high	708	3
1554	AUX DIG2 low	708	4
1555	AUX DIG3 high	709	3
1556	AUX DIG3 low	709	4
1561	AUX analog PD2 high	711	3
1562	AUX analog PD2 low	711	4
1563	AUX analog PD3 high	712	3
1564	AUX analog PD3 low	712	4
1565	AUX analog PUD5 high	0	3
1566	AUX analog PUD5 low	0	4
1567	AUX analog PUD6 high	714	3
1568	AUX analog PUD6 low	714	4
1569	AUX analog PUD7 high	715	3
1571	AUX analog PUD7 low	715	4
1572	AUX DIG4 high	716	3
1573	AUX DIG4 low	716	4
1574	AUX DIG5 high	520202	3
1575	AUX DIG5 low	520202	4
1576	AUX DIG6 high	520203	3
1577	AUX DIG6 low	520203	4
1578	AUX DIG7 high	520204	3
1579	AUX DIG7 low	520204	4
1581	AUX DIG8 high	520205	3
1582	AUX DIG8 low	520205	4
1583	AUX DIG9 high	520206	3
1584	AUX DIG9 low	520206	4
1585	AUX DIG10 high	520207	3
1586	AUX DIG10 low	520207	4
1589	AUX DIG11 high	520209	3
1591	AUX DIG11 low	520209	4
1592	AUX DIG12 high	520210	3
1593	AUX DIG12 low	520210	4
1602	Relay off high voltage	1485	4
1603	Relay on low voltage	1485	4
1604	Service Interval Expired	1350	31
1611	5VE1/2 simultaneous out-of-range	1079	31
1615	A/D loss	629	31
1616	Invalid interrupt	629	31
1621	Rx Inactive	0	31
1622	Rx Noise	0	31
1623	Invalid Packet Format	0	31
1624	Shutdown Request	0	31
1625	Shutdown Request	1110	31
1626	CAN1 Tx failure	639	12
1627	CAN1 Rx failure	639	12
1628	CAN1 address conflict failure	639	13
1629	J1939 TSC1 message receipt lost	695	9
1630	J1939 ETC message receipt lost	91	19
1631	PWM1-Gauge1 open / ground short	697	5
1632	PWM1-Gauge1 short to power	697	3
1633	PWM2-Gauge2 open / ground short	698	5
1634	PWM2-Gauge2 short to power	698	3

Flash Code	Fault Description	SPN	FMI
1635	PWM3-Gauge3 open / ground short	699	5
1636	PWM3-Gauge3 short to power	699	3
1637	PWM4-Gauge4 open / ground short	700	5
1638	PWM4-Gauge4 short to power	700	3
1639	PWM5 open / ground short	924	5
1640	PWM5 short to power	924	3
1646	CAN2 Tx failure	1231	12
1648	CAN2 Rx failure	1231	12
1650	CAN2 address conflict failure	1231	13
1651	J1939 ETC message loss while in-gear	91	9
1673	Calibration Configuration Error	1634	13
1674	Hardware ID Failure	1634	2
1675	Start command stuck active	1675	3
2111	Unable to reach lower TPS	51	7
2112	Unable to reach higher TPS	51	7
2135	TPS1/2 simultaneous voltages out of range	51	31
2229	BP high pressure	108	0
2295	Secondary FP low voltage	94	4
2296	Secondary FP high voltage	94	3
2300	Primary Loop Open or Low-Side Short to Ground (curr. meas. reqd)(Cylinder 1)	1268	5
2301	Primary Coil Shorted (current measurement required)(Cylinder 1)	1268	6
2303	Primary Loop Open or Low-Side Short to Ground (curr. meas. reqd)(Cylinder 2)	1269	5
2304	Primary Coil Shorted (current measurement required)(Cylinder 2)	1269	6
2306	Primary Loop Open or Low-Side Short to Ground (curr. meas. reqd)(Cylinder 3)	1270	5
2307	Primary Coil Shorted (current measurement required)(Cylinder 3)	1270	6
2309	Primary Loop Open or Low-Side Short to Ground (curr. meas. reqd)(Cylinder 4)	1271	5
2310	Primary Coil Shorted (current measurement required)(Cylinder 4)	1271	6
2312	Primary Loop Open or Low-Side Short to Ground (curr. meas. reqd)(Cylinder 5)	1272	5
2313	Primary Coil Shorted (current measurement required)(Cylinder 5)	1272	6
2315	Primary Loop Open or Low-Side Short to Ground (curr. meas. reqd)(Cylinder 6)	1273	5
2316	Primary Coil Shorted (current measurement required)(Cylinder 6)	1273	6
2318	Primary Loop Open or Low-Side Short to Ground (curr. meas. reqd)(Cylinder 7)	1274	5
2319	Primary Coil Shorted (current measurement required)(Cylinder 7)	1274	6
2321	Primary Loop Open or Low-Side Short to Ground (curr. meas. reqd)(Cylinder 8)	1275	5
2322	Primary Coil Shorted (current measurement required)(Cylinder 8)	1275	6
2428	Exhaust gas temperature high	173	0
3999	DBW drive current high	0	6
3999	HBA drive current high	0	6
3999	HBB drive current high	0	6
3999	Catalyst monitor - exhaust P low	4755	1
3999	Catalyst monitor - exhaust P high	4755	0
3999	UEGO1 internal supply voltage low	0	31
3999	UEGO2 internal supply voltage low	0	31

3.4 DTC Descriptions & Diagnostic Information

See the following pages for fault descriptions and diagnostic information, by DTC. Please note that fault descriptions and diagnostic information is in process – and will be provided in subsequent revisions to this document – for those DTCs not shown.

3.5 DTC 7 - Lockoff Short to Power

DTC	7	**SPN**	632	**FMI**	3

Hardware: Lockoff Valve

Hardware Description:

A normally closed electromechanical fuel shut-off is used to isolate the Dual Stage Regulator (DSR) or the Continuous Flow Valve (CFV) and all downstream components from the upstream fuel supply when the engine is shut off.

For all CFV systems, dual lock-off valves are required. For LNG applications, the dual lock-offs are a CFV Flange- mounted valve (EControls PN E2393500 or an application-specific variant) plus an in-line lock-off valve. For CNG applications, the dual lock-offs are a CFV Flange-mounted valve plus a high pressure CNG tank lock-off provided by the OEM.

Check Condition:	Key On / Engine Running

Fault Set Conditions (as defined in calibration):

• PWM low-side feedback >	90	% Vbat
• and PWM duty-cycle >	90	%
• to unlatch, MAP voltage must be >	0.500	volts

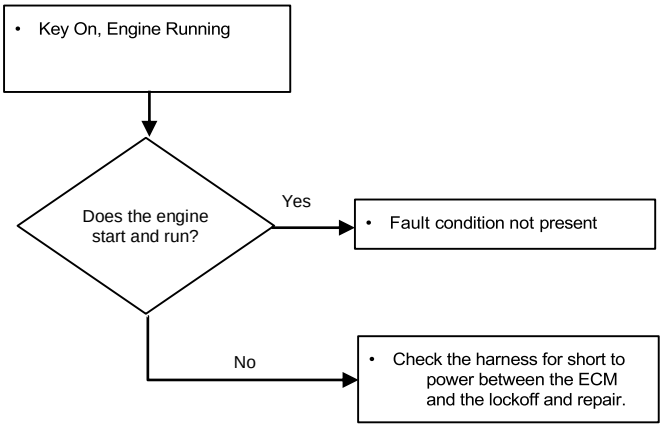
Fault Description:

This fault will set if the ECM detects high feedback voltage (% Vbat) on the lockoff while the lockoff circuit is in the on-state as defined in the calibration

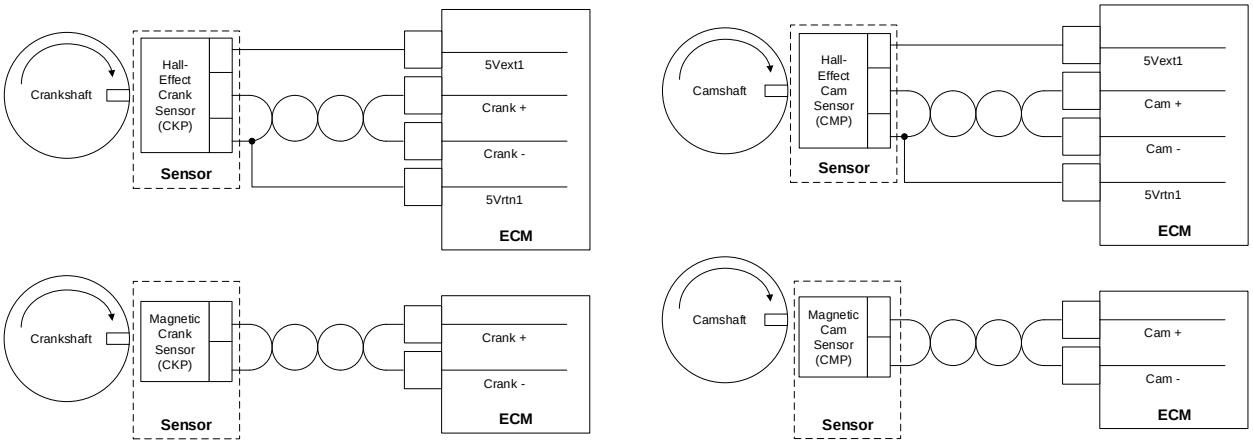
Corrective Actions:

Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	
Never Forget		AL Disable	X	Low Rev Limit		MIL Persist Disable	X
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable		Power Derate 1		Soft Warning		NOx Control System	

3.5.1 DTC 7 - Lockoff Short to Power (Trouble Tree)



3.6 DTC 16 - Crank and/or Cam Could Not Synchronize During Start



DTC	16	SPN	636	**FMI**	8

Hardware: Crankshaft Position Sensor/Camshaft Position Sensor

Hardware Description:

The crankshaft position sensor is a magnetic sensor (variable reluctant/magnetic pick-up or hall-effect) installed in the engine block adjacent to a “coded” trigger wheel located on the crankshaft. The sensor-trigger wheel combination is used to determine crankshaft position (with respect to TDC cylinder #1 compression) and the rotational engine speed. Determination of the crankshaft position and speed is necessary to properly activate the ignition, fuel injection, and throttle governing systems for precise engine control.

The camshaft position sensor is a magnetic sensor (variable reluctant/magnetic pick-up or hall-effect) installed in the engine block or valve train adjacent to a “coded” trigger wheel located on or off of the camshaft. The sensor-trigger wheel combination is used to determine cam position (with respect to TDC cylinder #1 compression). Determination of the camshaft position is necessary to identify the stroke (or cycle) of the engine to properly activate the fuel injection system and ignition (for coil-on-plug engines) for precise engine control.

Fault Enabled in Calibration?	**YES**		
Emissions-related Fault?	**YES**		
Check Condition:	Engine Cranking or Running		
Fault Set Conditions (as defined in calibration):			
• Cranking revs without sync >4		4.0	revs
• RPM>90		90	rpm

continued from previous page)

Possible Causes:

The ECM must see a valid crankshaft position and camshaft position (if applicable) signal properly aligned during cranking before it can synchronize the injection and ignition systems to initiate starting. If engine speed > x RPM and the crank and/or cam (if applicable) cannot synchronize within y cranking revs (NOTE: x and y defined in application-specific calibration), this fault will set.

Typically, conditions triggering this fault will result in an engine that will not start or run.

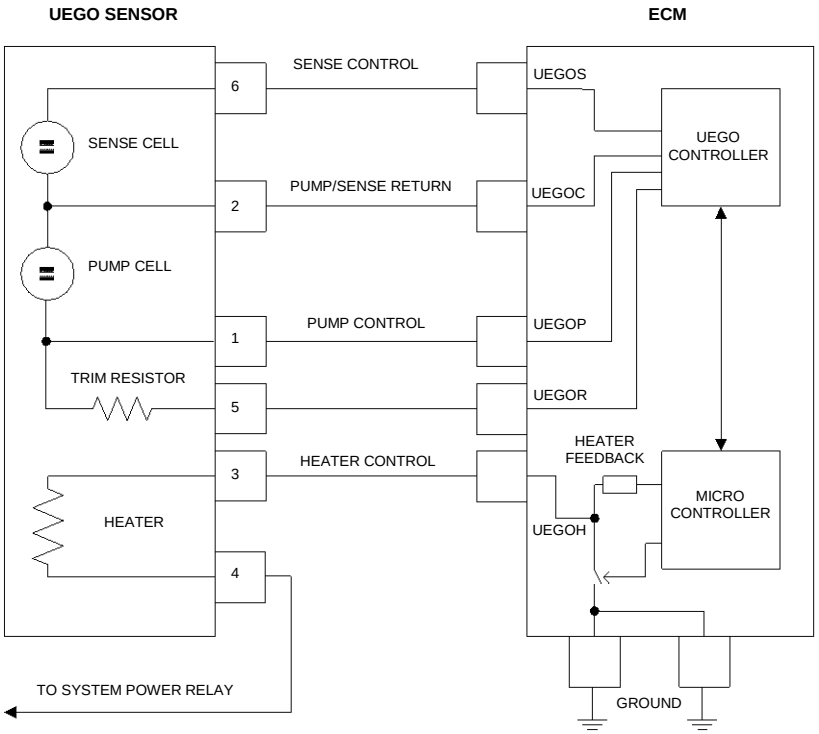
Corrective Actions:

Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	
Never Forget		AL Disable		Low Rev Limit		MIL Persist Disable	
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable		Power Derate 1		Soft Warning		NOx Control System	

Diagnostic Aids

- ☐ Check that crankshaft and/or camshaft position sensor(s) is/are securely connected to harness
- ☐ Check that crankshaft and/or camshaft position sensor(s) is/are securely installed into engine block
- ☐ Check crankshaft and/or camshaft position sensor(s) circuit(s) wiring for open circuit

3.7 DTC 31 – HEGO/UEGO Heater Open / Ground Short



DTC	31, 3031	SPN	3222	FMI	4

Sensor/Circuit: Universal Exhaust Gas Oxygen Sensor

Sensor Description:

A HEGO/UEGO sensor measures the exhaust content across a wide-range of air-fuel ratios with a linear output proportional to lambda/equivalence ratio/air-fuel ratio. Internal to the ECM there is an application specific integrated circuit/controller that controls the sensor. The HEGO/UEGO controller communicates internally within the ECM to the main microcontroller. The HEGO/UEGO controller must always be functioning and communicating with the main microcontroller for proper emissions control.

The ECM examines the sensors in order (1-4). The first pre-catalyst sensor found will be associated with Bank 1. The second pre-catalyst sensor will be associated with Bank 2 or will be used for averaging. The first post-catalyst sensor will be associated with Bank 1. The second post-catalyst sensor will be associated with Bank 2.

Check Condition:	Engine Running	
Fault Set Conditions (as defined in calibration):		
• Voltage feedback from the HEGO/UEGO sensor heater is always equal to ground voltage.		
• EGOH1 low-side feedback <	5%	Vbat
	0.5	Seconds

(continued from previous page)

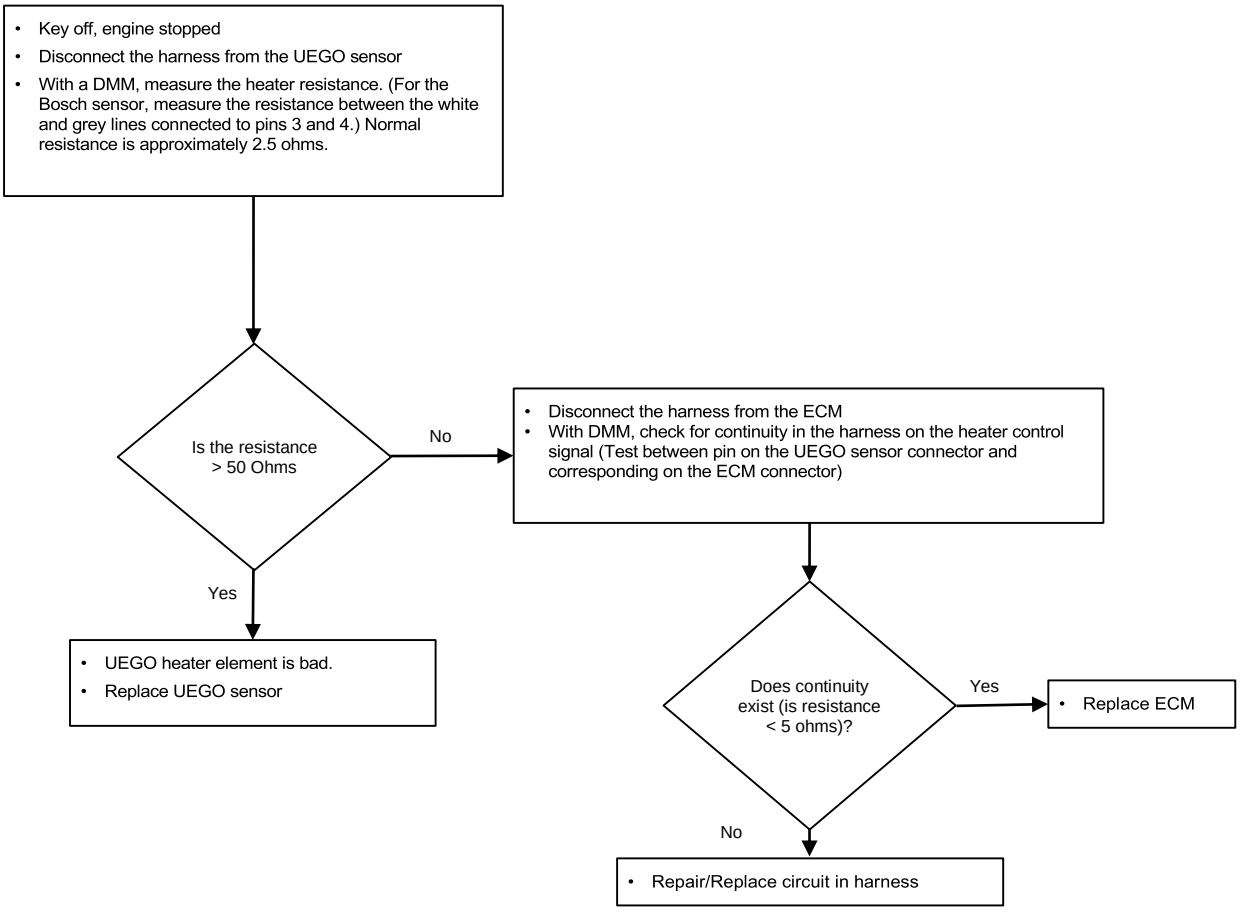
Fault Description:

This fault will set when the HEGO/UEGO heater control signal does not achieve Vbattery when the heater is switched off. This may be caused by a bad heater element in the HEGO/UEGO sensor, a break in the wire harness on the heater supply or control circuits, or fault within the ECM.

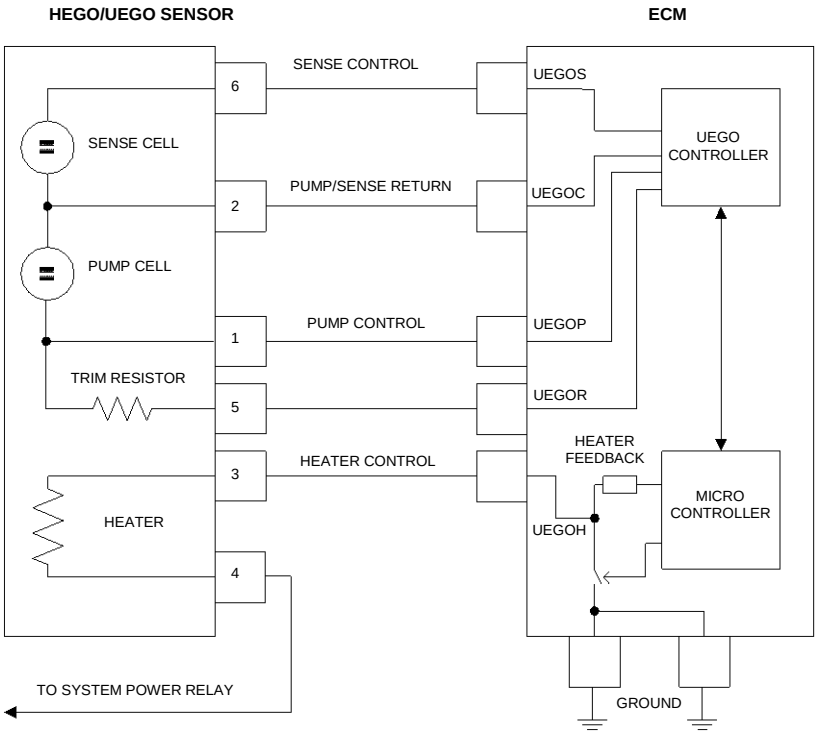
Corrective Actions:

HEGO/ UEGO#	Shutdown	Never Forget	Turn On MIL	CL Disable	CL Disable - key-cyc	AL Disable	AL Disable - key-cyc	Power Derate 1	Power Derate 2	Low Rev Limit	Force Idle	Soft Warning	Hard Warning	MIL Persist Disable	Stopped Check	NOx Control System
1	☐	☐	X	X	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

3.7.1 DTC 31 – HEGO/Uego Heater Open / Ground Short (Trouble Tree)



3.8 DTC 32 – HEGO/UEGO Heater Short to Power



DTC	32, 3032	SPN	3222	FMI	3

Sensor/Circuit: Universal Exhaust Gas Oxygen Sensor

Sensor Description:

A HEGO/UEGO sensor measures the exhaust content across a wide-range of air-fuel ratios with a linear output proportional to lambda/equivalence ratio/air-fuel ratio. Internal to the ECM there is an application specific integrated circuit/controller that controls the sensor. The HEGO/UEGO controller communicates internally within the ECM to the main microcontroller. The HEGO/UEGO controller must always be functioning and communicating with the main microcontroller for proper emissions control.

The ECM examines the sensors in order (1-4). The first pre-catalyst sensor found will be associated with Bank 1. The second pre-catalyst sensor will be associated with Bank 2 or will be used for averaging. The first post-catalyst sensor will be associated with Bank 1. The second post-catalyst sensor will be associated with Bank 2.

Check Condition:	Engine Running	
Fault Set Conditions (as defined in calibration):		
• Voltage feedback from the HEGO/UEGO sensor heater is always equal to the battery or supply voltage (short to Vbattery.)		
• EGOH1 low-side feedback >	90%	Vbat
	0.5	Seconds

(continued from previous page)

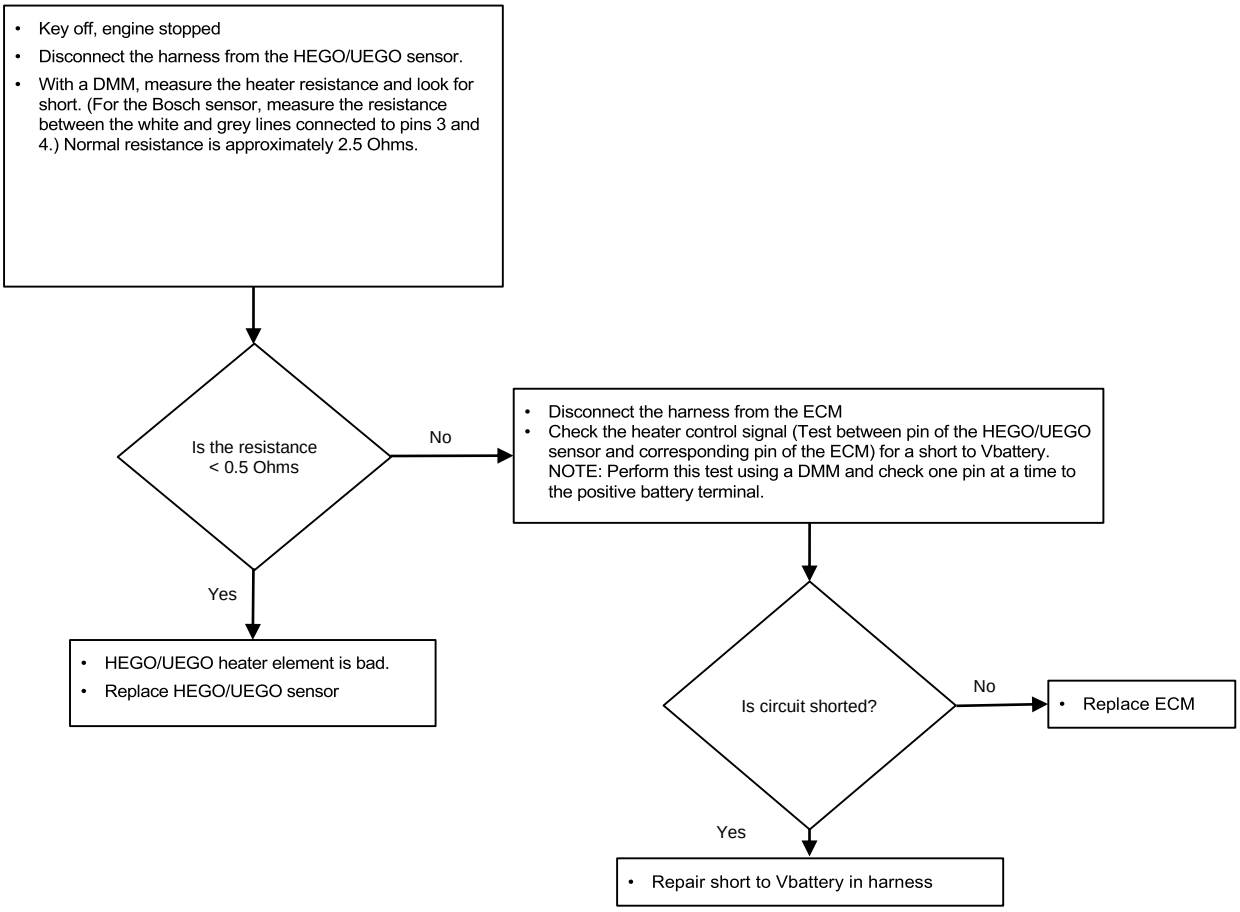
Fault Description:

This fault will set when the HEGO/UEGO heater control signal does not achieve zero volts when the heater is switched on. This may be caused by an internal fault within the ECM.

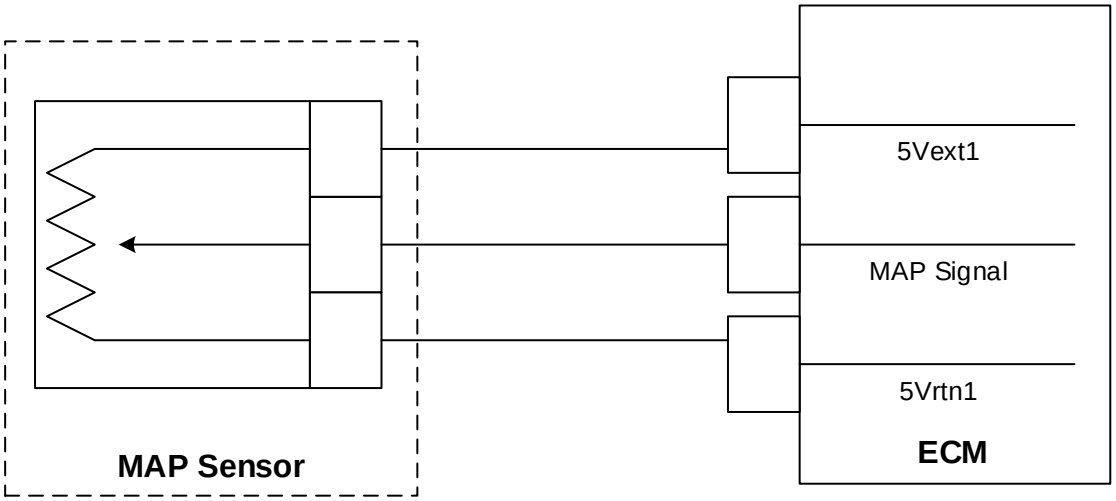
Corrective Actions:

HEGO/ UEGO#	Shutdown	Never Forget	Turn On MIL	CL Disable	CL Disable - key-cyc	AL Disable	AL Disable - key-cyc	Power Derate 1	Power Derate 2	Low Rev Limit	Force Idle	Soft Warning	Hard Warning	MIL Persist Disable	Stopped Check	NOx Control System
1	☐	☐	X	X	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

3.8.1 DTC 32 – HEGO/Uego Heater Short to Power (Trouble Tree)



3.9 DTC 107 - MAP Low Voltage



DTC	107	SPN	106	FMI	4

Hardware: Manifold Absolute Pressure Sensor

Hardware Description:

The Manifold Absolute Pressure sensor is a pressure transducer connected to the intake manifold. It is used to measure the pressure of air in the manifold prior to induction into the engine. The pressure reading is used in conjunction with other inputs to determine the rate of airflow to the engine, which thereby determines the required fuel flow rate.

Fault Enabled in Calibration?	**YES**
Emissions-related Fault?	**YES**
Check Condition:	Engine Cranking or Running

Fault Set Conditions (as defined in calibration):

• MAP voltage <	0.050	volts
• and TPS >	2.0	%
• and RPM <	4000	rpm
• to unlatch, MAP voltage must be >	0.500	volts

Possible Causes:

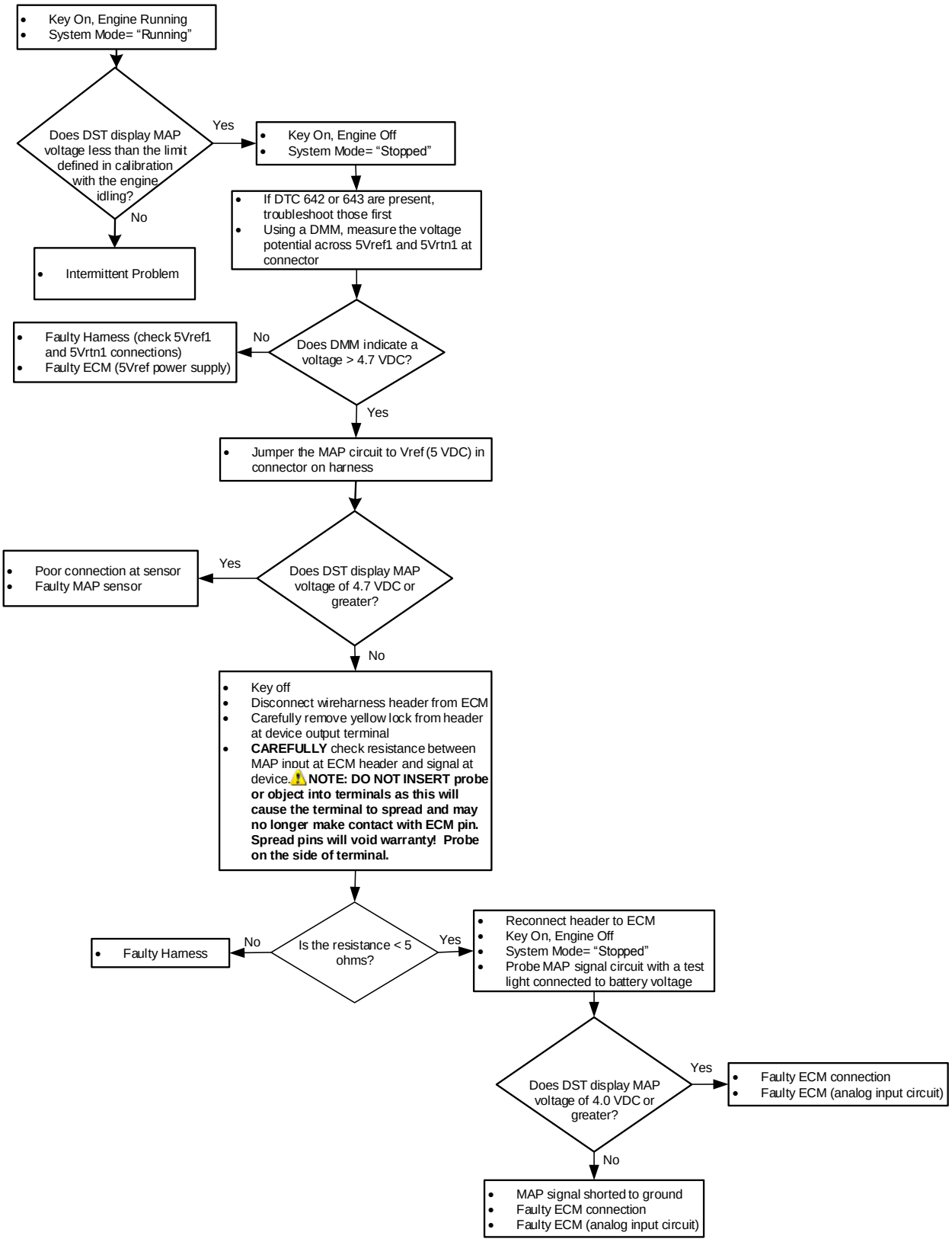
This fault will set when the MAP sensor voltage feedback is sensed as lower than what the sensor should normally produce as set in the diagnostic calibration. The limit is generally set at 0.10 VDC. In many cases, this condition is caused by the MAP sensor being disconnected from the engine harness, an open-circuit or short-to-ground of the MAP circuit in the wire harness, a loss of sensor reference voltage, or a failure of the sensor. When this fault occurs, the ECM operates in a limp home mode in which an estimated MAP based on TPS feedback is used to fuel the engine.

If the MAP sensor is integrated in a TMAP sensor and an IAT High Voltage fault (DTC 113) is also present, the sensor is likely disconnected from the wire harness.

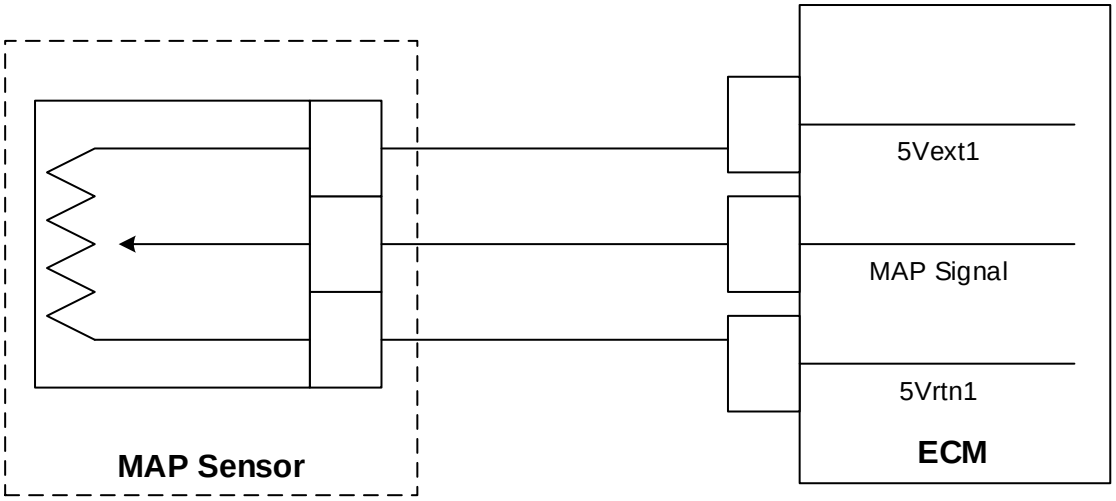
Corrective Actions:

Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	
Never Forget		AL Disable	X	Low Rev Limit		MIL Persist Disable	X
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable		Power Derate 1		Soft Warning		NOx Control System	

3.9.1 DTC 107 - MAP Low Voltage (Trouble Tree)



3.10 DTC 108 - MAP High Pressure



DTC	108	SPN	106	FMI	16

Hardware: Manifold Absolute Pressure Sensor

Hardware Description:

The Manifold Absolute Pressure sensor is a pressure transducer connected to the intake manifold. It is used to measure the pressure of air in the manifold prior to induction into the engine. The pressure reading is used in conjunction with other inputs to determine the rate of airflow to the engine, which thereby determines the required fuel flow rate.

Fault Enabled in Calibration?	**YES**
Emissions-related Fault?	**YES**
Check Condition:	Engine Cranking or Running

Fault Set Conditions (as defined in calibration):

• MAP pressure >	16.00	psia
• and TPS <	10.0	%
• and RPM >	1000	rpm
• to unlatch, MAP pressure must be <	10.00	psia

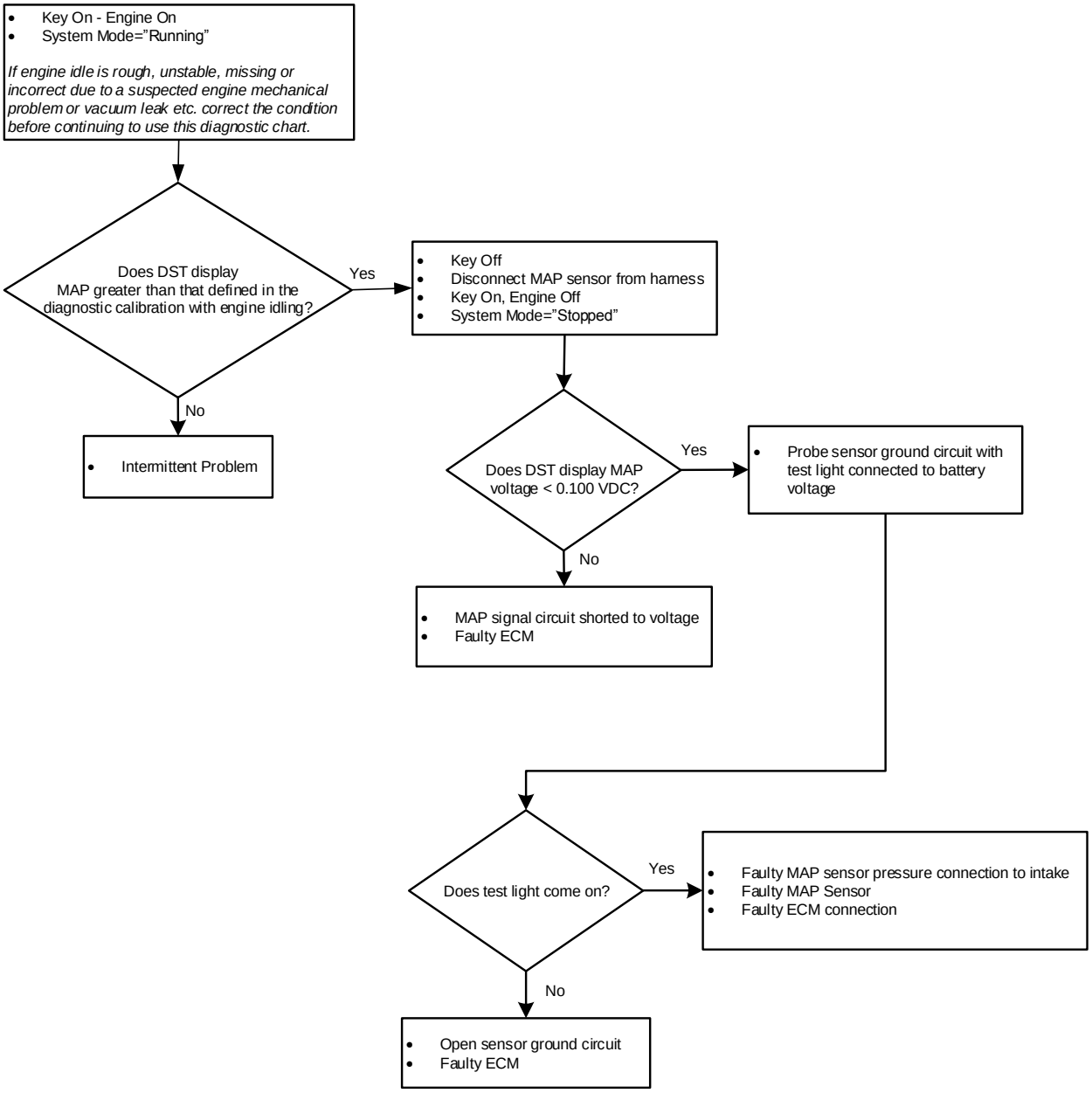
Possible Causes:

This fault will set when the MAP reading is higher than it should be for the given TPS, and RPM. When the fault is set the engine will typically operate in a limp home mode using an estimated MAP based on TPS feedback.

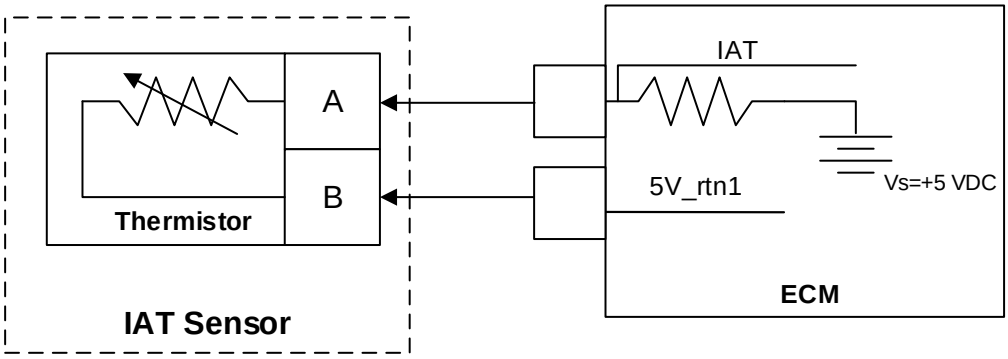
Corrective Actions:

Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	
Never Forget		AL Disable	X	Low Rev Limit		MIL Persist Disable	X
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable		Power Derate 1		Soft Warning		NOx Control System	

3.10.1 DTC 108 - MAP High Pressure (Trouble Tree)



3.11 DTC 111 - IAT Higher Than Expected Stage 1



DTC	111	SPN	105	FMI	15

Hardware: Intake Air Temperature Sensor

Hardware Description:

The Intake Air Temperature sensor is a thermistor (temperature sensitive resistor) located in the intake manifold of the engine. It is used to monitor incoming air and the output, in conjunction with other sensors, is used to determine the airflow to the engine. The ECM provides a voltage divider circuit so that when the air is cool, the signal reads higher voltage, and lower when warm.

The Manifold Air Temperature is a calculated value based mainly on the IAT sensor at high airflow and influenced more by the ECT/CHT at low airflow. It is used to monitor incoming air and the output, in conjunction with other sensors, is used to determine the airflow to the engine, and ignition timing.

Fault Enabled in Calibration?	**YES**
Emissions-related Fault?	**NO**
Check Condition:	Engine Running

Fault Set Conditions (as defined in calibration):

• run-time wait for all IAT HiExp faults:	20.0	seconds
• IAT >	175	deg F
• and RPM >	900	rpm

Possible Causes:

This fault will set if the Intake Air Temperature is greater than the stage 1 limit and the operating condition is at a speed greater than defined in the diagnostic calibration.

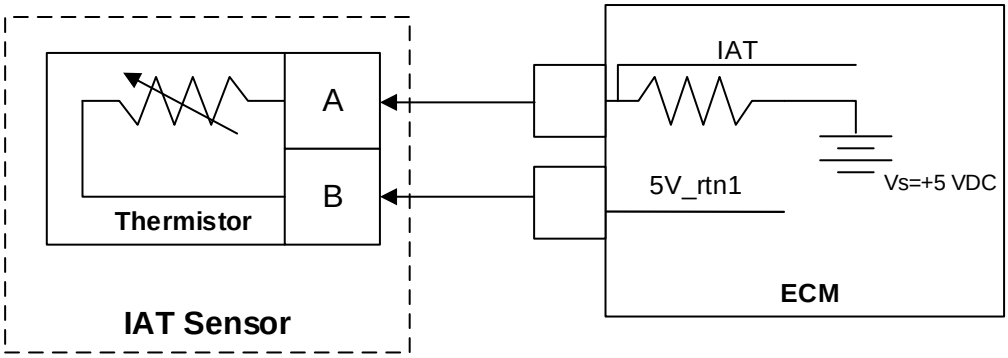
Corrective Actions:

Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	
Never Forget		AL Disable	X	Low Rev Limit		MIL Persist Disable	X
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable		Power Derate 1		Soft Warning		NOx Control System	

Diagnostic Aids

- ☐ This fault will set when inlet air is hotter than normal. The most common cause of high inlet air temperature is a result of a problem with routing of the inlet air. Ensure inlet plumbing sources are external, is cool, and is not too close to the exhaust at any point.
- ☐ Inspect the inlet air system for cracks or breaks that may allow unwanted air to enter the engine.
- ☐ If no problem is found, replace the IAT sensor with a known good part and retest.

3.12 DTC 112 - IAT Low Voltage



DTC	112	SPN	105	FMI	4

Hardware: Intake Air Temperature Sensor

Hardware Description:

The Intake Air Temperature sensor is a thermistor (temperature sensitive resistor) located in the intake manifold of the engine. It is used to monitor incoming air and the output, in conjunction with other sensors, is used to determine the airflow to the engine. The ECM provides a voltage divider circuit so that when the air is cool, the signal reads higher voltage, and lower when warm.

The Manifold Air Temperature is a calculated value based mainly on the IAT sensor at high airflow and influenced more by the ECT/CHT at low airflow. It is used to monitor incoming air and the output, in conjunction with other sensors, is used to determine the airflow to the engine, and ignition timing.

Fault Enabled in Calibration?	**YES**
Emissions-related Fault?	**NO**
Check Condition:	Engine Running

Fault Set Conditions (as defined in calibration):

• IAT voltage <	0.050	volts

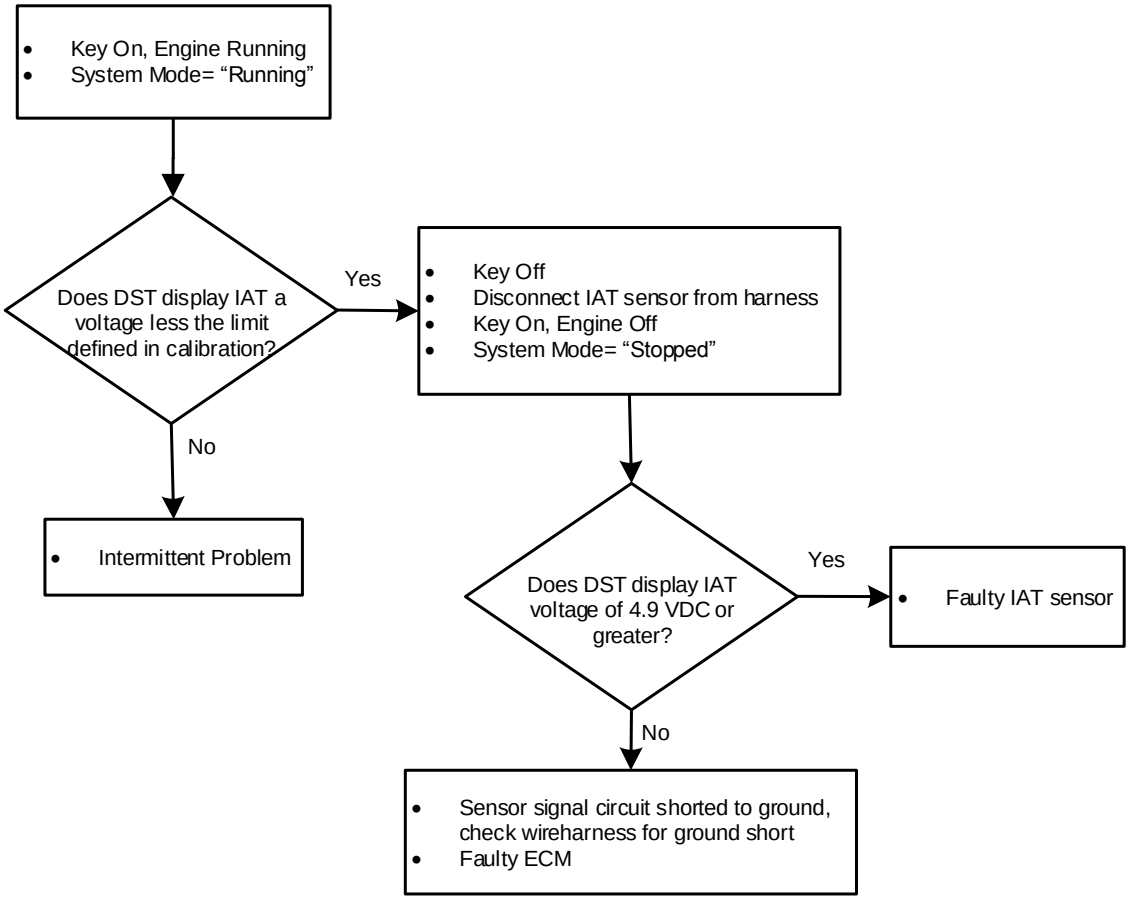
Possible Causes:

This fault will set if the signal voltage is less than the low voltage limit as defined in the diagnostic calibration anytime the engine is running. The limit is generally set to 0.100 VDC. The ECM will use a default value for the IAT sensor in the event of this fault.

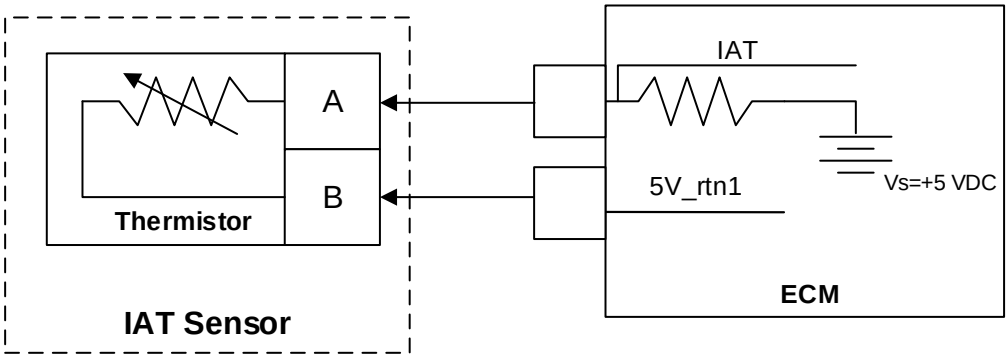
Corrective Actions:

Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	
Never Forget		AL Disable	X	Low Rev Limit		MIL Persist Disable	X
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable		Power Derate 1		Soft Warning		NOx Control System	

3.12.1 DTC 112 - IAT Low Voltage (Trouble Tree)



3.13 DTC 113 - IAT High Voltage



DTC	113	SPN	105	FMI	3

Hardware: Intake Air Temperature Sensor

Hardware Description:

The Intake Air Temperature sensor is a thermistor (temperature sensitive resistor) located in the intake manifold of the engine. It is used to monitor incoming air and the output, in conjunction with other sensors, is used to determine the airflow to the engine. The ECM provides a voltage divider circuit so that when the air is cool, the signal reads higher voltage, and lower when warm.

The Manifold Air Temperature is a calculated value based mainly on the IAT sensor at high airflow and influenced more by the ECT/CHT at low airflow. It is used to monitor incoming air and the output, in conjunction with other sensors, is used to determine the airflow to the engine, and ignition timing.

Fault Enabled in Calibration?	**YES**
Emissions-related Fault?	**NO**
Check Condition:	Engine Running

Fault Set Conditions (as defined in calibration):

• IAT voltage >	4.950	volts

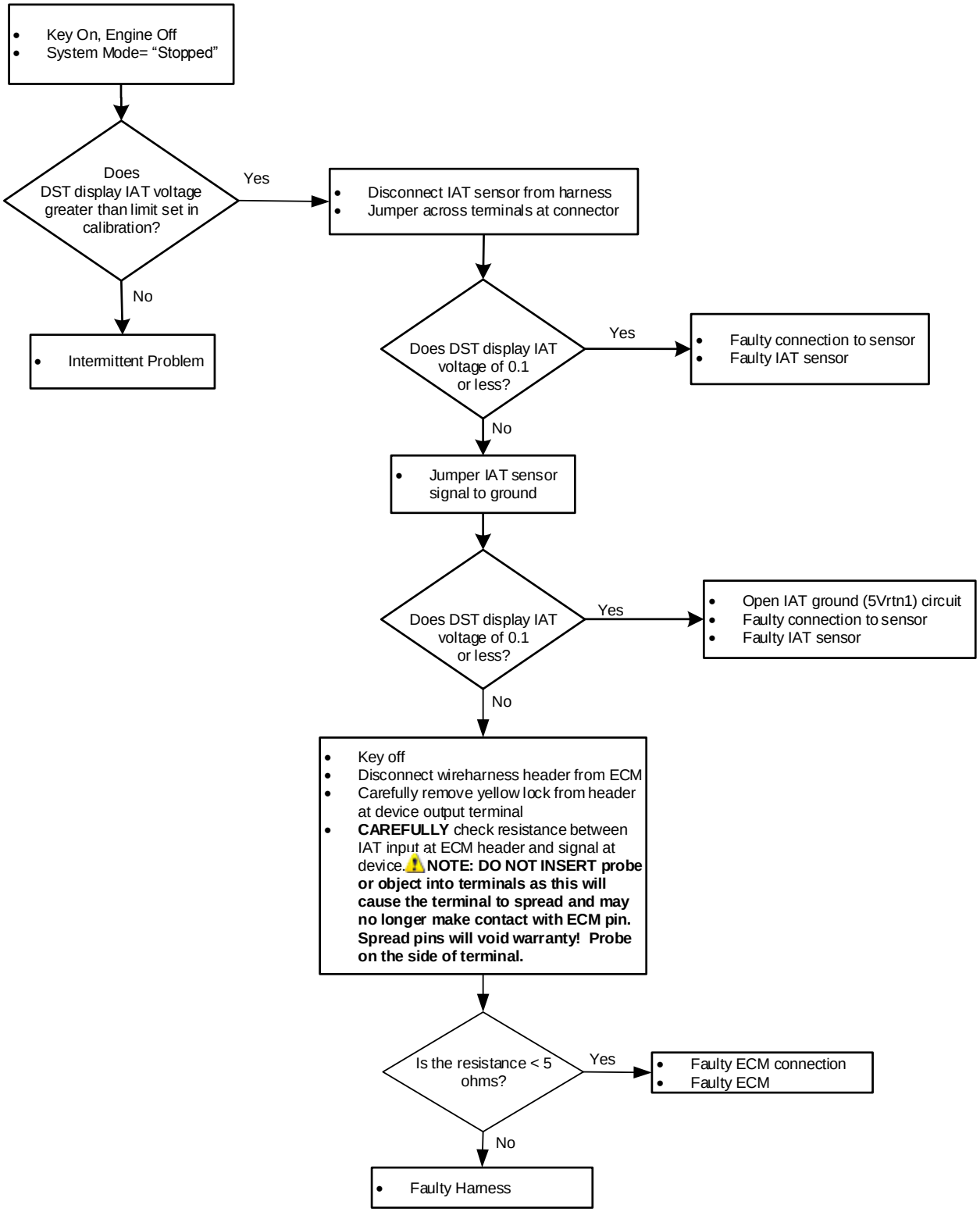
Possible Causes:

This fault will set if the signal voltage is higher than the high voltage limit as defined in the diagnostic calibration anytime the engine is running. The limit is generally set to 4.90 VDC. In many cases, this condition is caused by the IAT sensor being disconnected from the engine harness, an open-circuit or short-to-power of the IAT circuit in the wire harness, or a failure of the sensor. The ECM will use a default value for the IAT sensor in the event of this fault.

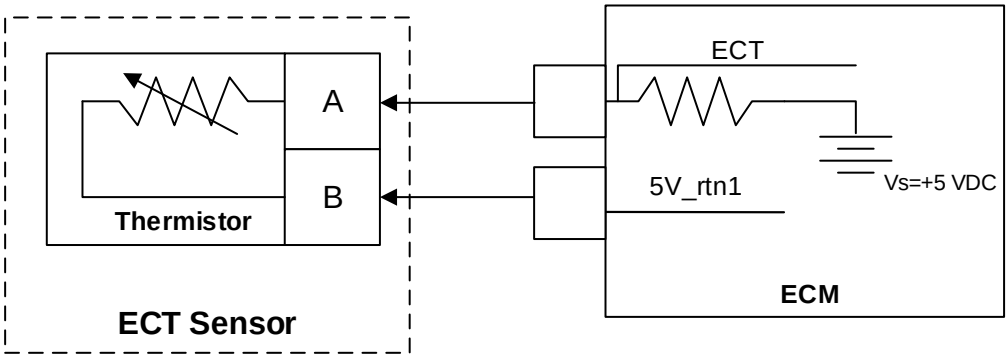
Corrective Actions:

Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	
Never Forget		AL Disable	X	Low Rev Limit		MIL Persist Disable	X
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable		Power Derate 1		Soft Warning		NOx Control System	

3.13.1 DTC 113 - IAT High Voltage (Trouble Tree)



3.14 DTC 116 - ECT Higher Than Expected (Stage 1)



DTC	116	SPN	110	FMI	15

Hardware: Engine Coolant Temperature Sensor

Hardware Description:

The Engine Coolant Temperature sensor is a thermistor (temperature sensitive resistor) located in the engine coolant. Some engines use a CHT sensor that is located in the coolant in the cylinder head. Some engines use an ECT (Engine Coolant Temperature) sensor that is located in the coolant near the thermostat. If the engine is equipped with a CHT sensor then the ECT value is estimated. If equipped with an ECT sensor then the CHT value is estimated. They are used for engine airflow calculation, ignition timing control, to enable certain features, and for engine protection.

The ECM provides a voltage divider circuit so when the sensor reading is cool the sensor reads higher voltage, and lower when warm.

Fault Enabled in Calibration?	**YES**
Emissions-related Fault?	**NO**
Check Condition:	Engine Running

Fault Set Conditions (as defined in calibration):

• ECT >	230	deg F
• and RPM >	1000	rpm
• and run-time >	15.0	seconds

Possible Causes:

When the coolant exceeds x deg. F and engine RPM exceeds y RPM for the latch time this fault will set, in order to help protect the engine in the event of over temperature.

Corrective Actions:

Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	X
Never Forget		AL Disable		Low Rev Limit		MIL Persist Disable	
Turn on MIL		AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable		Power Derate 1		Soft Warning	X	NOx Control System	

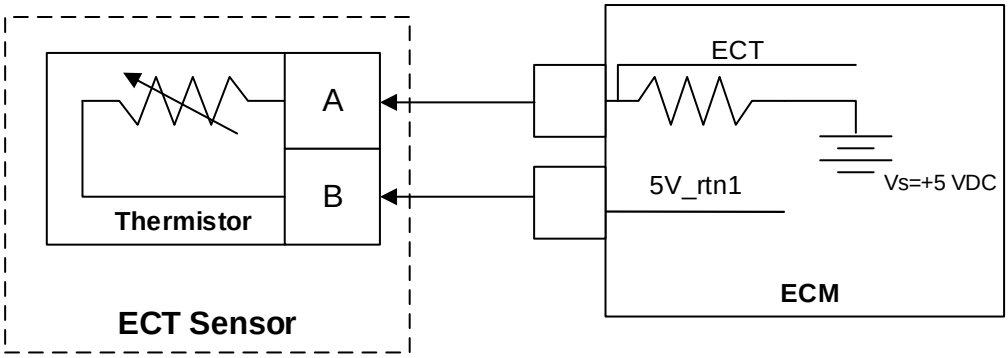
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Diagnostic Aids

- ☐ If the "ECT High Voltage" fault is also present, follow the troubleshooting procedures for that fault as it may have caused "ECT Higher Than Expected 1."
- ☐ If the cooling system utilizes an air-to-water heat exchanger (radiator) and fan:
  - Check that the radiator has a proper amount of ethylene glycol/water and that the radiator is not leaking.
  - Ensure that there is no trapped air in the cooling path.
  - Inspect the cooling system (radiator and hoses) for cracks and ensure connections are leak free.
  - Check that the fan is operating properly.
  - Check that the thermostat is not stuck closed.

- ☐ If the cooling system utilizes a water-to-water heat exchanger:
  - Check that the heat exchanger has a proper amount of ethylene glycol/water and that the heat exchanger is not leaking.
  - Ensure that there is no trapped air in the cooling path.
  - Inspect the cooling system (radiator and hoses) for cracks and ensure connections are leak free.
  - Check that the raw water pickup is not blocked/restricted by debris and that the hose is tightly connected.
  - Check that the thermostat is not stuck closed.
  - Check that the raw water pump/impeller is intact and that it is not restricted.

3.15 DTC 117 - ECT / CHT Low Voltage



DTC	116	SPN	110	FMI	4

Hardware: Engine Coolant Temperature Sensor

Hardware Description:

The Engine Coolant Temperature sensor is a thermistor (temperature sensitive resistor) located in the engine coolant. Some engines use a CHT sensor that is located in the coolant in the cylinder head. Some engines use an ECT (Engine Coolant Temperature) sensor that is located in the coolant near the thermostat. If the engine is equipped with a CHT sensor then the ECT value is estimated. If equipped with an ECT sensor then the CHT value is estimated. They are used for engine airflow calculation, ignition timing control, to enable certain features, and for engine protection.

The ECM provides a voltage divider circuit so when the sensor reading is cool the sensor reads higher voltage, and lower when warm.

Fault Enabled in Calibration?	**YES**
Emissions-related Fault?	**NO**
Check Condition:	Engine Running

Fault Set Conditions (as defined in calibration):

• ECT voltage <	0.050	volts

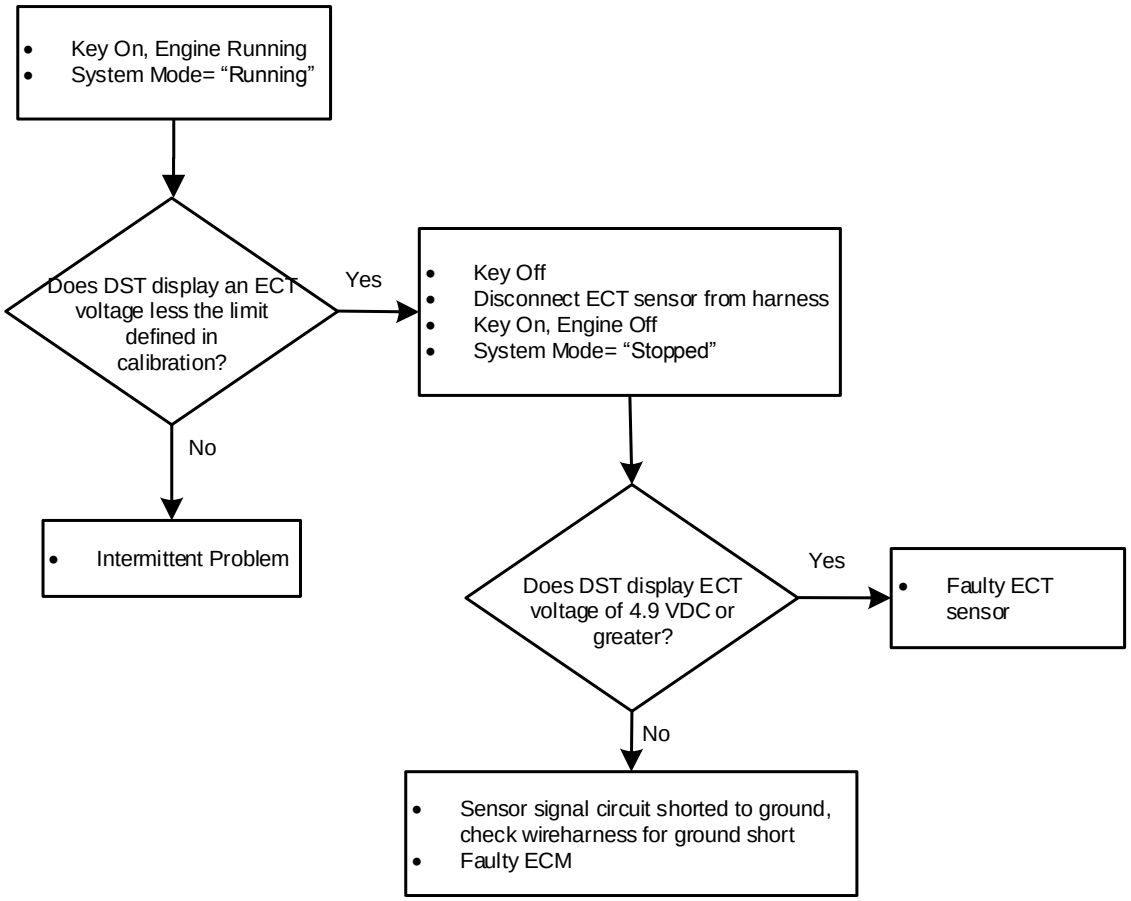
Possible Causes:

This fault will set if the signal voltage is less than the limit defined in the diagnostic calibration anytime the engine is running. The limit is generally set to 0.10 VDC. The ECM will use a default value for the CHT/ECT sensor in the event of this fault.

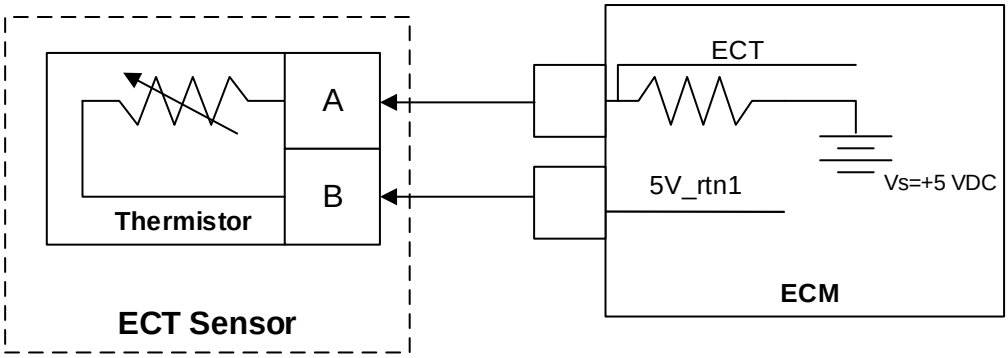
Corrective Actions:

Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	
Never Forget		AL Disable		Low Rev Limit		MIL Persist Disable	
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable		Power Derate 1		Soft Warning		NOx Control System	

3.15.1 DTC 117 - ECT / CHT Low Voltage (Trouble Tree)



3.16 DTC 118 - ECT / CHT High Voltage



DTC	116	SPN	110	FMI	3

Hardware: Engine Coolant Temperature Sensor

Hardware Description:

The Engine Coolant Temperature sensor is a thermistor (temperature sensitive resistor) located in the engine coolant. Some engines use a CHT sensor that is located in the coolant in the cylinder head. Some engines use an ECT (Engine Coolant Temperature) sensor that is located in the coolant near the thermostat. If the engine is equipped with a CHT sensor then the ECT value is estimated. If equipped with an ECT sensor then the CHT value is estimated. They are used for engine airflow calculation, ignition timing control, to enable certain features, and for engine protection.

The ECM provides a voltage divider circuit so when the sensor reading is cool the sensor reads higher voltage, and lower when warm.

Fault Enabled in Calibration?	**YES**
Emissions-related Fault?	**NO**
Check Condition:	Engine Running

Fault Set Conditions (as defined in calibration):

• ECT voltage >	4.950	volts

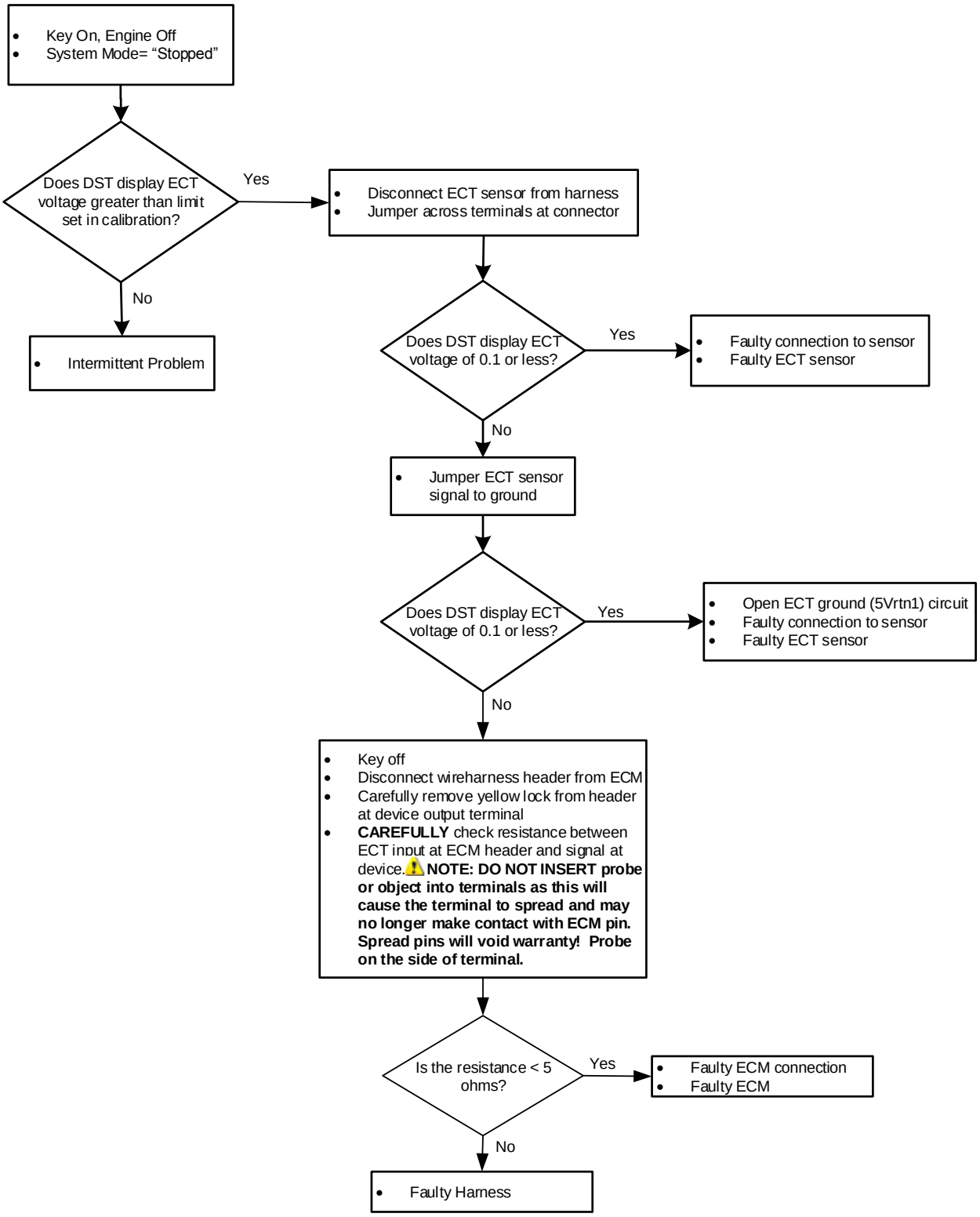
Possible Causes:

This fault will set if the signal voltage is higher than the high voltage limit as defined in the diagnostic calibration anytime the engine is running. The limit is generally set to 4.90 VDC. In many cases, this condition is caused by the CHT/ECT sensor being disconnected from the engine harness, an open-circuit or short-to-power of the CHT/ECT circuit in the wire harness, or a failure of the sensor. The ECM will use a default value for the CHT/ECT sensor in the event of this fault.

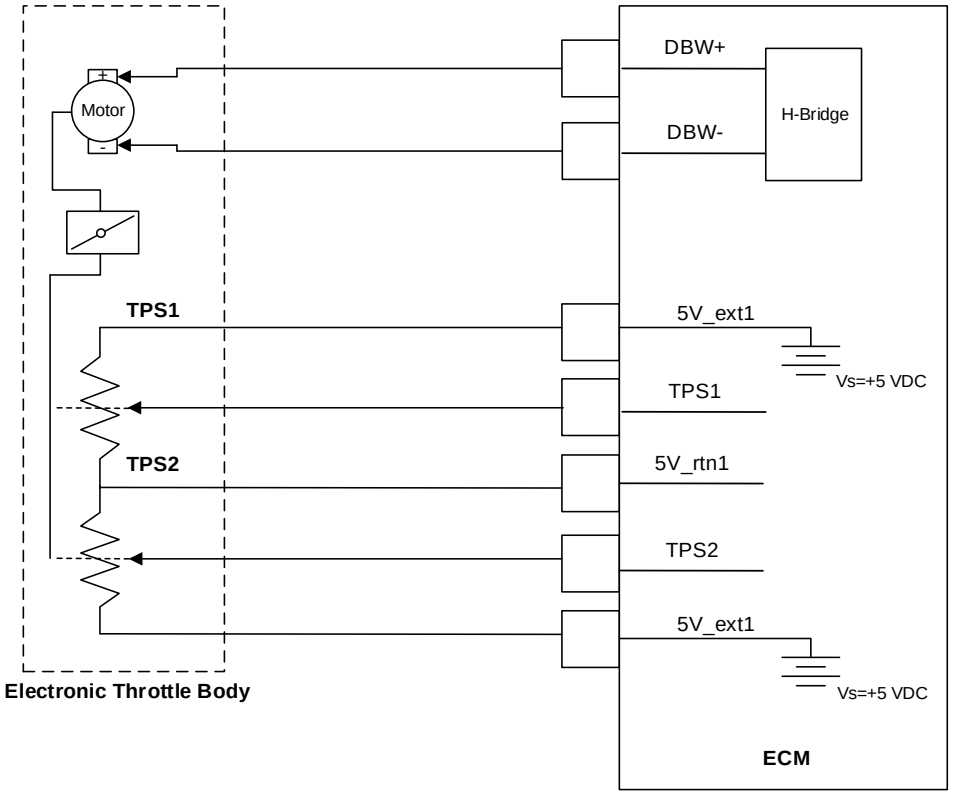
Corrective Actions:

Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	
Never Forget		AL Disable		Low Rev Limit		MIL Persist Disable	
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable		Power Derate 1		Soft Warning		NOx Control System	

3.16.1 DTC 118 - ECT / CHT High Voltage (Trouble Tree)



3.17 DTC 121 – TPS1 % Lower Than TPS2 %



DTC	121	SPN	51	FMI	1
Hardware:	Throttle Body-Throttle Position Sensor 1 & 2 (electronic throttle body only)				

Hardware Description:

The throttle controls the airflow through the engine, directly affecting the power output of the engine. When the throttle is electronically controlled in an Electronic Throttle Body it can be used to control the idle stability and limit engine speed based on operating conditions.

The Throttle Position Sensor uses either 1) a variable resistor and voltage divider circuit or 2) a non-contact hall-effect sensor to determine throttle plate position, and is located within the throttle body. The output of the TPS is linear with angular position. The TPS input(s) provide angular position feedback of the throttle plate. In mechanical throttle bodies this sensor is typically used to help improve return-to-idle governing when working in combination with an Idle Air Control motor. In an Electronic Throttle Body multiple position feedback sensors (usually two counteracting potentiometers/hall-effects) are used to perform speed governing with improved safety and redundancy.

Fault Enabled in Calibration?	**YES**
Emissions-related Fault?	**NO**
Check Condition:	Key-On, Engine Cranking, or Running

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Fault Set Conditions (as defined in calibration):		
• (TPS1% - TPS2%) <	-20.0	%

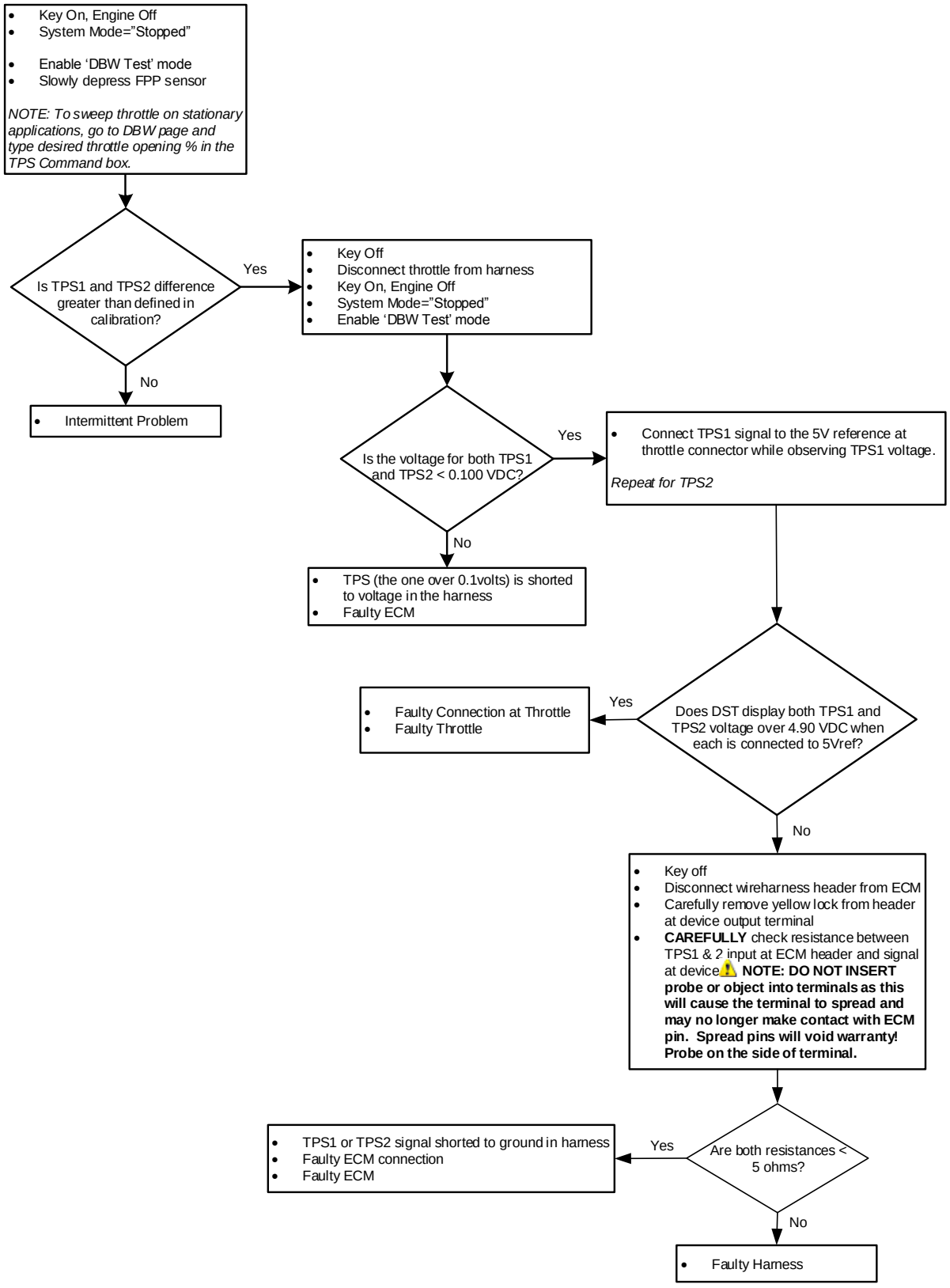
Possible Causes:

This fault will set if TPS1 % is lower than TPS2 % by the amount defined in the diagnostic calibration. At this point the throttle is considered to be out of specification, or there is a problem with the TPS signal circuit.

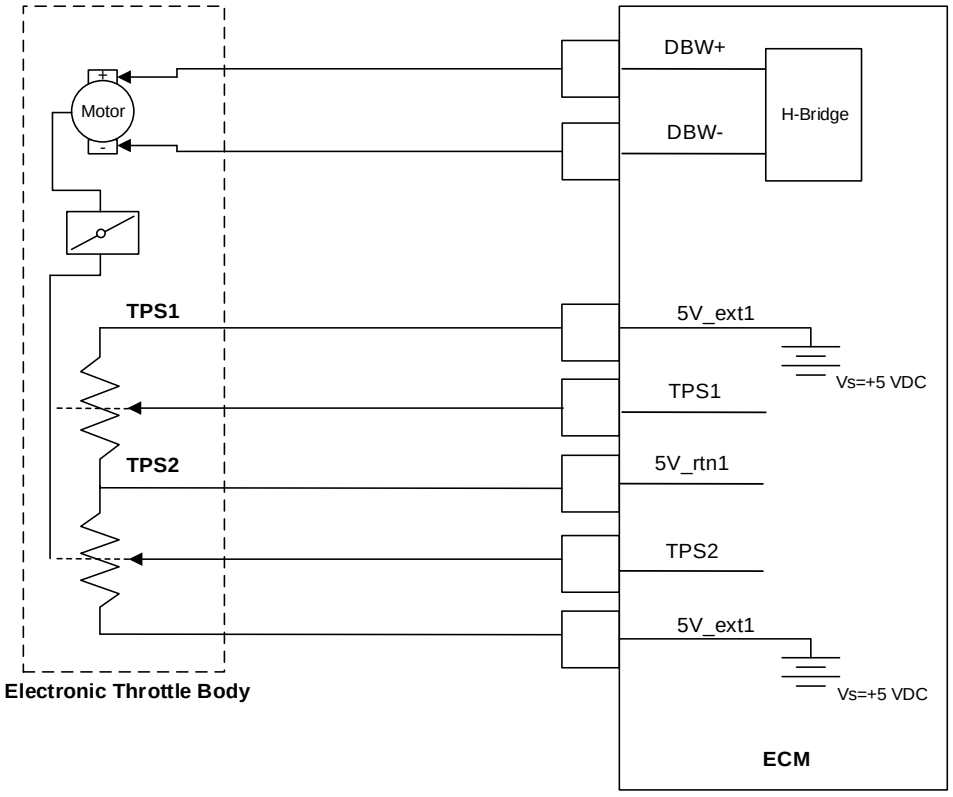
Corrective Actions:

Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	X
Never Forget		AL Disable		Low Rev Limit		MIL Persist Disable	
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable		Power Derate 1		Soft Warning		NOx Control System	

3.17.1 DTC 121 – TPS1 % Lower Than TPS2 % (Trouble Tree)



3.18 DTC 122 - TPS1 Signal Voltage Low



DTC	122	SPN	51	FMI	4
Hardware:	Throttle Body-Throttle Position Sensor 1 & 2 (electronic throttle body only)				

Hardware Description:

The throttle controls the airflow through the engine, directly affecting the power output of the engine. When the throttle is electronically controlled in an Electronic Throttle Body it can be used to control the idle stability and limit engine speed based on operating conditions.

The Throttle Position Sensor uses either 1) a variable resistor and voltage divider circuit or 2) a non-contact hall-effect sensor to determine throttle plate position, and is located within the throttle body. The output of the TPS is linear with angular position. The TPS input(s) provide angular position feedback of the throttle plate. In mechanical throttle bodies this sensor is typically used to help improve return-to-idle governing when working in combination with an Idle Air Control motor. In an Electronic Throttle Body multiple position feedback sensors (usually two counteracting potentiometers/hall-effects) are used to perform speed governing with improved safety and redundancy.

Fault Enabled in Calibration?	**YES**
Emissions-related Fault?	**NO**
Check Condition:	Key On, Engine Off

(continued from previous page)

Fault Set Conditions (as defined in calibration):		
• TPS1 voltage <	0.200	volts

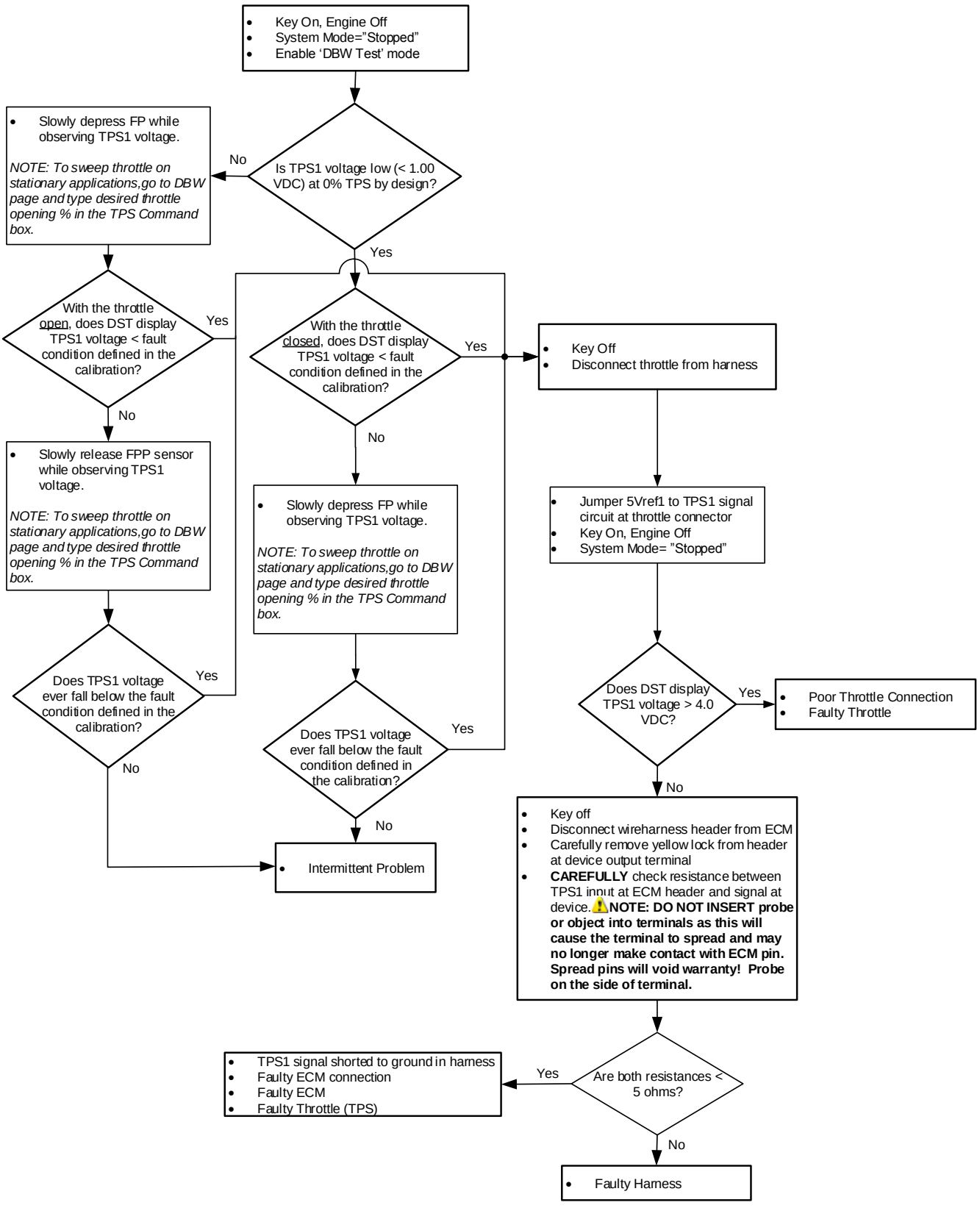
Possible Causes:

This fault will set if TPS1 voltage is lower than the low voltage limit as defined in the diagnostic calibration at any operating condition while the engine is cranking or running. The limit is generally set to 4.90 VDC. In many cases, this condition is caused by the TPS sensor being disconnected from the engine harness, an open-circuit or short-to-ground of the TPS circuit in the wire harness, or a failure of the sensor. This fault should be configured to trigger an engine shutdown and the engine will not start with this fault active.

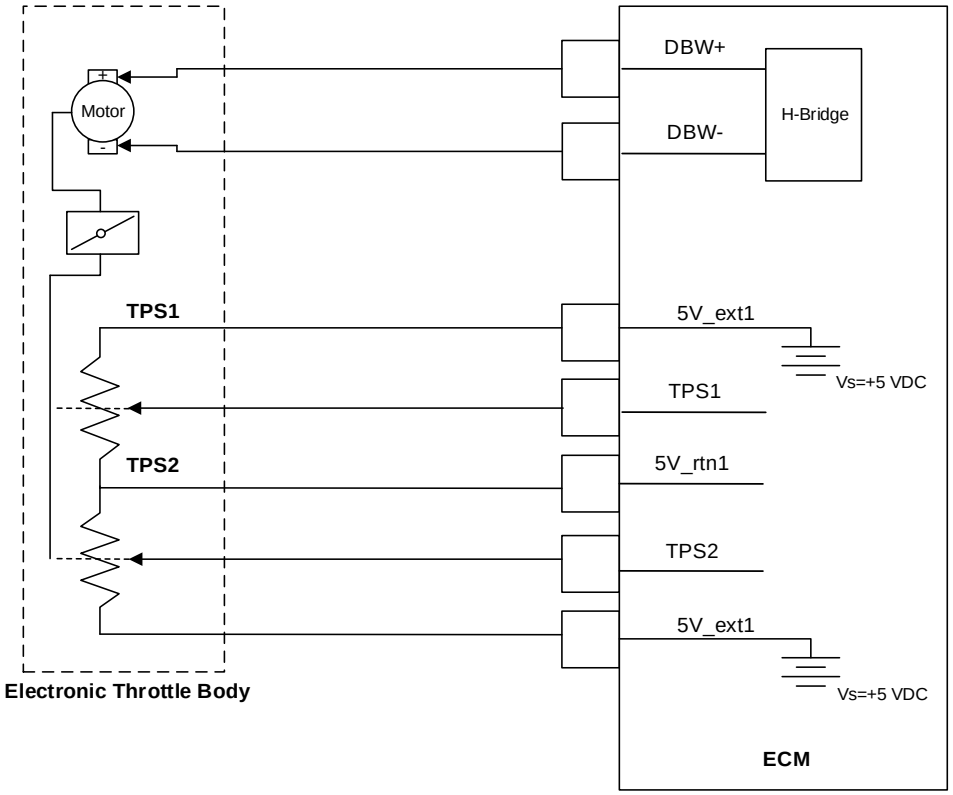
Corrective Actions:

Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	X
Never Forget		AL Disable		Low Rev Limit		MIL Persist Disable	
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable		Power Derate 1		Soft Warning		NOx Control System	

3.18.1 DTC 122 - TPS1 Signal Voltage Low (Trouble Tree)



3.19 DTC 123 - TPS1 Signal Voltage High



DTC	123	SPN	51	FMI	3
Hardware:	Throttle Body-Throttle Position Sensor 1 & 2 (electronic throttle body only)				

Hardware Description:

The throttle controls the airflow through the engine, directly affecting the power output of the engine. When the throttle is electronically controlled in an Electronic Throttle Body it can be used to control the idle stability and limit engine speed based on operating conditions.

The Throttle Position Sensor uses either 1) a variable resistor and voltage divider circuit or 2) a non-contact hall-effect sensor to determine throttle plate position, and is located within the throttle body. The output of the TPS is linear with angular position. The TPS input(s) provide angular position feedback of the throttle plate. In mechanical throttle bodies this sensor is typically used to help improve return-to-idle governing when working in combination with an Idle Air Control motor. In an Electronic Throttle Body multiple position feedback sensors (usually two counteracting potentiometers/hall-effects) are used to perform speed governing with improved safety and redundancy.

Fault Enabled in Calibration?	**YES**
Emissions-related Fault?	**NO**
Check Condition:	Key On, Engine Off

(continued from previous page)

Fault Set Conditions (as defined in calibration):		
• TPS1 voltage >	4.800	volts

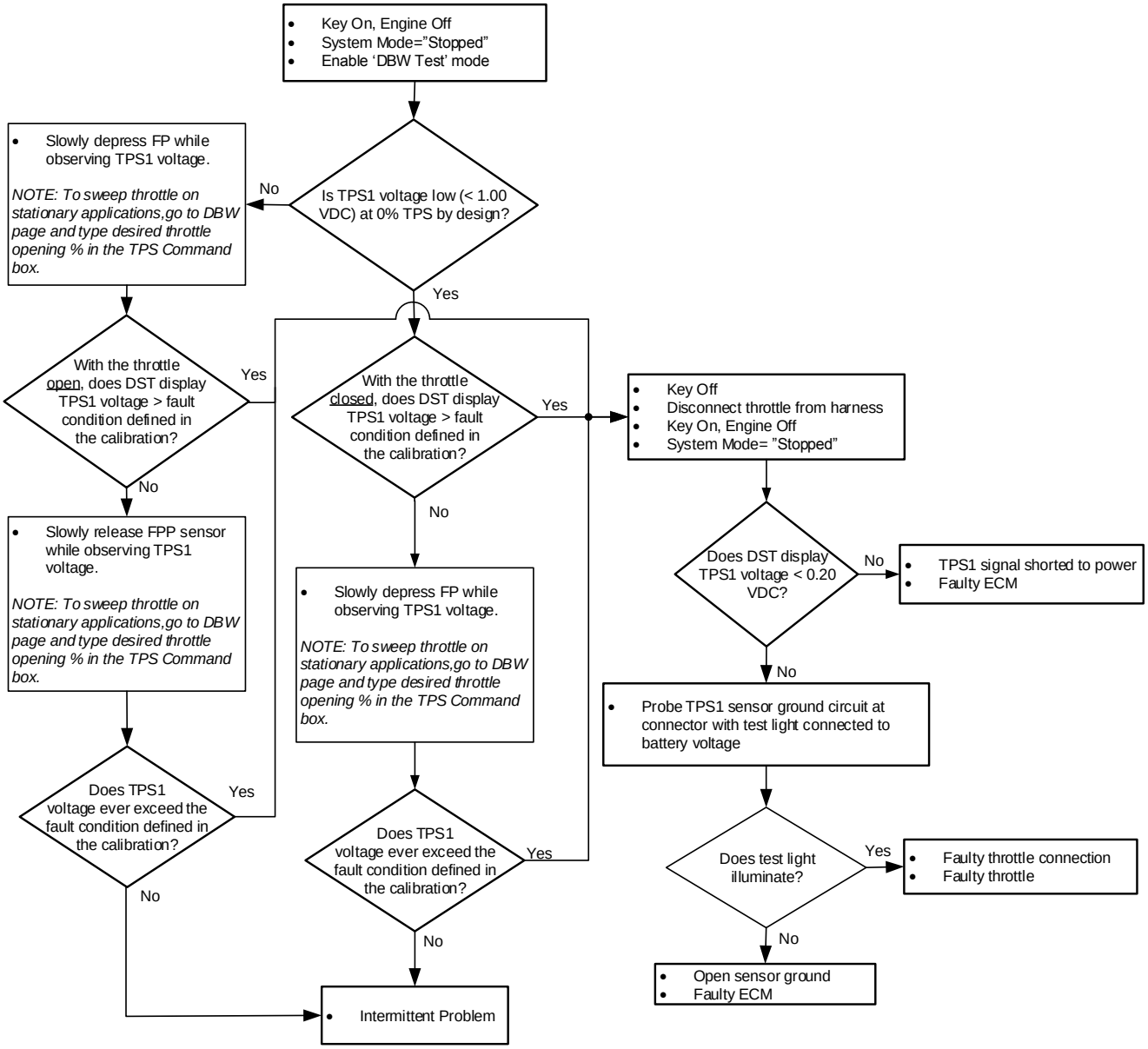
Possible Causes:

This fault will set if TPS1 voltage is higher than the limit set in the diagnostic calibration at any operating condition while the engine is cranking or running. The limit is generally set to 4.90 VDC. In many cases, this condition is caused by a short-to-power of the TPS circuit in the wire harness or a failure of the sensor.

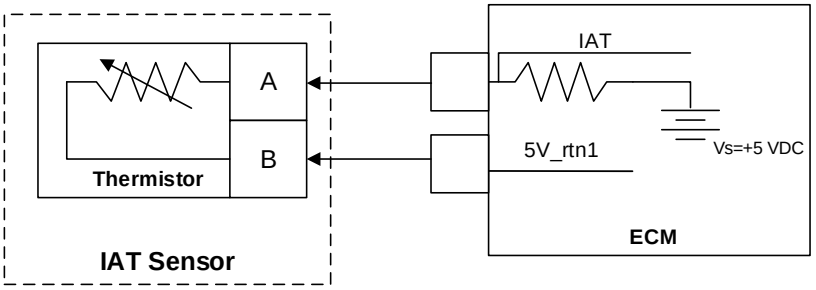
Corrective Actions:

Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	X
Never Forget		AL Disable		Low Rev Limit		MIL Persist Disable	
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable		Power Derate 1		Soft Warning		NOx Control System	

3.19.1 DTC 123 - TPS1 High Voltage (Trouble Tree)



3.20 DTC 127 - IAT Higher Than Expected Stage 2



DTC	127	SPN	105	FMI	0

Hardware: Intake Air Temperature Sensor

Hardware Description:

The Intake Air Temperature sensor is a thermistor (temperature sensitive resistor) located in the intake manifold of the engine. It is used to monitor incoming air and the output, in conjunction with other sensors, is used to determine the airflow to the engine. The ECM provides a voltage divider circuit so that when the air is cool, the signal reads higher voltage, and lower when warm.

The Manifold Air Temperature is a calculated value based mainly on the IAT sensor at high airflow and influenced more by the ECT/CHT at low airflow. It is used to monitor incoming air and the output, in conjunction with other sensors, is used to determine the airflow to the engine, and ignition timing.

Fault Enabled in Calibration?	**YES**
Emissions-related Fault?	**YES**
Check Condition:	Engine Running

Fault Set Conditions (as defined in calibration):

• IAT >	210	deg F
• and RPM >	600	rpm

Possible Causes:

This fault will set if the Intake Air Temperature is greater than the stage 2 limit and engine speed is greater than defined in the diagnostic calibration. Generally, a severe course of action will be set to prevent possible damage to the engine, specifically due to knock or detonation which cannot be sensed on some engines due to the lack of knock sensors. During this active fault, maximum throttle position is limited and a visual/audible warning will be activated.

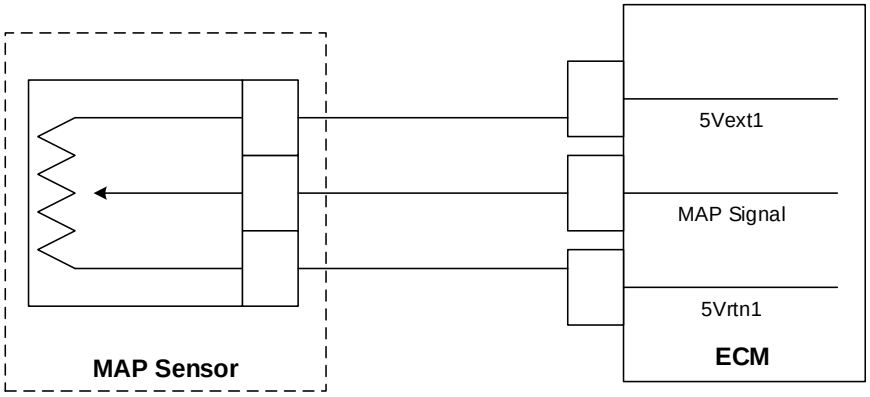
Corrective Actions:

Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	
Never Forget		AL Disable	X	Low Rev Limit		MIL Persist Disable	X
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable		Power Derate 1		Soft Warning		NOx Control System	

Diagnostic Aids

- ☐ This fault will set when inlet air is hotter than normal. The most common cause of high inlet air temperature is a result of a problem with routing of the inlet air. Ensure inlet plumbing sources are external, is cool, and is not too close to the exhaust at any point.
- ☐ Inspect the inlet air system for cracks or breaks that may allow unwanted under-hood air to enter the engine.
- ☐ If no problem is found, replace the IAT sensor with a known good part and retest.

3.21 DTC 129 - BP Low Pressure



DTC	129	SPN	108	FMI	1

Hardware: Barometric Temperature / Manifold Absolute Pressure Sensor

Hardware Description:

Barometric Pressure is estimated from the MAP sensor at key-on and in some calibrations during low speed/high load operation as defined in the engine's calibration. The barometric pressure value is used for fuel and airflow calculations and equivalence ratio targets based on altitude.

Fault Enabled in Calibration?	**YES**
Emissions-related Fault?	**YES**
Check Condition:	Key On, Engine Off or after BP estimate during low-speed/high load operation

Fault Set Conditions (as defined in calibration):

• BP pressure <	8.30	psia

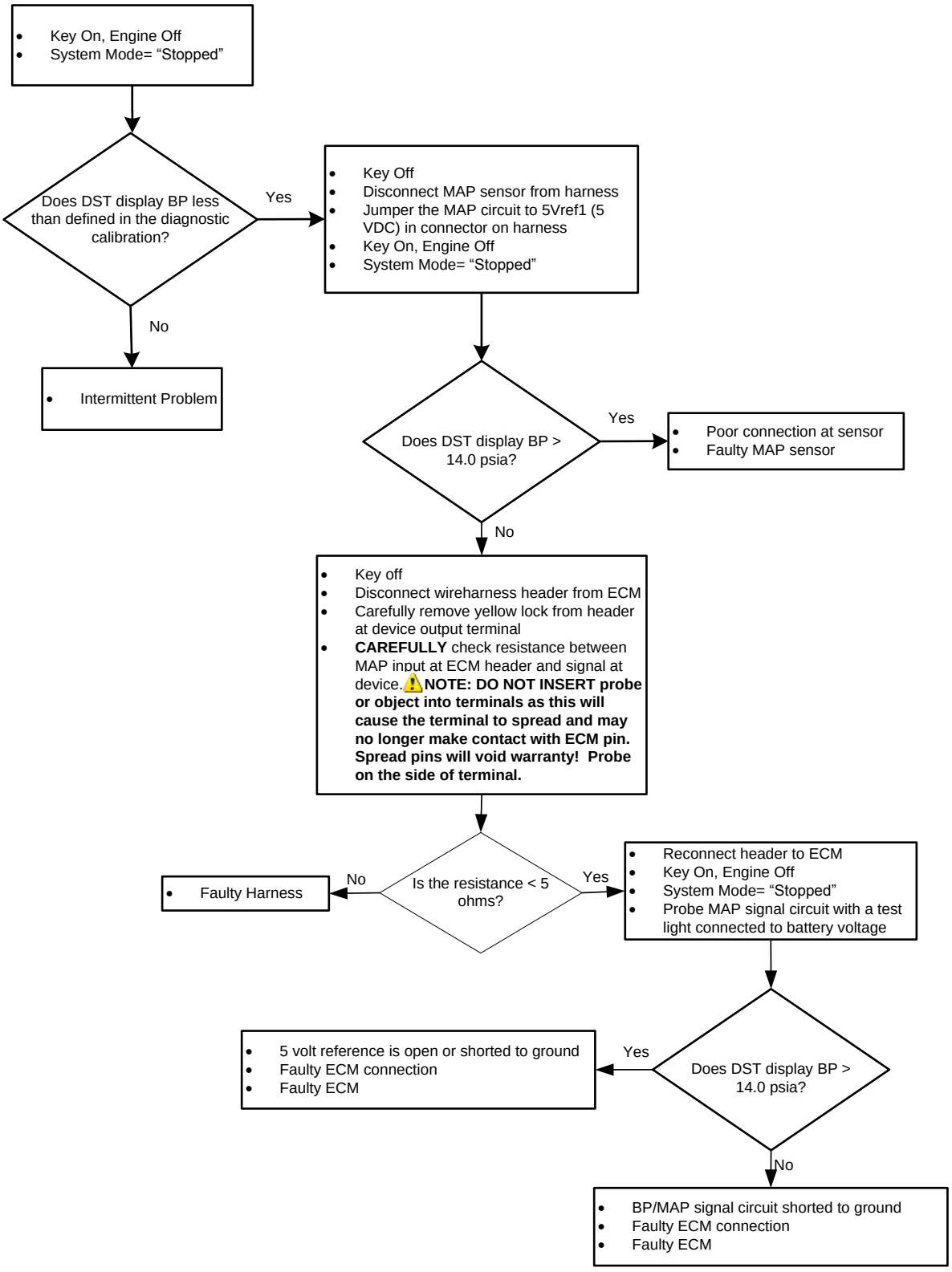
Possible Causes:

This fault sets if the barometric pressure is lower than the minimum set pressure (psia) as defined in the diagnostic calibration. In the event of an active fault, the MIL is illuminated for the remainder of the key on cycle, an audible warding and/or a secondary warning lamp is activated, and the Adaptive Learn function is disabled to prevent improper learning and population of the table.

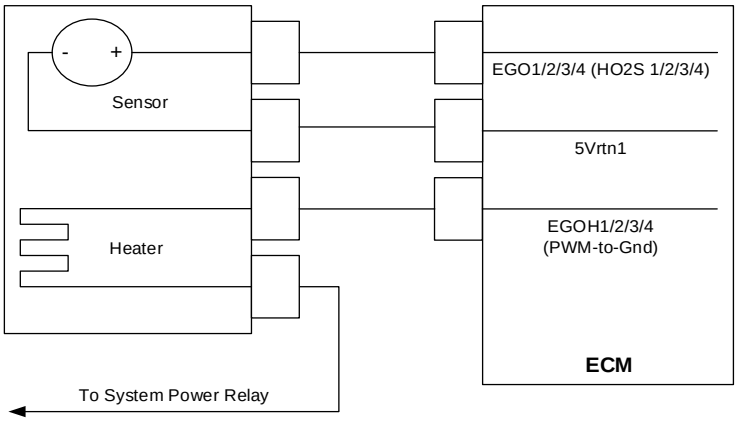
Corrective Actions:

Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	
Never Forget		AL Disable		Low Rev Limit		MIL Persist Disable	
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable		Power Derate 1		Soft Warning		NOx Control System	

3.21.1 DTC 129 - BP Low Pressure (Trouble Tree)



3.22 DTC 134 – EGO1 (HEGO) Open / Lazy (HO2S1)



DTC	134	**SPN**	3217	**FMI**	5

Hardware: Heated or Universal Exhaust Gas Oxygen Sensor (Bank 1-Sensor 1/Bank 1-Before Catalyst)

Hardware Description:

The HEGO/HO2S sensor is a switching-type sensor about stoichiometry that measures the oxygen content present in the exhaust to determine if the fuel flow to the engine is correct. A HEGO/UEGO sensor measures the exhaust content across a wide-range of air-fuel ratios with a linear analog output proportional to lambda/equivalence ratio/air-fuel ratio. In either case, if there is a deviation between the expected reading and the actual reading, fuel flow is precisely adjusted using the Closed Loop multiplier and then "learned" with the Adaptive multiplier. The multipliers only update when the system is in either "CL Active" or "CL + Adapt" control modes.

Fault Enabled in Calibration?	**YES**
Emissions-related Fault?	**YES**
Check Condition:	Engine Running

Fault Set Conditions (as defined in calibration):

• EGO cold persistently >	125.0	seconds

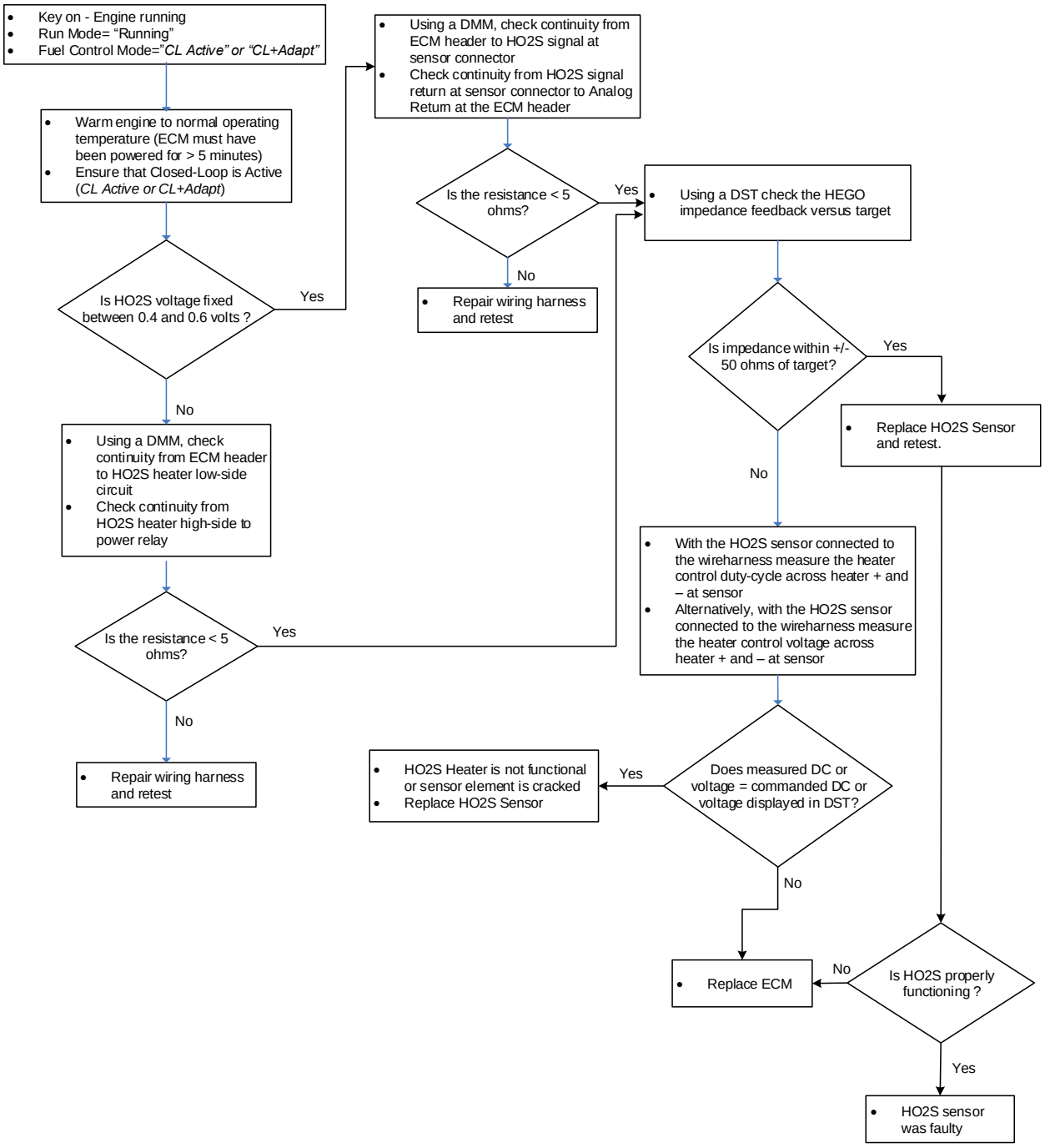
Possible Causes:

This fault will set if the sensor element is cold, non-responsive, or inactive for x seconds as defined in the diagnostic calibration. Cold, non-responsive, or inactive are determined based on two criteria 1) a measurement of the feedback sense element (zirconia) to determine its temperature or 2) a lack of change in sensor feedback.

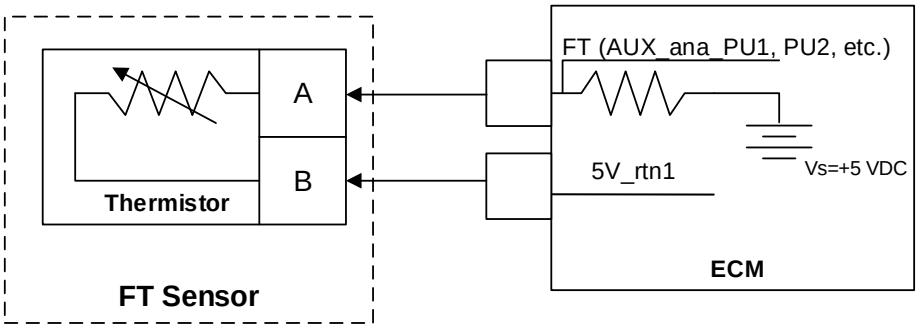
Corrective Actions:

Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	
Never Forget		AL Disable	X	Low Rev Limit		MIL Persist Disable	
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable	X	Power Derate 1		Soft Warning		NOx Control System	

3.22.1 DTC 134 – EGO1 Open / Lazy (HO2S1) (Trouble Tree)



3.23 DTC 187 - FT Gaseous Fuel Extremely Low



DTC	187	SPN	3468	FMI	1

Hardware: Gaseous Fuel Temperature Sensor

Hardware Description:

The Fuel Temperature sensor is a thermistor (temperature sensitive resistor) integrated into the EPR fuel outlet. It is used to monitor the gaseous fuel temperature exiting the EPR to be used as an input in a fuel temperature estimation of the temperature entering the gaseous mixer. This information is used to calculate a real-time fuel pressure correction in order to reduce fueling errors. The ECM provides a voltage divider circuit so that when the fuel is cool, the signal reads higher voltage, and lower when warm.

Fault Enabled in Calibration?	**YES**
Emissions-related Fault?	**NO**
Check Condition:	Engine Running

Fault Set Conditions (as defined in calibration):

• Fuel temp <	-40	deg F

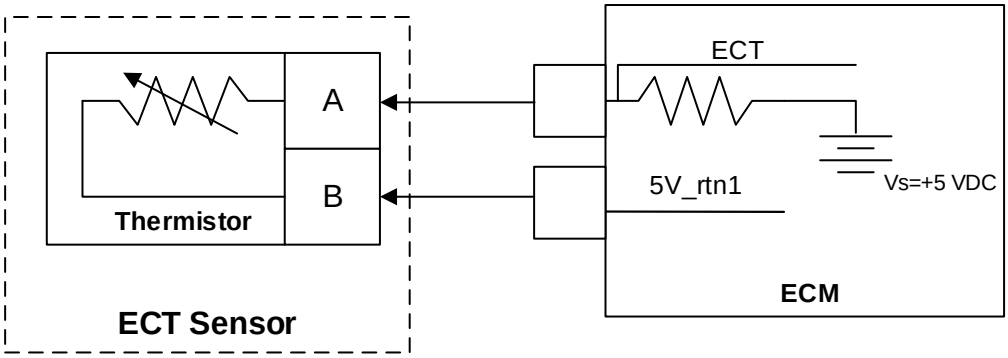
Possible Causes:

This fault is not user-modifiable. It is always enabled and is intended to protect the CFV from extremely low fuel temperatures by load limiting the system when the FT falls below the target temperature given in the fault conditions.

Corrective Actions:

Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	
Never Forget		AL Disable		Low Rev Limit		MIL Persist Disable	
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable		Power Derate 1		Soft Warning		NOx Control System	

3.24 DTC 217 - ECT Higher Than Expected 2



DTC	217	SPN	110	FMI	0

Hardware: Engine Coolant Temperature Sensor

Hardware Description:

The Engine Coolant Temperature sensor is a thermistor (temperature sensitive resistor) located in the engine coolant. Some engines use a CHT sensor that is located in the coolant in the cylinder head. Some engines use an ECT (Engine Coolant Temperature) sensor that is located in the coolant near the thermostat. If the engine is equipped with a CHT sensor then the ECT value is estimated. If equipped with an ECT sensor then the CHT value is estimated. They are used for engine airflow calculation, ignition timing control, to enable certain features, and for engine protection.

The ECM provides a voltage divider circuit so when the sensor reading is cool the sensor reads higher voltage, and lower when warm.

Fault Enabled in Calibration?	**YES**
Emissions-related Fault?	**NO**
Check Condition:	Engine Running

Fault Set Conditions (as defined in calibration):

• ECT >	245	deg F
• and RPM >	550	rpm
• and run-time >	15.0	seconds

Possible Causes:

This fault will help protect the engine in the event of over temperature. When the coolant exceeds x deg. F and engine RPM exceeds y RPM for the latch time this fault will set.

Corrective Actions:

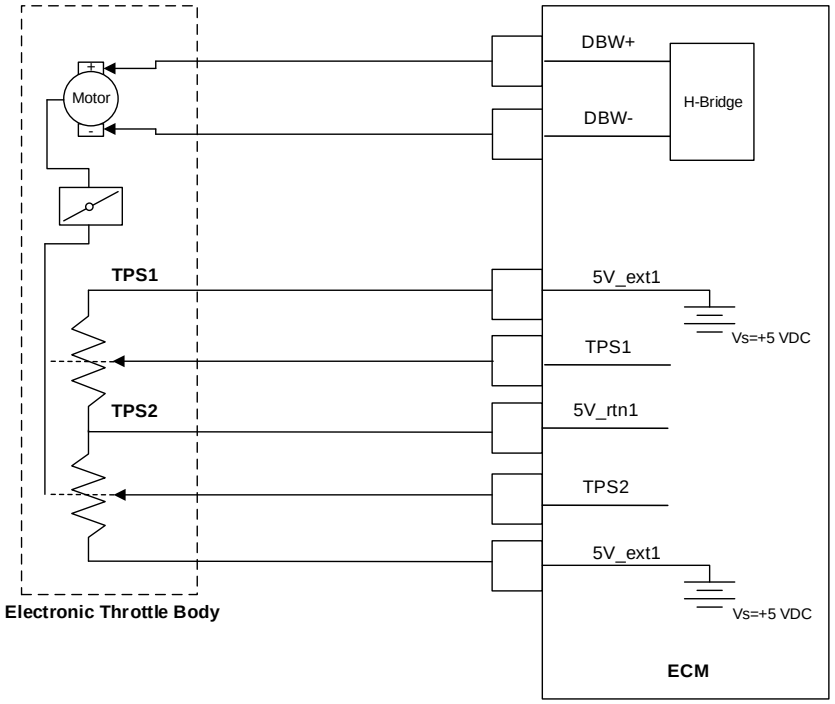
Shutdown	X	CL Disable key cyc.		Power Derate 2		Hard Warning	X
Never Forget		AL Disable		Low Rev Limit		MIL Persist Disable	
Turn on MIL		AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable		Power Derate 1		Soft Warning	X	NOx Control System	

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Diagnostic Aids:

- ☐ If the "ECT High Voltage" fault is also present, follow the troubleshooting procedures for that fault as it may have caused "ECT Higher Than Expected 2."
- ☐ If the cooling system utilizes an air-to-water heat exchanger (radiator) and fan:
  - Check that the radiator has a proper amount of ethylene glycol/water and that the radiator is not leaking
  - Ensure that there is no trapped air in the cooling path
  - Inspect the cooling system (radiator and hoses) for cracks and ensure connections are leak free
  - Check that the fan is operating properly
  - Check that the thermostat is not stuck closed
- ☐ If the cooling system utilizes a water-to-water heat exchanger:
  - Check that the heat exchanger has a proper amount of ethylene glycol/water and that the heat exchanger is not leaking
  - Ensure that there is no trapped air in the cooling path
  - Inspect the cooling system (radiator and hoses) for cracks and ensure connections are leak free
  - Check that the raw water pickup is not blocked/restricted by debris and that the hose is tightly connected
  - Check that the thermostat is not stuck closed
  - Check that the raw water pump/impeller is tact and that it is not restricted

3.25 DTC 219 - RPM Higher Than Max Allowed Governed Speed



DTC	219	SPN	515	FMI	15

Hardware: Max Govern Speed Override- Crankshaft Position Sensor

Description:

The Max Allowed Governed Speed overrides any higher max governor speeds programmed by the user. This fault is designed to help prevent engine or equipment damage.

Fault Enabled in Calibration?	**YES**
Emissions-related Fault?	**NO**
Check Condition:	Engine Running

Fault Set Conditions (as defined in calibration):

• RPM >	5700	rpm

Possible Causes:

This fault will set anytime the engine RPM exceeds the limit set in the diagnostic calibration for the latch time or more.

Corrective Actions:

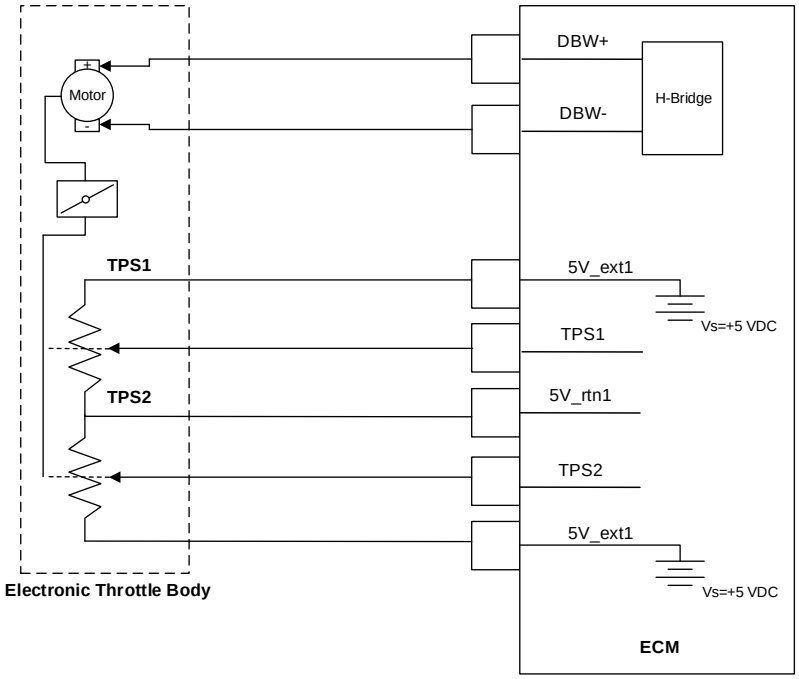
Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	
Never Forget		AL Disable		Low Rev Limit		MIL Persist Disable	X
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable		Power Derate 1		Soft Warning		NOx Control System	

Diagnostic Aid:

NOTE: If any other DTCs are present, diagnose those first.

- ☐ Ensure that no programmed governor speeds exceed the limit set in the diagnostic calibration for Max Gov Override Speed
- ☐ Check mechanical operation of the throttle
- ☐ Check the engine intake for large air leaks downstream of the throttle body

3.26 DTC 221 - TPS1 % Higher Than TPS2 %



DTC	221	SPN	51	FMI	0

Hardware: Throttle Body-Throttle Position Sensor 1 & 2 (electronic throttle body only)

Hardware Description:

The throttle controls the airflow through the engine, directly affecting the power output of the engine. When the throttle is electronically controlled in an Electronic Throttle Body it can be used to control the idle stability and limit engine speed based on operating conditions.

The Throttle Position Sensor uses either 1) a variable resistor and voltage divider circuit or 2) a non-contact hall-effect sensor to determine throttle plate position, and is located within the throttle body. The output of the TPS is linear with angular position. The TPS input(s) provide angular position feedback of the throttle plate. In an Electronic Throttle Body multiple position feedback sensors (usually two counteracting potentiometers/hall-effects) are used to perform speed governing with improved safety and redundancy.

Fault Enabled in Calibration?	**YES**
Emissions-related Fault?	**NO**
Check Condition:	Engine Running

Fault Set Conditions (as defined in calibration):

• (TPS1% - TPS2%) >	20.0	%

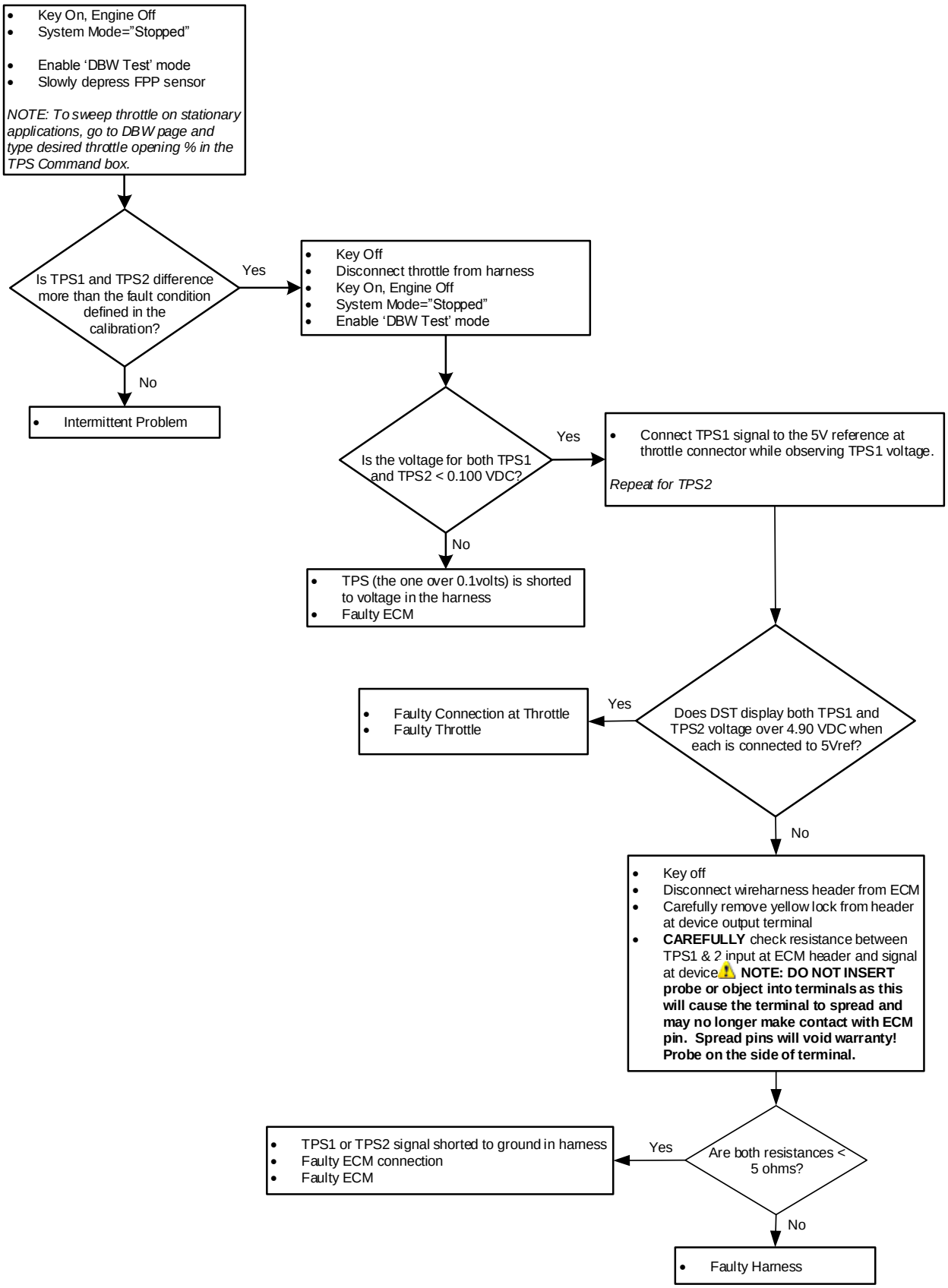
Possible Causes:

This fault will set if TPS1 % is higher than TPS2 % by the amount defined in the diagnostic calibration. At this point the throttle is considered to be out of specification, or there is a problem with the TPS signal circuit. During this active fault, an audible/visual alert device is activated and either an engine shutdown should is triggered or throttle control is set to use the higher of the two feedback signals for control in combination with a low rev limit and/or power derate.

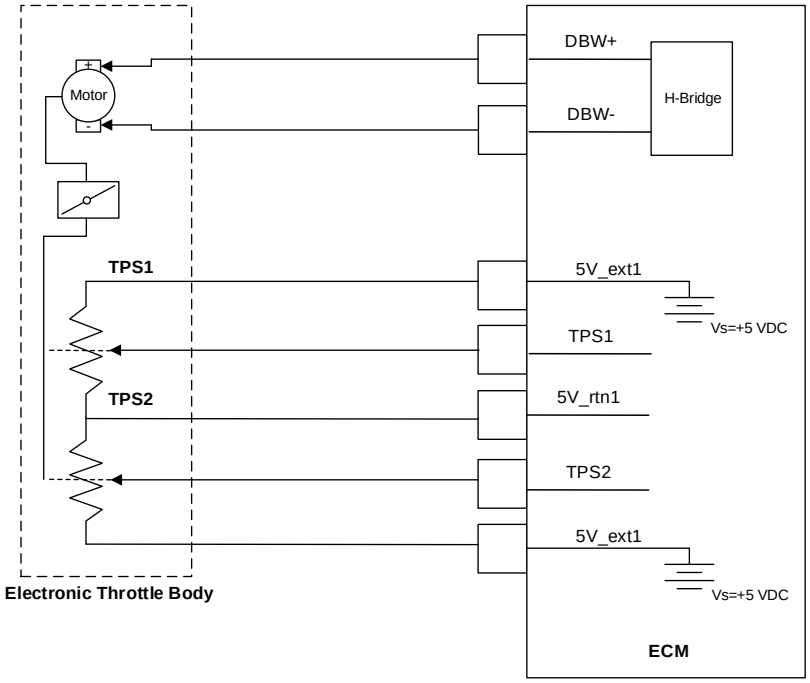
Corrective Actions:

Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	X
Never Forget		AL Disable		Low Rev Limit		MIL Persist Disable	
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable		Power Derate 1		Soft Warning		NOx Control System	

3.26.1 DTC 221 - TPS1 % Higher Than TPS2 %, (Trouble Tree)



3.27 DTC 222 - TPS2 Signal Voltage Low



DTC	222	SPN	3673	FMI	4
Hardware:	Throttle Body-Throttle Position Sensor 2 (electronic throttle body only)				

Hardware Description:

The throttle controls the airflow through the engine, directly affecting the power output of the engine. When the throttle is electronically controlled in an Electronic Throttle Body it can be used to control the idle stability and limit engine speed based on operating conditions.

The Throttle Position Sensor uses either 1) a variable resistor and voltage divider circuit or 2) a non-contact hall-effect sensor to determine throttle plate position, and is located within the throttle body. The output of the TPS is linear with angular position. The TPS input(s) provide angular position feedback of the throttle plate. In an Electronic Throttle Body multiple position feedback sensors (usually two counteracting potentiometers/hall-effects) are used to perform speed governing with improved safety and redundancy.

Fault Enabled in Calibration?	**YES**		
Emissions-related Fault?	**NO**		
Check Condition:	Engine Running		
Fault Set Conditions (as defined in calibration):			
• TPS2 voltage <		0.200	volts

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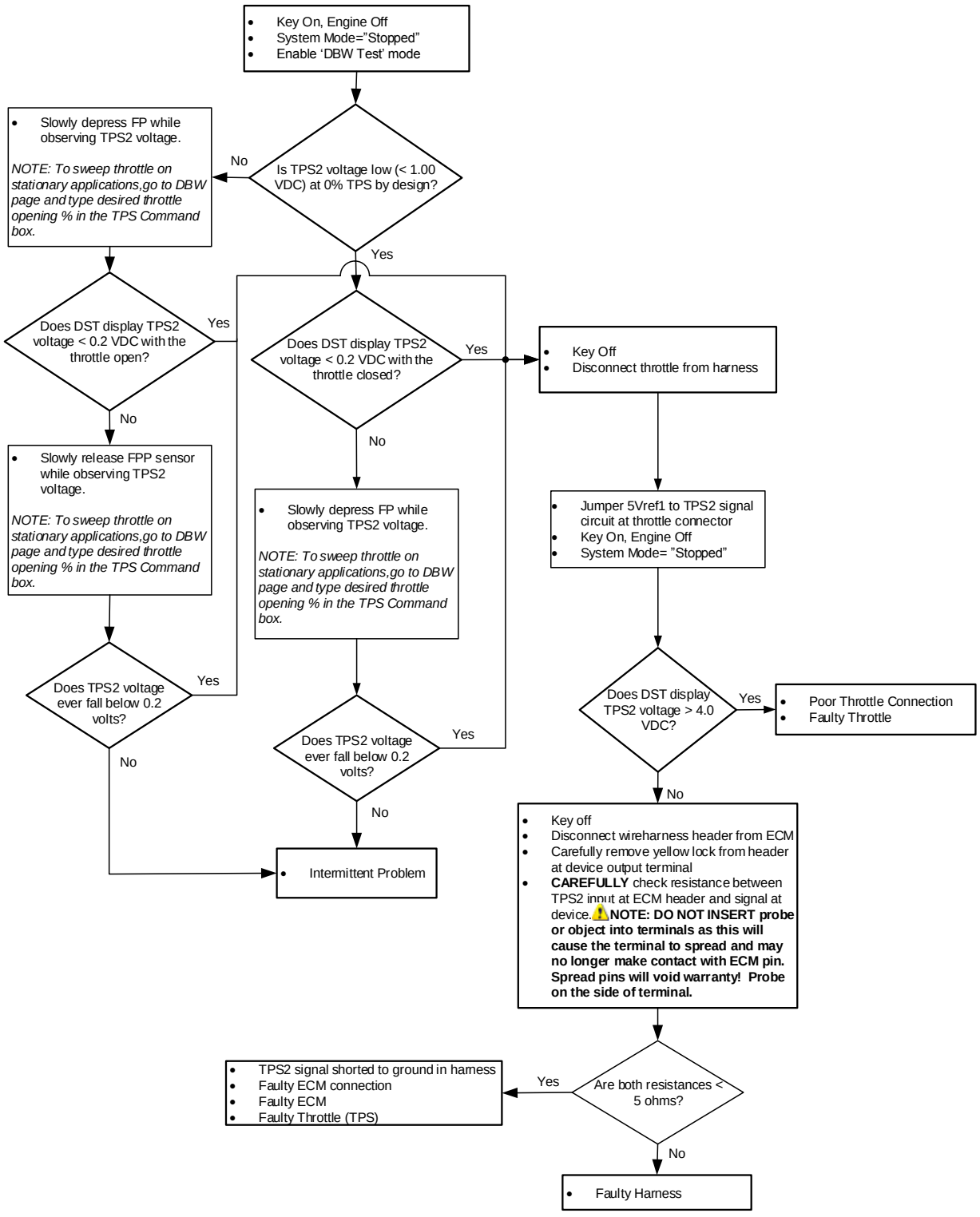
Possible Causes:

This fault will set if TPS2 voltage is lower than the low voltage limit as defined in the diagnostic calibration at any operating condition while the engine is cranking or running. The limit is generally set to 4.90 VDC. In many cases, this condition is caused by the TPS sensor being disconnected from the engine harness, an open-circuit or short-to-ground of the TPS circuit in the wire harness, or a failure of the sensor. This fault should be configured to trigger an engine shutdown and the engine will not start with this fault active.

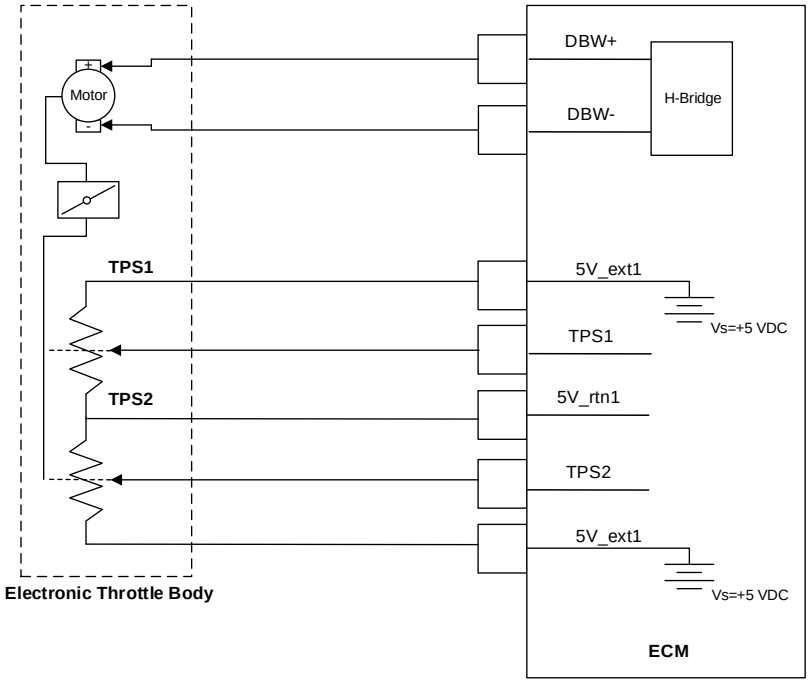
Corrective Actions:

Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	X
Never Forget		AL Disable		Low Rev Limit		MIL Persist Disable	
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable		Power Derate 1		Soft Warning		NOx Control System	

3.27.1 DTC 222 - TPS2 Signal Voltage Low (Trouble Tree)



3.28 DTC 223 - TPS2 Signal Voltage High



DTC	223	SPN	3673	FMI	3

Hardware: Throttle Body-Throttle Position Sensor 2 (electronic throttle body only)

Hardware Description:

The throttle controls the airflow through the engine, directly affecting the power output of the engine. When the throttle is electronically controlled in an Electronic Throttle Body it can be used to control the idle stability and limit engine speed based on operating conditions.

The Throttle Position Sensor uses either 1) a variable resistor and voltage divider circuit or 2) a non-contact hall-effect sensor to determine throttle plate position, and is located within the throttle body. The output of the TPS is linear with angular position. The TPS input(s) provide angular position feedback of the throttle plate. In an Electronic Throttle Body multiple position feedback sensors (usually two counteracting potentiometers/hall-effects) are used to perform speed governing with improved safety and redundancy.

Fault Enabled in Calibration?	**YES**
Emissions-related Fault?	**NO**
Check Condition:	Engine Running

Fault Set Conditions (as defined in calibration):

• TPS2 voltage >	4.800	volts

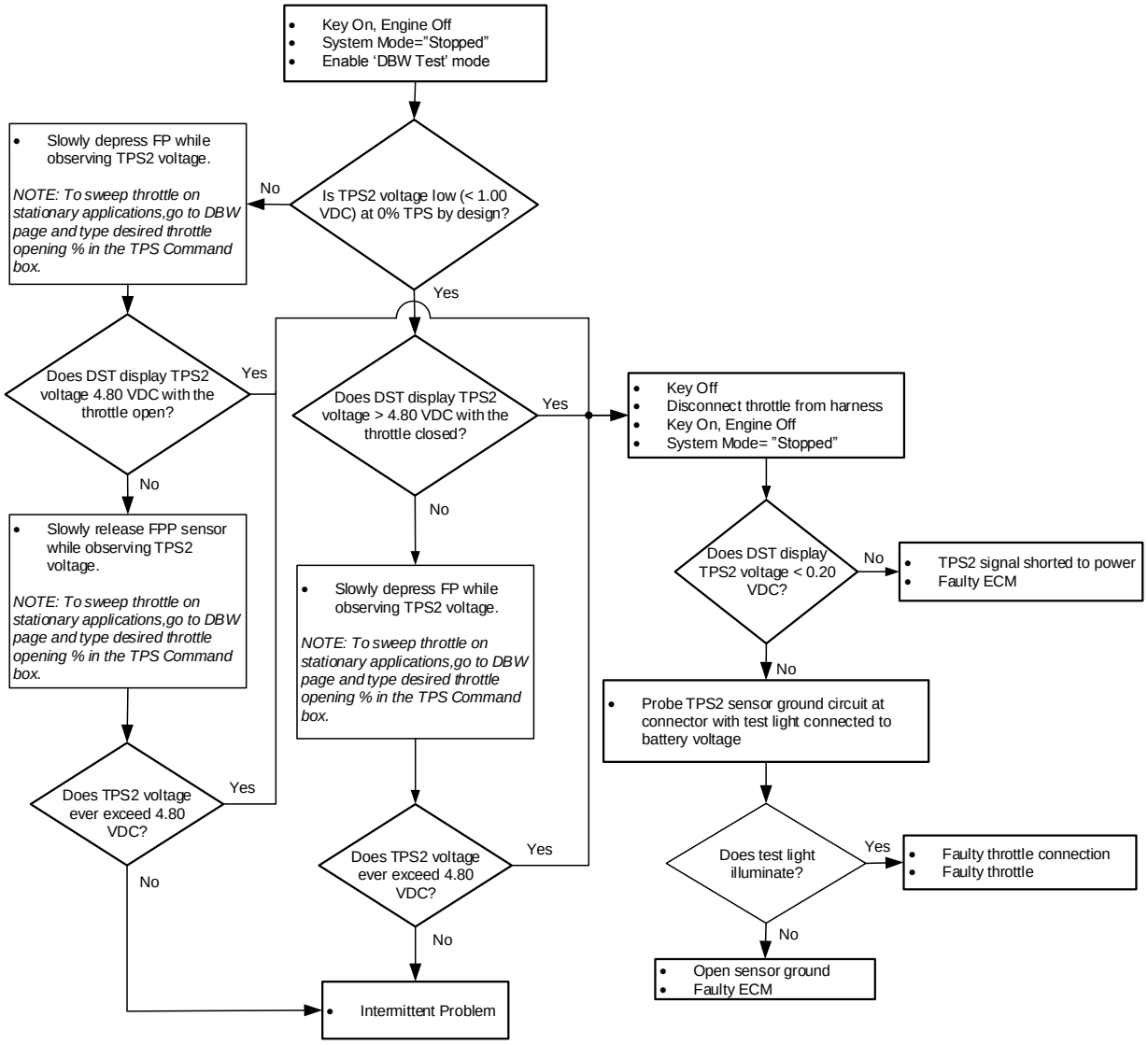
Possible Causes:

This fault will set if TPS2 voltage is higher than the limit set in the diagnostic calibration at any operating condition while the engine is cranking or running. The limit is generally set to 4.90 VDC. In many cases, this condition is caused by a short-to-power of the TPS circuit in the wire harness or a failure of the sensor. This fault should be configured to trigger an engine shutdown and the engine will not start with this fault active.

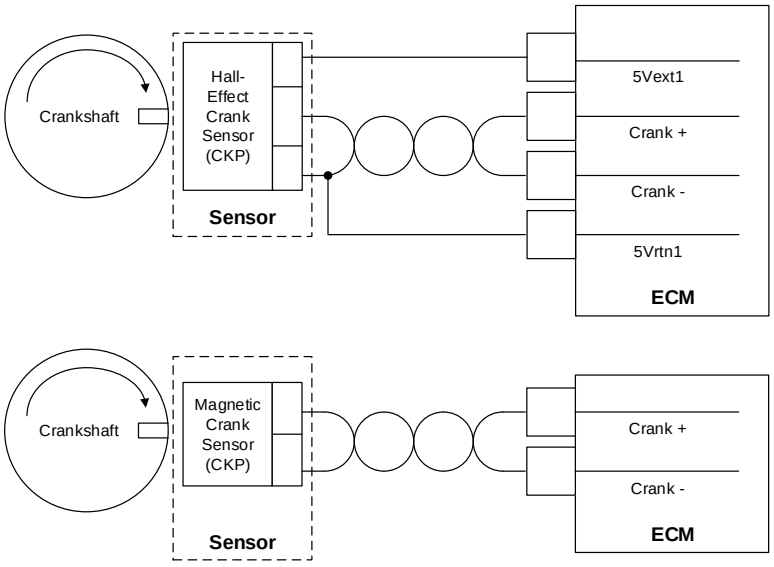
Corrective Actions:

Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	X
Never Forget		AL Disable		Low Rev Limit		MIL Persist Disable	
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable		Power Derate 1		Soft Warning		NOx Control System	

3.28.1 DTC 223 - TPS2 Signal Voltage High



3.29 DTC 336 - Crank Input Signal Noise



DTC	336	SPN	636	FMI	2

Hardware: Crankshaft Position sensor

Hardware Description:

The crankshaft position sensor is a magnetic sensor (variable reluctant/magnetic pick-up or hall-effect) installed in the engine block adjacent to a “coded” trigger wheel located on the crankshaft. The sensor-trigger wheel combination is used to determine crankshaft position (with respect to TDC cylinder #1 compression) and the rotational engine speed. Determination of the crankshaft position and speed is necessary to properly activate the ignition, fuel injection, and throttle governing systems for precise engine control.

Fault Enabled in Calibration?	**YES**
Emissions-related Fault?	**YES**
Check Condition:	Key On, Engine On

Fault Set Conditions (as defined in calibration):

• Number of invalid crank re-syncs	1	re-syncs
• within a time window of <=	800	ms

Possible Causes:

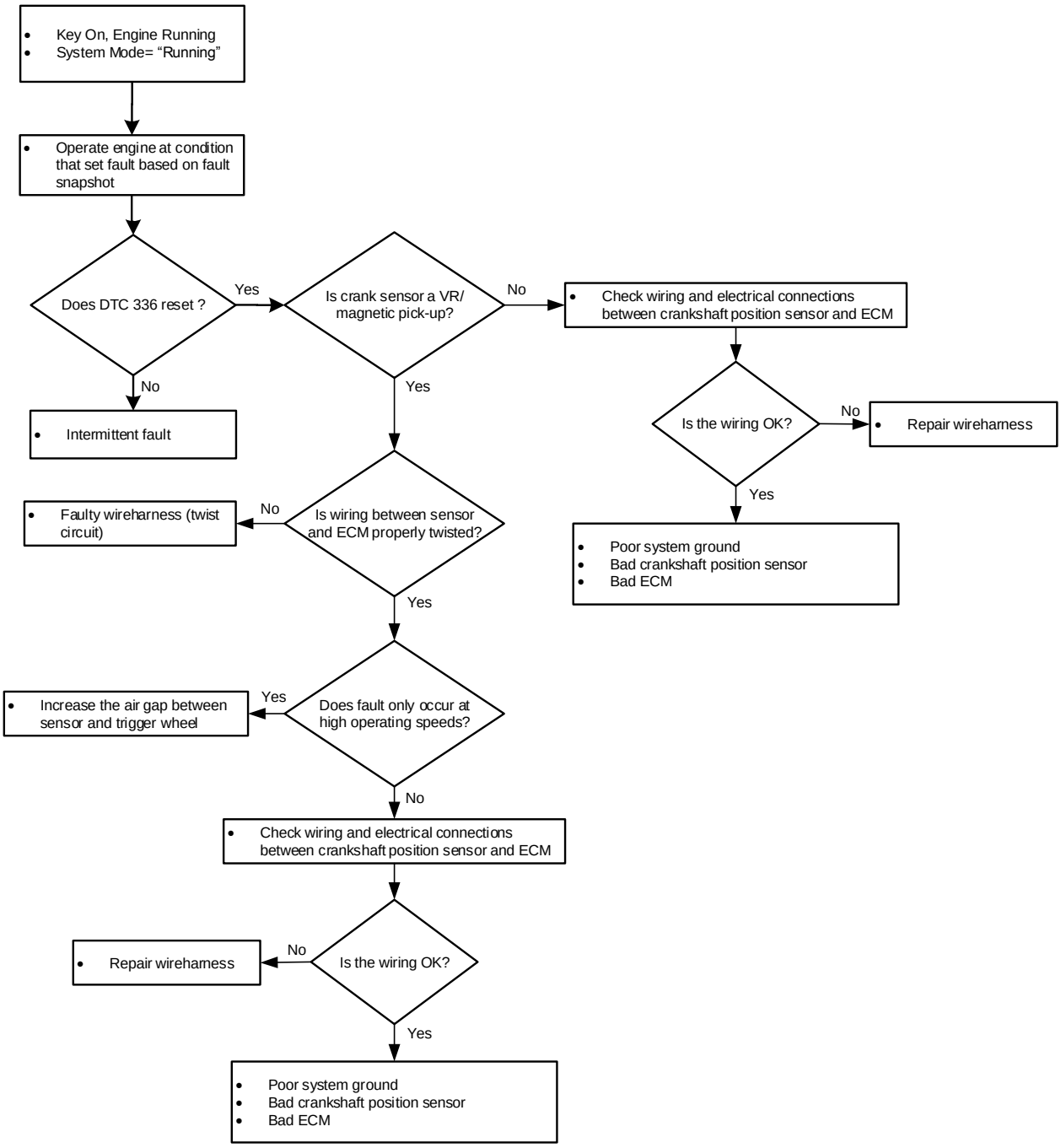
The ECM must see a valid crankshaft position signal while running. If no signal is present, the signal amplitude is too high (due to improper air gap with respect to trigger wheel), or an irregular crank pattern is detected causing the ECM to resynchronize x times for y ms or longer as defined in the diagnostic calibration, this fault will set. Irregular crank patterns can be detected by the ECM due to electrical noise, poor machining of trigger wheel, or trigger wheel runout and/or gear lash.

Ensure crank circuit used with VR/magnetic pick-up sensors are properly twisted.

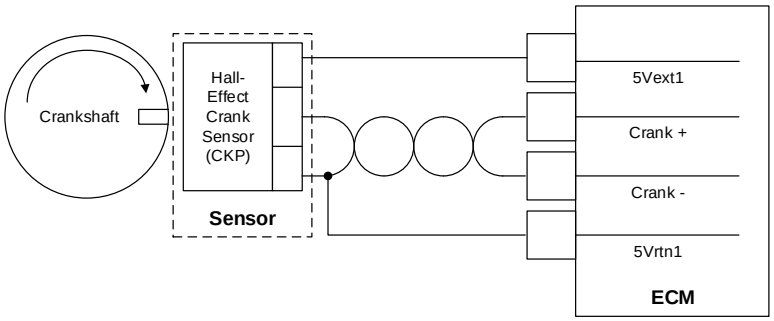
Corrective Actions:

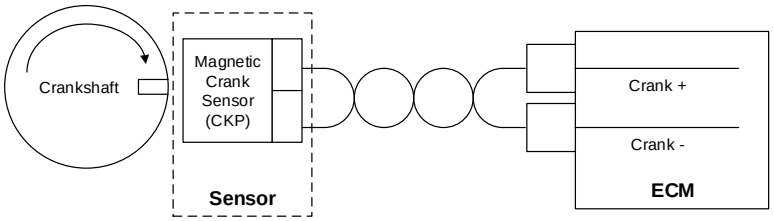
Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	
Never Forget		AL Disable		Low Rev Limit		MIL Persist Disable	
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable		Power Derate 1		Soft Warning		NOx Control System	

3.29.1 DTC 336 - Crank Input Signal Noise (Trouble Tree)



3.30 DTC 337 – Loss of Crankshaft Signal





DTC	337	SPN	636	FMI	4

Hardware: Crankshaft Position sensor

Hardware Description:

The crankshaft position sensor is a magnetic sensor (variable reluctant/magnetic pick-up or hall-effect) installed in the engine block adjacent to a "coded" trigger wheel located on the crankshaft. The sensor-trigger wheel combination is used to determine crankshaft position (with respect to TDC cylinder #1 compression) and the rotational engine speed. Determination of the crankshaft position and speed is necessary to properly activate the ignition, fuel injection, and throttle governing systems for precise engine control.

Fault Enabled in Calibration?	**YES**
Emissions-related Fault?	**YES**
Check Condition:	Key On, Engine On

Fault Set Conditions (as defined in calibration):

• Cam pulses without crank activity >	3	Cam pulses

Possible Causes:

The ECM must see a valid crankshaft position signal while running. If no signal is present while x cam pulses continue the fault will set. The engine typically stalls or dies as a result of this fault condition due to the lack of crankshaft speed input resulting in the inability to control ignition timing.

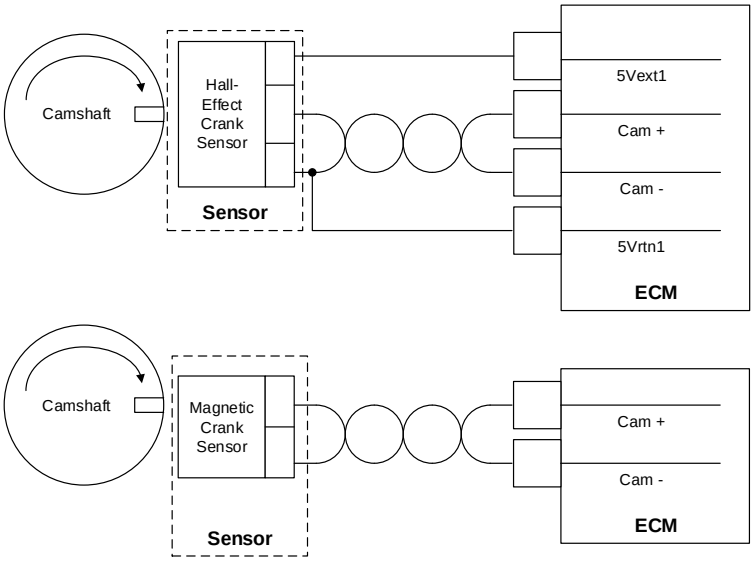
Corrective Actions:

Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	
Never Forget		AL Disable		Low Rev Limit		MIL Persist Disable	
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable		Power Derate 1		Soft Warning		NOx Control System	

3.30.1 DTC 337 – Loss of Crankshaft Signal (Diagnostic Aids)

- ☐ Check that crankshaft position sensor is securely connected to harness
- ☐ Check that crankshaft position sensor is securely installed into engine block
- ☐ Check crankshaft position sensor circuit wiring for open circuit

3.31 DTC 341 - Cam Input Signal Noise



DTC	341	SPN	723	FMI	2

Hardware: Crankshaft Position sensor

Hardware Description:

The camshaft position sensor is a magnetic sensor (variable reluctant/magnetic pick-up or hall-effect) installed in the engine block or valve train adjacent to a “coded” trigger wheel located on or off of the camshaft. The sensor-trigger wheel combination is used to determine cam position (with respect to TDC cylinder #1 compression). Determination of the camshaft position is necessary to identify the stroke (or cycle) of the engine to properly activate the fuel injection system and ignition (for coil-on-plug engines) for precise engine control.

Fault Enabled in Calibration?	**YES**
Emissions-related Fault?	**YES**
Check Condition:	Key On, Engine On

Fault Set Conditions (as defined in calibration):

• Number of invalid cam re-syncs	1	re-syncs
• within a time window of <=	700	ms

Possible Causes:

For a cam synchronized engine, the ECM must see a valid camshaft position signal while running. If no signal is present, the signal amplitude is too high (due to improper air gap with respect to trigger wheel), or an irregular cam pattern is detected causing the ECM to resynchronize x times for y ms or longer as defined in the diagnostic calibration, this fault will set. Irregular cam patterns can be detected by the ECM due to electrical noise, poor machining of trigger wheel, or trigger wheel runout and/or gear lash. Normally the engine will continue to run if equipped with a waste-spark or distributor ignition system.

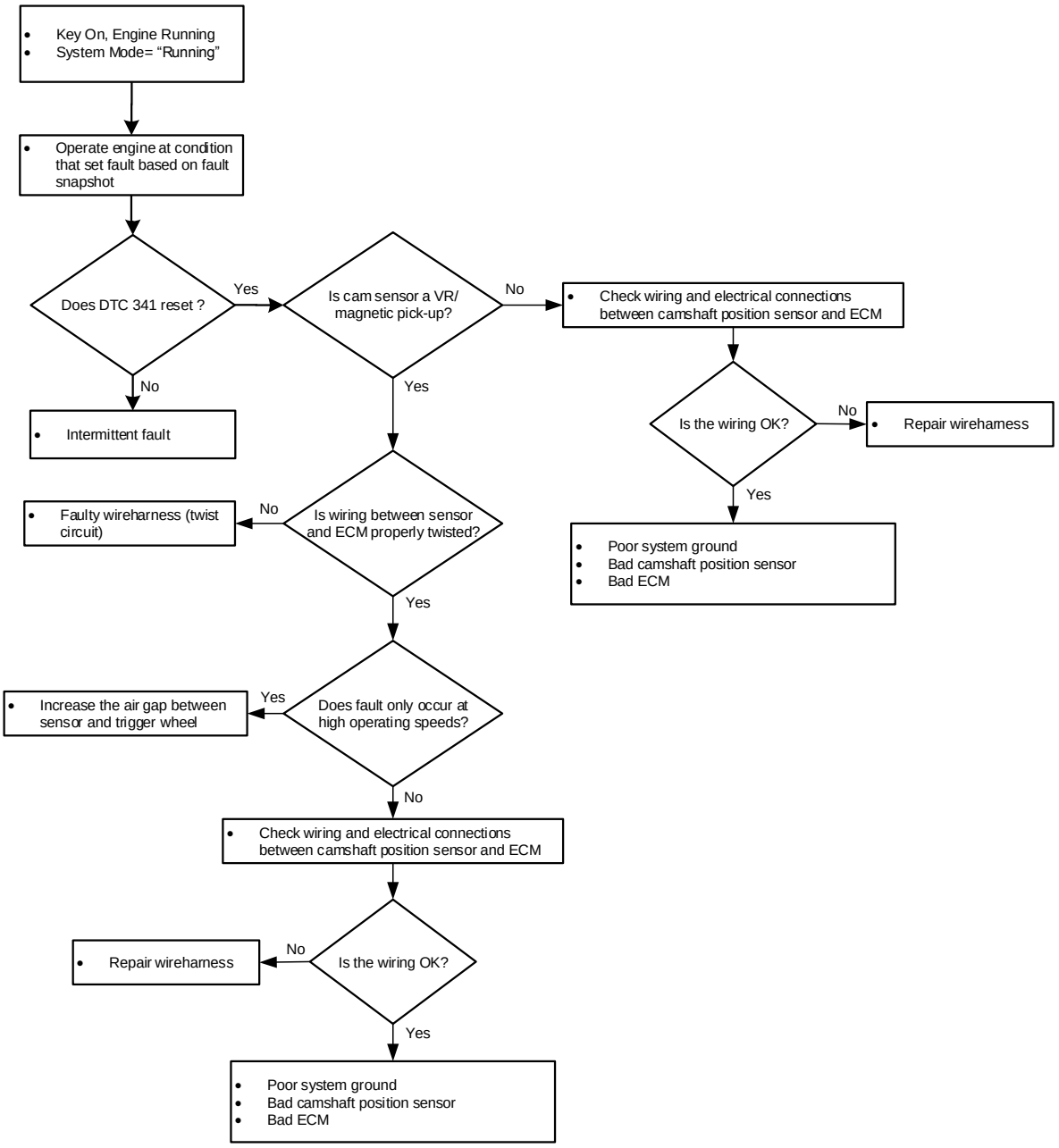
In some instances this fault can cause rough engine operation and can cause the engine to stall or die if equipped with coil-on-plug ignition engines.

Ensure cam circuit used with VR/magnetic pick-up sensors are properly twisted.

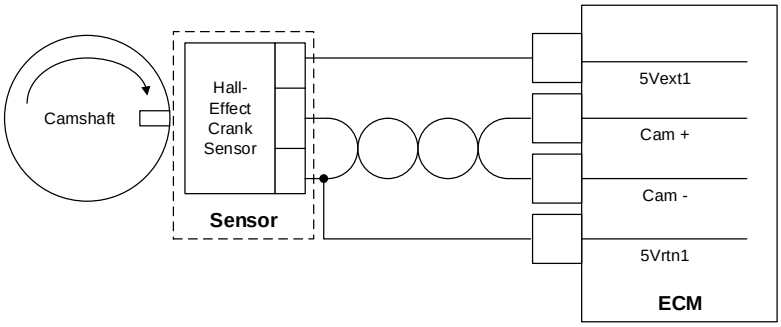
Corrective Actions:

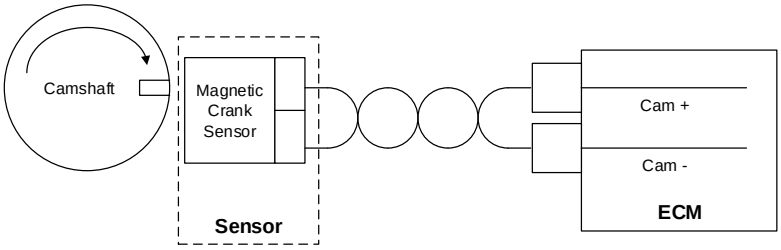
Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	
Never Forget		AL Disable		Low Rev Limit		MIL Persist Disable	
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable		Power Derate 1		Soft Warning		NOx Control System	

3.31.1 DTC 341 – Cam Input Signal Noise (Trouble Tree)



3.32 DTC 342 – Loss of Camshaft Input Signal





DTC	342	**SPN**	723	**FMI**	4

Hardware: Camshaft Position sensor

Hardware Description:

The camshaft position sensor is a magnetic sensor (variable reluctant/magnetic pick-up or hall-effect) installed in the engine block or valve train adjacent to a “coded” trigger wheel located on or off of the camshaft. The sensor-trigger wheel combination is used to determine cam position (with respect to TDC cylinder #1 compression). Determination of the camshaft position is necessary to identify the stroke (or cycle) of the engine to properly activate the fuel injection system and ignition (for coil-on-plug engines) for precise engine control.

Fault Enabled in Calibration?	**YES**
Emissions-related Fault?	**YES**
Check Condition:	Key On, Engine On

Fault Set Conditions (as defined in calibration):

• No cam pulse in	2.0	cycles
• and RPM >	100	rpm

Possible Causes:

For a cam synchronized engine, the ECM must see a valid camshaft position signal while running. This fault will set if valid crankshaft position data is received for x number of engine cycles while engine speed is greater than y RPM and no camshaft signal is received. Normally the engine will continue to run if equipped with a waste-spark or distributor ignition system. In some instances this fault can cause rough engine operation and can cause the engine to stall or die if equipped with coil-on-plug ignition engines.

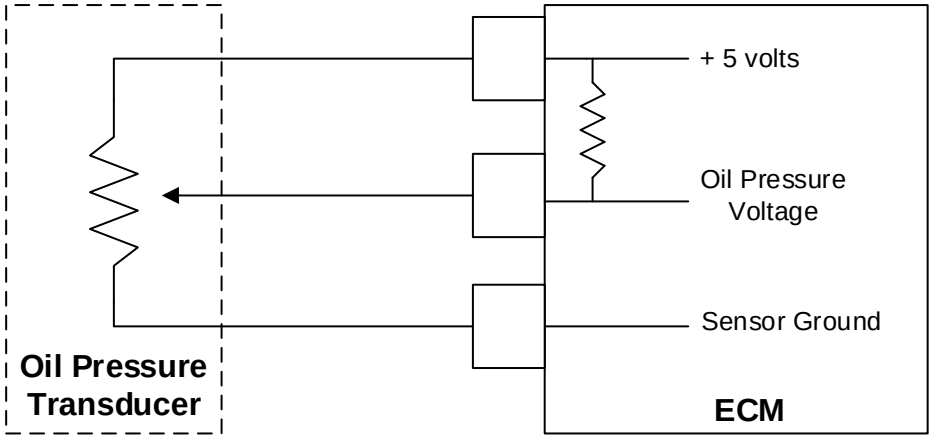
Corrective Actions:

Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	
Never Forget		AL Disable		Low Rev Limit		MIL Persist Disable	
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable		Power Derate 1		Soft Warning		NOx Control System	

3.32.1 DTC 342 – Loss of Camshaft Input Signal (Diagnostic Aids)

- ☐ Check that camshaft position sensor is securely connected to harness
- ☐ Check that camshaft position sensor is securely installed into engine block
- ☐ Check camshaft position sensor circuit wiring for open circuit

3.33 DTC 520 - Oil Pressure Low Stage 1 (Sender)



Sensor-Type

DTC	520	**SPN**	100	**FMI**	18

Measurement: Engine Oil Pressure

Description:

The ECM can be configured to monitor oil pressure through a proportional transducer or through a switch. Oil pressure monitoring is important to prevent engine damage due to low oil pressure resulting in higher friction and lack of lubrication. In addition, high oil pressure can be undesirable because it can cause oil to leak past seals and rings, can be a result of a restriction in the oil flow path, or can be a sign of a malfunctioning oiling system.

Fault Enabled in Calibration?	**YES**
Emissions-related Fault?	**NO**
Check Condition:	Key on, Engine on

Fault Set Conditions (as defined in calibration):

For RPM > lower limit AND RPM <=	650	rpm
• Stage 1: oil pressure <	10.0	psig
For RPM >=	1300	rpm
• Stage 1: oil pressure <	25.0	psig

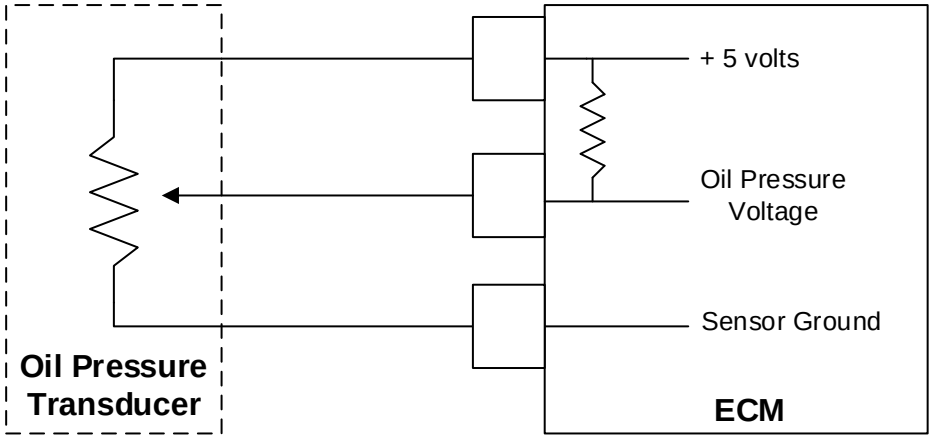
Possible Causes:

This fault sets if the engine oil pressure is lower than x psia and engine speed greater than y RPM as defined in the diagnostic calibration. Recommend a power derate and/or low rev limit to help prevent possible engine damage and reduce oil pressure.

Corrective Actions:

Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	X
Never Forget		AL Disable		Low Rev Limit		MIL Persist Disable	X
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable		Power Derate 1		Soft Warning	X	NOx Control System	

3.34 DTC 521 - Oil Pressure High (Sender)



Sensor-Type

DTC	521	**SPN**	100	**FMI**	0

Measurement: Engine Oil Pressure

Description:

The ECM can be configured to monitor oil pressure through a proportional transducer or through a switch. Oil pressure monitoring is important to prevent engine damage due to low oil pressure resulting in higher friction and lack of lubrication. In addition, high oil pressure can be undesirable because it can cause oil to leak past seals and rings, can be a result of a restriction in the oil flow path, or can be a sign of a malfunctioning oiling system.

Fault Enabled in Calibration?	**YES**
Emissions-related Fault?	**NO**
Check Condition:	Key on, Engine on

Fault Set Conditions (as defined in calibration):

• Oil pressure >	90.0	psig
• and RPM <	1300	rpm

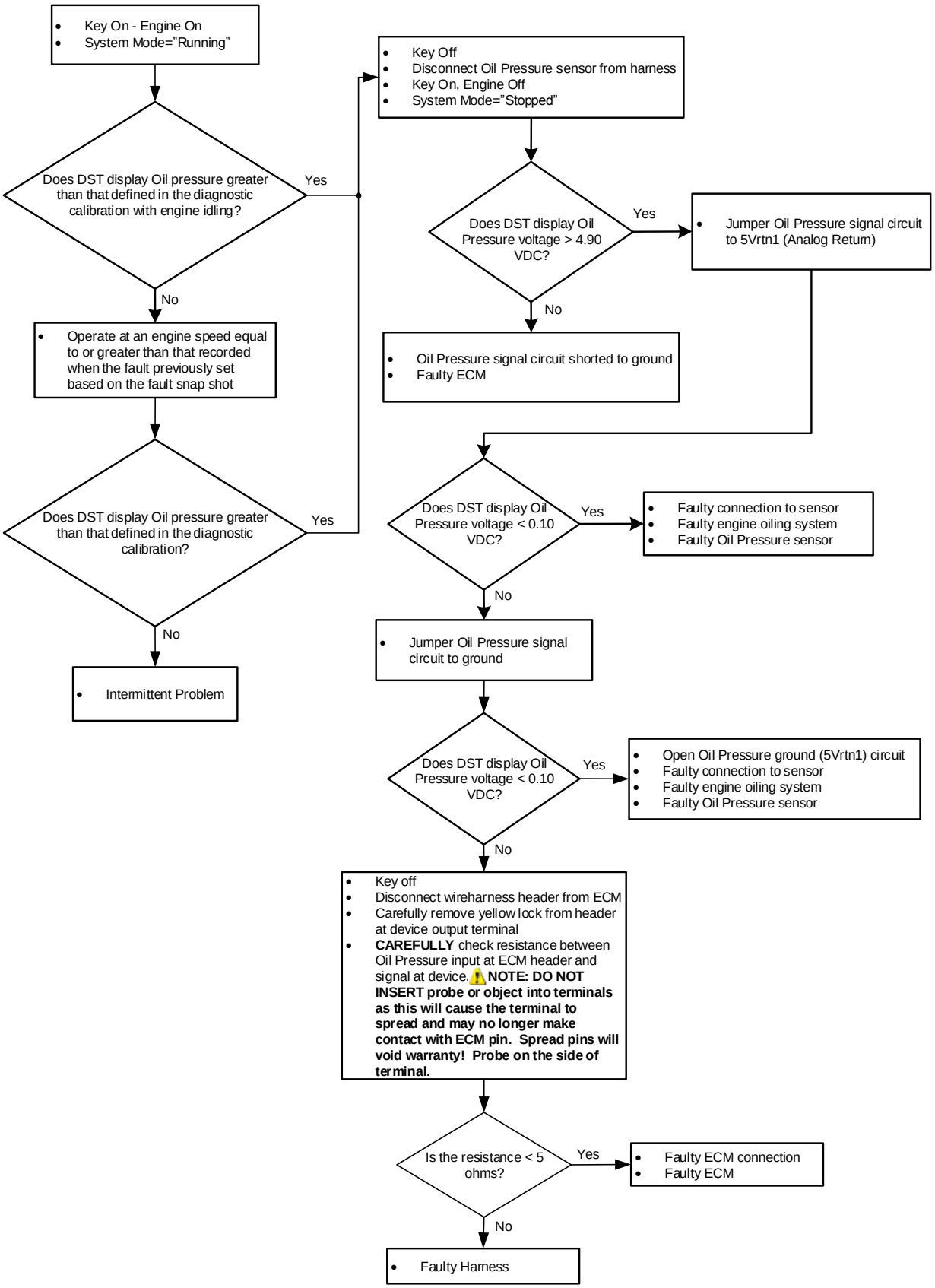
Possible Causes:

This fault sets if the engine oil pressure is higher than x psia and engine speed greater than y RPM as defined in the diagnostic calibration. Recommend a power derate and/or low rev limit to help prevent possible engine damage and reduce oil pressure.

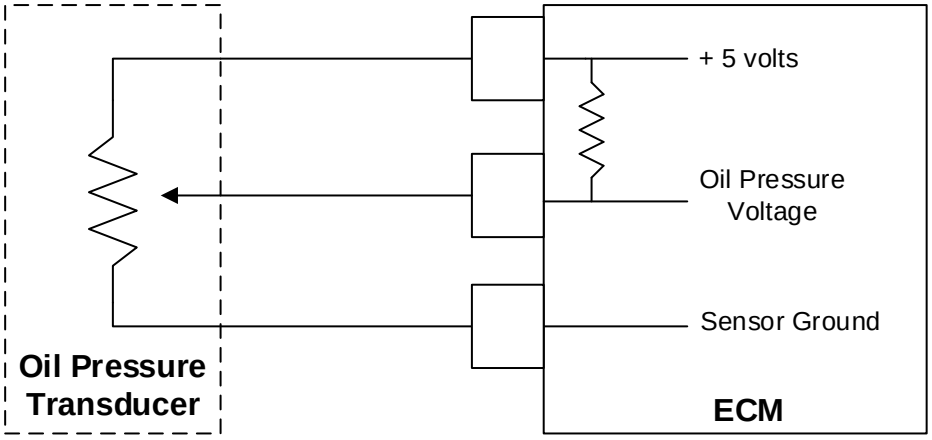
Corrective Actions:

Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	
Never Forget		AL Disable		Low Rev Limit		MIL Persist Disable	
Turn on MIL		AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable		Power Derate 1		Soft Warning	X	NOx Control System	

3.34.1 DTC 521 - Oil Pressure High (Sender) (Trouble Tree)



3.35 DTC 522 - Oil Pressure Sender Low Voltage



Sensor-Type

DTC	522	**SPN**	100	**FMI**	4

Measurement: Engine Oil Pressure

Description:

The ECM can be configured to monitor oil pressure through a proportional transducer or through a switch. Oil pressure monitoring is important to prevent engine damage due to low oil pressure resulting in higher friction and lack of lubrication. In addition, high oil pressure can be undesirable because it can cause oil to leak past seals and rings, can be a result of a restriction in the oil flow path, or can be a sign of a malfunctioning oiling system.

Fault Enabled in Calibration?	**YES**
Emissions-related Fault?	**NO**
Check Condition:	Key on, Engine on

Fault Set Conditions (as defined in calibration):

• Oil pressure sender voltage <	0.200	volts

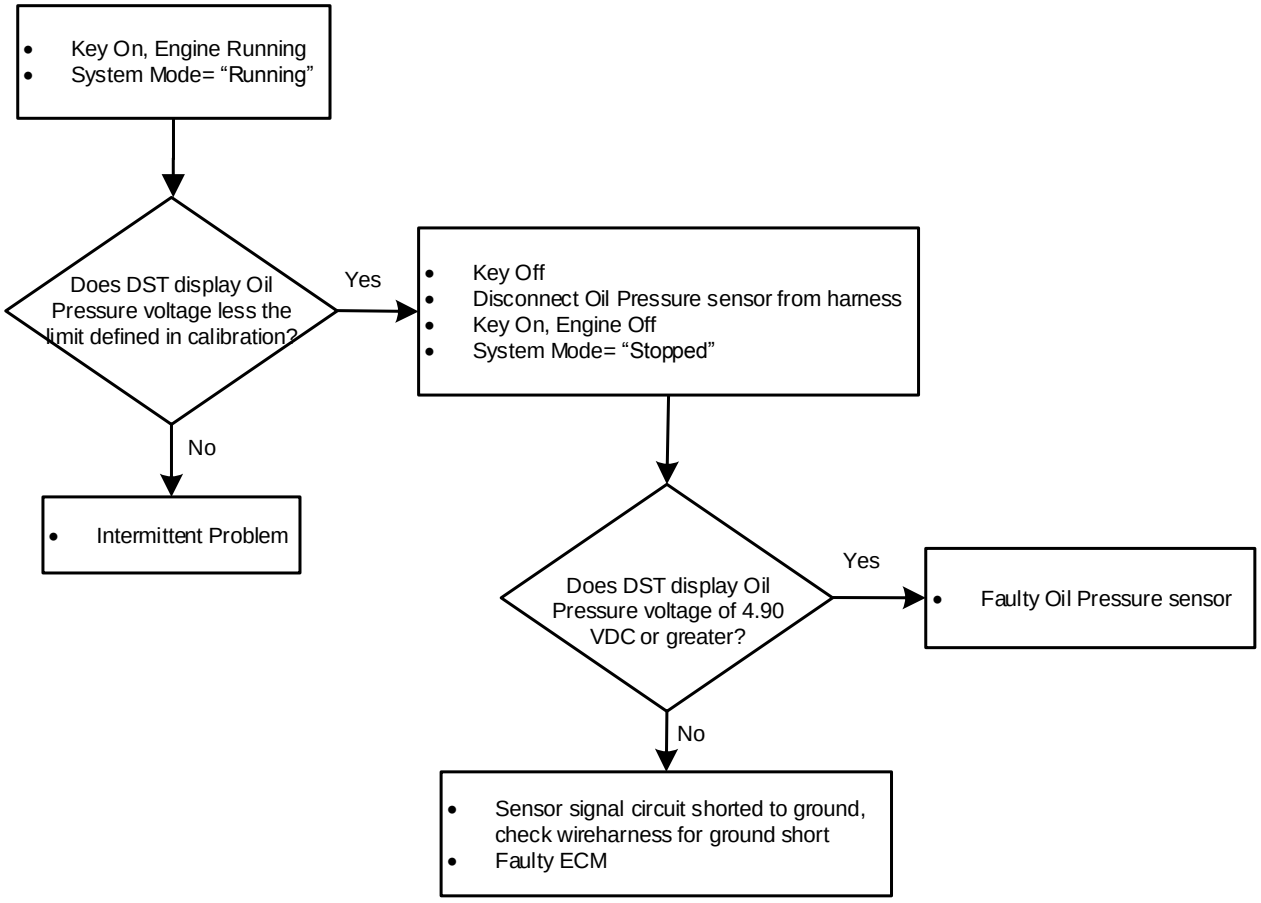
Possible Causes:

This fault sets if the engine oil pressure sender/transducer voltage is lower than defined in the diagnostic calibration. Recommend a power derate and/or low rev limit due to the inability to sense oil pressure and to reduce risk of potential engine damage.

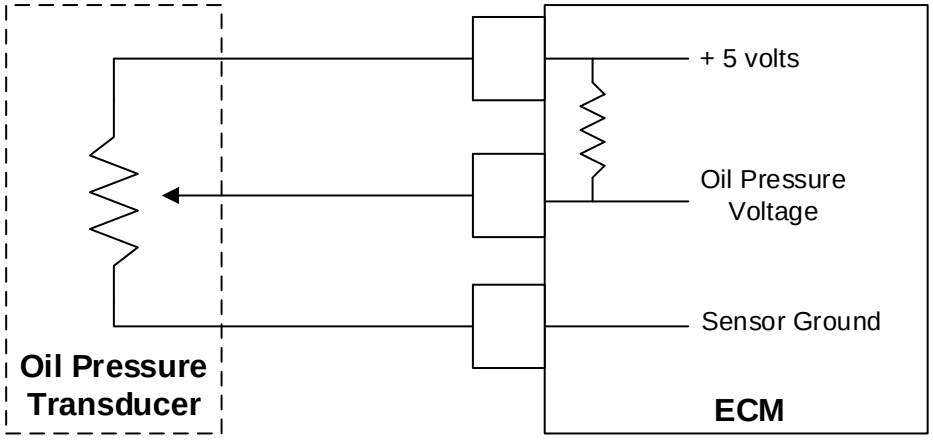
Corrective Actions:

Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	
Never Forget		AL Disable		Low Rev Limit		MIL Persist Disable	
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable		Power Derate 1		Soft Warning		NOx Control System	

3.35.1 DTC 522 - Oil Pressure Sender Low Voltage (Trouble Tree)



3.36 DTC 523 - Oil Pressure Sender High Voltage



Sensor-Type

DTC	523	**SPN**	100	**FMI**	3

Measurement: Engine Oil Pressure

Description:

The ECM can be configured to monitor oil pressure through a proportional transducer or through a switch. Oil pressure monitoring is important to prevent engine damage due to low oil pressure resulting in higher friction and lack of lubrication. In addition, high oil pressure can be undesirable because it can cause oil to leak past seals and rings, can be a result of a restriction in the oil flow path, or can be a sign of a malfunctioning oiling system.

Fault Enabled in Calibration?	**YES**
Emissions-related Fault?	**NO**
Check Condition:	Key on, Engine on

Fault Set Conditions (as defined in calibration):

• Oil pressure sender voltage >	4.800	volts

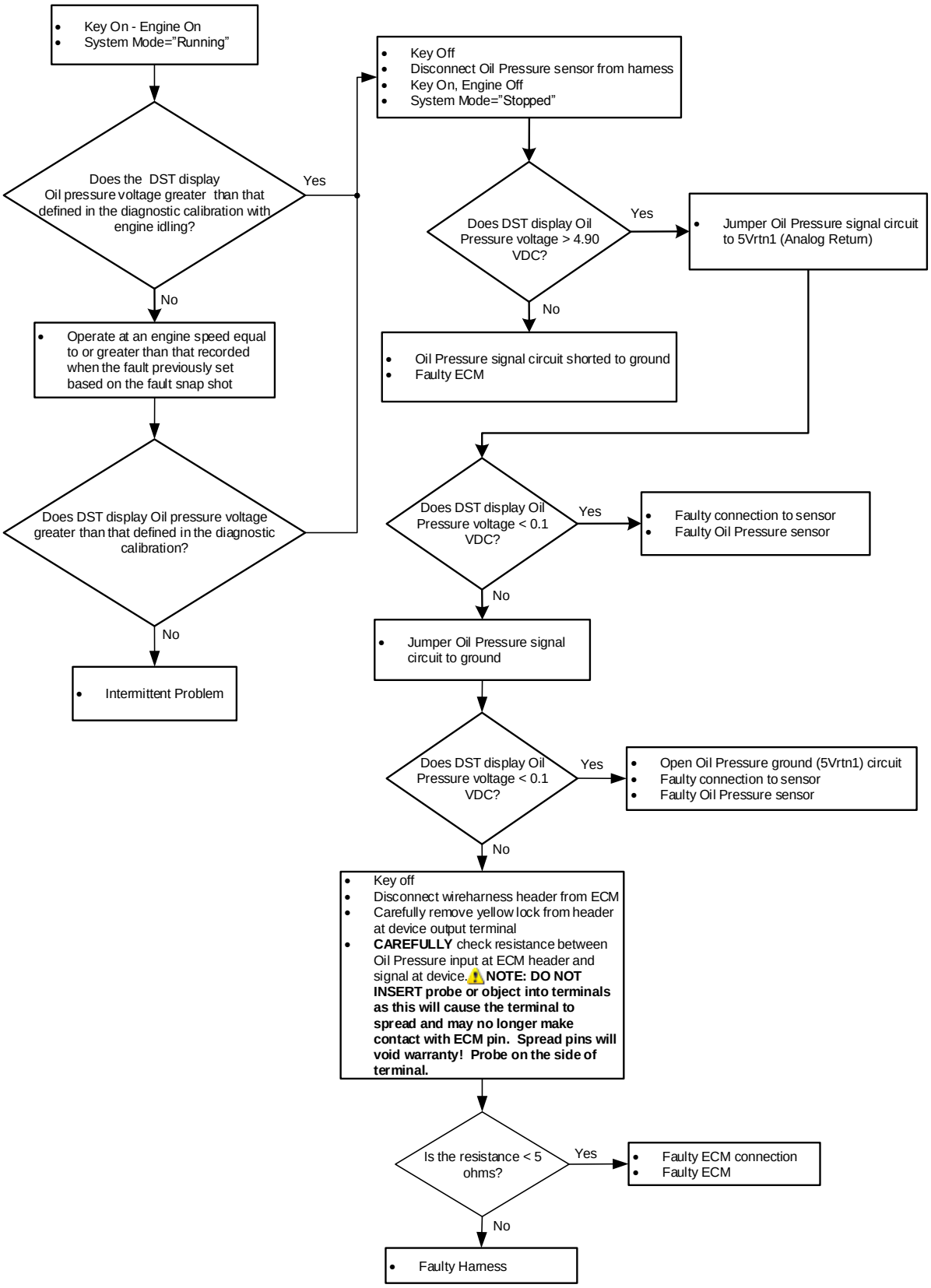
Possible Causes:

This fault sets if the engine oil pressure sender/transducer voltage is lower than defined in the diagnostic calibration. Recommend a power derate and/or low rev limit due to the inability to sense oil pressure and to reduce risk of potential engine damage.

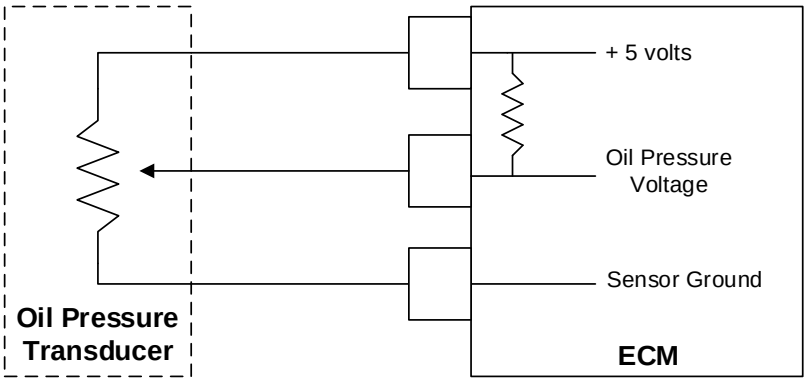
Corrective Actions:

Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	
Never Forget		AL Disable		Low Rev Limit		MIL Persist Disable	
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable		Power Derate 1		Soft Warning		NOx Control System	

3.36.1 DTC 523 - Oil Pressure Sender High Voltage (Trouble Tree)



3.37 DTC 524 - Oil Pressure Low Stage 2 (Sender)



Sensor-Type

DTC	524	**SPN**	100	**FMI**	1

Measurement: Engine Oil Pressure

Description:

The ECM can be configured to monitor oil pressure through a proportional transducer or through a switch. Oil pressure monitoring is important to prevent engine damage due to low oil pressure resulting in higher friction and lack of lubrication. In addition, high oil pressure can be undesirable because it can cause oil to leak past seals and rings, can be a result of a restriction in the oil flow path, or can be a sign of a malfunctioning oiling system.

Fault Enabled in Calibration?	**YES**
Emissions-related Fault?	**NO**
Check Condition:	Key on, Engine on

Fault Set Conditions (as defined in calibration):

For RPM > lower limit AND RPM <=	650	rpm
• Stage 2: oil pressure <	8.0	psig
For RPM >=	3100	rpm
• Stage 2: oil pressure <	15.0	psig

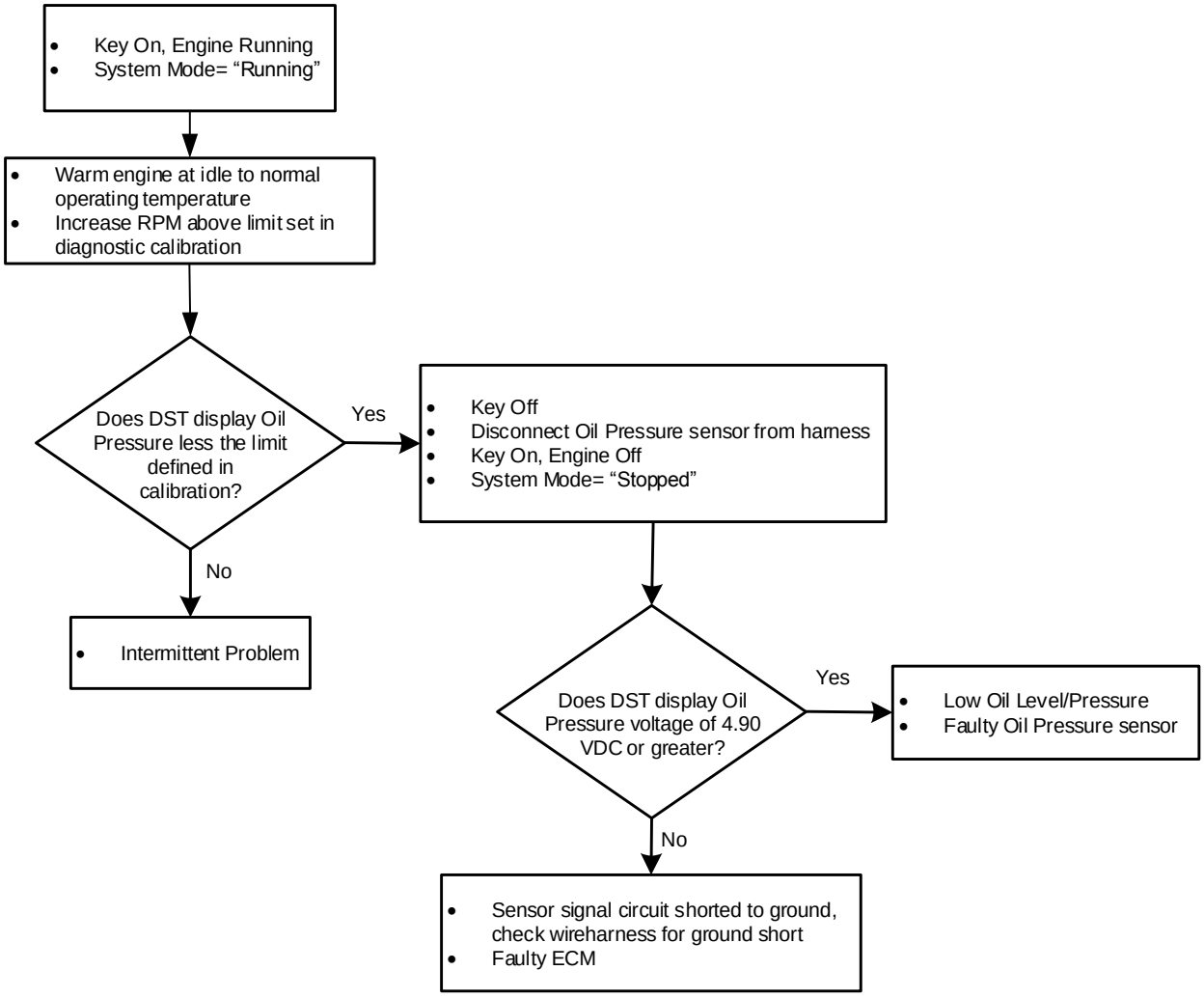
Possible Causes:

For systems that use a transducer, this fault sets if the engine oil pressure is less than x psia and engine speed is greater than y RPM after the engine has been running for z seconds as defined in the diagnostic calibration. The engine will should be configured to derate or force idle and/or shut down in the event of this fault to help prevent possible damage.

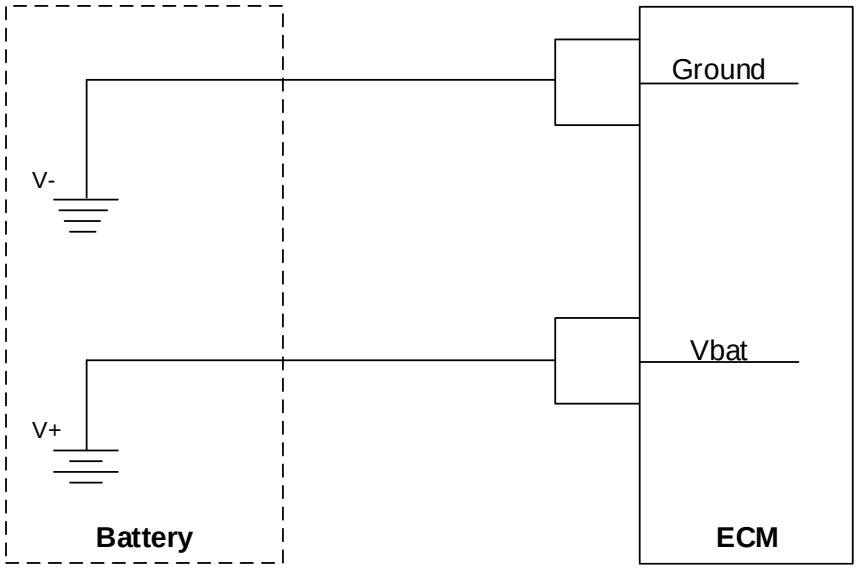
Corrective Actions:

Shutdown	X	CL Disable key cyc.		Power Derate 2		Hard Warning	X
Never Forget		AL Disable		Low Rev Limit		MIL Persist Disable	X
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable		Power Derate 1		Soft Warning	X	NOx Control System	

3.37.1 DTC 524 - Oil Pressure Low (Sender) (Trouble Tree)



3.38 DTC 562 - Battery Voltage (VBat) Low



DTC	562	SPN	168	FMI	17

Measurement: System Voltage to ECM

Description:

The battery voltage powers the ECM and must be within limits to correctly operate injector drivers, ignition coils, throttle, power supplies, and other powered devices that the ECM controls.

Fault Enabled in Calibration?	**YES**
Emissions-related Fault?	**NO**
Check Condition:	Key on, Engine on

Fault Set Conditions (as defined in calibration):

• Voltage <	10.00	volts
• and RPM >	1500	rpm

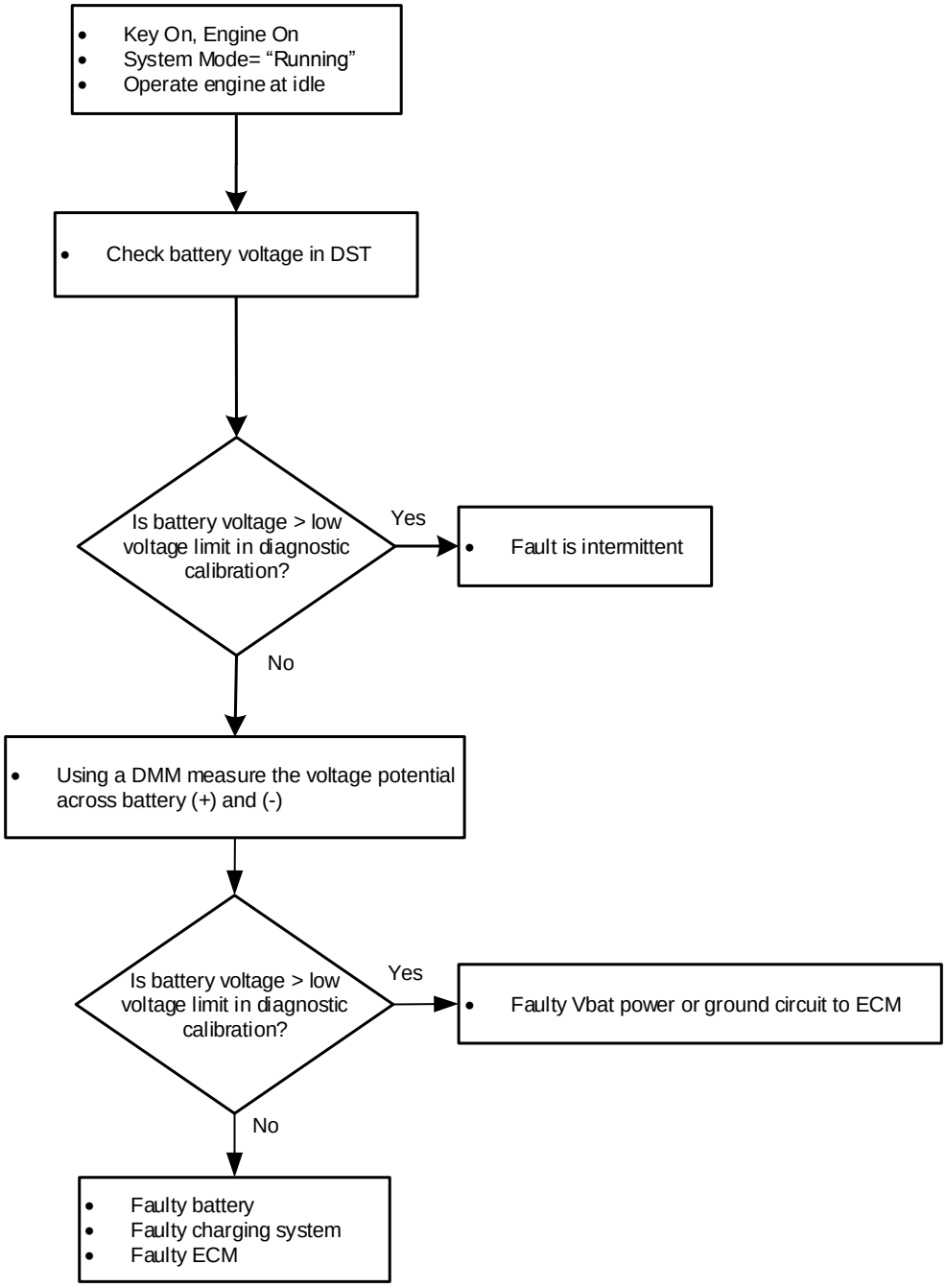
Possible Causes:

This fault will set if the ECM detects system voltage less than x volts while the engine is operating at y RPM as defined in the diagnostic calibration as the alternator should be charging the system. The adaptive learn is disabled to avoid improper adaptive learning due to the inability to correctly time injector firings.

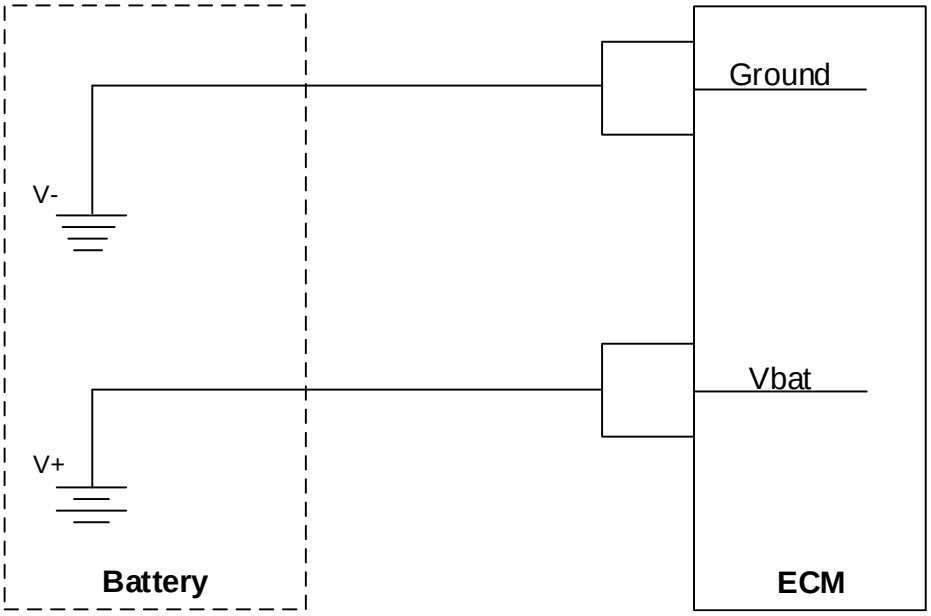
Corrective Actions:

Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	
Never Forget		AL Disable		Low Rev Limit		MIL Persist Disable	
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable		Power Derate 1		Soft Warning		NOx Control System	

3.38.1 DTC 562 - Battery Voltage (VBat) Low (Trouble Tree)



3.39 DTC 563 - Battery Voltage (VBat) High



DTC	563	SPN	168	FMI	15

Measurement: System Voltage to ECM

Description:

The battery voltage powers the ECM and must be within limits to correctly operate injector drivers, ignition coils, throttle, power supplies, and other powered devices that the ECM controls.

Fault Enabled in Calibration?	**YES**
Emissions-related Fault?	**NO**
Check Condition:	Key on, Engine Cranking or Running

Fault Set Conditions (as defined in calibration):

• Voltage >	16.00	volts

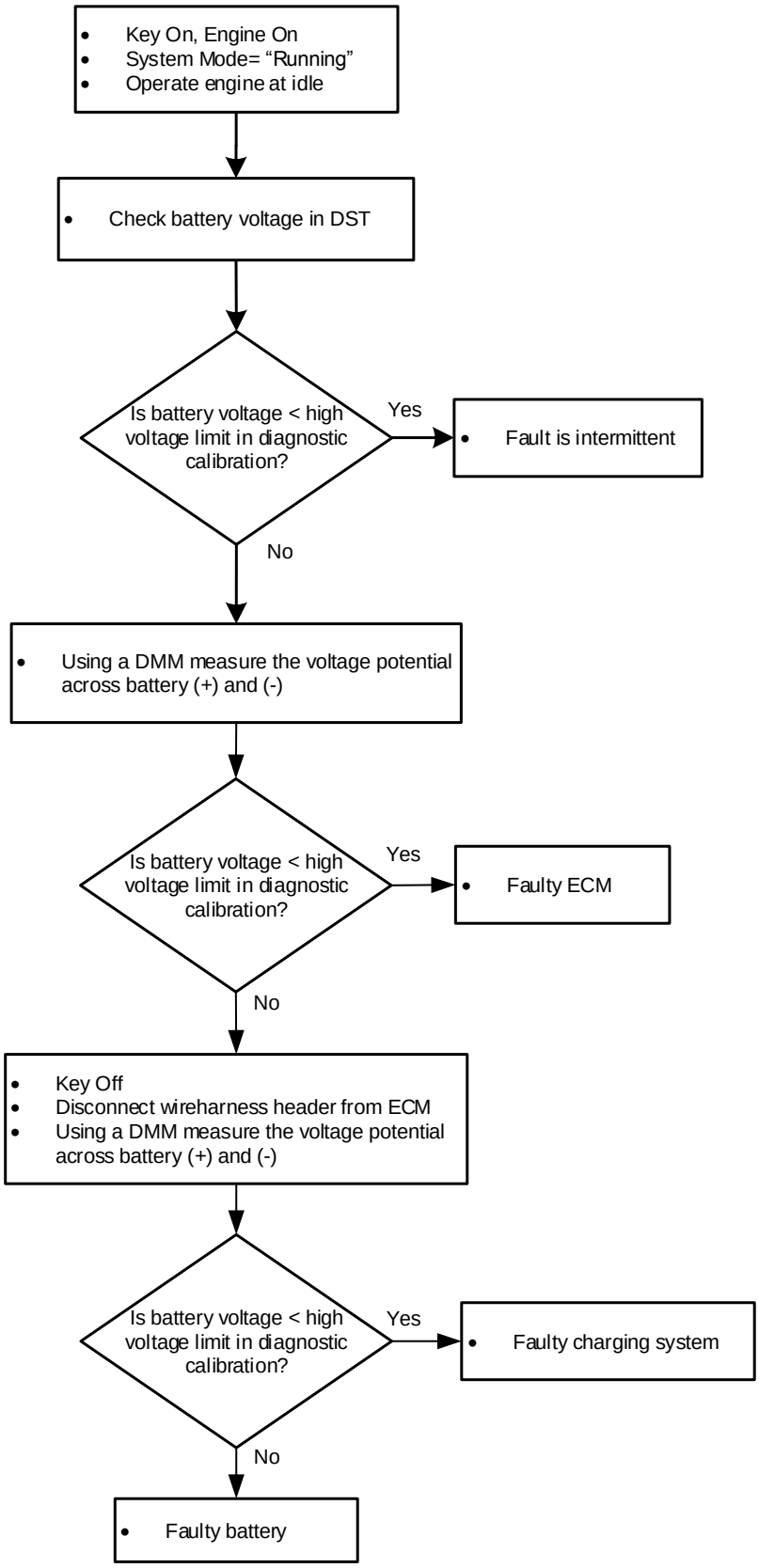
Possible Causes:

This fault will set if the ECM detects system voltage greater than x volts while the engine is running or cranking as defined in the diagnostic calibration. The adaptive learn is disabled to avoid improper adaptive learning.

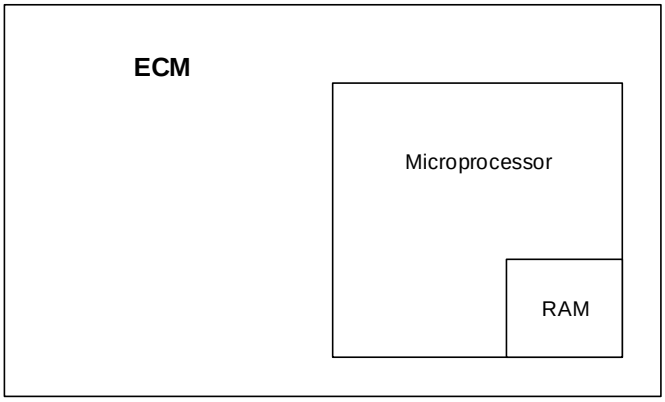
Corrective Actions:

Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	
Never Forget		AL Disable		Low Rev Limit		MIL Persist Disable	
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable		Power Derate 1		Soft Warning		NOx Control System	

3.39.1 DTC 563 - Battery Voltage (VBat) High (Trouble Tree)



3.40 DTC 601 - Microprocessor Failure – FLASH



DTC	601	SPN	628	FMI	13

Hardware: Engine Control Module – Flash Memory

Description:

The ECM has checks that must be satisfied each time an instruction is executed. Several different things can happen within the microprocessor that will cause this fault.

Fault Enabled in Calibration?	**YES**
Emissions-related Fault?	**NO**
Check Condition:	Key on

Fault Set Conditions (as defined in calibration):

- Internal microprocessor error

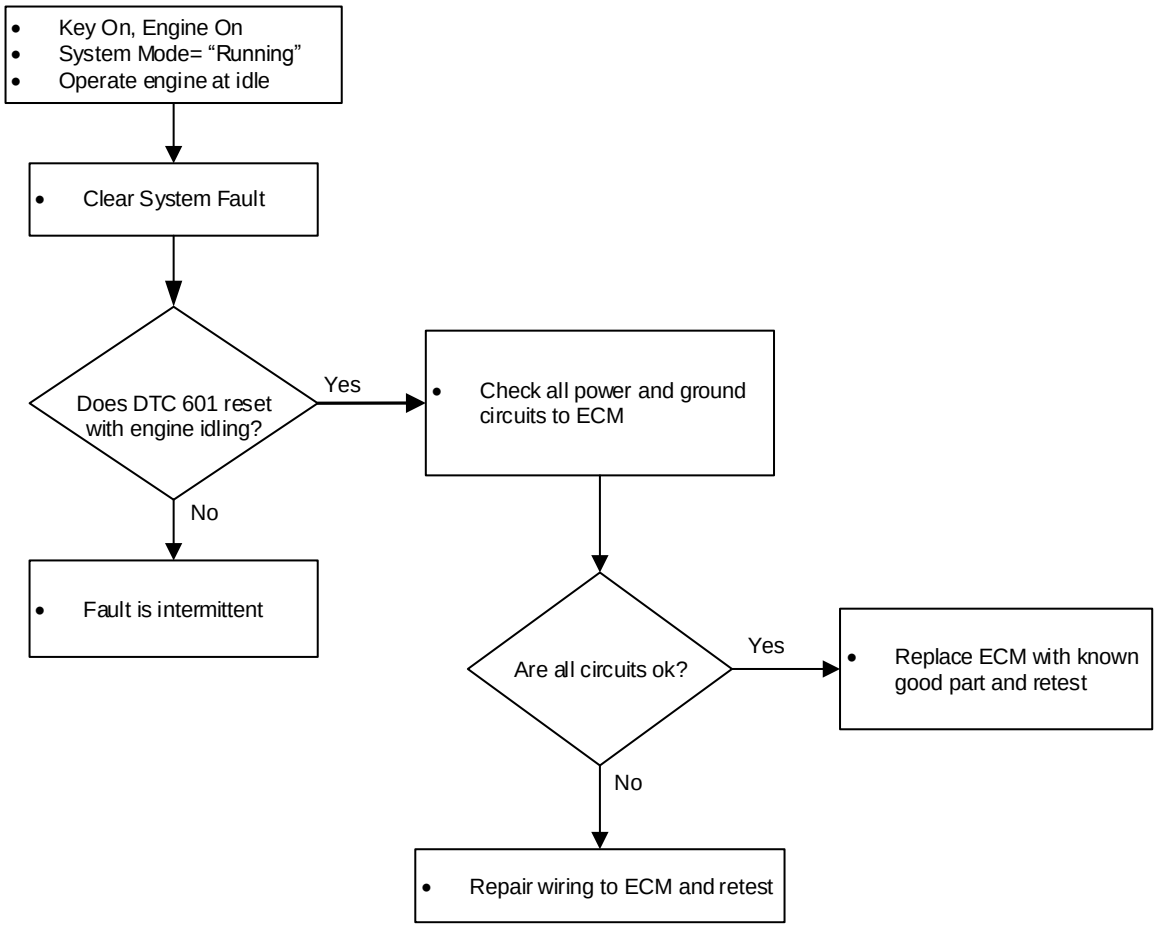
Possible Causes:

If this fault sets, the ECM will reset itself and log the code. The fault should be configured to never forget and will not self-erase and will not clear until a technician performs diagnostics and manually clears the code. This fault should be configured to set a power derate 2 and low rev limit to reduce possible engine damage and reduce possibility of an overspeed condition. A fault of flash memory can occur for any calibration variable set and thus could cause undesirable operation.

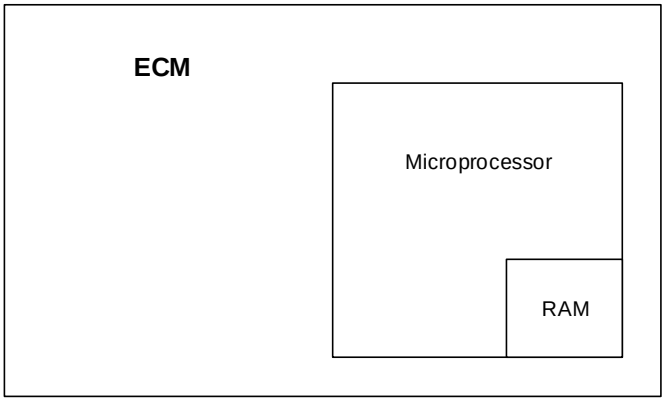
Corrective Actions:

Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	X
Never Forget	X	AL Disable		Low Rev Limit		MIL Persist Disable	
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable		Power Derate 1		Soft Warning		NOx Control System	

3.40.1 DTC 601 - Microprocessor Failure – Flash (Trouble Tree)



3.41 DTC 604 - Microprocessor Failure – RAM



DTC	604	SPN	630	FMI	12

Hardware: Engine Control Module – Random Access Memory

Description:

Random Access Memory is located within the microprocessor and can be read from or written to at any time. Data stored in RAM include DTCs (when fault configuration is set to “Battery Power Retained”), adaptive fuel learn tables, octane adaptation table, misfire adaption tables, and closed loop fuel multipliers. The ECM has checks that must be satisfied each time an instruction is executed.

Fault Enabled in Calibration?	**YES**
Emissions-related Fault?	**NO**
Check Condition:	Key on

Fault Set Conditions (as defined in calibration):

- Internal microprocessor error

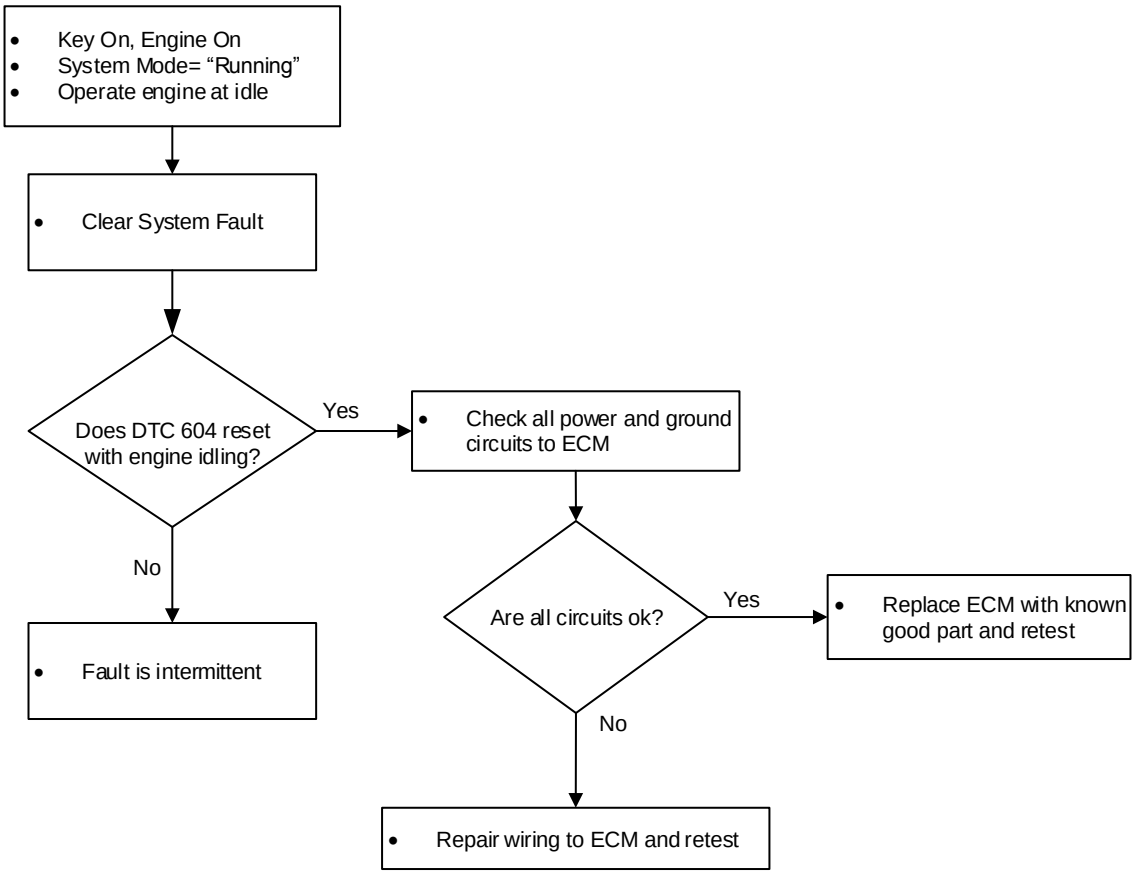
Possible Causes:

This fault will set if the ECM detects a problem accessing or writing information to RAM and should be configured to set a power derate 2 and low rev limit to reduce possible engine damage and reduce possibility of an overspeed condition. If this fault sets, the ECM will reset itself and log the code. This fault should be erased by a technician after diagnostics are performed. The fault should be configured to never forget and will not self-erase.

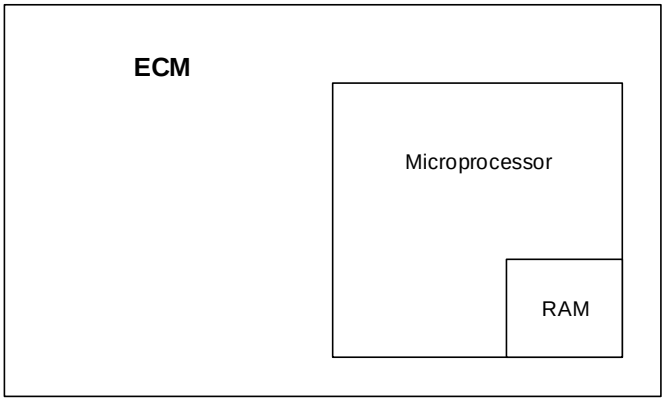
Corrective Actions:

Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	X
Never Forget	X	AL Disable		Low Rev Limit		MIL Persist Disable	
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable		Power Derate 1		Soft Warning		NOx Control System	

3.41.1 DTC 604 - Microprocessor Failure – RAM (Trouble Tree)



3.42 DTC 606 - Microprocessor Failure - COP



DTC	606	SPN	629	FMI	31

Hardware: Engine Control Module

Description:

The ECM has checks that must be satisfied each time an instruction is executed. Several different things can happen within the microprocessor that will cause this fault.

Fault Enabled in Calibration?	**YES**
Emissions-related Fault?	**NO**
Check Condition:	Key on

Fault Set Conditions (as defined in calibration):

- Internal microprocessor error

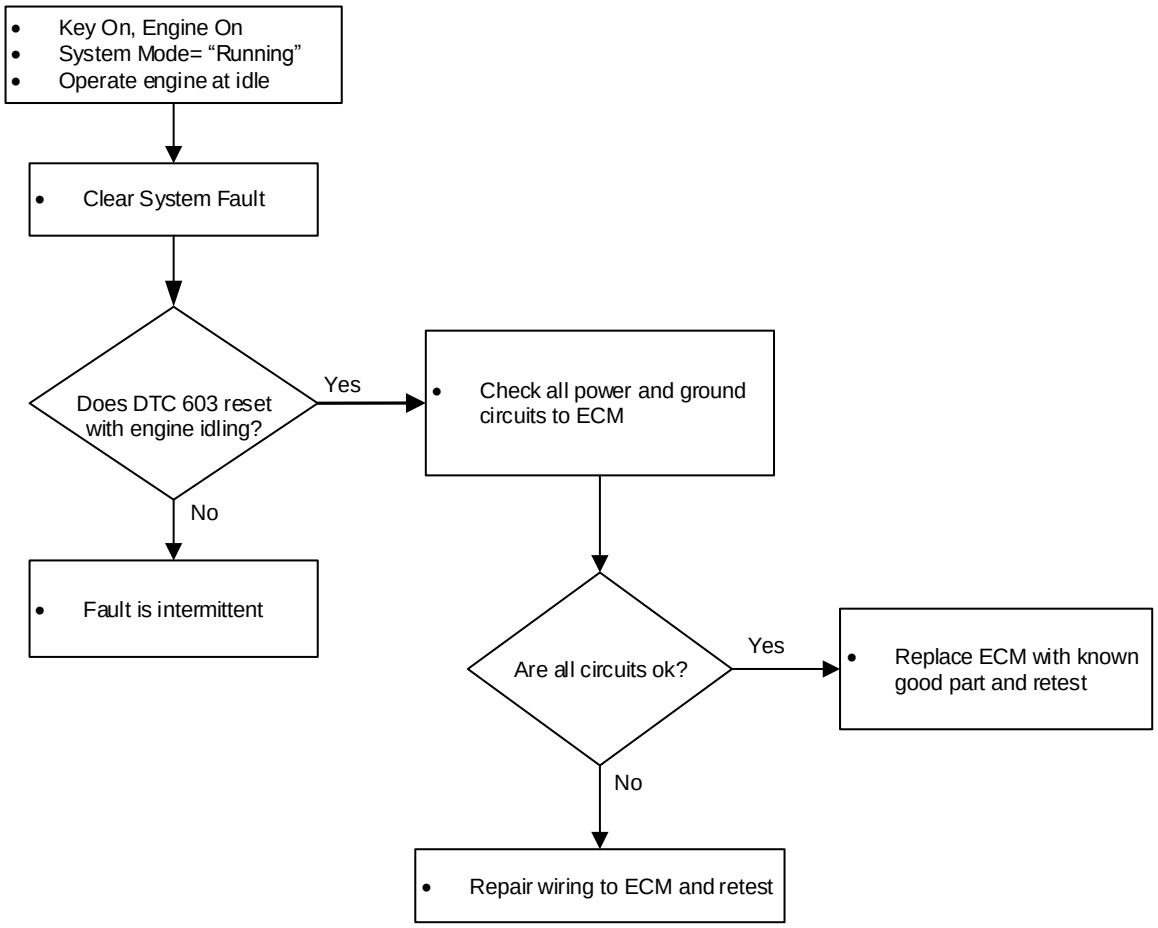
Possible Causes:

If this fault sets, the ECM will reset itself and log the code. The fault should be configured to never forget and will not self-erase and will not clear until a technician performs diagnostics and manually clears the code. This fault should be configured to set a power derate 2 and low rev limit to reduce possible engine damage and reduce possibility of an overspeed condition.

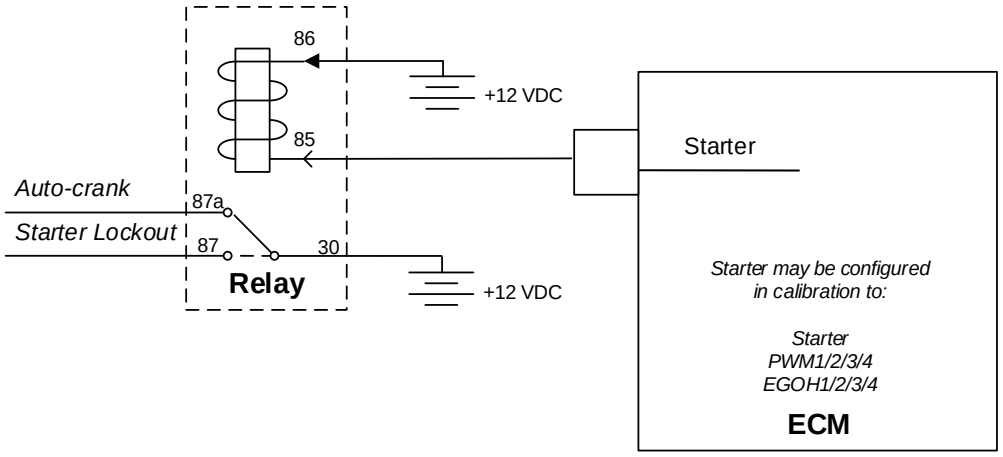
Corrective Actions:

Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	X
Never Forget	X	AL Disable		Low Rev Limit		MIL Persist Disable	
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable		Power Derate 1		Soft Warning		NOx Control System	

3.42.1 DTC 606 - Microprocessor Failure – COP (Trouble Tree)



3.43 DTC 615 - Start Relay Coil Open



DTC	615	SPN	1321	FMI	5

Hardware: Starter Relay

Description:

The ECM has auxiliary low-side drivers that can turn on warning devices or ground electromagnetic relay coils to control power to devices connected to the engine.

Fault Enabled in Calibration?	**YES**
Emissions-related Fault?	**NO**
Check Condition:	Key On, Engine Cranking

Fault Set Conditions (as defined in calibration):

• Low-side feedback <	10.0	% Vbat
OR		
• high-side feedback >	4.00	volts
• and short-to-power fault inactive		

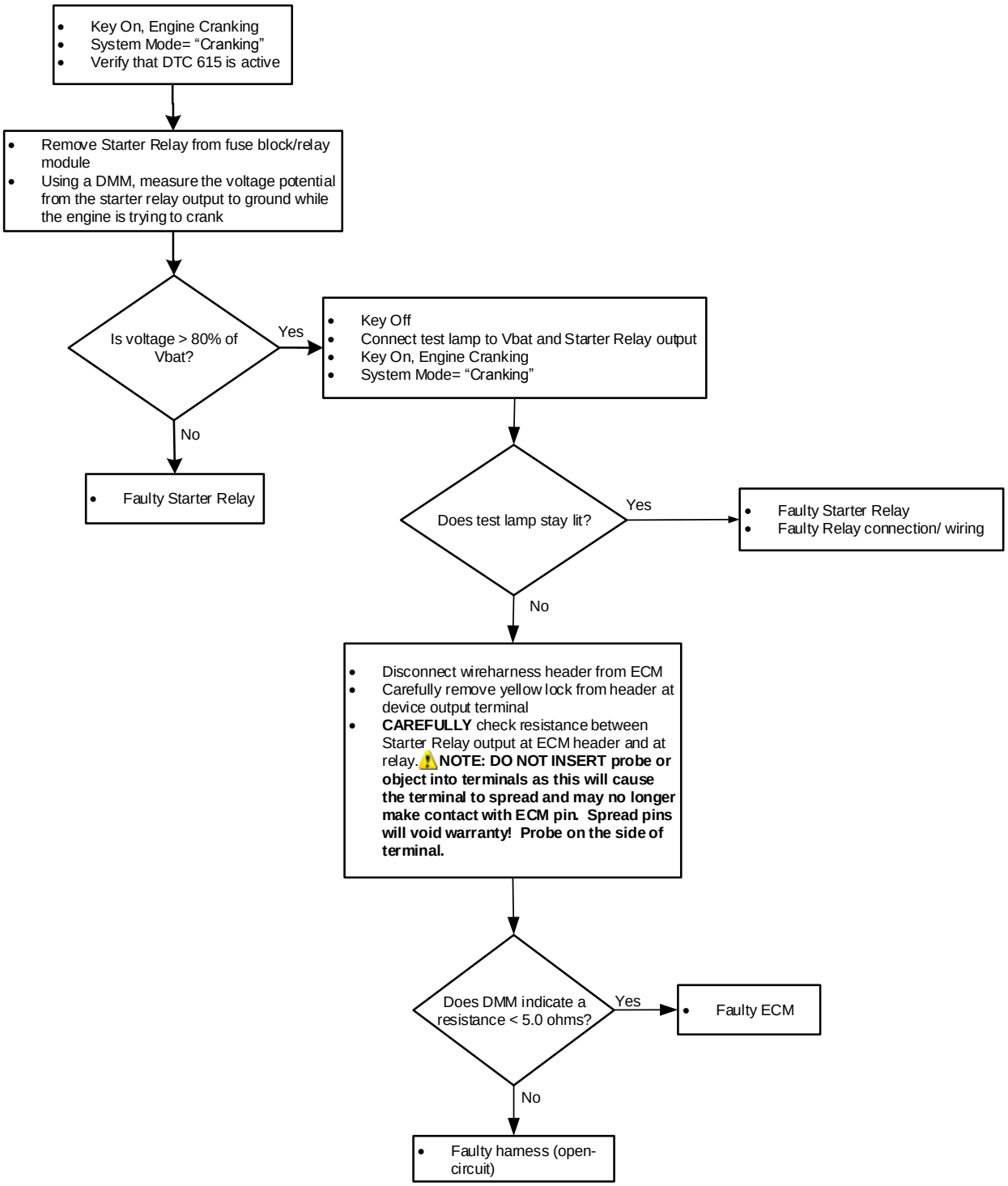
Possible Causes:

This fault sets if the output for the starter relay is detected as an open circuit. If this fault is active the starter motor will not receive power and will not engage.

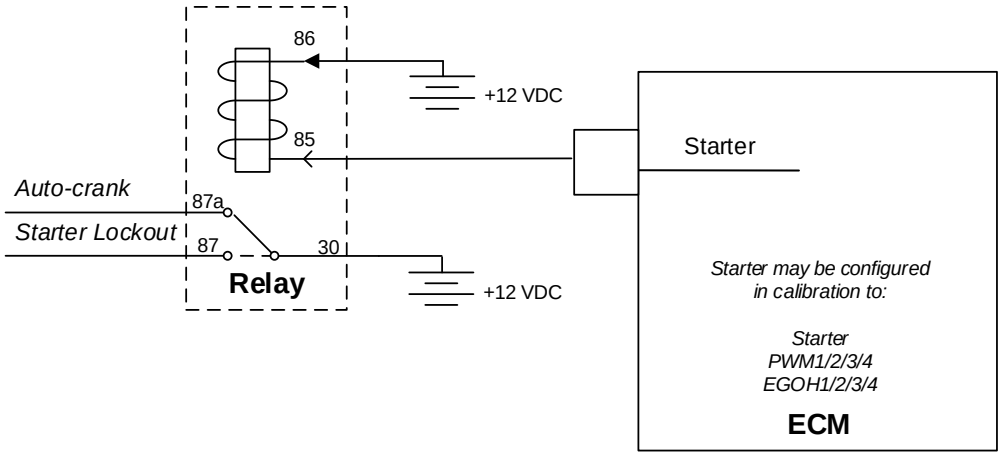
Corrective Actions:

Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	
Never Forget		AL Disable		Low Rev Limit		MIL Persist Disable	
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable		Power Derate 1		Soft Warning		NOx Control System	

3.43.1 DTC 615 - Start Relay Coil Open (Trouble Tree)



3.44 DTC 616 - Start Relay Control Ground Short



DTC	616	SPN	1321	FMI	4

Hardware: Starter Relay

Description:

The ECM has auxiliary low-side drivers that can turn on warning devices or ground electromagnetic relay coils to control power to devices connected to the engine.

Fault Enabled in Calibration?	**YES**
Emissions-related Fault?	**NO**
Check Condition:	Key On, Engine Cranking

Fault Set Conditions (as defined in calibration):

- Low-side diagnostics non-adjustable

OR

• high-side feedback <	10.0	% Vbat

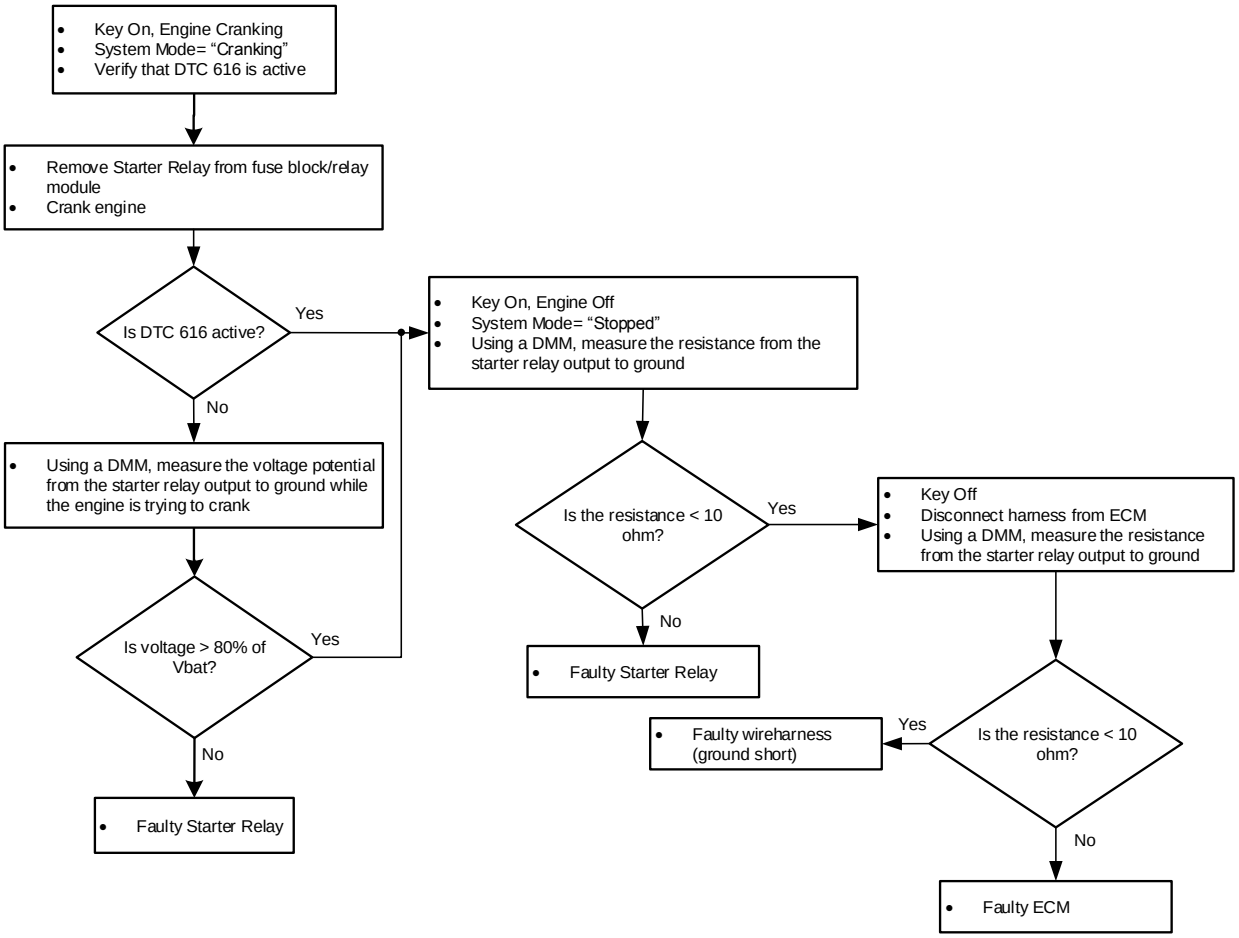
Possible Causes:

This fault sets if the output for the starter relay is detected as an open circuit. If this fault is active the starter motor will not receive power and will not engage.

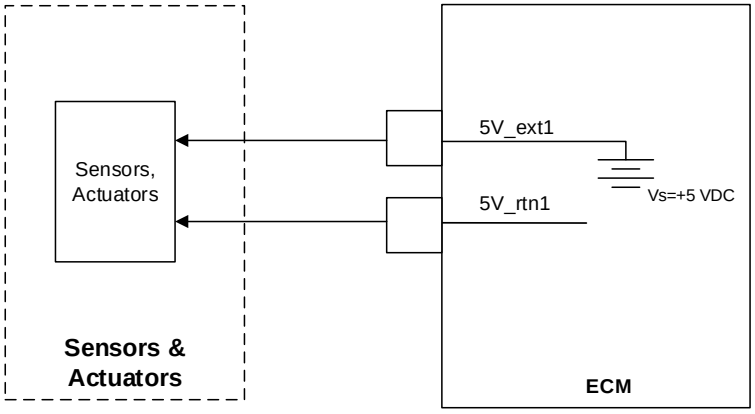
Corrective Actions:

Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	
Never Forget		AL Disable		Low Rev Limit		MIL Persist Disable	
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable		Power Derate 1		Soft Warning		NOx Control System	

3.44.1 DTC 616 - Start Relay Control Ground Short (Trouble Tree)



3.45 DTC 642 - Sensor Supply Voltage 1 Low (5Vext1)



DTC	642	SPN	1079	FMI	4

Hardware: External Sensor Supply Voltage Regulator

Description:

The external 5-volt supply powers sensors and other components in the engine control system. The accuracy of this supply is critical to the accuracy of the sensors' feedback, therefore, it is supplied from a precision regulator whose output is internally monitored by the ECM. The ECM monitors the 5-volt supply to ratio metrically correct sensor feedback and determine if the circuit is overloaded, shorted, or otherwise out of specification.

Fault Enabled in Calibration?	**YES**
Emissions-related Fault?	**NO**
Check Condition:	Key On, Engine Off and Running

Fault Set Conditions (as defined in calibration):

• 5VE1 <	4.60	volts

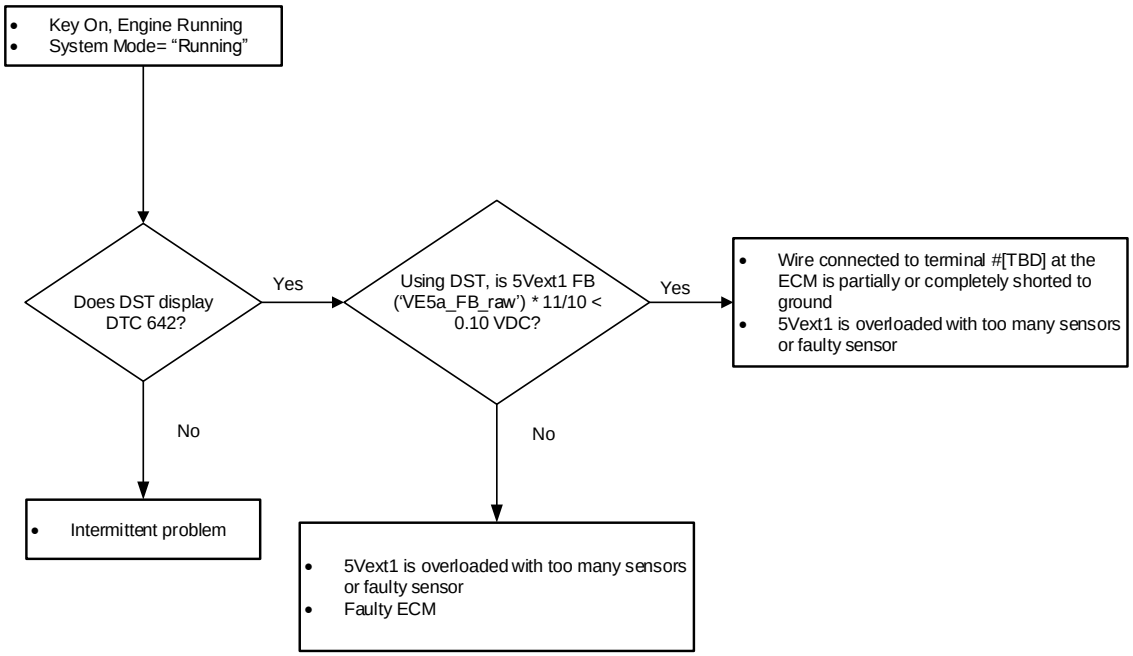
Possible Causes:

This fault will set if the internally measured voltage feedback of the regulator output is lower than the low voltage limit as defined in the diagnostic calibration anytime the engine is running or stopped at key-on (if applicable).

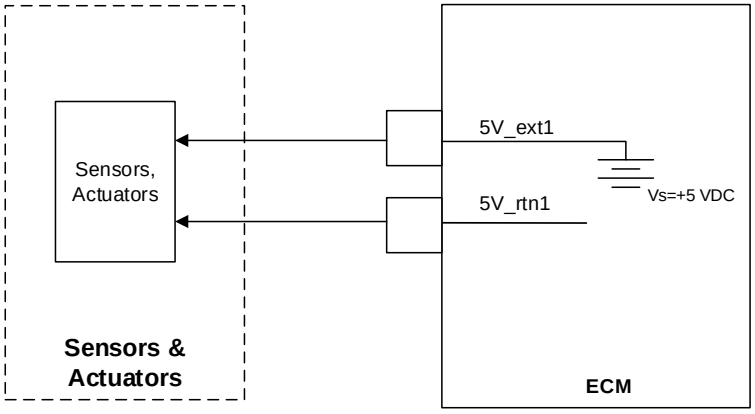
Corrective Actions:

Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	
Never Forget		AL Disable		Low Rev Limit		MIL Persist Disable	
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable		Power Derate 1		Soft Warning		NOx Control System	

3.45.1 DTC 642 - Sensor Supply Voltage 1 Low (5VEXT1) (Trouble Tree)



3.46 DTC 643 - Sensor Supply Voltage 1 High (5Vext1)



DTC	643	SPN	1079	FMI	3

Hardware: External Sensor Supply Voltage Regulator

Description:

The external 5-volt supply powers sensors and other components in the engine control system. The accuracy of this supply is critical to the accuracy of the sensors' feedback, therefore, it is supplied from a precision regulator whose output is internally monitored by the ECM. The ECM monitors the 5-volt supply to ratio metrically correct sensor feedback and determine if the circuit is overloaded, shorted, or otherwise out of specification.

Fault Enabled in Calibration?	**YES**
Emissions-related Fault?	**NO**
Check Condition:	Key On, Engine Off and Running

Fault Set Conditions (as defined in calibration):

• 5VE1 >	5.40	volts

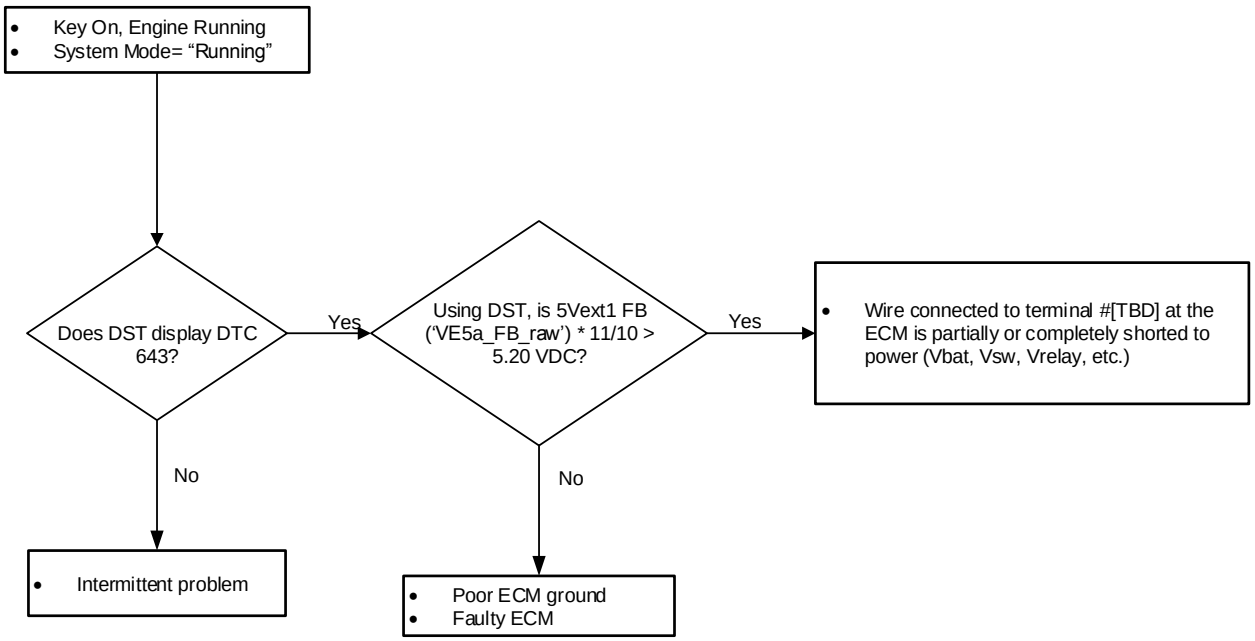
Possible Causes:

This fault will set if the internally measured voltage feedback of the regulator output is higher than the high voltage limit as defined in the diagnostic calibration anytime the engine is running or stopped at key-on (if applicable).

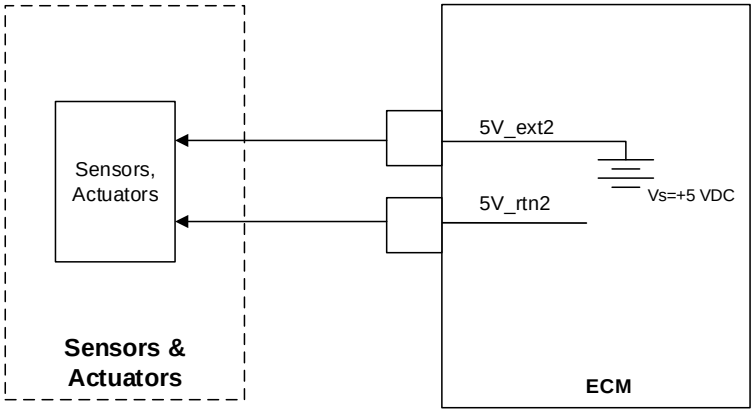
Corrective Actions:

Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	
Never Forget		AL Disable		Low Rev Limit		MIL Persist Disable	
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable		Power Derate 1		Soft Warning		NOx Control System	

3.46.1 DTC 643- Sensor Supply Voltage 1 High (5VEXT1) (Trouble Tree)



3.47 DTC 652 - Sensor Supply Voltage 2 Low (5Vext2)



DTC	652	SPN	1080	FMI	4

Hardware: External Sensor Supply Voltage Regulator

Description:

The external 5-volt supply powers sensors and other components in the engine control system. The accuracy of this supply is critical to the accuracy of the sensors' feedback, therefore, it is supplied from a precision regulator whose output is internally monitored by the ECM. The ECM monitors the 5-volt supply to ratio metrically correct sensor feedback and determine if the circuit is overloaded, shorted, or otherwise out of specification.

Fault Enabled in Calibration?	**YES**
Emissions-related Fault?	**NO**
Check Condition:	Key On, Engine Off and Running

Fault Set Conditions (as defined in calibration):

• 5VE2 <	3.00	volts

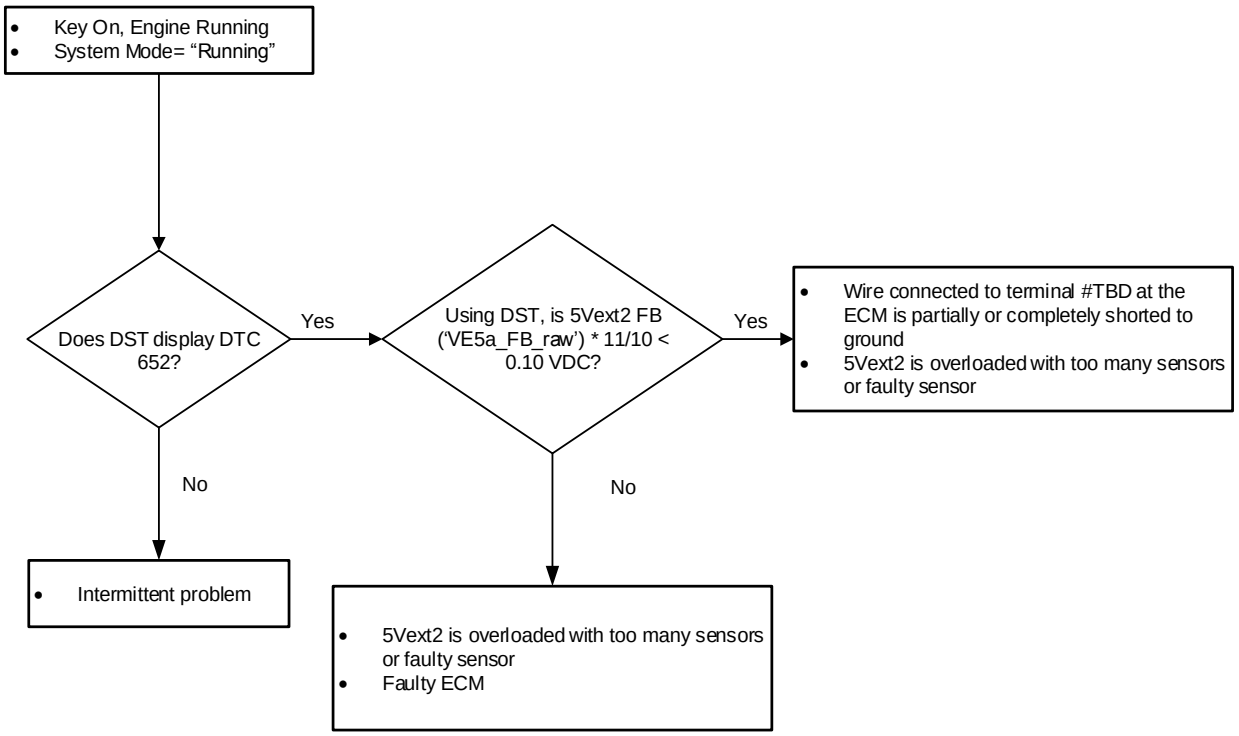
Possible Causes:

This fault will set if the internally measured voltage feedback of the regulator output is lower than the low voltage limit as defined in the diagnostic calibration anytime the engine is running or stopped at key-on (if applicable).

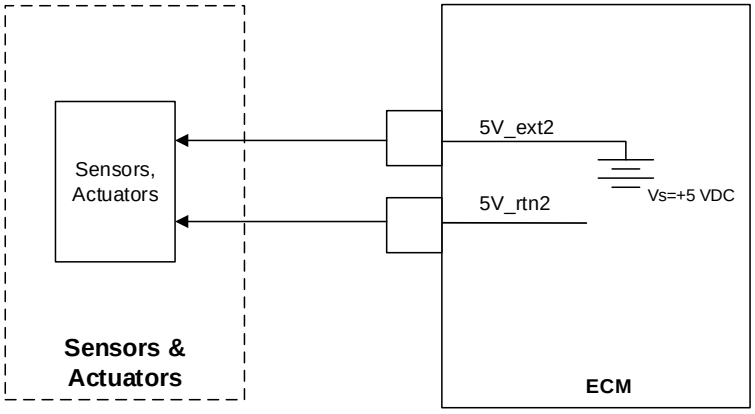
Corrective Actions:

Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	
Never Forget		AL Disable		Low Rev Limit		MIL Persist Disable	
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable		Power Derate 1		Soft Warning		NOx Control System	

3.47.1 DTC 652 - Sensor Supply Voltage 2 Low (5VEXT2) (Trouble Tree)



3.48 DTC 653 – Sensor Supply Voltage 2 High (5Vext2)



DTC	653	SPN	1080	FMI	3

Hardware: External Sensor Supply Voltage Regulator

Description:

The external 5-volt supply powers sensors and other components in the engine control system. The accuracy of this supply is critical to the accuracy of the sensors' feedback, therefore, it is supplied from a precision regulator whose output is internally monitored by the ECM. The ECM monitors the 5-volt supply to ratio metrically correct sensor feedback and determine if the circuit is overloaded, shorted, or otherwise out of specification.

Fault Enabled in Calibration?	**YES**
Emissions-related Fault?	**NO**
Check Condition:	Key On, Engine Off and Running

Fault Set Conditions (as defined in calibration):

• 5VE2 >	5.40	volts

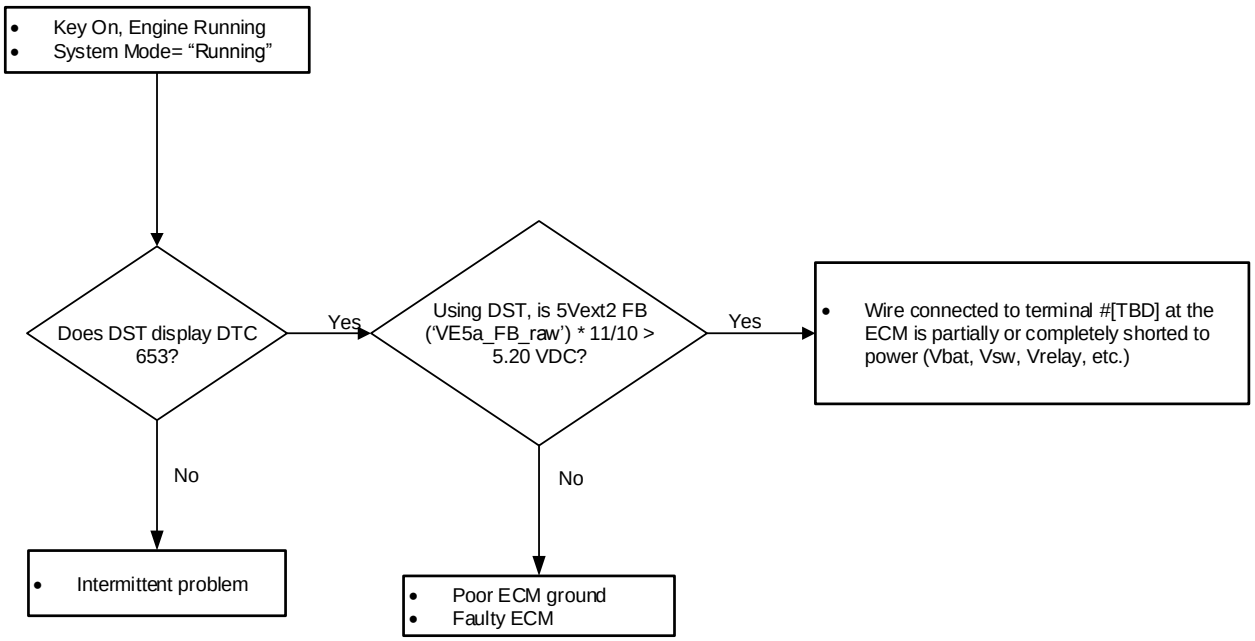
Possible Causes:

This fault will set if the internally measured voltage feedback of the regulator output is higher than the high voltage limit as defined in the diagnostic calibration anytime the engine is running or stopped at key-on (if applicable).

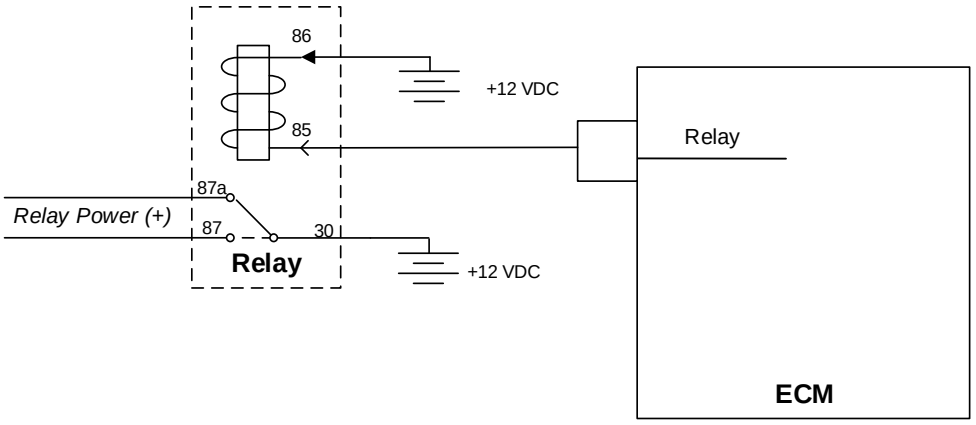
Corrective Actions:

Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	
Never Forget		AL Disable		Low Rev Limit		MIL Persist Disable	
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable		Power Derate 1		Soft Warning		NOx Control System	

3.48.1 DTC 653- Sensor Supply Voltage 2 High (5VEXT2) (Trouble Tree)



3.49 DTC 685 - Relay Coil Open



DTC	685	SPN	1485	FMI	5

Hardware: Power Relay

Description:

The ECM has auxiliary low-side drivers that can turn on warning devices or ground electromagnetic relay coils to control power to devices connected to the engine.

Fault Enabled in Calibration?	**YES**
Emissions-related Fault?	**NO**
Check Condition:	Key On, Engine Off

Fault Set Conditions (as defined in calibration):

• Low-side feedback <	10.0	% Vbat

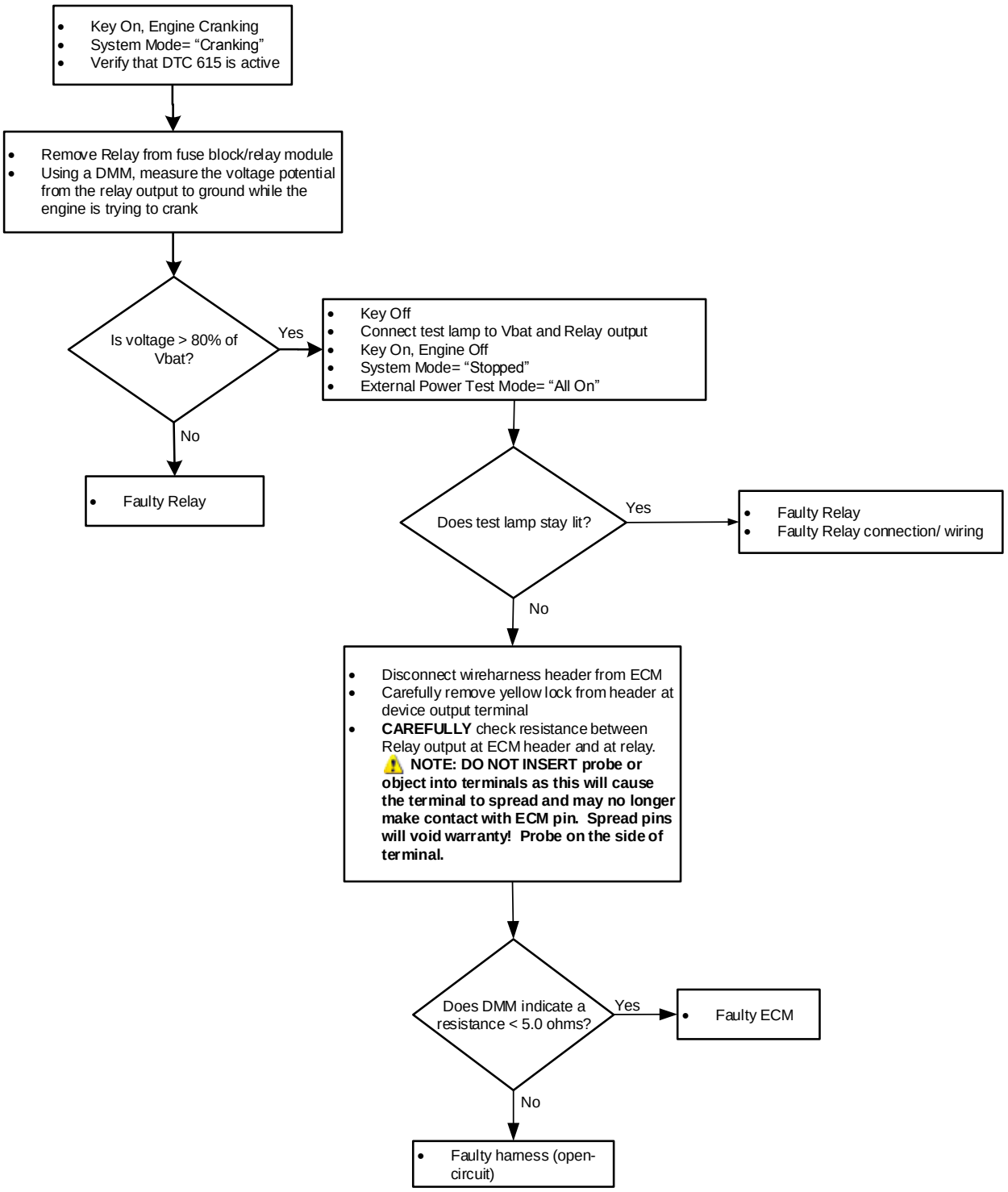
Possible Causes:

This fault sets if the output for the power relay is detected as an open circuit. If this fault is active the relay-powered device(s)(O_2 sensor(s), ignition coil(s), injector(s) or similar) will not receive power and the engine likely will not run.

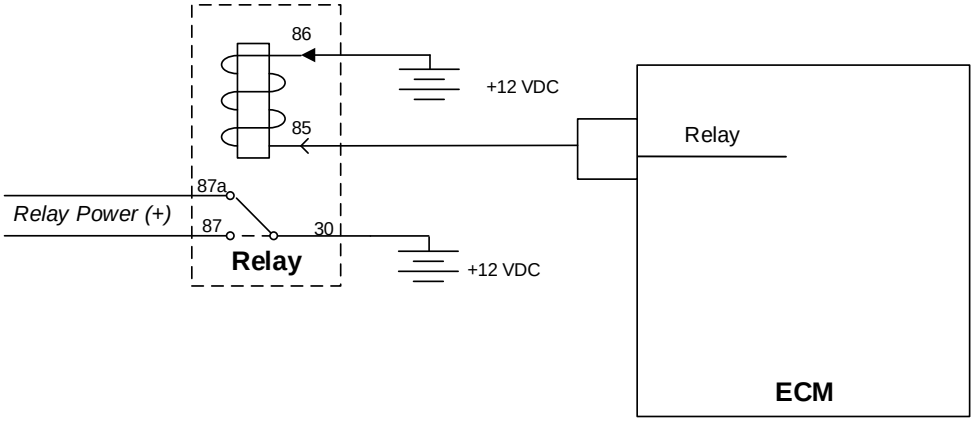
Corrective Actions:

Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	
Never Forget		AL Disable		Low Rev Limit		MIL Persist Disable	
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	X
CL Disable		Power Derate 1		Soft Warning		NOx Control System	

3.49.1 DTC 685 - Relay Coil Open (Trouble Tree)



3.50 DTC 686 - Relay Control Ground Short



DTC	686	SPN	1485	FMI	4

Hardware: Power Relay

Description:

The ECM has auxiliary low-side drivers that can turn on warning devices or ground electromagnetic relay coils to control power to devices connected to the engine.

Fault Enabled in Calibration?	**YES**
Emissions-related Fault?	**NO**
Check Condition:	Key On, Engine Off

Fault Set Conditions (as defined in calibration):

• Low-side feedback <	10.0	% Vbat

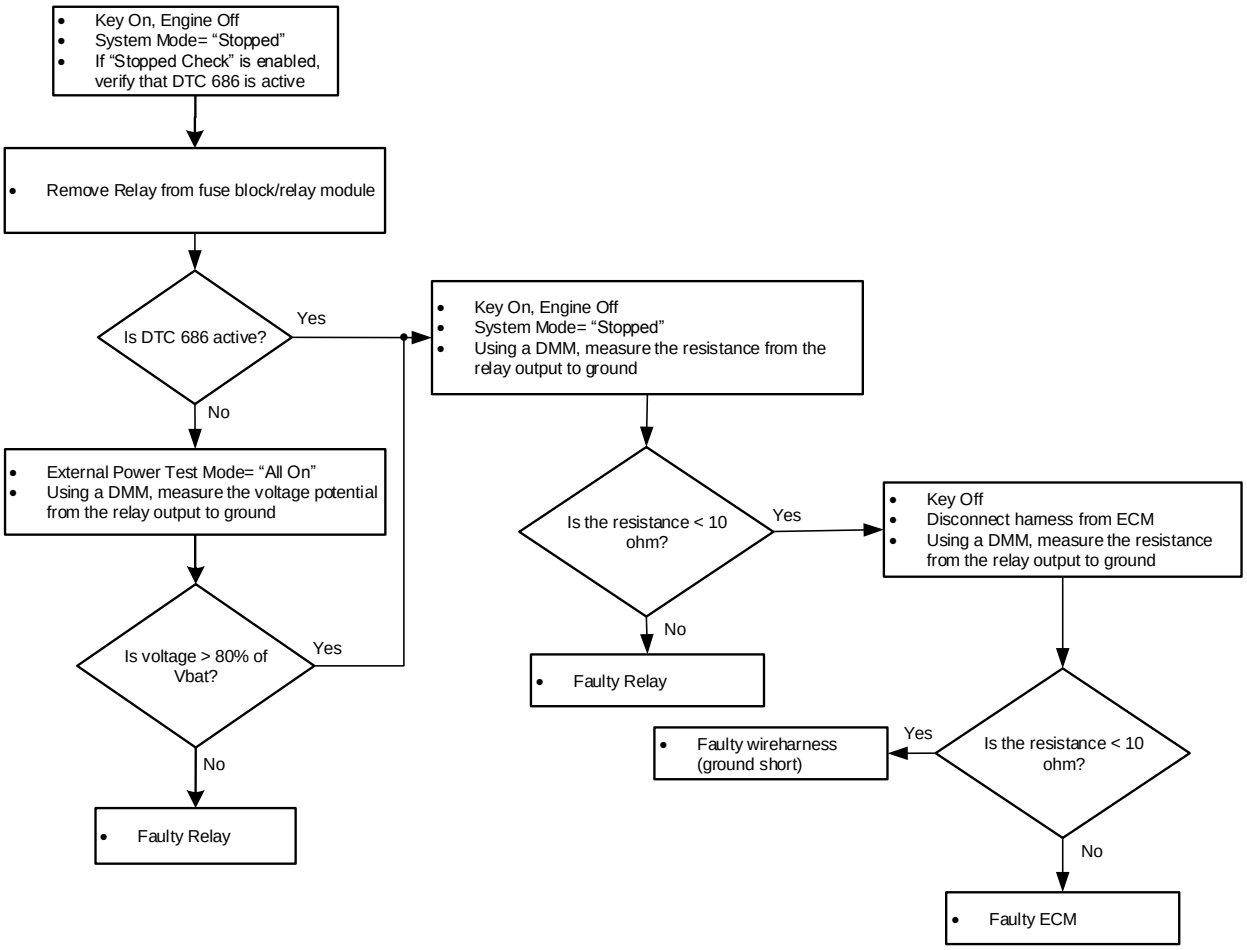
Possible Causes:

This fault sets if the output for the relay is detected as being shorted to ground. If this fault is active and the high-side of the relay is supplied, the relay-powered device(s)(O_2 sensor(s), ignition coil(s), injector(s) or similar) will run until the relay or high-side power is removed.

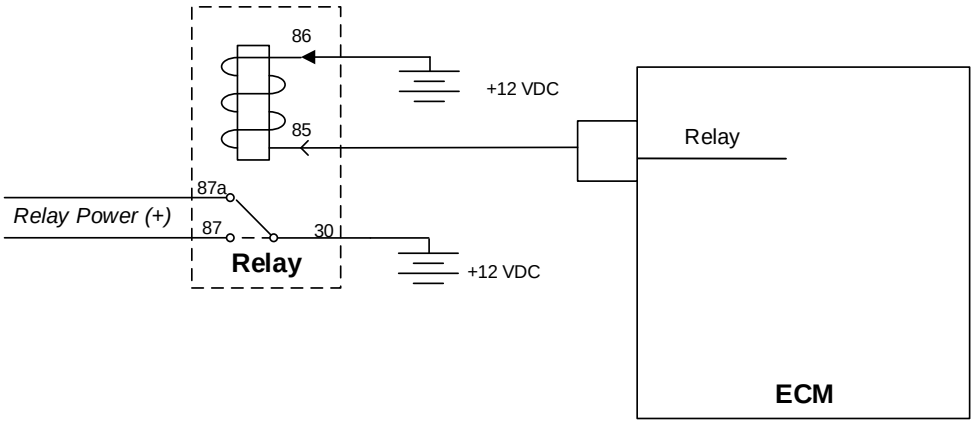
Corrective Actions:

Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	
Never Forget		AL Disable		Low Rev Limit		MIL Persist Disable	
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	X
CL Disable		Power Derate 1		Soft Warning		NOx Control System	

3.50.1 DTC 686 - Relay Coil Ground Short (Trouble Tree)



3.51 DTC 687 - Relay Coil Short to Power



DTC	687	SPN	1485	FMI	3

Hardware: Power Relay

Description:

The ECM has auxiliary low-side drivers that can turn on warning devices or ground electromagnetic relay coils to control power to devices connected to the engine.

Fault Enabled in Calibration?	**YES**
Emissions-related Fault?	**NO**
Check Condition:	Key On, Engine Off

Fault Set Conditions (as defined in calibration):

• Low-side feedback >	90.0	% Vbat

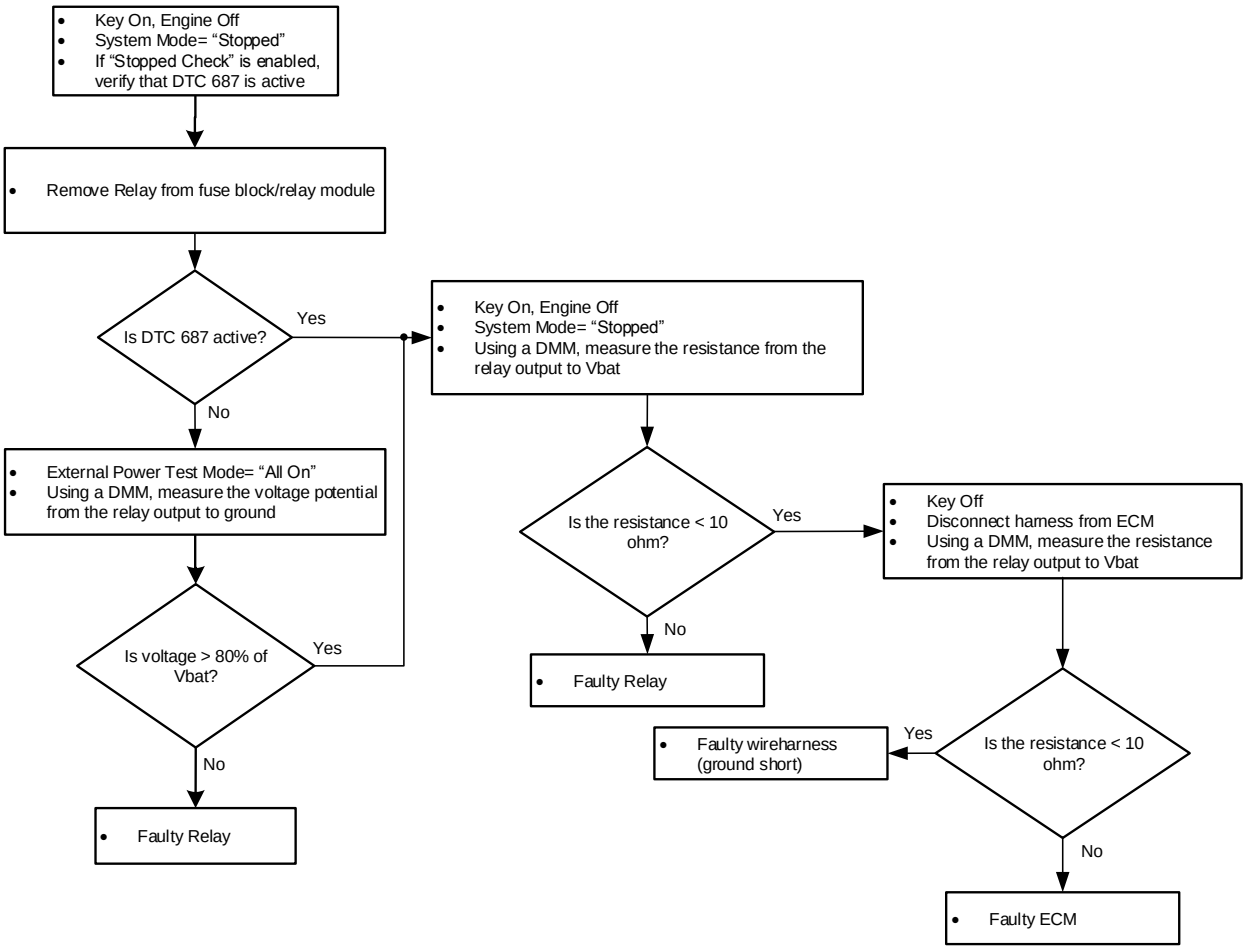
Possible Causes:

This fault sets if the output for the relay is detected as shorted to power. If this fault is active the relay-powered device(s)(O_2 sensor(s), ignition coil(s), injector(s) or similar) will not receive power and will not run.

Corrective Actions:

Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	
Never Forget		AL Disable		Low Rev Limit		MIL Persist Disable	
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable		Power Derate 1		Soft Warning		NOx Control System	

3.51.1 DTC 687 - Relay Coil Short to Power (Trouble Tree)



3.52 DTC 1089 (359) - Fuel Runout Longer Than Expected

DTC	1089 (359)	SPN	632	FMI	31

Hardware: Lockoff Valve

Hardware Description:

A normally closed electromechanical fuel shut-off is used to isolate the Dual Stage Regulator (DSR) or the Continuous Flow Valve (CFV) and all downstream components from the upstream fuel supply when the engine is shut off.

For all CFV systems, dual lock-off valves are required. For LNG applications, the dual lock-offs are a CFV Flange- mounted valve (EControls PN E2393500 or an application-specific variant) plus an in-line lock-off valve. For CNG applications, the dual lock-offs are a CFV Flange-mounted valve plus a high pressure CNG tank lock-off provided by the OEM.

Check Condition: Key Off / Engine Running

Fault Set Conditions (as defined in calibration):

• Fuel run-out engine run time >	20000	ms
• and ECT >	-40	deg F
• and ECT > above temp for	0	sec
• Historic fault forced indication*		

* This switch controls the soft or hard warning output if there is a historic fault stored for this lockoff diagnostic. If this switch is set to other than 'Disabled', then that particular warning output channel will be forced to an ON state continuously until the historic fault is cleared by either a technician or the start-cycle auto-clearing mechanism.

Fault Description:

This fault will set when the time past key-off/lockoff-off exceeds a calibrated duration value during fuel runout mode.

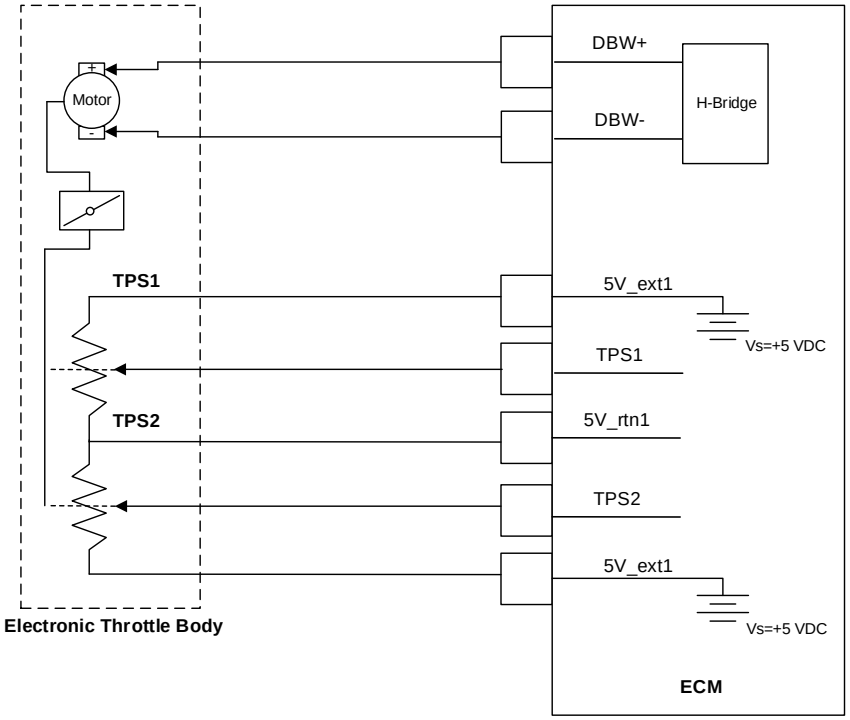
Corrective Actions *(see Table 1 for descriptions of individual corrective actions):*

Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	
Never Forget		AL Disable		Low Rev Limit		MIL Persist Disable	X
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable		Power Derate 1		Soft Warning		NOx Control System	

Diagnostic Aids/Trouble Tree

With the engine running disconnect the electrical connector on the fuel shut-off solenoid from the engine harness. If the engine continues to run after 60 seconds replace the fuel shut-off solenoid.

3.53 DTC 1111- RPM Above Fuel Rev Limit Level



DTC	1111	SPN	515	FMI	16

Measurement / Hardware:	Fuel Rev Limit- Crankshaft Position Sensor

Description (includes additional corrective actions):

This fault is designed to help prevent engine or equipment damage and will disable fuel injectors or gaseous fuel actuator to reduce engine speed. The throttle will also be lowered in order to govern the engine to the speed set in the diagnostic calibration for Max Gov Override.

Fault Enabled in Calibration?	**YES**
Emissions-related Fault?	**NO**
Check Condition:	Engine Running

Fault Set Conditions (as defined in calibration):

• rpm >	2200	rpm

Possible Causes:

This fault will set anytime the engine RPM exceeds the limit set in the diagnostic calibration for the latch time or more. This speed overrides any higher max governor speeds programmed by the user.

Corrective Actions:

Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	
Never Forget		AL Disable		Low Rev Limit		MIL Persist Disable	X
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable		Power Derate 1		Soft Warning		NOx Control System	

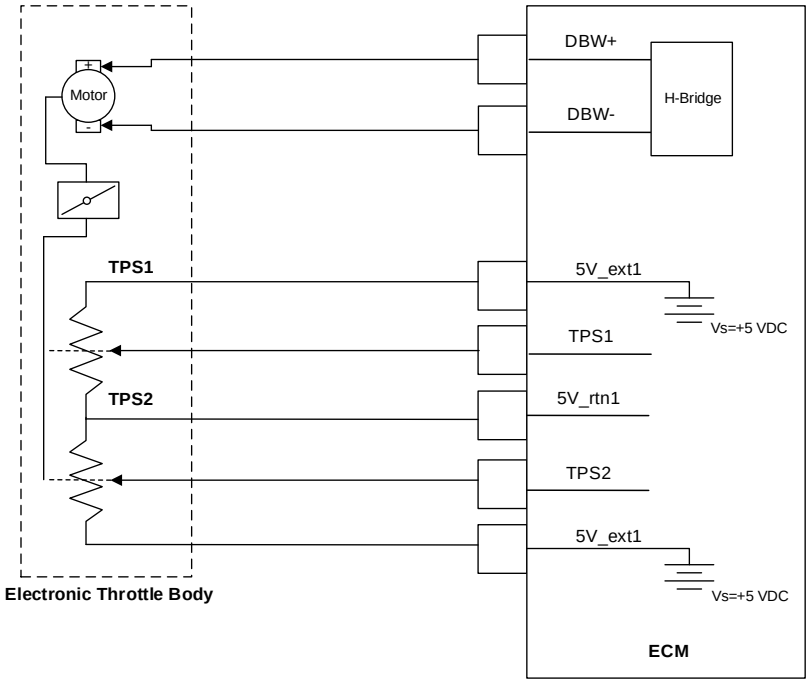
3.53.1 DTC 1111- RPM Above Fuel Rev Limit Level (Diagnostic Aids)

Diagnostic Aids

NOTE: If any other DTCs are present, diagnose those first.

- ☐ Ensure that no programmed governor speeds exceed the limit set in the diagnostic calibration for Max Gov Override Speed
- ☐ Check mechanical operation of the throttle
- ☐ Check the engine intake for large air leaks downstream of the throttle body

3.54 DTC 1112- RPM Above Spark Rev Limit Level



DTC	1112	SPN	515	FMI	0

Measurement / Hardware: Fuel Rev Limit- Crankshaft Position Sensor

Description (includes additional corrective actions):

This fault is designed to help prevent engine or equipment damage and will disable the ignition coils to reduce engine speed. In addition, the throttle will be lowered in order to govern the engine to the speed set in the diagnostic calibration for Max Gov Override and the fuel injectors or gaseous fuel control actuator will be disabled to reduce the engine speed below the speed set in the diagnostic calibration for Fuel Rev Limit.

Fault Enabled in Calibration?	**YES**
Emissions-related Fault?	**NO**
Check Condition:	Engine Running

Fault Set Conditions (as defined in calibration):

• rpm >	2300	rpm

Possible Causes:

This fault will set anytime the engine RPM exceeds the limit set in the diagnostic calibration for the latch time or more. This speed overrides any higher max governor speeds programmed by the user.

Corrective Actions:

Shutdown	X	CL Disable key cyc.		Power Derate 2		Hard Warning	
Never Forget		AL Disable		Low Rev Limit		MIL Persist Disable	
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable		Power Derate 1		Soft Warning		NOx Control System	

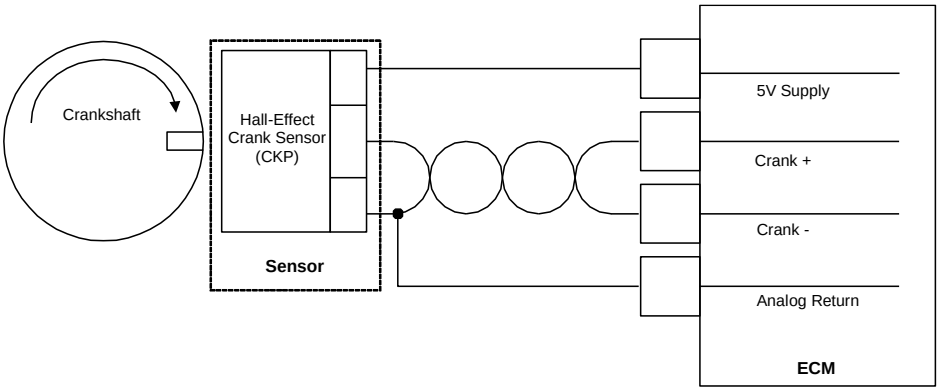
3.54.1 DTC 1112- RPM Above Spark Rev Limit Level (Diagnostic Aids)

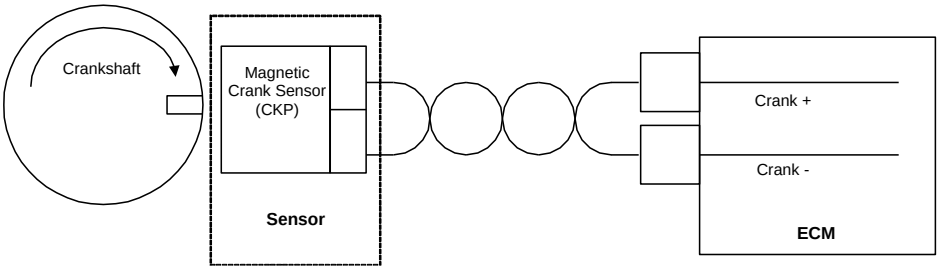
Diagnostic Aids

NOTE: If any other DTCs are present, diagnose those first.

- ☐ Ensure that no programmed governor speeds exceed the limit set in the diagnostic calibration for Max Gov Override Speed
- ☐ Check mechanical operation of the throttle
- ☐ Check the engine intake for large air leaks downstream of the throttle body

3.55 DTC 1113 - Fuel Runout Longer Than Expected





DTC	1113	**SPN**	515	**FMI**	31

Hardware: Crankshaft Position Sensor

Hardware Description:

This fault is designed to help prevent engine or equipment damage and will disable fuel injectors or gaseous fuel actuator to reduce engine speed. The throttle will also be lowered in order to govern the engine to the speed set in the diagnostic calibration for Max Gov Override.

Check Condition:	Engine Running

Fault Set Conditions (as defined in calibration):

• rpm >	2180	rpm

Fault Description:

This fault will set anytime the engine RPM exceeds the limit set in the diagnostic calibration for the latch time or longer.

Corrective Actions *(see Table 1 for descriptions of individual corrective actions)*:***:***

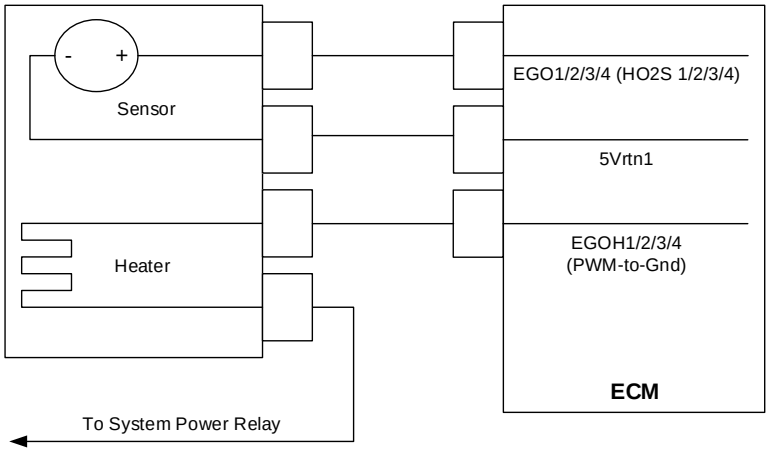
Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	
Never Forget		AL Disable		Low Rev Limit		MIL Persist Disable	
Turn on MIL		AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable		Power Derate 1		Soft Warning		NOx Control System	

Diagnostic Aids

NOTE: If any other DTCs are present, diagnose those first.

- Ensure that no programmed governor speeds exceed the limit set in the diagnostic calibration for Max Gov Override Speed
- Check mechanical operation of the throttle
- Check the engine intake for large air leaks downstream of the throttle body

3.56 DTC 1151 – Closed Loop High (LPG)



DTC	1151	SPN	4236	FMI	0

Sensor / Circuit: Heated or Universal Exhaust Gas Oxygen Sensor (Bank 1-Sensor 1/Bank 1-Before Catalyst)

Description:

The HEGO/HO2S sensor is a switching-type sensor around stoichiometry that measures the oxygen content present in the exhaust to determine if the fuel flow to the engine is correct. A HEGO/UEGO sensor measures the exhaust content across a wide-range of air-fuel ratios with a linear output proportional to lambda/equivalence ratio/air-fuel ratio. In either case, if there is a deviation between the expected reading and the actual reading, fuel flow is precisely adjusted for each bank using the Closed Loop multiplier and then “learned” with the Adaptive multiplier. The multipliers only update when the system is in either “CL Active” or “CL + Adapt” control modes. The purpose of the closed loop fuel multiplier is to quickly adjust fuel flow due to variations in fuel composition; engine wear, engine-to-engine build variances, and component degradation prior to adaptive learn fueling correction “learning” the fueling deviation.

Fault Enabled in Calibration?	**YES**
Emissions-related Fault?	**YES**
Check Condition:	Engine Running

Fault Set Conditions (as defined in calibration):

• CL_BM >	35	%
• and RPM >=	0	rpm
• and RPM <=	9999	rpm
• and MAP >=	0	psia
• and MAP <=	99	psia

(continued from previous page)

Possible Causes:

This fault sets if the Closed Loop multiplier exceeds the high limit of normal operation indicating that the engine is operating lean (excess oxygen) and requires more fuel than allowed by corrections. Often high positive fueling corrections are a function of one or more of the following conditions: 1) exhaust leaks upstream or near the HEGO sensor, 2) reduced fuel supply pressure to the gaseous fuel control system, 3) a fuel supply or manifold leak, 4) a non-responsive HEGO/UEGO sensor, and/or 5) a defective gaseous fuel control component (actuator/valve and/or mixer). This fault should be configured to disable adaptive learn for the remainder of the key-cycle to avoid improperly learning the adaptive learn table and may be configured to disable closed loop.

Corrective Actions:

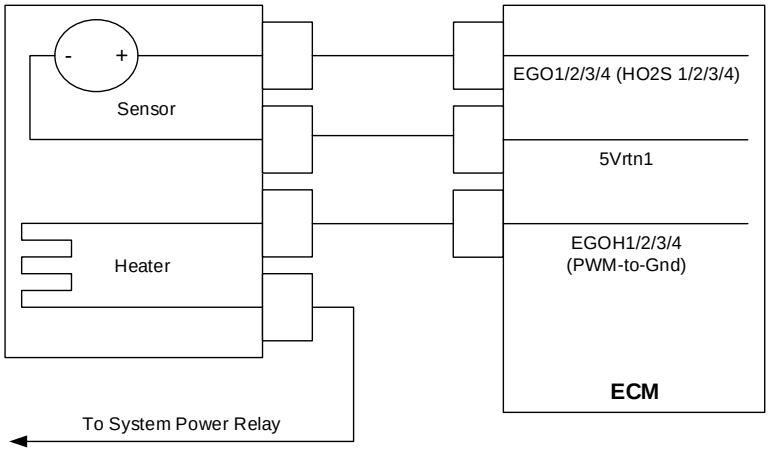
Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	
Never Forget		AL Disable	X	Low Rev Limit		MIL Persist Disable	
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable	X	Power Derate 1		Soft Warning		NOx Control System	

Diagnostic Aids

NOTE: If any other DTCs are present, diagnose those first.

- ☐ Oxygen Sensor Wire - Sensor may contact the exhaust. Check for short to ground between harness and sensor sense signal.
- ☐ Vacuum Leaks - Large vacuum leaks and crankcase leaks can cause a lean exhaust condition at light load.
- ☐ Fuel Pressure - System will be lean if fuel pressure is too low. Ensure fuel tank pressure is not too low and that gaseous fuel control actuator/regulator has proper fuel pressure under all operating conditions.
- ☐ Exhaust Leaks - If there is an exhaust leak, outside air can be pulled into the exhaust and past the O2 sensor causing a false lean condition.
- ☐ Fuel Quality - A drastic variation in fuel quality may cause the system to be lean including fuels with high inert gas content.
- ☐ System Grounding - ECM and engine must be grounded to the battery with very little resistance allowing for proper current flow. Faulty grounds can cause current supply issues resulting in many undesired problems.
- ☐ If all tests are OK, replace the HO2S or HEGO/UEGO sensor with a known good part and retest.

3.57 DTC 1152 – Closed Loop Low (LPG)



DTC	1152	SPN	4236	FMI	1

Sensor / Circuit: Heated or Universal Exhaust Gas Oxygen Sensor (Bank 1-Sensor 1/Bank 1-Before Catalyst)

Description:

The HEGO/HO2S sensor is a switching-type sensor around stoichiometry that measures the oxygen content present in the exhaust to determine if the fuel flow to the engine is correct. A HEGO/UEGO sensor measures the exhaust content across a wide-range of air-fuel ratios with a linear output proportional to lambda/equivalence ratio/air-fuel ratio. In either case, if there is a deviation between the expected reading and the actual reading, fuel flow is precisely adjusted for each bank using the Closed Loop multiplier and then “learned” with the Adaptive multiplier. The multipliers only update when the system is in either “CL Active” or “CL + Adapt” control modes. The purpose of the closed loop fuel multiplier is to quickly adjust fuel flow due to variations in fuel composition; engine wear, engine-to-engine build variances, and component degradation prior to adaptive learn fueling correction “learning” the fueling deviation.

Fault Enabled in Calibration?	**YES**
Emissions-related Fault?	**YES**
Check Condition:	Engine Running

Fault Set Conditions (as defined in calibration):

• CL_BM <	-35	%
• and RPM >=	0	rpm
• and RPM <=	9999	rpm
• and MAP >=	0	psia
• and MAP <=	99	psia

(continued from previous page)

Possible Causes:

This fault sets if the Closed Loop multiplier exceeds the low limit of normal operation indicating that the engine is operating rich (excess fuel) and requires less fuel than allowed by corrections. Often high negative fueling corrections are a function of one or more of the following conditions: 1) high fuel supply pressure to the gaseous fuel control or faulty pressure regulator and/or 2) a non-responsive HEGO/UEGO sensor. This fault should be configured to disable adaptive learn for the remainder of the key-cycle to avoid improperly learning the adaptive learn table and may be configured to disable closed loop.

Corrective Actions:

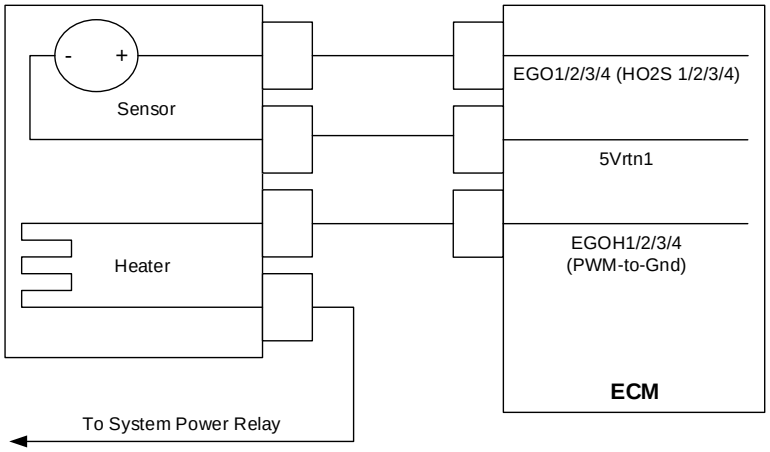
Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	
Never Forget		AL Disable	X	Low Rev Limit		MIL Persist Disable	
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable	X	Power Derate 1		Soft Warning		NOx Control System	

Diagnostic Aids

NOTE: If any other DTCs are present, diagnose those first.

- ☐ Oxygen Sensor Wire - Sensor may contact the exhaust. Check for short to ground between harness and sensor and on sensor harness
- ☐ Fuel Pressure - System will be rich if fuel delivery pressure is too high to gaseous control system. Check fuel pressure at the control actuator/valve under all operating conditions.
- ☐ System Grounding - ECM and engine must be grounded to the battery with very little resistance allowing for proper current flow. Faulty grounds can cause current supply issues resulting in many undesired problems.
- ☐ If all tests are OK, replace the HO2S or HEGO/UEGO sensor with a known good part and retest.

3.58 DTC 1153 – Closed Loop High Natural Gas



DTC	1153	SPN	4236	FMI	0

Sensor / Circuit: Heated or Universal Exhaust Gas Oxygen Sensor (Bank 1-Sensor 1/Bank 1-Before Catalyst)

Description:

The HEGO/HO2S sensor is a switching-type sensor around stoichiometry that measures the oxygen content present in the exhaust to determine if the fuel flow to the engine is correct. A HEGO/UEGO sensor measures the exhaust content across a wide-range of air-fuel ratios with a linear output proportional to lambda/equivalence ratio/air-fuel ratio. In either case, if there is a deviation between the expected reading and the actual reading, fuel flow is precisely adjusted for each bank using the Closed Loop multiplier and then "learned" with the Adaptive multiplier. The multipliers only update when the system is in either "CL Active" or "CL + Adapt" control modes. The purpose of the closed loop fuel multiplier is to quickly adjust fuel flow due to variations in fuel composition; engine wear, engine-to-engine build variances, and component degradation prior to adaptive learn fueling correction "learning" the fueling deviation.

Fault Enabled in Calibration?	**YES**
Emissions-related Fault?	**YES**
Check Condition:	Engine Running

Fault Set Conditions (as defined in calibration):

• CL_BM >	35	%
• and RPM >=	0	rpm
• and RPM <=	9999	rpm
• and MAP >=	0	psia
• and MAP <=	99	psia

(continued from previous page)

Possible Causes:

This fault sets if the Closed Loop multiplier exceeds the high limit of normal operation indicating that the engine is operating lean (excess oxygen) and requires more fuel than allowed by corrections. Often high positive fueling corrections are a function of one or more of the following conditions: 1) exhaust leaks upstream or near the HEGO sensor, 2) reduced fuel supply pressure to the gaseous fuel control system, 3) a fuel supply or manifold leak, 4) a non-responsive HEGO/UEGO sensor, and/or 5) a defective gaseous fuel control component (actuator/valve and/or mixer). This fault should be configured to disable adaptive learn for the remainder of the key-cycle to avoid improperly learning the adaptive learn table and may be configured to disable closed loop.

Corrective Actions:

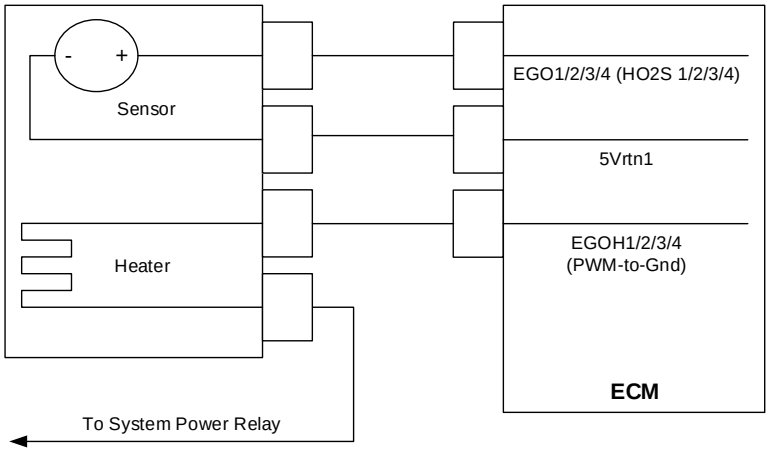
Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	
Never Forget		AL Disable	X	Low Rev Limit		MIL Persist Disable	
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable	X	Power Derate 1		Soft Warning		NOx Control System	

Diagnostic Aids

NOTE: If any other DTCs are present, diagnose those first.

- ☐ Oxygen Sensor Wire - Sensor may contact the exhaust. Check for short to ground between harness and sensor sense signal.
- ☐ Vacuum Leaks - Large vacuum leaks and crankcase leaks can cause a lean exhaust condition at light load.
- ☐ Fuel Pressure - System will be lean if fuel pressure is too low. Ensure fuel tank pressure is not too low and that gaseous fuel control actuator/regulator has proper fuel pressure under all operating conditions.
- ☐ Exhaust Leaks - If there is an exhaust leak, outside air can be pulled into the exhaust and past the O2 sensor causing a false lean condition.
- ☐ Fuel Quality - A drastic variation in fuel quality may cause the system to be lean including fuels with high inert gas content.
- ☐ System Grounding - ECM and engine must be grounded to the battery with very little resistance allowing for proper current flow. Faulty grounds can cause current supply issues resulting in many undesired problems.
- ☐ If all tests are OK, replace the HO2S or HEGO/UEGO sensor with a known good part and retest.

3.59 DTC 1154 – Closed Loop Low Natural Gas



DTC	1154	SPN	4236	FMI	1

Sensor / Circuit: Heated or Universal Exhaust Gas Oxygen Sensor (Bank 1-Sensor 1/Bank 1-Before Catalyst)

Description:

The HEGO/HO2S sensor is a switching-type sensor around stoichiometry that measures the oxygen content present in the exhaust to determine if the fuel flow to the engine is correct. A HEGO/UEGO sensor measures the exhaust content across a wide-range of air-fuel ratios with a linear output proportional to lambda/equivalence ratio/air-fuel ratio. In either case, if there is a deviation between the expected reading and the actual reading, fuel flow is precisely adjusted for each bank using the Closed Loop multiplier and then "learned" with the Adaptive multiplier. The multipliers only update when the system is in either "CL Active" or "CL + Adapt" control modes. The purpose of the closed loop fuel multiplier is to quickly adjust fuel flow due to variations in fuel composition; engine wear, engine-to-engine build variances, and component degradation prior to adaptive learn fueling correction "learning" the fueling deviation.

Fault Enabled in Calibration?	**YES**
Emissions-related Fault?	**YES**
Check Condition:	Engine Running

Fault Set Conditions (as defined in calibration):

• CL_BM <	-35	%
• and RPM >=	0	rpm
• and RPM <=	9999	rpm
• and MAP >=	0	psia
• and MAP <=	99	psia

(continued from previous page)

Possible Causes:

This fault sets if the Closed Loop multiplier exceeds the low limit of normal operation indicating that the engine is operating rich (excess fuel) and requires less fuel than allowed by corrections. Often high negative fueling corrections are a function of one or more of the following conditions: 1) high fuel supply pressure to the gaseous fuel control or faulty pressure regulator and/or 2) a non-responsive HEGO/UEGO sensor. This fault should be configured to disable adaptive learn for the remainder of the key-cycle to avoid improperly learning the adaptive learn table and may be configured to disable closed loop.

Corrective Actions:

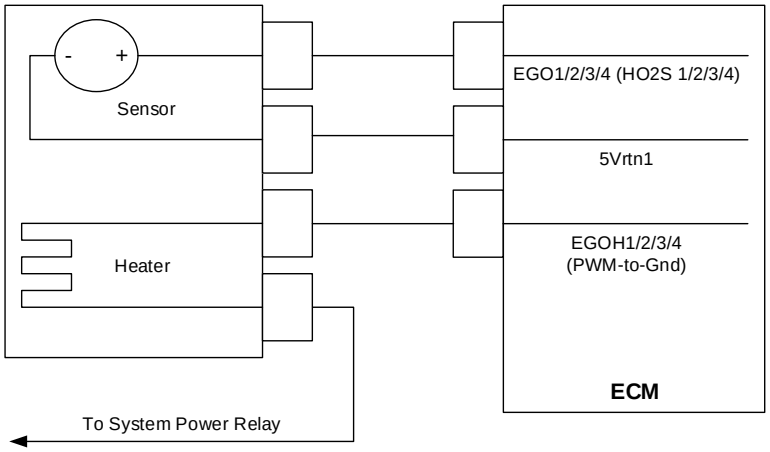
Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	
Never Forget		AL Disable	X	Low Rev Limit		MIL Persist Disable	
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable	X	Power Derate 1		Soft Warning		NOx Control System	

Diagnostic Aids

NOTE: If any other DTCs are present, diagnose those first.

- ☐ Oxygen Sensor Wire - Sensor may contact the exhaust. Check for short to ground between harness and sensor and on sensor harness
- ☐ Fuel Pressure - System will be rich if fuel delivery pressure is too high to gaseous control system. Check fuel pressure at the control actuator/valve under all operating conditions.
- ☐ System Grounding - ECM and engine must be grounded to the battery with very little resistance allowing for proper current flow. Faulty grounds can cause current supply issues resulting in many undesired problems.
- ☐ If all tests are OK, replace the HO2S or HEGO/UEGO sensor with a known good part and retest.

3.60 DTC 1161 – Aadaptive Learn High (LPG)



DTC	1161	SPN	4237	FMI	0

Sensor / Circuit: Heated or Universal Exhaust Gas Oxygen Sensor (Bank 1-Sensor 1/Bank 1-Before Catalyst)

Description:

The HEGO/HO2S sensor is a switching-type sensor around stoichiometry that measures the oxygen content present in the exhaust to determine if the fuel flow to the engine is correct. A HEGO/UEGO sensor measures the exhaust content across a wide-range of air-fuel ratios with a linear output proportional to lambda/equivalence ratio/air-fuel ratio. In either case, if there is a deviation between the expected reading and the actual reading, fuel flow is precisely adjusted for each bank using the Closed Loop multiplier and then “learned” with the Adaptive multiplier. The multipliers only update when the system is in either “CL Active” or “CL + Adapt” control modes. The purpose of the Adaptive Learn fuel multiplier is to adjust fuel flow due to variations in fuel composition, engine wear, engine-to-engine build variances, and component degradation.

Fault Enabled in Calibration?	**YES**
Emissions-related Fault?	**YES**
Check Condition:	Engine Running

Fault Set Conditions (as defined in calibration):

• AL_BM >	30.0	%
• and RPM >=	0	rpm
• and RPM <=	9999	rpm
• and MAP >=	0.00	psia
• and MAP <=	99.00	psia

(continued from previous page)

Possible Causes:

This fault sets if the Adaptive multiplier exceeds the high limit of normal operation indicating that the engine is operating lean (excess oxygen) and requires more fuel than allowed by corrections. Often high positive fueling corrections are a function of one or more of the following conditions: 1) exhaust leaks upstream or near the HEGO sensor, 2) reduced fuel supply pressure to the gaseous fuel control system, 3) a fuel supply or manifold leak, 4) a non-responsive HEGO/UEGO sensor, and/or 5) a defective gaseous fuel control component (actuator/valve and/or mixer). This fault should be configured to disable adaptive learn for the remainder of the key-cycle to avoid improperly learning the adaptive learn table and may be configured to disable closed loop.

Corrective Actions:

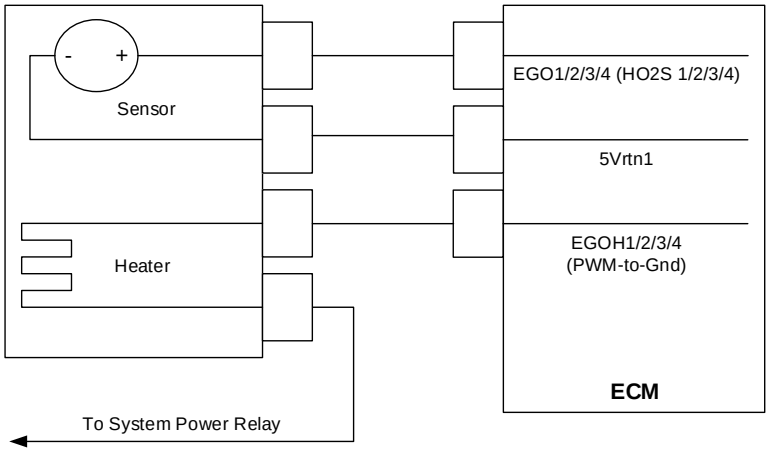
Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	
Never Forget		AL Disable	X	Low Rev Limit		MIL Persist Disable	
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable	X	Power Derate 1		Soft Warning		NOx Control System	

Diagnostic Aids

NOTE: If any other DTCs are present, diagnose those first.

- ☐ Oxygen Sensor Wire - Sensor may contact the exhaust. Check for short to ground between harness and sensor sense signal.
- ☐ Vacuum Leaks - Large vacuum leaks and crankcase leaks can cause a lean exhaust condition at light load.
- ☐ Fuel Pressure - System will be lean if fuel pressure is too low. Ensure fuel tank pressure is not too low and that gaseous fuel control actuator/regulator has proper fuel pressure under all operating conditions.
- ☐ Exhaust Leaks - If there is an exhaust leak, outside air can be pulled into the exhaust and past the O2 sensor causing a false lean condition.
- ☐ Fuel Quality - A drastic variation in fuel quality may cause the system to be lean including fuels with high inert gas content.
- ☐ System Grounding - ECM and engine must be grounded to the battery with very little resistance allowing for proper current flow. Faulty grounds can cause current supply issues resulting in many undesired problems.
- ☐ If all tests are OK, replace the HO2S or HEGO/UEGO sensor with a known good part and retest.

3.61 DTC 1162 – Adaptive Learn Low (LPG)



DTC	1162	SPN	4237	FMI	1

Sensor / Circuit: Heated or Universal Exhaust Gas Oxygen Sensor (Bank 1-Sensor 1/Bank 1-Before Catalyst)

Description:

The HEGO/HO2S sensor is a switching-type sensor around stoichiometry that measures the oxygen content present in the exhaust to determine if the fuel flow to the engine is correct. A HEGO/UEGO sensor measures the exhaust content across a wide-range of air-fuel ratios with a linear output proportional to lambda/equivalence ratio/air-fuel ratio. In either case, if there is a deviation between the expected reading and the actual reading, fuel flow is precisely adjusted for each bank using the Closed Loop multiplier and then "learned" with the Adaptive multiplier. The multipliers only update when the system is in either "CL Active" or "CL + Adapt" control modes. The purpose of the Adaptive Learn fuel multiplier is to adjust fuel flow due to variations in fuel composition, engine wear, engine-to-engine build variances, and component degradation.

Fault Enabled in Calibration?	**YES**
Emissions-related Fault?	**YES**
Check Condition:	Engine Running

Fault Set Conditions (as defined in calibration):

• CL_BM <	-30.0	%
• and RPM >=	0	rpm
• and RPM <=	9999	rpm
• and MAP >=	0.00	psia
• and MAP <=	99.00	psia

(continued from previous page)

Possible Causes:

This fault sets if the Adaptive multiplier exceeds the low limit of normal operation indicating that the engine is operating rich (excess fuel) and requires less fuel than allowed by corrections. Often high negative fueling corrections are a function of one or more of the following conditions: 1) high fuel supply pressure to the gaseous fuel control or faulty pressure regulator and/or 2) a non-responsive HEGO/UEGO sensor. This fault should be configured to disable adaptive learn for the remainder of the key-cycle to avoid improperly learning the adaptive learn table and may be configured to disable closed loop.

Corrective Actions:

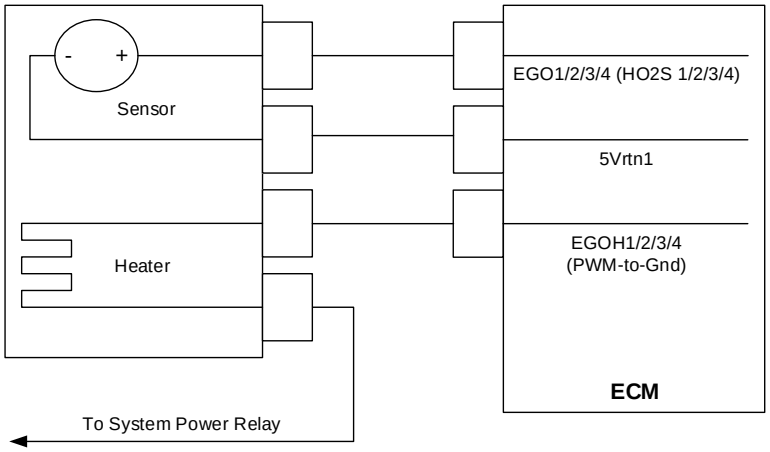
Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	
Never Forget		AL Disable	X	Low Rev Limit		MIL Persist Disable	
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable	X	Power Derate 1		Soft Warning		NOx Control System	

Diagnostic Aids

NOTE: If any other DTCs are present, diagnose those first.

- ☐ Oxygen Sensor Wire - Sensor may contact the exhaust. Check for short to ground between harness and sensor and on sensor harness
- ☐ Fuel Pressure - System will be rich if fuel delivery pressure is too high to gaseous control system. Check fuel pressure at the control actuator/valve under all operating conditions.
- ☐ System Grounding - ECM and engine must be grounded to the battery with very little resistance allowing for proper current flow. Faulty grounds can cause current supply issues resulting in many undesired problems.
- ☐ If all tests are OK, replace the HO2S or HEGO/UEGO sensor with a known good part and retest.

3.62 DTC 1163 – Adaptive Learn High (Natural Gas)



DTC	1163	SPN	4237	FMI	0

Sensor / Circuit: Heated or Universal Exhaust Gas Oxygen Sensor (Bank 1-Sensor 1/Bank 1-Before Catalyst)

Description:

The HEGO/HO2S sensor is a switching-type sensor around stoichiometry that measures the oxygen content present in the exhaust to determine if the fuel flow to the engine is correct. A HEGO/UEGO sensor measures the exhaust content across a wide-range of air-fuel ratios with a linear output proportional to lambda/equivalence ratio/air-fuel ratio. In either case, if there is a deviation between the expected reading and the actual reading, fuel flow is precisely adjusted for each bank using the Closed Loop multiplier and then "learned" with the Adaptive multiplier. The multipliers only update when the system is in either "CL Active" or "CL + Adapt" control modes. The purpose of the Adaptive Learn fuel multiplier is to adjust fuel flow due to variations in fuel composition, engine wear, engine-to-engine build variances, and component degradation.

Fault Enabled in Calibration?	**YES**
Emissions-related Fault?	**YES**
Check Condition:	Engine Running

Fault Set Conditions (as defined in calibration):

• AL_BM >	30.0	%
• and RPM >=	0	rpm
• and RPM <=	9999	rpm
• and MAP >=	0.00	psia
• and MAP <=	99.00	psia

(continued from previous page)

Possible Causes:

This fault sets if the Adaptive multiplier exceeds the high limit of normal operation indicating that the engine is operating lean (excess oxygen) and requires more fuel than allowed by corrections. Often high positive fueling corrections are a function of one or more of the following conditions: 1) exhaust leaks upstream or near the HEGO sensor, 2) reduced fuel supply pressure to the gaseous fuel control system, 3) a fuel supply or manifold leak, 4) a non-responsive HEGO/UEGO sensor, and/or 5) a defective gaseous fuel control component (actuator/valve and/or mixer). This fault should be configured to disable adaptive learn for the remainder of the key-cycle to avoid improperly learning the adaptive learn table and may be configured to disable closed loop.

Corrective Actions:

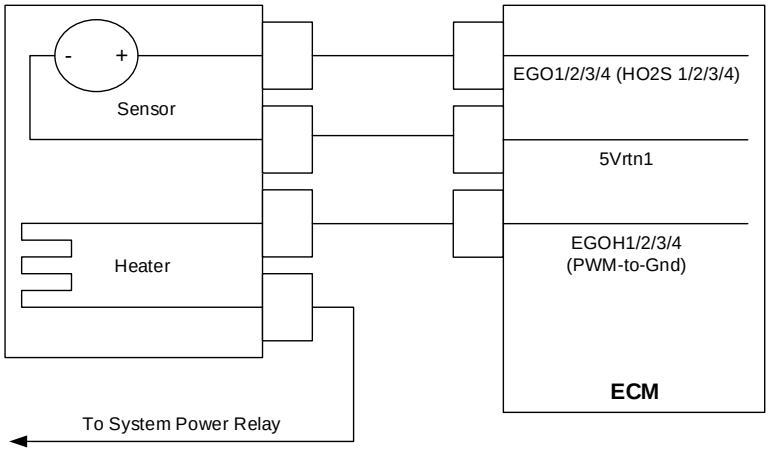
Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	
Never Forget		AL Disable	X	Low Rev Limit		MIL Persist Disable	
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable	X	Power Derate 1		Soft Warning		NOx Control System	

Diagnostic Aids

NOTE: If any other DTCs are present, diagnose those first.

- ☐ Oxygen Sensor Wire - Sensor may contact the exhaust. Check for short to ground between harness and sensor sense signal.
- ☐ Vacuum Leaks - Large vacuum leaks and crankcase leaks can cause a lean exhaust condition at light load.
- ☐ Fuel Pressure - System will be lean if fuel pressure is too low. Ensure fuel tank pressure is not too low and that gaseous fuel control actuator/regulator has proper fuel pressure under all operating conditions.
- ☐ Exhaust Leaks - If there is an exhaust leak, outside air can be pulled into the exhaust and past the O2 sensor causing a false lean condition.
- ☐ Fuel Quality - A drastic variation in fuel quality may cause the system to be lean including fuels with high inert gas content.
- ☐ System Grounding - ECM and engine must be grounded to the battery with very little resistance allowing for proper current flow. Faulty grounds can cause current supply issues resulting in many undesired problems.
- ☐ If all tests are OK, replace the HO2S or HEGO/UEGO sensor with a known good part and retest.

3.63 DTC 1164 – Adaptive Learn Low (Natural Gas)



DTC	1164	SPN	4237	FMI	1

Sensor / Circuit: Heated or Universal Exhaust Gas Oxygen Sensor (Bank 1-Sensor 1/Bank 1-Before Catalyst)

Description:

The HEGO/HO2S sensor is a switching-type sensor around stoichiometry that measures the oxygen content present in the exhaust to determine if the fuel flow to the engine is correct. A HEGO/UEGO sensor measures the exhaust content across a wide-range of air-fuel ratios with a linear output proportional to lambda/equivalence ratio/air-fuel ratio. In either case, if there is a deviation between the expected reading and the actual reading, fuel flow is precisely adjusted for each bank using the Closed Loop multiplier and then "learned" with the Adaptive multiplier. The multipliers only update when the system is in either "CL Active" or "CL + Adapt" control modes. The purpose of the Adaptive Learn fuel multiplier is to adjust fuel flow due to variations in fuel composition, engine wear, engine-to-engine build variances, and component degradation.

Fault Enabled in Calibration?	**YES**
Emissions-related Fault?	**YES**
Check Condition:	Engine Running

Fault Set Conditions (as defined in calibration):

• CL_BM <	-30.0	%
• and RPM >=	0	rpm
• and RPM <=	9999	rpm
• and MAP >=	0.00	psia
• and MAP <=	99.00	psia

(continued from previous page)

Possible Causes:

This fault sets if the Adaptive multiplier exceeds the low limit of normal operation indicating that the engine is operating rich (excess fuel) and requires less fuel than allowed by corrections. Often high negative fueling corrections are a function of one or more of the following conditions: 1) high fuel supply pressure to the gaseous fuel control or faulty pressure regulator and/or 2) a non-responsive HEGO/UEGO sensor. This fault should be configured to disable adaptive learn for the remainder of the key-cycle to avoid improperly learning the adaptive learn table and may be configured to disable closed loop.

Corrective Actions:

Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	
Never Forget		AL Disable	X	Low Rev Limit		MIL Persist Disable	
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable	X	Power Derate 1		Soft Warning		NOx Control System	

Diagnostic Aids

NOTE: If any other DTCs are present, diagnose those first.

- ☐ Oxygen Sensor Wire - Sensor may contact the exhaust. Check for short to ground between harness and sensor and on sensor harness
- ☐ Fuel Pressure - System will be rich if fuel delivery pressure is too high to gaseous control system. Check fuel pressure at the control actuator/valve under all operating conditions.
- ☐ System Grounding - ECM and engine must be grounded to the battery with very little resistance allowing for proper current flow. Faulty grounds can cause current supply issues resulting in many undesired problems.
- ☐ If all tests are OK, replace the HO2S or HEGO/UEGO sensor with a known good part and retest.

3.64 DTC 1171 - EPR / CFV Regulation Pressure Higher Than Expected

DTC	1171	SPN	520260	FMI	0

Hardware: EPR (HD EPR) or CFV

Description:

The EPR is the second generation of EControls' Electronic Pressure Regulator found in many industrial and heavy-duty applications. The 2nd generation EPR is a "smart" actuator integrated with the primary stage regulator designed to control gaseous fuel pressure in the secondary stage regulator. The EPR receives fuel pressure commands from the ECM and quickly and precisely modulates fuel pressure to the gaseous fuel mixer. The EPR allows for fast and accurate gaseous fuel control to provide a combustible mixture to the engine.

The third generation of EControls' Electronic Pressure Regulator is the DEPR. The DEPR is a "smart" actuator that is fed supply pressure through a DSR (Dual Stage Regulator). The DSR is fully mechanical. The DEPR receives fuel pressure commands from the ECM and quickly and precisely modulates fuel pressure to the gaseous fuel mixer. The DEPR allows for very fast and very accurate gaseous fuel control to provide a combustible mixture to the engine

The fourth generation of EControls' gaseous fuel control valve is the CFV. The CFV contains both a high-pressure Electronic Pressure Regulator and a precision Continuous Flow Valve. The inlet pressure to the CFV is typically 85 psig (586 kPa). The CFV receives mass flow commands from the ECM and quickly and precisely modulates both the fuel pressure and metering valve to achieve the desired mass flow. The CFV allows for very fast and very accurate gaseous fuel control to provide a combustible mixture to the engine.

Fault Enabled in Calibration?	**YES**
Emissions-related Fault?	**YES**
Check Condition:	Engine Running

Fault Set Conditions (as defined in calibration):

• EPR (actual-commanded) pressure >	1.50	in H2O
• or CFV (actual-commanded) pressure >	10.00	psi

Possible Causes:

This fault sets if the actual pressure sensed in the EPR/CFV is greater than the commanded pressure by X. Typical values for X are listed below (may vary per specific engine calibration):

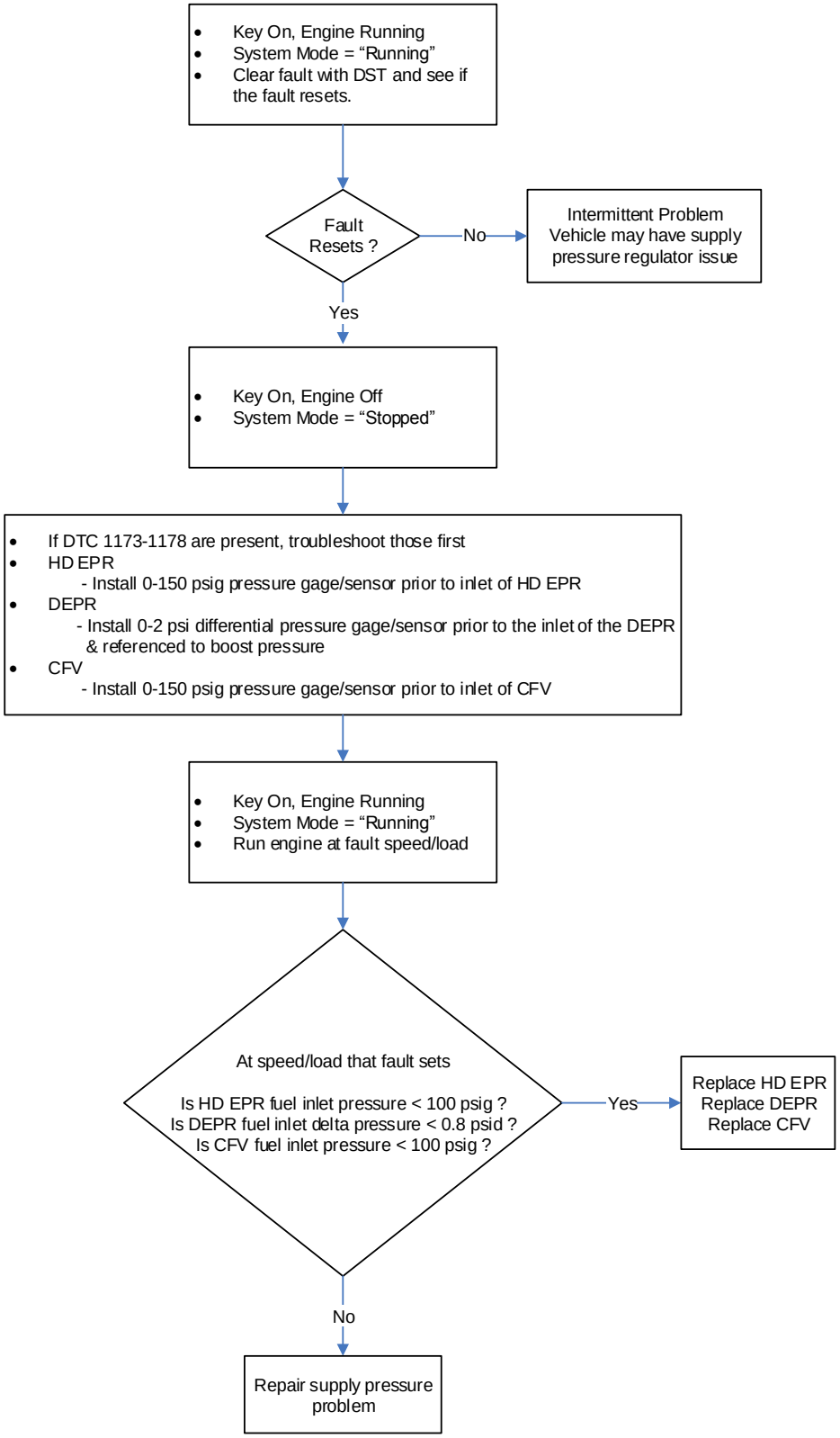
- X = + 2.0 in H2O for EPR (HD EPR or DEPR)
- X = + 10 psi (69 kPa) for CFV

This fault indicates that the device is at its minimum limit of authority and the pressure command cannot be achieved likely due to delivery/supply pressure being higher than expected. Adaptive fueling correction is disabled to avoid improper learning of the fuel correction table due to improper fuel supply pressure, and a Power Derate 1 condition is activated to reduce the possibility of engine damage.

Corrective Actions:

Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	
Never Forget		AL Disable	X	Low Rev Limit		MIL Persist Disable	X
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable	X	Power Derate 1		Soft Warning		NOx Control System	

3.64.1 DTC 1171 - EPR / CFV Regulation Pressure Higher Than Expected (Trouble Tree)



3.65 DTC 1172 - EPR / CFV Regulation Pressure Lower Than Expected

DTC	1172	SPN	520260	FMI	1

Hardware: EPR (HD EPR) or CFV

Description:

The EPR is the second generation of EControls' Electronic Pressure Regulator found in many industrial and heavy-duty applications. The 2nd generation EPR is a "smart" actuator integrated with the primary stage regulator designed to control gaseous fuel pressure in the secondary stage regulator. The EPR receives fuel pressure commands from the ECM and quickly and precisely modulates fuel pressure to the gaseous fuel mixer. The EPR allows for fast and accurate gaseous fuel control to provide a combustible mixture to the engine.

The third generation of EControls' Electronic Pressure Regulator is the DEPR. The DEPR is a "smart" actuator that is fed supply pressure through a DSR (Dual Stage Regulator). The DSR is fully mechanical. The DEPR receives fuel pressure commands from the ECM and quickly and precisely modulates fuel pressure to the gaseous fuel mixer. The DEPR allows for very fast and very accurate gaseous fuel control to provide a combustible mixture to the engine

The fourth generation of EControls' gaseous fuel control valve is the CFV. The CFV contains both a high-pressure Electronic Pressure Regulator and a precision Continuous Flow Valve. The inlet pressure to the CFV is typically 85 psig (586 kPa). The CFV receives mass flow commands from the ECM and quickly and precisely modulates both the fuel pressure and metering valve to achieve the desired mass flow. The CFV allows for very fast and very accurate gaseous fuel control to provide a combustible mixture to the engine.

Fault Enabled in Calibration?	**YES**
Emissions-related Fault?	**YES**
Check Condition:	Engine Running

Fault Set Conditions (as defined in calibration):

• EPR (actual-commanded) pressure <	-1.50	in H2O
• or CFV (actual-commanded) pressure <	-10.00	psi

Possible Causes:

This fault sets if the actual pressure sensed in the EPR/CFV is less than the commanded pressure by X. Typical values for X are listed below (may vary per specific engine calibration):

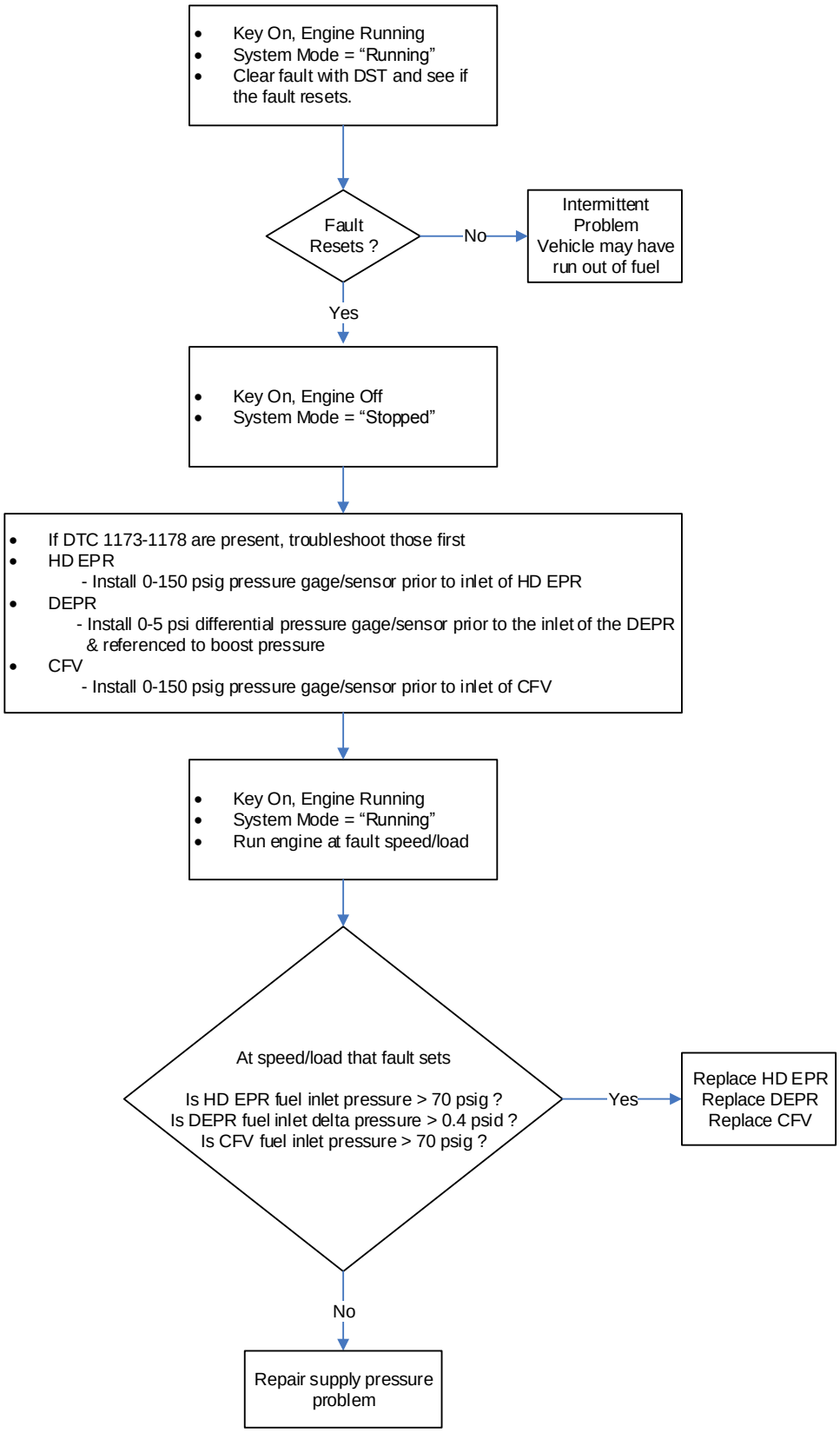
- X = + 2.0 in H2O for EPR (HD EPR or DEPR)
- X = + 10 psi (69 kPa) for CFV

This fault indicates that the device is at its minimum limit of authority and the pressure command cannot be achieved likely due to delivery/supply pressure being lower than expected. Adaptive fueling correction is disabled to avoid improper learning of the fuel correction table due to improper fuel supply pressure, and a Power Derate 1 condition is activated to reduce the possibility of engine damage.

Corrective Actions:

Shutdown		CL Disable key cyc.	X	Power Derate 2		Hard Warning	
Never Forget		AL Disable	X	Low Rev Limit		MIL Persist Disable	X
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable		Power Derate 1		Soft Warning		NOx Control System	

3.65.1 DTC 1172 - EPR / CFV Regulation Pressure Lower Than Expected (Trouble Tree)



3.66 DTC 1173 - EPR / CFV Comm Lost

DTC	1173	SPN	520260	FMI	31

Hardware: EPR (HD EPR) or CFV

Description:

The EPR is the second generation of EControls' Electronic Pressure Regulator found in many industrial and heavy-duty applications. The 2nd generation EPR is a "smart" actuator integrated with the primary stage regulator designed to control gaseous fuel pressure in the secondary stage regulator. The EPR receives fuel pressure commands from the ECM and quickly and precisely modulates fuel pressure to the gaseous fuel mixer. The EPR allows for fast and accurate gaseous fuel control to provide a combustible mixture to the engine.

The third generation of EControls' Electronic Pressure Regulator is the DEPR. The DEPR is a "smart" actuator that is fed supply pressure through a DSR (Dual Stage Regulator). The DSR is fully mechanical. The DEPR receives fuel pressure commands from the ECM and quickly and precisely modulates fuel pressure to the gaseous fuel mixer. The DEPR allows for very fast and very accurate gaseous fuel control to provide a combustible mixture to the engine

The fourth generation of EControls' gaseous fuel control valve is the CFV. The CFV contains both a high-pressure Electronic Pressure Regulator and a precision Continuous Flow Valve. The inlet pressure to the CFV is typically 85 psig (586 kPa). The CFV receives mass flow commands from the ECM and quickly and precisely modulates both the fuel pressure and metering valve to achieve the desired mass flow. The CFV allows for very fast and very accurate gaseous fuel control to provide a combustible mixture to the engine.

Fault Enabled in Calibration?	**YES**
Emissions-related Fault?	**YES**
Check Condition:	Engine Running

Fault Set Conditions (as defined in calibration):

• No EPR / CFV packets received within	500	ms

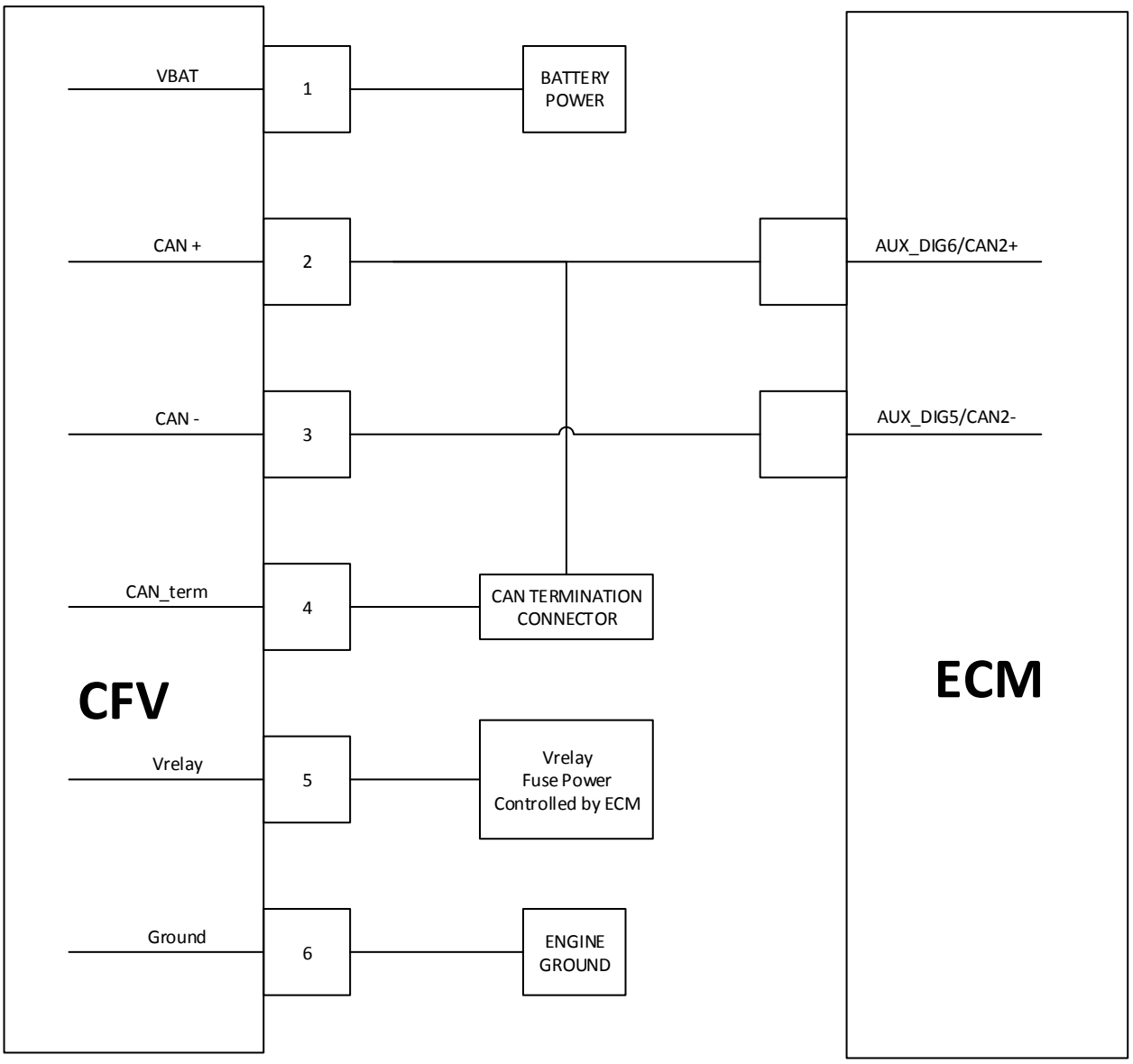
Possible Causes:

This fault sets if the ECM loses CAN communication with the EPR/CFV. This fault indicates that the ECM is no longer receiving CAN packets from the EPR/CFV which also results in the EPR/CFV not receiving communication from the ECM. This is often a result of a power loss at the EPR/CFV or improper CAN termination or wiring. Adaptive fueling correction is disabled to avoid improper learning of the fuel correction table, closed-loop is disabled, and a Power Derate 1 condition is activated to reduce the possibility of engine damage. The MIL is illuminated for the duration of the key on cycle.

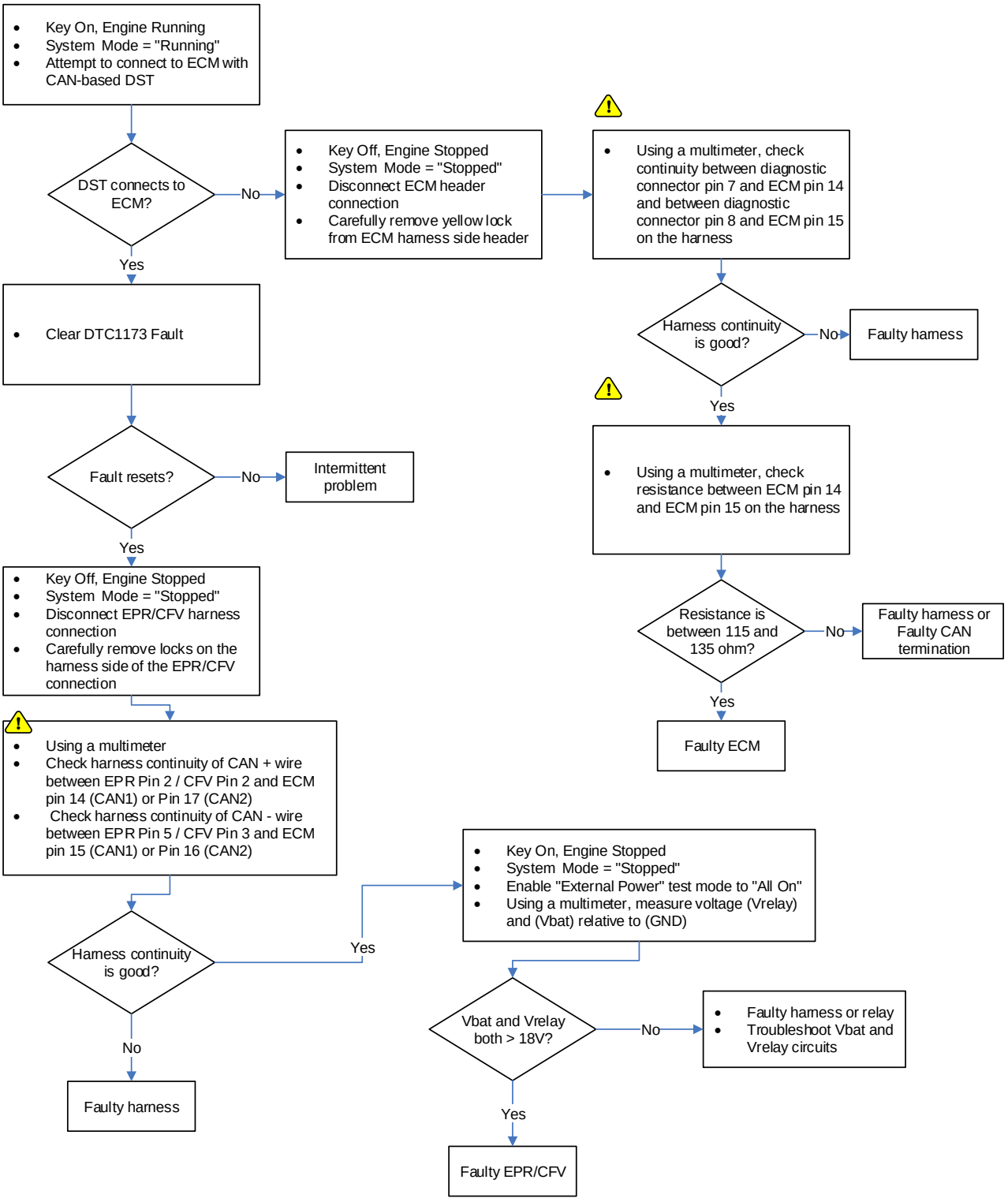
Corrective Actions:

Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	
Never Forget		AL Disable	X	Low Rev Limit		MIL Persist Disable	X
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable		Power Derate 1		Soft Warning		NOx Control System	

3.66.1 DTC 1173 - EPR / CFV Comm Lost (Schematic)



3.66.2 DTC 1173 - EPR / CFV Comm Lost (Trouble Tree)



NOTE: Do not insert probe or object into terminalsas this will cause the terminal to spread and it may no longer make electrical contact with its mate. Spread pins will void warranty. Probe instead on side of terminal.

3.67 DTC 1174 - EPR / CFV voltage supply high

DTC	1174	SPN	520260	FMI	3

Hardware: EPR (HD EPR) or CFV

Description:

The EPR is the second generation of EControls' Electronic Pressure Regulator found in many industrial and heavy-duty applications. The 2nd generation EPR is a "smart" actuator integrated with the primary stage regulator designed to control gaseous fuel pressure in the secondary stage regulator. The EPR receives fuel pressure commands from the ECM and quickly and precisely modulates fuel pressure to the gaseous fuel mixer. The EPR allows for fast and accurate gaseous fuel control to provide a combustible mixture to the engine.

The third generation of EControls' Electronic Pressure Regulator is the DEPR. The DEPR is a "smart" actuator that is fed supply pressure through a DSR (Dual Stage Regulator). The DSR is fully mechanical. The DEPR receives fuel pressure commands from the ECM and quickly and precisely modulates fuel pressure to the gaseous fuel mixer. The DEPR allows for very fast and very accurate gaseous fuel control to provide a combustible mixture to the engine

The fourth generation of EControls' gaseous fuel control valve is the CFV. The CFV contains both a high-pressure Electronic Pressure Regulator and a precision Continuous Flow Valve. The inlet pressure to the CFV is typically 85 psig (586 kPa). The CFV receives mass flow commands from the ECM and quickly and precisely modulates both the fuel pressure and metering valve to achieve the desired mass flow. The CFV allows for very fast and very accurate gaseous fuel control to provide a combustible mixture to the engine.

Fault Enabled in Calibration?	**YES**
Emissions-related Fault?	**YES**
Check Condition:	Engine Running

Fault Set Conditions (as defined in calibration):

• Voltage supply to EPR/CFV is >	33.0	VDC

Possible Causes:

This fault sets if the supply voltage to the EPR/CFV exceeds 33.0 VDC for greater than 3 seconds. Adaptive fueling correction is disabled to avoid improper learning of the fuel correction table. The MIL will be illuminated for the duration of the key on cycle.

Corrective Actions:

Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	
Never Forget		AL Disable	X	Low Rev Limit		MIL Persist Disable	X
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable		Power Derate 1		Soft Warning		NOx Control System	

3.68 DTC 1175 - EPR / CFV Voltage Supply Low

DTC	1175	SPN	520260	FMI	4

Hardware: EPR (HD EPR) or CFV

Description:

The EPR is the second generation of EControls' Electronic Pressure Regulator found in many industrial and heavy-duty applications. The 2nd generation EPR is a "smart" actuator integrated with the primary stage regulator designed to control gaseous fuel pressure in the secondary stage regulator. The EPR receives fuel pressure commands from the ECM and quickly and precisely modulates fuel pressure to the gaseous fuel mixer. The EPR allows for fast and accurate gaseous fuel control to provide a combustible mixture to the engine.

The third generation of EControls' Electronic Pressure Regulator is the DEPR. The DEPR is a "smart" actuator that is fed supply pressure through a DSR (Dual Stage Regulator). The DSR is fully mechanical. The DEPR receives fuel pressure commands from the ECM and quickly and precisely modulates fuel pressure to the gaseous fuel mixer. The DEPR allows for very fast and very accurate gaseous fuel control to provide a combustible mixture to the engine

The fourth generation of EControls' gaseous fuel control valve is the CFV. The CFV contains both a high-pressure Electronic Pressure Regulator and a precision Continuous Flow Valve. The inlet pressure to the CFV is typically 85 psig (586 kPa). The CFV receives mass flow commands from the ECM and quickly and precisely modulates both the fuel pressure and metering valve to achieve the desired mass flow. The CFV allows for very fast and very accurate gaseous fuel control to provide a combustible mixture to the engine.

Fault Enabled in Calibration?	**YES**
Emissions-related Fault?	**YES**
Check Condition:	Engine Running

Fault Set Conditions (as defined in calibration):

• Voltage supply to EPR/CFV is <	6.0	VDC
• and RPM >	1000	rpm

Possible Causes:

This fault sets if the supply voltage to the EPR/CFV is below 6.0 VDC for > 5 seconds while engine RPM > 1000. Adaptive fueling correction is disabled to avoid improper learning of the fuel correction table. The MIL will be illuminated for the duration of the key on cycle.

Corrective Actions:

Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	
Never Forget		AL Disable	X	Low Rev Limit		MIL Persist Disable	X
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable		Power Derate 1		Soft Warning		NOx Control System	

3.69 DTC 1176 - EPR / CFV Internal Actuator Fault Detection

DTC	1176	SPN	520260	FMI	12

Hardware: EPR (HD EPR) or CFV

Description:

The EPR is the second generation of EControls' Electronic Pressure Regulator found in many industrial and heavy-duty applications. The 2nd generation EPR is a "smart" actuator integrated with the primary stage regulator designed to control gaseous fuel pressure in the secondary stage regulator. The EPR receives fuel pressure commands from the ECM and quickly and precisely modulates fuel pressure to the gaseous fuel mixer. The EPR allows for fast and accurate gaseous fuel control to provide a combustible mixture to the engine.

The third generation of EControls' Electronic Pressure Regulator is the DEPR. The DEPR is a "smart" actuator that is fed supply pressure through a DSR (Dual Stage Regulator). The DSR is fully mechanical. The DEPR receives fuel pressure commands from the ECM and quickly and precisely modulates fuel pressure to the gaseous fuel mixer. The DEPR allows for very fast and very accurate gaseous fuel control to provide a combustible mixture to the engine

The fourth generation of EControls' gaseous fuel control valve is the CFV. The CFV contains both a high-pressure Electronic Pressure Regulator and a precision Continuous Flow Valve. The inlet pressure to the CFV is typically 85 psig (586 kPa). The CFV receives mass flow commands from the ECM and quickly and precisely modulates both the fuel pressure and metering valve to achieve the desired mass flow. The CFV allows for very fast and very accurate gaseous fuel control to provide a combustible mixture to the engine.

Fault Enabled in Calibration?	**YES**
Emissions-related Fault?	**YES**
Check Condition:	Engine Running

Fault Set Conditions (as defined in calibration):

- Internal Actuator Fault detected

Possible Causes:

This fault sets if the EPR/CFV detects an internal actuator fault. The fault is transmitted from the EPR/CFV to the ECM via CAN. If the fault is active, Adaptive Learn is disabled to prevent improper learning and updating of the table. The MIL is illuminated for the duration of the key on cycle.

If the EPR/CFV does not trigger either 1171, 1172, or either of the CFV Flow fault code(s), there is no issue with the EPR/CFV. If one or more of these faults are triggered, refer to the appropriate section for diagnostic information.

Corrective Actions:

Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	
Never Forget		AL Disable	X	Low Rev Limit		MIL Persist Disable	X
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable		Power Derate 1		Soft Warning		NOx Control System	

3.70 DTC 1177 - EPR / CFV Internal Circuitry Fault Detection

DTC	1177	SPN	520260	FMI	12

Hardware: EPR (HD EPR) or CFV

Description:

The EPR is the second generation of EControls' Electronic Pressure Regulator found in many industrial and heavy-duty applications. The 2nd generation EPR is a "smart" actuator integrated with the primary stage regulator designed to control gaseous fuel pressure in the secondary stage regulator. The EPR receives fuel pressure commands from the ECM and quickly and precisely modulates fuel pressure to the gaseous fuel mixer. The EPR allows for fast and accurate gaseous fuel control to provide a combustible mixture to the engine.

The third generation of EControls' Electronic Pressure Regulator is the DEPR. The DEPR is a "smart" actuator that is fed supply pressure through a DSR (Dual Stage Regulator). The DSR is fully mechanical. The DEPR receives fuel pressure commands from the ECM and quickly and precisely modulates fuel pressure to the gaseous fuel mixer. The DEPR allows for very fast and very accurate gaseous fuel control to provide a combustible mixture to the engine

The fourth generation of EControls' gaseous fuel control valve is the CFV. The CFV contains both a high-pressure Electronic Pressure Regulator and a precision Continuous Flow Valve. The inlet pressure to the CFV is typically 85 psig (586 kPa). The CFV receives mass flow commands from the ECM and quickly and precisely modulates both the fuel pressure and metering valve to achieve the desired mass flow. The CFV allows for very fast and very accurate gaseous fuel control to provide a combustible mixture to the engine.

Fault Enabled in Calibration?	**YES**
Emissions-related Fault?	**YES**
Check Condition:	Engine Running

Fault Set Conditions (as defined in calibration):

- Internal circuitry fault detected

Possible Causes:

This fault sets if the EPR/CFV detects an internal circuitry fault. The fault is transmitted from the EPR/CFV to the ECM via CAN. If the fault is active, Adaptive Learn is disabled to prevent improper learning and updating of the table. The MIL is illuminated for the duration of the key on cycle.

If the EPR/CFV does not trigger either 1171, 1172, or either of the CFV Flow fault code(s), there is no issue with the EPR/CFV. If one or more of these faults are triggered, refer to the appropriate section for diagnostic information.

Corrective Actions:

Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	
Never Forget		AL Disable	X	Low Rev Limit		MIL Persist Disable	X
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable		Power Derate 1		Soft Warning		NOx Control System	

3.71 DTC 1178 - EPR / CFV Internal Comm Fault Detection

DTC	1178	SPN	520260	FMI	12

Hardware: EPR (HD EPR) or CFV

Description:

The EPR is the second generation of EControls' Electronic Pressure Regulator found in many industrial and heavy-duty applications. The 2nd generation EPR is a "smart" actuator integrated with the primary stage regulator designed to control gaseous fuel pressure in the secondary stage regulator. The EPR receives fuel pressure commands from the ECM and quickly and precisely modulates fuel pressure to the gaseous fuel mixer. The EPR allows for fast and accurate gaseous fuel control to provide a combustible mixture to the engine.

The third generation of EControls' Electronic Pressure Regulator is the DEPR. The DEPR is a "smart" actuator that is fed supply pressure through a DSR (Dual Stage Regulator). The DSR is fully mechanical. The DEPR receives fuel pressure commands from the ECM and quickly and precisely modulates fuel pressure to the gaseous fuel mixer. The DEPR allows for very fast and very accurate gaseous fuel control to provide a combustible mixture to the engine

The fourth generation of EControls' gaseous fuel control valve is the CFV. The CFV contains both a high-pressure Electronic Pressure Regulator and a precision Continuous Flow Valve. The inlet pressure to the CFV is typically 85 psig (586 kPa). The CFV receives mass flow commands from the ECM and quickly and precisely modulates both the fuel pressure and metering valve to achieve the desired mass flow. The CFV allows for very fast and very accurate gaseous fuel control to provide a combustible mixture to the engine.

Fault Enabled in Calibration?	**YES**
Emissions-related Fault?	**YES**
Check Condition:	Engine Running

Fault Set Conditions (as defined in calibration):

- Internal comm fault detected

Possible Causes:

This fault sets if the EPR/CFV detects a loss of CAN communication with the ECM. The ECM is configured to illuminate the MIL, disable closed loop fueling correction and adaptive fueling correction, and initiate a Power Derate 1 condition to prevent possible damage to the engine.

Corrective Actions:

Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	
Never Forget		AL Disable	X	Low Rev Limit		MIL Persist Disable	X
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable		Power Derate 1		Soft Warning		NOx Control System	

3.72 DTC 1179 - CFV Flow Higher Than Commanded

DTC	1179	SPN	520260	FMI	15

Hardware: CFV

Description:

The fourth generation of EControls' gaseous fuel control valve is the CFV. The CFV contains both a high-pressure Electronic Pressure Regulator (1st Stage) and a precision Continuous Flow Valve (2nd Stage). The inlet pressure to the CFV is typically 85 psig (586 kPa). The CFV receives mass flow commands from the ECM and quickly and precisely modulates the 1st Stage to control the fuel pressure and the 2nd Stage to control the metering valve to achieve the desired mass flow. The CFV allows for very fast and very accurate gaseous fuel control to provide a combustible mixture to the engine.

Fault Enabled in Calibration?	**YES**
Emissions-related Fault?	**YES**
Check Condition:	Engine Running

Fault Set Conditions (as defined in calibration):

• (actual flow - commanded flow) >	9.96	%

Possible Causes:

This fault sets if the actual mass flow of the CFV is greater than the commanded mass flow by greater than X%, where typically,

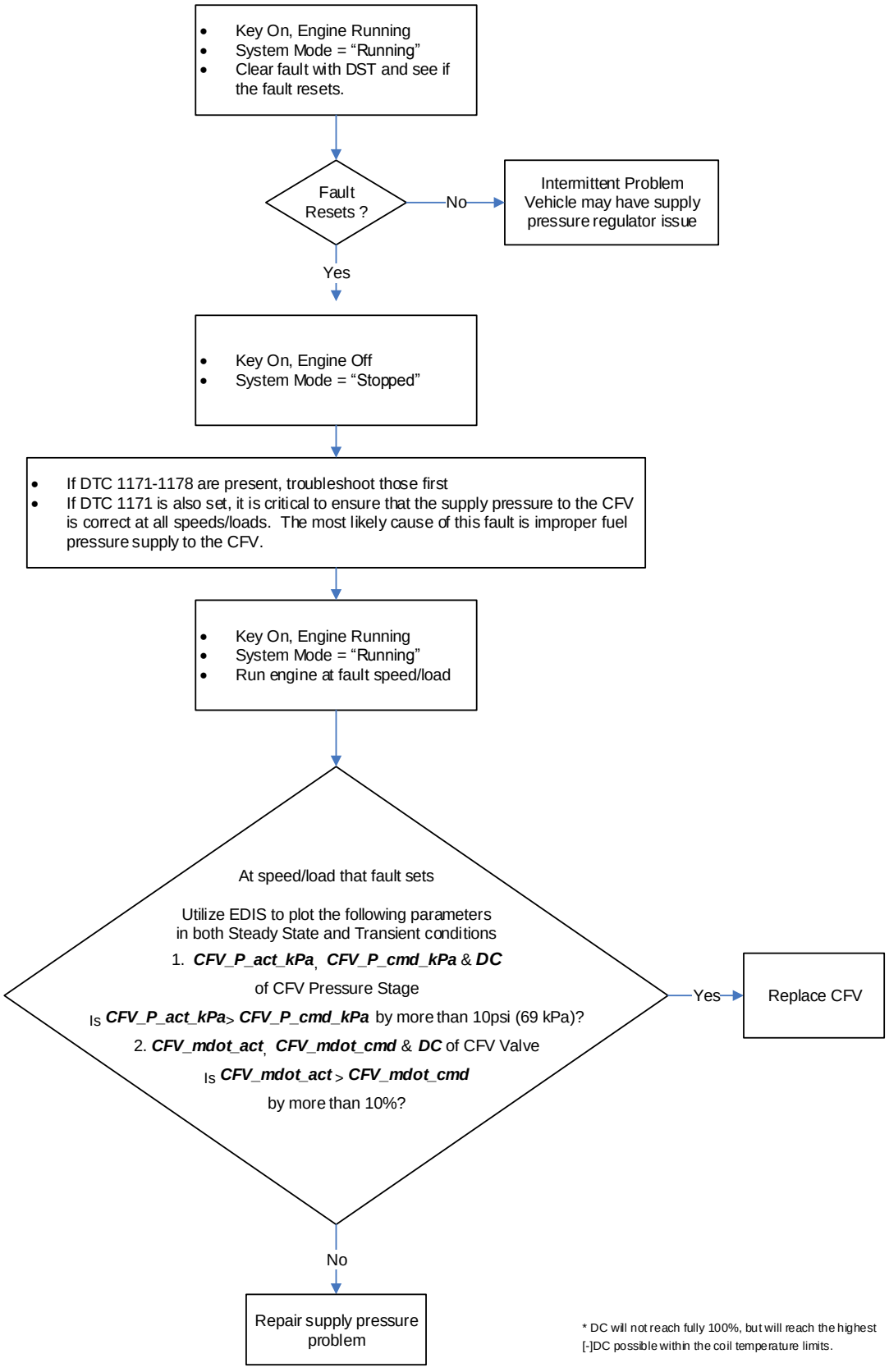
X = +10% of $\dot{m}_{cmd}$ (refer to engine specific calibration).

This fault indicates that the device is at its minimum limit of authority on one or both actuators and the CFV is unable to achieve the mass flow commanded by the ECM. This is most likely caused by the delivery/supply pressure to the CFV being higher than expected. Adaptive fueling correction is disabled to avoid improper learning of the fuel correction table due to improper fuel supply pressure.

Corrective Actions:

Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	
Never Forget		AL Disable	X	Low Rev Limit		MIL Persist Disable	
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable		Power Derate 1		Soft Warning		NOx Control System	

3.72.1 DTC 1179 CFV Flow Higher Than Commanded (Trouble Tree)



3.73 DTC 1180 - CFV Flow Lower Than Commanded

DTC	1180	SPN	520260	FMI	17

Hardware: CFV

Description:

The fourth generation of EControls' gaseous fuel control valve is the CFV. The CFV contains both a high-pressure Electronic Pressure Regulator (1st Stage) and a precision Continuous Flow Valve (2nd Stage). The inlet pressure to the CFV is typically 85 psig (586 kPa). The CFV receives mass flow commands from the ECM and quickly and precisely modulates the 1st Stage to control the fuel pressure and the 2nd Stage to control the metering valve to achieve the desired mass flow. The CFV allows for very fast and very accurate gaseous fuel control to provide a combustible mixture to the engine.

Fault Enabled in Calibration?	**YES**
Emissions-related Fault?	**YES**
Check Condition:	Engine Running

Fault Set Conditions (as defined in calibration):

• (actual flow - commanded flow) <	-9.96	%

Possible Causes:

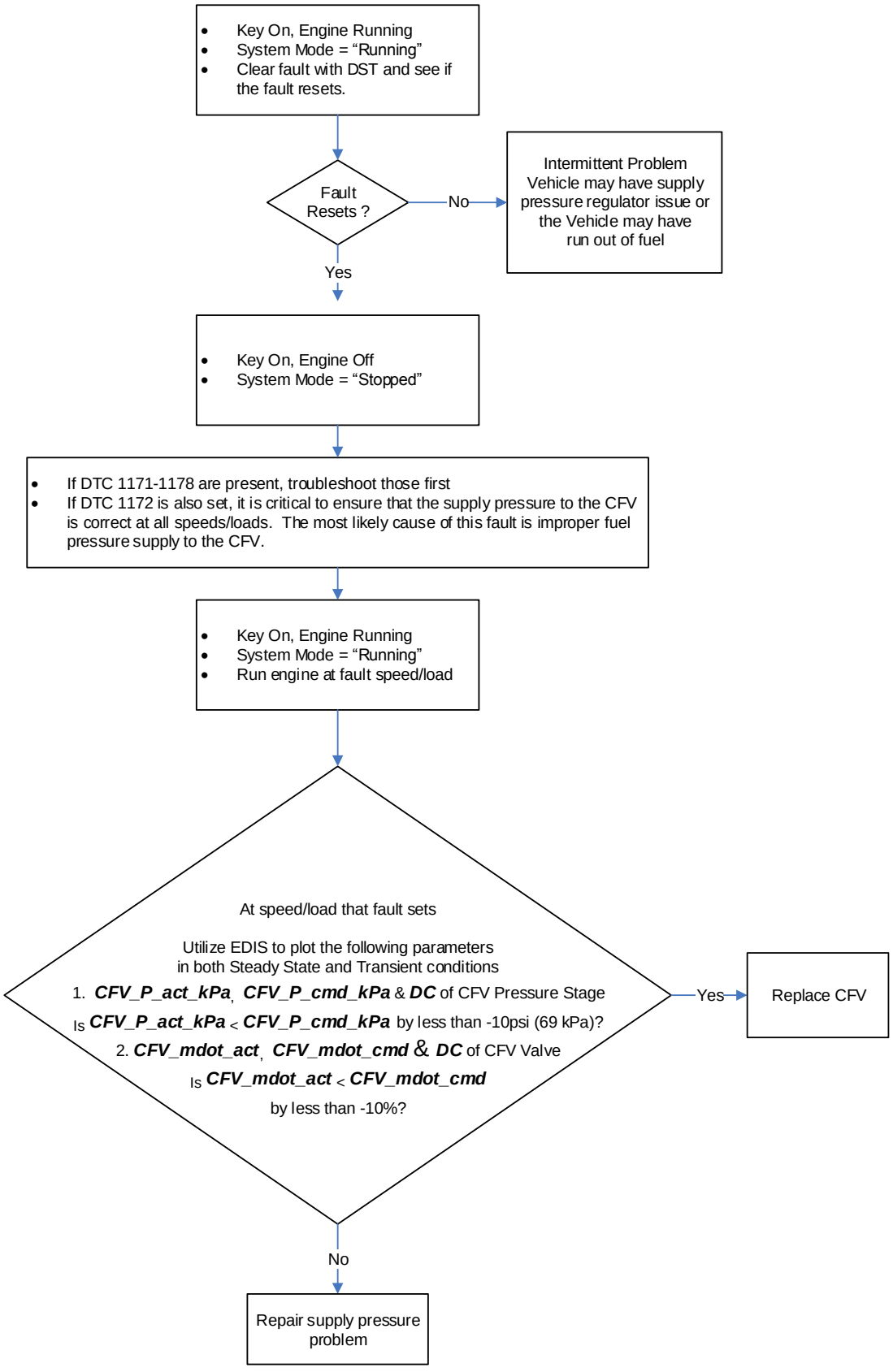
This fault sets if the actual mass flow of the CFV is less than the commanded mass flow by less than X%, where typically, X = -10% of $\dot{m}_{cmd}$ (refer to engine specific calibration).

This fault indicates that the device is at its maximum limit of authority on one or both actuators and the CFV is unable to achieve the mass flow commanded by the ECM. This is most likely caused by the delivery/supply pressure to the CFV being lower than expected. Adaptive fueling correction is disabled to avoid improper learning of the fuel correction table due to improper fuel supply pressure.

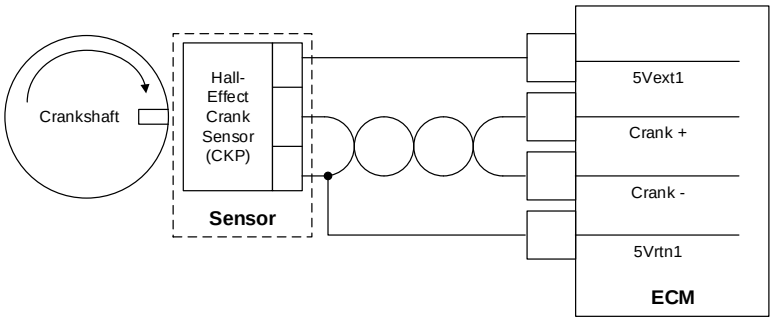
Corrective Actions:

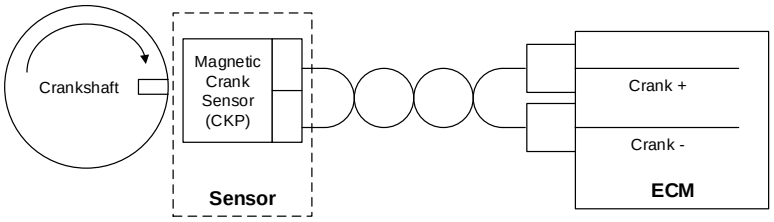
Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	
Never Forget		AL Disable	X	Low Rev Limit		MIL Persist Disable	
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable		Power Derate 1		Soft Warning		NOx Control System	

3.73.1 DTC 1180 CFV Flow Lower Than Commanded (Trouble Tree)



3.74 DTC 1311 – DTC 1318 - Misfire Detected (Cylinder 1-8)





DTC	1311	SPN	1323-1330	FMI	11

Sensor / Circuit: Cylinder #1 Misfire Detected-Driveability/Performance

Description:

The ECM is capable of detecting combustion misfire for certain crank-cam software modules. The ECM continuously monitors changes in crankshaft angular velocity, comparing acceleration rates on a cycle-to-cycle basis and determining if a given cylinder's rate of change is abnormal compared to other cylinders. This method of detection is better known as Instant Crank Angle Velocity (ICAV).

Misfire is of concern for four main reasons: 1) damage can occur to after-treatment systems due to the presence of unburned fuel and oxygen causing chemical reactions resulting in extremely high temperatures causing irreversible damage to catalytic coatings and/or substrates, 2) exhaust emissions increase during misfiring, 3) the engine's driveability suffers due to inconsistent operation, and 4) fuel economy suffers due to the need for higher power operating conditions to achieve the same brake torque. The GCP has two stages of misfire faults 1) emissions/catalyst damaging misfire detected and 2) driveability or general misfire detected.

Emissions/catalyst misfire is generally thought of as a per "bank" fault as multiple cylinders misfiring on the same bank cumulatively add unburned fuel and oxygen to that banks after-treatment device(s). The catalyst/emissions fault is configured to set based on one or both of the following conditions:

1) After-treatment temperatures experienced during this level of misfire are high enough to cause permanent damage to emission control components

2) Emissions are higher than allowed by legislation due to the presence or misfire.

(continued from previous page)

Therefore, if two cylinders misfire on the same bank together they both may set the misfire fault even if neither cylinder individually exceeds the catalyst/misfire threshold.

Typically the driveability level is calibrated to set prior to the emissions/catalyst level if a two stage fault is desired. This fault would set to notify the user of a problem prior to it causing damage to the exhaust after-treatment system.

Fault Enabled in Calibration?	**YES**
Emissions-related Fault?	**YES**
Check Condition:	Key On, Engine Running

Fault Set Conditions (as defined in calibration):

• Cylinder #1 misfiring >=	25	% max

Possible Causes:

Misfire is typically a result of one or more factors. These factors can include but may not be limited to:

1) a fouled or damaged spark plug(s),

2) a damaged or defective ignition coil(s) or coil wire(s) resulting in weak spark generation,

3) a plugged or contaminated injector(s) that intermittently sticks closed resulting in a lean cylinder charge,

4) an injector(s) that is stuck open causing an uncontrolled rich cylinder charge,

5) low fuel supply pressure resulting in multiple lean cylinders,

6) low cylinder compression due to a failed or worn piston ring(s) or non-seating valve(s) can result in a low cylinder pressure charge that may not be ignited, and

7) an exhaust leak in close proximity to an exhaust valve permitting uncontrolled amounts of oxygen to be drawn into a cylinder generating an excessively lean charge either directly resulting in misfire or possibly causing excessive combustion temperatures resulting in burned valves and loss of compression.

Misfire can be difficult to correct as it may be a function of one or more of the conditions mentioned above and may require checking and/or changing several components for each cylinder or cylinders affected.

This fault sets if the misfire counter for cylinder #1 exceeds the driveability misfire limit set in the misfire diagnostic calibration and is based on a percentage of misfire over a certain number of engine cycles.

Corrective Actions:

Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	
Never Forget		AL Disable		Low Rev Limit		MIL Persist Disable	
Turn on MIL		AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable		Power Derate 1		Soft Warning		NOx Control System	

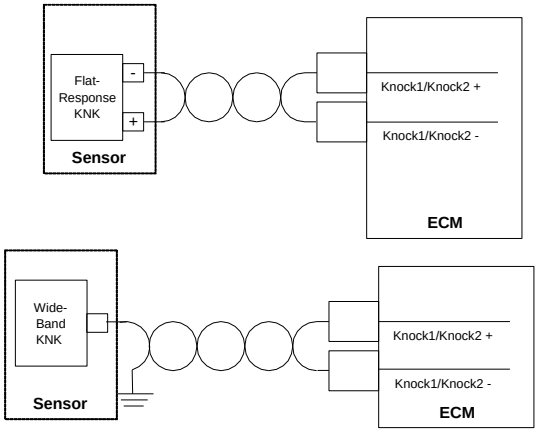
3.74.1 DTC 1311 - Misfire Detected (Cylinder 1-8) (Diagnostic Aids)

Diagnostic Aids

NOTE: If any other DTCs are present, diagnose those first.

- ☐ Oil Level- Many engines have valve trains that utilize lifters that are hydraulically actuated and require specific levels of oil to maintain proper pressure for lifter actuation. If the engine has improper oil, insufficient oil level, or has too much oil the hydraulic lifters may not function as intended causing changes in valve lift and timing. As a result, incomplete combustion may occur as a result of oil problems. Check engine oil level and oil type according to manufacture maintenance procedures.
- ☐ Fuel Level- Misfire can occur due to intermittent or prolonged loss of fuel pressure due to a lack of fuel supply. If misfire counts or faults set and a fuel pressure fault is not recorded, question the operator(s) about the possibility of running out of fuel before replacing components.
- ☐ Ignition System- Wear or damage to ignition system components (spark plugs, spark plug wires, distributor or ignition coils) can result in weak or misplaced spark causing partial combustion and thus partial misfire.
  - Spark Plug(s) – Check for fouled or damaged spark plugs. Replace and regap according to manufacture recommended procedure(s).
  - Spark Plug Wire(s) – Check that spark plug wire is properly connected to ignition coil and spark plug. If equipped, ensure that spark plug terminal nut is tight to plug and that there is not substantial wear on nut. Check for cracks in insulation of spark plug wire or boot. Replace spark plug wire(s) if deemed necessary according to manufacture recommended procedure(s).
  - Distributor modules- Check distributor for oxidized or corroded spark distribution conductors including the distributor rotor and distributor cap poles.
- ☐ Fuel Pressure – Check fuel rail pressure at key-on/engine-off or with External Power-All On test running. Monitor fuel rail pressure when key is turned off to determine if fuel pressure bleeds down too quickly. Run an injector fire test on a couple of injectors to monitor the pressure drop in the rail for each injector. If an injector appears to flow inconsistent compared to others, replace and retest.
- ☐ Cylinder Check – Run a compression test and cylinder leak test on suspected cylinder(s) to check mechanical integrity of piston rings and valve seats.
- ☐ Exhaust Leak – Pressurize exhaust system with 1-2 psig of air and check for pressure leaks around exhaust manifold gasket and pre-catalyst EGO sensor. Replace gasket(s) and tighten fasteners according to manufacture recommended procedure(s).

3.75 DTC 1325 - Knock Retard at Limit



DTC	1325	SPN	731	FMI	15

Hardware: Knock Sensor 1 / Knock Sensor 2

Hardware Description:

The knock sensor is used to detect detonation through mechanical vibration in the engine block and/or cylinder heads and provide feedback for the ignition system to retard spark to reduce knock intensity. In most applications the knock sensor is used to protect the engine from damage that can be caused from detonation or knock based on fixed spark advance. In other applications, the knock sensor is used to optimize spark advance and "learn" between spark tables based on fuel quality.

Fault Enabled in Calibration?	**YES**
Emissions-related Fault?	**YES**
Check Condition:	Key On, Engine On

Fault Set Conditions (as defined in calibration):

• RPM >	1500	rpm
• and MAP >	8	psia
• and knock spark retard at percent of maximum	100	%

Fault Description:

This fault sets when the engine is actively "hard knocking" (calculated knock percentage > calibrated Knock Validation Trigger parameter value), and also above the threshold settings.

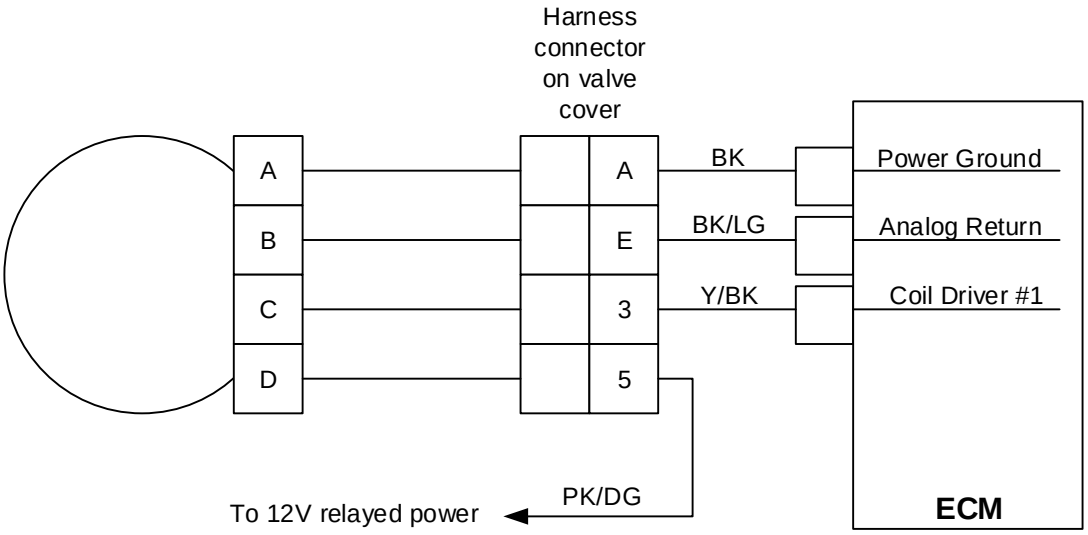
Corrective Actions:

Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	
Never Forget		AL Disable	X	Low Rev Limit		MIL Persist Disable	X
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable		Power Derate 1		Soft Warning		NOx Control System	

Diagnostic Aids

- ☐ If other DTCs exist diagnose these first.
- ☐ Refer to the engine manufacturer's service manual for additional information

3.76 DTC 1351 – DTC 1358 – Spark Plug or Coil Failure (Cylinders 1-8)



DTC	1351	**SPN**	520260	**FMI**	17
Sensor/Circuit:	Ignition/Spark Coil, cylinders 1-8 (Dumb-coil ONLY)				
Description: Coil driver #1 (correlates to DTC 1351) fires either the 1st cylinder in the firing order or the 1st cylinder in the block order depending on the configuration of the 'Injector/Spark Diagnostic Numbering' scheme as set in calibration. Drivers 2-8 (correlating to DTCs 1352-1358) follow in-kind.					
Fault Enabled in Calibration?	**YES**				
Emissions-related Fault?	**YES**				
Check Condition:	Key On, Engine On				
Fault Set Conditions (as defined in calibration): • Ignition/Spark drive circuitry (internal to the ECM) is overheating					
Possible Causes: This fault will set if the ECM detects that the spark/ignition drive circuitry within the ECM is over-heating. Once over-heating is detected and this fault is active, the ECM will kill spark on the affected channel until 255 seconds after the drive circuit cools or until the key switch is cycled depending upon the selection made in the diagnostic calibration.					

Corrective Actions:

Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	
Never Forget		AL Disable		Low Rev Limit		MIL Persist Disable	
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable		Power Derate 1		Soft Warning		NOx Control System	

DTC 1351 – DTC 1360 – SPARK PLUG OR COIL FAILURE (CYLINDERS 1-10)

(continued from previous page)

Typical causes of this fault include:

shorted coil

poor quality coil

coil loose from spark plug

plug gap too large (all inductive energy goes back on driver)

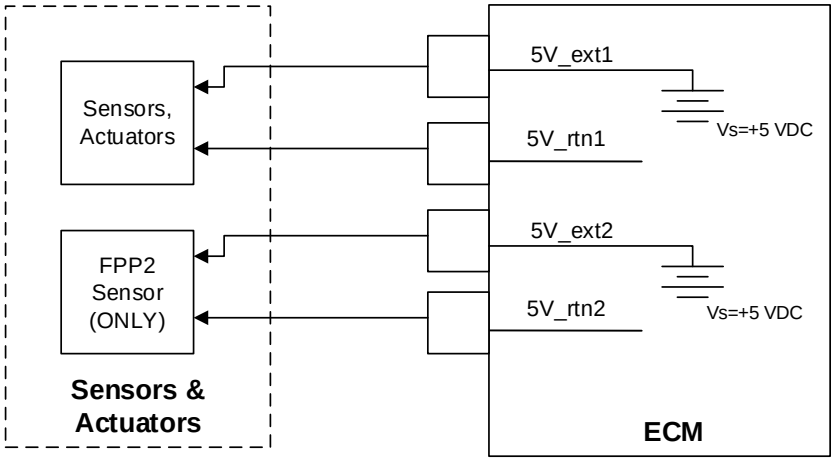
dwell time is set too long in the diagnostic calibration

ambient temp too high

Diagnostic Aids:

- ☐ Check plug gap on the cylinder associated with the fault.
- ☐ Check for loose connections at the coil and spark plugs. Look for evidence of charring or arcing around spark plugs.
- ☐ Check coil resistance and verify that it is within specifications. Look for a short internal to the coil.
- ☐ Ensure the use of high quality coils without a history of internal arcing or other failures.
- ☐ Verify that ambient conditions are not exceeding 85C on a continuous basis or 125C for short intervals. If so, verify that this fault stops occurring when ambient temperatures lower.
- ☐ Verify the dwell time set in the diagnostic calibration is not set too long and that adaptive dwell is enabled.

3.77 DTC 1611 - Sensor Supply Voltage (5Vext 1/2) Simultaneous Out-of-Range



DTC	1611	SPN	1079	FMI	31

Sensor/Circuit: Powered sensors/actuators and FPP2

Description:

5V_ext1 is a regulated 5 VDC output that supplies power to sensors and actuators. This power is generally supplied, but is not limited to hall-effects, potentiometers, switches, and pressure transducers. 5V_ext2 is a low-current 5 VDC power supply intended solely for powering a second potentiometer used for electronic throttle control in configurations where high redundancy is required. High accuracy of the power supplies are required in order to ensure proper signal scaling. Both power supplies have a feedback voltage that is monitored by the ECM to determine if the output is overloaded, shorted, or otherwise out of specification.

Fault Enabled in Calibration?	**YES**
Emissions-related Fault?	**NO**
Check Condition:	Engine On

Fault Set Conditions (as defined in calibration):

• AUX analog PU3 >	5.40	volts

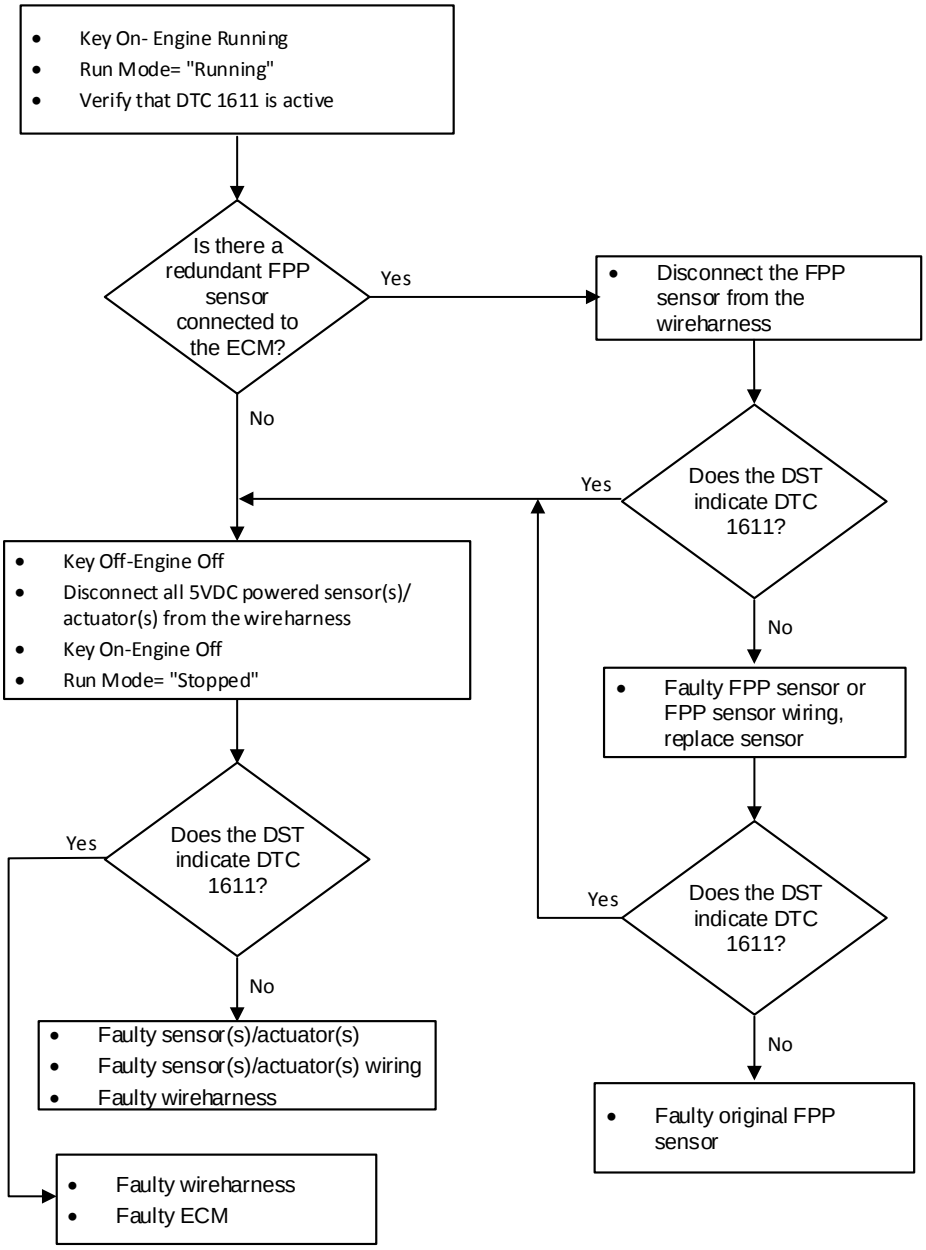
Possible Causes:

This fault indicates that both power supply feedback voltages are out-of-range as defined in the calibration. In configurations where the crank and/or camshaft position sensors are powered hall-effect sensors, the engine may stall due to loss of synchronization.

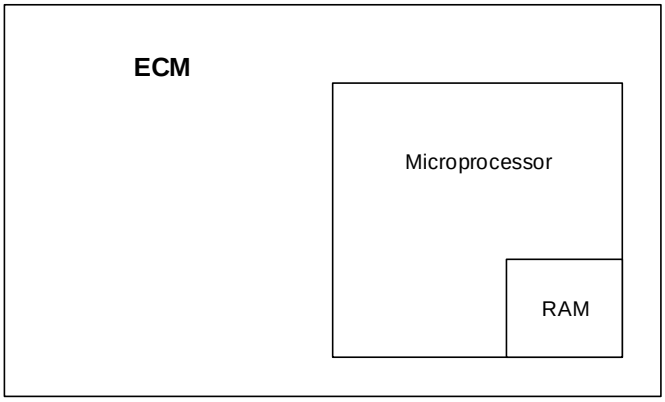
Corrective Actions:

Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	
Never Forget		AL Disable		Low Rev Limit		MIL Persist Disable	
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable		Power Derate 1		Soft Warning		NOx Control System	

3.77.1 DTC 1611 - Sensor Supply Voltage (5VEXT 1/2) Simultaneous Out-Of-Range , (Trouble Tree)



3.78 DTC 1612 - Microprocessor Failure - RTI 1



DTC	1612	SPN	629	FMI	31

Sensor/Circuit: Engine Control Module

Description:

The ECM will reset itself in the event this fault is set, and the MIL will be on until the code is cleared. This fault should be erased after diagnosis by removing battery power. It will not self-erase.

During this active fault, Power Derate (level 2) will be enforced. When this is enforced, maximum throttle position will be 20%. This is enforced until the fault is manually cleared.

Fault Enabled in Calibration?	**YES**
Emissions-related Fault?	**NO**
Check Condition:	Key On

Fault Set Conditions (as defined in calibration):

- Internal microprocessor error

Possible Causes:

The ECM has checks that must be satisfied each time an instruction is executed. Several different things can happen within the microprocessor that will cause this fault.

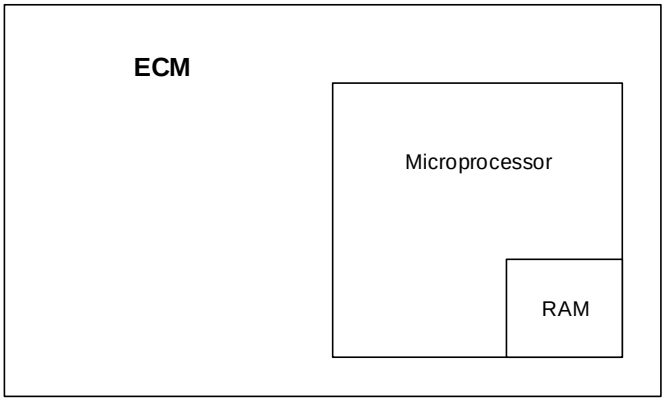
Corrective Actions:

Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	X
Never Forget	X	AL Disable		Low Rev Limit		MIL Persist Disable	
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable		Power Derate 1		Soft Warning		NOx Control System	

Diagnostic Aids:

- Replace ECM with known good unit and retest.

3.79 DTC 1613 - Microprocessor Failure - RTI 2



DTC	1613	SPN	629	FMI	31

Sensor/Circuit: Engine Control Module

Description:

The ECM will reset itself in the event this fault is set, and the MIL will be on until the code is cleared. This fault should be erased after diagnosis by removing battery power. It will not self-erase.

During this active fault, Power Derate (level 2) will be enforced. When this is enforced, maximum throttle position will be 20%. This is enforced until the fault is manually cleared.

Fault Enabled in Calibration?	**YES**
Emissions-related Fault?	**NO**
Check Condition:	Key On

Fault Set Conditions (as defined in calibration):

- Internal microprocessor error

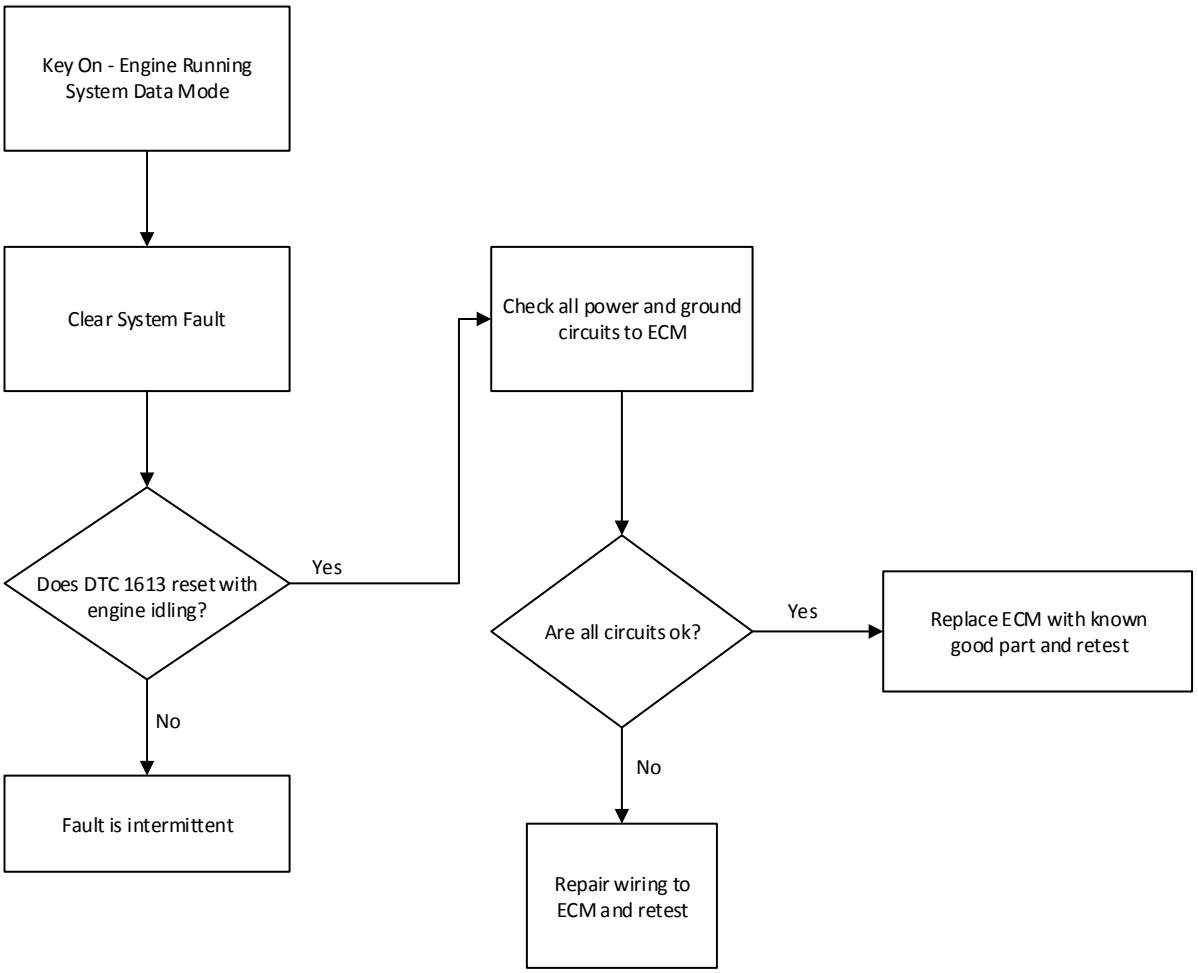
Possible Causes:

The ECM has checks that must be satisfied each time an instruction is executed. Several different things can happen within the microprocessor that will cause this fault.

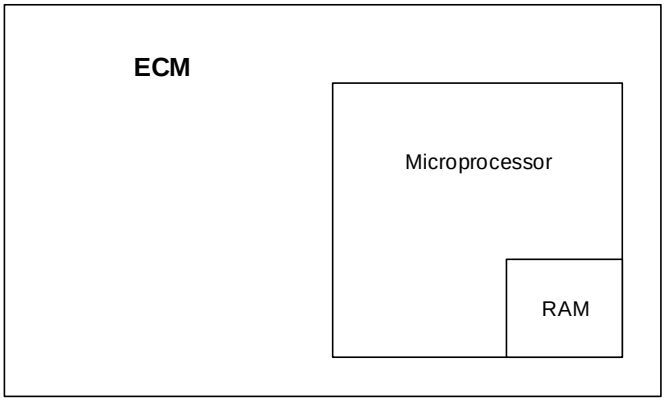
Corrective Actions:

Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	X
Never Forget	X	AL Disable		Low Rev Limit		MIL Persist Disable	
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable		Power Derate 1		Soft Warning		NOx Control System	

3.79.1 DTC 1613 - Microprocessor Failure - RTI 2 (Trouble Tree)



3.80 DTC 1614 - Microprocessor Failure - RTI 3



DTC	1614	SPN	629	FMI	31

Sensor/Circuit: Engine Control Module

Description:

The ECM will reset itself in the event this fault is set, and the MIL will be on until the code is cleared. This fault should be erased after diagnosis by removing battery power. It will not self-erase.

During this active fault, Power Derate (level 2) will be enforced. When this is enforced, maximum throttle position will be 20%. This is enforced until the fault is manually cleared.

Fault Enabled in Calibration?	**YES**
Emissions-related Fault?	**NO**
Check Condition:	Key On

Fault Set Conditions (as defined in calibration):

- Internal microprocessor error

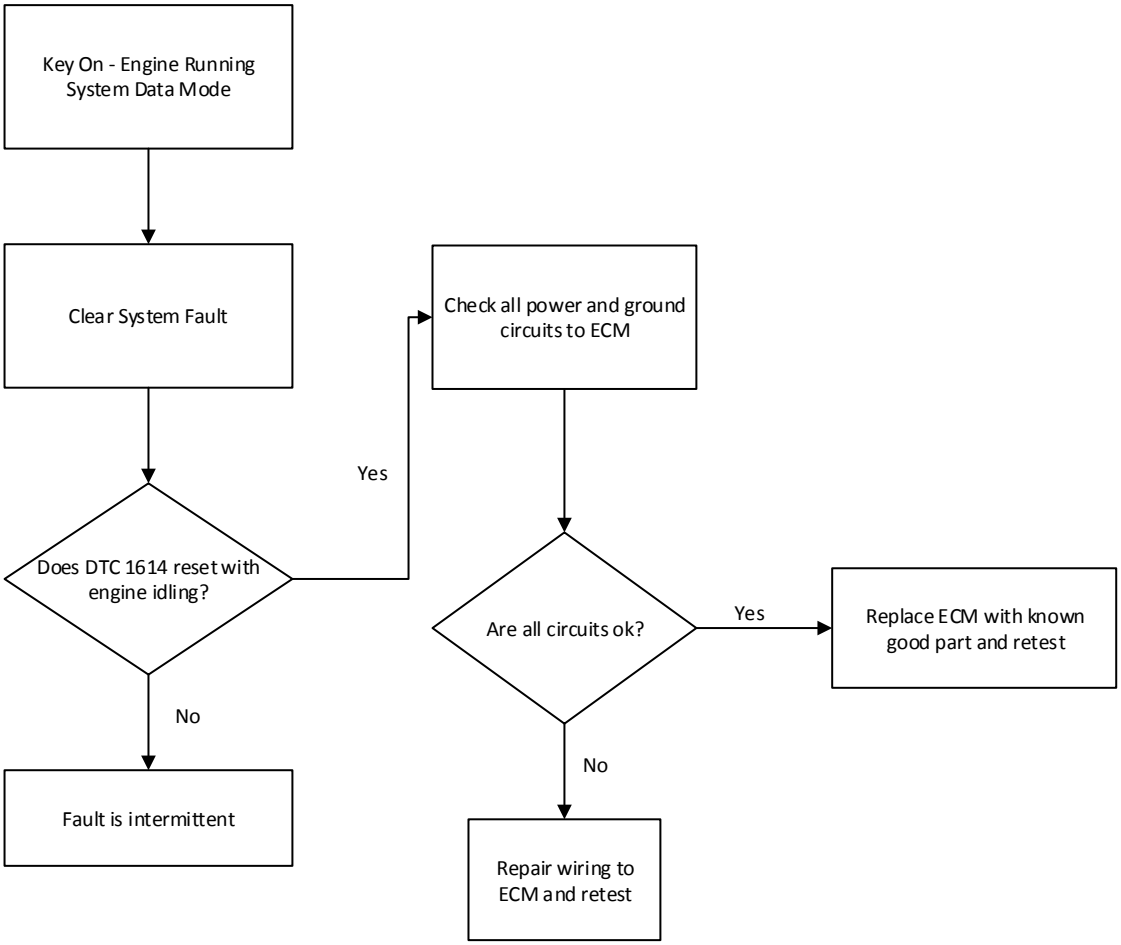
Possible Causes:

The ECM has checks that must be satisfied each time an instruction is executed. Several different things can happen within the microprocessor that will cause this fault.

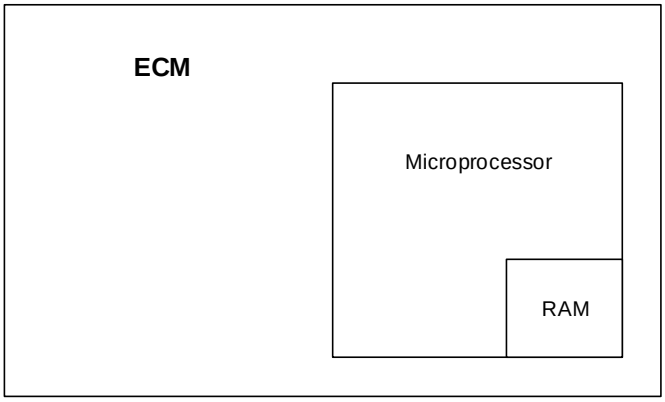
Corrective Actions:

Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	X
Never Forget	X	AL Disable		Low Rev Limit		MIL Persist Disable	
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable		Power Derate 1		Soft Warning		NOx Control System	

3.80.1 DTC 1614 - Microprocessor Failure - RTI 3 (Trouble Tree)



3.81 DTC 1615- Microprocessor Failure - A/D



DTC	1615	**SPN**	629	**FMI**	31

Sensor/Circuit: Engine Control Module

Description:

The ECM will reset itself in the event this fault is set, and the MIL will be on until the code is cleared. This fault should be erased after diagnosis by removing battery power. It will not self-erase.

During this active fault, Power Derate (level 2) will be enforced. When this is enforced, maximum throttle position will be 20%. This is enforced until the fault is manually cleared.

Fault Enabled in Calibration?	**YES**
Emissions-related Fault?	**NO**
Check Condition:	Key On

Fault Set Conditions (as defined in calibration):

- Internal microprocessor error

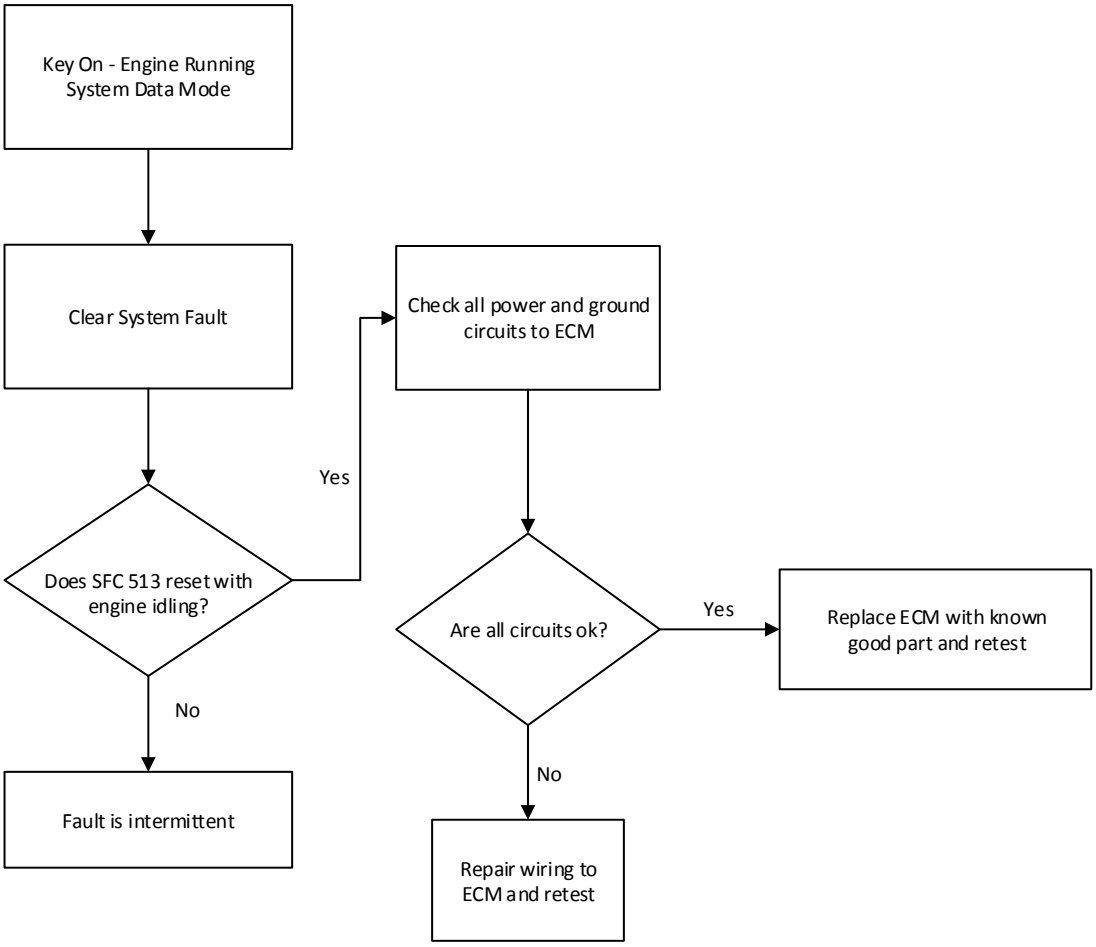
Possible Causes:

The ECM has checks that must be satisfied each time an instruction is executed. Several different things can happen within the microprocessor that will cause this fault.

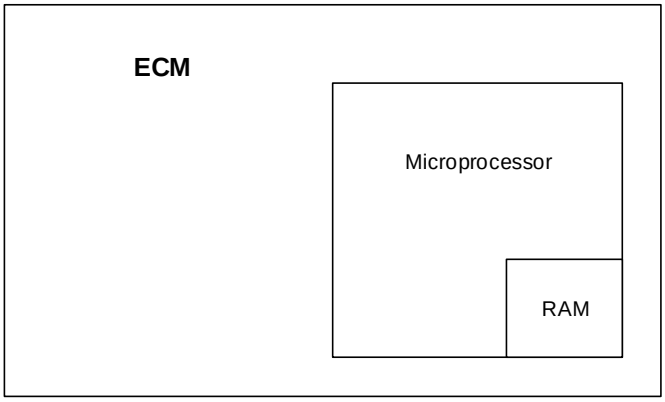
Corrective Actions:

Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	X
Never Forget	X	AL Disable		Low Rev Limit		MIL Persist Disable	
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable		Power Derate 1		Soft Warning		NOx Control System	

3.81.1 DTC 1615 - Microprocessor Failure – A/D (Trouble Tree)



3.82 DTC 1616 – Microprocessor Failure – Interrupt



DTC	1616	SPN	629	FMI	31

Sensor/Circuit: Engine Control Module

Description:

The ECM will reset itself in the event this fault is set, and the MIL will be on until the code is cleared. This fault should be erased after diagnosis by removing battery power. It will not self-erase.

During this active fault, Power Derate (level 2) will be enforced. When this is enforced, maximum throttle position will be 20%. This is enforced until the fault is manually cleared.

Fault Enabled in Calibration?	**YES**
Emissions-related Fault?	**NO**
Check Condition:	Key On

Fault Set Conditions (as defined in calibration):

- Internal microprocessor error

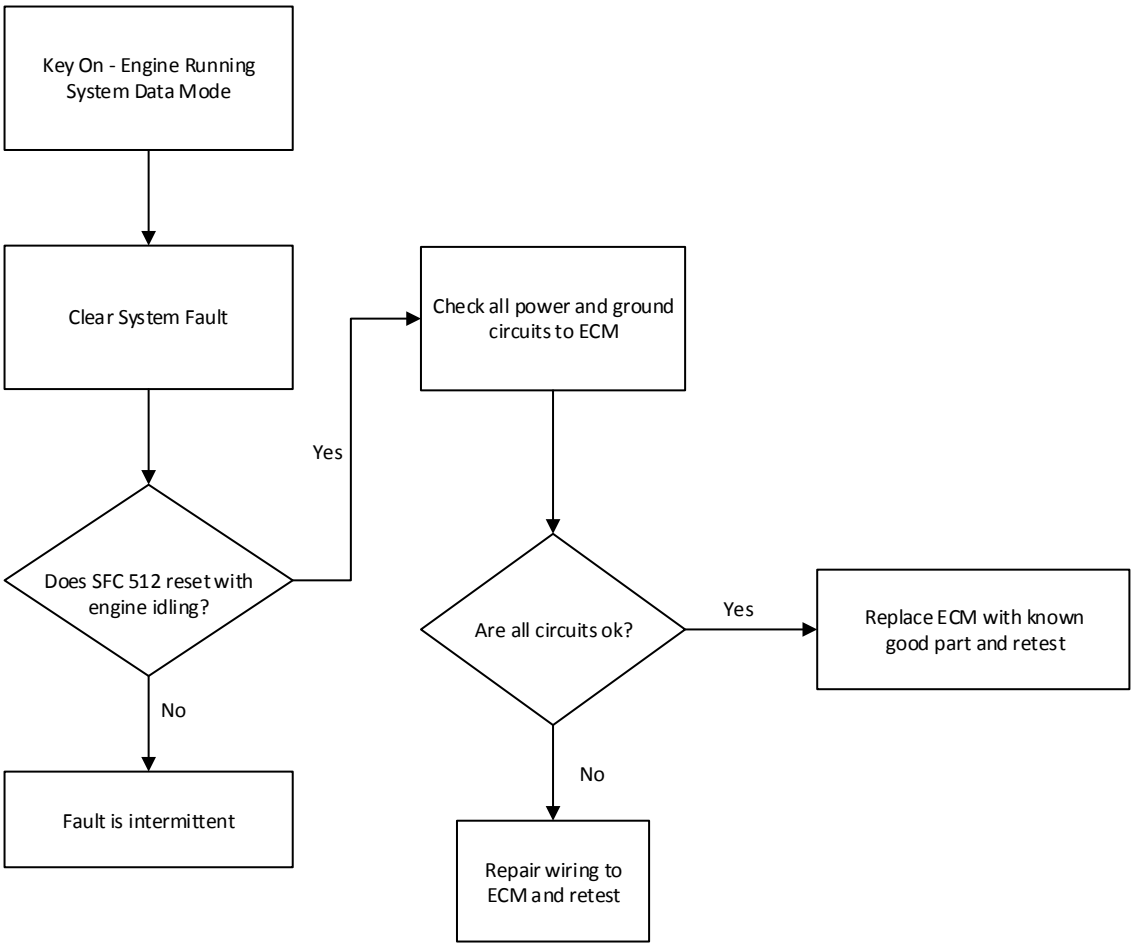
Possible Causes:

The ECM has checks that must be satisfied each time an instruction is executed. Several different things can happen within the microprocessor that will cause this fault.

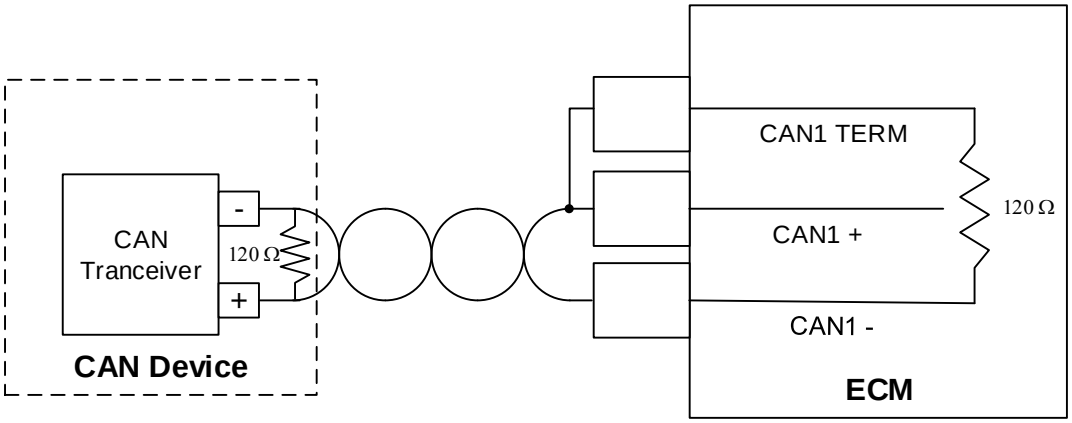
Corrective Actions:

Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	X
Never Forget	X	AL Disable		Low Rev Limit		MIL Persist Disable	
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable		Power Derate 1		Soft Warning		NOx Control System	

3.82.1 DTC 1616 - Microprocessor Failure – Interrupt (Trouble Tree)



3.83 DTC 1626 – CAN1 J1939 Transmit (Tx) Fault



DTC	1626	SPN	639	FMI	12

Sensor/Circuit: Controller Area Network

Description:

The Controller Area Network (CAN) is a serial communication network used to transmit and receive data between intelligent devices. Systems that utilize CAN communication include smart actuators (EPR), smart sensors (Envirotech), dash panels and gauges, and other microcomputers. Each smart sensor, actuator, or controller incorporates a CAN transceiver that interprets logic level signals on the network and translates the information into digital data.

Fault Enabled in Calibration?	**YES**
Emissions-related Fault?	**YES (If EPR-Equipped)**
Check Condition:	Key On, Engine Off and/or Running

Fault Set Conditions (as defined in calibration):

• Tx error counter >	100	failures

Possible Causes:

This fault will set if CAN communication is enabled and the ECM transceiver broadcasts a number of packets (as defined in the diagnostic calibration, must be set to less than 125 failures) to the network that are not received.

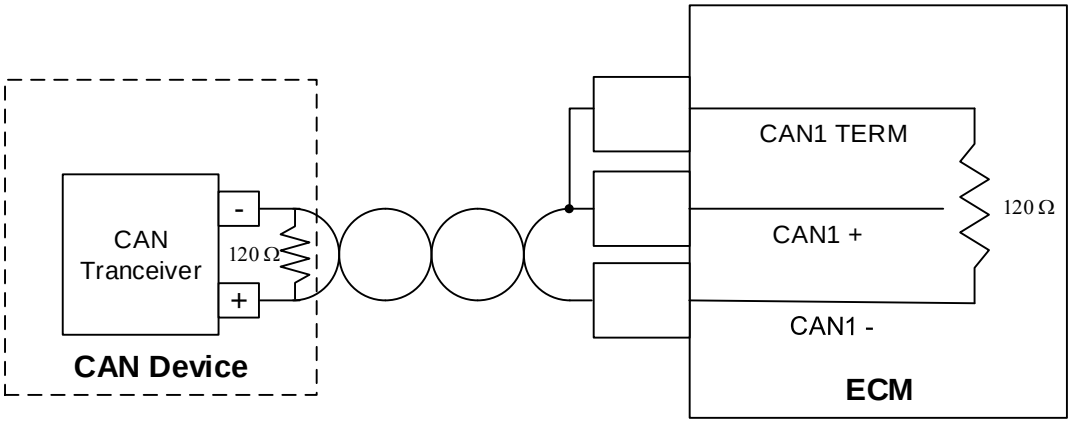
Corrective Actions:

Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	
Never Forget		AL Disable		Low Rev Limit		MIL Persist Disable	X
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable		Power Derate 1		Soft Warning		NOx Control System	

DTC 1626 – CAN1 J1939 TRANSMIT (TX) FAULT (Diagnostic Aides):

- ☐ Verify that all CAN devices are powered and are properly grounded
- ☐ Verify that the CAN1 network is properly terminated
- ☐ Check CAN1 wire routing with respect to noise sources (ignition coils, spark plug coil wires, etc.) and shield if necessary
- ☐ Check CAN1 (+) and (-) wires for short circuits

3.84 DTC 1627 – J1939 Receive (Rx) Fault



DTC	1627	SPN	639	FMI	12

Sensor/Circuit: Controller Area Network

Description:

The Controller Area Network (CAN) is a serial communication network used to transmit and receive data between intelligent devices. Systems that utilize CAN communication include smart actuators (EPR, CFV), smart sensors (Envirotech, HEGO/UEGO), dash panels and gauges, and other microcomputers. Each smart sensor, actuator, or controller incorporates a CAN transceiver that interprets logic level signals on the network and translates the information into digital data.

Check Condition:	Key On, Engine Off and/or Running

Fault Set Conditions (as defined in calibration):

• Rx error counter >	100	failures

Possible Causes:

This fault will set if CAN communication is enabled and the CAN device broadcasts a number of packets (as defined in the diagnostic calibration) to the ECM that are not received.

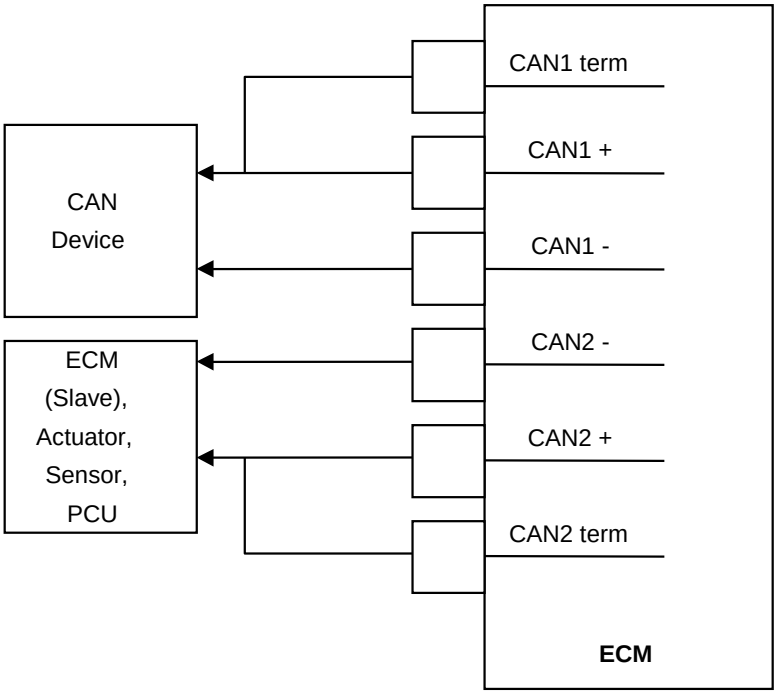
Corrective Actions:

Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	
Never Forget		AL Disable		Low Rev Limit		MIL Persist Disable	X
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable		Power Derate 1		Soft Warning		NOx Control System	

Diagnostic Aides:

- ☐ Verify that all CAN devices are powered and are properly grounded.
- ☐ Verify that the CAN network is properly terminated per J1939 requirements.
- ☐ Check CAN wire routing with respect to noise sources (coils, coil wires, etc.) and shield if necessary
- ☐ Check CAN (+) and (-) wires for short circuits

3.85 DTC 1628 - CAN1 Address Conflict Failure



DTC	1626	**SPN**	639	**FMI**	12

Sensor/Circuit: CAN Device(s)

Description:

The controller area network serves as a communication portal between intelligent devices. These devices may be but are not limited to other engine ECMs (slave), diagnostic tools, “smart” gauges, “smart” sensors, powertrain control units, vehicle controllers, actuators, etc. The network permits several devices to communicate with each other receiving and broadcasting commands as programmed. This type of network allows devices to be added to an entire system through only two conductors and permits all other devices to broadcast and receive commands to and from the device when properly commanded. CAN1 is used for general network communication including gauge display, scan tool communication, and other general 3rd party traffic. CAN2 is reserved solely for engine control (engine synchronization, throttle control, vehicle controller commands, etc.) and is limited to EControls Inc. approved devices only.

Fault Enabled in Calibration?	**YES**
Emissions-related Fault?	**NO**
Check Condition:	Key On, Engine on

Fault Set Conditions (as defined in calibration):

• Address conflict counter >	5	failures

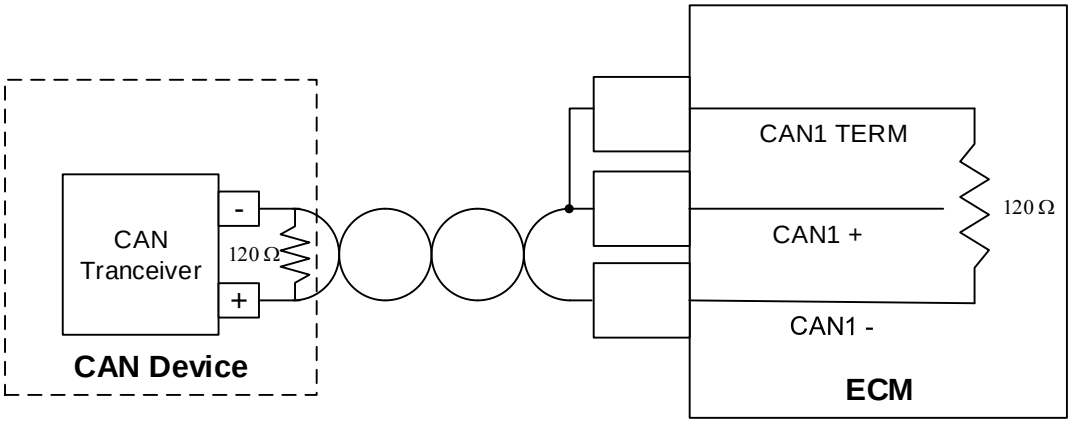
Possible Causes:

This fault indicates that there are two (2) or more devices on the network that use the same source address.

Corrective Actions:

Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	
Never Forget		AL Disable		Low Rev Limit		MIL Persist Disable	X
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	X
CL Disable		Power Derate 1		Soft Warning		NOx Control System	

3.86 DTC 1629 – J1939 TSC1 Message Receipt Loss



DTC	1629	SPN	695	FMI	9

Sensor/Circuit: Controller Area Network

Description:

The Controller Area Network (CAN) is a serial communication network used to transmit and receive data between intelligent devices. Systems that utilize CAN communication include smart actuators (EPR, CFV), smart sensors (Envirotech, HEGO/UEGO), dash panels and gauges, and other microcomputers. Each smart sensor, actuator, or controller incorporates a CAN transceiver that interprets logic level signals on the network and translates the information into digital data.

A special J1939 message called Torque/Speed Control #1 (TSC1) allows other CAN-enabled devices to control or limit the engine speed. While originally intended as a temporary means for the transmission to override engine speed during gear shifts, TSC1 messages have evolved to include permanent means of controlling engine speed by off engine control systems.

Check Condition:	Key On, Engine Running

Fault Set Conditions (as defined in calibration):

• Loss of TSC1 after engine running >=	5	seconds

Possible Causes:

This fault sets when the ECM fails to receive a TSC1 message for a calibratable time after an engine run condition is detected.

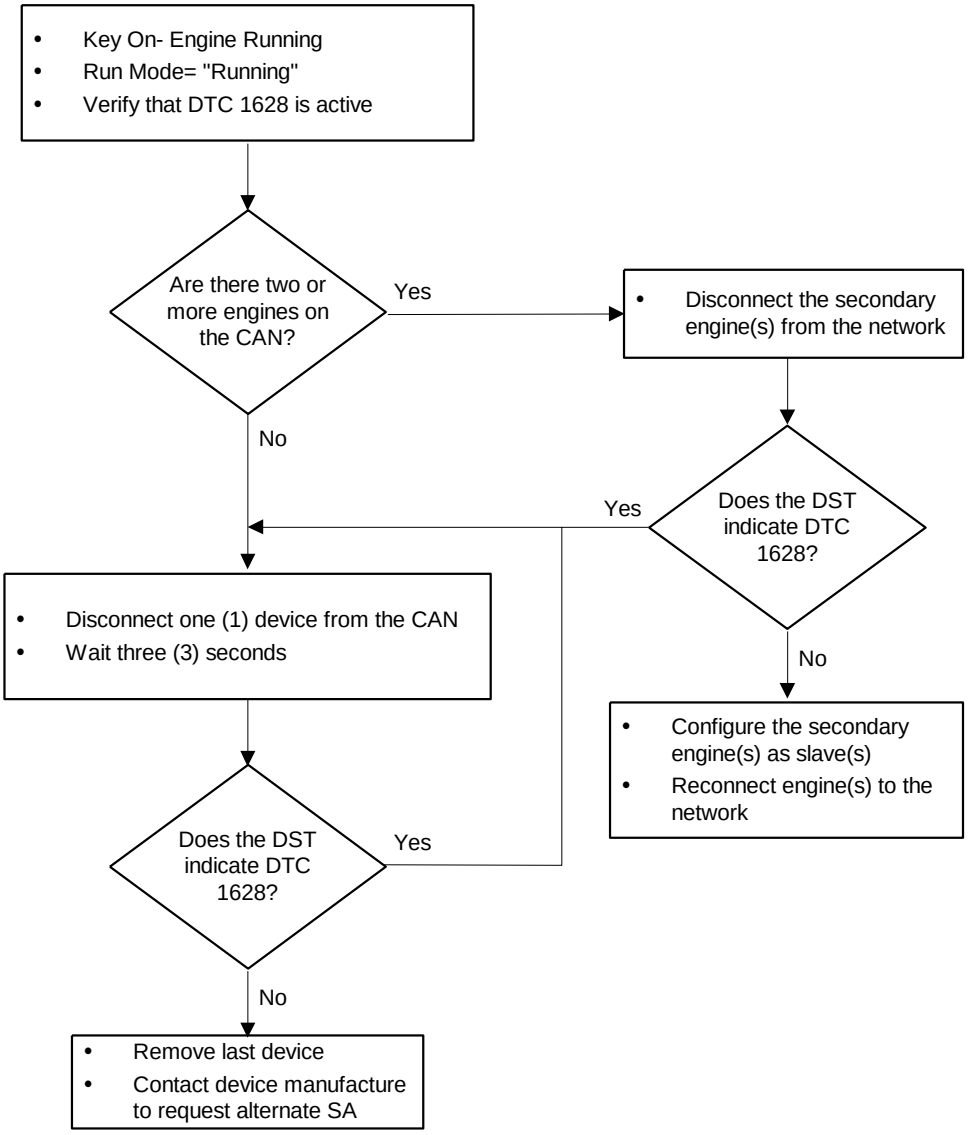
Corrective Actions:

Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	
Never Forget		AL Disable		Low Rev Limit		MIL Persist Disable	
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable		Power Derate 1		Soft Warning		NOx Control System	

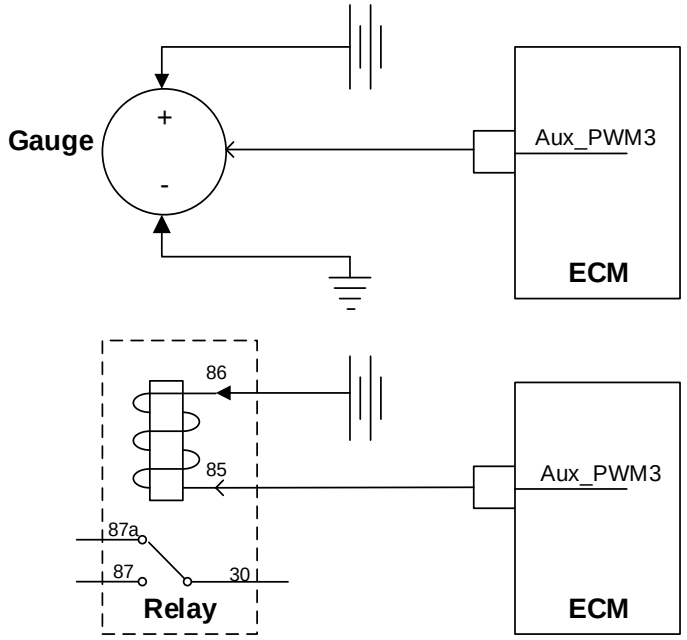
Diagnostic Aides:

- ☐ Verify source of TSC1 message (e.g., gen-set or vehicle controller) is powered and is properly grounded.
- ☐ Verify that the CAN network is properly terminated per J1939 requirements.
- ☐ Check CAN wire routing with respect to noise sources (coils, coil wires, etc.) and shield if necessary
- ☐ Check CAN (+) and (-) wires for short circuits

3.86.1 DTC 1628 - CAN1 Address Conflict Failure (Trouble Tree)



3.87 DTC 1635 – PWM3 Open / Ground Short



DTC	1635	SPN	699	FMI	5

Sensor/Circuit:	Analog gauge, proportional actuator, on-off device (see examples above)
Description:	AUX_PWM3 is an output that, depending on the ECM HW configuration, may be used to: Simulate the resistance of a sender to drive an analog gauge (Gauge driver config) PWM an analog gauge (PWM config) PWM the low-side of an on-off device (PWM config) PWM a proportional actuator (PWM config)
Fault Enabled in Calibration?	**YES**
Emissions-related Fault?	**NO**
Check Condition:	Key-On, Engine On

Fault Set Conditions (as defined in calibration):

• PWM 3 low-side feedback <	5.0	% Vbat
• and PWM duty-cycle <	5.0	%

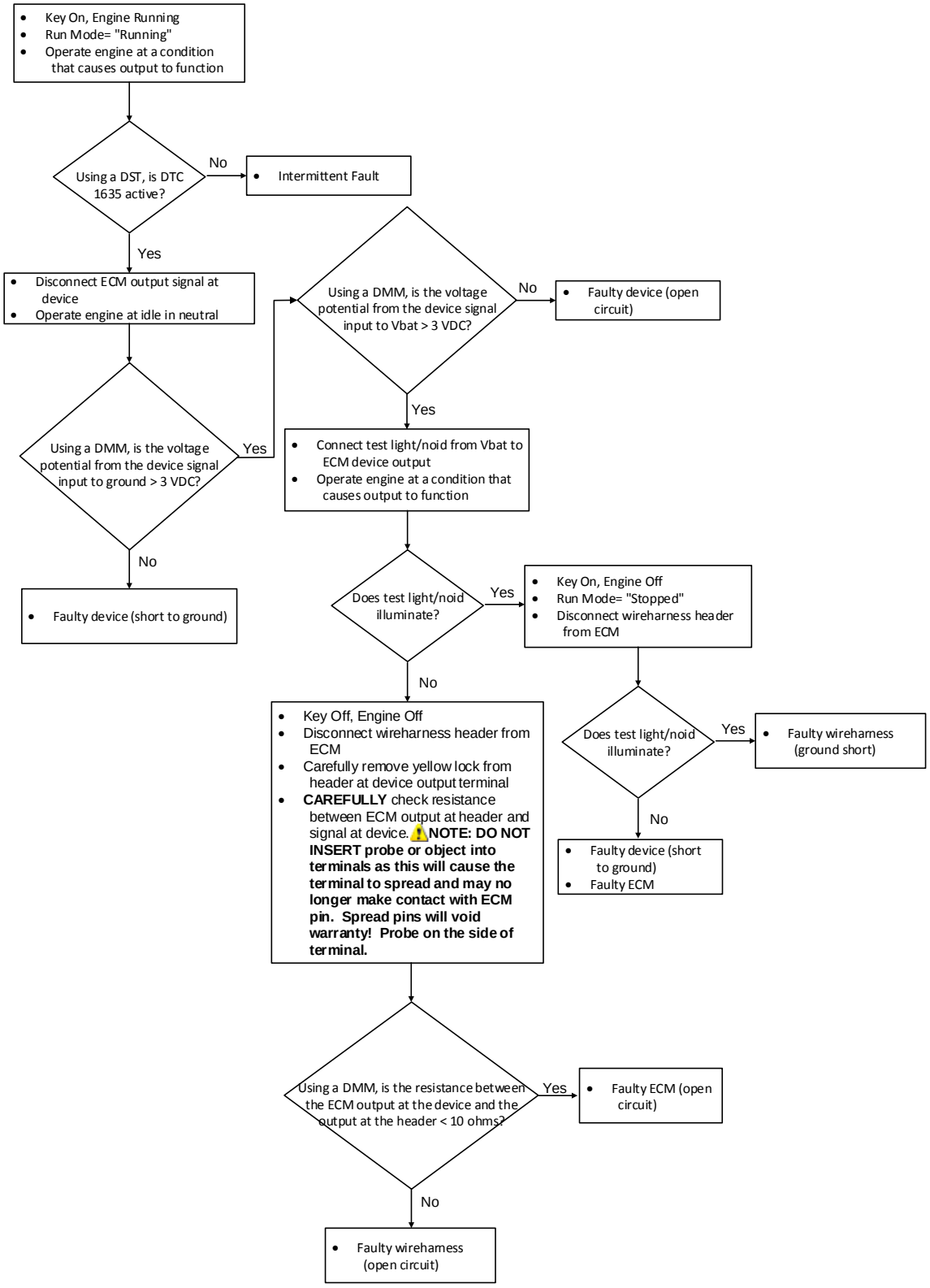
Possible Causes:

AUX PWM3 output open circuit or shorted to ground

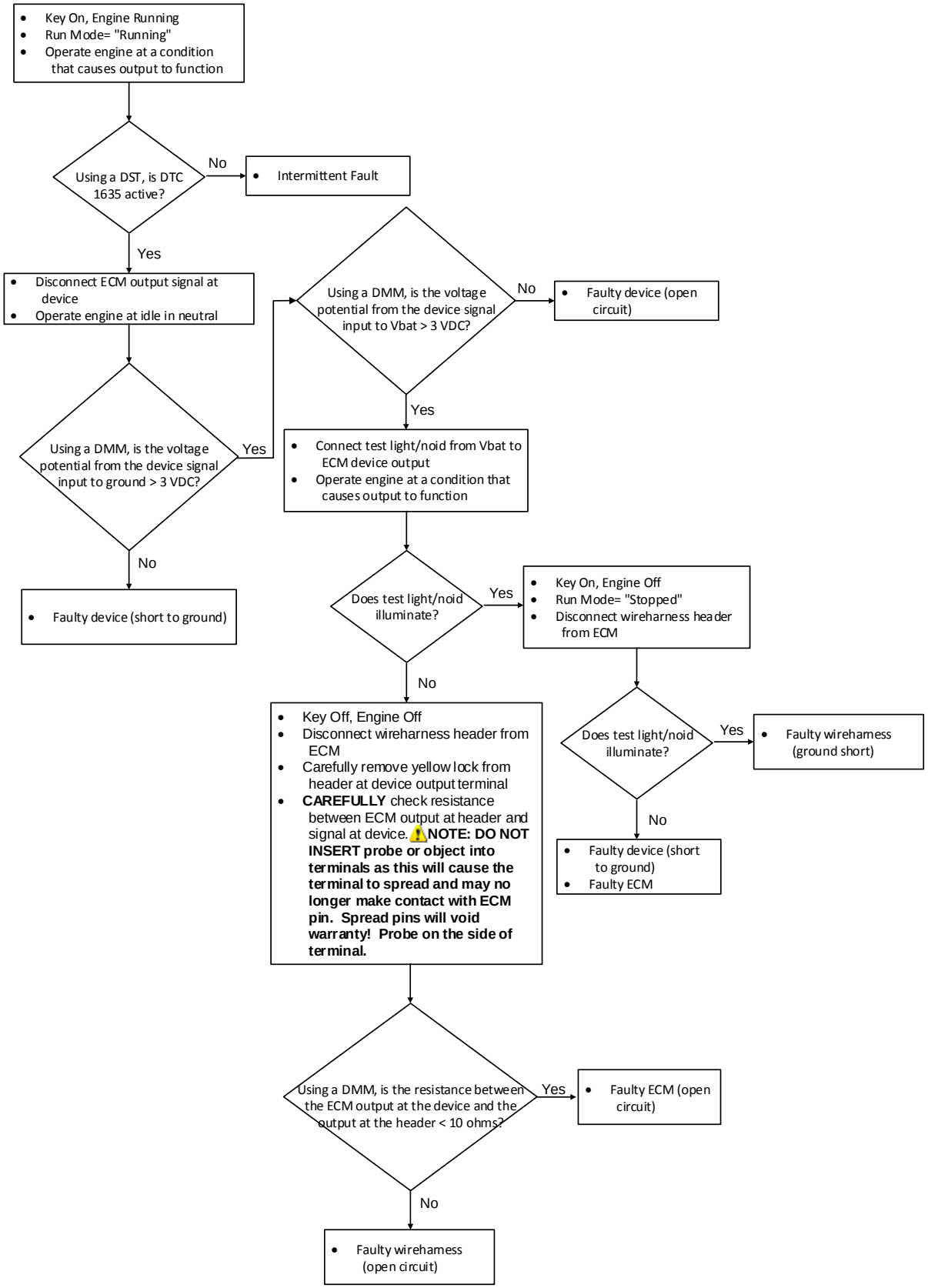
Corrective Actions:

Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	
Never Forget		AL Disable		Low Rev Limit		MIL Persist Disable	
Turn on MIL		AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable		Power Derate 1		Soft Warning		NOx Control System	

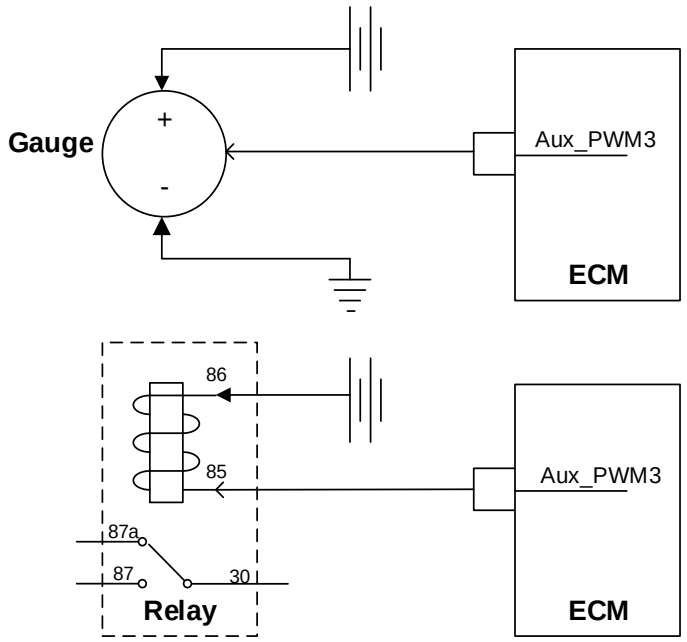
3.87.1 DTC 1635 – PWM3 Open / Ground Short (Trouble Tree), Duty-Cycle PWM Type



3.87.2 DTC 1635 – PWM3 Open / Ground Short (Trouble Tree), Resistance Simulation Type



3.88 DTC 1636 - PWM3 Short to Power



DTC	1636	SPN	699	FMI	3

Sensor/Circuit: Analog gauge, proportional actuator, on-off device (see examples above)

Description:

AUX_PWM3 is an output that, depending on the ECM HW configuration, may be used to:
Simulate the resistance of a sender to drive an analog gauge (Gauge driver config)
PWM an analog gauge (PWM config)
PWM the low-side of an on-off device (PWM config)
PWM a proportional actuator (PWM config)

Fault Enabled in Calibration?	**YES**
Emissions-related Fault?	**NO**
Check Condition:	Key-On, Engine On

Fault Set Conditions (as defined in calibration):

• PWM 3 low-side feedback >	90.0	% Vbat
• and PWM duty-cycle >	90.0	%
OR		
• PWM 3 current feedback >	5000	mA
• and PWM duty-cycle <	0.0	%

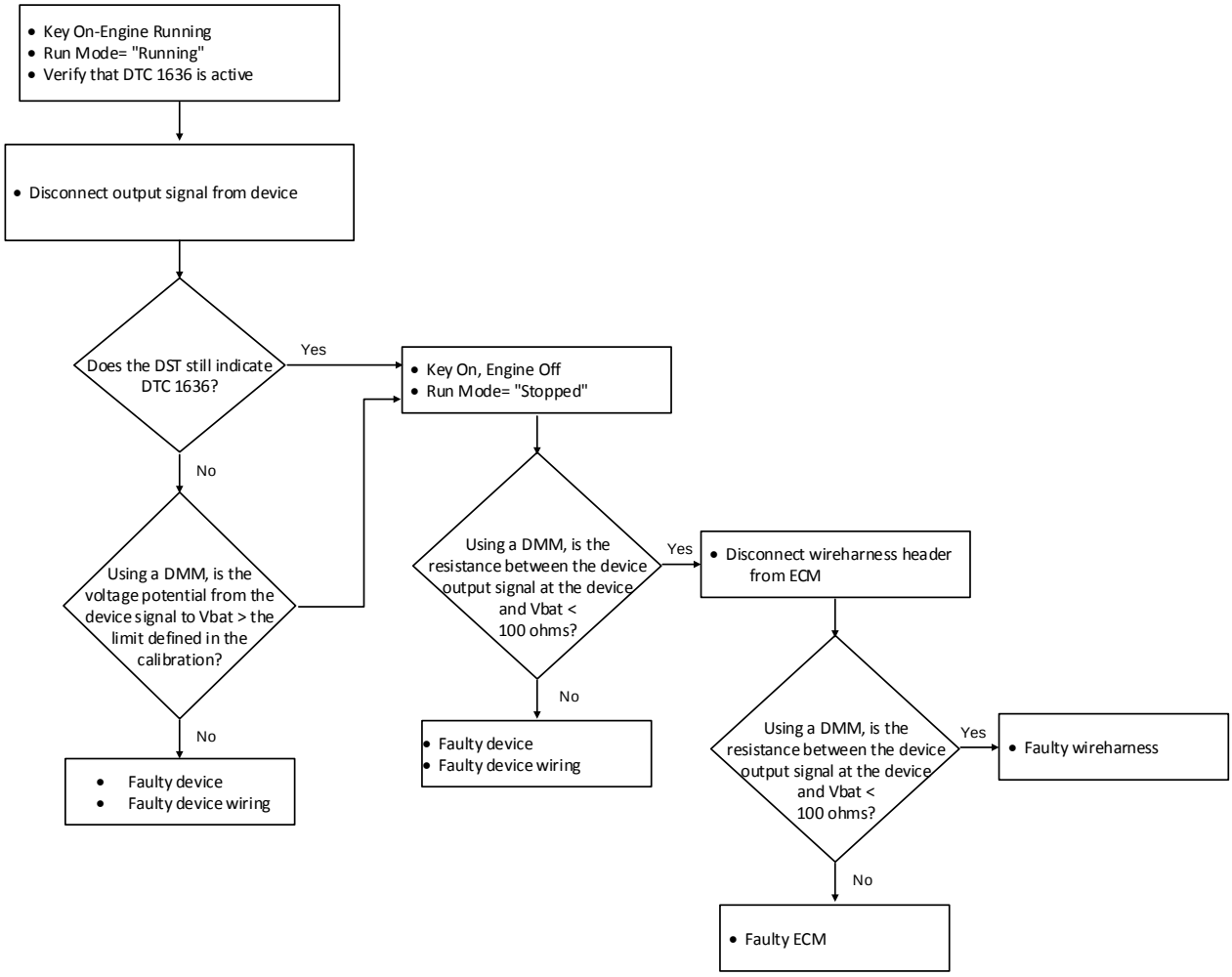
Possible Causes:

AUX PWM3 output shorted to power

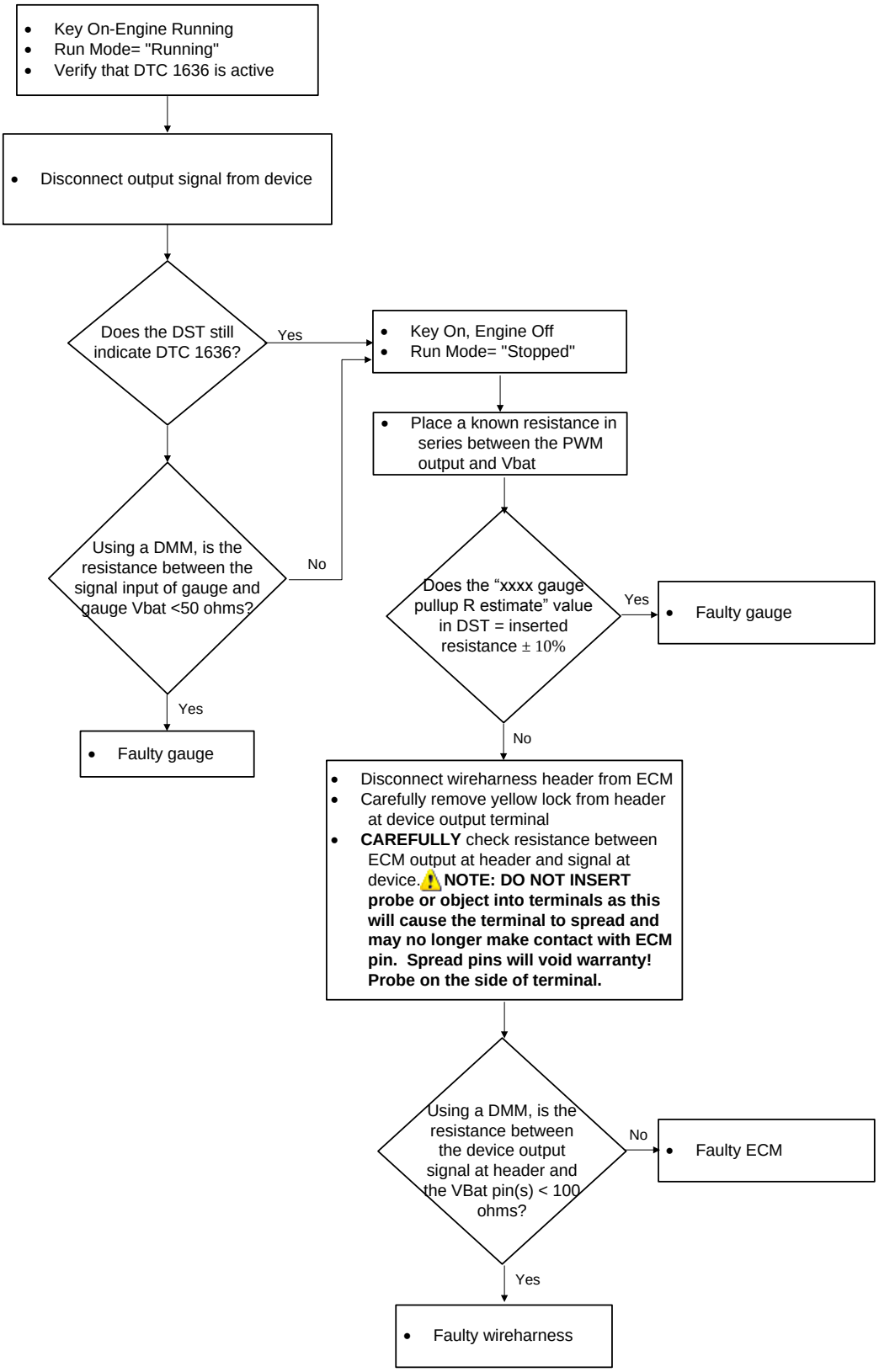
Corrective Actions:

Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	
Never Forget		AL Disable		Low Rev Limit		MIL Persist Disable	
Turn on MIL		AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable		Power Derate 1		Soft Warning		NOx Control System	

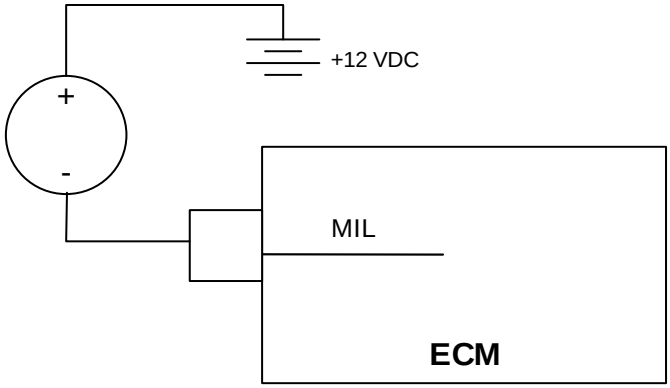
3.88.1 DTC 1636 – PWM3 Short to Power (Trouble Tree), Duty-Cycle PWM Type


• Key On-Engine Running
• Run Mode= "Running"
• Verify that DTC 1636 is active
• Disconnect output signal from device
Does the DST still indicate DTC 1636?
Yes
No
• Key On, Engine Off
• Run Mode= "Stopped"
Using a DMM, is the voltage potential from the device signal to Vbat > the limit defined in the calibration?
No
• Faulty device
• Faulty device wiring
Using a DMM, is the resistance between the device output signal at the device and Vbat < 100 ohms?
Yes
No
• Faulty device
• Faulty device wiring
• Disconnect wireharness header from ECM
Using a DMM, is the resistance between the device output signal at the device and Vbat < 100 ohms?
Yes
• Faulty wireharness
No
• Faulty ECM

3.88.2 DTC 1636 – PWM3 Short to Power (Trouble Tree), Resistance Simulation Type



3.89 DTC 1644 - MIL Control Ground Short



DTC	1644	SPN	1213	FMI	4

Sensor/Circuit: MIL

Description:

This ECM output is used to provide a low-side switch to a MIL that is used to indicate that an emission related fault has been set.

Fault Enabled in Calibration?	**YES**
Emissions-related Fault?	**NO**
Check Condition:	Key-On, Engine On

Fault Set Conditions (as defined in calibration):

- Ground short of MIL output

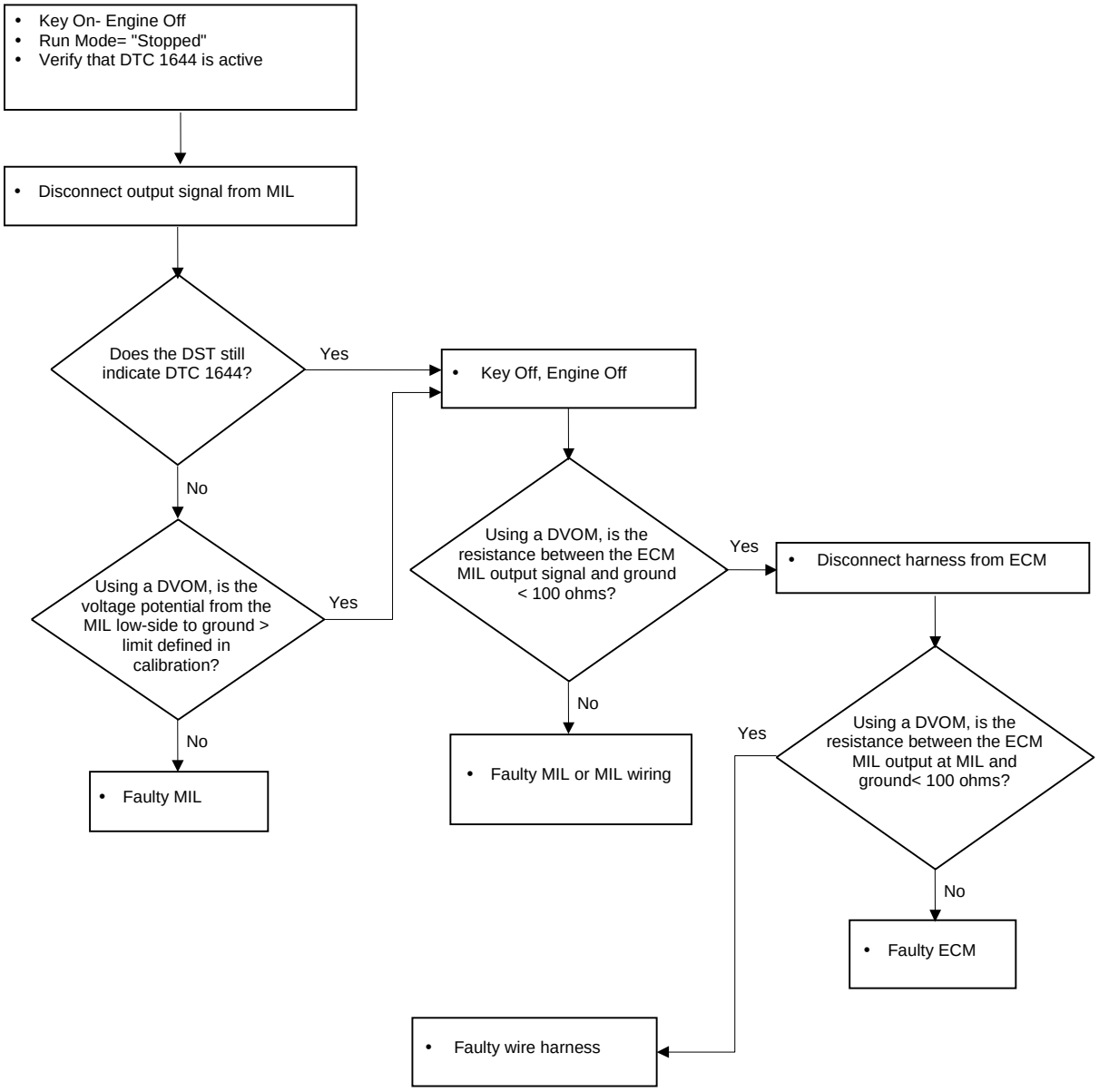
Possible Causes:

This fault will set if the ECM detects that there is a ground short of the MIL output.

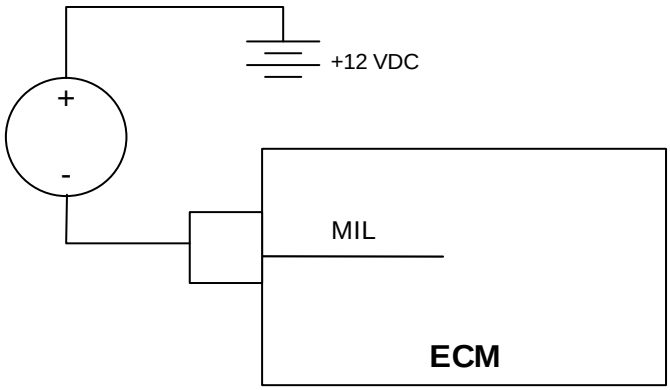
Corrective Actions:

Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	
Never Forget		AL Disable		Low Rev Limit		MIL Persist Disable	X
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	X
CL Disable		Power Derate 1		Soft Warning		NOx Control System	

3.89.1 DTC 1644 - MIL Control Ground Short (Trouble Tree)



3.90 DTC 1645 - MIL Control Short to Power



DTC	1645	**SPN**	1213	**FMI**	3

Sensor/Circuit: MIL

Description:

This ECM output is used to provide a low-side switch to a MIL that is used to indicate that an emission related fault has been set.

Fault Enabled in Calibration?	**YES**
Emissions-related Fault?	**NO**
Check Condition:	Key-On, Engine On

Fault Set Conditions (as defined in calibration):

• Low-side feedback >	90.0	% Vbat

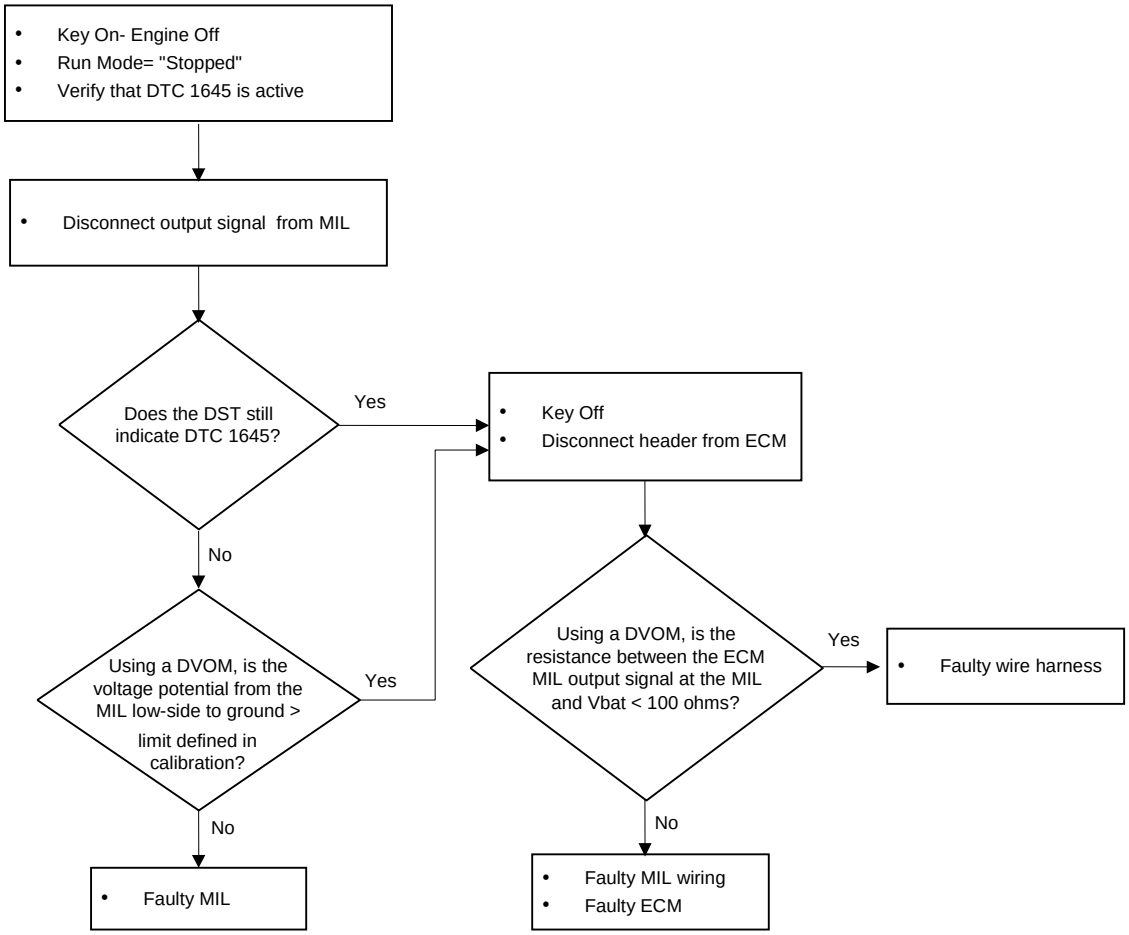
Possible Causes:

This fault will set if the ECM detects that the ECM MIL output shorted to power

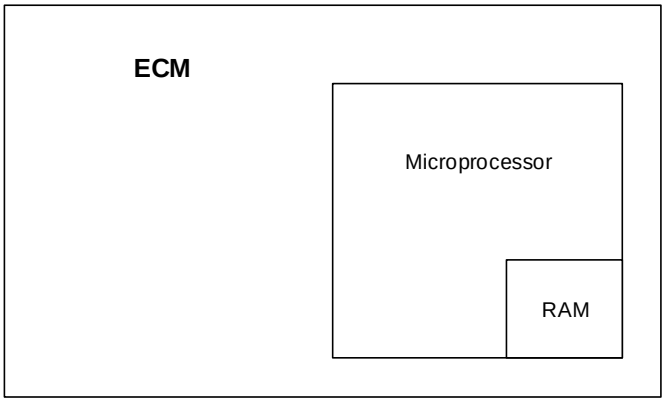
Corrective Actions:

Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	
Never Forget		AL Disable		Low Rev Limit		MIL Persist Disable	X
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	X
CL Disable		Power Derate 1		Soft Warning		NOx Control System	

3.90.1 DTC 1645 - MIL Control Short to Power (Trouble Tree)



3.91 DTC 1673 - Calibration Configuration Error



DTC	1673	SPN	1634	FMI	13

Sensor/Circuit: Calibration Configuration Error

Description:

The ECM checks certain safety-related calibration variables for acceptable values or ranges.

During this active fault, Power Derate (level 2) will be enforced. When this is enforced, maximum throttle position will be 20%. This is enforced until the fault is manually cleared. Adaptive Learn will be disabled for the duration of the key on cycle to prevent improper learning and updating of the table. The MIL will be illuminated for the duration of the key on cycle. Additionally, the fault should be configured to never forget and will not self-erase and will not clear until a technician performs diagnostics and manually clears the code.

Fault Enabled in Calibration?	**YES**
Emissions-related Fault?	**YES**
Check Condition:	Key On

Fault Set Conditions (as defined in calibration):

- Specific calibration variable checks do not return expected results

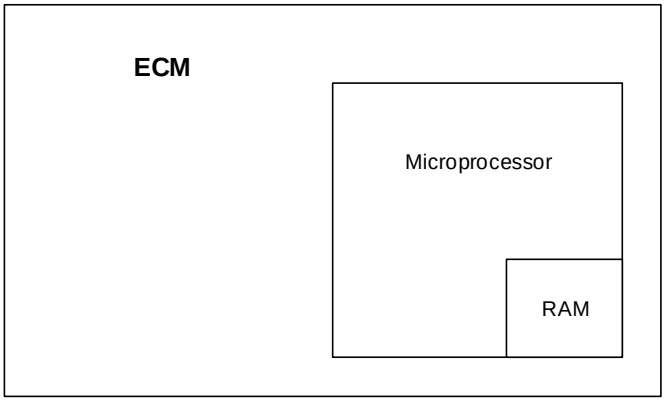
Possible Causes:

Specific calibration variable checks do not return expected results

Corrective Actions:

Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	
Never Forget	X	AL Disable		Low Rev Limit		MIL Persist Disable	
Turn on MIL	X	AL Disable key cyc.	X	Force Idle		Stopped Check	
CL Disable		Power Derate 1		Soft Warning		NOx Control System	

3.92 DTC 1674 - Hardware ID Failure



DTC	1674	**SPN**	1634	**FMI**	2

Sensor/Circuit: Engine Control Module- Hardware ID Failure

Description:

The ECM checks the MOT file against hardware ID tags that indicate the current ECM hardware revisions level.
If this fault sets, the ECM will reset itself and log the code. The fault should be configured to never forget and will not self-erase and will not clear until a technician performs diagnostics and manually clears the code. This fault should be configured to set a power derate 2 and low rev limit to reduce possible engine damage and reduce possibility of an overspeed condition

Fault Enabled in Calibration?	**YES**
Emissions-related Fault?	**YES**
Check Condition:	Key On

Fault Set Conditions (as defined in calibration):

- MOT file is too old for ECM hardware revision level.

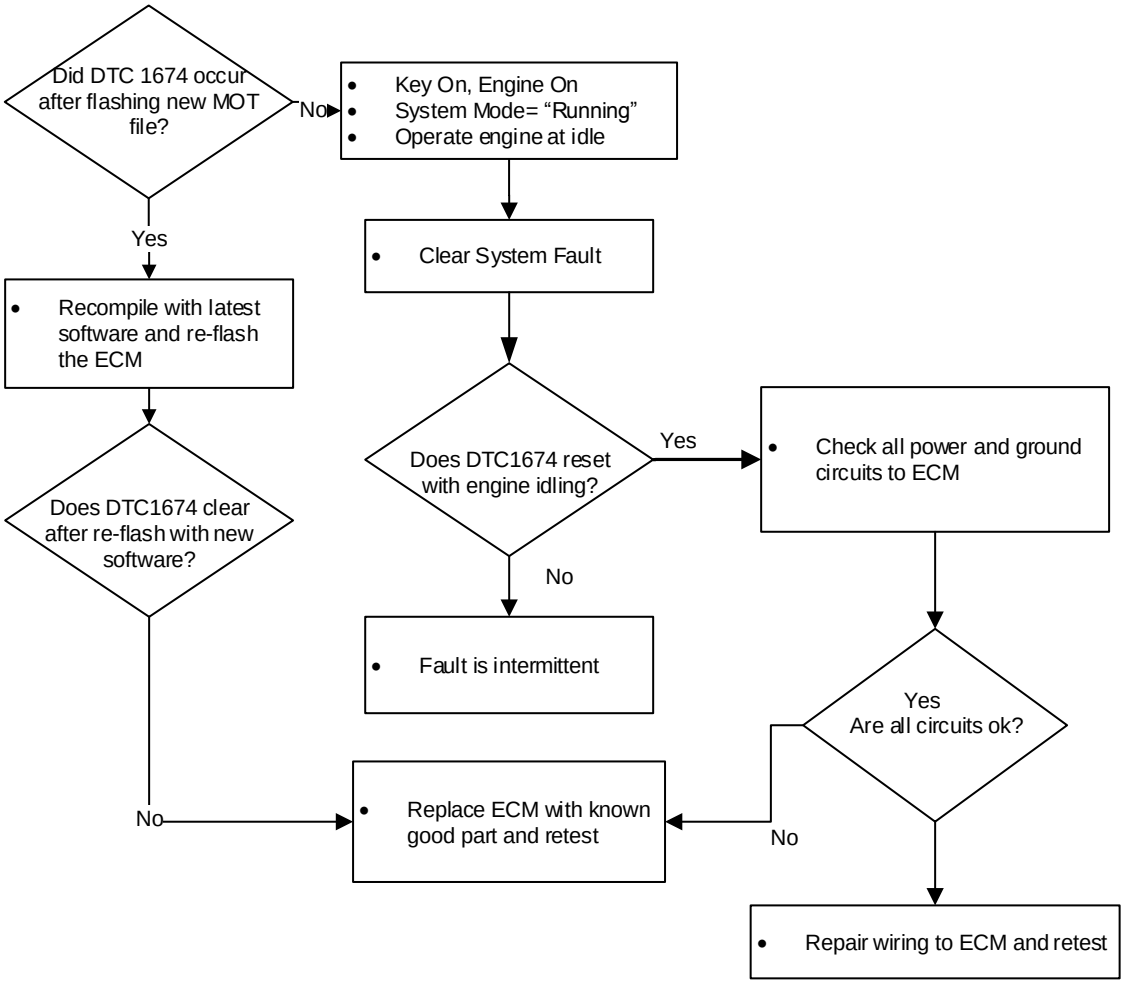
Possible Causes:

This fault will set when programming the ECM with a MOT file that is too old for the given hardware revision level.

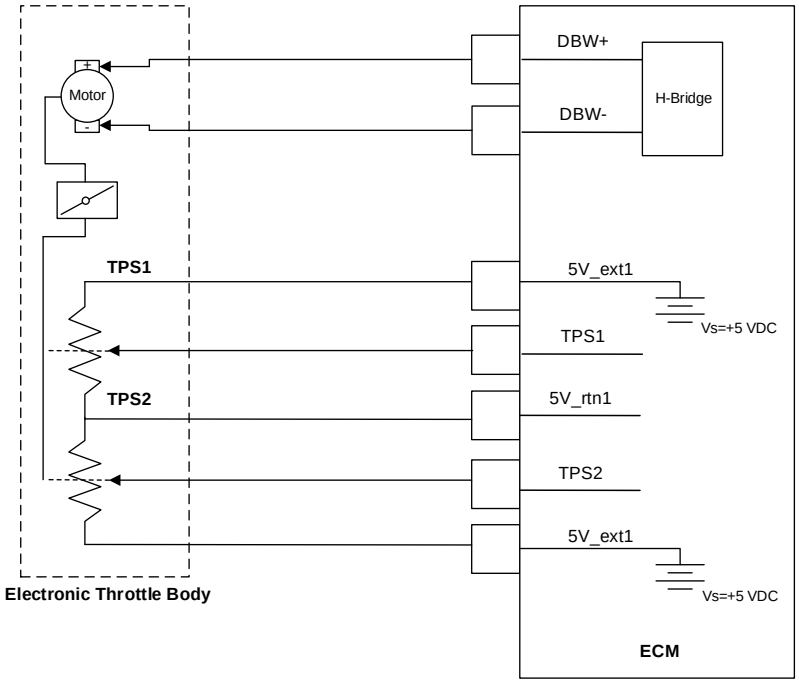
Corrective Actions:

Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	
Never Forget	X	AL Disable		Low Rev Limit		MIL Persist Disable	
Turn on MIL	X	AL Disable key cyc.	X	Force Idle		Stopped Check	
CL Disable		Power Derate 1		Soft Warning		NOx Control System	

3.92.1 DTC 1674 - Hardware ID Failure (Trouble Tree)



3.93 DTC 2111 - Unable to Reach Lower TPS



DTC	2111	SPN	51	FMI	7

Sensor/Circuit: Throttle Position Sensor

Description:

There are 2 Throttle Position Sensors located within the throttle which use variable resistors to determine signal voltage based on throttle plate position. TPS1 will read low voltage when closed and TPS2 will read high voltage when closed. The TPS1 and TPS2 percentages are calculated from these voltages. Although the voltages are different, the calculated values for the throttle position percentages should be very close to the same. The TPS values are used by the ECM to determine if the throttle is opening as commanded.

Fault Enabled in Calibration?	**YES**
Emissions-related Fault?	**NO**
Check Condition:	Cranking or Running

Fault Set Conditions (as defined in calibration):

- Throttle command is 20% less than throttle position for 200ms or longer

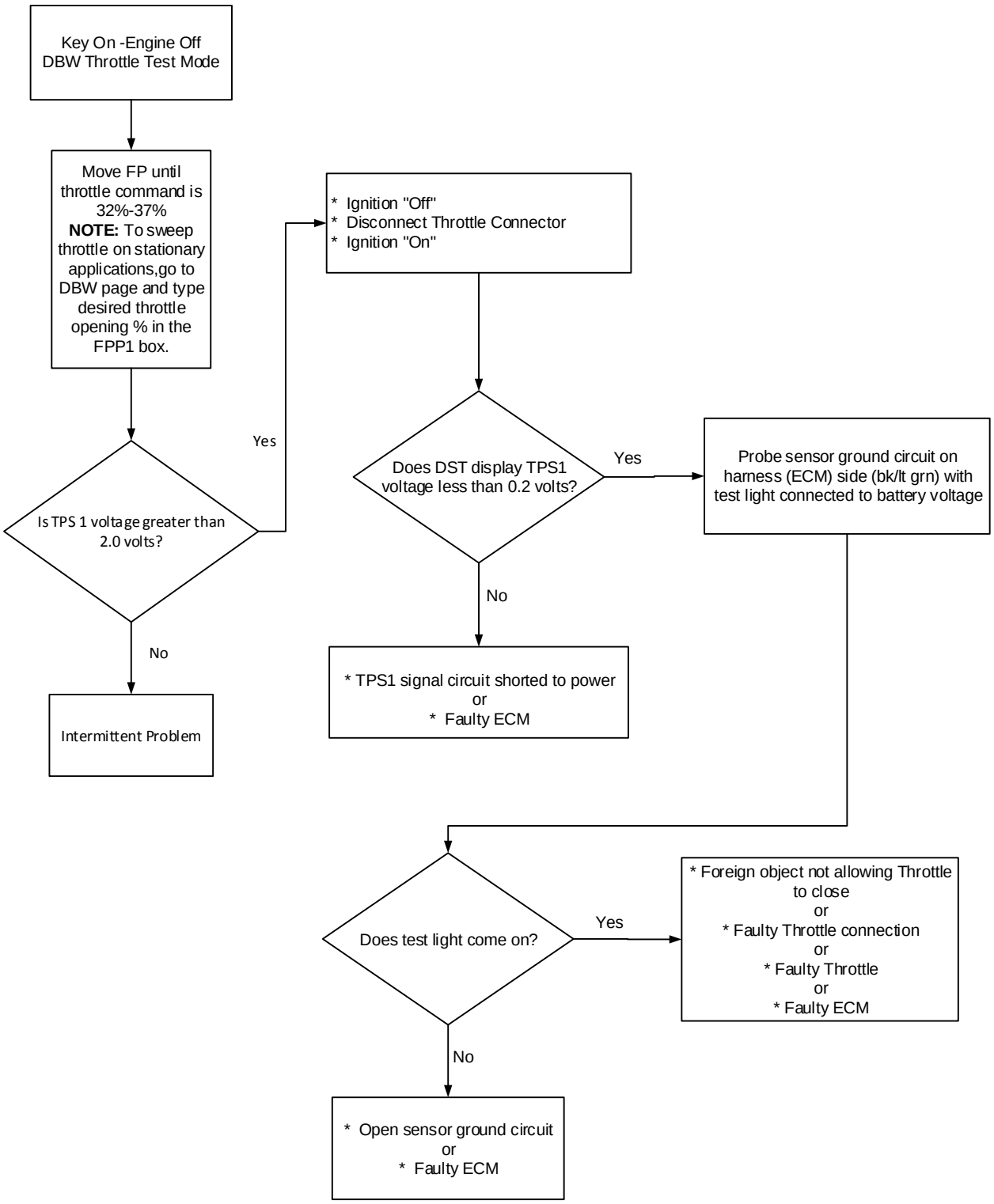
Possible Causes:

This fault will set if the throttle command is 20% less than the actual throttle position. During this active fault the MIL light will be on and the engine will shut down.

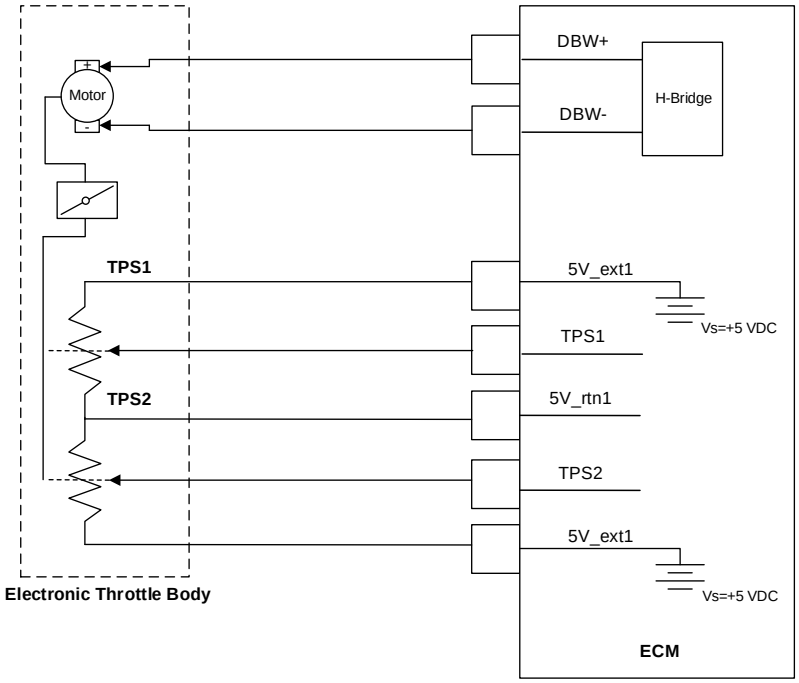
Corrective Actions:

Shutdown	X	CL Disable key cyc.		Power Derate 2		Hard Warning	X
Never Forget		AL Disable		Low Rev Limit		MIL Persist Disable	
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable		Power Derate 1		Soft Warning		NOx Control System	

3.93.1 DTC 2111 - UNABLE TO REACH LOWER TPS (Trouble Tree)



3.94 DTC 2112 - Unable to Reach Higher TPS



DTC	2112	**SPN**	51	**FMI**	7

Sensor/Circuit: Throttle Position Sensor

Description:

There are 2 Throttle Position Sensors located within the throttle which use variable resistors to determine signal voltage based on throttle plate position. TPS1 will read low voltage when closed and TPS2 will read high voltage when closed. The TPS1 and TPS2 percentages are calculated from these voltages. Although the voltages are different, the calculated values for the throttle position percentages should be very close to the same. The TPS values are used by the ECM to determine if the throttle is opening as commanded.

Fault Enabled in Calibration?	**YES**
Emissions-related Fault?	**NO**
Check Condition:	Cranking or Running

Fault Set Conditions (as defined in calibration):

- Throttle command is 20% more than actual throttle position

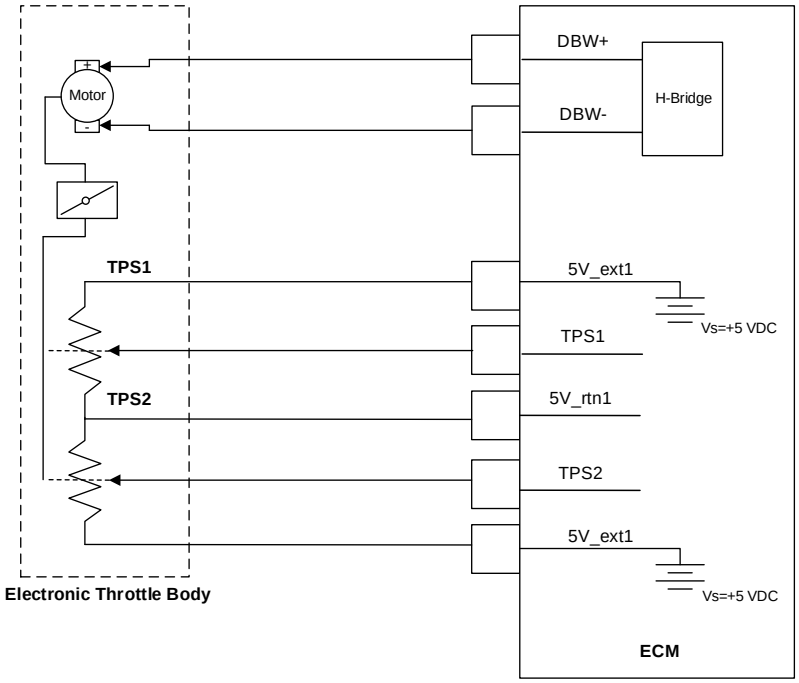
Possible Causes:

This fault will set if the throttle command is 20% or more than the actual throttle position. During this active fault the MIL light will be on and the engine will shut down.

Corrective Actions:

Shutdown	X	CL Disable key cyc.		Power Derate 2		Hard Warning	X
wNever Forget		AL Disable		Low Rev Limit		MIL Persist Disable	
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable		Power Derate 1		Soft Warning		NOx Control System	

3.95 DTC 2135 - Simultaneous Voltages Out of Range



DTC	2135	SPN	51	FMI	31

Hardware/Circuit: Electronic throttle body

Hardware/Circuit Description:

The throttle is an air valve used to control the amount of air available to the engine for combustion and thereby the engine's power output. An electronic throttle simply means that a motor is controlled electronically through an electronic control system to actuate the throttle valve. Electronic throttle control is advantageous because it tends to offer improved starting, improved idle governing, improved maximum speed governing, excellent load acceptance and steady-state speed governing, permits engine synchronization, and offers flexibility to protect the engine during certain fault conditions.

Check Condition:	Key On, Engine On

Fault Set Conditions (as defined in calibration):

• TPS1 voltage >	4.8	volts
or TPS1 voltage <	0.2	volts
AND		
• TPS2 voltage >	4.8	volts
or TPS2 voltage <	0.2	volts

Fault Description:

This fault is generated when both feedback sensors in the ETB (TPS1 and TPS2) simultaneously produce out-of- range faults. This fault indicates that there is no feedback of the throttle valve and as a result throttle control cannot take place. This fault is, and should always be, configured to shut the engine down.

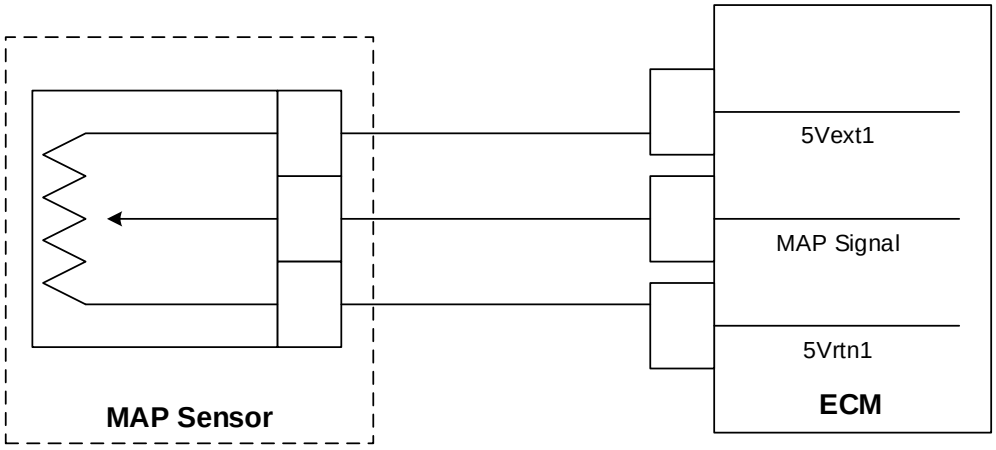
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Corrective Actions:							
Shutdown	X	CL Disable key cyc.		Power Derate 2		Hard Warning	X
Never Forget		AL Disable		Low Rev Limit		MIL Persist Disable	
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable		Power Derate 1		Soft Warning		NOx Control System	

Diagnostic Aids

- ☐ Troubleshoot according to TPS1 voltage out-of-range following DTC 122 and 123 procedures.
- ☐ Troubleshoot according to TPS2 voltage out-of-range following DTC 222 and 223 procedures.

3.96 DTC 2229 - BP High Pressure



DTC	2229	SPN	108	FMI	0

Hardware: Barometric Temperature / Manifold Absolute Pressure Sensor

Hardware Description:

Barometric Pressure is estimated from the MAP sensor at key-on and in some calibrations during low speed/high load operation as defined in the engine's calibration. The barometric pressure value is used for fuel and airflow calculations and equivalence ratio targets based on altitude.

Fault Enabled in Calibration?	**YES**
Emissions-related Fault?	**YES**
Check Condition:	Key On, Engine Off or after BP estimate during low-speed/high load operation

Fault Set Conditions (as defined in calibration):

• BP pressure >	16.50	psia

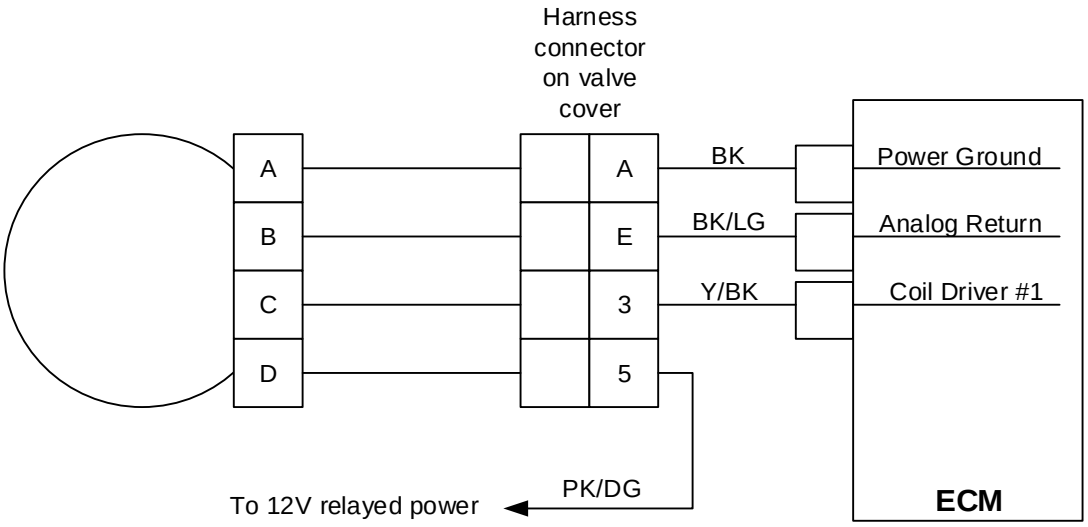
Possible Causes:

This fault sets if the barometric pressure is higher than the maximum pressure (psia) as defined in the diagnostic calibration.

Corrective Actions:

Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	
Never Forget		AL Disable		Low Rev Limit		MIL Persist Disable	
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable		Power Derate 1		Soft Warning		NOx Control System	

3.97 DTC 2300,2303,2306,2309,2312,2315,2318,2321 - Primary Loop Open or Low-Side Short to Ground (Curr. Meas. Reqd) (Cylinder 1-8)

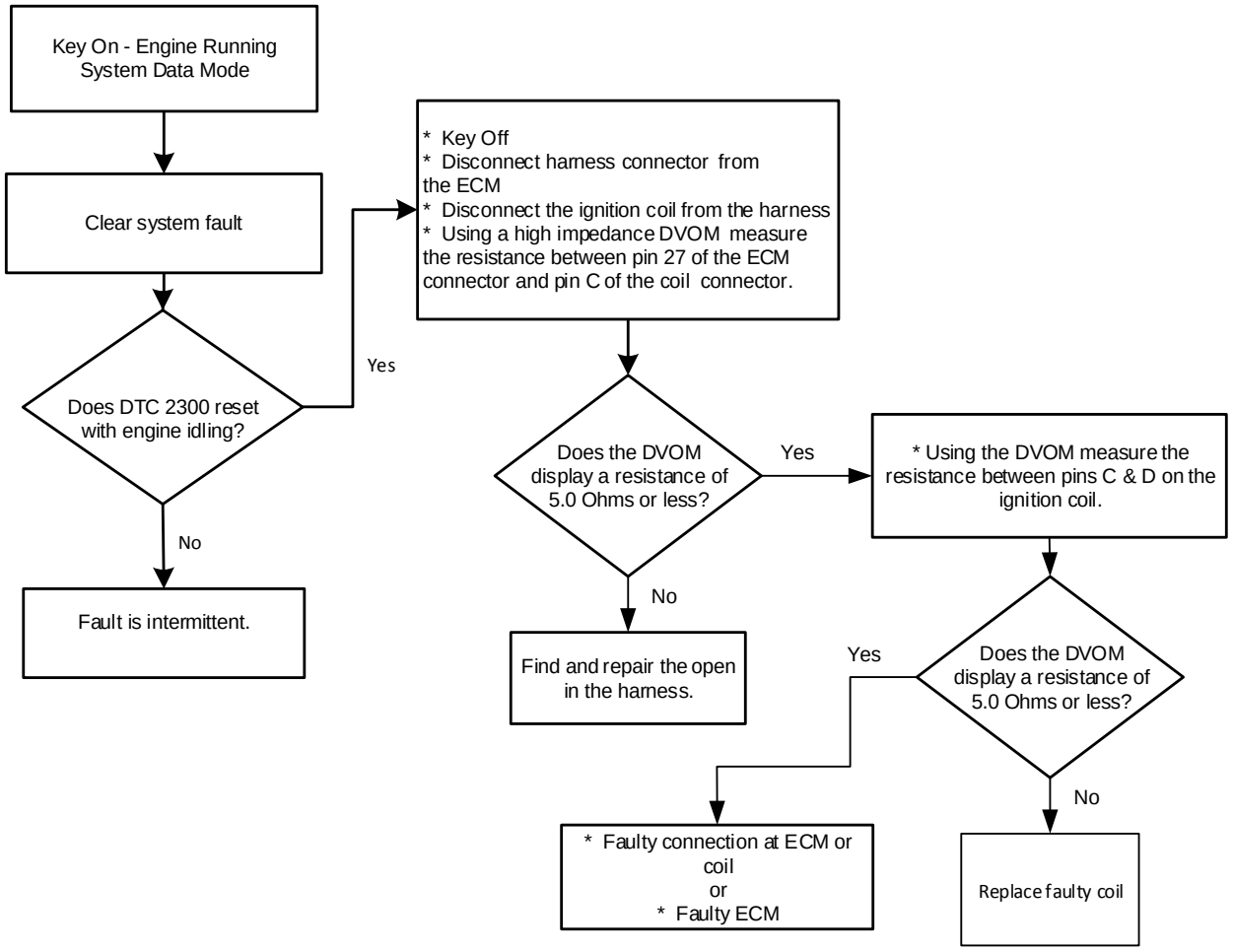


DTC	2300	**SPN**	1268-1275	**FMI**	5
Sensor/Circuit:	Ignition/Spark Coil, cylinder 1-8 (Dumb-coil ONLY)				
Description: Coil driver #1 fires either the 1st cylinder in the firing order or the 1st cylinder in the block order depending on the configuration of the 'Injector/Spark Diagnostic Numbering' scheme as set in calibration. The purpose of this fault is to detect a short-to-ground or open circuit in the harness or internal to the primary coil.					
Fault Enabled in Calibration?	**YES**				
Emissions-related Fault?	**YES**				
Check Condition:	Key On, Engine On				
Fault Set Conditions (as defined in calibration):					
• Diagnose faults while cranking		**Disabled/Enabled**			
• Battery voltage >		11.0	volts		
• Battery voltage <		16.0	volts		
• External spark module voltage >		8.5	volts		
If dwell current control = 'Adaptive Dwell':					
• dwell adjustment >=		1.9	ms		
• or total dwell >=		15.0	ms		
If dwell current control = 'Monitor Only':					
• final current <		0.50	amps		
• and crank dwell (external module only) <		90.0	ms		

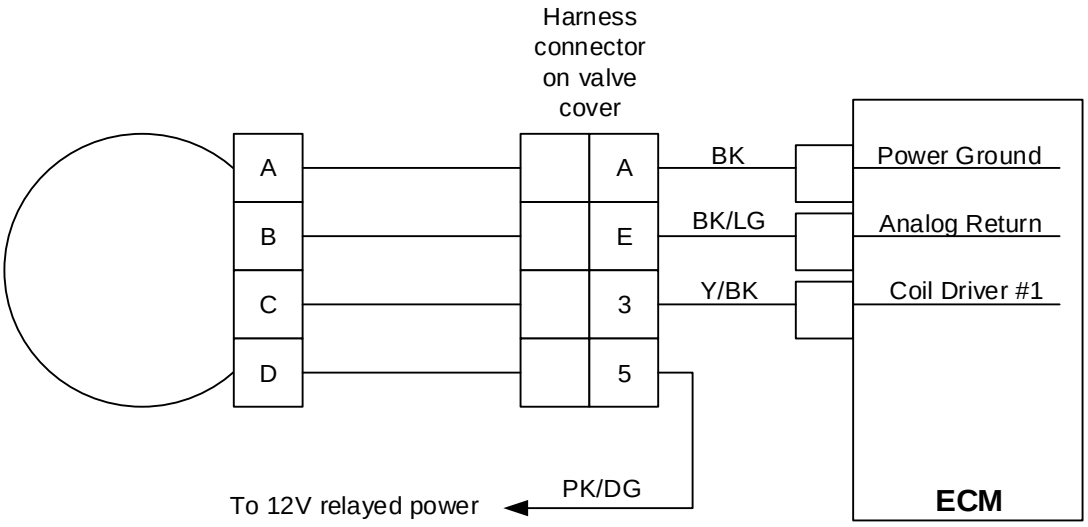
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Possible Causes:							
This fault will set if the ECM detects **x** number of coil firings in which the adaptive dwell adjustment is greater than **y** ms. or the total dwell is greater than **w** ms. and battery voltage is greater than **z** volts as defined in the diagnostic calibration.							
Corrective Actions:							
Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	
Never Forget		AL Disable		Low Rev Limit		MIL Persist Disable	
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable		Power Derate 1		Soft Warning		NOx Control System	

3.97.1 DTC 2300 - Primary Loop Open or Low-Side Short to Ground (Trouble Tree)



3.98 DTC 2301,2304,2307,2310,2313,2316,2319,2321 - Primary Coil Shorted (Current Measurement Required) (Cylinder 1-8)

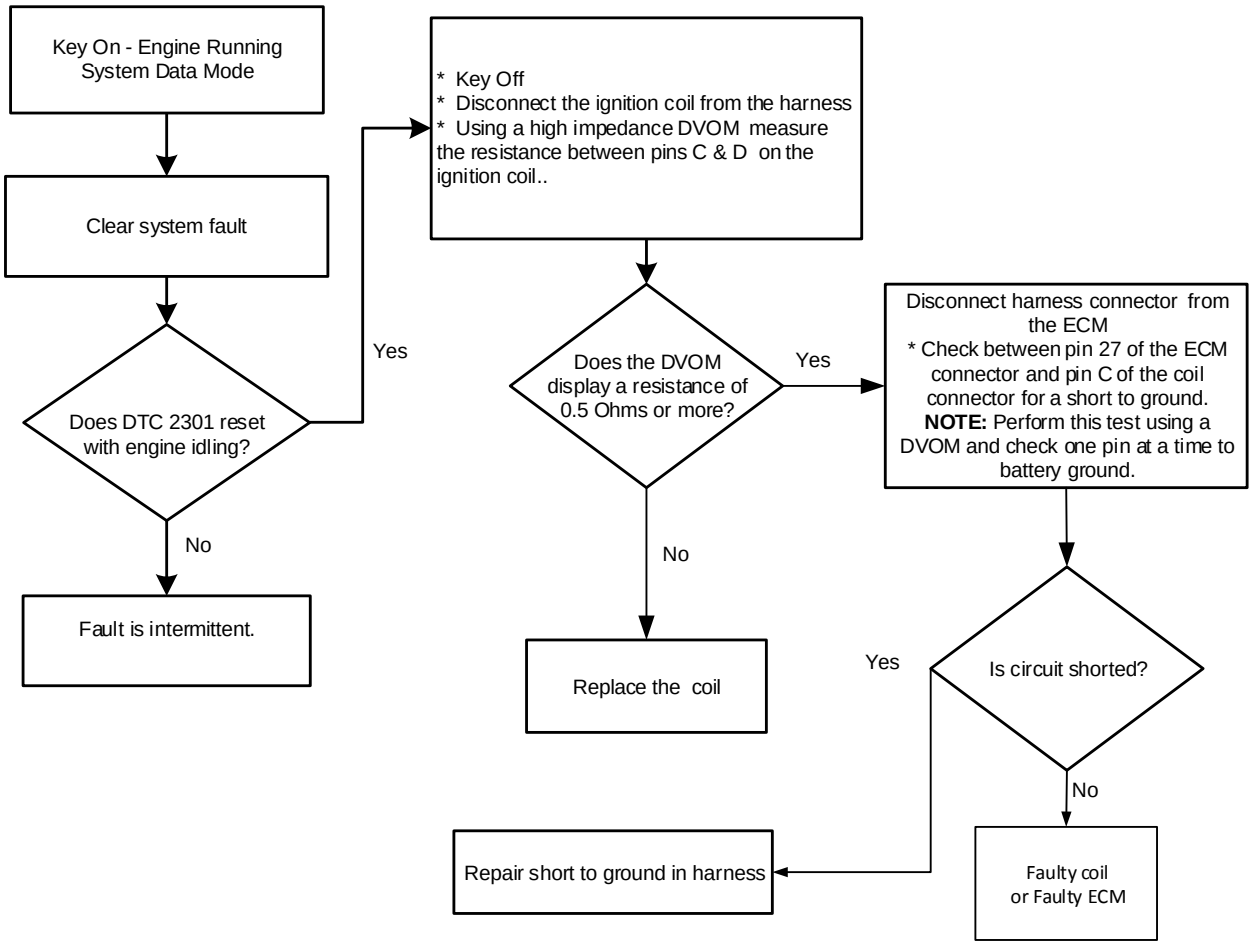


DTC	2301	SPN	1268-1275	FMI	6
Sensor/Circuit:	Ignition/Spark Coil, cylinder 1-8 (Dumb-coil ONLY)				
Description: Coil driver #1 fires either the 1st cylinder in the firing order or the 1st cylinder in the block order depending on the configuration of the 'Injector/Spark Diagnostic Numbering' scheme as set in calibration. The purpose of this fault is to detect a short-to-ground or open circuit in the harness or internal to the primary coil.					
Fault Enabled in Calibration?	**YES**				
Emissions-related Fault?	**YES**				
Check Condition:	Key On, Engine On				
Fault Set Conditions (as defined in calibration):					
• Diagnose faults while cranking			**Disabled/Enabled**		
• Battery voltage >			11.0	volts	
• Battery voltage <			16.0	volts	
• External spark module voltage >			8.5	volts	
If dwell current control = 'Adaptive Dwell':					
• dwell adjustment <=			-1.9	ms	
• or total dwell <=			0.5	ms	
If dwell current control = 'Monitor Only':					
• dwell adjustment <=			5.50	amps	
• or total dwell <=			90.0	us	

(from previous page)

Possible Causes:							
This fault will set if the ECM detects **x** number of coil firings in which the adaptive dwell adjustment is less than **y** ms. or the total dwell is less than **w** ms. and battery voltage is less than **z** volts as defined in the diagnostic calibration.							
Corrective Actions:							
Shutdown		CL Disable key cyc.		Power Derate 2		Hard Warning	
Never Forget		AL Disable		Low Rev Limit		MIL Persist Disable	
Turn on MIL	X	AL Disable key cyc.		Force Idle		Stopped Check	
CL Disable		Power Derate 1		Soft Warning		NOx Control System	

3.98.1 DTC 2301 - Primary Coil Shorted (Trouble Tree)



American Standard Fasteners Torque Specifications													
Size	Assembled into Cast Iron or Steel												Assembled into Aluminum
	Grade 2			Grade 5			Grade 8						
8-32	2.0	Nm	(18 in. lb.)	3.1	Nm	(27 in. lb.)	-						See Note 3
10-24	3.2	Nm	(28 in. lb.)	4.9	Nm	(43 in. lb.)	-						
10-32	3.6	Nm	(32 in. lb.)	5.5	Nm	(49 in. lb.)	-						
12-24	5.0	Nm	(44 in. lb.)	7.7	Nm	(68 in. lb.)	-						
1/4-20	7.6	Nm	(67 in. lb.)	11.6	Nm	(103 in. lb.)	16.5	Nm	(146 in. lb.)				
1/4-28	8.6	Nm	(76 in. lb.)	13.2	Nm	(117 in. lb.)	18.8	Nm	(166 in. lb.)				
5/16-18	15.5	Nm	(137 in. lb.)	24.0	Nm	(212 in. lb.)	33.9	Nm	(300 in. lb.)				
5/16-24	17.1	Nm	(151 in. lb.)	26.4	Nm	(234 in. lb.)	40	Nm	(28 ft. lb.)				
3/8-16	27	Nm	(243 in. lb.)	42	Nm	(31 ft. lb.)	60	Nm	(44 ft. lb.)				
3/8-24	31	Nm	(274 in. lb.)	47	Nm	(35 ft. lb.)	68	Nm	(50 ft. lb.)				
7/16-14	43	Nm	(32 ft. lb.)	68	Nm	(50 ft. lb.)	96	Nm	(71 ft. lb.)				
7/16-20	49	Nm	(36 ft. lb.)	76	Nm	(56 ft. lb.)	107	Nm	(79 ft. lb.)				
1/2-13	66	Nm	(49 ft. lb.)	103	Nm	(76 ft. lb.)	146	Nm	(108 ft. lb.)				
1/2-20	75	Nm	(55 ft. lb.)	117	Nm	(86 ft. lb.)	164	Nm	(121 ft. lb.)				
9/16-12	96	Nm	(71 ft. lb.)	149	Nm	(110 ft. lb.)	210	Nm	(155 ft. lb.)				
9/16-18	107	Nm	(79 ft. lb.)	165	Nm	(122 ft. lb.)	235	Nm	(173 ft. lb.)				
5/8-11	133	Nm	(98 ft. lb.)	206	Nm	(152 ft. lb.)	290	Nm	(214 ft. lb.)				
5/8-18	150	Nm	(111 ft. lb.)	232	Nm	(171 ft. lb.)	328	Nm	(242 ft. lb.)				
3/4-10	-			365	Nm	(269 ft. lb.)	515	Nm	(380 ft. lb.)				
3/4-16	-			405	Nm	(299 ft. lb.)	572	Nm	(422 ft. lb.)				
1-8	-			881	Nm	(650 ft. lb.)	1245	Nm	(918 ft. lb.)				
1-12	-			961	Nm	(709 ft. lb.)	1357	Nm	(1001 ft. lb.)				

Metric Fasteners Torque Specifications, Measured in Nm (ft. lb.)									
Size (mm)	Assemblies into Cast Iron or Steel								Assembled into Aluminum
	Grade 5.8		Grade 8.8		Grade 10.9		Grade 12.9		
Mxxx-04xxx-xx	1.9	(1.4)	2.9	(2.1)	4.3	(3.2)	4.3	(3.2)	See Note 3
Mxxx-05xxx-xx	3.8	(2.8)	5.8	(4.3)	8.5	(6.3)	8.5	(6.3)	
Mxxx-06xxx-xx	6.5	(4.8)	10.4	(7.7)	14.7	(11)	17.6	(13)	
Mxxx-08xxx-xx	16	(12)	25	(17)	36	(26)	43	(31)	
Mxxx-08xxx-xxF	17	(13)	27	(20)	38	(28)	46	(34)	
Mxxx-10xxx-xx	31	(23)	50	(37)	70	(52)	85	(62)	
Mxxx-10xxx-xxF	33	(24)	53	(39)	74	(55)	89	(66)	
Mxxx-12xxx-xx	55	(40)	87	(64)	123	(91)	147	(109)	
Mxxx-12xxx-xxF	60	(44)	95	(70)	134	(99)	161	(119)	
Mxxx-14xxx-xx	87	(64)	135	(103)	196	(145)	236	(174)	
Mxxx-14xxx-xxF	94	(69)	151	(111)	212	(156)	254	(188)	
Mxxx-16xxx-xx	135	(100)	217	(160)	305	(225)	365	(270)	
Mxxx-16xxx-xxF	145	(107)	231	(171)	325	(240)	390	(288)	
Mxxx-18xxx-xx	187	(138)	299	(221)	421	(310)	505	(373)	
Mxxx-18xxx-xxF	210	(155)	336	(248)	473	(349)	567	(419)	
Mxxx-20xxx-xx	264	(195)	423	(312)	595	(439)	714	(526)	
Mxxx-20xxx-xxF	293	(216)	469	(346)	660	(487)	792	(584)	
Mxxx-22xxx-xx	360	(266)	576	(425)	811	(598)	973	(718)	
Mxxx-22xxx-xxF	396	(292)	633	(467)	890	(657)	1068	(788)	
Mxxx-24xxx-xx	457	(337)	731	(539)	1028	(758)	1233	(910)	
Mxxx-24xxx-xxF	498	(367)	797	(588)	1121	(827)	1345	(992)	
Mxxx-27xxx-xx	-		1072	(790)	1507	(1112)	1809	(1334)	
Mxxx-27xxx-xxF	-		1156	(853)	1626	(1199)	1952	(1439)	
Mxxx-30xxx-xx	-		1453	(1072)	2043	(1507)	2452	(1809)	

Notes:

1. The torque values above are general guidelines. Always use the torque values specified in the service manuals and/or assembly drawings when they differ from the above torque values.
2. The torque values above are based on new plated threads. Increase torque values by 15% if non-plated threads are used.
3. At minimum, hardware threaded into aluminum must have two diameters of thread engagement. Hardware threaded into steel and cast iron must have 1.25 diameters of thread.
4. Torque values are calculated as equivalent stress loading on American hardware with an approximate preload of 75% of proof strength and a friction coefficient of 0.2.

Appendix B. Abbreviations

Acronym	Description
AL	Adaptive Learn
BP	Barometric Pressure
CAN	Controller Area Network
CCP	CAN Calibration Protocol
CHT	Cylinder Head Temperature
CKP	Crankshaft Position Sensor
CL	Closed Loop
CNG	Compressed Natural Gas
DBW	Drive-By-Wire
DC	Direct Current
DEPR	Direct-acting Electronic Pressure Regulator
DIG	Digital
DM	Diagnostic Message
DMM	Digital Multi-Meter (high impedance)
DST	Diagnostic Scan Tool
DTC	Diagnostic Trouble Code
DVOM	Digital Voltage and Ohm Meter (high impedance)
ECI	EControls Inc.
ECIPP	EControls Inc. Proprietary Protocol
ECM	Engine Control Module
ECOM	EControls Communication Interface
ECT	Engine Coolant Temperature
ECU	Engine Control Unit
ECM	Electronic Control Module, Engine Control Module
EEPROM	Electrically Erasable Programmable Read-Only Memory
EGO (HEGO)	Exhaust Gas Oxygen Sensor, typically heated
EMWT	Exhaust Manifold Water Temperature
ERWT	Exhaust Manifold Riser Temperature
ETB	Electronic Throttle Body
ETC	Electronic Throttle Control
FDR	Flight Data Recorder
FMI	Failure Mode Indicator
FO	Firing Order
FP	Fuel Pressure
FPP	Foot Pedal Position
FRP	Fuel Rail Pressure
FRT	Fuel Rail Temperature
FSO	Fuel Shut Off
FSS	Fault Snapshot
FT	Fuel Temperature
GCP	Global Control Platform
HDGCP	Heavy-Duty Global Control Platform (On-Road Heavy-Duty)
HEGO	Heated Exhaust Gas Oxygen Sensor (same as HO2S)
HO2S	Heated Oxygen Sensor (same as HEGO)
IAC	Idle Air Control
IAT	Intake Air Temperature
ICAV	Instant Crank Angle Velocity
IVS	Idle Validation Switch
LDGCP	Light-Duty Global Control Platform (Industrial, Smart/Logic Coil)
LED	Light Emitting Diode

Acronym	Description
LPG	Liquefied Propane Gas
MAP	Manifold Absolute Pressure
MDGCP	Medium-Duty Global Control Platform (Industrial, Dumb Coil)
MGCP	Marine Global Control Platform
µP	Microprocessor
Mfg	Manufacture
MIL	Malfunction Indicator Lamp
NG	Natural Gas
OBD	On-Board Diagnostics
OEM	Original Equipment Manufacture
PC	Personal Computer
PCU	Powertrain Control Unit
PD	Pull-down Resistor/Channel
PFI	Port Fuel Injection
PGN	Parameter Group Number
PU	Pull-up Resistor/Channel
PUD	Pull-up/Pull-down Resistor/Channel
PWM	Pulse Width Modulated
RAM	Random Access Memory
RLV	Redundant Lockoff Verification
RPM	Revolutions Per Minute
Rx	Receive
SAE	Society of Automotive Engineering
SA	Source Address
SPFI	Sequential Port Fuel Injection
SPN	Suspect Parameter Number
Tach	Tachometer
TBI	Throttle Body Injection
TBD	To be Determined
TDC	Top Dead Center
TIP	Throttle Inlet Pressure
TMAP	Temperature and Manifold Absolute Pressure
TOP	Turbine Outlet Pressure
TPS	Throttle Position Sensor
TSC	Torque/Speed Control
Tx	Transmit
UEGO	Universal Exhaust Gas Oxygen Sensor (also called wide-range EGO)
USB	Universal Serial Bus
VBat	Battery voltage
VDC	Voltage, Direct Current
VR	Variable Reluctance
Vsw	Switched, Ignition Voltage
WGP	Waste-Gate Pressure

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Original Instructions (English)

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KOHLER CO. Kohler, Wisconsin 53044
Phone 920-457-4441, Fax 920-459-1646
For the nearest sales/service outlet in the
US and Canada, phone 1-800-544-2444
KOHLERPower.com